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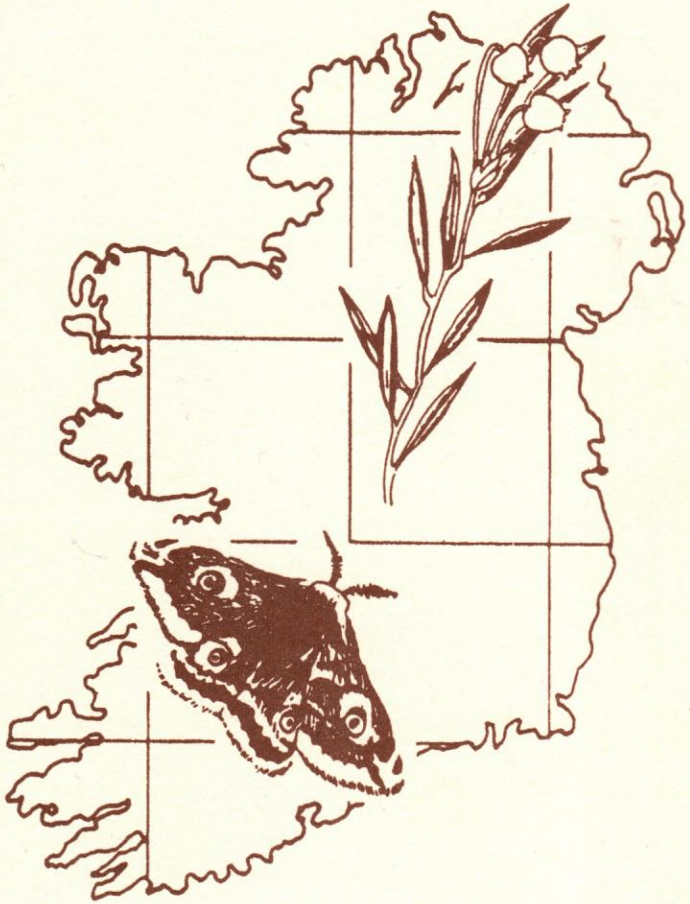

Bulletin No. 25

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THIS BULLETIN IS DEDICATED TO THE MEMORY OF PROFESSOR ROBERT EDMUND BLACKITH (1923-2000) IN RECOGNITION OF HIS CONTRIBUTION TO IRISH ZOOLOGY.

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ENQUIRIES CONCERNING THE BULLETIN (INCLUDING THE PURCHASE OF BACK ISSUES) MAY BE SENT TO THE IRISH BIOGEOGRAPHICAL SOCIETY C/O DR J. P. O'CONNOR, THE NATIONAL MUSEUM OF IRELAND, KILDARE STREET, DUBLIN 2, IRELAND.

BULLETIN OF THE IRISH BIOGEOGRAPHICAL SOCIETY
Number 25

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Bull. Ir. biogeog. Soc. No. 25 (2001)

EDITORIAL

2001 has been a marvellous year for the Society and *Bulletin* No. 25 is the largest one it has ever published. As a result, it has been necessary to have the volume sewn rather than stapled. A total of sixteen papers are included, ranging over a very diverse mix of subjects. Numerous species are added to the Irish fauna. In addition, there is a thought provoking series of articles on farms as biogeographical units. The Society is very grateful to all our contributors and the referees. Our membership has increased and we hope that both established and new members will enjoy the issue. This year, the Society has covered its costs and the subscription rate for 2002 will therefore remain unchanged. However an increase will be necessary in 2003. In addition to its *Bulletin*, the Society has also published over the years an important series of *Occasional Publications*. Details are given overleaf.

Bulletin No. 25 is dedicated to the memory of Professor Robert Blackith of Trinity College, Dublin. In 1993, both Robert and his wife Ruth were elected honorary life members of the Society in recognition of their contributions to Irish natural history. Sadly, Robert died last year. It is appropriate therefore that the Committee has decided to honour his memory by dedicating this volume to him. The Society is indebted to Dr Julian Reynolds for writing the obituary of this wonderful scientist and gentleman.

I also wish to thank Dr Pat Wallace, Director of the National Museum of Ireland, for his support; our sponsors for their generous and essential financial assistance; Mr J. M. C. Holmes for his kindness and expertise in producing the camera-ready copy; and the members of the Committee for their constant encouragement and friendship.

J. P. O'Connor
Editor
9 November 2001

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OCCASIONAL PUBLICATIONS OF THE IRISH BIOGEOGRAPHICAL SOCIETY

Number 1

Proceedings of The Postglacial Colonization Conference

D. P. Sleeman, R. J. Devoy and P. C. Woodman (editors)

Published 1986. 88pp. Price 3.81 euros*

Number 2

Biogeography of Ireland: past, present and future

M. J. Costello and K. S. Kelly (editors)

Published 1993. 149pp. Price 15.24 euros*

Number 3

A checklist of Irish aquatic insects

P. Ashe, J. P. O'Connor and D. A. Murray

Published 1998. 80pp. Price 7.62 euros*

Number 4

A catalogue of the Irish Braconidae (Hymenoptera: Ichneumonoidea)

J. P. O'Connor, R. Nash and C. van Achterberg

Published 1999. 123pp. Price 6.35 euros*

Number 5

The distribution of the Ephemeroptera in Ireland

M. Kelly-Quinn and J. J. Bracken

Published 2000. 223pp. Price 12.70 euros*

Number 6

A catalogue of the Irish Chalcidoidea (Hymenoptera)

J. P. O'Connor, R. Nash and Z. Bouček

Published 2000. 135pp. Price 10.16 euros*

The former Irish pound prices are given in euros. *To the rest of the world, please add 4 euros for postage.

Copies of these publications are available from the Irish Biogeographical Society, c/o Dr J. P. O'Connor, National Museum of Ireland, Kidare Street, Dublin 2, Ireland.

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A RECORD OF THE MONARCH BUTTERFLY *DANAUS PLEXIPPUS* L. (INSECTA: LEPIDOPTERA) FROM COUNTY WEXFORD, IRELAND, WITH A REVIEW OF OTHER IRISH OCCURRENCES

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James P. O'Connor

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On 25 September 1999, one of the authors (SC) was bird-watching at Tacumshin Lake in south Co. Wexford, in south-eastern Ireland (T050061). The day was bright and sunny, with a strong southerly on-shore breeze. While sitting on the southern shore at around 1600 hours BST, looking out over the lake, with the sand-dunes marking the division between it and the sea to the rear, a large butterfly was observed flying in from the sea. From its orange-brown colour and black-wing margins, it was recognised immediately as a monarch (*Danaus plexippus* L.). This identification was confirmed by consulting Whalley and Lewington (1999).

Using Zeiss binoculars, the specimen was followed until it flew into or just beyond a thick clump of sea aster (*Aster tripolium* L.) below SC and almost at the edge of the lake. Since the senior author wished to capture it to show to his bird-watching companion, he hastily assembled his net. But by then, the butterfly had disappeared, presumably after continuing its flight across the water. However, probably the same one was observed on the other side of the lake at Tacumshin during the following week.

Subsequently that evening, Mr Killian Mullarney, who lives in Wexford, informed SC of other records on the same day. Bird-watchers had seen four monarchs at Ballycotton, Co. Cork and another four on Cape Clear Island, Co. Cork. Most Irish records probably originate in the Canary Islands where the species is established. However, there had been a hurricane off the east coast of the United States a few days previous to the 25 September and this presumably was the explanation of the present sightings. Vanholder (1996) presented strong evidence for a Northern American origin of all involved migrating species of Lepidoptera including large numbers of monarchs and birds in 1995, correlated with suitable meteorological conditions.

The above records are of interest since there are so few Irish reports of this vagrant species which ranges in America from Peru to Canada. It also occurs in Australia, New Zealand, Papua and the larger East Indian islands. The Canary Islands were colonized by *D. plexippus* in 1880 (Higgins and Riley, 1980). Since there appears to be some confusion about previous Irish records (e.g. Hickin, 1992), these are listed below:-

CLARE: no locality (12 October 1995) (Vanholder, 1996; Skinner and Parsons, 1998); **CORK**: Ballycotton (16 October 1968) (Baynes, 1969); same locality (10 October 1997) (Hill, 1998; Skinner and Parsons, 2000); probably the same site as no locality is given (11 October 1997) (Bowles, 1997; Skinner and Parsons, 2000); Cape Clear Island (30 September 1981) (Haynes and Hillis, 1982); same locality (10 October 1996) (Hill, 1997; Skinner and Parsons, 1999); two miles east of Castletownberehaven (2 October 1985) one observed on Michaelmas daisies (Bretherton and Chalmers-Hunt, 1986; French, 1986); Castletownshend (20 October 1916) one taken by Major H. Chavasse (Donovan, 1936; Baynes, 1964); (Cape) Clear Island (8 October 1968; 31 October 1968) (Baynes, 1969); (W.) Cape Clear bird observatory (29 September 1981) one (per R. F. Haynes) (Bretherton and Chalmers-Hunt, 1982); Fota Island (end May/early June 1970) (per French) (Bretherton and Chalmers-Hunt, 1982); Fountainstown (W783578) (15 October 1995) (A. Myers in Skinner and Parsons (1998)). Professor Myers states (pers. comm.) that he was taking a bucket of vegetable scraps down to the compost heap at the bottom of the garden when a monarch flew up from a flower just beside him. It flew into a large *Olearia* bush where it sat for some minutes, then it glided off into the next garden before disappearing down to the sea. An unforgetable experience; Reanieshouse (W754519) near Nohaval, north east of Kinsale (22 September 1999). Ms Rosemary Hornibrooke observed a monarch there between 1130 and 1230 hours BST; no locality given (5 October 1996) two specimens (Hill, 1997; Skinner and Parsons, 1999); **DOWN**: Belfast (12 October 1995) (Vanholder, 1996; Skinner and Parsons, 1998); Downpatrick (14 October 1995) (Vanholder, 1996; Skinner and Parsons, 1998); no locality (14 October 1995) (Vanholder, 1996; Skinner and Parsons, 1998); **DUBLIN**: Glenageary (1974) (Hillis, 1976); Howth (4, 5 and 6 September 1932) all the one individual (Donovan, 1936; Baynes, 1964); **GALWAY**: Taylor's Hill (2 October 1981) (Haynes and Hillis, 1982); Galway City (2 October 1981) probably the same record as the previous one from Taylor's Hill. One seen in a garden (per R. F. Haynes)

(Bretherton and Chalmers-Hunt, 1982); **KERRY**: Dingle (11 August 1978) (Hillis, 1979; Chalmers-Hunt, 1982); (S.) Inch Sound near Killarney (24 September 1981) one resting on Marram grass and seen again by others later that day (J. Kirsley) (Bretherton and Chalmers-Hunt, 1982); Parknasilla (24 August 1975) (Hillis, 1976); Westcove near Cahirdaniel (27 September 1933) one taken by Miss M. M. Green (Donovan, 1936; Baynes, 1964); **LIMERICK**: Corbally (22 October 1932) N. H. Wilson (Donovan, 1936; Baynes, 1964); **WEXFORD**: Great Saltee Island (25 September 1981) (Haynes and Hillis, 1982; Bretherton and Chalmers-Hunt, 1982); **WICKLOW**: Rathnew (16 May 1965) (Baynes, 1966); no locality (August 1983) caught by a boy and identified dead by Mrs Jack of Belfast (I. Rippey per R. F. Haynes) (Bretherton and Chalmers-Hunt, 1984).

Acknowledgements

The authors wish to thank Mr K. G. M. Bond, Professor A. A. Myers and Mr K. Mullarney for their assistance.

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A CHECKLIST OF THE CALANOIDA AND THE SMALLER COPEPOD ORDERS (CRUSTACEA: COPEPODA) OF IRELAND

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The present paper constitutes the fifth and final part of an attempt to provide a comprehensive annotated checklist of the Copepoda of Ireland. The four earlier contributions in the series were on the Harpacticoida (Holmes and O'Connor, 1990), the Poecilostomatoida (Holmes and Gotto, 1992), the Siphonostomatoida (Holmes, 1998) and the Cyclopoida (Holmes and Gotto, 2000). This list deals mainly with the Order Calanoida, abundant in marine and freshwater plankton. To complete the series, several other smaller orders are included. These are the Platycopioida, Misophrioida, Mormonilloida and Monstrilloida.

As in the previous ones, this checklist is based primarily on a re-assessment of the published records in the scientific literature, augmented by some new data. The last complete checklist was by Pearson (1905, 1906), who listed 113 species (107 calanoids, 6 others) belonging to the present orders.

The Calanoida have been described as "the marine planktonic copepods *par excellence*" (Huys and Boxshall, 1991). They can occur at all depths and in vast numbers. They also inhabit brackish and freshwater habitats. Because of the ease of collecting, with a plankton tow-net, they were intensely investigated relatively early on, in copepod terms, in the nineteeth and early twentieth centuries.

This list is perhaps the least satisfactory in the series, for reasons which are discussed below. Few species are represented in the reference collections of the National Museum of Ireland, and the records from the literature are interpreted with reference to the identification guides which the original workers might have used. Many of the genera have changed over the past century. Much of the complilation could be described as a nomenclatorial update of the work of G. P. Farran, who flourished in the first half of the twentieth century. For this list, names mostly follow the checklist in the recent monograph on *The biology of calanoid copepods* by Mauchline (1998).

It is difficult to summarise such an intensely studied group as the Calanoida. While for many of the species the distributional records around Ireland are so sparse that each individual mention is noteworthy, for others their recorded occurrence and their abundance is so overwhelming that distribution can be reduced to generalisations, such as 'found abundantly in the plankton all around Ireland', or even represented as a loosely defined area on a map (see Farran, 1910). *Temora*, *Acartia* and *Calanus* occur so abundantly and ubiquitously around the coast that their individual occurrence is hardly worth mentioning.

Because the calanoids are very much creatures of the plankton of the world's oceans, there is the zoögeographical problem of where to draw the line around Ireland and which records to include. It was decided here to include any species whose distribution has ever been described with relation to Ireland. For example, material from a station described as on a bearing such as "40 miles north-north-west of Achill Head" would be included, irrespective of the distance offshore. This arbitary criterion for inclusion is much as was practiced by Peason and by Farran. More recently, localities tend to be described with refence to the ocean bottom topography, such as "Porcupine Seabight" or "Rockall Trough", which might amount to the same thing. The plankton identification sheets produced by ICES divide the seas around the British Isles into a number of "Sea Areas". For this list, sea area "South and West Ireland" is included, but sea area "Bristol Channel and Irish Sea" is not, because of uncertainty as to where in the Irish Sea material may have been collected. For many records the locality of capture is imprecise and reduced to a generalisation such as the 'West of Ireland'.

The old records are often difficult to interpret, not helped by the lack of reference material. Several of the names recorded by I. C. Thompson (1897, 1903) from off the West of Ireland or from Valentia (spelt Valencia), County Kerry, cannot be assigned. One can only hazard a guess as to what species they might have been. Examples are *Calanus propinquus* Brady, 1883, *Euchaeta marina* (Prestandrea, 1833), *Euchaeta oceana* I. C. Thompson, 1903, *Isochaeta longisetosus* I. C. Thompson, 1903 and *Acartia centrura* Giesbrecht, 1889.

The species list is laid out in much the same format as in previous contributions. The genera and species are listed in alphabetical order within families. Synonyms which appear in the Irish literature are given under the relevant modern names. Where a species has been recorded in the literature under a name which is not a synonym, i.e., misidentified, the original name is included for reference purposes. Material lodged in the National Museum of Ireland is indicated by NMI. For each species, the records are listed county by county in alphabetical order. Offshore records or records where the county is in doubt are categorised as 'Ireland'. For each county, the records are listed in order of date with the published records first and then the new unpublished data. For the published material, usually only the original record is cited as some papers repeat previous data. Material collected by the author is indicated by the abbreviation 'JMCH'.

Ecological information is kept to a minimum. For each species, data are given, *inter alia*, on whether it is (a) marine, brackish or freshwater; (b) associated with a particular habitat or animal group; (c) attracted to a light-trap (Holmes and O'Connor, 1988). Data on species attracted to the light-trap are sparse, not because the calanoids are not attracted, but because the trap has seldom been used in the open sea. Most of the collecting effort with the light-traps was concentrated in shallow inshore benthic situations.

The checklist contains 237 species in 34 families. All previous records, both marine and freshwater, are cited. In addition, there are 78 new records. Three species are new to Ireland. These are indicated by *.

Studies on the Irish fauna are far from complete. It is hoped therefore that this list will provide a basis for future research.

PLATYCOPIOIDA

Platycopiidae

***Platycopia perplexa* G. O. Sars, 1911**

CORK: Barloge, near Lough Hyne (Holmes, 1987).

Marine, benthos.

CALANOIDA

Pseudocyclopidae

***Pseudocyclops crassiremis* Brady, 1873**

CORK: Barloge Creek and Lough Hyne (Holmes, 1996).

Marine, benthos.

Pseudocyclops obtusatus **Brady and Robertson, 1873**

CORK: Glengariff (Herdman, 1891; I. C. Thompson, 1896); Lough Hyne (Holmes, 1983).

DONEGAL: Mulroy Lough (Brady, 1878).

GALWAY: Roundstone Bay (Brady and Robertson, 1873; Brady, 1902); Ballynakill Harbour (Farran, 1913).

Marine, benthos and in surface plankton. Light-trap.

Augaptilidae

Augaptilus anceps **Farran, 1908**

IRELAND: Fisheries station S.R.197, off west of Ireland (Farran, 1908).

Marine, plankton.

Augaptilus longicaudatus **(Claus, 1863)**

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908).

Marine, plankton.

Augaptilus megalurus **Giesbrecht, 1889**

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

Centraugaptilus cucullatus **(G. O. Sars, 1905)**

IRELAND: off west of Ireland (Rose, 1933).

Marine, plankton.

Centraugaptilus horridus **(Farran, 1908)**

(*Augaptilus horridus* Farran, 1908)

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

Centraugaptilus rattrayi **(T. Scott, 1893)**

(*Augaptilus rattrayi* T. Scott, 1893)

IRELAND: off west of Ireland (I. C. Thompson, 1903; Farran, 1908).

Marine, plankton.

***Euaugaptilus angustus* (G. O. Sars, 1905)**

(*Augaptilus angustus* G. O. Sars, 1905)

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Euaugaptilus bullifer* (Giesbrecht, 1889)**

(*Augaptilus bullifer* Giesbrecht, 1892)

IRELAND: off west of Ireland (Farran, 1908).

Marine, deep-water plankton.

***Euaugaptilus elongatus* (G. O. Sars, 1905)**

(*Augaptilus elongatus* G. O. Sars, 1905)

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Euaugaptilus facilis* (Farran, 1908)**

(*Augaptilus facilis* Farran, 1908)

IRELAND: Fisheries station S.R.197, off west of Ireland (Farran, 1908).

Marine, plankton.

***Euaugaptilus filigerus* (Claus, 1863)**

(*Augaptilus filigerus* (Claus, 1863))

IRELAND: off west of Ireland (I. C. Thompson, 1903; Farran, 1908).

Marine, plankton.

***Euaugaptilus gibbus* (Wolfenden, 1904)**

(*Augaptilus gibbus* Wolfenden, 1904)

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908).

Marine, plankton.

***Euaugaptilus hecticus* (Giesbrecht, 1889)**

(*Augaptilus hecticus* Giesbrecht, 1889)

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

***Euaugaptilus laticeps* (G. O. Sars, 1905)**

(*Augaptilus laticeps* G. O. Sars, 1905)

IRELAND: off west of Ireland (Farran, 1908).

Marine, deep-water plankton.

***Euaugaptilus magnus* (Wolfenden, 1904)**

(*Augaptilus magnus* Wolfenden, 1904)

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908).

Marine, plankton.

***Euaugaptilus nodifrons* (G. O. Sars, 1905)**

(*Augaptilus nodifrons* G. O. Sars, 1905)

Ireland: off west of Ireland (Farran, 1908).

Marine, plankton.

***Euaugaptilus palumbii* (Giesbrecht, 1892)**

(*Augaptilus palumboi* Giesbrecht, 1892)

Ireland: off west of Ireland (I. C. Thompson, 1903; Farran, 1908).

Marine, plankton.

***Euaugaptilus similis* (Farran, 1908)**

(*Augaptilus similis* Farran, 1908)

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Euaugaptilus squamatus* (Giesbrecht, 1889)**

(*Augaptilus brevicaudatus* G. O. Sars, 1905)

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Euaugaptilus truncatus* (G. O. Sars, 1905)**

IRELAND: off west of Ireland (Rose, 1933)

Marine, plankton.

***Haloptilus acutifrons* (Giesbrecht, 1892)**

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905).

Marine, plankton. Farran (1905) recorded what he thought might perhaps be *Haloptilus fertilis* (Giesbrecht, 1892), from an immature and imperfect male found off County Mayo, but that species seems to be confined to the Mediterranean (Rose, 1933). Lacking any voucher material, the identity of this tentative record cannot be regarded with much confidence.

***Haloptilus fons* Farran, 1908**

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Haloptilus longicornis* (Claus, 1863)**

KERRY: off County Kerry (I. C. Thompson, 1903).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905).

Marine, plankton.

***Haloptilus ornatus* (Giesbrecht, 1892)**

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

***Haloptilus spiniceps* (Giesbrecht, 1892)**

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

***Haloptilus tenuis* Farran, 1908**

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Pachyptilus abbreviatus* (G. O. Sars, 1905)**

(*Pontoptilus abbreviatus* G. O. Sars, 1905)

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Pontoptilus muticus* G. O. Sars, 1905**

IRELAND: off west of Ireland (Farran, 1908).

Marine, deep-water plankton.

Arietellidae

***Arietellus pavoninus* G. O. Sars, 1905**

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Arietellus plumifer* G. O. Sars, 1905**

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Arietellus setosus* Giesbrecht, 1892**

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

***Arietellus simplex* G. O. Sars, 1905**

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton. Farran (1908) also recorded an unnamed species of *Arietellus* sp. from off west of Ireland.

Marine, plankton.

