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THE STAPHYLINID AND CARABID (COLEOPTERA) FAUNA OF A RESTORED *MOLINIA-JUNCUS ACUTIFLORUS* GRASSLAND IN CO. CORK, IRELAND

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Abstract

An ungrazed *Molinia*-dominated wet grassland plot was restored in 2004 at a lowland farm in Co. Cork, Ireland, by removal of *Molinia* tussocks, re-instatement of grazing with traditional Kerry and Shorthorn cattle, and very occasional cutting. The 0.1ha plot, and adjacent unrestored dense *Molinia* and *Salix* carr, were suveyed for staphylinid and carabid beetles in 2019-2020. In total, 85 species of staphylinid and 28 species of carabid were recorded, of which 72 and 21 species, respectively, occurred in the restored plot, and 47 and 22 species, respectively, occurred in the unrestored dense *Molinia* and *Salix* carr. There was a high species diversity of *Philhygra* (Staphylinidae) (n = 8 spp.) in the site. Three species (*Acupalpus dubius*, *Philonthus fumarius*, *P. micantoides*) were recognised as being potentially dependent on the open grazed sward, and consequently susceptible to being extirpated by long-term grazing abandonment. Eight species of Carabidae, and 15 species of Staphylinidae, were recorded from emergence traps, but not from pitfall traps, demonstrating their value as a supplementary sampling technique to pitfall traps. The scydmaenine *Stenichnus collaris subseriatus* is recorded from Ireland for the first time.

Key words: Staphylinidae, Carabidae, *Molinia-Juncus acutiflorus*, habitat restoration, semi-natural grasslands, Kerry cattle, *Stenichnus collaris subseriatus*, first record.

Introduction

Extensively-grazed semi-natural grasslands are declining in Ireland and elsewhere due to the twin processes of agricultural intensification and abandonment of grazing (Bignall, 1998; Strijker, 2005; O'Neill *et al*., 2013; Uchida and Ushimaru, 2014; Rūsiņa *et al*., 2024). While the impacts of abandonment of extensive grassland management on biodiversity are well known to be negative (e.g. on flowering herbs and their pollinators, on insolation-requiring insects like butterflies and solitary bees, on short-turf feeding birds such as chough), less is known concerning impacts on epigeal invertebrates. Here, the results of a survey of the staphylinid and carabid fauna of a restored *Molinia caerulea/Juncus acutiflorus* grassland plot on a gley soil in south Cork, are reported. The restoration from an ungrazed *Molinia caerulea/Rubus fruticosus*

vegetation (Plate 1) being invaded by young *Salix cinerea* and *Betula pubescens*, was carried out by the removal of the *Molinia* tussocks (Plate 2) and young tree saplings, and reinstatment of grazing by traditional Kerry and Shorthorn cattle breeds (Plate 3), and with very occasional cutting in September.

The aim of the survey was to provide a baseline, for this site, of species which are likely to prefer restored *Molinia-Juncus acutiflorus* habitat as opposed to abandoned dense *Molinia* and *Salix* carr. In addition, the survey provides data on the alpha-diversity of wet grassland staphylinid and carabid beetles in this type of habitat, and adds to the relatively poorly known staphylind and carabid fauna of Co. Cork.

Methods

Study site

The surveyed site was an isolated *circa* 6.75ha area of wet woodland and wet grassland near Riverstick in south Co. Cork (see Good, 2001), and focussed on a 0.1ha plot in the townland of Boulaling (*Buaile Fhlainn*) (51.77939 latitude -8.483721 longitude) (Irish Grid Reference W666586), and nearby unrestored dense *Molinia* and *Salix* carr.

The restored plot was in an area of groundwater gley soil which supported *Molinia caerulea – Juncus acutiflorus* vegetation. Several attempts to partially drain this area, using clay pipes (19th century), and a deep main drain (1981), did not much affect the plot due to its location and the impermeable nature of the subsoil. In 1992, significant livestock grazing ceased in the plot, but was restored in 2004, followed by removal of *Molinia* tussocks and briars which had overgrown the area (Plate 1). The tussocks were removed by being pushed forward and up by a mini-excavator bucket (Plate 2), rather than being dug out, thereby minimising soil disturbance and colonisation by *Juncus effusus* rushes. The plot was subsequently grazed until 2019 by Kerry bullocks (Plate 3), a locally-adapted endangered breed of cattle (Browett *et al*., 2018), accompanied by several Shorthorn suckler cows. The cattle grazed the wet grassland in the area as part of a wider 12ha range mostly including organically-managed pasture on podzolic soil (with *Agrostis stolonifera*, *Anthoxanthum odoratum*, *Holcus lanatus* and *Lotus pedunculatus* dominating), at a stocking rate of < 1.0 LU/ha. The greatest intensity of grazing in the plot occurred during the winter and spring, due to the abundance of preferred forage in the *Anthoxanthum-Agrostis* pasture later in the season. In occasional years when the soil was sufficiently dry in September, the plot was also topped to allow greater light penetration to the sward.

