Potamopyrgus antipodarum 正體中文

System: Freshwater

Kingdom	Phylum	Class	Order	Family
Animalia	Mollusca	Gastropoda	Neotaenioglossa	Hydrobiidae

Common name Jenkin's spire shell (English), New Zealand mudsnail (English)

Synonym *Hydrobia jenkinsi* , (Smith, 1889)
Potamopyrgus jenkinsi , (Smith, 1889)

Similar species

Summary

Potamopyrgus antipodarum is an aquatic snail native to New Zealand that has invaded Australia, Europe, and North America. It can inhabit a wide range of ecosystems, including rivers, reservoirs, lakes, and estuaries. *P. antipodarum* may established extremely dense populations that can comprise over 95% of the invertebrate biomass in a river, alter primary production, and compete with or displace native mollscs and macroinvertebrates. They can spread rapidly in introduced areas and are able to withstand desiccation, a variety of temperature regimes, and are small enough that many types of water users could be the source of introduction to new areas.

[view this species on IUCN Red List]

Species Description

Potamopyrgus antipodarum, the New Zealand mudsnail, is a very small, aquatic snail whose elongate shell consists of 5 to 6 dextral, or right handed, whorls. It is often described as horn colored or light to dark brown. It has an operculum that covers its shell aperture. The average length of *P. antipodarum* is usually 4-6 mm in introduced locations but may reach 12 mm in its native range. Some populations bear a weak keel located mid whorl (Crosier *et al*, undated; Levri *et al*, 2007; NZMS Working Group, 2006; Ponder, 1988; Richards *et al*, 2002; Zaranko *et al*, 1997).

Notes

Potamopyrgus antipodarum was reported in some locations of Europe as *Potamopyrgus jenkinsi* by Smith (1989) (Gaino *et al*, 2008). Non-native populations of *P. antipodarum* are parthenogenetic and consist almost exclusively of female, clonal individuals. In the United States most western populations are a single clone, with a second in a short section of the Snake River, Idaho, and a third in eastern United States (NZMS Working group, 2006).

Lifecycle Stages

Potamopyrgus antipodarum may live more than a year and has been observed to grow at a rate of up to 0.1 mm/day at 21°C in laboratory conditions (Richards *et al*, 2002). It may reach sexual maturity in at 3.0-3.5 mm or in about six to nine months (Crosier *et al*, undated; Richards *et al*, 2002; Dybdahl & Kane, 2005; Moller *et al*, 1994 in Alonso & Castro-Diaz, 2008).

Habitat Description

Potamopyrgus antipodarum is an extremely tolerant species that is capable of inhabiting many aquatic conditions. It colonizes a wide range of habitats including rivers, lakes, streams, estuaries, reservoirs, lagoons, canals, ditches, and even water tanks (Brown *et al*, 2008; Crosier *et al*, undated). Reported depths range from 4-25, even 45 meters, but it most often occurs in the littoral zone and moderate depths of around 10 m (Cejka *et al*, 2008; Zaranko *et al*, 1997; Grigoorvich *et al*, 2003). *P. antipodarum* tolerates a wide range of temperatures, salinities, trophic conditions, water conditions, and current speeds (Gaino *et al*, 2008; Levri *et al*, 2007; Crosier *et al*, undated). It may occupy silt, sand, mud, concrete, vegetation, cobble, and gravel (Crosier *et al*, undated; Richards *et al*, 2002). Its densities are reported highest in systems with high primary productivity, constant temperatures, cobble substrate, and constant flow (Richards *et al*, 2002; Holomuzki & Biggs, 2007), and it thrives in disturbed watersheds (Cejka *et al*, 2008). Its upper thermal limits are around 28°C and lower limits are around freezing (Crosier *et al*, undated). It may reproduce at salinities of 0-15 ppt and tolerate 30-35 ppt for short periods of time (Cejka *et al*, 2008). It can withstand moderate desiccation and drought for several days (National Park Service, undated; Gaino *et al*, 2008).

Reproduction

Within its native range *Potamopyrgus antipodarum* reproduces sexually and asexually while non-native populations are parthenogenetic and consist almost exclusively of triploid females (Alonso & Castro-Diaz, 2008; Lively, undated). Reproduction is ovoviviparous and offspring are brooded by females in a brood pouch until they reach a mobile stage (Alonso & Castro-Diaz, 2008). Broods are reported to range from 20-120 embryos per female and they produce an average of 230 juveniles per year (Richards *et al*, 2002; Alonso & Castro-Diaz, 2008). *P. antipodarum* may reproduce year-round in favorable conditions, but the majority of its reproduction occurs in the spring and summer (Crosier *et al*, undated; Richards *et al*, 2002).

