

## MYRIAPODS OF MOORLAND HABITATS IN THE SIDLAW HILLS, ANGUS.

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### INTRODUCTION

Between 9th May and 24th October 1995 pitfall traps were operated by Adam Garside of Dundee Museum at 24 moorland sites in the Sidlaw Hills, Angus. Millipedes, of eight species, were well represented in the catch, which provides a unique opportunity to make quantitative comparisons between habitats, and to record the altitudinal and habitat range of each species. No comparable quantitative data appear to be available from moorland elsewhere in the British Isles, although most of the species reported here have been recorded from moorland in the north of England (Richardson, 1990; Richards, 1995). Pitfalls are not generally effective in catching centipedes and only 17 of two species were caught, at four sites.

### LOCATIONS AND HABITATS

Six areas were sampled, each with two to six sites varying in habitat, with one line of 9 pitfalls at each site (Figs 1, 2; Table 1). All the sites are remote from any buildings, walls, roads or other human artifacts or debris, except for the two highest, on Craigowl (sites 7 and 10) which produced nothing, and site 11 which was adjacent to farm buildings.

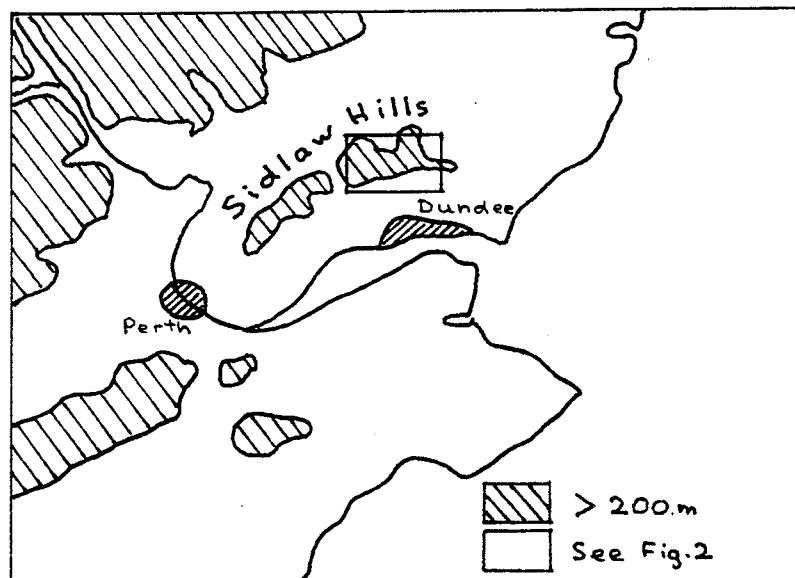


Figure 1. Location of the Sidlaw Hills.

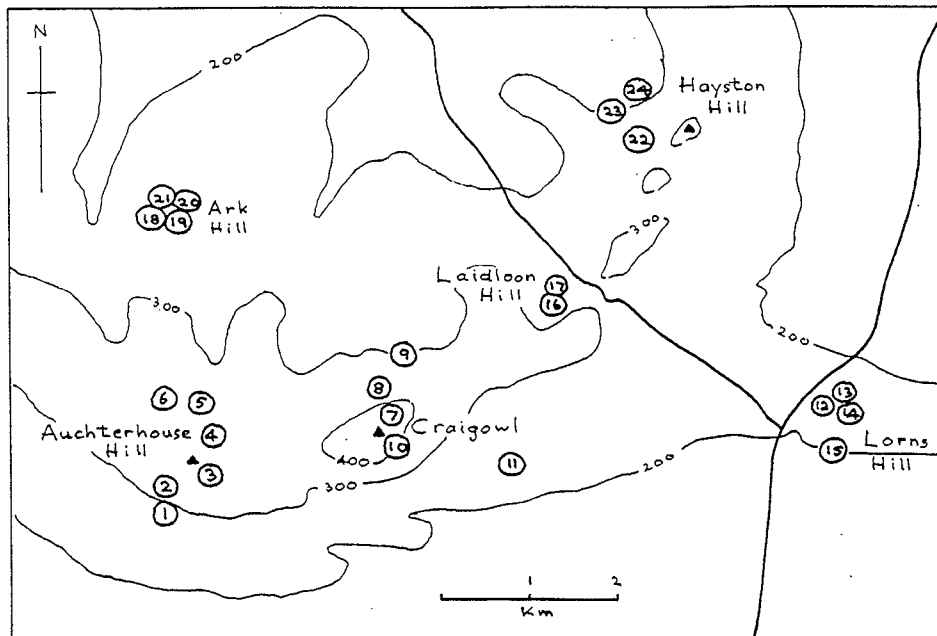


Figure 2. Location of the 24 trapping sites.