The vegetation (Table 9) was a mixture of *Juncus acutiflorus/articulatus – Holcus lanatus* grassland and *Molinia caerulea – Potentilla erecta* grassland (sensu O'Neill *et al*., 2013; see also Blackstock *et al*., 1998). For the purpose of this survey, three different restored areas were identified: (a) a sward characterized by frequent *Anthoxanthum odoratum*; (b) a flushed area

dominated by *Juncus acutiflorus*; and (c) a drier area characterized by frequent *Potentilla erecta* (see Table 9). In addition, two unrestored sites were sampled: (d) an adjacent area with dense *Molinia* tussocks, and briar adjacent to young *Salix cinerea* and *Betula pubescens*; and (e) an area of mature *Salix cinerea* carr *circa* 50m from the plot, with a shaded mossy groundlayer (Table 9).

Sampling methods

Each of the above five areas was sampled for Staphylinidae and Carabidae using two methods, pitfall traps and emergence traps. Four glass pitfall traps (with an inner diameter of 47mm) and 50% ethylene glyocol preservative were set in each habitat category (from 2 May to 16 July 2020), ensuring that a lip of soil covered the glass rim. Two emergence traps (covering an area of *circa* 1m^2) were operated in each habitat category from 2 May to 14 June 2020. The traps were made from malaise trap materials (including collecting bottle) (see Fig. 17 of Speight (2008)). One emergence trap was extensively torn (probably due to mammal activity) and had no sample (in the *Salix* carr, June 2020). However, as the data are not for quantitative comparison, this is less significant. Emergence traps were also used in autumn (11 August - 28 September) 2019.

Samples were also taken using an 'S-vac' suction sampler (a modified Stihl leaf-blower; see Good and Butler (2001)), with a *circa* 4m^2 sampled area for each sward type. Unfortunately, due to a failure of the engine, only samples from two of the sward types were taken.

Identification

Identification of Carabidae and Staphylinidae was undertaken using several works, but primarily Luff (2007), and Brundin (1942), Palm (1970), Lott and Anderson (2011) and Duff (2024), respectively. Nomenclature follows the checklist in Duff (2018), with two exceptions: (a) The Silphidae have recently been reclassified as a subfamily (Silphinae) of the Staphylinidae (Cai *et al*., 2022), supported by strong evidence that they evolved from within the Staphylinidae (Sikes, Thayer and Newton, 2024), and this is followed here with the inclusion of two silphine species; (b) *Mocyta* and *Philhygra*, listed as subgenera of *Atheta* in Schülke and Smetana (2015) and Duff (2018), have been recently reinstated as a genus by Muona (2024), a position also taken by Lee and Ahn (2012) and Klimaszewski *et al.* (2021).

Results

In total, 85 species of staphylinid and 28 species of carabid were found in the Boulaling site (Tables 1-7). Of these 72 species of staphylinid and 21 species of carabid occurred in the restored plot, and 47 species of staphylinid and and 22 species of carabid occurred in the unrestored dense *Molinia* and *Salix* carr. In the following paragraphs, the total in each category (restored swards (*Anthoxanthum* + flush + *Potentilla*) and unrestored habitat (dense *Molinia* + *Salix* carr) is given in parenthesis after each species (i.e. restored/unrestored); but bear in mind

that this is a 3/2 ratio of sampling effort.

Exceptionally high numbers of the large predatory species *Staphylinus dimidiaticornis* (222/2) were found in pitfall traps in the restored plot (Table 1). These data may be affected by trapping bias due to the greater ease of movement in open swards (see Heydemann, 1956; Thomas *et al*., 2006), as well as possible attraction to the ethylene glycol preservative. However, the exceptionally high numbers are unlikely to be just due to such bias, and the species is likely to genuinely prefer grazed wet grassland. *S. dimidiaticornis* is not listed as a wetland species by Lott (2003), and has been recorded as abundant in hay meadows dominated by *Holcus lanatus* and *Festuca rubra* (Good and Giller, 1990), in swamp/fen and lakeshore carr (Anderson, 1997), in ungrazed lakeshore *Sesleria* grassland near alder/willow carr (Good and Dorman, 2020), as well as running on woodland paths (Horion, 1965). It is consequently unlikely to be extirpated by the abandonment of grazing at this site.

Rybaxis longicornis (43/0) is a wetland species, but there are conflicting descriptions of its habitat in the literature. Lott (2003) cites moss and tussocks in carr, and Jeannel (1950) also mentions soil under old willows, whereas Horion (1949) cites wet meadows under moss and leaves, as well as margins of pools and ditches. Koch (1989) mentions both wet meadows and alder carr, as well as, especially, in the reed-zone of silting-up lakes and backwaters. It was likewise found to be abundant in the *Phragmites* reed-bed margin of Kilkeran Lake, West Cork (Good and Butler, 2000; J.A. Good, unpublished data). The results here (Tables 1, 3 and 5) would support a preferance for wet meadows, but, from the data in Lott (2003) and Jeannel (1950), it is also likely to survive in willow carr where grazing is abandoned.

