

# Revised distribution and habitat associations for the protected slug *Geomalacus maculosus* (Gastropoda, Arionidae) in Ireland

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The arionid slug *Geomalacus maculosus* is restricted globally to Ireland and northern Iberia and the species is protected under both European and Irish legislation. Surveys in Cos Cork, Kerry and Galway in Ireland during 2009 and 2010 recorded the species from a total of 43 hectads (10km grid squares) and from a range of habitats including deciduous forest, blanket bog and heath. We also found *G. maculosus* in conifer plantations and clearfell sites in seven hectads in Cos Cork, Kerry and Galway, and on wet grassland in Co. Kerry. The species requirement for nearby standing or flowing water was not supported by our sampling as we collected it from areas where there were no obvious waterbodies. Nevertheless, the above data comprise a range of 4300km<sup>2</sup> in the three counties and include three hectads (V55, V64 and V72) where the last records are pre-1970. In addition, *G. maculosus* was found in six hectads (Q91, V48, V82, V93, V94 and V97) where there are no previous records of the species.

*Key words:* Gastropoda, Arionidae, *Geomalacus*, Kerry slug, ecology, distribution, Ireland.

## INTRODUCTION

The Kerry slug, *Geomalacus maculosus* was first discovered in Co. Kerry, Ireland in 1842 and described as a new species in 1843 (Allman, 1843). Today, its global distribution is northern Iberia and Ireland (Platts & Speight, 1988; Kerney, 1999) and it is protected under Appendix II of the Bern Convention and in Annex II and Annex IV (a) of the EU Habitats Directive 92/43/EC. Under Irish legislation, the slug has further protection under the Wildlife Act 1976 under Statutory Instrument No. 112 of 1990 and seven Special Areas of Conservation (SACs) have been designated for its conservation (NPWS, 2010).

Historically, within Ireland *G. maculosus* has been considered to be restricted to the Devonian Old Red Sandstone strata of West Cork and Kerry where it occurs in three general habitat types. These are deciduous woodland (usually *Quercus* dominated); blanket bog or unimproved oligotrophic open moor; and lake shores (Platts & Speight, 1988; NPWS, 2010). Within these habitats, the species tends only to be present if there is outcropping of Devonian Old Red Sandstone, humid conditions and lichen, liverwort and/or

mosses in which the species shelters and feeds (Platts & Speight, 1988). However, *G. maculosus* has also recently been collected on both granite outcrops on blanket bog and from a conifer plantation in Lettercraffroe, Co. Galway (Kearney, 2010). Throughout its Irish range, specimens that occur in woodlands tend to be brown with yellow spots whereas in more open situations specimens tend to be grey/black with white spots (Fig. 1)(Platts & Speight, 1988; Taylor, 1906).

Since its discovery in Ireland, *G. maculosus* has been recorded from 52 hectads (10km grid squares – see Fig. 2) but in seven of these, the species has not been collected since 1970. This provided the incentive for the current study where all 52 hectads were resurveyed. In addition, apparent gaps (e.g. hectads V97, V94, V93 and V82) and eastern limits (e.g. hectads W37, W36 and W35) of the range of the species were also searched. Finally, we surveyed the area in Oughterard, Co. Galway where the slug was recently found (Kearney, 2010) in an attempt to determine the extent of its occurrence there.

#### MATERIALS AND METHODS

34

Diurnal activity is relatively common for *G. maculosus* during wet weather (Platts & Speight, 1988; Taylor, 1906) and as a result hand searching was carried out during such conditions to maximize the likelihood of finding specimens. At each site, outcrops or tree trunks were scanned or searched for approximately 45 minutes. Searching for the species in woodlands involved checking under ‘carpets’ of epiphytic bryophytes and lichens growing on tree trunks while on blanket bogs and heaths, specimens were often found by searching between the vegetation and the base of sandstone outcrops. In some instances, records were also generated during separate population dynamics investigations from traps specifically designed to collect *G. maculosus* (Mc Donnell & Gormally, 2011a, 2011b; O’Meara, 2011). As soon as a specimen was located in a hectad, its presence there was confirmed and the square was not revisited. If the species was not found, then a minimum of two sites were checked for each hectad.

