Australian Government

Department of the Environment and Energy

Department Risk Analysis

Application to add *Oncomelania hupensis quadrasi* (a freshwater snail) to the Environment Protection and Biodiversity Conservation Act 1999 *List of Specimens taken to be Suitable for Live Import*

August 2018

Introduction

Purpose of the proposed import

The purpose of the application is to allow the importation of wild strains of the freshwater snail, *Oncomelania hupensis quadrasi* from the Philippines to the Queensland Institute of Medical Research Berghofer Medical Research Institute. QMRI Berghofer have been using *O. h. quadrasi* in conjunction with mice for the maintenance of the human parasite *Schistosoma japonicum* for the past 25 years. This importation is necessary to source infected snails from wild populations to ensure the lab stocks do not become less pathogenic than endemic strains of the parasite.

Schistosomiasis or Bilharzia is caused by parasitic trematode worms of the genus *Schistosoma* with about 200 million people infected in 74 countries. In terms of impact the disease is second only to malaria as the most devastating parasitic disease (CDC, 2018).

Five species of shistomes infect humans, *Schistosoma japonicum, Schistosoma mansoni, Schistosoma mekongi, Schistosoma intercalatum, and Schistosoma haematobium.* Schistosomiasis caused by the parasitic blood fluke *Schistosoma japonicum* is transmitted to humans by the *Oncomelania* genus of freshwater snails (Attwood *et al.*, 2015). Approximately five million individuals are at risk of infection and close to one million are currently infected with *Schistosoma japonicum* (Olveda *et al.,* 2014).

The parasite cannot be cultivated in vitro and must be maintained through snail and mammalian hosts as part of its lifecycle. The snails are to be imported into a secure research facility and not for general importation.

Background

Under s303EC of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the responsible Minister may amend the *List of Specimens taken to be suitable for live import* (Live Import List) by including a specimen on the list. There are two parts to the List - Part 1 comprises specimens that can be imported without a permit under the EPBC Act. Part 2 comprises specimens that require a permit under the EPBC Act to be imported. Import restrictions generally apply to the species listed on Part 2, such as ‘for research only’ and ‘high security facilities only’. Additional conditions may also be applied when the permit for import is issued.

Before amending the Live Import List, the Minister must consult with appropriate agencies and other persons, and consider a report assessing the potential environmental impacts of the proposed amendment. When submitting an application to the Department to amend the Live Import List, all applicants are required to provide an accompanying report that addresses specific terms of reference. The Department undertakes a risk assessment using the information in the applicant’s report and any other sources of relevant information. The Department also considers comments and information received through the public consultation process (including states and territories). The application and accompanying report for the proposed import of *O. h. quadrasi* was released for public comment in November 2017.

Biology and Ecology of *Oncomelania hupensis quadrasi*

Snail description

Oncomelania hupensis is the intermediate snail host of *S. japonicum* and is comprised of seven subspecies. (Li *et al.,* 2009). *O. hupensis* is mostly found in China, Indonesia and the Philippines (Cheng *et al.,* 2016). The average female length is about 4.75 mm compared with males at 4 mm (McMullen, 1947).

Oncomelania hupensis quadrasi are a small, sexually dimorphic freshwater snail (Pesigan et al., 1958). They are only found in the Philippines with the islands of Leyte, Mindanao and Samar forming the bulk of the endemic regions for schistosomiasis (Olveda *et al.,* 2014).

The snail is a herbivore which feeds predominately during daylight on green algae and diatoms with the diet reflecting the types of vegetation found in the area. They may also eat desmids and euglenoids and vegetative detritus (Dazo and Moreno, 1962). They are not described as a pest species or having any negative environmental impacts in their native ranges.

Life cycle

Breeding is stimulated by rainfall with eggs being laid singly on solid objects mostly above the water line (Pesigan *et al.,* 1958). Depending on the temperature, hatching occurs after 10–25 days, with the newly-hatched snails passing through an aquatic life stage of about one to two weeks. Snails reach sexual maturity after 10–16 weeks and may live for 24–35 weeks (Pesigan *et al.,* 1958).

While rainfall events act as breeding triggers, human-initiated disturbances, such as rice paddy flooding and releases from small reservoirs can also induce breeding (Remais *et al.,* 2007).

