JUVENILE KERRY SLUGS (*GEOMALACUS MACULOSUS*) OBSERVED LIVING INSIDE FUNGAL FRUITING BODIES FOR THE FIRST TIME

The Kerry slug *Geomalacus maculosus* Allman is listed on Annexes II and IV of the EU 'Habitats Directive' (92/43/EEC) on the basis of its globally rare distribution (occurring in the West of Ireland and North-Western Iberia only). The species was previously believed to be associated with pristine oak-ash woodlands and peatlands in the South-West of Ireland[1, 2] but planted conifer forests have recently been recognised as an important additional habitat for Irish *G. maculosus* populations[3, 4, 5, 6]. Within forested habitats, *G. maculosus* has been reported to feed predominantly upon epiphytic lichens and liverworts, and occasionally on mosses and fungi[2]. Here we describe observations of juvenile *G. maculosus* feeding on, and living within fruiting bodies of mushrooms in a commercial conifer plantation in Co. Galway, Ireland. The mushrooms were identified as 'brittle-gills' belonging to the genus *Russula* Persoon but it was not possible to determine species due to the advanced age of the specimens[7].

Geomalacus maculosus juveniles (body lengths between 0.5–2cm) were observed feeding on the mushrooms on 18/10/2017 in a monoculture stand of Sitka spruce *Picea sitchensis* Carriere. A qualitative survey for *G. maculosus* was then undertaken on all *Russula* spp. mushrooms in the immediate vicinity (an area of approx. 100m^2). Five clusters of *Russula* spp. mushrooms were found in this area with each cluster consisting of 2–5 individual *Russula* spp. mushrooms. In total, 16 individual mushrooms were examined for the presence of *G. maculosus*. In every case, juvenile *G. maculosus* specimens were found on the external surface of the mushrooms and no other animal species were observed. Five of the larger *Russula* spp. mushrooms were also noted to have cavities leading inward from the hymenium (e.g. Fig. 1a). Juvenile *G. maculosus* were found resting inside the *Russula* spp. fruiting body when mushrooms containing these cavities were manually broken apart (e.g. Fig. 1b). Each of these five mushrooms contained juvenile *G. maculosus* feeding internally at densities of between 3–5 slugs per mushroom. This is a newly described feeding behaviour for *G. maculosus* and suggests that juveniles may use *Russula* mushrooms as a habitat, as well as a food source during Autumn.

Geomalacus maculosus populations undergo two reproductive events annually: once in mid-Autumn and once in mid-Spring[1,2]. The timing of reproductive events in slugs is influenced by a combination of interacting external cues such as temperature, photoperiodicity and moisture[8] Many animals have evolved phenological patterns that optimally match the seasonal occurrences of crucial ecological resources, so that the timing of reproductive events, for example, corresponds to an abundance of available food resources for newly-recruited juveniles[9].

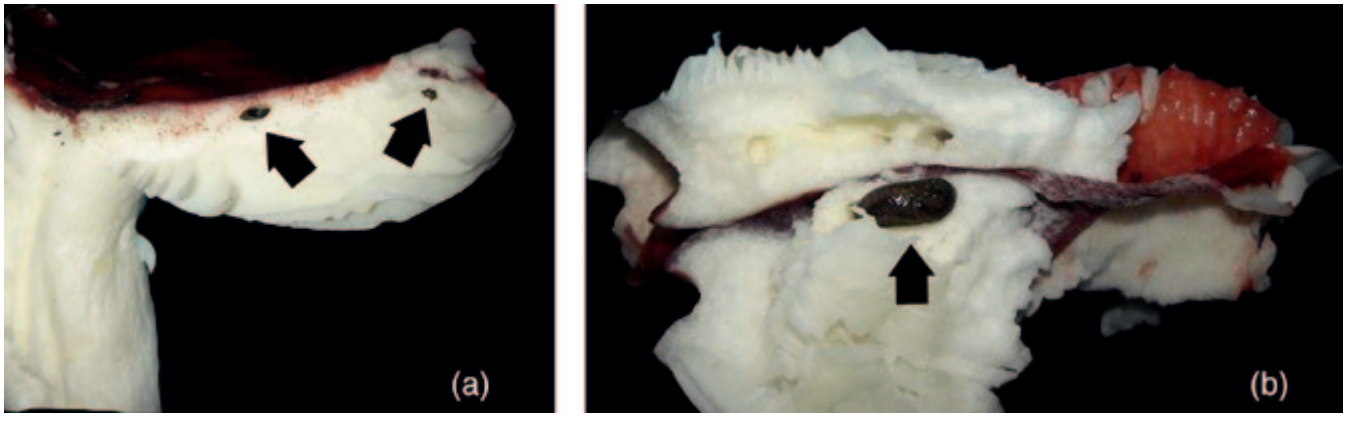

Figure 1 (a) Entrance cavities (arrows) caused by juvenile *G. maculosus*; and (b) the same *Russula* spp. mushroom broken open to show juvenile *G. maculosus* (arrow) resting inside

Jennings and Barkham[10] observed that the diet of arboreal woodland slugs changed from predominantly plant material to fungi in Autumn which was explained by the seasonal abundance of mushrooms as well as wetter, cooler weather conditions which encouraged feeding activity on fungi on the forest floor. Macrofungi are known to be an important food source for many terrestrial molluscs[8, 11] but to our knowledge the utility of mushrooms as a possible habitat for developing juveniles has not been previously reported in the literature.

In this sense, mushrooms may act as "nurseries" or shelters for juvenile slugs, and provide a high source of protein and carbohydrates to facilitate the rapid phase of post-embryonic development occurring within the first 3–6 months of growth in arionid slugs[8, 12].

Iberian *Geomalacus maculosus* populations are red-listed due to declines in their Iberian distribution and abundance[13] which places greater international significance on maintaining Irish populations as they become increasingly more important in a global context. The discovery of juvenile *G. maculosus* living inside *Russula* mushrooms can contribute to the conservation of this internationally-protected species in two ways, pending further replicated surveys. Firstly, forestry managers could consider postponing tree-felling operations in Autumn when *Russula* mushrooms are abundant in forests where *G. maculosus* occurs. Secondly, examining the conspicuous red *Russula* mushrooms for juvenile slugs could be a useful and relatively rapid additional survey technique for professional ecologists who may need to confirm the presence of *G. maculosus* as part of environmental assessment procedures.

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