RISK ASSESSMENT SUMMARY SHEET

Updated: October 2020

New Guinea flatworm (*Platydemus manokwari*)

- A long (4-6cm) terrestrial flatworm with a light central stripe on its upper surface.
- Transported around the world in soils associated with plants.
- Mainly found in tropical and sub-tropical regions, unlikely to be able to establish outdoors in GB given current climate conditions.
- Feeds mostly on snails - has caused serious declines in native species on pacific islands.

History in GB

Not known to be present in GB. In Europe, this species was recorded from a hothouse in botanic gardens in Caen, Normandy, France in 2013.

Native Distribution

Native to New Guinea (green). Approximate global distribution is shown (red)

Adapted from Jean-Lou, et al (2015). https://peerj.com/articles/1037/#fig-7

GB Distribution

Not recorded in GB.

Impacts

Impact will primarily depend on whether this species can establish in GB, which is unlikely. If it were to establish (e.g. in the Isles of Scilly) impact may be locally damaging, but geographically restricted.

Environmental

- Feeds mostly on snails, but also recorded feeding on slugs, annelids, nemerteans and insects.
- Where established, particularly on pacific islands, has caused significant declines in native snails and in some cases contributed to local extinctions.
- Listed among the list of 100 of the worlds worst invasive species.

Economic

- There have been concerns in France about possible impact on snail farming; however, this is a small sector in GB.

Social

- None

Introduction pathway

Contaminant of imported plants - most likely introduction pathway to GB

Spread pathway

Natural – slow and local, unlikely to be able to natural disperse long distances

Human mediated – exchange of plants could spread this species considerable distances

Summary

	Response	Confidence
Entry	MODERATELY LIKELY	MEDIUM
Establishment	UNLIKELY	HIGH
Spread	SLOW	MEDIUM
Impact	MODERATE	MEDIUM
Overall risk	LOW	HIGH

Rapid Risk Assessment of: *Platydemus manokwari* (New Guinea Flatworm)
Author: Archie K. Murchie
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Placed on NNSS website: October 2020

GB Non-native species Rapid Risk Assessment (NRRA)

Introduction:
The rapid risk assessment is used to assess invasive non-native species more rapidly than the larger GB Non-native Risk Assessment. The principles remain the same, relying on scientific knowledge of the species, expert judgement and peer review. For some species the rapid assessment alone will be sufficient, others may go on to be assessed under the larger scheme if requested by the Non-native Species Programme Board.

1 - What is the principal reason for performing the Risk Assessment? (Include any other reasons as comments)

Response: To rapidly assess the risk associated with this species in GB, following its detection in Europe in 2013 (reported early 2014).

2 - What is the Risk Assessment Area?

Response: Great Britain (England, Scotland, Wales and their islands)

3 - What is the name of the organism (scientific and accepted common; include common synonyms and notes on taxonomic complexity if relevant)?

Response: New Guinea flatworm *Platydemus manokwari* de Beauchamp, 1963.
Justine *et al.* (2014) confirm the dating of de Beauchamp's species description as 1963 but which elsewhere is given as 1962. Also known as the snail-eating flatworm (Cowie, 2010).

4 - Is the organism known to be invasive anywhere in the world?

Response: Yes.

Platydemus manokwari has established in 15 different territories (Justine *et al.*, 2014). These are mainly throughout the Pacific, e.g. Australia, Guam, the Philippines, Japan, Palau, Hawaii, French Polynesia, Samoa, Tonga, Vanuatu and Fiji. However, the flatworm has also established in the Maldives in the Indian Ocean. Since the initial PRA *P. manokwari* also been found in Singapore, Miami (Florida) and Puerto Rico (Justine *et al.*, 2015).

5 - What is the current distribution status of the organism with respect to the Risk Assessment Area?

Response: Not present in GB.

Recently (2013) recorded from a hothouse in botanic gardens (Jardin des Plantes) Caen, Normandy, France. This is the only record from Europe (Justine *et al.*, 2014, 2015).

6 - Are there conditions present in the Risk Assessment Area that would enable the organism to survive and reproduce? Comment on any special conditions required by the species?

