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Hydrological and environmental impact of earthworm depletion by the New Zealand flatworm (*Artioposthia triangulata*)

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Abstract

The predation of earthworms by the New Zealand flatworm is an environmental threat that may have consequences beyond the scope of merely reducing earthworm populations in the UK. The role of earthworms in developing soil structure is substantial and the effect of structural degradation on hydrological processes, following earthworm eradication, may therefore be major, with a resulting increase in flood risk from river systems and decrease in agricultural productivity of economic concern.

1. Hydrological importance of earthworms

The importance of the burrowing activities of earthworms in improving soil properties has long been realised, in relation to soil drainage and aeration. The introduction of earthworms to pastures where they are deficient produces a substantial increase in water infiltration (Newman, 1988). Aggregate formation by surface and sub-surface casting can increase porosity by improving soil structure and, hence, increase the water-holding capacity of the soil (Lee, 1985). In sandy soils, for example, large pore spaces may be infilled with finer material produced during cast formation; this increases soil water storage, and macropores created in burrowing improve drainage (Beven and Germann, 1982).

In soils such as clays, which represent up to 33% of the land area of England and Wales, a large proportion of which is devoted to cereal production (Cannel et al., 1984), earthworms may play a major role in soil aeration. Not only will worm burrows increase aeration directly but increased infiltration will reduce surface waterlogging, which will improve soil aeration indirectly. Earthworms can also be

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beneficial to plants in other ways. For example, whereas root growth may be severely restricted by resistant barriers in some soils, roots can exploit the channels left by earthworms if there is an active earthworm population (Marshall and Holmes, 1988).

2. Impact of the New Zealand flatworm

Since its first sighting in Belfast in 1963, *Artioposthia triangulata* (the New Zealand flatworm) has become well established in Northern Ireland (Blackshaw and Stewart, 1992) and Scotland (Boag et al., 1994). Increasing numbers have appeared in England, suggesting that *A. triangulata* is slowly advancing south, populating new areas which include progressively greater tracts of prime agricultural land. *A. triangulata* is a terrestrial planarian that feeds on earthworms (Blackshaw, 1991). It is capable of inflicting severe losses on indigenous earthworm populations to the point of elimination beyond detection limits (Blackshaw, 1990; Blackshaw and Stewart, 1992). The impact of 20 years' absence of earthworms on a grassland soil environment at a plot scale was demonstrated by Clements et al. (1991), who showed a dramatic change in soil structural properties. The hydrological impact on the environment and on agriculture of earthworm depletion at a much larger scale has yet to be determined. In view of the threat posed to indigenous earthworm populations, the indirect effects of *A. triangulata* on hydrological processes as a consequence of earthworm depletion may be devastating.

3. Hydrological and environmental consequence of earthworm depletion

A reduction in earthworm populations may often result in soil structural degradation, either by the process of natural decay over time or as a consequence of modern agricultural practice where fields are ploughed and the natural hydrological pathways truncated at plough depth. This loss of soil structure and porosity with a related increase in bulk density, more likely for heavy clay soils, potentially reduces infiltration and deep percolation of rainfall into the soil profile. Resultant surface waterlogging will reduce oxygen diffusion rates so that root growth and crop yield may be limited (Box, 1991). Along with the reduction in soil aeration, the water-holding capacity of the soil profile may be limited, possibly inducing further crop water stresses. The higher bulk density, in combination with an absence of worm burrows, will tend to limit root growth and this will induce further crop stress as competition for nutrients from a smaller soil volume is heightened.

As the rate of water movement through the soil profile is slowed and the soil water storage capacity reduced, an increase in the ratio of surface runoff to rainfall is likely. More water travelling rapidly over the soil surface to recharge river networks would increase the flood risk. Under flood conditions, increased transport of solutes, such as agrochemicals (pesticides and fertilisers), to surface water courses would increase surface water pollution. Greater volumes of water travelling over the soil surface would accelerate soil erosion and increase sediment transport to rivers.

The amelioration of these predicted hazards may be so costly as to be uneconomical and the reversal of these processes would be achievable only in the long term. The impact on the environment may be devastating as soil erosion, waterlogging and pollution become more pronounced. Agricultural and horticultural productivity may be reduced significantly. The financial cost of remediation to both the agricultural and urban communities may reach astronomical proportions as flooding becomes more commonplace. The lack of scientific information as to the influence of these changes on large-scale processes implies a necessity for further research on which to base a counter assault in defence of the indigenous earthworm.

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