****Paramisophria spooneri* Krishnaswamy, 1959**

GALWAY: 1♀, Kilkieran Bay, *Pseudocucumas* ground, maerl beds, September 1980, D. McGrath (NMI).

Marine, benthic. New to Ireland.

***Paraugaptilus buchani* Wolfenden, 1904**

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

Nullosetigeridae

***Nullosetigera helgae* (Farran, 1908)**

(*Phyllopus helgae* Farran, 1908)

MAYO: off County Mayo (Farran, 1905, tentatively as *Phyllopus bidentatus*).

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Nullosetigera impar* (Farran, 1908)**

(*Phyllopus impar* Farran, 1908)

MAYO: off County Mayo (Farran, 1905, tentatively as *Phyllopus bidentatus*).

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton. Farran (1908) referred all specimens previously identified as *P. bidentatus* Brady, 1883 to two new species of *Phyllopus*. Similarly, material recorded as *P. bidentatus* from off the west coast of Ireland by Thompson (1903) and Wolfenden (1904) probably belongs to the same two species.

The listing of *Nullosetigera bidentata* (Brady) by Rose (1933) (as *Phyllopus bidentatus* from the west of Ireland) is probably a mistake.

Heterorhabdidae

***Disseta palumboi* Giesbrecht, 1889**

(*Heterorhabdus grandis* Wolfenden, 1904)

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Farran, 1948e).

Marine, deep-water plankton.

***Hemirhabdus grimaldii* (Richard, 1893)**

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Farran, 1948e).

Marine, deep-water plankton.

***Heterorhabdus abyssalis* (Giesbrecht, 1889)**

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905); sea area 'south and west Ireland' (Farran, 1948f).

Marine, plankton.

***Heterorhabdus atlanticus* Wolfenden, 1905**

IRELAND: off west of Ireland (Pearson, 1906).

Marine, plankton.

***Heterorhabdus clausii* (Giesbrecht, 1889)**

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, deep-water plankton.

***Heterorhabdus norvegicus* (Boeck, 1872)**

MAYO: 40 miles north-north-west of Achill Head (Norman, 1903); off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Farran, 1948f).

Marine, deep-water plankton.

***Heterorhabdus papilliger* (Claus, 1863)**

IRELAND: off west of Ireland (I. C. Thompson, 1903); sea area 'south and west Ireland' (Farran, 1948f).

Marine, plankton.

***Heterorhabdus robustus* Farran, 1908**

(*Heterorhabdus vipera* (Giesbrecht), ***sensu*** Farran, 1905)

MAYO: off County Mayo (Farran, 1905, as *H. vipera*).

IRELAND: off west of Ireland (I. C. Thompson, 1903, as *H. vipera*; Wolfenden, 1904, as *H. vipera*; Farran, 1908); sea area 'south and west Ireland' (Farran, 1948f).

Marine, deep-water plankton.

***Heterorhabdus spinifrons* (Claus, 1863)**

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Farran, 1908); sea area 'south and west Ireland' (Farran, 1948f).

Marine, plankton.

***Heterostylites longicornis* (Giesbrecht, 1889)**

(*Heterorhabdus longicornis* (Giesbrecht, 1889))

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Farran, 1948e).

Marine, deep-water plankton.

***Heterostylites major* (Dahl, 1894)**

IRELAND: sea area 'south and west Ireland' (Farran, 1948e).

Marine, deep-water plankton.

***Mesorhabdus brevicaudatus* (Wolfenden, 1905)**

(*Mesorhabdus annectens* G. O. Sars, 1905)

KERRY: south-west of Valentia (Pearson, 1906).

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Farran, 1948e).

Marine, deep-water plankton.

Lucicutiidae

***Lucicutia clausi* (Giesbrecht, 1889)**

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

***Lucicutia curta* Farran, 1905**

MAYO: 'Helga' station off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Lucicutia flavicornis* (Claus, 1863)**

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905).

Marine, plankton.

***Lucicutia grandis* (Giesbrecht, 1895)**

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908).

Marine, plankton.

***Lucicutia longicornis* (Giesbrecht, 1889)**

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

***Lucicutia longiserrata* (Giesbrecht, 1889)**

IRELAND: off west of Ireland (I. C. Thompson, 1903; Farran, 1908).

Marine, plankton.

Lucicutia lucida **Farran, 1908**

IRELAND: Fisheries station S.R.197, off west of Ireland (Farran, 1908).

Marine, plankton.

Lucicutia magna **Wolfenden, 1903**

(*Lucicutia atlantica* Wolfenden, 1904)

IRELAND: Porcupine Bank (Farran, 1905); off west of Ireland (Farran, 1908).

Marine, plankton.

Metridinidae

Metridia brevicauda **Giesbrecht, 1889**

MAYO: off County Mayo (Farran, 1905, as *M. lucens*; Pearson, 1906).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908).

Marine, deep-water plankton.

Metridia longa **(Lubbock, 1854)**

GALWAY: Aran Islands (Fives, 1971).

KERRY: off County Kerry (I. C. Thompson, 1903, doubtful record).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904, doubtful records); sea area 'south and west Ireland' (Farran, 1948d).

Marine, deep-water plankton. Northern distribution (Farran, 1910; Wilson, 1932).

Metridia lucens **Boeck, 1864**

(*Paracalanus hibernicus* Brady and Robertson, 1873)

(*Metridia armata* Boeck, *sensu* Brady, 1878)

CLARE: Loop (spelt Loup) Head (Brady and Robertson, 1873).

CLARE/GALWAY: Galway Bay (Brady and Robertson, 1873; Boyd, 1973a).

CLARE/KERRY: off the mouth of the River Shannon (Brady and Robertson, 1873).

CORK: Fastnet Rock (Gough, 1906); off south coast (Farran, 1947b); Lough Hyne (Holmes, 1983, as *M. longa* (NMI)).

DOWN: Skulmartin Lightship (Gough, 1906).

GALWAY: High Island and Inishbofin (Farran, 1903); off Cleggan and off Inishshark (Farran,

1903, 1914); Mutton Island (Fives, 1969); Kilkieran Bay, of Kilkieran Harbour (Fives, 1970).
GALWAY/MAYO: Killary Harbour (Keegan and Mercer, 1986; Ryan *et al.*, 1986).
KERRY: Dingle Bay, and near Valentia (Brady and Robertson, 1873; Valentia (I. C. Thompson, 1896, 1897); Valentia (I. C. Thompson, 1900, as *M. longa*, probably this species (Pearson, 1906)).
MAYO: Inishturk and off Clare Island (Farran, 1903); 40 miles north-north-west of Achill Head (Norman, 1903); 6 specimens, off coast of County Mayo, 53°53'N. 10°51'W., 155m, 8 November 1988, D. Minchin (NMI).
WEXFORD: Coningbeg Lightship (Gough, 1906).
WICKLOW: South Arklow Lightship (Gough, 1906).
IRELAND: Rockall Bank, 51°22'N. 12°25'W. off south-west Ireland, and 53°24'N. 15°24'W. off west of Ireland (Brady and Robertson, 1873; Wolfenden, 1904; Farran, 1908); south-west Ireland (Malcomson, 1886); Porcupine Bank (Farran, 1905); Irish Sea, south and west coasts of Ireland (Farran, 1910, map; Selbie, 1911); west coast of Ireland (Farran, 1913; Fives, 1969); sea area 'south and west Ireland' (Farran, 1948d); around Ireland (Williams, 1988).

Marine, plankton.

***Metridia princeps* Giesbrecht, 1889**

MAYO: off County Mayo (Farran, 1905).
IRELAND: off west of Ireland (I. C. Thompson, 1903; Farran, 1908); sea area 'south and west Ireland' (Farran, 1948d).

Marine, plankton.

***Metridia venusta* Giesbrecht, 1889**

(*Metridia normani* Giesbrecht, 1892)

MAYO: 40 miles north-north-west of Achill Head (Norman, 1903); off County Mayo (Farran, 1905).
IRELAND: off west of Ireland (I. C. Thompson, 1903, regarded as doubtful by Farran (1905); Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Farran, 1948d).

Marine, deep-water plankton.

***Pleuromamma abdominalis* (Lubbock, 1856)**

KERRY: off County Kerry (I. C. Thompson, 1903).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Farran, 1948g).

Marine, plankton.

***Pleuromamma borealis* (Dahl, 1893)**

IRELAND: west of Ireland (Rose, 1933); sea area 'south and west Ireland' (Farran, 1948g).

Marine, plankton.

***Pleuromamma gracilis* (Claus, 1863)**

IRELAND: off west of Ireland (I. C. Thompson, 1903; Farran, 1908); sea area 'south and west Ireland' (Farran, 1948g).

Marine, plankton.

***Pleuromamma robusta* (Dahl, 1893)**

MAYO: 40 miles north-north-west of Achill Head (Sars, 1902; Norman, 1903); off Co. Mayo (Farran, 1905).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905); sea area 'south and west Ireland' (Farran, 1948g); north, west and south of Ireland (Williams, 1988).

Marine, plankton.

***Pleuromamma xiphias* (Giesbrecht, 1889)**

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland (Farran, 1948g).

Marine, plankton.

Centropagidae

***Centropages bradyi* Wheeler, 1900**

IRELAND: sea area 'south and west Ireland' (Farran, 1948a).

Marine, plankton.

***Centropages chierchiae* Giesbrecht, 1889**

CLARE: off West Clare (Fives, 1969).

Kerry: off County Kerry (I. C. Thompson, 1903).

Marine, plankton.

***Centropages hamatus* (Liljeborg, 1853)**

ANTRIM: Larne Lough (Pearson, 1906).

CLARE: Carrigaholt and Scattery Island (Herdman, 1891).

CLARE/GALWAY: Galway Bay (Boyd, 1973a).

CORK: Berehaven and Glengariff (Herdman, 1891); Fastnet Rock (Gough, 1906); Cork Harbour (Boyd, 1972); Lough Hyne (Holmes, 1980; Thain *et al.*, 1981; Holmes and O'Connor, 1991); several specimens, Castlehaven (W175293), light-trap, 5m, mud near *Zostera*, 17 August 1985, JMCH (NMI).

DONEGAL: off Pladda, Lough Foyle, Lough Swilly, Gola Island and Killybegs (Herdman, 1891; Herdman *et al.*, 1898; Pearson, 1906); off Moville (MacDonald, 1951); several specimens, Mulroy Bay, 22 May 1980, D. Minchin.

DOWN: Skulmartin Lightship (Gough, 1906); Strangford Lough (Gotto, 1951; Williams, 1954; Boyd, 1973b).

DUBLIN: Dalkey (O'Riordan, 1966); several specimens, the '40-Foot', Sandycove (O259281), light-trap, 10m, 5 September 1982, JMCH; 1 specimen, near Malahide (O239459), light-trap, 2m, sand, 29 April 1984, JMCH; 1 specimen, Broadmeadows (O224468), Malahide, light-trap, 2m, mud, 23 September 1984, JMCH; several specimens, Dalkey Sound (O272265), light-trap, 5m, 15 September 1985, JMCH; several specimens, Kelly's Rock (O3050), Lambay Island, light-trap, 15m, 20 June 1991, JMCH; several specimens, Tayleur Bay (O3251), Lambay Island, light-trap, 15m, 20 June 1991, JMCH; several specimens, Sunk Island (O321499), Lambay Island, light-trap, 10m, 20 June 1991, JMCH.

GALWAY: Killeany Bay, Aran Islands (Herdman, 1891; I. C. Thompson, 1896); off Cleggan, High Island, Inishbofin and off Freaghillaun (Farran, 1903); off Inishshark (Farran, 1903, 1914); Ballynakill (Farran, 1913, 1914); Mutton Island (Fives, 1969, 1971); Spiddal (Holmes, 1986).

GALWAY/MAYO: Killary Bay (Herdman, 1891; Farran, 1913, 1914; Keegan and Mercer, 1986; Ryan *et al.*, 1986).

KERRY: Valentia (I. C. Thompson, 1896, 1897, 1900); off County Kerry (I. C. Thompson, 1903); 1 specimen, Knightstown (V4277), Valentia Island, light-trap, 3m, 21 July 1986, JMCH.

MAYO: Inishturk and off Clare Island (Farran, 1903); Blacksod Bay (Farran, 1914, 1915).

WATERFORD: several specimens, Dunmore East (S6900), light-trap, 5m, coarse gravel, 23 June 1983, JMCH.

WEXFORD: Coningbeg Lightship (Gough, 1906).

WICKLOW: South Arklow Lightship (Gough, 1906).

IRELAND: west of Ireland (Brady and Robertson, 1873); west coast of Ireland (Pearson, 1906); off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Farran, 1948a).

Marine to brackish, inshore plankton. Light-trap.

***Centropages typicus* Krøyer, 1849**

CLARE: Carrigaholt and Scattery Island (Herdman, 1891).

CLARE/GALWAY: Galway Bay (Boyd, 1973a).

CORK: Fastnet Rock (Gough, 1906); Cork Harbour (Boyd, 1972); Long Island Bay, Sherkin (Cook and Jones, 1980); Lough Hyne (Holmes, 1980); Courtmacsherry Bay (Dorman, 1987, 1988).

DONEGAL: off Moville (MacDonald, 1951).

DOWN: Skulmartin Lightship (Gough, 1906); Pawle Reefs, Strangford Lough (Boyd, 1973b).

GALWAY: Killeany Bay, Aran Islands (Herdman, 1891; Fives, 1971); off Cleggan, High Island, Inishbofin and off Freaghillaun (Farran, 1903); off Inishshark (Farran, 1903, 1914); Ballynakill (Farran, 1913).

GALWAY/MAYO: Killary Harbour (Farran, 1914; Keegan and Mercer, 1986; Ryan *et al.*, 1986).

KERRY: Valentia (I. C. Thompson, 1896, 1897, 1900); off County Kerry (I. C. Thompson, 1903); Dingle Bay area (O'Riordan, 1986).

MAYO: Inishturk and off Clare Island (Farran, 1903); Blacksod Bay (Farran, 1914, 1915).

WEXFORD: Coningbeg Lightship (Gough, 1906).

WICKLOW: South Arklow Lightship (Gough, 1906).

IRELAND: west of Ireland (Brady and Robertson, 1873; Fives, 1969); south-west Ireland (Malcomson, 1886; Bourne, 1890a); off west of Ireland (I. C. Thompson, 1903; Farran, 1908); Porcupine Bank (Farran, 1905); sea area 'south and west Ireland' (Farran, 1948a).

Marine, plankton. Light-trap.

***Centropages violaceus* (Claus, 1863)**

IRELAND: sea area 'south and west Ireland' (Farran, 1948a).

Marine, plankton.

***Isias clavipes* Boeck, 1864**

ANTRIM: off Whitehead (Pearson, 1906, based on a manuscript record (Brady, 1904).

CLARE: Carrigaholt (Herdman, 1891).

CORK: Templenoe, Kenmare River, Berehaven and Glengariff (Herdman, 1891); Long Island Bay, Sherkin (Cook and Jones, 1980); Lough Hyne (Holmes, 1980; Thain *et al.*, 1981; Holmes and O'Connor, 1991); several specimens, Castlehaven (W175293), light-trap, 5m, mud near *Zostera*, 17 August 1985, JMCH; several specimens, Sherkin Island (W006259, W014259), light-traps, 4-10m, 3 August 1987, JMCH (NMI).

DONEGAL: Lough Swilly and Killybegs (Brady, 1878); Gola Island (Herdman, 1891).

DOWN: off Newcastle (Brady, 1902); Skulmartin Lightship (Gough, 1906); Strangford Lough (Boyd, 1973b).

DUBLIN: Dalkey (O'Riordan, 1966); 5 specimens, Dalkey Sound (O272265), light-trap, 5m, 15 September 1985, JMCH.

GALWAY: Clifden Bay and Roundstone Bay (Brady and Robertson, 1873); High Island, Inishbofin and off Freaghillaun (Farran, 1903); off Cleggan and off Inishshark (Farran, 1903, 1914); Ballynakill Harbour (Farran, 1913, 1914); Kilkieran Bay and Mutton Island (Fives, 1969); Spiddal (Holmes, 1986).

GALWAY/MAYO: Killary Harbour (Farran, 1914; Ryan *et al.*, 1986).

KERRY: Valentia (I. C. Thompson, 1896, 1897, 1900); several specimens, Knightstown (V4277), Valentia Island, light-trap, 3m, 21 July 1986, JMCH; several specimens, West Cove (V6160), near Derrynane, light-trap, 2m, 31 May 1992, JMCH.

MAYO: Inishturk and off Clare Island (Farran, 1903); Blacksod Bay (Farran, 1914, 1915).

WICKLOW: South Arklow Lightship (Gough, 1906).

Marine, surface plankton. Light-trap.

Diaptomidae

***Arctodiaptomus laticeps* (G. O. Sars, 1863)**

(*Diaptomus laticeps* G. O. Sars, 1863)

CORK: Gouganebarra Lake (Grainger, 1952, 1957b).

FERMANAGH: Lough Erne (Gurney, 1931).

GALWAY/MAYO: Lough Mask and Lough Corrib (Kane, 1907).

KERRY: Lough Inchiquin, Cloonee Lake, Caragh Lough, lakes in Glas Loughs group, Lough Nakirka, Lough Acoose, Lough Reagh, Cloon Lough, Lough Beg, Lough Fadda, Lough Brin, Lough Erhogh, Lough Managh, Lough Gargarry and Lough Guitane (Grainger, 1952); Derriana Lough and Cloonlaghlin Lough Upper (Grainger, 1957a).

LEITRIM: Lough Melvin (O'Riordan, 1971).

SLIGO: the Rosses (Kane, 1907); Lough Easky (Farran, 1947a).

Freshwater.

***Arctodiaptomus wierzejskii* (Richard, 1888)**

(*Diaptomus wierzejskii* Richard, 1888)

CORK: Lough Avaul Lesser, near Glengarriff (Farran, 1947a); Lough Akeen (Grainger, 1952); Glenkeel Lough, Mardoolig Lough, Lough Shanog and small unnamed loughs nearby (Grainger, 1957a).

GALWAY: turlough near Kilconly (Ali *et al.*, 1987).

KERRY: Lough Currane (Farran, 1947a, Grainger, 1952; O'Riordan, 1971); Waterville (O'Riordan, 1971); Looscaunagh Lake, Caragh Lough, unnamed lake near Derrygarriff Mountain, lakes in Glas Loughs group, Lough Nakirka, Lough Cappanalea, Lough Nambrackdarrig and Lough Cummernamuek (Grainger, 1952); Cloonlaghlin Lough Lower, Coomasahig Lough, Glan Lough (Grainger, 1957a).

MAYO: two sites near Kilmaine, Ballyglass, two sites south of Balla (Grainger, 1979) (NMI); turloughs near Ballyglass and Balla (Ali *et al.*, 1987); 4 specimens, turlough near Ballinrobe (M277648), 16 March 1987, JMCH.

Freshwater.

***Diaptomus castor* (Jurine, 1820)**

FERMANAGH: Upper Lough Erne (Creighton, 1893).

GALWAY: pools near Kilcolgan (Grainger, 1976); Roo West turlough and Tulla turlough (Reynolds and Marnell, 2000).

MEATH: near Rathmolyon (Grainger, 1966).

MAYO: two sites near Kilmaine, Ballyglass, and two sites south of Balla (Grainger, 1979); turlough near Ballyglass (Ali *et al.*, 1987); several specimens, turlough near Balla (M250813), 16 March 1987, JMCH; several specimens, turlough near Ballinrobe (M277648), 16 March 1987, JMCH (NMI).

WICKLOW: King's River, Lockstown (O'Riordan, 1971).

Freshwater.

***Diaptomus cyaneus* Gurney, 1909**

GALWAY: turloughs at Castlehacket and near Kilconly (Ali *et al.*, 1987); turlough near Kilconly (Grainger and Holmes, 1989).

MAYO: turloughs near Ballyglass and Balla (Ali *et al.*, 1987); turlough near Kilmaine (Grainger and Holmes, 1989); several specimens, turlough near Ballinrobe (M277648), 16 March 1987, JMCH (NMI).

ROSCOMMON: turloughs at Four Mile House and near Castleplunket (Ali *et al.*, 1987); turloughs near Athleague and Boyle (Grainger and Holmes, 1989).

Freshwater.

***Eudiaptomus gracilis* (G. O. Sars, 1863)**

(*Diaptomus gracilis* G. O. Sars, 1863)

(*Diaptomus sancti-patricii* Brady, 1892)

CAVAN: Lough Sillan (O'Connor, 1985).

CLARE: Lisdoonvarna (Kane, 1907).

CLARE/GALWAY/TIPPERARY: Lough Derg and River Shannon (Southern and Gardiner, 1926, 1932).

DONEGAL: Lough Divna, Dunfanaghy Salt Lake and Sessiagh Lough (O'Riordan, 1971).

DUBLIN: Mount Argus (O'Riordan, 1971).

FERMANAGH: Lough Erne (Kane, 1907; Battarbee, 1986).

GALWAY: Connemara (Brady, 1892); lakes in Connemara (Kane, 1907); Kylemore Lough (Popple, 1912); Mutton Island (Fives, 1969); Glendollagh Lough, Lough Inagh, Ballynakill

Lough, Shanakeever Lough, Lough Shindilla and Lough Derg (O'Riordan, 1971).

GALWAY/MAYO: Lough Mask and Lough Corrib (Kane, 1907); Killary Harbour (Ryan *et al.*, 1986).

KERRY: Upper Lake, Muckross Lake and Lough Leane, Killarney, Caragh Lough and Lough Beg (Grainger, 1952); Lough Caragh (O'Riordan, 1971).

LAOIS: Emo Park and Abbey Leix (McCall, 1983).

LEITRIM: Lough Melvin (O'Riordan, 1971); several specimens, Kilnamar Lough (H261063), Killegar, light-trap, 2m, 17 August 1991, JMCH (NMI).

LEITRIM/SLIGO: Lough Glencar (Kane, 1904).

MAYO: Clare Island, and sites in Clew Bay district (Scourfield, 1912); Doo Lough, Lough Conn and Moher Lough (O'Riordan, 1971).