Philonthus fumarius (22/2) is a wetland species and was recorded mostly in the flush (Tables 1 and 3). Horion (1965) and Koch (1989) mention its habitat in Central Europe to include alder carr, as well as marshes and muddy shores, but neither Lott (2003) nor Anderson (1997) mention carr, and they subsequently describe the species as frequent in nutrient-rich permanent mires (Lott and Anderson, 2011). Duff (2024) states it to be very local in Britain and Ireland apart from SE England.

Philonthus micantoides (29/4) was considered by Koch (1989) to be a stenotopic species of marshes and marshy and muddy shores of waterbodies, and by Lott (2003) and Lott and Anderson (2011) to occur in litter in fluctuating marsh. No records from carr were found in the literature.

Acupalpus dubius (85/10) was the only wetland carabid with distinctly higher numbers in the grazed plot (Tables 2, 4 and 6). For carabids, this may not be unexpected; in some other studies, species richness of carabid beetles did not show a clear response to the cessation of grazing (Meharg, 1988 (cited by McAdam and Montgomery (2000)); Pozsgai *et al*., 2022). The higher numbers of *A. dubius* in the grazed plot would appear to be a genuine effect, as the description of the habitat of this species emphasises short turf and open margins of pools (Lindroth, 1992),

and Anderson *et al*. (2000) mention warm (more insolated) marshy sites near coastal areas.

Philhygra diversity

Eight species of the genus *Philhygra* were recorded from the Boulaling site (Tables 1, 3, 5 and 7), representing 57% of the native Irish fauna of this genus (cf. Good and Anderson, 2017). Of these, two species, *P. gyllenhalii* and *P. hygrobia*, were not recorded from the restored plot. The habitats of the eight *Philhygra* species, as they apply to the Boulaling site, are as follows (data from Brundin (1942) (B), Koch (1989) (K), Lott (2003) (L), Palm (1970) (P), and Regan and Anderson (2004) (RA)):

Philhygra debilis: Marshy sedge-meadows (B, P); wet meadows, alder carr (K); riparian litter (L); *P. elongatula*: Eurytopic in wet or partially wet soils (P); wet meadows and alder carr (K); riparian and marsh litter (L); *P. gyllenhalii*: wet meadowland, small carrs with *Carex* and *Sphagnum* (P); marshes and alder carr (K), "above all in *Carex* meadows" (B); carr and marsh litter (L); *P. hygrobia*: wet and marshy habitats(P, K), carr litter (L); *P. malleus*: marshy and muddy water-margins (K), riparian and marsh litter (L); *P. obtusangula*: Carr litter (L), forest ponds and marshy soils (B, K, P), shaded pool margins (K); *P. palustris*: muddy shores of streams, in compost and old hay (P), fields and gardens on clay-rich soils, gravel quarries (K); riparian (L, RA); *P. volans*: marshy water margins (K), marsh and riparian litter (L).

The high species diversity of *Philhygra* (eight species) in such a small isolated area of wet woodland and wet grassland (6.75ha) is, at first, surprising. For instance, the intensively worked much larger Wicken Fen site in Norfolk (U.K.) contained, by comparison, nine species (Friday and Harley, 2000). However, in a comprehensive survey of the syrphid fauna of the farm between 2000 and 2002, ten species of the genus *Platycheirus* were recorded from the same 6.75ha area (Speight and Good, 2002). This, similarly, represents 50% of the Irish fauna of this genus (cf. Speight, 2008). Both indicate a diversity of microhabitats at this site, although the reasons for the coexistence of *Philhygra* species remain to be elucidated.

Philhygra obtusangula was abundant in the emergence trap samples from the *Salix* carr (Table 3), but absent from the pitfall and emergence traps in grazed plot (although two individuals were recorded here by suction sampling). This finding is in line with its reported habitat preference for carr and wooded wetlands (see above). Although it is not mentioned as notable in Great Britain (Hyman and Parsons, 1994), Duff (2024) describes *P. obtusangula* as very local. It requires more sampling in *Salix* carr to establish its status in south-west Ireland.

Philhygra gyllenhalii was considered an indicator species of high quality habitat by Good and Butler (2001). *P. hygrobia*, in contrast, was considered to be a notable species by Hyman and Parsons (1994). However, while *P. hygrobia* was reported in three wetland sites by Regan and Anderson (2004), *P. gyllenhalii* was not found. Here, it was only recorded from the *Salix* carr in emergence traps (and was also found in numbers in emergence traps in the same carr location in 2002 (J. A. Good, unpublished data).

