The Glasgow Naturalist (2016) Volume 26, Part 2, 35-42

Trichoptera (Caddisflies) caught by the Rothamsted Light Trap at Rowardennan, Loch Lomondside throughout 2009.

J.T. Knowler[1], P.W.H. Flint[2] and S. Flint[2]

[1]Corresponding author. 3 Balfleurs Street, Milngavie, Glasgow, G62 8HW
[2] 1 Ingleborough View, Butts Lane, High Bentham, North Yorkshire LA2 7AE

[1]E-mail: john.knowler@ntlworld.com
[2]E-mail: flintsentomologists@btinternet.com

INTRODUCTION

Since 1968 the Rothamsted Insect Survey (RIS) has operated a network of specially designed light-traps throughout the UK and the data obtained from them have been used to monitor the long term population trends of the most common and widespread British macro moths (Fox *et al*., 2006). A trap located at the Scottish Centre for Ecology and Natural Environment (formerly known as the Glasgow University Field Station) has been operated almost continuously since 1968 and has added greatly to knowledge of the moth assemblage on east Loch Lomondside (Salama et al., 2007; Knowler and Gregory, 2008; Knowler, 2010). In addition to moths, Rothamsted light traps catch and kill representatives of many other insect Orders and, during the years that the Rowardennan trap has been run, some of these have been collected and sent to relevant experts for identification. This paper presents an analysis of 1802 adult caddisflies recovered from the catch of the Rowardennan trap during 2009 and it relates these data to other Trichoptera records from the site.

METHODS

A standard Rothamsted light trap with a 200W tungsten filament is located at NS378960 close to the shore of Loch Lomond in an extensive belt of semi-natural oak woods comprising mostly *Quercus petraea x robor* hybrids but with alder (*Alnus glutinosa*) and sallow (*Salix* sp.) fringing the shore. Dubh Lochan is a small, nutrient-poor loch. At their closest points the shores of both Loch Lomond and Dubh Lochan are within 150 metres of the trap site. Flowing water, from the small torrential streams of the mountainous regions to the slow flowing Endrick Water and Leven River at the south of Loch Lomond, are a feature of the catchment but none are very close to the trap at Rowardennan. It was therefore anticipated that most caddisfly species recorded would be those of still water.

The trap is operated by volunteers who until 2008 sent the catch to RIS staff to identify the macro moths. Since 2009 moth identification has been undertaken by the first author and this has given him access to the other insects caught by the trap.

Throughout 2009 J.T.K collected caddisflies from the catch and papered them, storing each daily, weekend or four day Bank holiday catch in a separate date-labelled envelope. In 2012 Peter and Sharon Flint undertook to identify the papered insects. Papering is well known as an effective and economical technique for storing and transporting insect specimens; it has the disadvantage, however, that if specimens are papered in bulk they may start to disintegrate and parts such as legs and antennae become miss-associated. Fortunately most species of adult caddis, both male and female, can be reliably identified by examination of the genitalia alone and some (e.g. *Limnephilus lunatus*) are even immediately recognizable on sight by wing pattern. Specimens were re-wetted in 70% isopropyl alcohol and abdomens were softened and cleared in 10% potassium hydroxide. Identifications were carried out using Barnard and Ross (2012) and Macan (1973).

RESULTS AND DISCUSSION

Table 1 shows the total Trichoptera identified from the catch of the Rothamsted trap at Rowardennan throughout 2009. The data are considered reliably quantitative for most species because every caddisfly in the catch was collected. There are however two exceptions. There were a few days when there were so many *Tinodes waeneri* in the catch that not every individual was retained. Numbers recorded at the peak occurrence of this species are therefore an under-estimate. In addition, micro caddisflies (Hydroptilidae) are almost certainly under-reported, partly because they may have been missed by the first author but mainly because they may have been lost throughout mid-summer when the smallest insects were routinely sieved out of the catch before it was passed to the first author. Sieving was advantageous to identification of moths because it substantially decreased the very bulky biomass of the mid-summer catch that is dominated by the tiny bodies

of biting midges (Culicoides); very small species of other insect Orders may however have been lost. It is also possible that some species occurring in the area were not trapped at all where they are diurnal and not attracted to light (e.g. *Agapetus fuscipes*).

