NOBANIS –Invasive Alien Species Fact Sheet

Arthurdendyus triangulatus

Author of this fact sheet: Inger Weidema, Danish Forest and Nature Agency, Ministry of the Environment, Haraldsgade 53, DK-2100 Copenhagen Ø; +45 3947 2258; irw@sns.dk

Bibliographical reference – how to cite this fact sheet:
Weidema, I. (2006): NOBANIS – Invasive Alien Species Fact Sheet – ***Arthurdendyus triangulatus*** – From: Online Database of the North European and Baltic Network on Invasive Alien Species – NOBANIS www.nobanis.org, Date of access x/x/200x.

Species description

Scientific names: *Arthurdendyus triangulatus*, Dendy 1894, Platyhelminthes, Geoplanidae
Synonyms: *Artioposthia triangulata*, Dendy 1894
Common names: New Zealand flatworm (GB), Newzealandsk fladorm (DK), Neuseelandplattwurm (DE), Uus-Meremaa lameuss (EE), Du ver plat de Nouvelle-Zélande (F), Ný Selendski flatmaðkurin (FO), Nýsjálenski flatormurinn (IS), New zealandsk flatorm (NO), Nyazeeländska plattmasken (SE).

Fig 1. *Arthurdendyus triangulatus*, photo by Ole and Janice Mather-Christensen
More pictures on the web.

Species identification

Arthurdendyus triangulatus has a flattened body with pointed ends. As opposed to other worms such as earthworms or leeches the body is without segments and appendages. The colour of the body may vary from grey, brown to black, with a pale yellow margin and underside covered by grey-brown specks. The entire body is covered by sticky mucus. The size of the worm may vary from 5 to 20 cm (Christensen and Mather 1999).

Native range

The land planarian *A. triangulatus* originates from New Zealand, where it occurs naturally in forest soils, apparently without causing problems for the native earthworm fauna. In New Zealand the species is also found in cultivated soils such as gardens and plant nurseries (Christensen and Mather 1999).

Alien distribution

History of introduction and geographical spread

The New Zealand flatworm was first recorded in Northern Ireland in 1963 where it supposedly arrived with a shipment of roses or bulbs from the Christchurch area in New Zealand (Christensen and Mather 1999). The species has now reached all parts of Northern Ireland and is spreading southwards in the Republic of Ireland as well as in Scotland and England (Cannon *et al*. 1999). The species has been registered with certainty on the Faroe Islands from 1982 (Bloch 1992, Mather and Christensen 1994). It is suspected that the New Zealand flatworm was imported with plants from Britain (Bloch 1994).

Ecoclimatic surveys suggest that *A. triangulatus* may thrive in other parts of Europe, such as western Norway, southern Sweden, Denmark, Germany and northern parts of Poland, at least in places where cool and damp conditions are found (Boag *et al.* 1995).

Pathways of introduction

A. triangulatus was first recorded in the 1960s in gardens in Belfast and Edinburgh. It is believed that the flatworm was unintentionally introduced with flowers from Christchurch in New Zealand (Christensen and Mather 1999). The risk of non-intentional transfer is greatest from the commercial trade with hardy ornamental plants, but domestic garden trade also poses a prominent risk (Alford *et al.* 1998).

Alien status in region

The New Zealand flatworm is presently found on the Faroe Islands (Bloch 1994; Mather and Christensen 1994). See Table 1.

Country	Not found	Not established	Rare	local	Common	Very common	Not known
Denmark	X						
Estonia	X						
European part of Russia	X						
Finland	X						
Faroe Islands					X		
Germany	X						
Greenland	X						
Iceland	X						
Latvia	X						
Lithuania	X						
Norway	X						
Poland	X						
Sweden	X						

Table 1. The frequency and establishment of *A. triangulatus*, please refer also to the information provided for this species at www.nobanis.org/search.asp. Legend for this table: **Not found** –The species is not found in the country; **Not established** - The species has not formed self-reproducing populations (but is found as a casual or incidental species); **Rare** - Few sites where it is found in the country; **Local** - Locally abundant, many individuals in some areas of the country; **Common** - Many sites in the country; **Very common** - Many sites and many individuals; **Not known** – No information was available.