MONAGHAN: Rossmore and Drumreaske (Kane, 1907); Bragan (Popple, 1912); several specimens, turlough near Ballinrobe (M277648), 16 March 1987, JMCH (NMI).

SLIGO: Glencar (Kane, 1907).

WICKLOW: Lough Dan (O'Connor, 1985); Roundwood Reservoir (Dauod *et al.*, 1986a, 1986b); several specimens, Roundwood Reservoir, 23 May 1991, A. McNally.

IRELAND: Lough Neagh (Kane, 1907; Dakin and Latarche, 1913; Graham, 1970); Lough Ree (Kane, 1907).

Freshwater, lake plankton. Light-trap. A record of *Diaptomus vulgaris* Schmeil by Fives (1969), from Mutton Island, Galway Bay, is not accepted in this list, because of the unlikely locality and the lack of voucher material. Irish records of *Eudiaptomus graciloides* (Lilljeborg, 1888) by West and West (1906, as *Diaptomus graciloides* Sars) were dismissed by Scourfield (1912).

***Myxodiaptomus laciniatus* (Lilljeborg, 1889)**

(*Diaptomus laciniatus* Lilljeborg, 1889)

CORK: Lough Avaul, near Glengarriff (Farran, 1947a; Grainger, 1957a); Lough Allua, near Inchigeela and Shreelane Lakes (Grainger, 1952); Lough Bofinna (Grainger, 1957a); 2♀♀, Shreelane Lake (W169354), near Skibbereen, light-trap, 3m, 5 August 1988, JMCH (NMI).

KERRY: Lough Fadda (Grainger, 1952); Tahilla (O'Riordan, 1971).

SLIGO: Lough Easky (Farran, 1947a).

IRELAND: Ireland (Harding and Smith, 1960).

Freshwater, light-trap.

Temoridae

***Eurytemora affinis* (Poppe, 1880)**

(*Eurytemora hirundoides* (Nordqvist, 1888))

CORK: Long Island Bay, Sherkin (Cook and Jones, 1980); Lough Hyne (Holmes, 1985).

DOWN: Strangford Lough (Boyd, 1973b).

DUBLIN: several specimens, near Malahide (O239459), light-trap, 2m, sand, 29 April 1984, JMCH (NMI).

GALWAY: Spiddal (Holmes, 1986).

GALWAY/MAYO: Killary Harbour (Ryan *et al.*, 1986).

MAYO: Furnace Lough (O'Riordan, 1971).

Euryhaline, plankton. Light-trap.

***Eurytemora velox* (Liljeborg, 1853)**

(*Temora velox* Liljeborg, 1853)

(*Eurytemora lacinulata* (Fischer, 1853))

CLARE/GALWAY/TIPPERARY: Lough Derg and River Shannon (Southern and Gardiner, 1926, 1932).

DUBLIN: Malahide (Gurney, 1921).

FERMANAGH: Upper Lough Erne (Creighton, 1893, as *Tenura velox* [sic]); Lough Erne (Gurney, 1931).

GALWAY: Lough Derg (O'Riordan, 1971); Spiddal (Holmes, 1986).

LAOIS: Fisherstown (McCall, 1983).

LEITRIM: several specimens, Kilnamar Lough (H261063), Killegar, light-trap, 2m, 17 August 1991, JMCH (NMI).

MAYO: Clare Island and Achill Island (Scourfield, 1912).

WEXFORD: several specimens (*circa* 30,000), Ballyteige (S935065), light-trap, 1m, 6 June 1988, JMCH (NMI).

Freshwater to brackish. Light-trap.

***Temora longicornis* (O. F. Müller, 1792)**

ANTRIM/DOWN: Belfast (W. Thompson, 1856).

CLARE: Carrigaholt and Scattery Island (Herdman, 1891).

CLARE/GALWAY: Galway Bay (Boyd, 1973a).

CORK: Kinsale (Bourne, 1890b); Berehaven (Herdman, 1891); Fastnet Rock (Gough, 1906); Cork Harbour (Boyd, 1972); Carrigathorna, near Lough Hyne (Goss-Custard *et al.*, 1979); Long Island Bay, Sherkin (Cook and Jones, 1980); Lough Hyne (Holmes, 1980; Thain *et al.*, 1981; Kitching, 1987; Holmes and O'Connor, 1991); Courtmacsherry Bay (Dorman, 1988); several specimens, Castlehaven (W175293), light-trap, 5m, mud near *Zostera*, 17 August 1985, JMCH; several specimens, Sherkin Island (W006259, W014259), light-traps, 4-10m, 3 August 1987, JMCH.

DONEGAL: off Pladda, Lough Foyle (Herdman, 1891); off Moville (MacDonald, 1951); several specimens, Mulroy Bay, 22 May 1980, 16 July 1980, D. Minchin.

DOWN: Skulmartin Lightship (Gough, 1906); Strangford Lough (Gotto, 1951; Williams, 1954; Boyd, 1973b).

DUBLIN: Dalkey (O'Riordan, 1966); several specimens, the '40-Foot', Sandycove (O259281), light-trap, 10m, 5 September 1982, JMCH; 5 specimens, near Malahide (O239459), light-trap, 2m, sand, 29 April 1984, JMCH; 1 specimen, Broadmeadows (O224468), Malahide, light-trap, 2m, mud, 23 September 1984, JMCH; several specimens, Kelly's Rock (O3050), Lambay Island, light-trap, 15m, 20 June 1991, JMCH; several specimens, Tayleur Bay (O3251), Lambay Island, light-trap, 15m, 20 June 1991, JMCH; several specimens, Sunk Island (O321499), Lambay Island, light-trap, 10m, 20 June 1991, JMCH (NMI).

GALWAY: off Cleggan, High Island, Inishbofin and off Freaghillaun (Farran, 1903); off Inishshark (Farran, 1903, 1914); Ballynakill (Farran, 1913, 1914); Mutton Island (Fives, 1969, 1971); near Carna (Collins, 1981); Spiddal (Holmes, 1986).

GALWAY/MAYO: Killary Harbour (Farran, 1914; Keegan and Mercer, 1986; Ryan *et al.*, 1986).

KERRY: Valentia (I. C. Thompson, 1896, 1897, 1900), Templenoe, Kenmare Bay (Herdman, 1891); several specimens, Knightstown (V4277), Valentia Island, light-trap, 3m, 21 July 1986, JMCH.

MAYO: Inishturk and off Clare Island (Farran, 1903); off County Mayo (Farran, 1905); Clew Bay (Farran, 1913); Blacksod Bay (Farran, 1913, 1914, 1915).

WATERFORD: several specimens, Dunmore East (S6900), light-trap, 5m, coarse gravel, 23 June 1983, JMCH.

WEXFORD: Coningbeg Lightship (Gough, 1906).

WICKLOW: South Arklow Lightship (Gough, 1906).

IRELAND: coast of Ireland (Baird, 1850, as *T. finmarchica*); west of Ireland (Brady and Robertson, 1873); all around the Irish coast (Pearson, 1906); off west of Ireland (Farran, 1908); Irish Sea, south and west coasts of Ireland (Farran, 1910, map).

Marine, inshore plankton. Light-trap.

***Temoropia mayumbaensis* T. Scott; 1894**

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

Candaciidae

***Candacia armata* (Boeck, 1873)**

(*Candace pectinata* Brady, 1878)

(*Candacia pectinata* (Brady, 1878))

CLARE/GALWAY: Galway Bay (Boyd, 1973a).

CORK: Fastnet Rock (Gough, 1906); Cork Harbour (Boyd, 1972).

GALWAY: off Cleggan (Farran, 1903, 1913); Inishbofin (Farran, 1903); Inishmore, Aran Islands (Fives, 1969, 1971).

GALWAY/MAYO: Killary Harbour (Ryan *et al.*, 1986).

KERRY: Valentia (I. C. Thompson, 1896, 1897, 1900).

MAYO: Clew Bay (Farran, 1913).

WATERFORD: 1♂ 2♀♀, Station 46.0578. 16 miles south-south-east of Mine Head, 21 October 1978, R. Grainger (NMI); 1♀, Station 16.0478. 30 miles south of Tramore, 19 September 1978, R. Grainger (NMI).

WEXFORD: Coningbeg Lightship (Gough, 1906).

WICKLOW: South Arklow Lightship (Gough, 1906).

IRELAND: sea area 'south and west Ireland' (Farran, 1948c).

Marine, plankton.

***Candacia elongata* (Boeck, 1873)**

(*Candace rotunda* Wolfenden, 1904)

IRELAND: off west of Ireland (Wolfenden, 1904, as *Candace robusta* [sic]; Farran, 1908, as *Candacia rotundata* [sic]); Ireland (Rose, 1933); sea area 'south and west Ireland' (Farran, 1948c).

Marine, plankton.

***Candacia norvegica* (Boeck, 1865)**

(*Candace norvegica* Boeck, 1865)

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Farran, 1948c).

Marine, plankton.

***Candacia pachydactyla* (Dana, 1849)**

IRELAND: off west of Ireland (Shih, 1986).

Marine, plankton.

***Candacia tenuimana* (Giesbrecht, 1889)**

(*Candacia gracilimana* Farran, 1908)

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Farran, 1948c).

Marine, plankton.

***Candacia varicans* (Giesbrecht, 1892)**

IRELAND: sea area 'south and west Ireland' (Farran, 1948c).

Marine, plankton.

Pontellidae

***Anomalocera patersoni* Templeton, 1837**

ANTRIM: Larne Lough (Templeton, 1837; Baird, 1850; W. Thompson, 1856).

CORK: Fastnet Rock (Gough, 1906); Lough Hyne (Holmes, 1985); Courtmacsherry Bay

(Dorman, 1988).

DOWN: Skulmartin Lightship (Gough, 1906); Strangford Lough (Williams, 1954; Boyd, 1973b).

DUBLIN: Dublin Bay (Walker and Rees, 1980).

GALWAY: High Island, Inishbofin and off Freaghillaun (Farran, 1903); off Cleggan (Farran, 1913); Aran Islands (Fives, 1971); Spiddal (Holmes, 1986).

GALWAY/MAYO: Killary Harbour (Ryan *et al.*, 1986).

KERRY: Valentia (I. C. Thompson, 1896, 1897, 1900); off County Kerry (I. C. Thompson, 1903).

WEXFORD: Coningbeg Lightship (Gough, 1906).

WICKLOW: South Arklow Lightship (Gough, 1906).

IRELAND: west of Ireland (Brady and Robertson, 1873); south-west Ireland (Malcomson, 1886); off west of Ireland (Wolfenden, 1904, Farran, 1908); all parts of the Irish coast (Pearson, 1906); Irish Sea (Farran, 1908).

Marine, surface plankton. Light-trap.

***Labidocera kroeyeri* (Brady, 1883)**

(*Pontella kröyeri* Brady, 1883)

KERRY: Valentia (I. C. Thompson, 1897).

Marine, surface plankton.

***Labidocera wollastoni* (Lubbock, 1857)**

(*Pontella wollastoni* Lubbock, 1857)

GALWAY: Mutton Island (Fives, 1969).

CLARE: Scattery Island (Herdman, 1891).

DOWN: Skulmartin Lightship (Gough, 1906).

WICKLOW: South Arklow Lightship (Gough, 1906).

Marine, surface plankton. Light-trap.

***Pontella lobiancoi* (Canu, 1888)**

Ireland: 'Irish Seas' (Wilson, 1932).

Marine, plankton.

Parapontellidae

***Parapontella brevicornis* (Lubbock, 1857)**

(*Pontella brevicornis* (Lubbock, 1857))

ANTRIM: Larne (Pearson, 1905).

CLARE: Scattery Island (Herdman, 1891).

CORK: Kinsale Harbour (Brady and Robertson, 1873); Templenoe, Kenmare River (Herdman, 1891); Carrigathorna, near Lough Hyne (Goss-Custard *et al.*, 1979); Lough Hyne (Holmes, 1983; Holmes and O'Connor, 1991); 1♂ 1♀, Red Strand (W358327), Dirk Bay, near Clonakilty, light-trap, 5m, 14 August 1983, JMCH (NMI); several specimens, Castlehaven (W175293), light-trap, 5m, mud near *Zostera*, 17 August 1985, JMCH; several specimens, Sherkin Island (W006259), light-trap, 10m, 3 August 1987, JMCH.

DOWN: Skulmartin Lightship (Gough, 1906).

DUBLIN: Dalkey (O'Riordan, 1966); 1 specimen, Broadmeadows (O224468), Malahide, light-trap, 2m, mud, 23 September 1984, JMCH; 1♂ 1♀, Tayleur Bay (O3251), Lambay Island, light-trap, 15m, 20 June 1991, JMCH; 3♂♂ 1♀, Sunk Island (O321499), Lambay Island, light-trap, 10m, 20 June 1991, JMCH.

GALWAY: Clifden Bay (Brady and Robertson, 1873); off Cleggan, Inishbofin, off Inishshark and off Freaghillaun (Farran, 1903); Ballynakill Harbour (Farran, 1914); Mutton Island and Kilkieran Bay (Fives, 1969); Spiddal (Holmes, 1986).

GALWAY/MAYO: Killary Harbour (Keegan and Mercer, 1986; Ryan *et al.*, 1986).

KERRY: Valentia (I. C. Thompson, 1896, 1897, 1900); several specimens, Knightstown (V4277), Valentia Island, light-trap, 3m, 21 July 1986, JMCH.

MAYO: Westport Bay (Brady and Robertson, 1873); Clare Island area (Farran, 1913); Blacksod Bay (Farran, 1915).

WEXFORD: Coningbeg Lightship (Gough, 1906).

WICKLOW: South Arklow Lightship (Gough, 1906).

Marine, inshore surface plankton. Light-trap.

Acartiidae

***Acartia clausii* Giesbrecht, 1889**

(*Dias longiremis* Lilljeborg, *sensu* Brady, 1878)

ANTRIM: Larne (Pearson, 1906).

CLARE: Carrigaholt and Scattery Island (Herdman, 1891).

CLARE/GALWAY: Galway Bay (Boyd, 1973a).

CORK: Kinsale (Bourne, 1890b), Templenoe, Kenmare River, Berehaven and Glengariff (Herdman, 1891); Fastnet Rock (Gough, 1906); Reendonegan Lough (Grainger, 1957a); Cork Harbour (Boyd, 1972); Long Island Bay, Sherkin (Cook and Jones, 1980); Lough Hyne (Holmes, 1980; Thain *et al.*, 1981; Kitching, 1987; Holmes and O'Connor, 1991); several specimens, Castlehaven (W175293), light-trap, 5m, mud near *Zostera*, 17 August 1985, JMCH; several specimens, Sherkin Island (W006259, W014259), light-traps, 4-10m, 3 August 1987, JMCH.

DONEGAL: off Pladda, Lough Foyle, Gola Island and Killybegs (Herdman, 1891; Herdman *et al.*, 1898; Pearson, 1906); off Moville (MacDonald, 1951); several specimens, Mulroy Bay, 22 May 1980, D. Minchin.

DOWN: off Newcastle (Brady, 1902); Skulmartin Lightship (Gough, 1906); Strangford Lough (Gotto, 1951; Williams, 1954; Boyd, 1973b).

DUBLIN: Dalkey (O'Riordan, 1966); several specimens, the '40-Foot', Sandycove (O259281), light-trap, 10m, 5 September 1982, JMCH; 2 specimens, Broadmeadows (O224468), Malahide, light-trap, 2m, mud, 23 September 1984, JMCH; several specimens, Dalkey Sound (O272265), light-trap, 5m, 15 September 1985, JMCH; several specimens, Kelly's Rock (O3050), Lambay Island, light-trap, 15m, 20 June 1991, JMCH; several specimens, Tayleur Bay (O3251), Lambay Island, light-trap, 15m, 20 June 1991, JMCH; several specimens, Sunk Island (O321499), Lambay Island, light-trap, 10m, 20 June 1991, JMCH.

GALWAY: Killeany Bay, Aran Islands (Herdman, 1891); High Island, Inishbofin and off Freaghillaun (Farran, 1903); off Cleggan and off Inishshark (Farran, 1903, 1914); Ballynakill Harbour (Farran, 1914); Mutton Island (Fives, 1969); Spiddal (Holmes, 1986).

GALWAY/MAYO: Killary Harbour (Farran, 1914; Keegan and Mercer, 1986; Ryan *et al.*, 1986).

KERRY: Valentia (I. C. Thompson, 1896, 1897, 1900); off County Kerry (I. C. Thompson, 1903); 1 specimen, Knightstown (V4277), Valentia Island, light-trap, 3m, 21 July 1986, JMCH.

MAYO: Inishturk and off Clare Island (Farran, 1903); off County Mayo (Farran, 1905); Blacksod Bay (Farran, 1913, 1914, 1915); Lough Furnace (O'Riordan, 1971).

WATERFORD: several specimens, Dunmore East (S6900), light-trap, 5m, coarse gravel, 23 June 1983, JMCH.

WEXFORD: Coningbeg Lightship (Gough, 1906); Lady's Island lake (Healy *et al.*, 1982).

WICKLOW: South Arklow Lightship (Gough, 1906).

IRELAND: west of Ireland (Brady and Robertson, 1873; Farran, 1913; Fives, 1969); south-west Ireland (Malcomson, 1886; Bourne, 1890a); off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905); Irish Sea, and off south-west and south coasts of Ireland (Farran, 1910, map); sea area 'south and west Ireland' (Farran, 1948b).

Marine to brackish, plankton. Light-trap.

***Acartia discaudata* (Giesbrecht, 1881)**

(*Dias discaudatus* Giesbrecht, 1881)

CLARE: Scattery Island (Herdman, 1891).

CORK: Glengariff (Herdman, 1891); Lough Hyne (Holmes, 1983; Holmes and O'Connor, 1991).

DONEGAL: off Moville (MacDonald, 1951).

DOWN: off Newcastle (Brady, 1902); Strangford Lough (Boyd, 1973b; Holmes and Jeal, 1987).

GALWAY: off Cleggan, High Island and Inishbofin (Farran, 1903); Ballynakill Harbour (Farran, 1903, 1913, 1914); Mutton Island (Fives, 1969); Spiddal (Holmes, 1986).

GALWAY/MAYO: Killary Bay (Herdman, 1891; Farran, 1913, 1914; Ryan *et al.*, 1986).

KERRY: Valentia (I. C. Thompson, 1900); off Co. Kerry (I. C. Thompson, 1903).

MAYO: Inishturk (Farran, 1903).

IRELAND: sea area 'south and west Ireland' (Farran, 1948b).

Marine to brackish, inshore plankton. Light-trap.

***Acartia lefevreae* Bradford, 1976**

GALWAY/MAYO: Killary Harbour (Ryan *et al.*, 1986).

Marine, plankton.

***Acartia longiremis* (Liljeborg, 1853)**

DOWN: Skulmartin Lightship (Gough, 1906).

KERRY: off County Kerry (I. C. Thompson, 1903, doubtful record).

IRELAND: Irish Sea (Farran, 1910).

Marine, plankton.

Megacalanidae

***Bathycalanus princeps* (Brady, 1883)**

(*Megacalanus princeps* (Brady, 1883))

IRELAND: off south-west of Ireland (Pearson, 1906); off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Farran and Vervoort, 1951b).

Marine, deep-water plankton (Michel, 1994).

***Bathycalanus richardi* G. O. Sars, 1905**

(*Megacalanus bradyi* Wolfenden, 1905)

IRELAND: sea area 'south and west Ireland' (Farran and Vervoort, 1951b).

Marine, deep-water plankton.

***Megacalanus princeps* Wolfenden, 1904**

(*Megacalanus longicornis* (G. O. Sars, 1905))

IRELAND: off south-west of Ireland (Pearson, 1906); off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Farran and Vervoort, 1951b).

Marine, deep-water plankton.

Calanidae

***Calanoides carinatus* (Krøyer, 1849)**

IRELAND: west and south of Ireland (Williams and Conway, 1988).

Marine, deep-water plankton.

***Calanus finmarchicus* (Gunnerus, 1765)**

(*Cetochilus septentrionalis* Goodsir, 1843)

CLARE: Clare coast (Fives, 1969).

CLARE/GALWAY: Galway Bay (Fives, 1969; Boyd, 1973a).

CORK: Fastnet Rock (Gough, 1906); off south coast (Farran, 1947b); Cork Harbour (Boyd, 1972).

DONEGAL: off Pladda, Lough Foyle and Gola Island (Herdman, 1891).

DOWN: Strangford Lough (W. Thompson, 1847; Gotto, 1951; Williams, 1954; Boyd, 1973b); Skulmartin Lightship (Gough, 1906).

DUBLIN: Dalkey (O'Riordan, 1966).

GALWAY: Killeany Bay, Aran Islands (Herdman, 1891; Fives, 1969; Keegan, 1969); High Island, Inishbofin, off Freaghillaun and off Ballinakill Harbour (Farran, 1903); off Cleggan and off Inishshark (Farran, 1903, 1914); Mutton Island (Fives, 1969).

GALWAY/MAYO: Killary Harbour (Keegan and Mercer, 1986; Ryan *et al.*, 1986).

KERRY: Valentia (I. C. Thompson, 1896, 1897, 1900); off County Kerry (I. C. Thompson, 1903); Dingle Bay area (O'Riordan, 1986).

MAYO: off Clare Island and Inishturk (Farran, 1903); off County Mayo (Farran, 1905).

WEXFORD: Coningbeg Lightship (Gough, 1906).

WICKLOW: South Arklow Lightship (Gough, 1906).

IRELAND: west of Ireland (Brady and Robertson, 1873); south-west Ireland (Malcomson, 1886; Bourne, 1890a); off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904); Porcupine Bank (Farran, 1905); maps of distribution around coast of Ireland (Farran, 1911); sea area 'south and west Ireland' (Farran and Vervoort, 1951a); North Channel and towards Irish coast, Irish Sea (Bruce *et al.*, 1963); around Ireland (Keegan, 1969; Williams, 1988; Williams and Conway, 1988).

Marine, plankton.