Table 1. Caddisflies identified in the daily catch of the Rowardennan light trap throughout 2009. * indicates probable under-estimate.

Family	Species	Total Collected	Earliest and latest dates
Rhyacophilidae	*Rhyacophila obliterata* (McLachlan)	1 male	28-Sep
Hydroptilidae	*Oxyethira flavicornis* (Pictet)	1 male*	31-Aug
Polycentropodidae	*Plectrocnemia conspersa* (Curtis)	9 male, 4 female	24 Jun - 28 Oct
	Polycentropus flavomaculatus (Pictet)	1 male	04-Aug
Psychomyiidae	*Tinodes waeneri* (Linnaeus)	438 male*, 305 female*	29 May - 22 Sept
Hydropsychidae	*Hydropsyche siltalai* (Döhler)	1 male	14-Aug
Phryganeidae	*Agrypnia varia* (Fabricius)	8 male, 12 female	26 Jun - 18 Aug
Goeridae	*Goera pilosa* (Fabricius)	1 male, 28 female	30 Jun - 24 Jul
	Silo pallipes (Fabricius)	1 female	24-Jun
Lepidostomatidae	*Lepidostoma hirtum* (Fabricius)	26 male, 28 female	19 June - 14 Sep
Apataniidae	*Apatania wallengreni* (McLachlan)	225 male, 13 female	23 Mar - 19 May
Limnephilidae	*Drusus annulatus* (Stephens)	1 male	02-Sep
	Chaetopteryx villosa (Fabricius)	14 male, 8 female	28 Sep - 7 Dec
	Anabolia nervosa (Curtis)	54 male, 27 female	28 Aug - 29 Oct
	Glyphotaelius pellucidus (Retzius)	47 male, 19 female	30 Apr - 28 Sept
	Limnephilus centralis (Curtis)	1 male	25-Sep
	Limnephilus coenosus (Curtis)	1 male	02-Sep
	Limnephilus ignavus (McLachlan)	10 male	21 Aug - 14 Sep
	Limnephilus lunatus (Curtis)	147 male, 84 female	07 Aug - 11 Nov
	Limnephilus luridus (Curtis)	10 male, 3 female	26 Jun -10 Aug
	Limnephilus marmoratus (Curtis)	46 male, 31 female	05 Jun - 20 Oct
	Limnephilus rhombicus (Linnaeus)	2 male	16 Sep - 22 Oct
	Limnephilus sparsus (Curtis)	18 male, 6 female	14 Aug - 22 Sep
	Limnephilus stigma (Curtis)	1 male	31-Jul
	Halesus digitatus (Schrank)	6 male	31 Aug - 19 Oct
	Halesus radiatus (Curtis)	81 male, 26 female	04 Sep - 20 Oct
	Micropterna lateralis (Stephens)	6 male	29 May -03 July
	Potamophylax cingulatus (Stephens)	6 male, 7 female	20 Aug - 15 Sept
	Potamophylax latipennis (Curtis)	2 male, 4 female	01 Jul - 01 Oct
Sericostomatidae	*Sericostoma personatum* (Spence)	1 female	27-Jul
Odontoceridae	*Odontocerum albicorne* (Scopoli)	2 female	26-Jun
Leptoceridae	*Athripsodes bilineatus* (Linnaeus)	1 male	date uncertain
	Ceraclea albimacula (Rambur)	4 male	23 Jul - 27 Jul
	Ceraclea annulicornis (Stephens)	3 male	26 Jun - 27 Aug
	Ceraclea dissimilis (Stephens)	14 male, 6 female	24 Jul - 8 Sep
	Mystacides azurea (Linnaeus)	1 female	19-Jun