Table 1: Sites at which pitfall traps were set.

1	Auchterhouse Hill	NO 350393	Dry grassland	265 m
2	"	NO 351395	Dry heather	300 m
3	"	NO 355396	Dry heather	390 m
4	"	NO 3554400	Dry heather	360 m
5	"	NO 3553404	Wet grassland	330 m
6	"	NO 350405	Bog	350 m
7	Craigowl Hill	NO377401	Dry heather	445 m
8	"	NO 375405	Wet grassland	340 m
9	"	NO 378409	Dry heather	300 m
10	"	NO 377399	Dry grassland	450 m
11	"	NO 391402	Wet grassland	255 m
12	Lorns Hill	NO 429402	Wet grassland	205 m
13	"	NO 431403	Dry heather	205 m
14	"	NO 430402	Wet heather	205 m
15	"	NO 430398	Dry grassland	200 m
16	Laidloon Hill	NO 396416	Dry grassland	270 m
17	"	NO 397418	Dry heather	270 m
18	Ark Hill	NO 349426	Dry grassland	230 m
19	"	NO 352426	Dry heather	285 m
20	"	NO 353427	Dry heather	285 m
21	"	NO 352428	Dry grassland	275 m
22	Hayston Hill	NO 406453	Dry heather	265 m
23	"	NO 403438	Dry grassland	200 m
24	"	NO 406441	Wet grassland	195 m

In the following descriptions of habitats, generic names only are used for the following species of plants: *Calluna vulgaris* (heather), *Cytisus scoparius* (broom), *Empetrum nigrum* (crowberry), *Nardus stricta* (mat grass), *Pteridium aquilinum* (bracken), *Ulex europaeus* (gorse), *Vaccinium myrtillus* (bilberry).

**Auchterhouse Hill** (sites 1-6). All these sites were lightly grazed by sheep, with signs of cattle at site 1.

Site 1. Dry acid grass (*Nardus*, *Agrostis*, *Festuca*), abundant *Pteridium*; no dead wood; 10 m from *Ulex*.

Site 2. Dry *Calluna*, c.30 cm, with scattered *Pteridium* and *Vaccinium*; *Ulex* nearby.

Site 3. Dry *Calluna*, c.30 cm, occasional *Vaccinium* and *Empetrum*; one small branch of dead wood; 100 m from scattered larch and much dead wood.

Site 4. Dry *Calluna*, with frequent *Vaccinium* and *Empetrum*, some grass; scattered larch c.10 m either side.

Site 5. Damp acid grass dominated by *Pteridium* on gentle slope; 10 m from *Calluna*.

Site 6. Bog in slight depression; *Juncus*, *Sphagnum* and *Carex* dominant, but few tussocks; water level close to or at surface, but some islands and perimeter with drier *Calluna*.

**Craigowl** (sites 7-11). All except site 11 were lightly grazed by sheep and devoid of any trees or dead wood.

Site 7. Dry *Calluna*, c.30 cm, with sparse *Empetrum* and *Vaccinium*; on north-facing slope near summit.

Site 8. Wet tussocky grassland with abundant *Deschampsia caespitosa* and *Juncus* on gentle slope.

Site 9. Dry, deep *Calluna*, 40-50 cm, with little else.

Site 10. Short dry grass on moderate south-facing slope, with occasional stunted *Vaccinium*.

Site 11. Tall grass and herb in fenced enclosure recently planted with broad-leaved trees; *Cytisus*, *Ulex* and disturbed ground nearby.

**Lorns Hill** (sites 12-15). Level moorland with scattered pines; no domestic stock.

Site 12. Wet grass, with tussocks and short grass, dominated by *Deschampsia caespitosa* and *Juncus*; *Cytisus* and *Ulex* within 5 m. No dead wood nor trees.

Site 13. Dry *Calluna*, c.30 cm, with occasional *Erica tetralix*; scattered dead trees and young pines.

Site 14. Wet *Calluna* with frequent *Empetrum*, *Erica tetralix* and *Polytrichum* moss; some dead wood and scattered young pines.

Site 15. Dry grass dominated by *Deschampsia flexuosa* and *Agrostis capillaris*, with deep thatch; scattered *Cytisus*; *Calluna* nearby.