***Calanus helgolandicus* (Claus, 1863)**

(*Calanus finmarchicus* (Gunnerus), *sensu* Brady, 1878)

CORK: Long Island Bay, Sherkin (Cook and Jones, 1980, as *C. finmarchicus/helgolandicus*, probably this species); Lough Hyne (Holmes, 1980; Holmes and O'Connor, 1991);

Courtmacsherry Bay (Dorman, 1987, 1988).
DUBLIN: several specimens, Tayleur Bay (O3251), Lambay Island, light-trap, 15m, 20 June 1991, JMCH; 8 specimens, Sunk Island (O321499), Lambay Island, light-trap, 10m, 20 June 1991, JMCH (NMI).
GALWAY: Killeany Bay, Aran Islands (Fives, 1969; Keegan, 1969); Mutton Island (Fives, 1969); Spiddal (Holmes, 1986).
GALWAY/MAYO: Killary Harbour (Ryan *et al.*, 1986).
MAYO: Blacksod Bay (Farran, 1915); Quinsheen (Fives, 1969).
IRELAND: all previous published records of *C. finmarchicus* around Ireland (Pearson, 1906); off west of Ireland (Farran, 1908); all along west coast of Ireland (Farran, 1913); around Ireland (Keegan, 1969; Williams and Conway, 1988).

Marine, plankton. Light-trap. Early workers, e.g., Brady (1878), did not distinguish between the more northern *C. finmarchicus* and the more southern *C. helgolandicus*, and all *Calanus* records were listed as *C. finmarchicus*. Sars (1901) figured both, but they remain difficult to distinguish and their status around the British Isles "has been, and still is, a bone of contention" (Farran and Vervoort, 1951a). Pearson (1906) listed all previous records around Ireland as *C. helgolandicus*. The relationship between the two forms was discussed by Sars (1901), Wolfenden (1904), Farran (1905, 1911), Mauchline (1956), O'Riordan (1966) and Keegan (1969) among others. More recent distribution maps (e.g. Shih, 1986; Conover, 1988) have Ireland in the zone covered by both species.

***Calanus hyperboreus* Krøyer, 1838**

IRELAND: off west of Ireland (Farran, 1908, 1911); sea area 'south and west Ireland' (Farran and Vervoort, 1951a).

Marine, plankton.

***Calanus minor* (Claus, 1863)**

(*Nannocalanus minor* (Claus))

IRELAND: north, west and south of Ireland (Williams and Conway, 1988).

Marine, plankton.

Mesocalanus tenuicornis **(Dana, 1849)**

(*Calanus tenuicornis* Dana, 1849)

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905); sea area 'south and west Ireland' (Farran and Vervoort, 1951a); north, west and south of Ireland (Williams and Conway, 1988).

Marine, plankton.

Neocalanus gracilis **(Dana, 1849)**

(*Calanus gracilis* Dana, 1849)

KERRY: off County Kerry (I. C. Thompson, 1903).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Farran, 1908); sea area 'south and west Ireland' (Farran and Vervoort, 1951a); north, west and south of Ireland (Williams and Conway, 1988).

Marine, plankton. A record of *Neocalanus cristatus* (Krøyer, 1848) from off the west of Ireland (Thompson, 1903, as *Calanus cristatus*) is regarded as doubtful.

Paracalanidae

Calocalanus contractus **Farran, 1926**

IRELAND: sea area 'south and west Ireland' (Farran and Vervoort, 1951e).

Marine, plankton.

Calocalanus pseudocontractus **Bernard, 1958**

IRELAND: sea area 'south and west Ireland' (Bernard, 1960; Corral, 1972).

Marine, plankton.

Calocalanus pavo **(Dana, 1849)**

Kerry: off west of Valentia (Wolfenden, 1904).

Marine, plankton.

Calocalanus styliremis **Giesbrecht, 1888**

GALWAY: off Inishshark (Farran, 1903, 1913).

IRELAND: off west of Ireland (Farran, 1908, 1914); sea area 'south and west Ireland' (Farran and Vervoort, 1951e).

Marine, plankton.

***Ischnocalanus tenuis* (Farran, 1926)**

(*Calocalanus tenuis* Farran, 1926)

IRELAND: sea area 'south and west Ireland' (Farran and Vervoort, 1951e).

Marine, plankton.

***Paracalanus nanus* G.O.Sars, 1907**

GALWAY: Mutton Island (Fives, 1969).

Marine, plankton.

***Paracalanus parvus* (Claus, 1863)**

CLARE/GALWAY: Galway Bay (Boyd, 1973a).

CORK: Fastnet Rock (Gough, 1906); Cork Harbour (Boyd, 1972); Lough Hyne (Thain *et al.*, 1981; Holmes, 1983; Holmes and O'Connor, 1991).

DOWN: Skulmartin Lightship (Gough, 1906); Portaferry, Strangford Lough (Williams, 1954).

DUBLIN: Dalkey (O'Riordan, 1966); 1 specimen, Dalkey Sound (O272265), light-trap, 5m, 15 September 1985, JMCH.

GALWAY: High Island, Inishbofin and off Freaghillaun (Farran, 1903); off Cleggan and off Inishshark (Farran, 1903, 1914); Mutton Island and Kilkieran Bay (Fives, 1969); Spiddal (Holmes, 1986).

GALWAY/MAYO: Killary Harbour (Farran, 1914; Keegan and Mercer, 1986; Ryan *et al.*, 1986).

MAYO: off Clare Island and Inishturk (Farran, 1903); off County Mayo (Farran, 1905); Blacksod Bay (Farran, 1915).

WEXFORD: Coningbeg Lightship (Gough, 1906).

IRELAND: off north-west Ireland (Herdman *et al.*, 1898; Pearson, 1906); off west of Ireland (Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905); Irish Sea, south and west coasts of Ireland (Farran, 1910, map); west coast of Ireland (Farran, 1913); sea area 'south and west Ireland' (Farran and Vervoort, 1951d).

Marine, plankton. Light-trap.

***Paracalanus pygmaeus* (Claus, 1863)**

IRELAND: sea area 'south and west Ireland' (Farran and Vervoort, 1951d).

Marine, plankton.

Mecynoceridae

***Mecynocera clausi* I. C. Thompson, 1888**

KERRY: off County Kerry (I. C. Thompson, 1903).

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

Bathypontiidae

***Bathypontia elongata* G. O. Sars, 1905**

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

Eucalanidae

***Eucalanus attenuatus* (Dana, 1849)**

KERRY: off County Kerry (I. C. Thompson, 1903).

MAYO: 40 miles north-north-west of Achill Head (Norman, 1903).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Farran, 1908); sea area 'south and west Ireland' (Farran and Vervoort, 1951c).

Marine, plankton.

***Eucalanus crassus* Giesbrecht, 1888**

GALWAY: Inish Mór, Aran Islands (Fives, 1969).

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1905, 1908).

Marine, plankton.

***Eucalanus elongatus* (Dana, 1849)**

GALWAY: Inishbofin (Farran, 1903).

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905); west of Ireland (Farran, 1911, map); sea area 'south and west Ireland' (Farran and Vervoort, 1951c).

Marine, plankton.

Rhinocalanus nasutus **Giesbrecht, 1888**

CLARE: south of the Aran Islands and west of Clare (Fives, 1969, 1971).

CLARE/GALWAY: Galway Bay (Boyd, 1973a).

CORK: off Fastnet (Farran, 1910).

KERRY: Valentia (I. C. Thompson, 1897, 1900, as *R. cornuta*, probably this species; Anon., 1897).

MAYO: 40 miles north-north-west of Achill Head (Norman, 1903); off County Mayo (Farran, 1905).

KERRY: off Tearaght (Farran, 1910).

IRELAND: off west of Ireland (I. C. Thompson, 1903, also as *R. cornuta*; Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905); off west and south-west of Ireland (Farran, 1910, map); sea area 'south and west Ireland' (Farran and Vervoort, 1951c).

Marine, plankton.

Spinocalanidae

Mimocalanus cultrifer **Farran, 1908**

IRELAND: Fisheries stations S.R.139 and S.R.175, off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Farran and Vervoort, 1951i).

Marine, deep-water plankton.

Mimocalanus nudus **Farran, 1908**

IRELAND: Fisheries station S.R.139, off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Farran and Vervoort, 1951i).

Marine, deep-water plankton.

Monacilla typica **G.O.Sars, 1905**

(*Oxycalanus spinifer* Farran, 1908)

IRELAND: Fisheries station S.R.139, off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Farran and Vervoort, 1951i).

Marine, deep-water plankton.

Spinocalanus abyssalis **Giesbrecht, 1888**

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905); sea area 'south and west Ireland' (Farran and Vervoort, 1951h).

Marine, deep-water plankton.

***Spinocalanus angusticeps* G. O. Sars, 1920**

IRELAND: sea area 'south and west Ireland' (Farran and Vervoort, 1951h).

Marine, deep-water plankton.

***Spinocalanus magnus* Wolfenden, 1904**

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905); sea area 'south and west Ireland' (Farran and Vervoort, 1951h).

Marine, plankton.

***Spinocalanus spinosus* Farran, 1908**

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Farran and Vervoort, 1951h).

Marine, deep-water plankton.

Clausocalanidae

***Clausocalanus arcuicornis* (Dana, 1849)**

GALWAY: Inishbofin (Farran, 1903, 1913); Mutton Island (Fives, 1969).

MAYO: off Clare Island and Inishturk (Farran, 1903, 1913).

IRELAND: off west of Ireland (Farran, 1908, 1914); west and south-west Ireland (Farran, 1911, map); sea area 'south and west Ireland' (Farran and Vervoort, 1951g).

Marine, plankton.

***Clausocalanus pergens* Farran, 1926**

IRELAND: off south and west coasts of Ireland (Farran, 1926); sea area 'south and west Ireland' (Farran and Vervoort, 1951g).

Marine, plankton.

***Ctenocalanus vanus* Giesbrecht, 1888**

GALWAY: Mutton Island (Fives, 1969, as *C. nanus* [sic]).

MAYO: Inishturk (Farran, 1903, 1913); off County Mayo (Farran, 1905, 1914).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905); sea area 'south and west Ireland' (Farran and Vervoort, 1951g).

Marine, plankton.

***Microcalanus pusillus* G. O. Sars, 1903**

(*Microcalanus pygmaeus pusillus* Sars)

IRELAND: off west of Ireland (Farran, 1908, tentative record); Irish Sea and south-west coast of Ireland (Farran, 1911); sea area 'south and west Ireland' (Farran and Vervoort, 1951f).

Marine, plankton. Thain *et al.* (1981) recorded *Microcalanus* sp. from Lough Hyne, Co. Cork. However, despite persistent collecting at that site by the author, *Microcalanus* has not been encountered since.

***Pseudocalanus elongatus* (Boeck, 1864)**

(*Clausia elongata* (Boeck, 1864))

(*Pseudocalanus minutus elongatus* Boeck, 1864)

CLARE/GALWAY: Galway Bay (Boyd, 1973a).

CORK: Glengariff (Herdman, 1891); Fastnet Rock (Gough, 1906); Cork Harbour (Boyd, 1972); Long Island Bay, Sherkin (Cook and Jones, 1980); Carrickanorane, Sherkin Island (Wilson, 1980); Lough Hyne (Thain *et al.*, 1981; Holmes, 1983; Kitching, 1987; Holmes and O'Connor, 1991); several specimens, Castlehaven (W175293), light-trap, 5m, mud near *Zostera*, 17 August 1985, JMCH.

DONEGAL: off Pladda, Lough Foyle, Lough Swilly, Gola Island and Killybegs (Herdman, 1891).

DOWN: Skulmartin Lightship (Gough, 1906); Strangford Lough (Gotto, 1951; Williams, 1954; Boyd, 1973b), 2 specimens, Ballyhenry Island (J575520), Strangford Lough, light-trap, 1m, 21 April 1984, F. Jeal.

DUBLIN: Dalkey (O'Riordan, 1966); several specimens, Dalkey Sound (O272265), light-trap, 5m, 15 September 1985, JMCH; several specimens, Kelly's Rock (O3050), Lambay Island, light-trap, 15m, 20 June 1991, JMCH; 8 specimens, Tayleur Bay (O3251), Lambay Island, light-trap, 15m, 20 June 1991, JMCH; several specimens, Sunk Island (O321499), Lambay Island, light-trap, 10m, 20 June 1991, JMCH.

GALWAY: Killeany Bay, Aran Islands (Herdman, 1891); High Island, Inishbofin and off Freaghillaun (Farran, 1903); off Cleggan and off Inishshark (Farran, 1903, 1914); Ballynakill Harbour (Farran, 1914); Mutton Island (Fives, 1971); Spiddal (Holmes, 1986).
GALWAY/MAYO: Killary Bay (Herdman, 1891; Farran, 1914; Keegan and Mercer, 1986; Ryan *et al.*, 1986).
KERRY: Valentia (I. C. Thompson, 1896, 1897, 1900); off County Kerry (I. C. Thompson, 1903).
MAYO: off Clare Island and Inishturk (Farran, 1903); off County Mayo (Farran, 1905); Blacksod Bay (Farran, 1914, 1915).
WATERFORD: several specimens, Dunmore East (S6900), light-trap, 5m, coarse gravel, 23 June 1983, JMCH.
WEXFORD: Coningbeg Lightship (Gough, 1906).
WICKLOW: South Arklow Lightship (Gough, 1906).
IRELAND: off west of Ireland (Brady and Robertson, 1873; I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908); south-west Ireland (Bourne, 1890a); Porcupine Bank (Farran, 1905); Irish Sea, south and west coasts of Ireland (Farran, 1910, map); west of Ireland (Farran, 1913; Fives, 1969); sea area 'south and west Ireland' (Farran and Vervoort, 1951f).
Marine, plankton. Light-trap.

Aetideidae

***Aetideopsis armata* (Boeck, 1872)**
(*Euchaeta armata* Boeck, 1872)
(*Pseudaetideus armatus* Wolfenden, 1904)
(*Chiridius armatus* (Boeck), *sensu* Sars, 1901)
GALWAY: off Inishshark (Farran, 1903, 1913).
MAYO: off County Mayo (Farran, 1905).
IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952c).
Marine, plankton.

Aetideopsis multiserrata **(Wolfenden, 1904)**

(*Faroella multiserrata* Wolfenden, 1904)

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952a).

Marine, plankton.

Aetideopsis rostrata **G. O. Sars, 1903**

IRELAND: west coast of Ireland (Wilson, 1932); sea area 'south and west Ireland' (Vervoort, 1952a).

Marine, deep-water plankton.

Aetideus armatus **(Boeck, 1872)**

(*Pseudocalanus armatus* Boeck, 1872)

(*Aetideus armatus* Brady, 1883, partim)

(*Aetideus tenuirostris* Wolfenden, 1904)

KERRY: off County Kerry (I. C. Thompson, 1903).

MAYO: off County Mayo (Farran, 1905).

IRELAND: off West of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908, 1911); Porcupine Bank (Farran, 1905); sea area 'south and west Ireland' (Vervoort, 1952a).

Marine, plankton.

Aetideus giesbrechti **Clève, 1904**

(*Euaetideus giesbrechti* (Clève, 1904))

IRELAND: off west of Ireland (Farran, 1908); off south-west Ireland (Farran, 1911); sea area 'south and west Ireland' (Vervoort, 1952a).

Marine, plankton.

Bradyetes inermis **Farran, 1905**

MAYO: 'Helga' station off County Mayo (Farran, 1905).

IRELAND: sea area 'south and west Ireland' (Vervoort, 1952b).

Marine, epibenthic plankton.

***Bradyidius armatus* Giesbrecht, 1897**

(*Pseudocalanus armatus* Boeck, *sensu* Brady, 1878)

(*Undinopsis bradyi* G. O. Sars, 1884 *nomen nudum*)

(*Bradyanus armatus* Vanhöffen, 1897)

(*Undinopsis bradyi* G. O. Sars, 1902)

CORK: several specimens, Lough Hyne (W0928), light-traps, 20-40m, June 1997, JMCH (NMI).

DOWN: Skulmartin Lightship (Gough, 1906).

KERRY: Valentia (I. C. Thompson, 1896, 1897, 1900; Anon., 1896); west of Ireland (Giesbrecht and Schmeil, 1898, probably after Thompson).

MAYO: off Clare Island (Farran, 1903, 1913); off County Mayo (Farran, 1905).

WEXFORD: Coningbeg Lightship (Gough, 1906).

WICKLOW: South Arklow Lightship (Gough, 1906).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904); Porcupine Bank (Farran, 1905); sea area 'south and west Ireland' (Vervoort, 1952b).

Marine, epi-benthic mud. Light-trap. Sars (1903, page 163) commented on a variant of this species. It appears to come in two forms according to the structure of the fifth leg in the male - a typical form with a slender left leg and rudimentary right leg, and an inshore form, found in the upper reached of fjords, with no trace of the right leg, and so similar to that found in *Aetideus armatus*. This latter uniramous form of *Bradyidius* is the one which is to be found in the deeper parts of Lough Hyne, Co. Cork. The form described and illustrated by Brady (1978) under the name *Pseudocalanus armatus* corresponds to this form, with its apparently uniramous fifth leg.

***Chiridiella gibba* Deevey, 1974**

(*Chiridiella macrodactyla* G. O. Sars, *sensu* Farran, 1908)

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952c).

Marine, deep-water plankton.

Chiridius gracilis **Farran, 1908**

(*Chiridius poppei* Giesbrecht, *sensu* Farran, 1905)

MAYO: off County Mayo (Farran, 1905; Pearson, 1906).

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952c).

Marine, plankton.

Chirundina streetsii **Giesbrecht, 1895**

(*Euchirella carinata* Wolfenden, 1902)

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952h).

Marine, plankton.

Comantenna brevicornis **(G. O. Sars, 1902)**

(*Bryaxis brevicornis* G. O. Sars, 1902)

MAYO: off County Mayo (Farran, 1905).

IRELAND: sea area 'south and west Ireland' (Vervoort, 1952b).

Marine, epi-benthic plankton.

Euchirella bitumida **With, 1915**

(*Euchirella galeata* Giesbrecht, *sensu* Farran, 1908)

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

Euchirella curticauda **Giesbrecht, 1888**

(*Euchirella curticauda*, var. *atlantica* Wolfenden, 1904)

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952f).

Marine, plankton.

Euchirella maxima **Wolfenden, 1905**

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952f).

Marine, plankton.

***Euchirella messinensis* (Claus, 1863)**

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952f).

Marine, plankton.

***Euchirella pulchra* (Lubbock, 1856)**

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

***Euchirella rostrata* (Claus, 1866)**

(*Euchaeta hessei* Brady, 1883)

IRELAND: off west of Ireland (I. C. Thompson, 1903; Farran, 1908); Porcupine Bank (Farran, 1905); sea area 'south and west Ireland' (Vervoort, 1952f).

Marine, plankton.

***Euchirella truncata* Esterly, 1911**

(*Euchirella intermedia* With, 1915)

IRELAND: west of Ireland (Rose, 1933).

Marine, plankton.

***Gaetanus armiger* Giesbrecht, 1888**

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904).

Marine, plankton.

***Gaetanus brevispinus* (G. O. Sars, 1900)**

(*Gaidius brevispinus* (G. O. Sars, 1900))

(*Gaidius major* Wolfenden, 1904)

(*Gaidius affinis* G. O. Sars, 1905)

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Wolfenden, 1904, Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952d).

Marine, plankton.

***Gaetanus kruppii* Giesbrecht, 1903**

(*Gaetanus major* Wolfenden, 1903)

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952e).

Marine, deep-water plankton.

***Gaetanus latifrons* G. O. Sars, 1905**

(*Gaetanus holti* Farran, 1905)

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952e).

Marine, plankton.

***Gaetanus miles* Giesbrecht, 1888**

KERRY: off County Kerry (I. C. Thompson, 1903).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952e).

Marine, plankton.

***Gaetanus minor* Farran, 1905**

MAYO: 'Helga' station off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952e).

Marine, plankton.

***Gaetanus pileatus* Farran, 1903**

(*Gaetanus caudani* Canu, *sensu* Wolfenden, 1904)

GALWAY: off Cleggan (Farran, 1903; Anon., 1903).

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952e).

Marine, plankton.

***Gaetanus robustus* G. O. Sars, 1905**

(*Gaidius validus* Farran, 1908)

IRELAND: Fisheries station S.R.231, off west of Ireland (Farran, 1908).

Marine, deep-water plankton.

***Gaetanus tenuispinus* (G. O. Sars, 1900)**

(*Gaidius tenuispinus* (G. O. Sars, 1900))

(*Gaidius pungens* Giesbrecht, *sensu* Wolfenden, 1904)

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); off south-west Ireland (Farran, 1911); sea area 'south and west Ireland' (Vervoort, 1952d).

Marine, plankton.

***Paracomantenna minor* (Farran, 1905)**

(*Bryaxis minor* Farran, 1905)

MAYO: 'Helga' station off County Mayo (Farran, 1905).

IRELAND: sea area 'south and west Ireland' (Vervoort, 1952b).

Marine, epibenthic plankton.

***Pseudeuchaeta brevicauda* G. O. Sars, 1905**

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952h).

Marine, deep-water plankton.

***Pseudochirella cryptospina* (G. O. Sars, 1905)**

(*Gaidius parvispinus* Farran, 1908)

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952g).

Marine, plankton.

***Pseudochirella notacantha* (G. O. Sars, 1905)**

(*Gaidius notacanthus* G. O. Sars, 1905)

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952g).

Marine, deep-water plankton. From the description, the specimens recorded by Farran (1908) under the name *Gaidius notacantha* appear to belong to that species, but the corresponding figure (Plate III, figure 7) is of the ♂ P5 of *Pseudochirella pustulifera*. Possibly Farran had mixed collections. Certainly, Markhaseva (2000) stated that the P5 of *Gaidius notacantha* figured by Farran is not from *Pseudochirella notacantha*.

***Pseudochirella obtusa* (G. O. Sars, 1905)**

(*Euchirella obtusa* (G. O. Sars, 1905))

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952g).

Marine, deep-water plankton.

***Pseudochirella pustulifera* (G. O. Sars, 1905)**

(*Euchirella wolfendeni* Farran, 1908)

IRELAND: off west of Ireland (Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952g).

Marine, deep-water plankton.

***Undeuchaeta major* Giesbrecht, 1888**

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952h).

Marine, deep-water plankton.