Some species of caddisfly exhibited a fairly narrow flight period (Table 1 and Fig. 1) with a bell-shaped curve of abundance typical of a univoltine species. Thus, *Apatania wallengreni*, the earliest species recorded, occurred from late March to mid-May peaking in mid-April. This is significantly earlier than the April to June occurrence with a peak in early May that was reported by Crichton for the same site in 1968-1970 (Crichton 1981). The difference may be explained by the weather patterns for the years concerned. Thus, data for Paisley (the nearest station for which weather data for the years concerned can be accessed) reveal that it was considerably colder from February to-April 1968-1970 than in 2009 (http://www.metoffice.gov.uk/pub/data/weather/uk/climate/stationdata/paisleydata.txt.) Similar bell-shaped curves were exhibited by *Lepidostoma hirtum* occurring from mid-June to mid-September; for *Anabolia nervosa* from late August to late October and for *Chaetopteryx villosa* from late September to early December (Fig. 1).

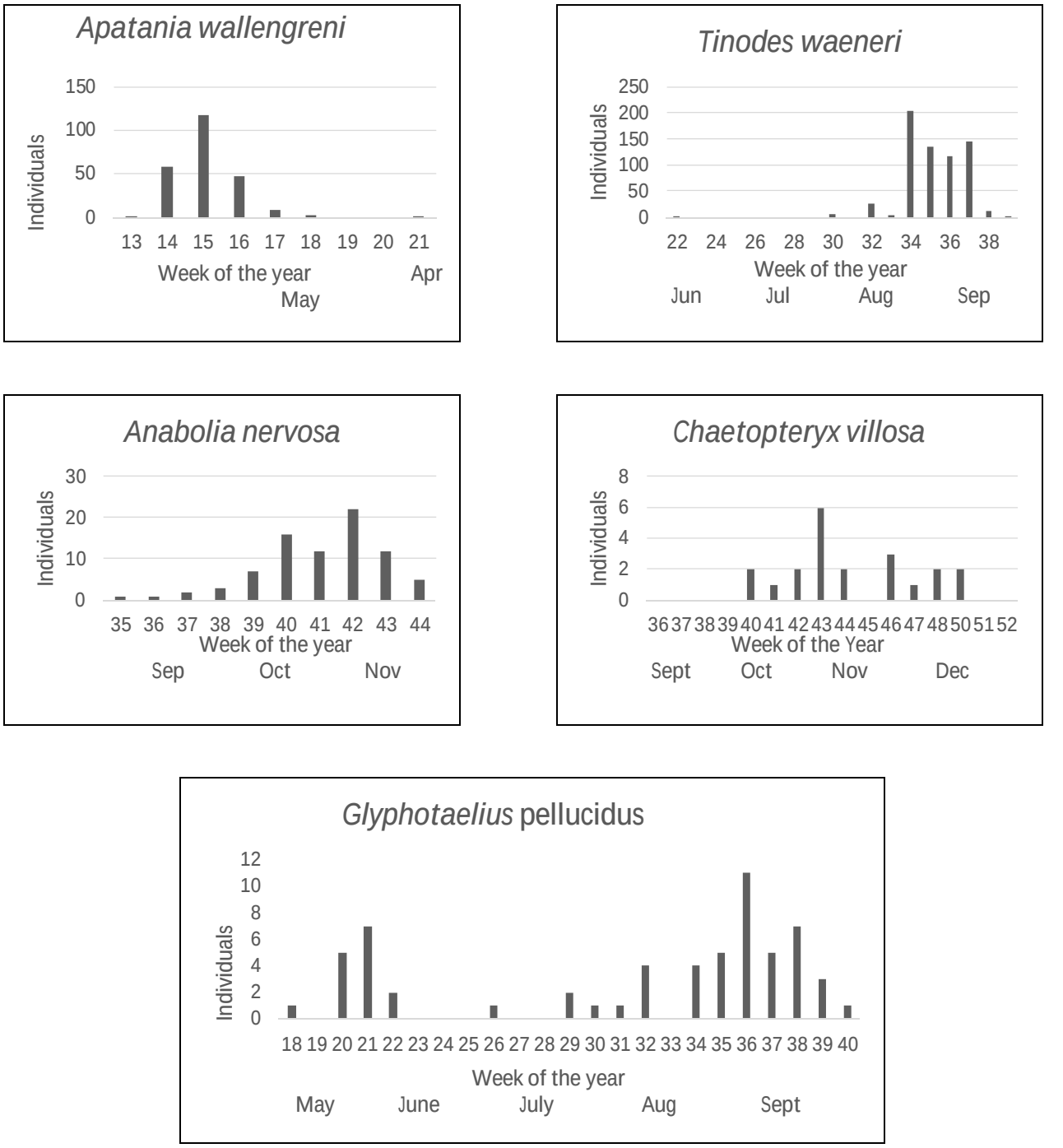

Fig. 1. Weekly catches of selected caddisfly species caught in the Rowardennan light trap during 2009.