Both *Philhygra debilis* and *P. palustris* appear to be local in both Great Britain and Ireland (Anderson, 1997; Regan and Anderson, 2004; Duff, 2024). However, *P. palustris* appears to be more eurytopic and not as restricted to wet meadows as *P. debilis*. *P. debilis*, being local and stenotopic, could be considered an indicator species for wet meadow habitat, but it was only represented by a single male, and given its recorded occurrence in alder carr, it could derive from this habitat (which is *circa* 100m from the sampled plot) or from nearby *Salix* carr.

Two *Philhygra* species, *elongatula* (n = 3) and *malleus* (n = 6) were only recorded from the grazed plot (Table 1, 3 and 5). They were by far the two most frequent species in wetland samples reported by Lott (2003), although *P. malleus* was also recorded frequently in swede fields in Norway (Andersen, 1985). It may be associated with the drained margins under *Salix* canopy more so than wet grassland.

Other species

Gabrius breviventer occurred in considerable numbers (n = 54) in emergence traps in the *Anthoxanthum* sward (Table 3), indicating breeding occured in this habitat, and that the species is less tolerant of wetter soil conditions.

The wingless *Geostiba circellaris* occurred in numbers, but only in pitfall traps and not in emergence traps, indicating its reluctance to climb, at least during the sampled months. This observation may be relevant to interpreting its dispersal mechanism(s).

Pterostichus rhaeticus was abundant in the *Salix* carr (Tables 1 and 3), but its sibling species *P. nigrita* was also provisionally identified in the same area as *P. rhaeticus*. The determination is provisional as the only reliable character distinguishing these two species in the inflated endophallus, and inflation is not possible in samples preserved in alcohol (Anderson, 2002). However, the co-occurrence of both species has been reported from Cos Galway and Tyrone (Anderson, 2002; Regan and Anderson, 2004), so this provisional determination may be correct.

Stenichnus collaris subseriatus, recorded from the *Salix* carr (Table 1), has not apparently been previously recorded from Ireland (Duff, 2024). This is recently cited as a valid species (e.g. Duff, 2024), although it has not yet been formally described as such (Sapieja, 2022). It was determined using the aedeagal illustrations in Sapieja (2022) and Duff (2024).

Emergence traps

Eight species of Carabidae, and fifteen species of Staphylinidae, were recorded from emergence traps (May-July) (Tables 3 and 4) but not from pitfall traps (Tables 1 and 2), despite the sampling effort for the latter amounting to 320 trap-days. This demonstrates the value of small emergence traps as a supplement to pitfall traps. Nine species were only recorded from emergence traps operated in autumn (Tables 5 and 6). Regrettably, because of a machine fault, there was insufficient comparative data from the suction sampler. However, seven species of staphylinid were recorded only by this technique (Table 7), indicating that emergence traps are not a substitute for suction sampling.

Discussion

It was considered necessary to remove the *Molinia* tussocks because grazing intact *Molinia* alone was found to result in an insufficiently open sward. However, removal is likely to be a carbon-negative practice, because of the amount of carbon stored in the tussocks (Baggaley *et al*., 2021). Nevetheless, restoration of even a small area of *Molinia-Juncus acutiflorus* wet grassland, and grazing by cattle, clearly benefitted the biodiversity of the farm, with the flourishing of plant species like *Dacytlorhiza maculata* and *Scutellaria minor*. This was also shown by the high species diversity of both staphylinids and carabids recorded in the restored area, with species such as *Philonthus fumarius*, *P. micantoides* and *Acupalpus dubius* which may also be dependent on the open sward conditions. Speight (2008: 60) predicted two syrphid species, dependent on the wet grassland habitat, would be extirpated from the farm if this area remained disused in the long-term. For staphylinids and carabids, there may be further species in this category, if literature records of their occurrence in carr derive from beetles during the non-breeding part of their life cycle. Also, the south-facing flushes under *Salix* canopy, but adjacent to dense *Molinia* stands, may provide a more open habitat which is available now, but not in future decades during succession to tree cover. More data on the fauna of *Salix* carr microhabitats are clearly required to answer such questions.

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TABLE 1. Adult Staphylinidae from pitfall traps (May - July 2020) from a restored wet meadow (flush, *Anthoxanthum* sward and *Potentilla* sward), and unrestored adjacent habitats (dense *Molinia* tussocks and *Salix* carr).

