

A SEASONAL STUDY OF AERIAL INSECTS CLOSE TO A MOORLAND STREAM

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There is little published about the insect fauna of moorland habitats in this country. Pearsall (1950) and Cragg (1961) summarize some of the available information. This study was undertaken as a result of work on trout (*Salmo trutta* L.) at Moor House (Crisp 1963) in which it was shown that insects of 'terrestrial' origin were often taken as food. It was hoped by regular sampling to investigate the composition of the aerial fauna present around a stream frequented by trout. Preliminary observations in such a place suggested that, while a few species were distinctly hydrophile, the great majority were of accidental occurrence. To test this, collections were made over the water and also on a bank of the stream.

THE STUDY AREA

The Moor House National Nature Reserve has been described by Conway (1955). Manley (1936) likened the climatic conditions in the area to those of southern Iceland and Millar (1964) has summarized 10 years of weather records for the Reserve.

Five stations were sampled in a 30 m stretch of Rough Sike, a beck in the upper Tees system in the Reserve at a height of 550 m (1800 ft) O.D. (Nat. Grid NY 756328). It flows through moorland and over limestone and glacial drift and is a narrow, shallow beck on average 1.5 m wide, the depth rarely exceeding 30 cm in pools when in normal flow. The bed is stony with little vegetation, because of the scouring action of frequent floods. In periods of drought filamentous algae become plentiful. The moss *Fontinalis squamosa* Hedw. grows on stones in the more stable parts of the bed. The bank where the traps were placed rose to about 30 cm above the usual water level. It was a well-drained peat-alluvium, the dominant plants being *Nardus stricta* L. and *Juncus squarrosus* L., with *J. effusus* L. and *Potentilla erecta* (L.) less common. During the experiment it was grazed regularly by sheep and occasionally by a horse.

COLLECTING METHODS

Five sheets of celluloid 10×10 cm covered with banding gum, of the type used on fruit trees, were floated on wooden rafts in the stream. The rafts were anchored to a stake on each bank by nylon lines and were weighted with lead so that they floated with the sticky surface uppermost about 1 cm above the water surface. Five more sticky traps of similar size were placed on the bank about 1 m from the water's edge. The catch, removed by immersing the traps in petrol, was then preserved in 70% alcohol. Sampling started in mid-March, when the ice melted in the stream, and continued until the end of the year (1963).

COMPOSITION OF THE CATCH

In the 9½ month period 17 525 insects were caught. Table 1 gives the breakdown of the catch into orders. The Diptera, which formed the greater part of it, were given closer

attention than the other orders. The Ephemeroptera, Plecoptera, Trichoptera and Coleoptera however, on account of their large size, were an important part of the whole biomass. The 'Micro-Hymenoptera' were a diverse collection. They were mainly small to very small species (1–3 mm) which are well represented in upland regions.

Table 2 shows those families of Diptera which contributed more than 1% of the catch; 95% of the flies caught over the stream belonged to four families (Chironomidae, Empididae, Ephydriidae and Muscidae), while on the bank seven families contributed 94% (Chironomidae, Mycetophilidae, Sphaeroceridae, Muscidae, Cecidomyiidae, Phoridae and Tipulidae).

Table 1. *Annual catch on five traps total 1/20 m²*

	Caught over stream	Caught on bank
Coleoptera	14	22
Diptera	13 106	3717
Ephemeroptera	29	1
Hemiptera	54	61
Micro-Hymenoptera	82	131
Plecoptera	60	94
Trichoptera	102	42
Others	3	7

Comparison between the catch on the bank and that over the stream

Although the distance between the traps on the bank and those in the stream was at most 2 m, there were significant differences at the 95% probability level between their catches. Over three times as many flies were caught on the traps in the stream, because of the increased numbers of Chironomids and some species of Empidids breeding in the stream, together with terrestrial Empidids which habitually swarm over water surfaces

Table 2. *Numbers of flies caught per trap 1/100 m² in 1963, with 95% confidence limits*

	Caught over stream	Caught on bank
Cecidomyiidae	11 ± 8	61 ± 70*
Chironomidae	1255 ± 249*	242 ± 172
Dolichopodidae	12 ± 17	15 ± 3
Empididae	1019 ± 381*	18 ± 13
Ephydriidae	110 ± 31*	2 ± 3
Muscidae	105 ± 58	79 ± 22
Mycetophilidae	34 ± 11	134 ± 27*
Phoridae	9 ± 7	47 ± 10*
Sphaeroceridae	25 ± 18	101 ± 41*
Tipulidae	28 ± 14	30 ± 11