Ecology

Habitat description
The New Zealand flatworms are found in relatively undisturbed soils near the soil surface under coverage such as stones, tiles, pots or pieces of old wood that create damp conditions. Optimal temperatures for the animals are 12-15 °C, while temperatures above +20 °C appear to be lethal (Christensen and Mather 1999). The New Zealand flatworms feed almost exclusively on native earthworms thereby reducing the number of these markedly (Christensen and Mather 1995). Presently, it is not clear whether the presence of the species is determined by availability of earthworms or if the flatworms are also regulated by other factors such as micro-climate or predators. In its native range temperatures above 20ºC. are known to be lethal to the species (Christensen and Mather 1999).

Reproduction and life cycle
Arthurdendyus triangulatus is hermaphroditic, meaning that all adult individuals may reproduce after mutual fertilisation. After fertilisation an egg-capsule is formed which may contain up to 14 new individuals. A flatworm may produce approximately 0.5 egg-capsules per week and potentially *A. triangulatus* may tenfold their population size within a few months (Christensen and Mather 2001).

Dispersal and spread
Egg capsules and the flatworms themselves are spread passively by commercial and non-commercial transport of plant and soil material. Locally the New Zealand flatworms move around through naturally occurring crevices in the soil or by utilising passages that earthworms have made. Surface movements of up to 17 meter per hour have been demonstrated (Mather and Christensen 1995). An important feature is the ability of the flatworm is to survive extended periods of time without food. Survival without food for more than one year has been reported (Christensen and Mather 1995). Such long-term survival of at least some of the New Zealand flatworm individuals makes earthworm re-colonisation from adjacent non-infected areas difficult.

Impact

Affected habitats and indigenous organisms
Field experiments in Ireland have demonstrated that the flatworms severely and quickly reduce the diversity and number of native earthworm species (Blackshaw 1990). These results were confirmed under agricultural and horticultural conditions in the Faroe Islands (Christensen and Mather 1995, Mather and Christensen 1994). The immense reproductive capacity of the invasive species and the fact that a single New Zealand flatworm may theoretically consume 52 earthworms per year explains why earthworm population size may drop rapidly on the infested sites (Christensen and Mather 2001).

Earthworms are known to be vital in both natural and semi-natural ecosystems, since they decompose dead plant material, aerate and drain the soil, and maintain intricate relationships with both fungi and bacteria. Furthermore earthworms are very important as a food source for native bird and animal species (Christensen and Mather 1999). The indirect impact that the New Zealand flatworm may have on the soil quality has not been studied but it is assumed that a decreasing earthworm population would severely change soil properties and the environmental conditions. Potentially *A. triangulatus* could severely threaten native biodiversity as well as the fertility of Europe’s farmland (Christensen and Mather 1999).

Some non-scientific observations from the Faroe Islands indicate that areas where previous heavy infestations of flatworms resulted in an absence of earthworms, may after some time reach a sort of equilibrium, with less flatworms and more earthworms (although not as much as before flatworm infestation). These observations, however, still have to be substantiated by scientific observations.

Genetic effects
No genetic effects have been reported.

Human health effects
The mucus that surrounds the New Zealand flatworm may irritate the skin and cause allergic reactions (DEFRA 2005).

Economic and societal effects (positive/negative)
Due to the dispersal pathway of the New Zealand flatworm, the most affected habitat is domestic gardens. Recently systematic surveys of grassland fields in Northern Ireland have demonstrated that *A. triangulatus* is spreading into agricultural grasslands (Murchie *et al.* 2003).

Management approaches

Prevention methods
The national border control measures in use were not effective enough to prevent the original introduction of the New Zealand flatworm and other alien flatworm species to e.g. the British Isles or the Faroe Islands. Since then the European Plant Protection Organisation (EPPO) has produced two standards related to the New Zealand flatworm: “Import requirements concerning *Arthurdendyus triangulatus*” (PM 1/3 (1)) and “Nursery inspection, exclusion and treatment for *Arthurdendyus triangulatus*” (PM 1/4 (1)) (EPPO 2000a and EPPO 2000b).