***Undeuchaeta plumosa* (Lubbock, 1856)**

(*Undeuchaeta minor* Giesbrecht, 1892)

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); sea area 'south and west Ireland' (Vervoort, 1952h).

Marine, plankton.

***Valdiviella insignis* Farran, 1908**

IRELAND: off west of Ireland (Farran, 1908).

Marine, deep-water plankton.

Euchaetidae

***Euchaeta acuta* Giesbrecht, 1892**

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905).

Marine, plankton.

***Euchaeta media* Giesbrecht, 1888**

IRELAND: west of Ireland (Rose, 1933).

Marine, plankton.

***Euchaeta spinosa* Giesbrecht, 1892**

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

***Pareuchaeta barbata* (Brady, 1883)**

(*Euchaeta barbata* Brady, 1883)

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908).

Marine, plankton.

***Pareuchaeta bisinuata* (G. O. Sars, 1907)**

(*Euchaeta bisinuata* G. O. Sars, 1907)

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Pareuchaeta gracilis* (G. O. Sars, 1905)**

(*Euchaeta quadrata* Farran, 1908)

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

****Pareuchaeta hebes* (Giesbrecht, 1888)**

MAYO: 2♂♂ 3♀♀, off coast of County Mayo, 53°53'N. 10°51'W., 155m, 8 November 1988, D. Minchin (NMI).

Marine, plankton. New to Ireland.

***Pareuchaeta norvegica* (Boeck, 1872)**

(*Euchaeta norvegica* Boeck, 1872)

CORK: Bar Rock, Cork Harbour (Boyd, 1972).

GALWAY: north Galway Bay (Boyd, 1973a).

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908, 1911); off north, west and south of Ireland (Williams, 1988).

Marine, plankton.

***Pareuchaeta rubicunda* (Farran, 1908)**

(*Euchaeta rubicunda* Farran, 1908)

IRELAND: Fisheries station S.R.231, off west of Ireland (Farran, 1908).

Marine, plankton.

***Pareuchaeta sarsi* (Farran, 1908)**

(*Euchaeta sarsi* Farran, 1908)

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Pareuchaeta scotti* (Farran, 1908)**

(*Euchaeta scotti* Farran, 1908)

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Pareuchaeta tonsa* (Giesbrecht, 1895)**

(*Euchaeta tonsa* Giesbrecht, 1895)

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

Stephidae

***Stephos minor* T.Scott, 1892**

GALWAY: 1♂, Kilkieran Bay, *Pseudocucumas* ground, maerl dunes, 19 May 1980, D. McGrath (NMI).

Marine, benthic. New to Ireland.

***Stephos rustadi* Strömgren, 1969**

CORK: Lough Hyne (Thain *et al.*, 1981; Holmes, 1985; Kitching, 1987, 1991).

Marine, epibenthic in low oxygen concentrations (Kitching, 1991). Light-trap.

***Stephos scotti* G. O. Sars, 1902**

CORK: Lough Hyne (Holmes, 1983; Holmes and O'Connor, 1991); 1♂ 2♀♀, Lough Hyne (W097280), light-trap, 2m, 28 June 1994, JMCH (NMI).

GALWAY: Fahy Bay, Ballynakill (Farran, 1913).

Marine. Plankton. Light-trap.

Diaixidae

***Diaixis hibernica* (A. Scott, 1896)**

(*Scolecithrix hibernica* A. Scott, 1896)

CORK: Lough Hyne (Thain *et al.*, 1981; Holmes, 1985).

DOWN: between Dundrum and Dundalk Bay (A. Scott, 1896).

GALWAY: Mutton Island (Fives, 1969, 1970).

GALWAY/MAYO: Killary Harbour (Ryan *et al.*, 1986).

Marine, epibenthic. Light-trap. Collections made with the light-trap in the deeper parts of Lough Hyne, below 30m, sometimes contain many specimens of this species, and sometimes, under apparently similar conditions, very few specimens. This can occur even on the same night, indicating some sort of swarming behaviour.

***Diaixis pygmaea* (T. Scott, 1894)**

(*Scolecithrix pygmaea* T. Scott, 1894)

CORK: Fastnet Rock (Gough, 1906).

DOWN: Skulmartin Lightship (Gough, 1906).

GALWAY: Inishbofin, off Cleggan (Farran, 1903, 1913).

WEXFORD: Coningbeg Lightship (Gough, 1906).

IRELAND: Porcupine Bank (Farran, 1905).

Marine, epibenthic.

Tharybidae

***Neoscolecithrix farrani* Smirnov, 1935**

(*Oothrix bidentata* Farran, 1905)

Mayo: 'Helga' stations off County Mayo (Farran, 1905).

Marine, plankton.

Undinella brevipes **Farran, 1908**

(*Undinella simplex* (Wolfenden), *sensu* Farran, 1926)

IRELAND: off west of Ireland (Farran, 1908, 1926).

Marine, plankton.

Undinella oblonga **G. O. Sars, 1900**

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

Pseudocyclopiidae

Pseudocyclopia stephoides **I. C. Thompson, 1895**

CORK: Barloge, near Lough Hyne (Holmes, 1987).

Marine, benthos.

Phaennidae

Brachycalanus atlanticus **(Wolfenden, 1904)**

(*Xanthocalanus atlanticus* Wolfenden, 1904)

KERRY: west of Valentia (Wolfenden, 1904).

MAYO: off County Mayo (Farran, 1905).

Marine, plankton. Othman and Greenwood (1988) suggested that the *atlanticus* of Farran may not belong to the same species as the *atlanticus* of Wolfenden.

Cephalophanes refulgens **G. O. Sars, 1907**

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

Cornucalanus chelifer **(I. C. Thompson, 1903)**

(*Scolecithrix chelifer* I. C. Thompson, 1903)

(*Onchocalanus chelifer* (I. C. Thompson, 1903))

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Farran, 1908).

Marine, plankton.

***Onchocalanus cristatus* (Wolfenden, 1904)**

(*Xanthocalanus cristatus* Wolfenden, 1904)

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908).

Marine, deep-water plankton.

***Onchocalanus hirtipes* G. O. Sars, 1905**

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Phaenna spinifera* Claus, 1863**

KERRY: off County Kerry (I. C. Thompson, 1903).

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905).

Marine, plankton. Specimens recorded as '*Xanthocalanus* sp.' from off Co. Mayo and Porcupine Bank (Farran, 1905) may possibly belong to this species.

***Talacalanus greeni* (Farran, 1905)**

(*Xanthocalanus greeni* Farran, 1905)

MAYO: 'Helga' station off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Farran, 1908).

Marine, deep-water plankton.

***Xanthocalanus fallax* G. O. Sars, 1919**

(*Xanthocalanus borealis* G. O. Sars, 1900, *sensu* G. O. Sars, 1902)

MAYO: off County Mayo (Farran, 1905).

IRELAND: Porcupine Bank (Farran, 1905).

Marine, plankton.

***Xanthocalanus giesbrechti* I. C. Thompson, 1903**

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

***Xanthocalanus obtusus* Farran, 1905**

MAYO: 'Helga' station off County Mayo (Farran, 1905).

Marine, plankton.

***Xanthocalanus pinguis* Farran, 1905**

MAYO: 'Helga' station off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Farran, 1908; Wilson, 1932).

Marine, plankton.

***Xanthocalanus subagilis* Wolfenden, 1904**

IRELAND: off west of Ireland (Rose, 1933).

Marine, plankton.

Scolecithricidae

***Amallothrix emarginata* (Farran, 1905)**

(*Scolecithrix emarginata* Farran, 1905)

(*Scolecithrix obtusifrons* (G. O. Sars), *sensu* Farran, 1908)

MAYO: 'Helga' station off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Farran, 1908).

Marine, deep-water plankton.

***Amallothrix gracilis* (G. O. Sars, 1905)**

(*Scolecithrix globiceps* Farran, 1908)

IRELAND: off west of Ireland (Farran, 1908).

Marine, deep-water plankton.

***Amallothrix robusta* (T. Scott, 1894)**

(*Scolecithrix robusta* T. Scott, 1894)

(*Scaphocalanus robustus* (T. Scott, 1894))

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Amallothrix valens* (Farran, 1926)**

(*Scolecithrix valens* Farran, 1926)

IRELAND: off west of Ireland (Farran, 1926).

Marine, deep-water plankton.

***Amallothrix valida* (Farran, 1908)**

(*Scolecithrix valida* Farran, 1908)

IRELAND: Fisheries station S.R.224, off west of Ireland (Farran, 1908).

Marine, deep-water plankton.

***Archescolecithrix auropecten* (Giesbrecht, 1892)**

(*Scolecithrix auropecten* Giesbrecht, 1892)

(*Scolecithricella auropecten* (Giesbrecht, 1892))

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

***Lophothrix frontalis* Giesbrecht, 1895**

(*Scolecithrix frontalis* (Giesbrecht, 1895))

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908).

Marine, plankton.

***Scaphocalanus brevicornis* (G. O. Sars, 1900)**

(*Scolecithrix brevicornis* G. O. Sars, 1900)

(*Scolecithrix gracilipes* Farran, 1908)

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Scaphocalanus curtus* (Farran, 1926)**

(*Scolecithrix curta* Farran, 1926)

IRELAND: off west of Ireland (Farran, 1926).

Marine, plankton.

***Scaphocalanus echinatus* (Farran, 1905)**

(*Scolecithrix echinata* Farran, 1905)

(*Amallophora echinata* (Farran, 1905))

IRELAND: Porcupine Bank (Farran, 1905); off west of Ireland (Farran, 1908).

Marine, plankton.

***Scaphocalanus magnus* (T. Scott, 1894)**

(*Scolecithrix cristata* Giesbrecht, 1895)

(*Amallophora magna* T. Scott, 1894)

(*Scolecithrix magna* (T. Scott, 1894))

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908).

Marine, plankton.

***Scaphocalanus major* (T. Scott, 1894)**

(*Scolecithrix major* T. Scott, 1894)

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

***Scolecithricella dentata* (Giesbrecht, 1892)**

(*Scolecithrix dentata* Giesbrecht, 1892)

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Farran, 1905, 1908).

Marine, plankton.

***Scolecithricella laminata* (Farran, 1926)**

(*Scolecithrix laminata* Farran, 1926)

(*Amallothrix laminata* (Farran, 1926))

IRELAND: off west of Ireland (Farran, 1926).

Marine, deep-water plankton.

***Scolecithricella minor* (Brady, 1883)**

(*Scolecithrix minor* Brady, 1883)

GALWAY: off Inishshark (Farran, 1903, 1913).

MAYO: off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Wolfenden, 1904; Farran, 1908); Porcupine Bank (Farran, 1905).

Marine, plankton.

Scolecithricella ovata **(Farran, 1905)**

(*Scolecithrix ovata* Farran, 1905)

MAYO: 'Helga' station off County Mayo (Farran, 1905).

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

Scolecithrix bradyi **Giesbrecht, 1888**

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

Scolecithrix danae **(Lubbock, 1856)**

IRELAND: off west of Ireland (I. C. Thompson, 1903).

Marine, plankton.

Scopalatum farrani **Roe, 1975**

(*Xanthocalanus typicus* (T. Scott), *sensu* Farran, 1908)

IRELAND: Fisheries station S.R.197, off west of Ireland (Farran, 1908).

Marine, plankton.

Scottocalanus persecans **(Giesbrecht, 1892)**

(*Scolecithrix persecans* Giesbrecht, 1892)

IRELAND: off west of Ireland (I. C. Thompson, 1903; Farran, 1908).

Marine, deep-water plankton.

Scottocalanus securifrons **(T. Scott, 1894)**

(*Scolecithrix securifrons* T. Scott, 1894)

(*Lophothrix securifrons* Wolfenden, 1904)

MAYO: 40 miles north-north-west of Achill Head (Norman, 1903).

IRELAND: off west of Ireland (I. C. Thompson, 1903; Wolfenden, 1904; Farran, 1908).

Marine, deep-water plankton.

MISOPHRIOIDA

Misophriidae

Misophria pallida **Boeck, 1864**

CORK: Lough Hyne (Holmes, 1996).

DONEGAL: Mulroy Lough (Brady, 1878; Boxshall, 1990).

GALWAY: Ballynakill (Farran, 1913).

Marine, benthos.

MORMONILLOIDA

Mormonillidae

***Mormonilla minor* Giesbrecht, 1891**

(*Mormonilla atlantica* Wolfenden, 1905)

IRELAND: off west of Ireland (Pearson, 1906; Farran, 1908).

Marine, plankton.

***Mormonilla phasma* Giesbrecht, 1891**

IRELAND: off west of Ireland (I. C. Thompson, 1903; Farran, 1908).

Marine, plankton.

MONSTRILLOIDA

Monstrillidae

***Cymbasoma rigida* I. C. Thompson, 1888**

(*Monstrilla rigida* (I. C. Thompson, 1888))

(*Thaumaleus rigidus* (I. C. Thompson, 1888))

CORK: Lough Hyne (Holmes, 1985).

DONEGAL: Gola Island (Herdman, 1891).

DUBLIN: 1♀, Tayleur Bay (O3251), Lambay Island, light-trap, 15m, 20 June 1991, JMCH.

GALWAY: Ballynakill Harbour (Farran, 1913); Mutton Island and Kilkieran Bay (Fives, 1969).

KERRY: Valentia (I. C. Thompson, 1900, as *T. claparedii*; 1896, as *T. rigidus*).

Marine, plankton. Light-trap.

***Cymbasoma rostrata* (T. Scott, 1904)**

(*Thaumaleus rostratus* T. Scott, 1904)

GALWAY: off Inishbofin (Farran, 1913).

Marine, plankton.

***Cymbasoma thompsoni* (Giesbrecht, 1892)**

(*Thaumaleus thompsonii* Giesbrecht, 1892)

CORK: Lough Hyne (Holmes, 1985; Holmes and O'Connor, 1991).

DOWN: Skulmartin Lightship (Gough, 1906, as *Haemocera danae*).

KERRY: Valentia (I. C. Thompson, 1897, as *Monstrilla danae*; I. C. Thompson, 1900, as *Thaumaleus thompsonii*).

Marine, plankton. Light-trap.

***Monstrilla helgolandica* Claus, 1863**

CORK: Lough Hyne (Holmes, 1985); 1♀, Castlehaven (W175293), light-trap, 5m, mud near *Zostera*, 17 August 1985, JMCH (NMI); 1♀ Courtmacsherry Bay, light-trap, 40m, 13 August 1986, JMCH.

GALWAY: Mutton Island (Bailey, 1963; Fives, 1969); Aran Islands (Fives, 1971); Little Killary (Keegan and Mercer, 1986).

Marine, plankton, Light-trap.

***Monstrilla longiremis* Giesbrecht, 1892**

CORK: Cork Harbour (Boyd, 1972).

DOWN: Strangford Lough (Gotto, 1966; Boyd, 1973b).

Marine, plankton.

***Monstrilla longicornis* I. C. Thompson, 1890**

ANTRIM: Larne Lough (Pearson, 1904, as *Monstrilla longiremis*; Pearson, 1906; Gotto, 1966).

IRELAND: off west of Ireland (Farran, 1908).

Marine, plankton.

***Monstrillopsis gracilis* (Gurney, 1927)**

CORK: Lough Hyne (Holmes, 1985); 1♀, Sherkin Island (W014259), light-trap, 4m, 3 August 1987, JMCH (NMI); 1♀, Lough Hyne (W095288), light-trap, 5m, 23 September 1987, JMCH (NMI).

Marine, plankton, light-trap.

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TURLOUGH PASTURES AS A HABITAT FOR STAPHYLINIDAE AND CARABIDAE (COLEOPTERA) IN SOUTH-EAST GALWAY AND NORTH CLARE, IRELAND

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Abstract

A total of 78 species of Staphylinidae, and 37 species of Carabidae, were recorded from recently dewatered pasture and woodland soils at four turloughs (seasonal karst-groundwater lakes) sampled in spring 1996. A large number of these species (18 or *circa* 16%) were considered indicators of ecologically well-developed habitat, and indicate the high conservation value of turloughs in this region for the characteristic soil fauna of flooded ecosystems. Distinct differences between the fauna of pastures on relatively deeper till soils and that of the shallow marl-rich soil of an epikarst turlough were detected. Five staphylinid species are recorded new to Ireland:- *Atheta difficilis* (Brisout), *A. excellens* (Kraatz), *A. orphana* (Erichson), *Carpelimus subtilicornis* (Roubal) and *Disopora coulsoni* (Last).

Introduction

Dinneen (1927) translates *turlach*, from which the name turlough is derived, as "a winter lake or mere, dry or marshy in summer". Turloughs are a priority habitat type for conservation in Ireland under the EU Habitats Directive, for which purpose they have been defined as "Temporary lakes principally filled by subterranean waters and particular to karstic limestone areas" (European Commission, 1999). It is not necessary for turloughs to completely dry out in summer to maintain their character. There are a number of permanent lakes whose upper water levels fluctuate extensively in the same manner as turloughs; their soils, vegetation, hydrology and fauna are often similar to completely dry turloughs, and these can be considered as lakes with turlough margins. Indeed, as pointed out by Cabot (1999), *tur-lach* means a dried out place rather than a dried out lough.

Dinneen (1927) also mentions the use of *turlach* in the imprecation, or curse, '*go n-imthighidh an tuile de'n turlach leat*' ("may the flood from the winter lake [i.e. bad luck] go with you"), and this aspect of turloughs was highlighted in the winter of 1995/96 when many farmers, and residents of the Gort area of south-east Galway, suffered serious flooding and consequent hardship. In response to this, and as a means to assess the cost-benefit of possible engineering solutions to alleviate the flooding, the Office of Public Works (OPW) commissioned a detailed study of the hydrogeology and ecology of the Gort-Ardrahan area (Jennings O'Donovan and Partners/Southern Water Global, 1998), of which this survey of the staphylinid and carabid fauna formed part.

Methods

Data for four sites are presented here as a preliminary account, although a more extensive set of site-samples was taken. It is intended to publish data from the remaining samples at a future date. In addition to the detailed information in the OPW report (Jennings O'Donovan and Partners/Southern Water Global, 1998), published photographs, satellite images and a hydrological map of the region can be found in Feehan and O'Donovan (1993), and Coxon (1987a) provides a map of turloughs in mid-west Ireland.

The four turloughs were sampled using pitfall traps and a suction sampler (Table 1). Leaf litter in a turlough system with a woodland margin (Coole-Garryland) was also sampled by sieving and pitfall traps (Table 1). Because measures to alleviate high-water flooding would impact most on the upper parts of the turloughs, rather than their basins, sampling was carried out in the upper areas. In consequence, marshy, fen and summer-permanent lake-shore parts of the turlough basin, if they occurred, were not sampled. All sampled turlough areas were pastures, grazed by either sheep, cattle or horses.

Details of sampling are summarised in Table 1. Three sampling methods were used:- (1) A set of four plastic cup pitfall traps with undiluted ethylene glycol (commercial antifreeze) as preservative; (2) Suction sampling using a Stihl® BR 400 suction apparatus, mounted on the operator's back. This machine (referred to as an 'S-vac' to distinguish it from the 'D-vac' suction sampler) has a suction pipe of 58mm diameter (0.0026m^2 surface area). Six subsamples of 100 x 1.5 sec. 'sucks' per subsample were taken at each site, resulting in a total area of 1.56m^2 covered. Because the hand-held pipe was shaken when the apex of the pipe was in the vegetation, a larger area (*circa* 2m^2) was effectively sampled; (3) Sieving of woodland leaf litter, taking 16 subsamples of *circa* 0.07m^2 each (total *circa* 1.1m^2), using a coarse-meshed metal sieve.

Species were selected as indicators of well-developed habitat if:- (1) they have a restricted preference to the types of flooded soil habitat associated with turloughs and lake shores, and (2) they are reported in the literature as being local or rare, from which it is assumed that they are less likely to survive in historically degraded ecosystems. By 'well-developed habitat' it is meant that the ecosystem is sufficiently undisturbed by human activity to allow it to retain many local or rare characteristic species. The presence of two or more indicator species, likely to breed in the habitats sampled, is considered an indication of habitat quality, given the sampling effort involved.

Nomenclature of Staphylinidae follows Anderson *et al.* (1997) for Irish species, with the exception of the genus *Bisnius* (=*Philonthus* partim) where it follows Smetana (1995); and Hansen (1996) and Lohse and Lucht (1989) for species new to Ireland. Nomenclature of Carabidae follows Anderson *et al.* (2000). Plant nomenclature follows Stace (1997). Voucher specimens of several indicator species have been deposited in the National Museum of Ireland, and other species have been retained in the senior author's collection.

Results

In total, 78 species of staphylinid and 37 species of carabid were recorded from the four sites. Of these, 14 species of staphylinid (18%) and four species of carabid (11%) are considered indicators of well-developed habitat, and five staphylinid species are new to Ireland (*Atheta difficilis* (Brisout), *A. excellens* (Kraatz), *A. orphana* (Erichson), *Carpelimus subtilicornis* (Roubal), *Disopora coulsoni* (Last)). Species found at each site are listed in Tables 2-4, where they are separated into sets of species associated with different sites, to facilitate visual comparison of species occurrence at each site (multivariate analysis is precluded due to the very small data set).

Atheta basicornis (Staphylinidae) is a stenotopic flood-plain species particularly associated with fungus-infected *Salix* and other trees (Koch, 1989). It has been recorded only once from Ireland (Nicholson, 1920; Anderson, 1997b), and is local in Great Britain (Hyman and Parsons, 1994).

Atheta difficilis (Staphylinidae) has not been previously recorded from Ireland (Anderson *et al.*, 1997). It is a wetland species which is local in England (Hyman and Parsons, 1994), recorded from France, but, although likely to occur, is not yet known from Central Europe (Lohse and Lucht, 1989). It was recorded from three turloughs and leaf-litter in Garryland Wood (Tables 2 and 4), and has also been taken from wetland plant-litter in Great Britain (Hyman and Parsons, 1994). A closely related species, *A. laticeps* (Thomson), has also been recorded from flood meadows in Sweden. The species recorded as *A. laticeps* from Corsica and north-east Italy (Porta, 1926) is of a similar pale colour to *A. difficilis*, contrasting with the darker *A. laticeps* as separated by Lohse and Lucht (1989). If the southern European form is indeed *A. difficilis*, then the distribution pattern of the east Burren turloughs, southern England and southern Europe corresponds to the characteristic Burren turlough carabid assemblage, forming part of the southern-temperate faunal element of the Irish fauna, described by Anderson (2000).