**Laidloon Hill** (sites 16 and 17). Grazed by cattle and sheep; no trees nor dead wood; almost level ground.

Site 16. Dry grass, closely cropped, scattered short *Pteridium*.

Site 17. Short dry *Calluna*, 10 cm; little else.

**Ark Hill** (sites 18-21). All were lightly grazed by cattle.

Site 18. Dry grass on gentle slope, slightly tussocky; sparse *Pteridium*, *Calluna* and *Erica cinerea*.

Site 19. Dry tussocky *Calluna*, 30 cm, sparse *Pteridium* and grass.

Site 20. Dry *Calluna*, as 19 but more northerly aspect.

Site 21. Dry grass, as 18 but almost level.

**Hayston Hill** (sites 22-24).

Site 22. Dry *Calluna*, 30 cm, on gentle north-facing slope; a few small patches of grass.

Site 23. Dry grass, grazed by sheep, sparse tussocks.

Site 24. Wet grass and *Juncus*, with large tussocks and deep thatch.

## METHODS

Pitfall traps containing antifreeze were placed 2 m apart in one line of 9 traps at each site. These were set from 9th May to 24th October 1995 and were emptied approximately monthly. Adult myriapods were identified by the author to species and sex (except for some *Ommatoiulus sabulosus* in July which were not sexed). No attempt was made to record the stadium of each, but very few early stadia were present (<1%) and these were disregarded in subsequent analyses. It is however possible that a few late, but immature stadia were included in the totals for adult female julids. All the specimens are preserved in the Dundee Museum.

## RESULTS

Of the 24 sites, 21 produced millipedes, representing eight species (Tables 2-4). These are all large, surface-active species. It is possible that other species, living permanently within the topsoil or at the soil-litter interface could be present since these rarely fall into pitfall traps even in those lowland localities where they are common. However such species appear not to have been recorded in moorland or montane habitats in Scotland.

**Dry grass** (Table 2). Sites classed as 'dry grass' that produced millipedes were at altitudes of 200 - 275 m. Two higher sites, at 295 and 450 m, produced nothing. This was the only habitat in which all eight species were recorded and one of the five productive sites, site 1 at 265 m on Auchterhouse Hill, had seven, including *Ophiulus pilosus* and *Polydesmus inconstans*. *Julus scandinavicus* was the only species present at all the productive sites although in two of them *Ommatoiulus sabulosus* was dominant. Brief hand-searching on 25 Oct. 1996 produced a single specimen of *Nanogona polydesmoides*, a species not found in any of the pitfalls, under a stone on dry grass about 5 m from the unproductive site 10 at 450 m on Craigowl. However this was only about 100 m from a hill-top radio installation with disturbed ground and concrete. Total numbers of millipedes at productive sites ranged from three at site 16, closely grazed by cattle, to 321 at site 1.

**Table 2. Numbers of millipedes at dry grassland sites.**

Site:	1	10	15	16	18	21	23
<i>Ommatoiulus sabulosus</i>	96		3		40	46	
<i>Tachypodoiulus niger</i>			10				
<i>Cylindroiulus punctatus</i>	5		1		16	2	
<i>Julus scandinavicus</i>	46		25	3	1	7	
<i>Ophiulus pilosus</i>	50						
<i>Polydesmus angustus</i>	74				2		
<i>Polydesmus denticulatus</i>	24		1	2	2		
<i>Polydesmus inconstans</i>	26						
Total	321	0	40	5	61	55	0

**Dry heather** (Table 3). Of the ten dry heather sites, nine were productive (205 - 390 m), the only unproductive one being the highest at 445 m. Five species were recorded, and all five were present at two sites. *Ommatoiulus sabulosus* was dominant (and very abundant) at four sites, but *Julus scandinavicus* was present at all and dominant at three. The only site with short heather (10cm), site 17, produced only one millipede (*Julus scandinavicus*); all the others had deep heather and five of these produced over 200 millipedes each.

**Table 3. Numbers of millipedes at dry heather sites. (Site 7 had nil.)**

Site:	2	3	4	9	13	17	19	20	22
<i>O. sabulosus</i>	171	216	30	1	188		268	312	
<i>C. punctatus</i>	2	2	1		1		5	8	7
<i>J. scandinavicus</i>	55	147	169	59	1	1	66	65	51
<i>P. angustus</i>	40		10	3	16				
<i>P. denticulatus</i>	1	1	8					2	
Total	269	366	218	63	206	1	339	387	58

**Wet grass** (Table 4). Wet grass sites ranged from 195 to 340 m and all were productive, with total catches ranging from 45 to 395, the highest recorded at any site. *Julus scandinavicus* was again the only constant species, but seven species were recorded (all except *Polydesmus inconstans*) with a maximum of six at one (Craigowl, 255 m). *Ommatoiulus sabulosus* was dominant at two but absent from two others. *Polydesmus* spp. were well represented, and dominant at one - site 24, which was the wettest, with extensive *Juncus*.