Nutrition

Potamopyrgus antipodarum grazes on periphyton, diatoms, and plant and animal detritus (Richards *et al*, 2002; Alonso & Castro-Diaz, 2008; Brown *et al*, 2008; Levri *et al*, 2008).

General Impacts

Potamopyrgus antipodarum may establish very dense populations, consume large amounts of primary production, alter ecosystem dynamics, compete with and displace native invertebrates, and negatively influence higher trophic levels. Its ecological plasticity, high competitive ability, high reproductive rate, high capacity for various dispersal methods, and ability to avoid predation make it a formidable colonizer capable of establishing abundant populations with significant effects on ecosystems (Alonso & Castro-Diaz, 2008). *P. antipodarum* and its impacts are similar to that of the extremely problematic invasive Zebra Mussel (*Dreissena polymorpha*) (National Park Service, undated).

P. antipodarum can establish extremely dense populations of tens to hundreds of thousands of individuals per square meter in introduced environments. In Australia densities of 50,000 snails/m2 have been recorded (Ponder 1988; Schrieber *et al*, 1998). In the United States densities of 200,000, 500,000 and even 800,000 snails/m2 have been recorded in several locations (Davidson *et al*, 2008; Dorgelo, 1987 in Brown *et al*, 2008; Crosier *et al*, undated; Hall *et al*, 20003; Levri *et al*, 2007).

These large populations undoubtedly have significant effects on ecosystems. *P. antipodarum* can consume up to 75% of gross primary production, dominate secondary production by composing up to 97% of invertebrate biomass, and excreting 65% of total NH4 thereby dominating C and N cycles as in the case of Polecat Creek, Wyoming. Its secondary productivity is one of the highest ever reported (194 g AFDM m-2 yr-1), being 7–40 times higher than that of any macroinvertebrate in Greater Yellowstone area (Hall *et al*, 2003; Hall *et al*, 2006; Richards *et al*, 2002). Such alteration of ecosystems likely results in far reaching cascading ecological impacts (Crosier *et al*, undated; Davidson *et al*, 2008; Alonso & Castro-Diaz, 2008). It has also been indicated that it may increase CO2 levels by precipitating calcium bicarbonate to calcium carbonate to produce shells (Chavaud *et al*, 2003 in NZMS Working Group, 2006).

P. antipodarum may displace, inhibit growth in, and compete with native invertebrates for resources in introduced locations (Alonso & Castro-Diaz, 2008; Cowie *et al*, 2009; Davidson *et al*, 2008; Hall *et al*, 2006; Kerans *et al*, 2005). High densities of *P. antipodarum* were believed to have negative interactions with native macroinvertebrates in several locations in Montana (Kerans *et al*, 2005). In the Snake River, Idaho, its site of initial introduction in the United States, it is believed to be a major cause of five species of native mollusks recently becoming endangered (Crosier *et al*, undated). This includes the endangered hydrobiid snail *Taylorconcha serpenticola* (Richards *et al*, 2004 in Brown *et al*, 2008). It is believed to limit absolute growth and the growth rate of the native desert valvata snail (*Valvata utahensis*) in the Snake River as well (Lysne & Koetsier, 2008). It dominates the Mont Saint-Michael Bay in western France and represented 80% of gastropods collected from all sites (Gerard *et al*, 2003). Similarly, *P. antipodarum* made up 83% of the mollusk community in a reservoir near an industrial area in Poland (Lewen & Smolski, 2006). *P. antipodarum* has been found to significantly inhibit growth in endemic snail *Pyrulopsis robusta* in Polecat Creek, Wymoing (Riley *et al*, 2008). A negative correlation has been demonstrated with *P. antipodarum* and important invertebrate species mayflies, stoneflies, caddisflies, and chironomids (Crosier *et al*, undated). It has also been to have a negative correlation with native hydrobiid snails in Tasmania (Poner, 1988).

P. antipodarum directly affects fish by being a poor and mostly un-digestible food source. Although rainbow trout *Onchorynchus mykiss* and brown trout *Salmo trutta* were found to feed on *P. antipodarum* in a study, about 80% of those consumed passed through their system undigested (NZMS Working Group, 2006). Not only does *P. antipodarum* replace energetic food sources, but it is believed to inflict poor health and reduce survivorship in fish that consume it based the significantly worse condition of fish with *P. antipodarum* in their guts (Vinsen & Baker, 2008). These direct as well as indirect impacts on fish by *P. antiopdarum* threaten fisheries in locations where it has established.