Public participation in the survey was encouraged by establishing a project website ([www.kerryslug.com](http://www.kerryslug.com)). The web-

site contained background information on the ecology of *G. maculosus*, diagnostic information on how to correctly identify the species, information on its distribution and how to contact the project team. An ecological information leaflet on *G. maculosus* was also distributed to relevant stakeholders (including National Parks and Wildlife Service Rangers in Cos Cork and Kerry; Killarney National Park Education Centre, Co. Kerry and Irish malacologists) and was made available for download from the project website and also the website of the Conchological Society of Great Britain and Ireland. Finally, popular press articles were published in national and local newspapers which advertised and provided information on the survey.

Members of the public submitting records were required to include a photograph of the specimen as this enabled the project team to confirm the identification of the species. In addition, if the record was from a hectad where the species had not been previously collected, we visited the new locality in an attempt to confirm its presence. Supplementary Information 1 shows a map of numbered Irish hectads. Presence and absence date locality data generated during our surveys are presented in Supplementary Information 2 and Supplementary Information 3.

#### RESULTS AND DISCUSSION

During the survey, *G. maculosus* was recorded from a total of 43 hectads in Ireland and from a range of habitats including deciduous forest, blanket bog and heath (Fig. 2). Specimens were also observed in habitats previously considered unsuitable for the species including commercial conifer plantations, clearfell sites and wet grassland (Supplementary Information 2). These data comprise a range of 4300km<sup>2</sup> and include three hectads (V55, V64 and V72) where the last records are pre-1970 and six hectads where there are no previous records of the species (Fig. 2). These new hectads include reported gaps in the range (V82, V93, V94 and V97) highlighted in the recent Kerry Slug Threat Response Plan (NPWS, 2010) and hectad V48.

Of particular interest are the records of *G. maculosus* in hectads M03 (Co. Galway) and Q91 (Co. Kerry) where the species was collected in commercial conifer plantations (pri-



Fig. 1. Woodland (left) and open (right) forms of *Geomalacus maculosus*.

marily comprised of *Picea sitchensis* and *Pinus contorta*). The species was first reported in M03 by Kearney (2010) and we recorded it consistently there on conifers and on granite outcrops on blanket bog from January 2010 to February 2011. Until the recent discovery of the species in Co. Galway, *G. maculosus* was thought to be found in Ireland solely in areas where the underlying geology was sandstone. Its presence on granite, therefore, raises questions about its reported habitat and geological specificity in Ireland. To help address this issue it is useful to examine the geological associations of the species in northwest Iberia where *G. maculosus* has been recorded on granites, slates, quartzite, schists, gneiss and serpentine (Castillejo et al., 1994) so its presence on granite in Co. Galway then may be considered relatively unsurprising. Nevertheless, this association has obvious implications for future national surveys and the conservation of the species in Ireland.

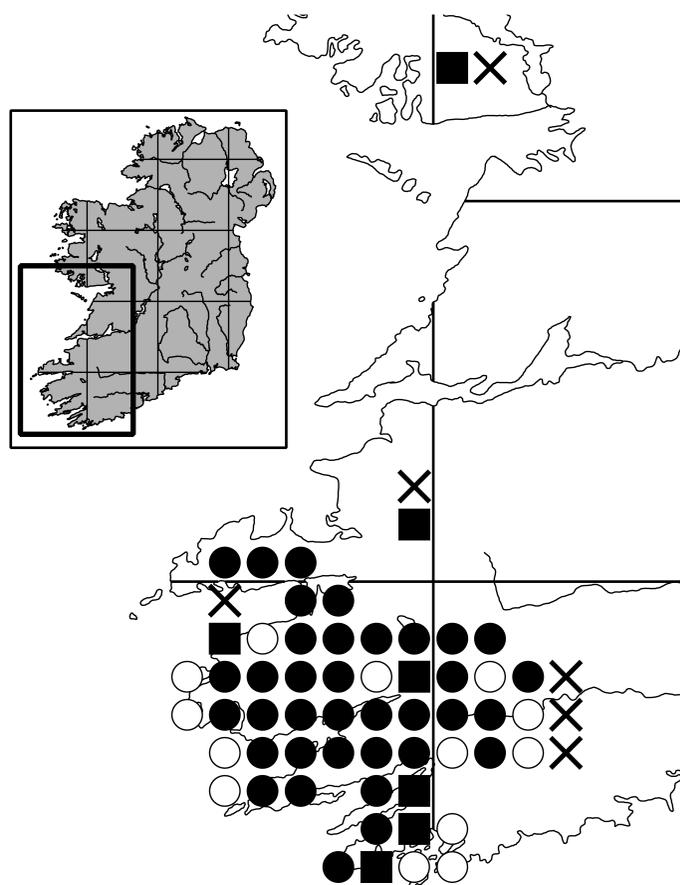
The presence of *G. maculosus* in hectad Q91 is also of note as this area was outside of the previously known range of the species in Co. Kerry. Interestingly, this record is also from a conifer plantation similar to the habitat where *G. maculosus* was found in Co. Galway (Kearney, 2010). In fact,