	Restored			***Unrestored***	
Species	***Flush***	***Anth.***	***Pot.***	***Molin.***	***Salix***
Aloconota gregaria (Erichson)	1	-	2	-	-
Amischa analis (Gravenhorst)	-	-	-	1	-
Anotylus rugosus (Fabricius)	24	28	1	31	1
Astenus lyonessius (Joy)	-	2	-	-	-
Brachygluta fossulata (Reichenbach)	-	1	-	-	-
Bryaxis bulbifer (Reichenbach)	-	-	2	-	1
Bryaxis puncticollis (Denny) ♂	-	1	-	-	-
Calodera aethiops (Gravenhorst)	1	-	2	-	-
Callicerus obscurus Gravenhorst	-	-	-	1	-
Carpelimus corticinus (Gravenhorst)	5	7	5	11	-
Euconnus hirticollis (Illiger)	3	3	-	2	-
Gabrius breviventer (Sperk)	1	5	2	-	-
Geostiba circellaris (Gravenhorst)	2	1	6	8	5
Gyrohypnus angustatus Stephens	-	1	-	-	-
Habrocerus capillaricornis (Gravenhorst)	-	-	-	-	1
Ischnosoma splendidum (Gravenhorst)	-	2	1	1	3
Lathrobium brunnipes (Fabricius)	2	1	-	1	2
Lesteva sicula heeri Fauvel	-	-	-	5	-
Liogluta microptera Thomson	-	-	-	17	-
Mocyta amplicollis (Mulsant & Rey) ♂♂♀	-	6	-	-	-
Mocyta fungi (Gravenhorst)	2	3	-	3	-
Myllaena brevicornis (Matthews)	-	-	1	3	-
Ocypus aeneocephalus (DeGeer)	-	-	1	-	-
Oxypoda elongatula Aubé	-	-	1	-	1
Philhygra elongatula (Gravenhorst)	-	1	-	-	-
Philhygra hygrobia (Thomson)	-	-	-	-	1
Philhygra malleus Joy	3	-	-	-	-
Philhygra obtusangula Joy	-	-	-	-	4
Philhygra volans (Scriba)	1	-	-	1	-
Philonthus carbonarius (Gravenhorst)	-	-	1	-	-
Philonthus cognatus Stephens	-	-	1	-	-

TABLE 1 (Continued).

	Restored			*Unrestored*	
Species	***Flush***	***Anth.***	***Pot.***	***Molin.***	***Salix***
Philonthus fumarius (Gravenhorst)	9	-	-	-	1
Philonthus micantoides Benick & Lohse	1	1	-	-	-
Philonthus nigrita (Gravenhorst)	1	-	-	-	-
Phosphuga atrata (Linnaeus)	-	-	-	1	-
Pselaphus heisei Herbst	-	-	3	-	-
Quedius curtipennis Bernhauer	-	-	4	-	2
Quedius fuliginosus (Gravenhorst)	3	-	1	-	-
Quedius fumatus (Stephens)	-	-	-	-	1
Quedius semiobscurus (Marsham)	-	1	-	-	-
Reichenbachia juncorum (Leach)	-	-	9	-	-
Rugilus erichsoni (Fauvel)	-	15	5	-	-
Rybaxis longicornis (Leach)	2	27	9	-	-
Sepedophilus marshami (Stephens)	-	1	-	3	-
Sepedophilus nigripennis (Stephens)	1	3	1	1	-
Staphylinus dimidiaticornis Gemminger	17	99	104	1	1
Stenichnus collaris subseriatus Franz	-	-	-	-	2
Stenus bimaculatus Gyllenhal	2	2	1	12	6
Stenus brunnipes Stephens	-	1	2	-	-
Stenus fulvicornis Stephens	-	4	1	1	-
Stenus juno (Paykull)	3	-	-	1	1
Tachinus rufipes (Linnaeus)	6	5	-	27	-
Tachyporus dispar (Paykull)	-	5	2	-	-
Xantholinus longiventris Heer	-	9	3	-	-

TABLE 2. Adult Carabidae from pitfall traps (May - July 2020) from a restored wet meadow (flush, *Anthoxanthum* sward and *Potentilla* sward), and unrestored adjacent habitats (dense *Molinia* tussocks and *Salix* carr).

	Restored			*Unrestored*	
Species	***Flush***	***Anth.***	***Pot.***	***Molin.***	***Salix***
Abax parallelepipedus (Piller & Mitterpacher)	-	-	-	-	9
Acupalpus dubius Schilsky	2	4	21	2	-
Agonum emarginatum (Gyllenhal)	-	-	-	-	1
Agonum gracile Sturm	1	-	-	-	1
Anchomenus dorsalis (Pontoppidan)	-	1	-	-	-
Bembidon lampros (Herbst)	2	6	-	1	-
Bembidion mannerheimi Sahlberg	42	78	52	62	29
Carabus granulatus Linnaeus	5	-	1	2	1
Demetrias atricapillus (Linnaeus)	1	1	-	-	-

TABLE 2 (Continued).