* Catch significantly higher.

for feeding and mating. The Ephydriids were caught mainly on the rafts. The Muscids were interesting for, though the total numbers present on the two sets of traps were roughly equal, the catches in the two situations were of different species. The Dolichopodids, a riparian group, were more or less evenly distributed. The remaining families are essentially terrestrial, their presence on the traps in the stream being due to accident. In this context it should be noted that in this locality, days without a moderate to strong wind are the exception. Table 2 gives the numbers of individuals of the families caught per trap in the two habitats during the year.

Table 3

(a) The weekly catch of flies on the stream bank

	March	April				*	May		June				July				*	August				September				*	October				Total	% of catch
Cecidomyiidae					1	5†	143	37	9	16	2	1				3†	4	10	16	33	19	3							303	8		
Chironomidae		1	2	7	5	68†	165	222	40	15	6	12	34	86	41	159	24	68†	67	34	52	39	3	2	3	1	2	1212	33			
Cordiluridae					1	3†	1				1	5	1	3							2							29	<1			
Dolichopodidae			1			†				2	1	1	2	5	6	16	5	15‡	14	1	2	1						76	2			
Empididae							4	43	21			3	1		1		3	2	2								91	2				
Ephydriidae									1								1				2	2					12	<1				
Muscidae						4†	24	58	41	11	9	30	50	33	13	12	2	21†	18	17	4	12	1			1	393	11				
Mycetophilidae				4	3	6†	11	66	119	16	3	11	7	10	25	21	17	25†	37	44	78	127	8	2	2		15	671	18			
Phoridae				1	1		7	11	14	3		15	54	14	19	20	7		12	6	12	19					4	236	6			
Sphaeroceridae		3	8	18	15	6†	12	15	11	4	7	77	56	39	10	16	3	44†	33	10	7	68	4	7	2	9	507	14				
Tipulidae						3†	8	34	4	1					1			4†	3		2	1	2	17	38	29	1	152	4			

(b) The weekly catch of flies over the stream

	March	April				*	May		June				July				*	August				September				*	October				Total	% of catch
Cecidomyiidae						1†	3	16	4	2					1	2	9	5	10	3	1							57	<1			
Chironomidae		13	10	12	57	39	446†	443	583	333	37	64	97	306	480	747	173	146†	152	137	788	538	2	12	8	8	33	6274	48			
Cordiluridae						2†	2		4		2	2	2	3		1	2†					1						24	<1			
Dolichopodidae									1	13			1	6	22		6	2†	3		2	1						60	<1			
Empididae	1					1†	22	562	556	7	22	156	220	105	260	1399	694	540‡	218	86	38	45	8	1	1		5	5096	39			
Ephydriidae								17	55	5	7	57	156	22	23	51	28	7†	23	2	10	78						552	4			
Muscidae				1		11†	20	81	76	47	48	12	3	9	16	43	57	47†	9	2	6	9					2	523	4			
Mycetophilidae							4	21	13	1		1	3	4	13	11	1†	24	39	15	11	1					2	165	1			
Phoridae								1	2		1	1	3	1	2			7	6	7	5	1					45	<1				
Sphaeroceridae			2	2		2†	2	33	4			19	4	3	2	10	1	15†	15	1	1	4	2	1	1		1	125	<1			
Tipulidae						1†	3	18	17		1			1	1	3	3	3†	5	5	3	8	2	7	29	24	4	140	1			

* Week partly in two months. † Three weeks. ‡ Two weeks.

Biomass observations

As the various flies caught on the traps differed greatly in size, an attempt has been made to express the results on a weight basis. The weights given here have been calculated from the weight of 100 individuals dried to constant weight at 105° C. Where several species of different weight were present in a family, the total given takes into account the correct proportion of the species. The value for Chironomids is probably too low as it was based on a summer collection: in the spring there was a higher proportion of larger individuals. Table 4 gives the weight caught in g/year/m² for both sets of traps. Some of the less frequent but larger species contribute more to the annual biomass than very abundant but smaller ones.

Notes on individual families

Tipulidae: On the bank three common species occurred in succession, *Tipula subnodicornis* in early June, *T. paludosa* in the second half of August and *T. pagana* in early and mid-October. These species also occurred on the rafts but in lesser numbers. The numbers were brought nearly equal by the presence on the rafts of *Dicranota* spp. from July to September. These results agree with those of Coulson (1959) who gave much information on this family at Moor House.