Furthermore, new EU regulations have been implemented in the EU countries – Council Directive 2000/29/EC of May 2000 (on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community). Through the national implementation of this directive the member states have the legal basis to deny the import of plants or plant products infested with *Arthurdendyus triangulatus*.

Although there are now international phytosanitary measures and regulations the enforcement is still a daunting task – especially since more and more private trade takes place via the Internet. Considering the level of plant trade between countries there is still a risk that the New Zealand flatworm will eventually become introduced to new areas. The import of plants from countries that have the flatworm may increase the risk.

Apart from adequate national border control measures a good level of awareness of the risk of moving plant material is essential to limit the introduction to new areas. In the United Kingdom the Department for Environment, Food and Rural Affairs has produced a code of practice to Prevent the Spread of Non-Indigenous Flatworms (DEFRA 2005). This Code is a practical guide to help producers and traders of nursery stock to detect and thereby to limit the spread of non-indigenous flatworms, notably the 'New Zealand' flatworm, *Arthurdendyus triangulatus*, and the 'Australian' flatworm, *Australoplana sanguinea*. Adherence to this code of practice is central to prevent the dispersal of the New Zealand flatworm.

In the Faroes there is public awareness concerning the New Zealand flatworm, but no non-governmental nor official measures have been taken to prevent dispersal. There is no national border control of plant material (Janus Hansen, pers. comm).

Eradication, control and monitoring efforts
At present no eradication methods (trapping or spraying with pesticides) have proven successful against the New Zealand flatworm (Blackshaw *et al.* 1996).

Information and awareness
Scientists in Denmark initiated an information campaign with a folder and an Internet page in 1999 (Christensen and Mather 1999) with the aim of increasing awareness regarding the New Zealand flatworm and the way it is spread. The result is an increased knowledge and awareness of the potential threat the New Zealand flatworm poses. Should the species arrive to the country it is anticipated that the information campaign will ensure an early and adequate response from the agricultural community and biologists.

On the Faroe Islands the New Zealand flatworm is well known as a species. However, there is a lack of public knowledge about the dispersal pathways – and therefore public awareness may not help to prevent dispersal of the species.

Knowledge and Research
Research is ongoing regarding specific aspects of the biology of *A. triangulatus* as well as related to the establishment and development of populations in new areas and to the risks to local earthworm fauna following introduction. The following institutes are involved in the work:
England: Central Science Laboratory, York
Scotland: Scottish Crop Institute, Dundee
Northern Ireland: The Queen´s University, Belfast
Denmark, The Faroes & Scotland: Aarhus University

Recommendations or comments from experts and local communities
The Faroe Islands consist of distinct islands linked by bridges, tunnels and ferries. There are regulations regarding the movement of e.g. sheep between islands. Such regulations for soil and plants would probably act to reduce the rate of spread.
Turf roofs are common and movement of turf is a likely dispersal pathway. Precise knowledge of where the New Zealand flatworm occurs and dissemination of this knowledge would probably reduce the transfer of soil, plants and turf.

References and other resources

Contact persons
Ole Mather-Christensen and Janice Mather-Christensen (DK) Biological Institute, University of Aarhus, Bygning 135, DK-8000 Aarhus C, Phone: +45 8942 1111, E-mail: ole.m.christensen@biology.au.dk and janice.mather@biology.au.dk

Dorete Bloch (FO) Museum of Natural History – FO-100 Tórshavn, Faroe Islands, Phone +298 352320, E-mail: doreteb@ngs.fo

Christina Birnbaum (EE) Estonian Agricultural University, Kreutzwaldi 64, Tartu 51014, E-mail: chbirnbaum@yahoo.com

Melanie Josefsson (SE) Swedish Environmental Protection Agency, c/o Dept of Environmental Analysis, SLU, P.O. Box 7050, SE-757 55 Uppsala, Sweden. Tel: +46 18 673148 Fax: +46 18 673156.E-mail: Melanie.Josefsson@snv.slu.se