	Restored			*Unrestored*	
Species	***Flush***	***Anth.***	***Pot.***	***Molin.***	***Salix***
Nebria brevicollis (Fabricius)	-	-	-	-	2
Oxypselaphus obscurus (Herbst)	-	-	-	-	2
Poecilus versicolor (Sturm)	-	-	1	-	-
Pterostichus diligens (Sturm)	2	1	-	1	-
Pterostichus minor (Gyllenhal)	5	-	-	-	4
Pterostichus ?*-nigrita* (Paykull)	-	-	1	-	2
Pterostichus rhaeticus Heer	4	-	-	-	25
Pterostichus strenuus (Panzer)	1	3	-	2	1
Pterostichus vernalis (Panzer)	-	-	1	-	-
Trechus quadristriatus (Schrank)	-	1	-	1	-

TABLE 3. Adult Staphylinidae from emergence traps (May - June 2020) from a restored wet meadow (flush, *Anthoxanthum* sward and *Potentilla* sward), and unrestored adjacent habitats (dense *Molinia* tussocks and *Salix* carr). Species not recorded in pitfall traps (Table 1) are marked with an asterisk.

	Restored			*Unrestored*	
Species	***Flush***	***Anth.***	***Pot.***	***Molin.***	***Salix***
Aloconota gregaria (Erichson)	-	1	-	-	2
Amischa analis (Gravenhorst)	-	2	2	-	1
**Amischa decipiens* (Sharp)	-	1	2	-	-
**Amischa nigrofusca* (Stephens)	-	-	1	-	-
Anotylus rugosus (Fabricius)	-	-	1	-	-
Astenus lyonessius (Joy)	1	-	-	-	-
**Atheta nigripes* (Thomson)	-	-	1	-	-
Calodera aethiops (Gravenhorst)	-	-	-	2	2
Carpelimus corticinus (Gravenhorst)	-	1	6	-	-
**Dinaraea angustula* (Gyllenhal)	-	-	1	-	-
**Fagniezia impressa* (Panzer) ♀	-	-	1	-	-
Gabrius breviventer (Sperk)	2	54	5	1	-
Mocyta amplicollis (Mulsant & Rey)	-	-	-	1	-
Mocyta fungi (Gravenhorst)	-	-	-	1	3
**Nicrophorus vespilloides* Herbst	-	-	-	1	-
Oxypoda elongatula Aubé	1	-	1	1	-
**Philhygra debilis* (Erichson)	-	-	1	-	-
Philhygra elongatula (Gravenhorst)	-	2	-	-	-
**Philhygra gyllenhalii* (Thomson)	-	-	-	-	6
Philhygra hygrobia (Thomson)	-	-	-	-	3
Philhygra malleus Joy	1	-	2	-	-
Philhygra obtusangula Joy	-	-	-	-	24
Philhygra volans (Scriba)	7	2	-	-	3
Philonthus cognatus Stephens	-	-	2	-	-

TABLE 3 (Continued).

	Restored			*Unrestored*	
Species	***Flush***	***Anth.***	***Pot.***	***Molin.***	***Salix***
Philonthus fumarius (Gravenhorst)	5	1	6	-	-
Philonthus micantoides Benick & Lohse	4	-	22	-	3
Philonthus nigrita (Gravenhorst)	1	-	-	-	-
Phosphuga atrata (Linnaeus)	-	-	-	1	-
Rybaxis longicornis (Leach)	-	-	5	-	-
**Sepedophilus littoreus* (Linnaeus)	-	-	1	-	-
Stenus bimaculatus Gyllenhal	-	-	-	-	1
Stenus fulvicornis Stephens	-	4	2	1	1
**Stenus picipes* Stephens	1	-	-	-	-
**Stenus nanus* Stephens	-	1	-	-	-
**Tachyporus chrysomelinus* (Linnaeus)	-	2	1	10	2
Tachyporus dispar (Paykull)	-	-	1	-	-
**Tachyporus hypnorum* (Fabricius)	-	1	-	-	-
**Tachyporus nitidulus* (Fabricius)	-	-	-	1	-
**Tachyporus pusillus* Gravenhorst	-	-	-	-	1

TABLE 4. Adult Carabidae from emergence traps (May - June 2020) from a restored wet meadow (flush, *Anthoxanthum* sward and *Potentilla* sward), and unrestored adjacent habitats (dense *Molinia* tussocks and *Salix* carr). Species not recorded in pitfall traps (Table 2) are marked with an asterisk.

	Restored			*Unrestored*	
Species	***Flush***	***Anth.***	***Pot.***	***Molin.***	***Salix***
Acupalpus dubius Schilsky	1	6	50	8	-
Agonum emarginatum (Gyllenhal)	1	-	-	-	1
**Amara familiaris* (Duftschmid)	-	-	-	-	2
**Amara lunicollis* Schiødte	-	-	-	1	-
**Amara plebeja* (Gyllenhal)	-	-	-	1	1
Bembidon lampros (Herbst)	-	-	-	-	1
Carabus granulatus Linnaeus	-	-	1	-	-
Demetrias atricapillus (Linnaeus)	-	-	-	1	-
**Leistus fulvibarbis* Dejean	-	-	-	-	2
**Loricera pilicornis* (Fabricius)	-	-	-	-	2
**Notiophilus biguttatus* (Fabricius)	-	1	-	-	-
**Paradromius linearis* (Olivier)	1	1	-	1	-
Pterostichus rhaeticus Heer	-	-	-	-	2
Trechus quadristriatus (Schrank)	-	-	-	-	1

TABLE 5. Adult Staphylinidae from emergence traps (August - September 2019) from a restored wet meadow (flush, *Anthoxanthum* sward and *Potentilla* sward), and unrestored adjacent habitat (dense *Molinia* tussocks). Species not recorded in 2020 are marked with an asterisk.