**Wet heather** (Table 4). This site (14) produced an abundance of *Ommatoiulus sabulosus* (104) but only one other species, a single *Polydesmus angustus*, in spite of the presence of dead wood.

**Bog** (Table 4). The small numbers probably reflect the wetness of the ground, but the fact that five species were present could represent proximity to some drier ground with heather.

**Table 4. Numbers of millipedes at wet grassland sites (5-24), bog (6) and wet heather (14).**

Site:	5	8	11	12	24	6	14
<i>Ommatoiulus sabulosus</i>	208		11	82		21	104
<i>Tachypodoiulus niger</i>			4	6			
<i>Cylindroiulus punctatus</i>	2	2	1			5	
<i>Julus scandinavicus</i>	144	8	16	1	1	13	
<i>Ophiulus pilosus</i>					21		
<i>Polydesmus angustus</i>	9	20	4		33	2	1
<i>Polydesmus denticulatus</i>	32	17	9		27	4	
Total	395	47	45	89	82	45	105

## ALTITUDE

No species of millipede in Britain is confined to higher altitudes, but the altitudinal limits of the lowland species vary considerably. *Ommatoiulus sabulosus*, *Julus scandinavicus* and *Polydesmus angustus* are often the only species at higher altitudes in the Highlands, with a limit around 650 m in the case of *Julus scandinavicus*. The apparent absence of any millipedes at the two highest sites in the Sidlaws, at 445 and 450 m, is probably determined by exposure. *O. sabulosus*, *J. scandinavicus*, *P. angustus* and *Polydesmus dentatus* have been recorded at these and slightly higher altitudes in more sheltered localities in the Highlands (personal observation). Five species were recorded here at 390 m (*Ommatoiulus sabulosus*, *Cylindroiulus punctatus*, *Julus scandinavicus* and *Polydesmus denticulatus*); *Ophiulus pilosus* was recorded only at 255 m; *Tachypodoiulus niger* up to 255 m; and *Polydesmus inconstans* only at 265 m.

## THE SPECIES OF MILLIPEDES

*Ommatoiulus sabulosus* (Fig.3a). This was the dominant species at most sites, up to 390 m, and was very abundant at some, especially in June, although inexplicably absent or scarce at others, e.g. Craigowl and Hayston Hill. It is a widespread lowland species but usually only abundant or dominant on coastal dunes, sandy soils and heathland, with records up to 550 m in Perthshire. It appears to be more tolerant of acidic conditions than other millipedes.

This species takes from two to four years to reach maturity. The virtual absence of immatures therefore suggests that these live entirely in the deeper layers of the litter and topsoil, as presumably do the adults prior to June since they too were virtually absent from the catches during the period 9 May to 5 June. They were also very scarce from August onwards. This could be due to post-breeding mortality, or to a return to lower levels in the