Other species were on the wing for much longer periods. Thus, *Glyphotaelius pellucidus*, known by fishermen as the mottled sedge, is described as being on the wing in May and June and from August to September with a diapause in July (Barnard and Ross, 2012). On Loch Lomondside, it exhibited a similar prolonged flight period but it appeared that the diapause was during all of June and early July. *Limnephilus marmoratus*, known as the cinnamon sedge, is also described as having a very prolonged flight time from May to November with a probable summer diapause (Barnard and Ross, 2012). However at Rowardennan it was recorded from June to November with no evidence of diapause. It may be relevant that Denis (1977) has shown that, in the laboratory, Limnephilidae can show no diapause when reared with a long photoperiod. *Tinodes waeneri* was recorded from late May to late September but there was only one record in May with none in June or until late July. No recorded species showed any evidence of multi-voltinism as distinct from a prolonged emergence period. It should be noted, however, that because of its effects on metabolism and nutritional factors, water temperature is an important factor influencing life history patterns in aquatic insects (Danks and Oliver, 1972; Humpesch, 1982; Brittain, 1983; McCafferty and Periera, 1984; Sweeney and Vannote, 1986) and may well have influenced these data. Indeed temperature is known to result in flexible voltinism in Trichopteran species. Thus, Mackay (1979) found that the thermal regime affected the growth rates and consequently the number of generations per year of Hydropsyche.

In preparing this paper, it has transpired that 2009 was not the first time that caddisflies were collected from the Rothamsted trap at Rowardennan. For part of 1968 and all of 1969, 1970 and 1971, staff at the Rothamsted Insect Survey, retained caddisflies from the catch at Rowardennan and from 77 other Rothamsted traps and sent them to M. I. Crichton at the Department of Zoology, Reading University for identification. His records of the Limnephilidae including those identified from the 1968 Rowardennan catch formed part of a study of members of this family caught by the Rothamsted Insect Survey throughout the UK (Crichton, 1971). Records of the members of other families identified from the 1968 catch and those of all caddisflies caught during 1969-1971 appear to have only been published in summary form (Crichton, 1974) and as life histories (Crichton, Fisher and Woiwod, 1978; Crichton and Fisher, 1981). However, the original data remains preserved in the records of the Rothamsted Insect Survey and are here compared with the data collected in 2009 (Table 2).

It is notable from the data of Crichton that the abundance of some species fluctuated considerably from year to year. See, for instance, the differences between the numbers of *Limnephilus lunatus* caught in the years 1969, 1970 and 1971 (Table 2). This is sometimes also apparent when these data are compared with the 2009 records. Thus 107 *Halesus radiatus* were recorded in 2009 but only 14 in 1969, 13 in 1971 and none in 1970. For the most part, however, species that were the most abundant in 1968 to 1971 remained the most common species in 2009.

From 1983 to 1986 aquatic invertebrate surveys were conducted throughout the Loch Lomond catchment. Collection sites included Loch Lomond, Dubh Lochan, other areas of still water such as quarries plus flowing water tributaries of varying pH, nutrient levels and flow rate within the catchment (Adams et al., 1990). These surveys identified the larvae of 56 species of Trichoptera of which 22 were found in Loch Lomond. Three of these were also found in Dubh Lochan and a further two were only recorded from Dubh Lochan. The Rothamsted light trap is very close to both the shore of Loch Lomond and to Dubh Lochan so these 24 species are included in table 2 so that larval and adult records can be compared. A further 33 caddisfly species recorded in the aquatic invertebrate surveys were only recorded in the flowing water of the tributaries of the Loch Lomond catchment. These are only included in table 2 if adults were caught in the Rowardennan trap during 1969 – 1971 surveys and/or during 2009.