	Restored			***Unrestored***
Species	***Flush***	***Anth.***	***Pot.***	***Molin.***
**Aleochara lanuginosa* Gravenhorst	-	-	-	2
Amischa analis (Gravenhorst)	1	2	2	2
**Amischa bifoveolata* (Mannerheim)	-	-	2	-
Amischa decipiens (Sharp)	1	-	-	-
**Amischa* sp.	-	1	-	-
Anotylus rugosus (Fabricius)	1	-	-	-
Astenus lyonessius (Joy)	-	-	-	1
**Dalotia coriaria* (Kraatz)	3	-	-	-
Calodera aethiops (Gravenhorst)	1	-	-	-
Carpelimus corticinus (Gravenhorst)	1	-	-	-
Gabrius breviventer (Sperk)	3	-	-	-
**Gyrophaena* sp. ♀	2	-	-	-
**Lathrobium elongatum* (Linnaeus)	1	-	-	-
Mocyta amplicollis (Mulsant & Rey) ♀	1	1	-	-
Mocyta fungi (Gravenhorst)	1	-	-	1
**Oxypoda brevicornis* (Stephens)	1	-	-	-
**Philhygra palustris* (Kiesenwetter) ♂	-	-	1	1
Philonthus carbonarius (Gravenhorst)	1	-	2	1
Philonthus cognatus Stephens	1	3	4	1
Philonthus fumarius (Gravenhorst)	1	-	-	1
Philonthus micantoides Benick & Lohse	4	-	1	-
**Quedius levicollis* (Brullé)	-	-	-	1
Sepedophilus nigripennis (Stephens)	-	-	1	1
Staphylinus dimidiaticornis Gemminger	-	2	-	-
Stenus juno (Paykull)	-	-	-	1
Tachyporus chrysomelinus (Linnaeus)	-	1	1	2
Tachyporus hypnorum (Fabricius)	1	1	-	-

TABLE 6. Adult Carabidae from emergence traps (August - September 2019) from a restored wet meadow (flush, *Anthoxanthum* sward and *Potentilla* sward), and unrestored adjacent habitat (dense *Molinia* tussocks). Species not recorded in 2020 are marked with an asterisk.

	Restored			***Unrestored***
Species	***Flush***	***Anth.***	***Pot.***	***Molin.***
Acupalpus dubius Schilsky	1	-	-	-
Amara familiaris (Duftschmid)	1	-	-	-
**Bembidion aeneum* Germar	1	-	-	-
Bembidion mannerheimi Sahlberg	1	-	-	-
Trechus quadristriatus (Schrank)	-	1	1	1

TABLE 7. Adult Staphylinidae from S-vac suction samples (*circa* 4m^2; 10 July 2020) from restored wet meadow: 'Flush' - *Juncus acutiflorus* flush; 'Anth.' - *Anthoxanthum odoratum* sward. Species not recorded in pitfall or emergence traps (Table 1) are marked with an asterisk.

Species	***Flush***	***Anth.***
Amischa analis (Gravenhorst)	-	2
Amischa nigrofusca (Stephens)	2	-
Astenus lyonessius (Joy)	1	3
Bryaxis bulbifer (Reichenbach)	2	1
Carpelimus corticinus (Gravenhorst)	1	1
Euconnus hirticollis (Illiger)	1	-
**Eusphalerum luteum* (Marsham)	-	1
Gabrius breviventer (Sperk)	1	4
Mocyta amplicollis (Mulsant & Rey)	-	4
Mocyta fungi (Gravenhorst)	4	2
**Omalium excavatum* Stephens	-	1
Philhygra obtusangula Joy	2	-
Reichenbachia juncorum (Leach)	1	2
Rugilus erichsoni (Fauvel)	1	-
Rybaxis longicornis (Leach)	16	17
Sepedophilus nigripennis (Stephens)	3	5
Stenus bimaculatus Gyllenhal	-	1
Stenus brunnipes Stephens	-	2
**Stenus flavipes* Stephens	-	5
Stenus fulvicornis Stephens	4	6
**Stenus impressus* Germar	-	1
Stenus juno (Paykull)	-	2
**Stenus nitidiusculus* Stephens	6	1
**Stenus similis* (Herbst)	-	1
Tachyporus dispar (Paykull)	-	2
Tachyporus pusillus Gravenhorst	-	1
**Tachyporus solutus* Erichson	-	1

TABLE 8. Adult Carabidae from S-vac suction samples (*circa* 4m^2; 10 July 2020) from restored wet meadow: 'Flush' - *Juncus acutiflorus* flush; 'Anth.' - *Anthoxanthum odoratum* sward. Species not recorded in pitfall or emergence traps (Table 1) are marked with an asterisk.