Atheta excellens (Staphylinidae) has not been previously recorded from Ireland (Anderson *et al.*, 1997). It is a eurytopic species, recorded from *Sphagnum*, bird carrion and decaying plant matter in woods, blanket bogs and wooded pools, according to Koch (1989), and for this reason is not considered an indicator species. It has a predominantly boreo-montane distribution in Europe (Burakowski *et al.*, 1981).

Atheta orphana (Staphylinidae) has not been previously recorded from Ireland (Anderson *et al.*, 1997). It is a eurytopic species with a preference for mouldy leaves, according to Koch (1989), occurring in gardens, hedges and woods, as well as on floodplain soils, and because of its broad habitat range, it has not been considered an indicator species. However, it appears to be uncommon to rare in much of its European range (Palm, 1970; Burakowski *et al.*, 1981; Benick and Lohse, 1974; Hyman and Parsons, 1994).

Bembidion clarkii (Dawson) (Carabidae) is described by Koch (1989) as stenotopic, restricted to marshy pools and ponds in woods. In Ireland and Great Britain, it occurs locally in fens, turloughs, pond and lakes, often shaded by woodland or carr (Hyman and Parsons, 1992; Owen, 1997; Luff, 1998; Anderson *et al.*, 2000).

Bembidion doris (Panzer) (Carabidae) is local in Ireland and Great Britain, recorded from fens, swamps, riparian habitats and lakeshores (Anderson *et al.*, 2000; Luff, 1998). In Central

Europe, it is restricted to lentic water margins including pools in woodland and marshy woods (Koch, 1989).

Calodera nigrita Mannerheim (Staphylinidae) is a northern Palaearctic species local in Great Britain and generally local in Europe (Horion, 1967; Hyman and Parsons, 1994). It has apparently only been previously recorded in Ireland, in the nineteenth century from Armagh (Anderson, 1997b; Johnson and Halbert, 1902). Koch (1989) defines the species as eurytopic, but states that it is particularly associated with the margins of ponds and pools (otherwise recorded from marshy flood plains and woodland marshes).

Carpelimus subtilicornis (Staphylinidae) is a stenotopic species of flooded riparian soils (Koch, 1989), where it can occur in abundance (Lott, 1999). *C. subtilicornis* has not been recorded from Ireland previously (Anderson *et al.*, 1997), although it may well occur in collections as *C. corticinus* (Gravenhorst) (see Lohse (1964) for diagnostic characters and aedeagal illustrations). It is a northern and central European species (Horion, 1963), although not very local in Great Britain (not being listed in Hyman and Parsons (1994)).

Disopora (*=Aloconota*) *coulsoni* (Staphylinidae) has not been previously validly recorded from Ireland (Anderson *et al.*, 1997; the record in Good and Giller (1990) was based on a misidentification). It is local in Great Britain and rare in Scandanavia and Central Europe, where it is restricted to marsh soils (Palm, 1970; Benick and Lohse, 1974; Hyman and Parsons, 1994). It was only recorded from Roo West turlough (Table 2).

Hygropora cunctans (Erichson) (Staphylinidae) is local or rare throughout Europe (Horion, 1967), very local in Great Britain (Hyman and Parsons, 1994), and only known in Ireland from two turloughs (in Counties Clare and Roscommon (Lott and Bilton, 1991; Owen, 1997). It is a wetland species restricted to marshy shores, wet meadows and bogs (Horion, 1967; Koch, 1989).

The specimen of *Meotica exilis* (Knoch) (Staphylinidae) was a macropterous, macrophthalmous male, keying out in the *Die Käfer Mitteleuropas* keys (Lohse, 1974; Lohse and Lucht, 1989; Vogel, 1998) as a form of *M. exilis* or *M. pallens* (Redtenbacher), but possessing the aeadeagus of *M. exilis*, as illustrated in Lohse (1974). The form of the fore-body (relatively large protruding eyes, relatively elongate elytra, etc.), however, most resembles that illustrated (in Lohse, 1974) for *M. lohsei* Benick (now a synonym of *M. pallens* (see Vogel, 1998)). There has been some confusion in this genus, with a large number of subspecific forms described as species (Vogel, 1998). This is the second Irish record of *M. exilis*. It was previously recorded from Killarney, Co.Kerry, by Bullock (1930) (Anderson, 1997b). The habitat concept for this species also varies:- Horion (1967) has a more restricted habitat concept than Koch (1989), the latter considering the species eurytopic. It may, like *Platynus livens* (Gryllenhal) (see below), be part of the south-western element of the fauna, identified for carabids by Anderson (2000). Because of the taxonomic and ecological uncertainties associated with this species, it has not been considered as an indicator species.

There is a single Irish record of *Oxypoda lentula* Erichson (Staphylinidae) (near Belfast) (Anderson, 1997b), a species local or rare throughout Europe (Horion, 1967), but apparently not uncommon in Great Britain (Anderson, 1997b). It is stenotopic, restricted to marshy water margins, pools and ponds, and wet woods (Horion, 1967; Koch, 1989).

Pelophila borealis (Paykull) (Carabidae) is a riparian or turlough species in Ireland (Anderson *et al.*, 2000; Lott and Bilton, 1991). It has been recorded recently from 38 sites in Northern Ireland (Anderson *et al.*, 2000) and a number of sites in the Republic of Ireland (Speight *et al.*, 1982; Lott and Bilton, 1991; Owen, 1997; Good and Butler, 2000), but is known only from Inverness, Orkney and Shetland in Scotland in Great Britain (Luff, 1998). It is a boreal species, known elsewhere in Europe from northern and montane Fennoscandia and Russia (Anderson, 2000; Trautner and Geigenmüller, 1987).

Philhygra gyllenhalii (Thomson) (Staphylinidae) was recently recorded from Lady's Island Lake, Co. Wexford (Good and Butler, 1998), and there are three old records from other parts of Ireland (Johnson and Halbert, 1902; Anderson, 1997b). Although this species is not listed by Hyman and Parsons (1994) as being rare or notable in Great Britain, it appears to be local or rare throughout Europe (Palm, 1970; Benick and Lohse, 1974). The species is stenotopic, restricted to marshes, alder carr and bogs (Koch, 1989).

There are a number of Irish records for *Philonthus furcifer* Renkonen (Staphylinidae) (Lott and Foster, 1990; Lott and Bilton, 1991; Anderson, 1997b; Owen, 1997; Good and Butler, 1998; 2000), a species not recorded from Great Britain. It is rare in Europe, and is restricted to marshy shores (Horion, 1967).

Platynus (=*Agonum*) *livens* (Gyllenhal) (Carabidae) has only been recorded from two sites in

Ireland, both turloughs, in Garryland (Speight *et al.*, 1982) and Coolreash Lough (near Mullagh Mór) (Anderson, 1997a). In Britain, where it is local, it has been recorded from alder and willow carr, wet woodland, and marshes, wet meadows and fens including reservoirs (Hyman and Parsons, 1992), and may require woodland for hibernation (Luff, 1998). In Central Europe, the species has a wider habitat range (Koch, 1989).

Platystethus nodifrons Mannerheim (Staphylinidae) is a local to rare species throughout Europe (Horion, 1963), including Ireland and Great Britain (Hammond, 1971; Hyman and Parsons, 1994; Anderson, 1997b). It has been recorded from muddy shores, boggy pools and in sedge and reed litter in wetlands (Horion, 1963; Hammond, 1971). It appears to have a requirement for organic-rich flooded soils, and was the most abundant species encountered in this survey at turloughs with deeper soils (Table 2).

Schistoglossa gemina (Erichson) (Staphylinidae) is widespread but local in Great Britain (Hyman and Parsons, 1994), and widespread but rare in Central Europe (Benick and Lohse, 1974; Palm, 1970). There are at least five previous records from Ireland (O'Mahony, 1929; Good and Butler, 1998). The species occurs in marshy lake shores, wet meadows and marshes including wet ditches in sand dunes (Koch, 1989; Hyman and Parsons, 1994).

Sepedophilus pedicularius (Gravenhorst) (Staphylinidae) is restricted to sedge, reed, grass and *Salix* litter in marshes (Hyman and Parsons, 1994). Its occurrence (as a singleton) in recently-flooded deciduous leaf litter (Garryland Wood, Table 4), away from wetland vegetation, may represent an overwintering straggler rather than a breeding population. Two individuals occurred in the upper mossy pasture zone *circa* 10m from the woodland margin at Garryland (in a sample not included here), and three individuals occurred in the *Potentilla anserina* zone at Lough Coy (Table 2). This suggests that the species can maintain a spring population in turlough soils. It is local in Ireland (Anderson, 1997b; Owen, 1997), and in Great Britain (Hyman and Parsons, 1994).

Stenus carbonarius Gyllenhal (Staphylinidae) is local in Ireland, restricted to lowland fens, mesotrophic bog and richly vegetated lakeshores, according to Anderson (1997b), and has also been recorded from turloughs (Owen, 1997). It is also local in Great Britain, where it is recorded from similar habitats (Hyman and Parsons, 1994). It is not uncommon in parts of continental Europe, but is restricted to flooded marshy soils on shores of lakes, ponds and rivers (Horion, 1963).

Stenus nigritulus Gyllenhal (Staphylinidae) is known from four sites in Ireland (Anderson, 1997b; Good and Butler, 1998), including the Coole-Garryland turlough system (Anderson, 1987). It is very local and declining in Great Britain, according to Hyman and Parsons (1994), and scattered and rare in France, but not uncommon in Fennoscandia and eastern Central Europe (Horion, 1963). The species is restricted to marshy shores, including flooded meadows (Horion, 1963), riverbanks and salt-marshes (Hyman and Parsons, 1994).

Discussion

In addition to the well-known turlough Crustacea which can survive dessication (Reynolds, 1996), a group of beetle species has also been recognised as particularly characteristic of the turloughs in the north Clare/south-east Galway area. Bilton (1988) described an aquatic beetle assemblage associated with water margin mosses (*Agabus labiatus* (Brahm), *Dryops similaris* Bollow and *Graptodytes bilineatus* (Sturm)), unknown elsewhere in Britain and Ireland, and particularly sensitive to environmental degradation. Also, in one of the few cases where characteristic arthropods are listed in the *Interpretation Manual for European Union Habitats* (European Commission, 1999), five carabids are included for turloughs (*Agonum lugens* (Duftschmid), *Badister meridionalis* Puel, *Blethisa multipunctata* (L.), *Pelophila borealis* (Paykull) and *Platynus livens* (Gyllenhal)), although the caveat is added that they are characteristic of intermittently flooded areas rather than strictly characteristic of turloughs. Furthermore, the following assemblage of carabids and staphylinids, otherwise known from only one or two other sites in Ireland (Anderson, 1997b; Anderson *et al.*, 2000), have been recorded from the Coole-Garryland turlough system (*Acupalpus consputus* (Duftschmid), *Badister meridionalis*, *B. peltatus* (Panzer), *Platynus livens* and *Philonthus punctus* (Gravenhorst) (Anderson, 1981; Speight *et al.*, 1982; Lott and Bilton, 1991)).

The large proportion of staphylinid and carabid species considered as indicator species in this brief investigation (accounting for 16% of the recorded fauna), shows that the above assemblage of species characteristic of turloughs can be expanded considerably. It also further demonstrates the exceptional conservation importance of turloughs in north Clare and south-east Galway for soil communities, including sites outside the Coole-Garryland Nature Reserve.

The habitat factors operating at turloughs are complex, involving, *inter alia*, rate and timing of water draw-down and recharge, soil type (especially moisture-holding and thermal characteristics, which will vary with the proportion of marl, peaty and sandy components (cf. Coxon, 1987b), and surrounding overwintering habitat (e.g. woodland at Garryland, limestone pavement at Roo West). Although results are presented here for only four sites, the assemblages recorded suggest that there is a difference between the fauna of turlough pastures such as Roo West (with Burren Series soils and very shallow glacial till cover on otherwise exposed epikarst limestone), and turlough pastures on soils derived from relatively deeper glacial till (Kinvarra and Kilcolgan Series (see Finch *et al.* (1971) and Gardiner and Radford (1980) for soil series descriptions). Roo West turlough contained *Aloconota coulsoni*, *Pterostichus cupreus* (L.) and *Stenus nigritulus*, otherwise not recorded from the other sampled turloughs, as well as just single individuals of *Calodera nigrita* and *Platystethus nodifrons*, species recorded in high numbers from the Coole-Garryland turloughs (Tables 2 and 3). As pointed out by Anderson (2000), the heat retention capacity of the Burren turlough soils is particularly important for their characteristic fauna. *Stenus nigritulus* has only been recorded in Ireland on free-draining sandy or rendzina limestone soils associated with lakes or turloughs (Anderson, 1984, 1987; Good and Butler, 1998). *Pterostichus cupreus* is also thermophilic in Ireland (Anderson *et al.*, 2000).

Dr M. C. D. Speight recorded 44 carabid species from the Coole-Garryland Nature Reserve turloughs and woodland during the years 1975 to 1980, and has kindly permitted us to include the list in Table 5, which also includes records from Anderson (1981) from the same period. This Coole-Garryland list includes 17 species recorded from turlough margins, or in the woodland during winter, which were not recorded during this survey, including four extra indicator species: *Acupalpus consputus*, *Badister meridionalis*, *B. sodalis* (Duftschmid) and *Stenolophus mixtus* (Herbst). It is notable that the number of indicator species represents 15% of the carabid fauna from the 1975-80 list, the same percentage of indicator species (15%) as recorded for the staphylinid + carabid fauna from the 1996 list (Tables 2-4). This is despite probable differences in sampling locations (e.g. there are more bare ground species (e.g. *Bembidion lampros* (Herbst), *Nebria brevicollis* (Fabr.), *Platynus dorsale* (Pontoppidan), *Pterostichus cupreus* (L.)) in the Speight list). The characteristic of the Coole-Garryland area is that it is a woodland-turlough complex, whereas most other turloughs are associated with hedges, scrub and pasture, and this may account for the occurrence of a rare component to the fauna, such as *Acupalpus consputus*, *Agonum livens* and *Badister meridionalis*. However, no equivalent group of staphylinids, restricted to Coole-Garryland, was discovered, and the number of indicator staphylinid species was the same at Garryland and Lough Coy (see Table 2).

The staphylinid and carabid fauna of turlough pastures demonstrates, at its best, the rich assemblage of beetle species adapted to moist free-draining seasonally-flooded mineral soils. As in the case of other disturbed habitats, such as salt-marshes or cultivated soils for annual field crops, many species share an adaptation to the disturbing factor, in this case flooding. However, in the case of turloughs, toleration by overwintering adult beetles of flooding may be more critical than the ability of larvae to survive disturbance, for species which breed in the turlough pastures (most of the indicator staphylinid and carabid species are spring-breeders with summer larval and pupal stages). With relatively rapidly falling water levels (e.g. as recorded for Garryland by Johnson and Peach (1998)), the young larvae can be left 'high and dry', but in a nutrient-enriched and biologically active environment (equally, they are susceptible to being reflooded if waters rise following heavy rainfall, although this will be occasional and temporary in most turloughs). Thus, like species annually colonising cultivated field crop soils, turlough-breeding species are exploiting a temporary seasonal habitat rich in food, and emerge as adults in summer to eventually disperse to overwintering quarters in scrub, woodland, rock crevices or field margins above the level at which they bred. However, while a field crop species can select a cavity in a grass tussock as an overwintering cell with the strong likelihood that it will be buffered from lethally cold temperatutes (see Luff, 1965, 1966), the turlough species cannot *a priori* select an overwintering habitat which will be free from flooding, because the maximum winter water levels vary from year to year. Adaptations such as diapause and low-oxygen demand in the overwintering beetle may allow it to survive prolonged periods of flooding. This raises the question of what depth of water these species can tolerate. The ecophysiology of the characteristic soil fauna of flooded soils of turloughs is an area open for study. Earthworms (Lumbricidae), for instance, occurred under stones quite far down the turlough pasture at Lough Coy, and presumably face similar problems as do the soil

Coleoptera. The authors are unaware of any study of earthworms in turloughs; their identity and role in turlough pasture nutrient dynamics remains a mystery.

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TABLE 1. Details of sites and sampling of four turlough pastures, and two associated woodland sites. Hydrogeological details of sites are in Jennings O'Donovan and Partners/Southern Water Global (1998).

Site	Grid ref.	Sampling technique	Sampling dates
	Habitat type		
Coole (Co. Galway)	M435049	Pitfall traps	29 September - 16 October 1996
	Betula/Quercus leaf litter, woodland margin of Coole river turlough; part of Coole-Garryland turlough complex.		
Garryland (Co. Galway)	M415036	Pitfall traps	6 May - 1 June 1996
		Suction sampler	6 May 1996
	Sheep grazed short sward turlough pasture with *Potentilla anserina*. Turlough near (*circa* 25m) mature deciduous woodland; part of Coole-Garryland turlough complex.		
	M416036	Sieve samples	2 June 1996
	Fraxinus/Quercus/Crataegus leaf litter, flooded during winter.		
Lough Coy (Co. Galway)	M488073	Pitfall traps	6 May - 2 June 1996
		Suction sampler	6 May 1996
	Cattle-grazed medium-sward turlough pasture with *Potentilla anserina*. Permanent lake turlough margin with scrub (*Crataegus*, *Prunus spinosa* etc.); part of NE-SW karst turlough system.		
Newtown Lake (Co. Galway)	M425025	Pitfall traps	5 May - 6 June 1996
		Suction sampler	5 May 1996
	Sheep-grazed short sward turlough pasture. Turlough with permanent marshy lake between wooded and open limestone pavement.		
Roo West (Co. Clare)	M384019	Pitfall traps	14 May - 21 June 1996
		Suction sampler	14 May 1996
	Cattle/sheep-grazed short sward calcareous pasture with *Salix repens*. Epikarst turlough with slow water draw-down in spring, on marl-rich shallow drift near limestone pavement (Burren series soils).		

TABLE 2. Staphylinidae recorded from pitfall traps and suction samples from turlough pastures at Garryland turlough, Lough Coy, Newtown Lake turlough, and Roo West turlough. Indicator species are marked with an asterisk.

Species	**Garryland**	**Coy**	**Newtown**	**Roo West**
Aloconota gregaria (Erichson)	1	27	7	4
Amischa analis (Gravenhorst)	6	2	8	30
Amischa decipiens (Sharp)	5	-	-	9
Anotylus rugosus (Fabricius)	3	17	2	3
Atheta difficilis (Brisout) *	9	-	5	8
Atheta graminicola (Gravenhorst)	6	65	12	3
Atheta orphana (Erichson)	12	-	2	1
Calodera aethiops (Gravenhorst)	9	3	3	2
Calodera nigrita Mannerheim *	17	14	12	1
Carpelimus rivularis (Motschulsky)	3	1	-	1
Carpelimus subtilicornis (Roubal) *	38	4	8	3
Gabrius coxalus (Hochhuth)	9	5	2	5
Geostiba circellaris (Gravenhorst)	3	1	-	1
Hygropora cunctans (Erichson) *	6	-	6	1
Ischnopoda atra (Gravenhorst)	6	20	-	3
Lathrobium fulvipenne Gravenhorst	5	2	-	-
Lathrobium fovulum Stephens	2	-	-	-
Lathrobium impressum Heer	11	3	-	-
Lathrobium quadratum (Paykull)	5	4	4	-
Oxypoda umbrata (Gyllenhal)	1	13	16	2
Philhygra elongatula (Gravenhorst)	6	2	6	1
Philhygra gyllenhalii (Thomson) *	4	-	-	-
Philhygra malleus (Joy)	13	26	-	2
Philonthus carbonarius (Gravenhorst)	2	-	-	1
Philonthus cognatus Stephens	18	10	19	25
Philonthus furcifer Renkonen *	7	11	3	-
Philonthus micans (Gravenhorst)	1	-	1	-
Philonthus nigrita (Gravenhorst)	2	-	-	-
Philonthus quisquiliarius (Gyllenhal)	3	7	1	-
Platystethus nodifrons Mannerheim *	180	120	90	1
Sepedophilus marshami (Stephens)	1	-	-	-
Stenus boops Ljungh	12	1	4	1
Stenus canaliculatus Gyllenhal	7	1	1	-
Stenus carbonarius Gyllenhal *	9	6	-	-
Stenus cicindeloides (Schaller)	7	-	-	-
Stenus fuscipes Gravenhorst	41	44	36	23
Stenus incrassatus Erichson	2	-	-	-

TABLE 2 (continued)

Species	**Garryland**	**Coy**	**Newtown**	**Roo West**
Stenus juno (Paykull)	2	-	-	-
Stenus nanus Stephens	2	-	1	-
Stenus tarsalis Ljungh	13	3	-	-
Tachyporus dispar (Paykull)	4	1	1	5
Tachyporus pusillus Gravenhorst	2	7	2	1
Acrotona aterrima (Gravenhorst)	-	1	-	-
Amischa nigrofusca (Stephens)	-	1	-	-
Atheta amplicollis (Mulsant & Rey)	-	4	4	12
Atheta atramentaria (Gyllenhal)	-	5	-	-
Atheta basicornis (Mulsant & Rey) *	-	1	-	-
Atheta celata (Erichson)	-	1	-	-
Atheta excellens (Kraatz)	-	1	-	-
Carpelimus gracilis (Mannerheim)	-	1	-	-
Gabrius trossulus (Nordmann)	-	1	-	-
Oxypoda lentula Erichson *	-	1	-	-
Philhygra melanocera (Thomson)	-	2	-	-
Platystethus arenarius (Geoffroy)	-	2	1	-
Sepedophilus pedicularius (Gravenhorst) *	-	3	-	-
Tachyporus nitidulus (Fabricius)	-	1	-	1
Aleochara lanuginosa Gravenhorst	-	-	1	-
Micropeplus porcatus (Paykull)	-	-	1	-
Philonthus laminatus (Creutzer)	-	-	2	-
Tachinus signatus Gravenhorst	-	-	2	-
Anotylus tetracarinatus (Block)	-	-	-	1
Atheta fungi (Gravenhorst)	-	-	-	2
Atheta triangulum (Kraatz)	-	-	-	1
Disopora coulsoni (Last) *	-	-	-	2
Gabrius subnigritulus (Reitter)	-	-	-	1
Meotica exilis (Knoch)	-	-	-	1
Oxytelus laqueatus (Marsham)	-	-	-	1
Schistoglossa gemina (Erichson) *	-	-	-	1
Staphylinus dimidiaticornis Gemminger	-	-	-	2
Stenus nigritulus Gyllenhal *	-	-	-	2
Total no. species	42	42	31	37
Total no. indicator species	8	8	6	8

TABLE 3. Carabidae recorded from pitfall traps and suction samples from turlough pastures at Garryland turlough, Lough Coy, Newtown Lake turlough and Roo West turlough. Indicator species are marked with an asterisk.

