Título: EFFECTS OF CLIMATE CHANGE ON TERRESTRIAL SLUGS AND THEIR PREDATORS

Nombre: El-Danasoury, Heba-T-Alla

Universidad: Universidad de Santiago de Compostela

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Dirección:

> **Director:** Francisco Javier Iglesias Piñeiro

Tribunal:

> **presidente:** José Castillejo Murillo

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> **vocal:** Marta González Warleta

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Resumen: As temperature is considered the most dominant environmental factor affecting the biology of ectotherms, it is expected that global warming will have a deep impact on their population dynamics, leading to invasions and spread of pests and diseases able to survive under warmer climatic conditions. A number of species of terrestrial slugs and snails are considered important agricultural pests because they cause serious damage to plants cultivated by man, affecting a wide variety of species and productive sectors. The slug Deroceras reticulatum (Müller, 1774) is a successful opportunistic and invasive species considered the most serious slug pest worldwide.

The most common method of slug control is the use of chemical molluscicides, either metaldehyde or methiocarb. Both molluscicidal compounds have negative impacts on non-target organism, such as carabid beetles, which in turn are important predators of terrestrial gastropods, and also on domestic and wild animals. A chemical molluscicide with iron phosphate as active ingredient was thought to be safe to wildlife and domestic animals, but recent research have shown that it presents significant hazards to soil inhabiting invertebrates, domestic animals and human child. Regarding natural enemies, slugs and snails are preyed upon by a wide

range of both vertebrates and invertebrates, and are parasitized by a number of dipterans, nematodes and mites. Carabid beetle predators and parasitic nematodes are regarded as the most promising biological control agents.

The main objective of this PhD work is to explore potential changes in the feeding behaviour of the pest slug Deroceras reticulatum, as well as in the behaviours of some of their most important natural enemies, under climatic conditions predicted for Galicia by the last third of the century. The studied natural enemies were the carabid beetles Harpalus rufipes (De Geer, 1774) and Poecilus cupreus (Linnaeus, 1758), and the slug parasitic nematode Phasmarhabditis hermaphrodita Schneider, 1859). In order to achieve this general objective, different experiments were performed under laboratory controlled conditions and under semi-natural conditions.

Chapter 1 reports two experiments designed to assess the behavioural response of D. reticulatum to different climate manipulations in terms of herbivory, by measuring the damage inflicted by slug populations to lettuce seedlings. The results showed significant changes in the feeding pressure exerted by D. reticulatum under predicted climatic conditions, pointing to a higher potential of the species for crop damaging.

Chapter 2 reports a series of laboratory experiments designed to assess the capability of the carabid beetle H. rufipes to kill eggs and different-sized D. reticulatum slugs. The results showed that H. rufipes is able to kill considerable amounts of eggs and small juveniles of D. reticulatum, both in no-choice and in choice situations, suggesting that this beetle might realise an important contribution to the control of D. reticulatum populations.

Chapter 3 reports two experiments designed to examine the effect of temperature on the predatory activity of the carabid beetles H. rufipes and P. cupreus on the eggs of D. reticulatum. H. rufipes killed more eggs than P. cupreus and its predatory activity significantly increased with increasing temperature, suggesting that biological pest control performed by H. rufipes upon D. reticulatum may be enhanced under predicted climate warming conditions.

Chapter 4 reports an outdoor experiment comparing the performance of the slug biocontrol agent nematode P. hermaphrodita, under normal winter conditions and under winter warming conditions. The results suggest that P. hermaphrodita may perform better in controlling D. reticulatum populations, under predicted conditions of winter warming.

Overall, from the obtained results it should be expected that both the pest slug D. reticulatum and its natural enemies H. rufipes and P. hermaphrodita will be affected by predicted conditions of climate. Specifically, it should be expected a higher potential of D. reticulatum populations for crop damaging, and an enhanced performance of H. rufipes and P. hermaphrodita as biological control agents of D. reticulatum. In turn, these findings emphasize the importance of taking into account natural enemies and ecological interactions when modelling the response of species to climate change.