Additionally, *P. antiopdarum* has fouling potential as it is known to pass through water pipes, emerge from domestic traps, and may block water pipes, meters, or irrigation systems (Ponder, 1988; Cotton, 1942 in Zaranko, 1997; NZMS Working Group, 2006). *P. antipodarum* has also been found to be infected by blood fluke *Sanguinicola* sp. in Europe and represents a possible vector to new locations (Gerard & LeLannic, 2003).

Management Info
Preventative measures: Once *Potamopyrgus antipodarum* establishes eradication is improbable in most locations and often impractical in those where possible. Prevention of its introduction and containing existing populations is important for minimizing its spread and impacts. Its populations are likely to expand throughout its introduced range. The present distributions of *P. antipodarum* in North America and Australia specifically are predicted to expand. In North America, it is believed to continue to spread through western watersheds and in the Great Lakes. If it reaches the rivers of the Mississippi basin, it will spread rapidly and abundantly. In Australia it is thought to continue to spread along the east coast and may establish in the southwest if a suitable vector is provided (Loo *et al*, 2007a).
Educating anglers, hunters, boaters, aquaculturalists, and the general public about *P. anitpodarum*, methods of its spread, its potential impacts, and control methods is important. Because its spread to new locations is the result of human activity public awareness about *P. antipodarum* is necessary. The expansion of present efforts and new initiatives to slow the spread of *P. antipodarum* by environmental and governmental agencies such as the National Parks Service is essential to conservation (NZMS Working Group, 2006).
Local and federal governments should also take steps to legally prohibit the importation, possession, and transport of *P. antipodarum*. In the United States California, Colorado, Kansas, Montana, Utah, Washington, and Wyoming have already done so, while Alaska, Hawaii, Idaho, Nevada, Oregon require prior authorization for its importation, possession, or transport. Colorado and California quarantined and closed fishing access to certain locations in attempts to curb its spread. Alaska, Hawaii, Indiana, Kansas, Montana, Oregon, and Washington have all developed state aquatic nuisance management plans that include *P. antipodarum* (NZMS Working Group, 2006).
Transportation via contaminated aquatic equipment, such as wading gear, is a major method of spread of *P. antipodarum* (Crosier, undated; Davidson *et al*, 2008; Richards *et al*, 2004; NZMS Working Group, 2006). Several methods of removing *P. antipodarum* have been recommended including desiccation, heating, freezing, washing, and chemical treatment. The laying out and drying of equipment at 30ºC for at least 24 hours or at 40ºC for 2 hours has proven effective (Davidson *et al*, 2008; Richards *et al*, 2004; Crosier *et al*, undated). Submerging it in water at about 50 ºC for a few minutes is also effective as *P. antipodarum* can survive at 43 ºC for short periods (Medhurst, 2003 in NZMS Working Group, 2006). Freezing gear for 6-8 hours will also kill *P. anitpodarum* (Davidson *et al*, 2008; Richards *et al*, 2004; Medhurst, 2003 in NZMS Working Group, 2006). Scrubbing and thoroughly rinsing may effectively remove it as well (Crosier *et al*, undated). Finally, chemical treatment is also effective. Benzethonium chloride, chlorine bleach, Formula 409, Pine-Sol, ammonia, and copper sulfate all effectively kill *P. antipodarum*. However, bleach and Pine-Sol were found to damage some materials. The use of copper sulfate, benzethonium chloride, or Formula 409 disinfectant immersion baths or in dry sacks are believed to provide the most acceptable chemical methods of removing *P. antipodarum* (Hosea & Finlayson, 2005).
Ballast water and hull fouling is believed to be the most common vector of introducing *P. antipodarum* to new locations (Alonso & Castro-Diaz, 2008). Adhering to local, federal, and international ballast water regulations such as those provided by GloBallast is essential to reducing the discharge of contaminated ballast water and helping prevent the establishment of *P. antipodarum* (NZMS Working Group, 2006). Although due to its very small size, it may not be practical to clean *P. antipodarum* off of large hulls or recreational craft in every instance, promoting information and resources to clean water craft before existing certain contaminated sites would help reduce its spread. Additionally, the cleaning of anchors may also reduce its spread (NZMS Working Group, 2006).
Physical: Control of *P. antipodarum* is possible in certain isolated locations such as small lakes, ponds, irrigation canals, and fish hatcheries. Draining waters and allowing substrate to heat and dry completely in the summer or freeze in the winter will kill *P. antipodarum*. Irrigation canals are routinely shut down for plant control and may be treated for snails as well (NZMS Working Group, 2006). The use of flame throwers on the walls and raceways has been effectively employed in hatcheries (Richards *et al*, 2004; Dwyer *et al*, 2003 in NZMS Working Group, 2006). It has also been suggested that barriers such as copper stripping or electrical weirs may limit the movement of *P. antipodarum* particularly in keeping it from high risk areas (NZMS Working group, 2006).
Chemical: Chemical treatment of aquatic systems poses risks to surrounding drainages and native species. Small lakes and ponds may be isolated from drainages may isolated from drainages for chemical treatment. Chemical methods used to eradicate *P. antipodarum* include: Bayer 73 copper sulfate, and 4-nitro-3-trifluoromethylphenol sodium salt (TFM). The only molluscicide known to have been tested against *P. antipodarum* is Bayluscide (a.i. niclosamide). This test, conducted by Montana Fish, Wildlife, and Parks (FWP), was conducted in small spring creek along the lower Madison River. One hundred percent mortality was achieved after 48 exposure units, which consisted of 1 ppm Bayluscide for 1 hour (Don Skarr, Montana FWP, personal communication in NZMS Working Group, 2006).
Application of GreenClean® PRO, a non-copper-based algaecide, was found to be an effective means to prevent and possibly eliminate *P. antipodarum* in the lab. Mortality was 100% within 72 hours of exposure to a 0.5% concentration for 2 and 4 minutes, 1% concentration for 30 seconds, and minimum of 0.33% concentration for 8 minutes. Mortality was also 100%, 48 hours after exposure to a 4% concentration for 2 minutes and 0.55% concentration for 8 minutes. Although effective in the lab, its effectiveness in the remains uncertain (NZMS Working Group, 2006).
Biological control: Parasites of *P. antipodarum* are another potential method of control. Studies of the efficacy and specificity of a trematode parasite from its native range as a biological control have demonstrated promising results ((Dybdahl *et al*. 2005 in NZMS Working Group, 2006; Emblidge and Dybdahl *in prep* in NZMS Working Group, 2006). Also the parasite *Micophallus* sp. has been found to highly specific and effective in most genotypes of *P. antipodarum* including those in the western US (Dybdahl and Lively, 1998 in NZMS Working Group, 2006; Dybdahl & Lively, 1998 in NZMS Working Group, 2006).
Integrated management: An integrated management and control plan for *P. antipodarum* should be implemented in locations that are colonized and those that may potentially be invaded. This plan should include preventive measures, public education, monitoring, and appropriate treatment to slow its spread and eradicate where possible and practical. Plans should account for the specific needs of individual locations and follow the guidelines provided by the Aquatic Nuisance Species Task Force (ANSTF) (NZMS Working Group, 2006).