Table 4. Dry weight at 105° C in g/m²/year with 95% confidence limits

	Caught over stream	Caught on bank
Calliphoridae	0.78 ± 0.31	1.57 ± 0.58
Chironomidae	8.28 ± 1.64	1.60 ± 0.84
Cordiluridae	1.37 ± 0.67	1.66 ± 0.71
Empididae	31.54 ± 11.79	0.33 ± 0.24
Ephydriidae	1.99 ± 0.56	0.04 ± 0.03
Muscidae	17.68 ± 9.78	13.22 ± 3.73
Mycetophilidae	0.47 ± 0.15	2.01 ± 0.39
Sphaeroceridae	1.01 ± 0.70	3.25 ± 1.32
Tipulidae	9.44 ± 4.72	10.24 ± 1.02

Bibionidae: One species, *Bibio lepidus*, occurred in some numbers on the bank in October. The other spring species were rare.

Mycetophilidae: Not identified but most specimens were *Sciara* spp.

Empididae: Four species were very common over the stream. Of these *Wiedemannia rhynchops insularis* and *W. bistigma* were considered to be confined to the stream. Neither was caught on the bank. They occurred together resting on the sides of stones just above the water. Where the stones were moist they were found feeding on Chironomids and mating. The males did not offer food to the female before copulation. *W. bistigma* had a shorter flight period. The larvae of *Wiedemannia* spp. were common in *Fontinalis* on partly submerged stones. The other two common species, *Anacrostichus verralli* and *Hilara chorica*, have been observed swarming over water but neither was seen to feed or mate. *H. chorica* alone is widely distributed in the lowlands.

Dolichopodidae: *Campsicnemus loripes* and *Hydrophorus nebulosus* occurred very early in the year, but it was mid-July before the others appeared.

Ephydriidae: The *Hydrellia* sp. was common on the rafts from June to September. The larvae in this genus are leaf miners.

Sphaeroceridae: The *Limosina* were not identified. Five species of *Copromyza* were present: *C. hirtipes* was the commonest, *C. similis* and *C. stercoraria* fairly common,

while *C. nitida* and *C. nigra* were rare. These, together with some of the *Limosina*, probably bred in the sheep- and horse-dung on the bank.

Cordiluridae: Surprisingly few were caught. *Scopeuma stercorarium* was twice as common as *S. squalidum*.

Muscidae: Most of these flies caught on the rafts belonged to the genera *Limnophora* s.l. and *Prosalpia*. Few of these were caught on the bank (see Table 5). There *Paregle aestiva* and other species of Anthomyiinae predominated. The category 'other Anthomyiinae', numerous on the bank but less so on the rafts, consisted of rather small species extremely difficult to determine. *Nupedia dissecta* and *Pseudonupedia intersecta* were certainly included in it. *Prosalpia sepiella* was observed resting close to the water on stones in the stream. *P. conifrons*, while behaving in the same way, was also found further from the water. *Limnophora riparia* has an aquatic larva. As the adults of the other Moor House species of this genus behaved in a similar way, sitting on stones in the stream, these may also be found to have aquatic larvae. *Lispe tentaculata*, a predatory fly found

Table 5. Numbers of Muscidae caught on 1/20 m² in 1963

	No. on rafts	No. on bank
<i>Helina lucorum</i>	4	12
<i>Limnophora meadei</i>	155	15
<i>L. riparia</i>	13	0
<i>L. uniseta</i>	34	2
<i>Myospila meditabunda</i>	2	5
<i>Orthella caesarion</i>	6	15
Other Anthomyiinae	91	190
<i>Paregle aestiva</i>	17	134
<i>Phaonia errans</i>	8	10
<i>Prosalpia conifrons</i>	7	6
<i>P. sepiella</i>	186	4

near water, was uncommon. The other species were probably not particularly associated with the stream.

Affinities of the fauna

The small number of species caught reflects the general paucity of the fauna, which shows a close similarity to that of Iceland and Sub-Arctic regions. Although only relatively few species are found at Moor House, some are so abundant that they must be well adapted to the rigours of the environment.

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SUMMARY

From the spring thaw to the end of the year 17 525 aerial insects were caught by a sticky trap technique over the surface and on the bank of the stream. Diptera, including 89 determined species, accounted for 96% of the catch. Over three times as many Diptera were caught over the stream as on the bank, this excess being due mainly to Chironomids and Empidids.