As might be expected, species abundant as larvae in water bodies near to the Rothamsted trap were usually commonly caught in the trap. There were exceptions however. *Agapetus fuscipes* were frequent in Loch Lomond but the adult was never caught in the light trap. This was undoubtedly because the adults are day-flying and not attracted to light (Barnard and Ross, 2012). Conversely, *Apatania wallengreni*, was caught in the moth trap in large numbers early in the year, but was not recorded in the aquatic invertebrate surveys. It is not unusual for the larvae of this species to be unrecorded where the adult is common probably because they occur in deeper water (Ian Wallace, *pers. comm*.). For the most part, caddisfly species only recorded in the flowing water of tributaries in the aquatic invertebrate survey were uncommon in the light trap; presumably reflecting the distance that adults would have to fly to the trap. Again there were apparent exceptions. Thus, *Halesus radiatus*, the lava of which was only found in the flowing water of tributaries of the Loch Lomond catchment, was common as an adult in the trap in 2009 and fairly common in 1969 and 1971. The larva is however known to also occur in still water despite not yet being found in Loch Lomond (Barnard and Ross, 2012). *Potamophylax latipennis* was not recorded in the aquatic survey but has since been recorded from the loch (Wallace, *pers. comm*.)

Table 2. A comparison of the caddisfly species recorded in the catch of the Rowardennan light trap in 2009 with those caught in the same trap during 1968 to 1971 and with those species recorded as larvae during invertebrate surveys from 1983 to 1987. * indicates incomplete data, LL indicates species found in Loch Lomond, DL indicates species found in Dubh Lochan and "tributaries only" indicates that the species concerned was recorded in the light trap but, during the aquatic invertebrate survey, larvae were only found in flowing water of tributaries. Species found in tributaries but not recorded in the light trap are omitted.

Family	Species	Total adults in moth trap in 2009	Status in 1983-87 aquatic invertebrate survey (larvae)	Rothamsted Survey 1968*	1969	1970	1971
Rhyacophilidae	*Rhyacophila dorsalis*	not recorded	tributaries only				2
	Rhyacophila obliterata	1	not recorded				
Glossosomatidae	*Agapetus fuscipes*	not recorded	frequent LL				
	Glossosoma boltoni	not recorded	tributaries only	1	3	1	1
Hydroptilidae	*Oxyethira flavicornis*	1	not recorded				
Polycentropodidae	*Cyrnus trimaculaus*	not recorded	recorded LL		30		13
	Cyrnus flavidus	not recorded	frequent LL				
	Holocentropus dubius	not recorded	recorded DL			1	4
	Neureclipsis bimaculata	not recorded	recorded LL				
	Plectrocnemia conspersa	13	tributaries only	3	32	4	37
	Plectrocnemia geniculata	not recorded	frequent LL	9	1	2	1
	Polycentropus flavomaculatus	1	frequent LL		82	9	42
	Polycentropus irroratus	not recorded	recorded DL	1	4		
	Polycentropus kingi	not recorded	tributaries only		2	1	
Psychomyiidae	*Tinodes waeneri*	743+	frequent LL	51	60	6	53
	Lype phaeopa	not recorded	rare LL, also tributaries				
Hydropsychidae	*Hydropsyche instabilis*	not recorded	tributaries only	1	2		
	Hydropsyche siltalai	1	not recorded				
Phryganeidae	*Agrypnia varia*	20	rare LL	2	15	18	73
	Phryganea grandis	not recorded	tributaries only		4	4	
Goeridae	*Goera pilosa*	29	rare LL, also tributaries	1	3	6	2
	Silo pallipes	1	not recorded				
Lepidostomatidae	*Crunoecia irrorata*	not recorded	not recorded		1		
	Lepidostoma hirtum	54	common LL	52	466	200	87
Apataniidae	*Apatania wallengreni*	238	not recorded	1	44	91	73