Pathway
The most frequently cited method of long distance dispersal of *Potamopyrgus antipodarum* is through ship ballast water (Alonso & Castro-Diaz, 2008).

Principal source: New Zealand Mudsnail Management and Control Working Group, 2006. National Management and Control Plan for the New Zealand Mudsnail (*Potamopyrgus antipodarum*) DRAFT. Prepared for the Aquatic Nuisance Species Task Force by the New Zealand Mudsnail Management and Control Plan Working Group Draft August 2006
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Compiler: National Biological Information Infrastructure (NBII) & IUCN/SSC Invasive Species Specialist Group (ISSG)

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ALIEN RANGE

[1] ATLANTIC - NORTHEAST
[4] AUSTRALIA
[1] AUSTRIA
[1] BELARUS
[1] BELGIUM
[1] CANADA
[1] CZECH REPUBLIC
[1] DENMARK
[1] ESTONIA
[1] FINLAND
[1] FRANCE
[1] GERMANY
[1] GREECE
[1] IRAQ
[1] ITALY
[1] JAPAN
[1] LAKE ERIE
[1] LAKE ONTARIO
[1] LAKE SUPERIOR
[1] LATVIA
[1] LEBANON
[1] LITHUANIA
[2] MEDITERRANEAN & BLACK SEA
[1] NETHERLANDS
[1] NORWAY
[1] POLAND
[1] ROMANIA
[1] RUSSIAN FEDERATION
[1] SLOVAKIA
[1] SLOVENIA
[1] SPAIN
[1] ST. LAWRENCE RIVER
[1] SWEDEN
[1] SWITZERLAND
[1] TURKEY
[1] UKRAINE
[5] UNITED KINGDOM
[11] UNITED STATES

Red List assessed species 4: CR = 1; EN = 2; VU = 1;

Alzoniella delmastroi **EN**
Dianella thiesseana **CR**
Pseudamnicola gasulli **VU**
Salenthydrobia ferrerii **EN**

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Managment information
Aquatic Invaders of Belarus., 2007. Alien Species Database *Potamopyrgus antipodarum*
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/.
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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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Spanish:
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