Species	Garryland	Coy	Newtown	Roo West
Agonum marginatum (Linnaeus)	16	5	2	-
Agonum afrum (Duftschmid)	1	1	1	6
Agonum muelleri (Herbst)	5	14	7	-
Agonum viduum (Panzer)	1	-	1	-
Amara similata (Gyllenhal)	1	-	-	-
Bembidion aeneum Germar	3	44	36	-
Bembidion assimile Gyllenhal	2	-	3	5
Bembidion clarkii (Dawson) *	39	-	17	-
Bembidion dentellum (Thunberg)	12	4	2	3
Bembidion guttula (Fabricius)	5	23	7	13
Bembidion mannerheimii Sahlberg	3	13	-	-
Bembidion tetracolum Say	1	4	-	-
Blethisa multipunctata (Linnaeus)	1	1	-	-
Chlaenius nigricornis (Fabricius)	10	4	1	3
Clivinia fossor (Linnaeus)	28	2	21	21
Dyschirius globosus (Herbst)	22	16	-	6
Dyschirius luedersi Wagner	1	-	-	-
Elaphrus riparius (Linnaeus)	-	1	-	-
Loricera pilicornis (Fabricius)	8	-	1	-
Pelophila borealis (Paykull) *	10	3	2	-
Platynus albipes (Fabricius)	3	-	-	-
Platynus livens (Gyllenhal) *	1	-	-	-
Pterostichus anthracinus (Illiger)	26	-	1	-
Pterostichus crenatus (Duftschmid)	3	3	-	1
Pterostichus minor (Gyllenhal)	5	-	2	1
Pterostichus nigrita (Paykull)	20	13	2	7
Pterostichus strenuus (Panzer)	8	5	2	5
Agonum piceum (Linnaeus)	-	3	-	-
Bembidion doris (Panzer) *	-	1	-	-
Carabus granulatus Linnaeus	-	1	3	8
Harpalus rufipes (DeGeer)	-	1	-	-
Amara aenea (DeGeer)	-	-	-	1
Nebria brevicollis (Fabricius)	-	-	-	16
Ocys harpaloides (Audinet-Serville)	-	-	-	1
Pterostichus cupreus (Linnaeus)	-	-	-	11
Total no. species	26	21	18	16
Total no. indicator species	3	2	2	0

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TABLE 4. Staphylinidae and Carabidae recorded from sieve samples of *Fraxinus/Quercus/Crataegus* leaf litter from Garryland Wood, and autumn pitfall traps in *Betula/Quercus* leaf litter in Coole Wood.

Species	Garryland Wood	Coole Wood
STAPHYLINIDAE		
Aloconota insecta (Thomson)	6	-
Amischa analis (Gravenhorst)	12	-
Amischa decipiens (Sharp)	1	1
Anotylus rugosus (Fabricius)	1	-
Atheta amplicollis (Mulsant & Rey)	5	3
Atheta difficilis (Brisout) *	2	-
Atheta fungi (Gravenhorst)	1	-
Atheta graminicola (Gravenhorst)	2	1
Bisnius fimetarius (Gravenhorst)	2	-
Calodera aethiops (Gravenhorst)	6	-
Gabrius subnigritulus (Reitter)	2	-
Geostiba circellaris (Gravenhorst)	16	1
Habrocerus capillaricornis (Gravenhorst)	3	-
Lathrobium fulvipenne Gravenhorst	1	1
Lathrobium boreale (Hochhuth)	1	-
Lathrobium longulum Gravenhorst	2	-
Oxypoda umbrata (Gyllenhal)	1	-
Platystethus nodifrons Mannerheim *	2	-
Sepedophilus marshami (Stephens)	3	-
Sepedophilus pedicularius (Gravenhorst) *	1	-
Stenus fuscipes Gravenhorst	4	-
Tachinus laticollis Gravenhorst	2	-
Tachyporus obtusus (Linnaeus)	1	-
Lathrobium fovulum Stephens	-	1
Lathrobium impressum Heer	-	1
Stenus juno (Paykull)	-	2
CARABIDAE		
Agonum afrum (Duftschmid)	1	-
Bembidion clarkii (Dawson) *	1	12
Bembidion guttula (Fabricius)	2	3
Bembidion tetracolum Say	1	-
Clivinia fossor (Linnaeus)	9	-
Platynus albipes (Fabricius)	1	-
Platynus obscurum (Herbst)	1	-
Pterostichus minor (Gyllenhal)	3	-
Pterostichus nigrita (Paykull)	5	-
Pterostichus strenuus (Panzer)	4	2
Bembidion aeneum Germar	-	1
Bembidion dentellum (Thunberg)	-	4
Dyschirius globosus (Herbst)	-	1
Ocys harpaloides (Audinet-Serville)	-	1
Trechus obtusus Erichson	-	1

TABLE 5. Carabidae recorded by M. C. D. Speight, and Anderson (1981), from Coole-Garryland turloughs and woodland during 1975-1980 (data by kind permission of Dr M. C. D. Speight; see also Speight (1976a, b, 1977; Speight *et al.*, 1982)). Indicator species are marked with an asterisk.

Abax parallelepipedus (Piller & Mitterpacher)
Acupalpus consputus (Duftschmid) *
Agonum afrum (Duftschmid)
Agonum marginatum (Linnaeus)
Agonum muelleri (Herbst)
Agonum piceum (Linnaeus)
Amara plebeja (Gyllenhal)
Badister meridionalis Puel *
Badister peltatus (Panzer)
Badister sodalis (Duftschmid) *
Bemdidion aeneum Germar
Bembidion clarkii (Dawson) *
Bembidion dentellum (Thunberg)
Bembidion lampros (Herbst)
Bembidion mannerheimii Sahlberg
Bembidion tetracolum Say
Blethisa multipunctata (Linnaeus)
Carabus granulatus Linnaeus
Carabus problematicus Herbst
Chlaenius nigricornis (Fabricius)
Clivinia fossor (Linnaeus)
Elaphrus cupreus Duftschmid
Elaphrus riparius (Linnaeus)
Harpalus rufipes (DeGeer)
Leistus fulvibarbis Dejean
Loricera pilicornis (Fabricius)
Nebria brevicollis (Fabricius)
Ocys harpaloides (Audinet-Serville)
Olisthopus rotundatus (Paykull)
Pelophila borealis (Paykull) *
Platynus albipes (Fabricius)
Platynus dorsale (Pontoppidan)
Platynus livens (Gyllenhal) *
Platynus obscurum (Herbst)
Pterostichus anthracinus (Illiger)
Pterostichus crenatus (Duftschmid)
Pterostichus cupreus (Linnaeus)
Pterostichus diligens (Sturm)
Pterostichus madidus (Fabricius)
Pterostichus melanarius (Illiger)
Pterostichus minor (Gyllenhal)
Pterostichus nigrita (Paykull)
Pterostichus strenuus (Panzer)
Pterostichus versicolor (Sturm)
Stenolophus mixtus (Herbst) *
Trechus obtusus Erichson

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THE *CLECOM* PROJECT LIST OF IRISH NON-MARINE MOLLUSCA

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Summary

A checklist of the 158 species of non-marine Mollusca now known from Ireland is presented, following the nomenclature used in the Pan-European CLECOM project.

Introduction

The massive and ambitious CLECOM (Checklist of the European continental Mollusca) project has the stated objective of "creating a uniform and validated index to the European continental molluscs, for use as a practical tool in the inventorisation and monitoring of biodiversity" (Falkner *et al.*, 2001a). The expression "European continental" is in this instance employed in the sense of "pertaining to the continent of Europe". Initiated in 1989, the project has pan-European coverage of both species and specialists. Its first major product, a checklist of the non-marine Mollusca of the CLECOM I area, annotated to show from which European States/parts of Europe each species is known, has now appeared (Falkner *et al.*, 2001a). The CLECOM I area includes Atlantic parts of Europe, with Ireland as one named category among them, so the CLECOM I list incorporates an up-to-date and thoroughly revised list of the Irish non-marine molluscs.

The purpose of the present text is to make the CLECOM I list of Irish non-marine Mollusca more accessible to those in Ireland who might wish to employ it. The most recent of previous lists covering all of the Irish non-marine molluscs is that incorporated into Kerney *et al.* (1999), which employs a more traditional nomenclature. Where there are nomenclatural differences between the list in Kerney *et al.* (*op. cit.*) and the CLECOM I list of Falkner *et al.* (2001a), that is indicated in the list presented here. But those differences are not discussed in the present text.

Another development concerning study of Irish molluscs is publication of the database of shelled Gastropoda of western Europe (Falkner *et al.*, 2001b). This database covers all of the shelled gastropods known from Ireland, but does not cover either slugs or bivalves. The shelled gastropod species *Euconulus trochiformis* (Montagu), *Physella gyrina* (Say) and *Quickella arenaria* (Potiez and Michaud) also seem to have been inadvertently omitted from the database list for Ireland. The database provides coded data on habitat, microhabitat, biological traits, range and degree of endemism for all of the species covered, creating an analytical tool for use in interpretation of gastropod faunas. There is an accompanying text, which provides examples of applications of the database. The database employs much of the same nomenclature as is found in the CLECOM I list. But there are a few name changes introduced in the CLECOM I list that were not incorporated into the database. Those changes are indicated in the list presented here. In addition, five species are included as Irish in the database, but not in the CLECOM I list. These are *Cernuella aginnica* (Locard), *Cernuella neglecta* (Draparnaud), *Helicodonta obvoluta* (Müller), *Radix ovata* (Draparnaud) and *Stagnicola fuscus* (Pfeiffer).

The CLECOM I list follows a phylogenetic organisation of the taxa. Here, the families are presented in alphabetical order, under their Orders, and genera and species are also presented alphabetically, under their families and genera, respectively. Additional taxonomic levels (i.e. Superorder, Superfamily, Subfamily, Tribe, Subgenus) used in the CLECOM 1 list are not referred to here. The Irish fauna of non-marine Mollusca now totals 158 species, of which seven are additions to those listed for Ireland in Kerney *et al.* (1999).

CHECKLIST OF IRISH NON-MARINE MOLLUSCA

Phylum MOLLUSCA	**Name in Kerney** (1999) (if different)
Class GASTROPODA	* = addition to Kerney (1999)
Order Neritopsina	
Neritidae	
Theodoxus fluviatilis (L., 1758)	
Order Architaenioglossa	
Aciculidae	
Acicula fusca (Montagu, 1803)	

Viviparidae

Viviparus viviparus (L., 1758)

Order Neotaenioglossa

Assimineidae

Assiminea grayana Fleming, 1828

Bithyniidae

Bithynia leachii (Sheppard, 1823)

Bithynia tentaculata (L., 1758)

Hydrobiidae

Hydrobia ventrosa (Montagu, 1803)

Mercuria anatina (Poiret, 1801) — *Mercuria confusa* (Frauenfeld, 1863)

Obrovia neglecta Muus, 1963 — *Hydrobia neglecta*

Peringia ulvae (Pennant, 1777) — *Hydrobia ulvae*

Potamopyrgus antipodarum (Gray, 1843)

Pomatiidae

Pomatias elegans (O. F. Müller, 1774)

Order Ectobranchia

Valvatidae

Valvata cristata O. F. Müller, 1774

Valvata macrostoma Mörch, 1864 *

Valvata piscinalis piscinalis (O. F. Müller, 1774)

Order Pulmonata

Acroloxidae

Acroloxus lacustris (L., 1758)

Agriolimacidae

Deroceras laeve (O. F. Müller, 1774)

Deroceras panormitanum (Lessona & Pollonera, 1882)

Deroceras reticulatum (O. F. Müller, 1774)

Arionidae

Arion ater (L., 1758)

Arion circumscriptus Johnston, 1828	
Arion distinctus J. Mabille, 1868	
Arion fasciatus (Nilsson, 1823)	
Arion flagellus (Collinge, 1893)	
Arion fuscus (O. F. Müller, 1774)	*Arion subfuscus* Draparnaud, 1805
Arion hortensis A. Férussac, 1819	
Arion intermedius (Normand, 1852)	
Arion lusitanicus (J. Mabille, 1868)	
Arion owenii Davies, 1979	
Arion rufus (L., 1758)	*
Arion silvaticus (Lohmander, 1937)	
Geomalacus maculosus (Allman, 1843)	
Boettgerillidae	
Boettgerilla pallens (Simroth, 1912)	
Carychiidae	
Carychium minimum O. F. Müller, 1774	
Carychium tridentatum (Risso, 1826)	
Clausiliidae	
Balea perversa (L., 1758)	
Clausilia bidentata bidentata (Ström, 1765)	
Cochlodina laminata laminata (Montagu, 1803)	
Cochlicopidae	
Cochlicopa lubrica (O. F. Müller, 1774)	
Cochlicopa lubricella (Porro, 1838)	
Cochlicopa repentina Hudec, 1960	*
Ellobiidae	
Leucophytia bidentata (Montagu, 1808)	
Myosotella myosotis (Draparnaud, 1801)	*Ovatella myosotis*
Enidae	
Merdigera obscura (O. F. Müller, 1774)	*Ena obscura*

Euconulidae	
Euconulus fulvus (O. F. Müller, 1774)	
Euconulus praticola (Reinhardt, 1883)	*Euconulus alderi* (Gray, 1840)
Euconulus trochiformis (Montagu, 1803)	*
Ferussaciidae	
Cecilioides acicula (O. F. Müller, 1774)	
Gastrodontidae	**(Zonitidae)**
Zonitoides excavatus (Alder, 1830)	
Zonitoides nitidus (O. F. Müller, 1774)	
Helicidae	
Arianta arbustorum arbustorum (L., 1758)	
Cepea hortensis (O. F. Müller, 1774)	
Cepea nemoralis nemoralis (L., 1758)	
Cornu aspersum aspersum (O. F. Müller, 1774)	*Helix aspersa*
Helicigona lapicida lapicida (L., 1758)	
Theba pisana pisana (O. F. Müller, 1774)	
Hygromiidae	**(Helicidae)**
Ashfordia granulata (Alder, 1830)	
Candidula intersecta (Poiret, 1801)	
Cernuella virgata (Da Costa, 1778)	
Cochlicella acuta (O. F. Müller, 1774)	
Helicella itala (L., 1758)	
Monachoides incarnatus incarnatus (O. F. Müller, 1774)	
Trichia hispida (L., 1758)	
Trichia striolata abludens (Locard, 1888)	*Trichia striolata* C. Pfeiffer, 1828
Zenobiella subrufescens (Miller, 1822)	*Perforatella subrufescens*
Lauriidae	**(Pupillidae)**
Lauria cylindracea (Da Costa, 1778)	
Leiostyla anglica (Wood, 1828)	
Limacidae	

Lehmannia marginata (O. F. Müller, 1774)	
Lehmannia valentiana (A. Férussac, 1822)	
Limacus flavus (L., 1758)	*Limax flavus*
Limacus maculatus Kaleniczenko, 1851	*Limax maculatus*
Limax cineroniger Wolf, 1803	
Limax maximus L., 1758	
Lymnaeidae	
Galba truncatula (O. F. Müller, 1774)	*Lymnaea truncatula*
Lymnea stagnalis (L., 1758)	
Myxas glutinosa (O. F. Müller, 1774)	
Omphiscola glabra (O. F. Müller, 1774)	*Lymnaea glabra*
Radix auricularia auricularia (L., 1758)	*Lymnaea auricularia*
Radix balthica (L., 1758)	*Lymnaea peregra* in Kerney, 1999, *Radix peregra* in Falkner *et al.* 2001b
Stagnicola corvus (Gmelin, 1791)	*
Stagnicola palustris (O. F. Müller, 1774)	*Lymnaea palustris*
Milacidae	
Milax gagates (Draparnaud, 1801)	
Tandonia budapestensis (Hazay, 1880)	
Tandonia rustica (Millet, 1843)	
Tandonia sowerbyi (A. Férussac, 1823)	
Otinidae	
Otina ovata (Th. Brown, 1827)	
Oxychilidae	**(Zonitidae)**
Aegopinella nitidula (Draparnaud, 1805)	
Aegopinella pura (Alder, 1830)	
Nesovitrea hammonis (Ström, 1765)	*Perpolita hammonis* in Falkner *et al.*, 2001b
Oxychilus alliarius (Miller, 1822)	
Oxychilus cellarius (O. F. Müller, 1774)	
Oxychilus draparnaudi (Beck, 1837)	

Oxychilus navarricus helveticus (Blum, 1881)	
Patulidae	**(Discidae)**
Discus rotundatus (O. F. Müller, 1774)	
Physidae	
Aplexa hypnorum (L., 1758)	
Physa fontinalis (L., 1758)	
Physella gyrina (Say, 1821)	*
Planorbidae	**(Ancylidae)**
Ancylus fluviatilis O. F. Müller, 1774	
Anisus septemgyratus (O. F. Müller, 1774)	*
Anisus spirorbis (L., 1758)	*Anisus leucostoma* Millet, 1813
Anisus vortex (L., 1758)	
Bathyomphalus contortus (L., 1758)	
Gyraulus albus (O. F. Müller, 1774)	
Gyraulus crista (L., 1758)	
Gyraulus laevis (Alder, 1838)	
Hippeutis complanatus (L., 1758)	
Planorbarius corneus (L., 1758)	
Planorbis carinatus (O. F. Müller, 1774)	
Planorbis planorbis (L., 1758)	
Pristilomatidae	**(Zonitidae)**
Vitrea contracta (Westerlund, 1871)	
Vitrea crystallina (O. F. Müller, 1774)	
Punctidae	
Punctum pygmaeum (Draparnaud, 1801)	
Pupillidae	
Pupilla muscorum (L., 1758)	
Pyramidulidae	
Pyramidula umbilicata (Montagu, 1803)	*Pyramidula rupestris* (Draparnaud, 1801)

Succineidae

Oxyloma elegans elegans (Risso, 1826) *Oxyloma pfeifferi* (Rossmässler, 1835)

Quickella arenaria (Potiez & Michaud, 1835) *Catinella arenaria* Bouchard Chantereaux (1837)

Succinea putris (L., 1758)

Succinella oblonga (Draparnaud, 1801) *Succinea oblonga*

Testacellidae

Testacella haliotidea Draparnaud, 1801

Testacella maugei A. Férussac, 1819

Testacella scutulum J. Sowerby, 1820

Valloniidae

Acanthinula aculeata (O. F. Müller, 1774)

Spermodea lamellata (Jeffreys, 1830)

Vallonia costata (O. F. Müller, 1774)

Vallonia excentrica Sterki, 1893

Vallonia pulchella (O. F. Müller, 1774)

Vertiginidae

Columella aspera Waldén, 1966

Columella edentula (Draparnaud, 1805)

Vertigo angustior Jeffreys, 1830

Vertigo antivertigo (Draparnaud, 1801)

Vertigo geyeri Lindholm, 1925

Vertigo lilljeborgi (Westerlund, 1871)

Vertigo moulinsiana (Dupuy, 1849)

Vertigo pusilla O. F. Müller, 1774

Vertigo pygmaea (Draparnaud, 1801)

Vertigo substriata (Jeffreys, 1833)

Vitrinidae

Semilimax pyrenaicus (A. Férussac, 1821)

Vitrina pellucida (O. F. Müller, 1774)

Class BIVALVIA

Order Unionoida

Dreissenidae

Dreissena polymorpha polymorpha (Pallas, 1771)

Margaritiferidae

Margaritifera margaritifera durrovensis Phillips, 1928 *

Margaritifera margaritifera margaritifera (L., 1758)

Sphaeriidae

Musculium lacustre (O. F. Müller, 1774)

Pisidium amnicum (O. F. Müller, 1774)

Pisidium casertanum (Poli, 1791)

Pisidium conventus Clessin, 1877

Pisidium henslowanum (Sheppard, 1823)

Pisidium hibernicum Westerlund, 1894

Pisidium lilljeborgii Clessin, 1886

Pisidium milium Held, 1836

Pisidium moitessierianum Paladilhe, 1866

Pisidium nitidum Jenyns, 1832

Pisidium obtusale (Lamarck, 1818)

Pisidium personatum Malm, 1855

Pisidium pseudosphaerium J. Favre, 1927

Pisidium pulchellum Jenyns, 1832

Pisidium subtruncatum Malm, 1855

Sphaerium corneum (L., 1758)

Unionoidae

Anodonta anatina anatina (L., 1758)

Anodonta cygnaea cygnaea (L., 1758)

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LEPIDOPTERA IN 1997 AT KILCOLMAN NATIONAL NATURE RESERVE, CO. CORK, IRELAND

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Summary

1997 was, unfortunately, a very poor year for insects, on account of the poor weather during the summer, in particular the cold, wet June. 301 species of Lepidoptera were recorded: 246 macro-moths, 41 micro-moths and 14 butterflies. The total list for Kilcolman now stands at 367 (256 macro-moths, 94 micro-moths and 17 butterflies).

The first Irish record of *Ypsolopha mucronella* (Scopoli) (Yponomeutidae) and the second Irish record of *Euchromius ocellea* (Haworth) (Pyralidae) both occurred in February 1998.