Response: *Platydemus manokwari* has been mostly recovered from tropical and subtropical pacific islands bounded by latitudes of c. 30° N and c. 30° S (Sugiura, 2009). Consequently, 10°C has been postulated as the threshold temperature for the establishment of *P. manokwari*, and low winter temperatures may limit survival in temperate regions (Sugiura, 2009). The specimens found in France were in a hothouse in Caen. Despite this, the authors of the paper stated that *P. manokwari* may well survive externally in Normandy (Justine *et al.*, 2014). This was based on comparisons with Pindaunde station, Mt.Wilhelm in New Guinea. This is a natural site for *P. manokwari* and at 3625 m altitude represents a sub-alpine forest habitat (mean daily temperature 11.6° C, mean minimum 4°C, mean maximum of 16.7° C, minimum of -0.8° C, precipitation 3450 mm per year). However, sitting relatively close to the equator (5°, 46'S) seasonal fluctuations in temperature are much less extreme than in north-west Europe.

Further considerations are humidity levels and soil moisture. Other than high humidity being essential for *P. manokwari* survival, the specific requirements are unknown. However, given that at least 12 non-indigenous flatworms have established in GB (Boag & Yeates, 2001), soil moisture and micro-habitat humidity do not appear particularly limiting to terrestrial flatworms in GB.

Justine *et al.* (2014) caution that an ecoclimatic risk assessment has not been conducted. It would seem that, in agreement with Sugiura (2009), low winter temperatures may be the limiting factor in the Risk Assessment Area.

7 - Does the known geographical distribution of the organism include ecoclimatic zones comparable with those of the Risk Assessment Area or sufficiently similar for the organism to survive and thrive?

Response: Aside from the recent Caen hothouse record, the most northerly record of *P. manokwari* is from Yokohama, Japan (Eldredge, 1994; Justine *et al.*, 2014). However, this refers to a transfer of 200 specimens from the Philippines to Yokohama for laboratory experiments, after which they were preserved (Sugiura, 2008). Sugiura (2009) gives the subtropical island Chichijima (27°, 04' N) (Ogasawara Islands, Japan) as the highest latitude of occurrence. This means that the known range of *P. manokwari* is tropical / subtropical. No parts of GB are tropical / subtropical. From the published literature, it is questionable that *P. manokwari* would survive and thrive externally in GB. If it were to do so, areas with mild maritime climates such as coastal areas of the south west (Cornwall, Devon), as well as southern islands (the Channel Islands and Isles of Scilly) would be the most likely areas for establishment.

8 - Has the organism established viable (reproducing) populations anywhere outside of its native range (do not answer this question if you have answered 'yes' to question 4)?

Response: N/A

9 - Can the organism spread rapidly by natural means or by human assistance?

Response: Terrestrial flatworms creep along the soil surface: for *Arthurdendyus triangulatus*, Boag & Neilson (2014) gave a maximum rate of movement in the wild as 15 m in 7 days or 2.14 m per day; Gibson & Cosens (1998) found the flatworm to disperse 17 m in 30 days. Therefore natural movement and dispersal is gradual and local. Justine *et al.* (2014) commented that *P. manokwari* appeared incapable of travelling long distances on its own. Long to medium range dispersal is therefore through human assistance, as exemplified by the number of disparate Pacific islands affected by *P. manokwari*. Human-mediated dispersal of *P. manokwari* has occurred by two mechanisms. In the case of the Caen record, it was almost certainly introduced inadvertently with imported plants. Secondary dispersal can then occur, through local exchange of plants and soil (Cowie, 2010). This has been one of the main factors in the national spread of *A. triangulatus* in the UK and Ireland (Cannon *et al.*, 1999).

Platydemus manokwari has also been introduced deliberately as a biological control agent for the giant African snail *Achatina fulica*. This has been considered as an example of the foibles of classical biological control. *Achatina fulica* was originally introduced deliberately as a food source, and accidentally with plants, to more than 50 regions from the 1840's onwards (Civeyrel & Simberloff, 1996). With *A. fulica* having high fecundity, a polyphagous diet and few natural enemies where it was introduced, the snail rapidly became a pest. Subsequently, biological control agents were released to control *A. fulica* but unfortunately, at the time (largely before the 1980's), without proper host-specificity assessments (Civeyrel & Simberloff, 1996). *Platydemus manokwari* along with the predatory snail species *Euglandina rosea* and *Gonaxis* spp. formed the bulk of the biocontrol releases. However, due to non-specific predation, both *E. rosea* and *P. manokwari* have been implicated in the decline and extinction of endemic snail species, especially partulid tree snails (Hopper & Smith, 1992).