Females can store sperm and produce viable eggs for up to 3 months post mating with the average female producing about 26 eggs during its adult life. (Pesigan *et al.,* 1958).

Climate

In the Philippines, the snails are confined to areas with no distinct dry season (Olveda *et al.*, 2014) inhabiting flat areas where water is retained (Pesigan *et al.,* 1958). Abundance is linked to wet areas such as swamps, creeks and rice fields but maybe found in areas of stagnant or active water flow such as drains (Dazo and Moreno, 1962).

O. hupensis snails are highly sensitive to seasonal weather conditions, including temperature flooding, and humidity. Adult snails are not highly susceptible to scouring flood flows but suffer from desiccation or stranding under dry conditions (Remais, *et al.,* 2007). The snails are generally found in areas with an annual rainfall greater than 750 mm with a range of 802.9 mm–1192.2 mm rain/year being optimal. Rainfall above or below this range inhibits breeding. Although land surface temperatures higher than 19ºC, can inhibit the growth of snails it has been shown land temperatures are a poor predictor of range (Cheng *et al.,* 2016).

A more accurate predictor of climatically suitable range is water temperature. Surface water temperature ranges between 27 to 30º C and sediment temperature ranges of 25.3 to 28.3ºC have been found to correlate to the highest snail populations (Legaspino *et al.,* 2014). The minimum temperature needed for parasite development is > 15.4°C (King, 2008) It is predicted that as global warming progresses, more areas currently deemed as marginal for snail and

schistosome habitat are expected to become recognized transmission zones due to increased “accumulated degree-days” necessary for parasite development and transmission (King, 2008). The physiological tolerance of the snail is 5.8ºC (Zhou *et al.,* 2008).

Environment

The preferred habitat of *O. h. quadrasi* is flood plains, swamps and flooded forests (Pesigan *et al.,* 1958). Drainage channels, small canals, roadside ditches are important habitats, particularly in terms of schistosomiasis transmission (Legaspino *et al.,* 2014). Snails are found primarily on the banks but some are also found in very shallow water less than 20 cm deep. *O. h. quadrasi* has preference for areas shaded by vegetation, where the water temperature is relatively constant and cool (Madsen *et al.,* 2008). Although important in disease transmission, rice fields do not provide optimal habitat for *O. h. quadrasi* due to their instability in terms of vegetation, water levels and disturbance (Legaspino *et al.,* 2014). The snails have a low tolerance for turbidity or stagnant water but prefer sluggish water flows over faster moving water (Pesigan *et al.,* 1958)

An important characteristic of the snail habitat is that it never dries out for any length of time. Permanent water appears to be the most important habitat requirement for *O. h. quadrasi* (Pesigan *et al.,* 1958). Flooding has been shown to disperse the snails into new areas (Zhou *et al.,* 2008).

Species infected

The parasite, *Schistosoma japonicum,* is highly host specific with the Philippine strain of the parasite only being maintained and spread via *O. h. quadrasi* snails. The Chinese strain of *S. japonicum is* carried by *O. h. hupensis,* the Japanese strain by *O. h. nosophora*, and the Taiwanese strain by *O. h. formosa* (DeWitt, 1954). This intimate parasite - snail relationship means that there is limited ability for strains of the parasite to exist in other sub species of *O. hupensis* or other snail species. The Philippine strain of *S japonicum* when exposed to *O. h. hupensis* and *O. h. nosophora* only infected 20 and 9.6 percent of snails respectively. (Hsű and Hsű, 1960).

A wide variety of mammals (up to 28 genera and 7 orders) have been found to be definitive hosts for schistosomiasis. The faeces of these species contain the *S. japonicum* miracidia which infect the snails (McGarvey *et al.,* 2006). Surveys of *S. japonicum* endemic areas of the Philippines showed dogs, cats, pigs, rats, and buffalo as animal vectors of *S. japonicum*, with a direct relationship between dog and cat infections and the prevalence of human infections (McGarvey *et al.,* 2006).

Other studies found that rats contribute significantly to contamination of the environment with *S. japonicum* eggs, with up to 95% of rats (Madsen *et al.,* 2008) 14.9% of dogs and 2% of buffalo being found to be infected (Rudge *et al.,* 2008).