Additional contacts:
Northern Ireland: Dr. Archie K. Murchie, E-mail: archie.murchie@dani.gov.uk
Scotland: Dr. Brian Boag, web-site:www.scri.sari.ac.uk
England: Dr. R.J.C. Cannon (http://flatworm.csl.gov.uk) & Prof. R. Blackshaw (rod.blackshaw@plymouth.ac.uk)

Links

Biological and ecological studies of the New Zealand Flatworm – a joint research project in the UK

University of Aarhus, Denmark – Information folder on *A. triangulatus* – in Danish

DEFRA's code of practice to prevent the spread of non-indigenous flatworms

References

Alford, D.V., Boag, B., Johns, P.M., and Yeates, G.W. (1998). Report on the OECD Workshop on Terrestrial Flatworms - Christchurch, New Zealand 1998. - Pedobiologia 42: 385-388.

Blackshaw, R.P. (1990). Studies on *Artioposthia triangulata* (Dendy) (Tricladida: Terricola), a predator of earthworms. - Annals of Applied Biology 116: 169-176.

Blackshaw, R.P., Moore, J.P., and Alston, R. (1996). Removal trapping to control *Artioposthia triangulata*. - Annals of Applied Biology 129: 355-360.

Bloch, D. (1992). A note on the occurence of land planarians in the Faroe Islands. - Fródskaparrit 38: 63-68.

Bloch, D. (1994). Tann stóri flatmadkurin er komin og verdur verandi. - Frodi 3: 26-27.

Boag, B., Evans, K.A., Neilson, R., Yeates, G.W., Johns, P.M., Mather, J.G., and Christensen, O.M. (1995). The potential spread of terrestrial planarians *Artioposthia triangulata* and *Australoplana sanguinea var. alba* to continantal Europe. - Annals of Applied Biology 127: 385-390.

Cannon, R.J.C., Baker, R.H.A. Taylor, M. and Moore, J.P (1999). A review of the status of the New Zealand flatworm in the UK. Ann. Appl. Biol., 135:597-614.

Christensen, O.M. and Mather, J.G. (1995). Colonisation by the land planarian *Artioposthia triangulata* and impact on lumbricid earthworms at a horticultural site. - Pedobiologia 39: 144-154.

Christensen, O.M. and Mather, J.G. (1999). Den Newzealandske Fladorm - En eksotisk organisme der truer regnorme: 1-3.

Christensen, O.M. and Mather, J.G. (2001). Long-term study of growth in the New Zealand flatworm *Arthurdendyus triangulatus* under laboratory conditions. Pedobiologia 45:535-549

DEFRA 2005 - Code of practice to prevent the spread of non-indigenous flatworms

EPPO 2000a - "Import requirements concerning *Arthurdendyus triangulatus*" (PM 1/3 (1))

EPPO 2000b - "Nursery inspection, exclusion and treatment for *Arthurdendyus triangulatus*" (PM 1/4 (1))

Johns, P. M. and Boag, B. (2003) The spread and distribution of terrestrial planarians (Turbellaria: Tricladida: Geoplanidae) within New Zealand. New Zealand Journal of Ecology (2003) 27(2): 201-206 - Web-version

Mather, J.G. and Christensen, O.M. (1994). The exotic land planarian *Artioposthia triangulata* in the Faroe Islands: colonisation and habitats. - Fródskaparrit 40: 49-60.

Mather, J.G. and Christensen, O.M. (1995). Surface movement rates of the New Zealand flatworm *Artioposthia triangulata*: Potential for spread by active migration. - Annals of Applied Biology 126: 563-570.
Mather-Christensen, Ole - Natural History Museum, University of Aarhus, DK

Murchie, A.K., Moore, J.P., Walters, K.F.A. and Blackshaw, R.P. (2003). Invasion of agricultural land by the earthworm predator, *Arthurdendyus triangulatus* (Dendy). Pedobiologia, 47(5-6): 920-923.

Date of creation/modification of this species fact sheet: 10-10-2006