Species	***Flush***	***Anth.***
Acupalpus dubius Schilsky	5	2
Bembidon lampros (Herbst)	1	1
Bembidion mannerheimi Sahlberg	4	5
Demetrias atricapillus (Linnaeus)	1	4

TABLE 9. Vegetation of the restored wet grassland plot and adjacent unrestored habitats at Boulaling. Nomenclature follows Stace and Thomson (2019) and Smith (2004) (not all mosses were determined).

***'*Anthoxanthum *sward'*:** Frequent: *Anthoxanthum odoratum*, *Filipendula ulmaria*, *Juncus acutiflorus*, *Molinia caerulea*, *Plantago lanceolata, Valeriana officinalis*. Present: *Agrostis canina*, *Cardamine palustris*, *Carex nigra*, *Carex pulicarus*, *Carex viridis*, *Cirsium palustris*, *Dactylorhiza maculata*, *Eupatorium cannabinum, Galium palustre*, *Holcus lanatus*, *Jacobaea aquatica*, *Lathrys pratensis*, *Lotus uliginosus*, *Potentilla erecta*, *Ranunculus acris*, *R. flammula*, *R. repens*, *Stachys palustris*, *Taraxacum officinale*, *Vicia cracca*.
***'Flush'*:** Dominant species: *Juncus acutiflorus*, *Mentha aquatica*. Frequent/present: *Agrostis canina*, *Carex nigra*, *Galium palustre*, *Holcus lanatus*, *Juncus effusus*, *Lotus uliginosus*, *Pseudoscleropodium purum*, *Ranunculus flammula*, *Senecio palustris*, *Sphagnum denticulatum*.
***'*Potentilla *sward'*:** Frequent species : *Juncus acutiflorus*, *Molinia caerulea*, *Potentila erecta*. Frequent (in patches)/present: *Agrostis capillaris*, *Anthoxanthum odoratum*, *Betula pubescens* (seedling), *Carex nigra*, *Cirsium palustre*, *Dactylorhiza maculata*, *Festuca rubra*, *Holcus lanatus*, *Jacobaea aquatica*, *Lotus uliginosus*, *Luzula multiflora*, *Pedicularis sylvatica*, *Pseudoscleropodium purum*, *Rhytidiadelphus squarrosus, Salix cinerea* (seedling), *Scutellaria minor, Sphagnum denticulatum*.
***'Dense* Molinia *tussocks'*:** Dominant species: *Molinia caerulea* (tussocks), *Rubus fruticosus* agg. Frequent/present: *Deschampsia caespitosa*, *Dryopterus dilitata*, *Filipendula ulmaria*, *Juncus acutiflorus*, *Juncus conglomeratus*, *Salix cinerea* (sapling), *Stachys palustris*.
Salix *carr*: Dominant: closed-canopy mature *Salix cinerea oleifolia* with *Kindbergia praelonga* in ground layer. Frequent/present: *Blechnum spicant*, *Carex remota*, *Cirsium palustre*, *Deschampsia caespitosa*, *Galium palustre*, *Hedera helix*, *Jacobaea aquatica, Juncus effusus* (very sparse plants), *Lonicera periclymenum*, *Ranunculus repens*, *Rubus fruticosus* agg.

PLATE 1. Ungrazed *Molinia* and *Rubus* prior to restoration.

PLATE 2. Example of ground surface after removal of *Molinia* tussocks by pushing the tussocks out with an excavator bucket, and removing them off the plot.

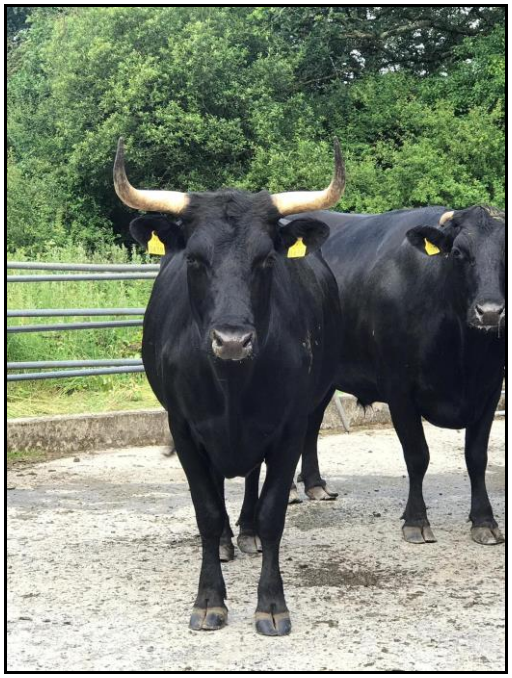

PLATE 3. Two of the Kerry bullocks used in the grazing trial.