10 - Could the organism itself, or acting as a vector, cause economic, environmental or social harm in the Risk Assessment Area?

Response: Yes, potential environmental damage. *Platydemus manokwari* feeds mostly on snails, although it has also been recorded feeding on slugs, annelids, nemerteans and insects (Iwai *et al.*, 2010; Justine *et al.*, 2014; Sugiura, 2010). The flatworm is listed as one of the "100 World's Worst Invader Alien Species" due to its role in the decline of endemic terrestrial snails on various Pacific islands (Cowie, 2010). Therefore, the threat if *P. manokwari* became established is that it would feed on indigenous British snails. Experience with other terrestrial flatworms, in particular *A. triangulatus*, would suggest little natural predation in the invaded habitat, allowing flatworm populations to build-up unhindered. A decline in snail biodiversity is troubling and it is likely that certain species would be more vulnerable to predation than others. *Arthurdendyus triangulatus*, as a predator of earthworms, has differential impacts on individual species, determined by earthworm micro-habitat, rate of reproduction and the ability to absorb predation pressure (Murchie & Gordon, 2013). Although it is difficult to predict European snail species at risk from *P. manokwari*, concerns would be initially raised for those of conservation importance. Terrestrial snail species listed in the Natural Environment and Rural Communities (NERC) Act 2006 (Section 41) as of principal importance are: *Quickella arenaria*, *Truncatellina cylindrical*, *Vertigo angustior*, *Vertigo genesii*, *Vertigo geyeri* and *Vertigo moulinsiana*. As well, there are a small number of woodland and wetland molluscs which are near-endemic to Britain and Ireland and which would be at risk if this predator established here, e.g.: *Leiostyla anglica*, *Spermodea lamellate*, *Zenobiella subrufescens* and

Acicula fusca (R. Anderson, pers comm.). A decline in snails could have knock-on effects on other British wildlife that feed on them, e.g. thrushes, glow-worm beetles (Lampyridae), marsh flies (Sciomyzidae), frogs, hedgehogs and others. Less tangible are the potential effects of *P. manokwari* on the wider role of snails in the ecosystem, in terms of decomposition processes and nutrient recycling. *Arthurdendyus triangulatus* has significant knock-on economic effects on both native wildlife and agriculture (Boag & Neilson, 2006; Boag *et al.*, 2010; Murchie, 2018).

Platydemus manokwari is a paratenic host of the parasitic nematode, *Angiostrongylus cantonensis*, in Japan (Asato *et al.*, 2004).

Entry Summary

Estimate the overall likelihood of entry into the Risk Assessment Area for this organism (comment on key issues that lead to this conclusion).

Response: *moderately likely*
Confidence: *medium*

Comments (include list of entry pathways in your comments):

The most likely entry pathway into GB is accidental introduction with horticultural products. Given that the record in France is from a botanic garden, presumably subject to eradication and well publicised, this particular infestation would be an unlikely source. *Platydemus manokwari* has been actively distributed around the Pacific since the 1960's. The introduction to Europe in 2013 must therefore be considered as a rare event. In addition, the pathway in the French case is fairly specific and has been denoted as high risk for other flatworm species. Provided that publicity and education are maintained, interceptions in botanic gardens would pose less of a risk than if the flatworm was discovered in the commercial horticultural trade. In GB, codes of practice specifically regarding the dangers of accidental importation of non-indigenous flatworms have been distributed to the horticultural trade (MAFF, 1996). Nevertheless the fact that *P. manokwari* was imported at all, does raise the possibility of further introductions. Internet trade in exotic plants is increasing and instant landscaping requiring potted trees and shrubs poses a particular risk. Furthermore, since the original PRA was produced, the invasive *Obama nungara* was found in Cambridgeshire and Kent (Carbayo *et al.*, 2016), and another non-indigenous species, *Marionfyfea adventor*, found in the UK, Netherlands and France (Jones & Sluys, 2016), illustrating the continual invasion risk posed by terrestrial flatworms.

There is a very slight possibility that somebody may try to introduce *P. manokwari* as a biocontrol agent for snails or slugs but this would require wilful ignorance and disproportionate effort.

Establishment Summary

Estimate the overall likelihood of establishment (comment on key issues that lead to this conclusion).