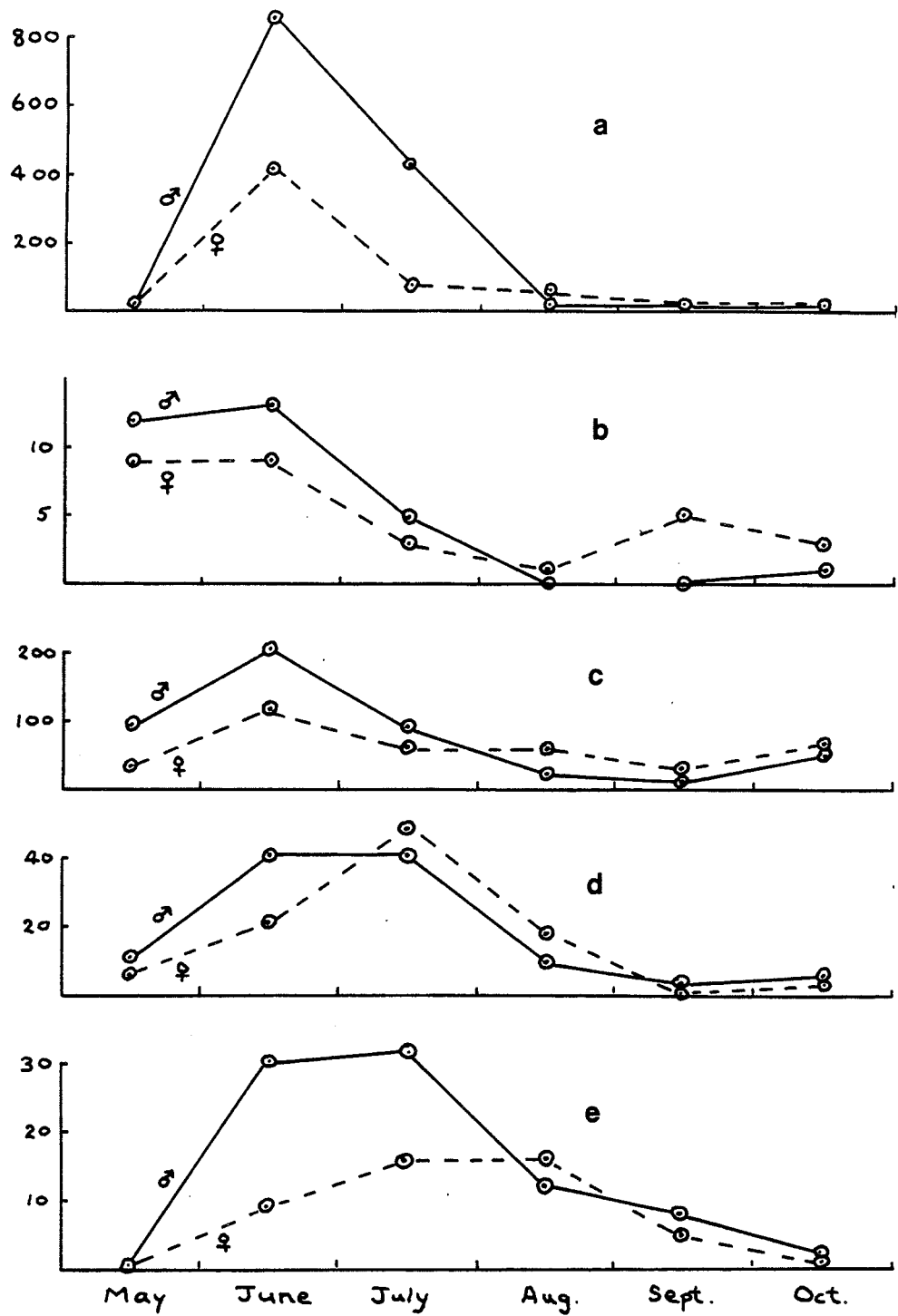


Figure 3. Seasonal pattern of the more abundant species. In *O. sabulosus* the July figures are extrapolated from a sample of 255 that were sexed.

(a) *Ommatoiulus sabulosus*.

(b) *Cylindroiulus punctatus*.

(c) *Julus scandinavicus*.

(d) *Polydesmus angustus*.

(e) *Polydesmus denticulatus*.

soil. The latter seems more probable since both sexes are known to be capable of living for several years after reaching sexual maturity (Blower, 1985).

*Tachypodoiulus niger*. This species was found in small numbers and only at three grassland sites, up to 255 m. It may be significant that all these had broom and/or gorse nearby. It is a common lowland species, often abundant in woodland, but is generally scarce or absent in moorland habitats. These records may well be close to the altitudinal limit in Scotland. However in a study in the Pyrenees it was found at 2800 m, higher than any other species but nevertheless close to the tree-line (Mauriès, *vide* Hopkin & Read, 1992).

*Cylindroiulus punctatus* (Fig.3b). This was found only in small numbers but in all habitats, up to 390 m. It is an abundant and ubiquitous species in woodland, but often survives on moorland, for example in the dead wood of tree stumps. However at several of these sites, both in heather and grass, no dead wood was visible, other than that derived from heather and other dwarf shrubs. At site 8, one was found by hand searching in *Juncus* litter remote even from any dwarf shrubs.

*Julus scandinavicus* (Fig.3c). In line with previous records, this species was the most widespread, being found at all productive sites, up to 390 m. It was the dominant species at two dry grass sites, three dry heather sites and two wet grass sites.

*Ophiulus pilosus*. Found only at two grassland sites, up to 265 m. This is consistent with the situation in the Sheffield area where it 'occurs sporadically in acid heathland . . . but is very much replaced by *J.scandinavicus* in these locations' (Richards, 1995).