we have also collected the species from the trunks of conifers in a quantitative study at Glanteenassig Forest (hectad Q51) in Co. Kerry (Barrett, 2011) and from conifer plantations in hectads V46, V47, V69, V77 and V94. We therefore conclude that conifer plantations are a suitable habitat for the species in Ireland.

Why *G. maculosus* is restricted to the southwest (Cos Cork and Kerry) and west (Co. Galway) of Ireland is an important question to address in terms of the conservation of the species. According to Rodriguez et al. (1993) the species has a preference throughout its Irish and Iberian range for an Atlantic climate where mean annual rainfall is above 1000 mm and mean annual temperature lies between 8°C and 12°C. The entire Irish west coast falls into this meteorological category ([www.meteireann.ie](http://www.meteireann.ie)) which helps explain its presence in Cos Cork, Kerry and Galway but it does not account for its absence in other areas of the west where suitable geology, climate and habitats exist. This would suggest that some other factors are involved in determining the Irish distribution of *G. maculosus*. One possibility that needs to be considered is that the species native range in Ireland is the southwest and that it was inadvertently introduced to Co. Galway (e.g. during forestry operations) but to test this hypothesis detailed information regarding its range in Connemara and a genetic comparison of populations from both areas would be necessary.

During surveys, juvenile slugs were regularly encountered during the day foraging on the north side of trunks, but on outcrops on blanket bogs and heaths, adults were more regularly observed and juveniles were seldom encountered. Platts & Speight (1988) stated that *G. maculosus* is rarely observed more than a few metres from standing or flowing water but this microhabitat association was not supported by our sampling as we collected the species from areas where there were no obvious waterbodies, particularly in woodlands. Occasionally, we found the woodland form (brown and yellow) in more open situations (e.g. blanket bog) and the open form (black and white) in wooded areas.

A range of sites in other hectads were also visited during wet, overcast conditions but no specimens of *G. maculosus* were located (Supplementary Information 3). These include hectads W35, W36 and W37 which are adjacent to the cur-



**Fig. 2.** Distribution map of *Geomalacus maculosus* in Ireland. Solid circles represent historical records confirmed during 2009-2011, hollow circles are historical records unconfirmed during 2009-2011, solid squares represent new records during 2009-2011 and X's are hectads where no specimens were collecting during our surveys.

rent eastern range limit of the species in Ireland and V36 where the species has been reportedly collected (Kerney, 1999) but has not been verified (NPWS, 2010). While, *G. maculosus* was not found in thirteen hectads where there are previous records for the slug, it was collected in six new hectads during this survey. Without further resources which would permit more extensive searching of the thirteen hectads, it would, at this stage, be unwise to make a definitive

pronouncement regarding the current conservation status of the species. However, it is important to bear in mind that there were suitable geology and habitats within these hectads and consequently, they should be a priority for future survey efforts. Also, given that the species can survive in commercial conifer plantations, we also suggest that future national surveys for *G. maculosus* target this habitat throughout the country.

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