Response: *unlikely*
Confidence: *high*

Comments (state where in GB this species could establish in your comments, include map if possible):

Platydemus manokwari is found in tropical and subtropical regions. It is moderately likely that it could establish in hothouses in GB, in a manner similar to *Bipalium kewense* (Sluys, 2016). However, it is unlikely to establish in the external environment. With the exception of hothouses, it has not established above a latitude of 30°. Suigura (2009) suggested that the establishment temperature threshold for *P. manokwari* was 10°C. Below this temperature, survival decreased. In GB, mean annual temperatures are above 10 °C in Cornwall, the Isles of

Scilly and the Channel Islands (www.metoffice.gov.uk). There is a precedent for non-indigenous flatworms establishing in these regions: *Australoplana sanguinea* was recorded in 1980 in the Isles of Scilly (Jones, 1981). However, despite these regions having maritime climates, winter mean temperatures are much lower. Therefore although *P. manokwari* could establish outdoors during the summer months, it would be at the limits of its temperature thresholds and vulnerable to cold winter conditions. The cold-hardiness of *P. manokwari* is not known though.

Spread Summary

Estimate overall potential for spread (comment on key issues that lead to this conclusion).

Response: *slow*
Confidence: *medium*

Comments:

Platydemus manokwari has not established in GB. With sufficient awareness and appropriate procedures, it is unlikely that *P. manokwari* will establish and spread in GB the next 5 years.

Spread of *P. manokwari* is by two methods: natural movement and anthropochorous transfer. Accidental or deliberate human-mediated transference in contaminated material is by far the more likely mechanism for significant spread of *P. manokwari*. The problem with non-natural movement is that it is unpredictable and can cover large distances. Infected localities (normally gardens or horticultural centres) then serve as foci that allow natural movement into the surrounding countryside. The human factor is the major element in spread of these invasive flatworms. Strong biosecurity measures implemented by government, along with raising awareness and education are therefore key to limit spread.

Impact Summary

Estimate overall severity of impact (comment on key issues that lead to this conclusion)

Response: *moderate*
Confidence: *medium*

Comments (include list of impacts in your comments):

Platydemus manokwari is a voracious and indiscriminate predator of terrestrial molluscs. Where it has become established, it undoubtedly has a major impact on indigenous snail fauna; in some cases contributing to local extinction. This has been particularly true in the oceanic Pacific island ecosystems, where endemic *Partulidae* and *Mandarina* spp. have been decimated (Cowie, 2010). The question here is whether *P. manokwari* can establish in GB and to what extent. From the available data, it is predicted that establishment, if any, will be geographically limited and that *P. manokwari* will not spread widely in GB. In the areas most vulnerable to establishment, e.g. the Scilly Isles, the terrestrial mollusc fauna is an impoverished version of that on the mainland (Lewis *et al.*, 2008); so although locally damaging, the national impact will be less severe.

Some articles in the media have alluded to the impact of *P. manokwari* on snail production in France (e.g. '*Escargot could follow the dodo, scientists warn*', The Telegraph 4th March 2014). Whilst, these headlines are deliberately sensationalist, there is nevertheless a possible impact on GB heliciculture. There is limited information on snail farming in GB. A newspaper report gave production of 750,000 snails in 2014 (Milmo, 2014). Using figures from Scotland's Rural College farm diversification advisory service (SRUC, 2019), gives a potential sector value of £90K to £140K. If snails are sold prepared and processed as an artisan product their value can be as high as £35 per kg, which would give a maximum sector output of £400K. The impact of *P. manokwari* on this sector will depend on the production method. Snails reared intensively in heated indoor facilities will be less exposed to *P. manokwari* invasion but the flatworm could survive well under these conditions. However, management of the flatworm may be straightforward by clearing and disinfecting the rearing rooms. For extensive outdoor rearing, eradication of an invasive flatworm could be more problematic, although, as stated above, it is unlikely that *P. manokwari* will survive well outdoors in GB.

Climate Change

What is the likelihood that the risk posed by this species will increase as a result of climate change?

Response: *high*
Confidence: *high*

Comments (include aspects of species biology likely to be affected by climate change (e.g. ability to establish, key impacts that might change and timescale over which significant change may occur):

Climate change predictions suggest increased temperature and milder wetter winters in GB (Gosling *et al.*, 2011). As postulated already, *P. manokwari* would be limited in its establishment potential in GB due to low winter temperatures. Increased temperature would therefore increase the likelihood and range of establishment of this species. Increases in precipitation are also likely to be favourable to *P. manokwari* as it requires high microhabitat humidity.

