Biotic and abiotic drivers of the burrowing behaviour of signal crayfish (Pacifastacus leniusculus): USA (native) versus UK (invasive) populations

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Aims

The invasive signal crayfish (*Pacifastacus leniusculus*) is recognised as an important driver of fine sediment dynamics in rivers, and their novel burrowing behaviour in British rivers likely reduces bank stability and may lead to accelerated bank collapse. Experiments undertaken in the UK indicated that river substrate and crayfish population density were important for determining burrowing behaviour, but there was no difference between different tested UK populations from rivers where burrows were present and where burrows were absent. This suggests that burrowing is not a learned behaviour, and thus burrowing and associated geomorphic effects may be observed from any expanding or transplanted population. This research aimed to examine the comparative potential zoogeomorphic effects of crayfish from a range of source populations, including signal crayfish from their native range.

Methods

An identical set of experiments were undertaken to those in the UK but with crayfish from their native range and an invaded river in Montana, USA. A bentonite clay 'riverbank' was installed at one end of 16 mesocosms, with experimental treatments of an alternative shelter (large cobble, deep silt substrate, no shelter), different crayfish population densities (one, two or four crayfish), and crayfish from different source populations (native and invasive, Montana, USA) were tested in a factorial manner. These results were compared with those from the two tested British invasive populations.

Main Findings

Crayfish from all four populations constructed burrows in the experiments. This demonstrates that all signal crayfish have the capacity to undertake geomorphic work. The mass of sediment excavated by crayfish was inversely proportional to the relative establishment of the invasive population (Figure 1). In experimental conditions, there was no difference in burrowing activity between the native population and the most strongly established British invasive population. The most recently introduced population, in Montana, USA, excavated the greatest mass of riverbank sediment. Animals are able to change their behaviour upon becoming invasive, but this is the first quantification of an entirely new behaviour exhibited *in situ* only by invasive populations in comparison with native populations. The fact that crayfish that did not burrow in the field, but were able to burrow in mesocosms, suggests extreme behavioural plasticity, where the geomorphic effects of invasive species can change over time. Whilst burrows have only previously been observed in the UK, signal crayfish are invading new territory throughout Europe and the USA, where potential burrowing may have substantive geomorphic effects. These results enable for future spatial and temporal sediment modelling considering the further spread of signal crayfish invasion considering all source populations.

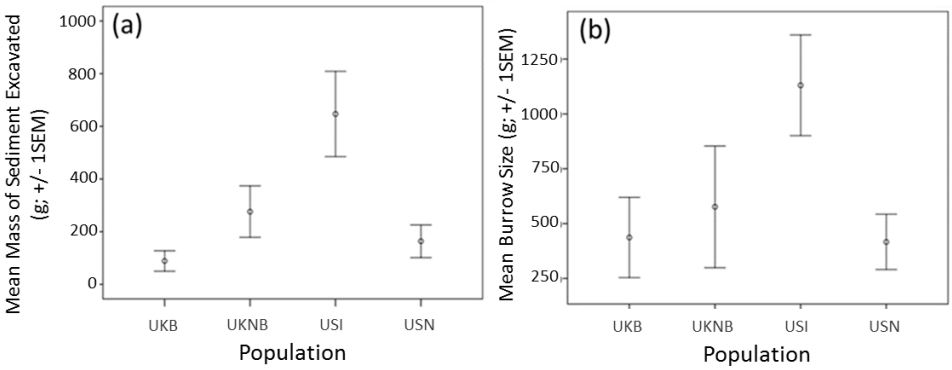

Figure 1. The (a) mean mass of sediment excavated and (b) mean burrow size constructed by signal crayfish from the UK where burrows were present (UKB) and absent (UKNB), the USA invasive population (USI) and the USA native population (USN) of signal crayfish.

Value of BSG grant

The BSG grant funded travel to Montana State University, USA, and pump primed funding from other sources (Santander, RGS, and the Loughborough University Seed-corn Fund) for accommodation and equipment. The results of this project formed the basis of a key chapter of my PhD, and a second chapter using the methods and equipment established here. The results of this project were presented at the London Freshwater Group (March 2019), the Symposium for European Freshwater Science (June 2019), and the American Geophysical Union fall meeting (December 2019). From my visit to Montana State University, I have fostered multiple international connections and future collaborations. These results have formed the basis for a manuscript currently in preparation.