Impact of New Zealand Flatworm on agriculture and wildlife in Scotland

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Fig. 1
New Zealand flatworm
(*Arthurdendyus triangulatus*)

Introduction

First recorded outside New Zealand in the 1950s surveys showed that by 1995 the New Zealand flatworm (Fig. 1) had a geographical distribution which encompassed over 90% of Scotland's land area (Fig. 2) (Boag *et al*., 1997) but only a very few records were from farmland. In Northern Ireland a similar low percentage (4%) of farms were also found to be infested during a survey in 1991 but a follow up survey in 1998-1999 found 70% infested (Murchie *et al* ., 2003).
No similar follow up survey has taken place in Scotland.

There are a numerous reports of the New Zealand flatworm significantly decreasing earthworm populations (even to below detectable levels) while other studies suggest that both the New Zealand flatworm and earthworms may coexist but with either fewer earthworms or with an altered earthworm community structure.
Although between 1997 and 2002 SEERAD financed a study of the biology and ecology of the New Zealand flatworm (which also did a pest risk analysis for the UK) this study did not attempt to quantify the economic impact of the New Zealand flatworm on agriculture or the effect on wildlife even though these were likely to be adversely affected by the establishment of New Zealand flatworm in Scotland.

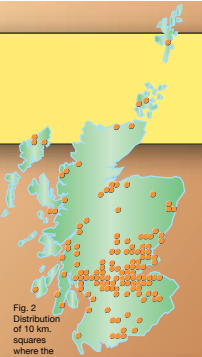

Fig. 2
Distribution of 10 km. squares where the New Zealand flatworm were recorded.

However, there are now 16 years of published scientific data on *A. triangulatus* which means that now a preliminary assessment of the detrimental economic and environmental impact of the New Zealand flatworm is possible. These data, presented here, could be used as basis upon which Scottish Executive can make informed decisions when prioritising the allocation of resources to controlling the spread and establishment of alien species.

Impact on wildlife

Earthworms constitute the major item in the diet of a number of Scottish animals and birds (Table 1 & 2). In 1995 the chief scientists group of MAFF commissioned a report on "The potential impact of the New Zealand flatworm (*Artioposthia triangulata*) on agriculture and the environment in England and Wales" which suggested that the New Zealand flatworm and the resultant loss of earthworms had the potential to "affect soil structure and the balance of terrestrial ecosystems (with a particular effect on food chains)".

Table 2. Birds likely to be affected severely by earthworm loss (after Alford *et al*., 1995)

Moorhen
Oystercatcher
Golden plover
Lapwing
Stone curlew
Snipe
Woodcock
Little Owl
Blackbird
Ring Ousel
Redwing
Song thrush
Rook

Table 1. Possible impact of the New Zealand flatworm on native mammals. (after Alford *et al*., 1995)

Species of Mammal	Possible effect
Mole	Extinction
Common Shrew	Population suppression, possible local extinction
Badger	Population suppression, possible local extinction
Hedgehog	Population suppression, possible local extinction
Stoat	Possible local extinction in 'lean' years
Fox	Probably unaffected

Fig. 3
Moles represent one of the mammals particularly at risk from the New Zealand flatworm

However, although a similar report was not commissioned for Scotland (even though the New Zealand flatworm was far more prevalent in Scotland), what little evidence there is would support the predictions made in that report. In a New Zealand flatworm infested area between Dunoon and Loch Eck, where moles (Fig 3) were known to be plentiful after World War II, there are now none i.e. they probably have become locally permanently extinct (Boag, 2000 and subsequent observations). The impact on other animals at risk is unknown e.g. badgers, hedghogs and shrews as no research has been commissioned to ascertain their status.

Impact on soil processes

Haria et al., (1998) while investigating the effect of the New Zealand flatworm on drainage found that "in the short term infestations by flatworms and consequent depletion of earthworms increased infiltration" but that "as macropores degenerate or are removed over time, an increased risk of surface run off may result in increased pollution and flood hazards, whilst reduced drainage and subsequent waterlogging may reduce agricultural productivity in certain soils".
Jones *et al*., (2001) found that earthworm community structure was altered with the numbers of anecic species, (those which come to the surface and both aid soil drainage and are food for birds and mammals) were particularly badly affected.
The impact of reduced earthworm numbers, due to the New Zealand flatworm, on other aspects of soil biology can only be speculatively assessed by extrapolating from the published literature showing the beneficial effects of earthworms.

Impact on agricultural productivity

The European lumbricid earthworms were deliberately introduced into New Zealand to increased the productivity of pastures. Increases in grass yields after the addition of earthworms of 28%-110% have been reported which settled down to a 20%-30% increase after several years (Stockdill, 1982). To try and estimate the detrimental impact on Scottish Agriculture the following 2 independent assessments were undertaken.

1) The Monetary Value of Earthworms

In 1999 the value of earthworms on agricultural productivity was estimated to be £0.08 to £0.48 per kilo of earthworms in the soil depending upon the crop. The average biomass of earthworms in grassland in Scotland is about 75g/m^2 and the area of both rough grazing and total grassland is over 4.5 million hectares, If it is assumed that grass is a low value crop and valued at only £0.08 per kilo and earthworms occur in 2.25 million hectares then earthworms would be worth approximately £135 million to grassland productivity in Scotland. However in the only published field data from Scotland where the flatworm had a patchy distribution a 12% reduction in earthworm populations was recorded (Boag et al., 1999). If this data is then extrapolated to the value of earthworms in grassland in the whole of Scotland then the New Zealand flatworm could have the potential to have a detrimental impact on grass production of £16 million.

2) Impact on Grassland Productivity

The value of finished cattle, calves, sheep and lambs and of their products to the Scottish economy in 2004 was estimated at approximately £1bn. If it is assumed that a) only 50% of their nutritional intake is from grass, b) that earthworms are only present in half of the grazed area (due to low pH levels restricting earthworm numbers) and c) that earthworms increased grassland productivity by 6-7% (compared with estimates of 20% for New Zealand) then earthworms would still make a contribution of at least £17m to grass production in Scotland.

The above estimates do not consider the impact of earthworms on arable or horticultural crops where some studies have shown earthworms to have a beneficial effect nor does it consider the effects of waterlogging. Anecdotal evidence from the farmers who have land infested with flatworms between Dunoon and Loch Eck have reported a decrease in grass growth and an increase in rushes over the last two or three decades which they attribute to the infestation of the New Zealand flatworm. (Figs. 4-5). Unfortunately there is no way of conclusively proving these associations either in the past or in the future as the New Zealand flatworm is scheduled under section 9 of the Countryside and Wildlife Act 1981 which precludes the introduction of the flatworm to monitor their effects.

Fig. 4 View of field where New Zealand was found in 1992

Fig. 5 View of same field in 1999 showing extensive waterlogging and invasion of rushes

Conclusion

The economic cost of the New Zealand flatworm to Scottish Agriculture may equal or exceed those of other well established alien species e.g. potato cyst nematodes (Pickup, 2004) and rabbits (Hartley, 2001). However control strategies for both of these pests exist whereas none has yet been devised for the New Zealand flatworm. Until an assessment of the impact of the New Zealand flatworm on Scotland's agriculture and environment has been undertaken the "precautionary principle" should be promoted and publicised. For example farmers should be made aware of the possible detrimental impact of the New Zealand flatworm and told of the practical measures which can be used to stop or slow down its spread e.g. inspect all silage and hay bales they bring onto their farm since once it becomes established there is no known way of eradicating it.

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