Conclusion

Estimate the overall risk (comment on the key issues that lead to this conclusion).

Response: *low*
Confidence: *high*

Comments:

Platydemus manokwari is a tropical / sub-tropical species, whose establishment in the wild in GB is likely to be limited by its cold-hardiness. The European record from France is from a botanic garden hothouse and not from the wild. *Platydemus manokwari* could perhaps survive in mild coastal habitats in GB but would be vulnerable to low temperatures, either providing insufficient warmth to complete their life-cycles or causing direct mortality.

If *P. manokwari* were to gain a foothold in GB, evidence from elsewhere suggests that this is a highly invasive and adaptable species that would predate indigenous snails. The impact of such predation is a decline in native biodiversity. The direct economic impacts would be relatively small; although if *P. manokwari* were found in plants or other produce intended for export, other countries may apply import restrictions. The risk posed by *P. manokwari* will increase with climate change due to higher temperatures and milder, wetter winters, increasing the likelihood of establishment and range expansion. Education and awareness are key to preventing importation and spread of this species. Data on the cold-hardiness of *P. manokwari* would aid greatly in assessing further the establishment risk in GB.

Management options (brief summary):

1 - Has the species been managed elsewhere? If so, how effective has management been?

Response: No, there does not seem to have been a successful effort to control *Platydemus manokwari* populations. As of 2015, *P. manokwari* was confined to a single glasshouse in France but had not been eradicated (Justine *et al.*, 2015).

2 - List the available control / eradication options for this organism and indicate their efficacy.

Response: Management options are listed by Cowie (2010) and Justine *et al.* (2014) but are limited. No chemical control means have been tested for *P. manokwari* and experience with *Arthurdendyus triangulatus* suggest that use of insecticides would be problematic in terms of efficacy, application and environmental impact (Blackshaw, 1996; Cannon *et al.*, 1999). Antihelminthic compounds would seem the most likely candidates for effective active ingredients but this has not been studied.

Biological control is similarly limited. Terrestrial planarians are eaten by predatory beetles, birds, amphibians, reptiles and small mammals (Cannon *et al.*, 1999; Gibson *et al.*, 1997; Winsor *et al.*, 2004). However, these are generalist and opportunistic predators and flatworms are not preferred prey items due to their distastefulness and toxicity (Winsor *et al.*, 2004). A predatory snail from Brazil, *Rectartemon depressus*, has been suggested as a potential biocontrol agent for terrestrial flatworms but is untested with respect to *P. manokwari* (Justine *et al.*, 2014; Lemos *et al.*, 2012). Gregarine and nematode parasites, and a keratoplatid parasitoid have been collected from terrestrial flatworms, so offer potential for biological control, but have not been utilised in such a way (Winsor *et al.*, 2004) and there are no specific records of parasites from *P. manokwari* (Justine *et al.*, 2014).

3 - List the available pathway management options (to reduce spread) for this organism and indicate their efficacy.

Response: In GB, terrestrial flatworms have mostly been spread through movement in ornamental plants and soil. The most effective means of control is to limit establishment and spread from other regions through enhanced biosecurity and surveillance. Phytosanitary measures such as hot-water treatment have the potential to kill terrestrial flatworms within root balls of plants (Cannon *et al.*, 1999; Justine *et al.*, 2014; Murchie & Moore, 1998). A 5 minute exposure to water temperatures of ≥ 43 °C was sufficient to kill *P. manokwari* (Sugiura, 2009).

Specific guidelines have been published to limit the spread of *A. triangulatus* (EPPO, 2001a; EPPO, 2001b; EPPO, 2001c). These guidelines could form the basis of a management strategy for *P. manokwari*.

4 - How quickly would management need to be implemented in order to work?

Response: Effective management to eradicate terrestrial flatworms or limit their spread must be conducted as soon as an intercepted specimen is notified to authorities. Due to their soil-dwelling cryptic nature, terrestrial flatworms often go unnoticed until impacts on native fauna are apparent. Often as well, legislative authority is unclear to allow access to private land and which eradication procedures to be followed. GB has extensive experience with the potential problems caused by *A. triangulatus* (Murchie, 2008) and the lessons learned from dealing with this species should not go unhindered when considering *P. manokwari*.

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Provide here a list of the references cited in the course of completing assessment

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