Ecological Functions of Slug Mucus: Understanding the Behaviour of the EU Protected Kerry Slug, *Geomalacus maculosus*

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Abstract

The mating system and ecological role of the EU-protected Kerry slug Geomalacus maculosus remains largely unknown. I tested hypotheses on the ecological function of slug mucus and found that slugs can (1) detect and recognize conspecifics based on cues in mucus, and (2) potential predators can detect slugs using the same cues. Furthermore, slugs can detect possible predators based on residual kairomones, suggesting the evolution of a basic avoidance response to generalist predators. This research represents the first steps to generate data on the behaviour of this rare species. Future work will include field studies and predictive modelling of population dynamics under different climactic and ecological scenarios.

1. Introduction

Terrestrial gastropods exude mucus for locomotion, protection against desiccation and locating home areas or possible mates. All terrestrial gastropods are hermaphroditic and can either self-fertilise or outcross with a mating partner. Self-fertilisation can incur fitness costs via increased energetic investment and inbreeding depression. Thus simultaneous hermaphrodites should possess mechanisms to locate mates, and to locate mates of the correct species. The Kerry slug *Geomalacus maculosus* is a rare EU-protected terrestrial slug which was historically restricted to SW Ireland and NW Iberia. Though Iberian populations are in decline, *G. maculosus* is expanding its range in Ireland, and is now found in Co. Galway and possibly in other parts of the country. The mating behaviour of *G. maculosus* has not been formally described. Furthermore, only one record of predation on the Kerry slug has been recorded. In order to understand any potential impact the slug may have on invertebrate communities in novel habitats, data on the basic biology of this species are required.

2. Materials and Methods

Slugs and beetles were isolated into individual containers for 48hr prior to each trial, and maintained in a dark cupboard (experiments had to be performed using infrared cameras in darkness). Individual animals were then allowed to crawl over 10.5 x 21cm sections of moistened filter paper. Additional sections were moistened but not exposed to any animals, resulting in a 21cm^2 arena which was 50% animal exposed paper and 50% untreated control paper. Three experiments were performed, recorded and analysed using Tracksys Ethovision behavioural capturing software.

(1) Mate Location Assay:
Slugs were caught in Oughterrard, Co. Galway, and Co. Cork, and maintained in containers with a substrate of moist paper. All slugs were fed organic carrots for 1 month, and then starved for 48hr prior to experiments. Individuals were tested in arenas (described above) for 2hr trials and their duration and movement in each treatment zone (mucus vs. untreated) was examined.
(2) Prey Location Assay:
Pterostichus niger beetles were live-caught using pitfall traps beside the river Corrib on NUI Galway campus grounds. They were fed live worms and minced beef ad-libitum and maintained in containers with a 3cm layer of compost as substrate. None were exposed to slugs while kept in the laboratory.
(3) Predator Detection Assay:
Beetles were maintained in containers on 10.5 x 21cm sections of moistened filter paper prior to the experiment. The paper was then removed and placed in the arena in the same manner as described above. Slugs were isolated into individual containers for 48hr prior to experiments. No slugs had been previously exposed to beetles. As with the mate location assay, slug behaviour was examined in arenas under two treatments (beetle kairomone exposed paper vs. untreated).

Results:

The Kerry slug spent significantly more time in areas treated with conspecific mucus than untreated areas. Furthermore, *G. maculosus* spent significantly more time on filter paper sections treated with conspecific mucus than those treated with the mucus of an unrelated slug species *Limacus maculatus*, suggesting that the Kerry slug possesses a mechanism to discriminate species based on some cue in pedal mucus, and that the slugs may use these cues to locate potential mating partners in the wild.
The carabid beetle *P. niger* showed increased activity and spent more time in areas treated with slug mucus than untreated areas, suggesting that this generalist feeder may be a predator of *G. maculosus* in nature.
Kerry slugs could also detect the presence of the predatory *P. niger* based on residual kairomones left on moist filter paper. Slugs spent significantly less time in beetle-exposed areas, and showed increased velocity and turning rates overall, suggesting a general anti-predator kinesis. I plan on incorporating mating and predation data, as well as field data, as parameters in predictive models to understand how slug distribution may change in the future.