Establishment

No members of the *Oncomelania* genus have been reported in Australia (Ponder *et al.,* 2016; ALA, 2018). No snail species found in Australia have been identified as transmitting any of the *Schistosoma* parasites (Lu *et al.,* 2018). *O. hupensis* has also been reported as carrying and transmitting *Angiostrongylus cantonensis* (Rat Lungworm) (Lu *et al.,* 2018). *A. cantonensis* is

present in Australia (ALA, 2018) with human infections reported (Lu *et al.,* 2018). The subspecies of *O. hupensis* was not identified so it is unknown if *O. h quadrasi* could be a vector for the tapeworm in Australia if introduced.

Importation of *O. h. quadrasi* would be subject to approval by the Commonwealth Department of Agriculture and Water Resources.

Related Live Import List listings

Oncomelania hupensis hupensis was added to Part 2 the Live Import List prior to 2005 with the conditions: Research only. High Security Facilities.

Three strains of *Schistosoma* (*S haematobium, S, japonicum* and *S. mansoni*) are listed on Part 2 of the Live Import List under 'Research only. High security facilities only'.

Conservation status

O. h. quadrasi is not listed on the IUCN Red List (Rintelen, 2011) or the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES, 2018) list. The species is not listed on the EPBC Act Live Import List.

Risk assessment

Assessing the risk of the potential of introducing a new organism into the environment involves assessing the risk of it becoming established and spreading and the likely impacts if establishment occurred.

There are no accepted risk assessment models that can be used to calculate the establishment risk of invertebrates in Australia. Bomford (2008) found that for vertebrates, the level of risk can be assumed in accordance with the four key factors of establishment success. These factors are:

- Propagule pressure – the release of large numbers of animals at different times and places enhances the chance of successful establishment
- Climate match – introduction to an area with a climate that closely matches that of the species' original range
- History of establishment elsewhere – previous successful establishment
- Taxonomic group – belonging to a family or genus which has a high establishment success rate.

Although these factors apply to vertebrates, they have been used as a guide for this risk assessment of *O. h. quadrasi*. In addition, using the information compiled from research into the above factors for *O. h. quadrasi*, the potential impacts of establishment of feral populations can also be assumed.

Risk of establishment

Propagule pressure – the release of large numbers of animals at different times and places

The potential listing of *O. h. quadrasi* would be for research purposes in secure facilities only. This means all imports would be subject to an import permit which would limit the numbers of the snails imported.

The likelihood of escape of specimens from the nominated accredited biosecure facility is negligible. Quarantine facilities are required to have security measures in place to ensure that the movement of specimens in and out of the facility are tightly controlled and these measures should negate any chance of the specimens escaping.

The applicants have maintained the *O. h. quadrasi* snails for 25 years and last imported the snails in 1999. Strict and diligent controls on the *Oncomelania* snails and the *Schistosoma* parasites have ensured that there has been no release of live snails or viable tissue.

As the importation of the species would be restricted to research purposes only and the specimens will be kept in an accredited biosecure facility, all waste would be treated to a standard well beyond that which would kill all eggs or larvae. A one-off deliberate or accidental release is unlikely and multiple releases would be highly improbable.

O. h. quadrasi is dioecious with separate male and female individuals so both sexes would need to be released together for them to able to potentially reproduce. This would further lower the propagule pressure risk.

Climate match – introduction to an area with a climate that closely matches that of the species' original range

The native range of *O. h. quadrasi* in the Philippines is limited to areas providing the specific environmental requirements of the species. Many areas in the Philippines do not meet one of these requirements and as a result the snails have not established. This means the species is climatically constrained in its home range even on a local scale. There are no records of the snail establishing outside its native range.

The Climatch model commonly used for determining potential regions where the proposed species may establish was not conducted. The literature shows that water temperatures are more critical than air temperatures for predicting the range of *O. h. quadrasi* (Cheng *et al.,* 2016). As Climatch uses air temperatures, it is unsuited for predicting where *O. h. quadrasi* may establish in Australia.

Given the snails preference for warm shallow permanently flooded areas with aquatic vegetation, it is possible the snail might find suitable habitats in parts of the tropical regions of Queensland and the Northern Territory if they were released. A study of potential invasive snails in the USA found that snails of the *Pomatiopsidae* family, of which *O. h. quadrasi* is a member, posed no threat as it was assessed that their ecological requirements probably could not be met in the United States (Cowie *et al.,* 2009).