*Polydesmus angustus* (Fig.3d). This species was found in all habitats, at frequencies ranging from an average of 16% of the millipede catch in dry grass to 2-4% in heather and bog. Where numbers were adequate for comparisons it was the dominant polydesmid at six sites, but was closely followed by *P.denticulatus* at two of these and exceeded by *P.denticulatus* at one other. It was present in all six months with a peak in July and August. In woodland in Surrey, pitfall trapping showed a similar seasonal pattern but with the peak earlier, in June (Banerjee, 1967). This is a very widespread species and is usually the most abundant (often the only) flat-backed millipede in a variety of habitats. It has been recorded throughout the Highlands but mostly in woodland.

*Polydesmus denticulatus* (Fig.3e). Considering the apparent scarcity of this species when hand-searching, it was rather surprising to find it in all habitats and at 12 of the productive sites, although this is consistent with experience elsewhere indicating that it is a difficult species to find except by pitfall trapping (e.g. Richards, 1995). It was scarce in heather, but represented 13% of the total catch in wet grass (exceeding *P.angustus*) and 6% in dry grass. This species has been recorded sparsely in the Scottish lowlands, in a variety of woodland and open habitats, without any clear pattern. However its predominance in wet grassland is concordant with studies in continental Europe showing it to be unusually tolerant of winter flooding (Hopkin & Read, 1992). Although there are records from coastal Caithness, the published atlas (British Myriapod Group, 1988) does not show any in the Highlands. However it was found in 1995 on Ben Lui (NN 2627), on herb-rich and



base-rich ledges at about 600 m, remote from woodland (personal observation) and in 1991 in Glen Shiel (NH 01) (Jones, 1992).

*Polydesmus inconstans*. Found only at one site, on dry grassland at Auchterhouse Hill at 265 m, where however it was slightly more numerous than *P.denticulatus*. This is a generally scarce species throughout the lowlands, but without any clear indication of habitat restriction in the available records, although most are from woodland.

## CENTIPEDES

The general scarcity of centipedes in pitfall traps means that negative records should not be considered significant.

*Geophilus carpophagus*. One at site 1; one at site 18 (both dry grassland). This is normally the commonest geophilomorph centipede in moorland habitats.

*Lamyctes fulvicornis*. Site 16 (short dry grass): July - 1, Sept. - 6, Oct. - 2; site 24 (wet grass): August - 2. Not hitherto recorded in Angus, but the habitats and season are typical.

*Lithobius forficatus*. Found in nearby disturbed sites, including the summit of Craigowl at 450 m.

*Lithobius melanops*. Site 3 (dry heather): one found by hand in dead wood.

## CONCLUSIONS

Millipedes are generally difficult to find in moorland by direct searching, especially if logs and stones are scarce or absent. Pitfall trapping reveals their nocturnal activity, while they presumably spend the day (and the winter months) within the leaf-litter and topsoil. Although some species of the larger julids and polydesmids are well known to move seasonally between upper layers and vegetation in summer and lower layers including the soil in winter, little information appears to be available on the extent to which they are active and feeding in the lower layers. All species were very scarce in May but reached peaks of abundance in June and July. Although this indicates the start of surface activity in June, it is not clear to what extent this represents the beginning of the year's activity or simply a change from subterranean to surface activity. The summer of 1995 was exceptionally dry: at Invergowrie, 10 km south of the Sidlaws and close to sea-level, rainfall in August 1995 was only 16% of the 30-year average (Table 5). It is therefore possible that the decline in numbers after July (and the virtual disappearance of *Ommatoiulus sabulosus*,

**Table 5.** Monthly rainfall (mm) at Invergowrie, 10 km south of the Sidlaw Hills, for May to October 1995, compared with the 30-year averages for these months. (Courtesy of Scottish Crop Research Institute)

	M	J	J	A	S	O
1995	59	34	27	11	123	91
30-year average	53	52	56	67	67	63

a long-lived species) might be due to a premature move to lower levels to escape drought. However the above-average rainfall in September and October does not appear to have led to any significant reappearance. The preponderance of males, especially in the early months, is consistent with previous experience of pitfall trapping, reflecting greater activity of males (e.g. Blower, 1970).

The general abundance of millipedes at most of these sites suggests that at all except the highest they probably play a major role in the consumption of dead plant material. Conversely their absence at higher altitudes could substantially enhance the rate of peat formation.

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