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APPENDIX

- Tipulidae: *Tipula staegeri* Nielsen, *T. paludosa* Meigen, *T. czizeki* de Jong, *T. subnodicornis* Zetterstedt, *T. pagana* Meigen, *Dicranota guerini* Zetterstedt, *Molophilus ater* Meigen.
- Trichoceridae: *Trichocera* sp.
- Anisopodidae: *Anisopus fenestralis* (Scopoli).
- Psychodidae: *Psychoda* sp.
- Ceratopogonidae: *Culicoides* sp., *Serromyia femorata* (Meigen).
- Simuliidae: *Simulium* sp.
- Bibionidae: *Biblio pomonae* (Fabricius), *B. lepidus* Loew, *Dilophus femoratus* (Meigen).
- Scatopsidae: *Scatopse notata* (Linnaeus).
- Rhagionidae: *Rhagio scolopacea* (Linnaeus), *Symphoromyia crassicornis* (Panzer).
- Empididae: *Tachydromia nigratarsis* (Fallen), *Bicellaria subpilosa* Collin, *Hilara chorica* (Fallen), *Xanthempis trigramma* Meigen, *Platyptera borealis* Linnaeus, *Anacrostichus lucida* Zetterstedt, *A. verralli* Collin, *Lundstroemiella hybotina* Zetterstedt, *Rhamphomyia variabilis* Fallen, *R. sulcata* (Meigen), *R. morio* (Zetterstedt), *Wiedemannia rhynchops* Nowicki subsp. *insularis* Collin, *W. bistigma* (Curtis), *Kowarzia bipunctata* (Haliday), *Hydrodromia stagnalis* (Haliday), *Dolichocephala guttata* (Haliday).
- Dolichopodidae: *Dolichopus vitripennis* Meigen, *D. lepidus* Staeger, *D. rupestris* Haliday, *D. plumipes* (Scopoli), *Hydrophorus nebulosus* Fallen, *Liancalus virens* (Scopoli), *Xiphandrium albomaculatum* Becker, *Campsicnemus scambus* (Fallen), *C. loripes* (Haliday), *Ectomus alpinus* (Haliday), *Sympycnus dessouteri* Parent.
- Lonchopteridae: *Lonchoptera lutea* Panzer.
- Syrphidae: *Eristalis pertinax* (Scopoli), *Helophilus pendulus* (Linnaeus), *Sericomyia borealis* (Fallen), *S. lappona* (Linnaeus), *Platycheirus albimanus* (Fabricius).
- Dryomyzidae: *Dryomyza decrepita* Zetterstedt.
- Sepsidae: *Sepsis cynipsea* (Linnaeus), *Themira lucida* (Staeger).
- Helomyzidae: *Helomyza infera* Collin, *Leria serrata* (Linnaeus).
- Ephydriidae: *Hydrellia incana* (Stenhammar), *Stictoscatella quadrata* (Fallen).
- Sphaeroceridae: *Sphaerocera curvipes* Latreille, *Copromyza nitida* Meigen, *C. nigra* Meigen, *C. similis* Collin, *C. hirtipes* (Robineau-Desvoidy), *C. stercoraria* Meigen, *Limosina* sp.
- Cordiluridae: *Scopeuma stercorarium* (Linnaeus), *S. squalidum* (Meigen).
- Calliphoridae: *Cynomya mortuorum* (Linnaeus), *Calliphora erythrocephala* (Meigen), *C. vomitoria* (Linnaeus).
- Muscidae: *Orthellia caesarion* (Meigen), *Myospila meditabunda* (Fabricius), *Phaonia errans* (Meigen), *Lispe tentaculata* (Degeer), *Limnophora (Spilogona) meadei* Schnabl, *L. (S) solitaria* Collin, *L. (Limnophora) uniseta* Stein, *L. (Calliphrys) riparia* (Fallen), *Helina lucorum* (Fallen), *H. fratercula* (Zetterstedt), *Hylemya strigosa* (Fabricius), *Nupedia dissecta* (Meigen), *Pseudonupedia intersecta* (Meigen), *Paregle aestiva* (Meigen), *Prosalpia sepiella* (Zetterstedt), *P. conifrons* (Zetterstedt).

Members of the following families were not named: Chironomidae, Mycetophilidae, Cecidomyiidae, Phoridae.