History of establishment elsewhere – previous successful establishment

There is no evidence showing the species has established outside its native range in the Philippines (Rintelen, 2011; Cowie *et al.,* 2009).

Taxonomic group – belonging to a family or genus which has a high establishment success rate

There is no evidence that the *Oncomelania* genus has established outside their native range. (Rintelen, 2011; Cowie *et al.,* 2009).

Potential impacts of established feral populations

The Global Invasive Species Database (2018) does not list any member of the *Oncomelania* genus as being invasive. The related snail *O. h. hupensis* is listed on the Live Import List, with no reports of the species escaping captivity and forming feral populations.

The main threat of *O. h. quadrasi* establishing in Australia would be as a potential carrier of Schistosomiasis. As none of the strains of Schistosomiasis are present in Australia, it is unlikely that the parasite and snail would be present simultaneously in the environment to propagate the disease. Given the parasites life cycle it is also highly unlikely it could complete its life cycle in Australia even if schistosomiasis infected snails were released into the environment and they managed to establish (Applicant report).

It is possible that if the snails were to establish they may compete with other native snails or invertebrates but as there are no reports of environmental impacts from any of the *Oncomelania* snails in their native range (Cowie *et al.,* 2009), impacts in Australia are unlikely to be significant.

Risk summary and mitigation measures

The risk of animals escaping or being deliberately released into the wild is negligible given the strict security measures that would be undertaken. The imported animals would be required to remain in Quarantine Approved Premises for the duration of their lives. These premises are audited by the Commonwealth Department of Agriculture and Water Resources and have to meet strict criteria to ensure that animals are kept in a highly secure environment that prevents escape of animals and any related pathogens. All waste products and contaminated materials are to be appropriately treated or disposed as part of the certification of the facilities.

Table 1: Summary of risks and mitigation measures

Risk	Likelihood	Impact	Mitigation measures	Overall risk
Release or escape of adult specimens	unlikely	minor	The species will be held in a Quarantine Approved facility.	Low
Release or escape of immature specimens	unlikely	minor	The species will be held in a Quarantine Approved facility.	Low
Disease transmission to wild Australian	unlikely	low	The import of the snails will need to meet the conditions applied by the Department	low

snail and native species populations			of Agriculture and Water Resources as part of their import permit. For the duration of the research, the snails will be housed in a quarantine approved facility. Therefore there is a very low chance of interacting with native species.	
Theft and deliberate release	unlikely	unknown	Quarantine facilities are required to have security measures in place to ensure that access is controlled. The Security procedures would mean that the risk of theft is extremely low. The species are not reported to be part of the aquarium trade. It is unlikely that they would be of interest to any groups apart from Schistosomiasis researchers.	Low

The listing of *O. h. quadrasi* should only occur under Part 2 the Live Import List. While the proposed snails for research purposes are unlikely to pose an environmental risk, the potential importation of the species for other purposes such as for the aquarium trade would pose a higher risk of the species being released from human control and possibly forming a feral population. As these risks have not been examined a more general listing should not be considered.

Comments on the proposal to import *O. h. quadrasi.*

Three responses were received when the application and reports were released for public comment in November 2017:

One State Government department and one Territory Government department supported the amendment of the Live Import List to include *O. h. quadrasi* for research purposes in high security facilities as specified in the application.

One organisation sought further details:

- provide species naming authority;
- where the snails would be sourced from;
- a map of the species native range; and
- If the snails eggs are resistant to desiccation.

In response to the comments received, QMRI Berghofer provided a revised risk assessment report and additional information on 31 January 2018 that addressed these points.

Conclusion

The Department has undertaken a risk analysis and reviewed the available information on *O. h. quadrasi* and the proposed amendment to include this species on the Live Import List.

The biology and ecology of *O. h. quadrasi* suggests that if released, the species probably would not be able to establish populations in Australia due to its very specific environmental requirements. Evidence from around the world indicates that the species has never established a population outside its native range in the Philippines.

On the basis that the species is very unlikely to establish in Australia and the very low risk of the imported populations of *O. h. quadrasi* escaping from the secure facilities and becoming established in the wild, it is recommended that *Oncomelania hupensis quadrasi* be listed on Part 2 of the Live Import List, with conditions restricting imports to '**Research only. High security facilities only**'.

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