Limnephilidae	*Drusus annulatus*	1	tributaries only				
	Chaetopteryx villosa	20	rare LL				
	Anabolia nervosa	81	recorded LL		8		40
	Glyphotaelius pellucidus	66	not recorded	1	15	3	5
	Limnephilus affinis	not recorded	recorded LL		2		
	Limnephilus bipunctatus	not recorded	not recorded	2			
	Limnephilus centralis	1	not recorded	1	15	9	4
	Limnephilus coenosus	1	not recorded		1		
	Limnephilus decipiens	not recorded	recorded LL				
	Limnephilus elegans	not recorded	not recorded		1		
	Limnephilus extricatus	not recorded	tributaries only		2		
	Limnephilus griseus	not recorded	not recorded				1
	Limnephilus ignavus	10	not recorded				
	Limnephilus lunatus	231	not recorded		298	12	467
	Limnephilus luridus	13	not recorded		13	11	8
	Limnephilus marmoratus	77	frequent LL, recorded DL	3	49	19	38
	Limnephilus rhombicus	2	recorded LL & DL		1		1
	Limnephilus sparsus	24	not recorded		3	2	14
	Limnephilus stigma	1	not recorded				
	Limnephilus vittatus	not recorded	not recorded		1		
	Halesus digitatus	6	rare LL		3		
	Halesus radiatus	107	tributaries only		14		13
	Mesophylax impunctatus	not recorded	not recorded		36	1	13
	Micropterna lateralis	6	not recorded		5	6	2
	Micropterna sequax	not recorded	not recorded	1	1	2	5
	Potamophylax cingulatus	13	not recorded		8	1	7
	Potamophylax latipennis	6	tributaries only		3		4
	Stenophylax vibex	not recorded	not recorded			1	
Sericostomatidae	*Sericostoma personatum*	1	common LL		1		
Odontoceridae	*Odontocerum albicorne*	2	recorded LL & DL				
Leptoceridae	*Arthripsodes bilineatus*	1	tributaries only		1		
	Arthripsodes commutatus	not recorded	not recorded		8		1
	Ceraclea albimacula	4	not recorded				
	Ceraclea annulicornis	3	not recorded				1
	Ceraclea dissimilis	20	not recorded		168	15	16
	Mystacides azurea	1	recorded LL			1	
	Mystacides	not recorded	recorded LL				

longicornis				
Mystacides nigra	not recorded	not recorded	1	
Oecetis lacustris	not recorded	not recorded		3
Oecetis ochracea	not recorded	recorded LL	2	

One group of caddisflies, including *Glyphotaelius pellucidus*, *Limnephilus centralis*, *Limnephilus coenosus*, *Limnephilus griseus*, *Limnephilus luridus*, *Limnephilus sparsus*, *Limnephilus stigma* and *Limnephilus vittatus*, that were recorded in the trap but not during the aquatic invertebrate survey, were those that breed in very small water bodies including temporary puddles, ditches, small moorland bog pools, fens, marshes and ponds (Barnard and Ross, 2012). This presumably reflects the fact that with the exception of Balmaha Pond a small shallow nutrient-rich pond and Fairy Loch, a small nutrient-poor loch, such habitats did not feature in the aquatic invertebrate survey. Perhaps the scattered and often temporary breeding sites of these species require that the adults are relatively wide-ranging and they are then caught in a trap that is not particularly near to such habitats. Whilst active lateral dispersal of adult caddisflies may be limited, there are indications that some species, particularly the Limnephilidae regularly travel greater distances (Kelly, Bilton and Rundle, 2001).

ACKNOWLEDGEMENTS

The Rowardennan light trap data form a part of the Rothamsted Insect Survey and the authors are particularly grateful to Chris Shortall and Ian Woiwod for making historical caddisfly data available. Ian Wallace, of the UK Trichoptera Recording Scheme, gave us access to unpublished records for Loch Lomond and made very helpful comments and suggestions on the manuscript. The authors would also like to thank Stuart Wilson and colleagues of Scottish Centre for Ecology and Natural Environment Glasgow University (SCENE) who operate the trap at Rowardennan and Colin Adams also of SCENE for information on the aquatic invertebrates of Loch Lomond.

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