Introduction

Kilcolman National Nature Reserve is a 53hectare fen near Buttevant in north Co. Cork (in the vice-county of East Cork). The fen has developed in an impervious clay-lined basin overlaying limestone bedrock. The water level within the basin is determined primarily by rainfall, with water exiting *via* a swallow-hole (the sluggara) at the south end of the basin. In the winter the sluggara becomes waterlogged and the fen floods.

The combination of topography and hydrology has resulted in the development of a topogenous mire, i.e. a basin peat-land where there is little obvious water through-flow. Due to its relatively circum-neutral pH (5.2-6.6), measured over 93 stations throughout the fen in August 1992, Kilcolman can be classified as rich fen (Morgan, 1992).

Nine main habitats within the reserve were defined by the Base-line survey in 1992 (Morgan, 1992), and these are listed below. The reserve is surrounded by agricultural land, mainly pasture.

(i) Woodland and scrub (a variety of species including Scots pine *Pinus sylvestris*, willow *Salix* spp., alder *Alnus glutinosa*, birch *Betula* spp., ash *Fraxinus excelsior* and sycamore *Acer pseudoplatanus*);

(ii) Hedgerows and shelterbelts (including hawthorn *Crataegus monogyna* and blackthorn *Prunus spinosa*);

(iii) Neutral dry grassland (in the southwest corner of the fen);

(iv) Marsh/marshy grassland (with purple moor-grass *Molinia caerulea*, meadowsweet *Filipendula ulmaria* or soft rush *Juncus effusus* dominant);

(v) Tall herb/ruderal (isolated patches of introduced species);

(vi) Fen (the majority of the reserve);

(vii) Swamp (dominated by reed canary grass *Phalaris arundinacea*);

(viii) Inundation vegetation (the margins of the fen, subject to large seasonal fluctuations in water level);

(ix) Open water (scattered, small, permanent ponds).

About 270 species of plant have been recorded at the reserve (O'Mahony, 1992; Shaw, 1997), with botanical surveys largely concentrating on the fen itself; the plant species occurring in the other habitats will greatly increase this number.

The non-avian fauna of the reserve has only been studied since 1989, although there were some casual records, particularly of mammals, prior to this. The base-line survey and the employment of wardens through the summer have expanded the knowledge of the reserve, though there is still much to be learned. Lepidoptera are one of the better-studied groups; all moth-trapping prior to 1997 is shown in Table 1.

TABLE 1. Moth-trapping prior to 1997.

Dates	Recorder	Trapping	Reference
Aug 1989	K.G.M.Bond	One night with MV trap	Bond (1990)
Sept 1990 - Dec 1991	J. Evans	Extensive trapping with Heath Trap	Bond (1992)
June-Aug 1992	K.G.M.Bond	Four nights with MV trap	Bond (1992)
Sept 1994 - Dec 1995	P. Holt	Extensive trapping with Heath Trap	Holt (1996)

The total number of species recorded by the above was 263, with 73 species of "micro-moths" (this group largely ignored to date) and 190 species of "macro-moths".

Butterflies were also recorded by the above (also Shaw, 1997) with 17 species in total recorded at the reserve.

The weather of 1997

The weather obviously plays an important part in the surveying of an area, affecting both the insects themselves and influencing trapping and recording. The data summarised in Table 2 covers the period 12 March to 28 November (the trapping period) and is a very general summary of the overall conditions.

TABLE 2. Summary of weather conditions in 1997.

Notes: [1]All measurements made on-site, and therefore not official figures; [2]97mm fell continuously from 3-5 August; [3]Including a total of 95mm on just four, separate, days.

Period	summary	typical wind	typical temps. (°C)[1] min	max	rainfall[1] (mm)
12 March - 4 May	Mild and Dry	SW	3-10	13-18	43
5 - 14 May	Cold and Wet	NW	0-5	10-14	26.5
15 May - 2 June	Warm and Dry	E	6-10	18-23	6
3 June - 6 July	Cold and Wet	NW	7-11	15-18	90.5
7 July - 2 Aug	Warm and Dry	SW	10-13	19-24	44
3 - 22 Aug	Hot and Wet	SE	13-16	20-24	118.5[2]
23 Aug - 22 Oct	Mild and Dry	SW	9-13	15-18	145.5[3]
23 Oct - 28 Nov	Mild and Wet	variable	5-8	10-14	132

Moths

Methodology

The majority of recording was carried out using a Skinner moth-trap, with a 125watt Mercury-vapour bulb. This trap was always situated in the northeast corner of the reserve, on the drive behind the Observatory, and was operated on most suitable nights from March to November (a total of 122 nights). It was on from dusk until dawn, when it was closed before any moths escaped (and before any birds arrived). On a few occasions it was turned off during the night, due to rain. Note that a variable number of moths attracted to the light do not enter the trap, but remain settled elsewhere in the vicinity. As many of these as possible were found, but inevitably some would be missed, proportionately more on busy nights.

A portable Heath Trap with a blue bulb was also used on 11 nights between April and August and on two nights in November. It was usually positioned on the edge of the fen under the pine trees along the East Ride, but was also used in the shelterbelt on the north side of the lake and by the back pond/dairy walls.

All moths in the traps were placed into a dust-bin, which was left in a shady place, with the lid slightly ajar, thus letting moths escape in their own time, whilst preventing birds access. The bin was usually left *circa* 200m from the trap site, so that moths did not go straight back in the following night.

Casual records were also collected during everyday work on the reserve. Day-flying (or disturbed) individuals and specimens attracted to lighted windows were noted and fence posts were regularly checked.

Identification was checked, where necessary, using Skinner (1984) for macro-moths, and Goater (1986) for pyralids.

Results

Totals of 246 species of macro-moth, 34 species of pyralid and seven others were recorded. All species are listed in Appendix 1, together with the dates recorded (usually first and last dates of each generation), the total number of specimens caught and the maximum single catch. A few species recorded in early 1998 are also included, as are ten species recorded previously, but not in 1997.

The total number of species now recorded at Kilcolman (as at March 2nd 1998) stands at 350: 256 macro-moths and 94 micro-moths.

Most abundant species

The most abundant species are listed in Table 3. The order in which they are ranked is a function of four factors: total number caught, maximum single catch, average number caught during the flight period and the total number of nightly appearances. This allows a more favourable comparison between species flying at different times of the year, when the amount of trapping may be substantially different.

TABLE 3. The 40 most abundant species recorded at Kilcolman in 1997.

Rank	Species	Total	Maximum	1991 Rank (Bond, 1992)
1	Large Yellow Underwing	1949	237	7
2	Small Square-spot	1369	244	11
3	Hebrew Character	1362	147	3
4	Common Rustic	929	170	4
5	Common Quaker	536	84	
6	Buff Ermine	545	59	10
7	Clouded Drab	398	53	
8	Riband Wave	401	48	
9	*Agriphila tristella*	221	75	
10	Bright-line Brown-eye	496	32	13
11	Lesser Broad-bordered Yellow Underwing	336	38	9
12	Garden Tiger	232	51	2
13	Early Grey	230	43	
14	Dark Arches	331	35	8
15	Flame Carpet	344	36	
16	Muslin Moth	241	32	
17	Common Carpet	353	30	
18	Smoky Wainscot	259	26	6
19	*Crambus pascuella*	150	55	
20	*Agriphila straminella*	161	35	
21	*Eudonia mercurella*	215	25	
22	White Ermine	283	19	5
23	*Dipleurina lacustrata*	196	25	
24	Brimstone	249	29	
25	Elephant Hawk-moth	249	23	
26	Common Marbled Carpet	270	18	
27	Square-spot Rustic	133	31	
28	Poplar Hawk-moth	251	19	
29	*Evergestis pallidata*	154	25	
30	Green Carpet	173	19	18
31	The Flame	147	22	
32	Burnished Brass	156	17	17
33	Rosy Rustic	136	14	12
34	Early Thorn	134	13	
35	Heart & Dart	128	15	16
36	Flame Shoulder	138	11	21
37	Grey Pine Carpet	119	14	
38	Straw Dot	107	12	
39	Small Fan-footed Wave	89	15	
40	Brussels Lace	101	12	

Table 3 includes every species represented by more than 100 individuals. The majority of species listed are very common and widespread in Ireland. Of interest are the relatively large numbers of Elephant Hawk-moth (feeds on willowherb *Epilobium* spp., bedstraws *Galium* spp., *Fuchsia* etc.) and Brussels Lace (feeds on lichen growing on oak *Quercus* spp., blackthorn and old fences (Skinner, 1984).

These results are not really comparable to those from 1991, as different equipment was used (Heath Trap in 1991, Skinner Trap in 1997). The trap designs are different, but more importantly they use different bulbs with differing attraction. Thus the top species in 1991, oblique carpet, had a total of 301. Interestingly, although this species totalled only 89 in 1997, the top catch of 11 occurred in the Heath Trap.

Notable species

One species was recorded as new to Ireland: the yponomeutid *Ypsolopha mucronella*. A single specimen was attracted to the observatory outside light on the night of 8 February 1998. The species is found locally in southern Britain, and overwinters as an adult. The foodplant is spindle *Euonymus europaeus*, which has not been noted at the reserve. The moth is not a migratory species.

A single female *Euchromius ocellea* taken at Mercury-vapour light on the night of 18 February 1998 was the second Irish record (the first occurring in the 1930's). This rare migrant pyralid occurred during a spell of warm southerly winds coming directly from north Africa. Other migrants at around the same time included Scarce Bordered Straw, Dark Sword-grass and a total of 26 Rush Veneers (this immigration being in complete contrast to the whole of 1997!).

A specimen of the tortrix *Tortricodes alternella* was also taken at light on 18 February 1998. This species, which flies in February/March, has been recorded in only three Irish vice-counties, all in the east of the country.

Table 4 lists the species recorded which are considered to be uncommon or local in Ireland, or specifically associated with fens (Ken Bond, pers. comm.).

TABLE 4. Irish status and foodplants of notable moth species recorded at Kilcolman.

Notes. [1] Bond (1992), [2] Agassiz and Langmaid (1992)

Species	**Irish status**	**foodplant(s)**
Rhigognostis incarnatella[1, 2]	Rare	Dame's-violet *Hesperis matronalis* and other crucifers
Crambus scoticus[1]	Rare	unknown (grasses)
Agriphila selasella[1]	Fen species	various grasses
Catoptria margaritella	Local	unknown (moss and grass)
Donacaula mucronellus[1]	Fen species	sedges
Eudonia pallida[1]	Fen species	mosses/lichens
Evergestis pallidata	Fen species	Cruciferae
Ebulea crocealis	Local	Irish fleabane *Inula salicina* and Ploughman's spikenard *I. conyzae*
Trachycera advenella	Local	Hawthorn and *Sorbus* species
Dioryctria abietella	Local	Scots pine and other conifers
Lesser Cream Wave *Scopula immutata*[1]	Fen species	Meadowsweet, Valerian *Valeriana officinalis*
Oblique Carpet *Orthonama vittata*[1]	Fen species	Bedstraws *Galium* species
Pine Carpet *Thera firmata*	Local	Pines
Barred Rivulet *Perizoma bifaciata*[1]	Local	Red bartsia *Odontites verna*
Chimneysweeper *Odezia atrata*	Local	Pignut *Conopodium majus*
Latticed Heath *Semiothisa clathrata*[1]	Local	Leguminosae
Lilac Beauty *Apeira syringaria*	Increasing	Honeysuckle *Lonicera periclymenum*, Privet *Ligustrum* species, Ash *Fraxinus excelsior*
Oak Beauty *Biston strataria*	Local	Various trees
Early Moth *Theria primaria*	Local	Hawthorn, Blackthorn
Round-winged Muslin *Thumatha senex*[1]	Fen species	Lichens, mosses
Double Dart *Graphiphora augur*[1]	Local	Various trees
The Campion *Hadena rivularis*	Coastal	*Silene* and *Lychnis* spp.
Chamomile Shark *Cucullia chamomillae*	Coastal	Mayweeds, chamomiles
The Sprawler *Brachionycha sphinx*[1]	Local	Various trees
The Miller *Acronicta leporina*[1]	Local	Trees, mainly birch *Betula* species
Small Clouded Brindle *Apamea unanimis*[1]	Local fen sp.	Grasses including *Phalaris arundinacea*
Marbled Minor *Oligia strigilis*[1]	Uncertain	Grasses
Silver Hook *Deltote uncula*[1]	Fen sp.	Sedges and coarse grasses

Butterflies

Methodology

Two transects were carried out, weather permitting, once in each ten-day period (i.e. three times a month, or as near as possible). One transect, set up in 1995 (Holt, 1996) ran from the observatory, along the drive to the East Ride, and then to the East Hide. In 1997, the transect was divided into eight sections, each of approximately 50m length, and butterflies were recorded in each. The sections are defined in Appendix 2.

The second transect ran along the west edge of the fen and around the raised neutral grassland. It consisted of ten compartments, each of approximately 50m in length. These are defined in Appendix 2. (n.b. the spring water level in 1997 was extremely low; the west edge of the fen may not be traversable in a "normal" year). Butterflies were also recorded during everyday work on the reserve.

Results

Fourteen species were recorded in 1997. They are listed in Appendix 1, with first and last dates (of each brood, where possible) and peak counts (except for Painted Lady, where the total number of individuals is given).

Transect results are shown in Tables 5 (east transect) and 6 (west transect). The breakdown of records by compartment for both transects is shown in Table 7.

TABLE 5. Butterfly transect results for the east transect.

Speckled Wood and Green-veined White were the most numerous species throughout. Orange-tip was common in spring and Red Admiral in August, otherwise the remaining species were recorded only in very small numbers.

Month:	April			May			June			July		August				Sep
Species Date:	11	22	30	16	24	30	9	16	29	7	16	2	9	15	24	5
Wood White					1	3										
Large White				1		1		1					1			1
Small White				1												
Green-veined White	4	10	9	4	1	4	1	1			4	6	5	6		2
Orange-tip	5	8	5	4	1	1										
Common Blue						1										
Red Admiral									1			4	7	5		
Painted Lady														1		
Small Tortoiseshell			1	1											1	
Peacock		2		1										1	1	
Speckled Wood	2	6	3	2	9	15	11	7	1	1		6	7	19	29	20
Meadow Brown										2	3	4				
Ringlet										3	1	1				

TABLE 6. Butterfly transect results for the west transect. Eight of the 12 species were recorded in good numbers during their respective seasons.

Month:	Apr	May			June			July			August			Sep
Species Date:	26	13	19	26	5	14	21	4	17	28	8	17	30	9
Wood White		1	7	3	4	3	2							
Large White			1	1	1									
Green-veined White	30	19	21	8	1				4	4	15	12	2	
Orange-tip	20	10	11	4										
Small Copper		4	6	1						10	14	10	2	
Common Blue												2	1	
Red Admiral													1	
Small Tortoiseshell								2	2	3	5	2	5	1
Peacock											3	3		
Speckled Wood	4	1	1		3	1	1				1	15	10	7
Meadow Brown						3	4	28	20	6	6			
Ringlet							3	17	14	3				

TABLE 7. Records of butterflies in each section of the transects.

	East transect								West transect									
	drive			East Ride					fen edge						grassland			
Compartments:	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	9	10
Wood White				1	1	1		1		1		9	5	4				1
Large White	2			1	1			1			2		1					
Small White						1												
Green-veined White	16	7	1	5	11	7	5	5	12	7	13	17	8	9	22	10	7	11
Orange-tip	1	5		1	2	4	7	4	2	3	5	3	9	6	8	3	2	4
Small Copper									11	8	3	10	9		1		2	3
Common Blue								1	1			2						
Red Admiral	13	1		2		1					1							
Painted Lady	1																	
Small Tortoiseshell	1			1				1		1		5	8	1	1	2	1	1
Peacock	3			1				1		1			3					2
Speckled Wood	10	13	19	10	19	15	18	34	7	8	9	2	10	8				
Meadow Brown	1			1		3	2	2	8	6	5	8	16	7	4	8	1	4
Ringlet				4				1	4	9	10	11	1	1				1

In Table 7, Red Admiral and Speckled Wood showed a strong preference for the East transect over the West. Most Red Admirals were recorded on the buddleia *Buddleja davidii* on section 1 of the East transect, whilst the dappled light-and-shade along most of the drive and the east ride is the preferred habitat of the Speckled Wood.

The West transect supported larger numbers of Wood White, Small Copper, Small Tortoiseshell, Meadow Brown and Ringlet than did the East transect. This is because the western edge of the fen is a more stable, natural habitat, rich in the herbs and grasses that are the foodplants for these species. Such plants are largely missing from the drive and the East Ride (which would be dominated by gorse *Ulex europaeus*, if left uncontrolled). The western edge is also sheltered from the prevailing southwest winds, whilst receiving sunlight for most of the day - an ideal combination for Butterflies.

The west edge was notably the stronghold for both Wood White and Small Copper (although both were recorded from all parts of the reserve during the course of the year). Both main foodplants, meadow vetchling *Lathyrus pratensis* and common sorrel *Rumex acetosa* respectively, were very common there.

The scarcity of both Large and Small Whites genuinely reflected their status during the year. The main Common Blue colony was found at the limestone hollow/cave area, with its distinct flora including an abundance of the main foodplant, bird's-foot trefoil *Lotus corniculatus*. Only a few wandering individuals were seen elsewhere on the reserve, generally at the end of the flight periods.

Discussion

1997 was unfortunately a very poor year for insects on account of the generally unfavourable weather conditions during the summer.

The spring weather was generally extremely good, and the early part saw impressive numbers of the four commonest spring moth species (Hebrew Character, Common Quaker, Clouded Drab and Early Grey all appearing in the top 13 most abundant species for the year). The good weather also saw early emergences for many species, e.g. Orange-tip from 7 April. There was something of a set-back in early May, with very cold conditions, exemplified by the Clouded Silver which chose to rest on the Observatory on 4 May and did not move again until 12 May!

However, the latter half of May saw very high temperatures and there were some exceptionally early appearances, such as Meadow Brown from 28th.

The most telling period of the year appeared to be the cold, wet June. Although the weather was better during July, three days of continuous rain in early August again had a visible effect on diurnal species (eg. no Ringlets seen after the rain). A comparison of East Ride transect results for the last three years (shown in Appendix 3) underlines the effect that the weather had, with particularly Large White, Green-veined White and Small Tortoiseshell showing huge reductions in summer populations. It may be that moths never really recovered either, although there are no comparable data (and species such as Small Square Spot and Large Yellow Underwing were not in short supply). Inevitably some species will have been under-represented, some to the point of absence.

Migration was virtually non-existent (it was far more evident in February 1998!), although this is of little consequence in a site survey such as this. Several species were recorded which will have wandered from nearby habitats, particularly heathland species (eg. Narrow-winged Pug and Grey Scalloped Bar).

Of note are the flight periods of White-spotted Pug clearly showing two generations - there is some ambiguity about this in the literature (Riley and Prior, 1990). A noticeable feature of Common Carpet was that the first generation were very evident during the day, but infrequent at light, whilst the reverse was true for the second generation.

There is much more further study that could be undertaken. Almost all light trapping to date has been at the northeast corner of the reserve, actually hidden from the fen by a fence. Trapping at other localities within the reserve would increase the variety of species recorded, e.g. the western edge (see butterfly results), the willow scrub at the south end, the limestone hollow/cave area, the gorse-dominated East Ride, etc. In particular, micro-moths have been largely ignored - further study of this group would undoubtedly turn up species of interest.

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APPENDIX 1. Lepidoptera.

All species of pyralid moth, macro-moth and butterfly recorded in 1997 are listed. For completeness, the 13 species recorded previously but not seen in 1997 are included (together with the year of the first record). For the full list of "micro-moths" so far recorded at Kilcolman, see Bond (1992). Only ten species of micro-moth (other than pyralids) are included here (seven of which are new to the list), although the totals are given for the number recorded in each family.

Species numbers follow Bradley and Fletcher (1979) with amendments, whilst nomenclature follows Leraut (1997).

For each species the first and last date recorded (of each generation, where appropriate) is given, followed in parentheses by the total number of individuals and the maximum single catch at light (if > 1). For species represented by three or fewer single specimens in any generation, all dates are given.

Totals generally include all specimens at light (Mercury-vapour and Actinic) and other odd records, e.g. found at rest or disturbed during the day, attracted to lighted windows etc. However, for some species (marked with an asterisk*) only those at light are counted, with day-flying individuals ignored. For exclusively day-flying species, totals are not given.

Notes (in the list): [1] Note that genitalia were not examined; [2] The generations may have overlapped, and the split may be somewhat arbitrary, although it corresponds to a lull between two peaks.

Hepialidae (4)

14	Ghost Moth *Hepialus humuli* (Linnaeus, 1758)	June 2 - July 19	(8, 2)
16	Gold Swift *Phymatopus hecta* (Linnaeus, 1758)	June 8 - July 9	(up to 10)
17	Common Swift *Korscheltellus lupulinus* (Linnaeus, 1758)	not recorded (1992)	
18	Map-winged Swift *K. fusconebulosa* (DeGeer, 1778)	June 1 - July 8	(13, 2)
		Oct 5	

Gracillariidae (2)

288	*Caloptilia stigmatella* (Fabricius, 1781)	March 20	

APPENDIX 1 (continued)

Yponomeutidae (4)			
451	*Ypsolopha mucronella* (Scopoli, 1763)	Feb 8, 1998	
464	Diamond-back Moth *Plutella xylostella* (Linnaeus, 1758)	May 31; June 28-July 9 (5)	
		Aug 8 - Sept 26	(7, 2)
Chimabachidae (7)			
663	*Diurnea fagella* (Denis & Schiffermüller, 1775)	March 12 - 25	(6, 2)
Tortricidae (26)			
937	*Agapeta hamana* (Linnaeus, 1758)	July 6 - Aug 8	(20, 6)
938	*A. zoegana* (Linnaeus, 1767)	Aug 2, 12	(3, 2)
1025	*Tortricodes alternella* (Denis & Schiffermüller, 1775)	Feb 18, 1998	
1048	Garden Rose Tortrix		
	Acleris variegana (Denis & Schiffermüller, 1775)	Aug	
1234	*Pammene regiana* (Zeller, 1849)	July	
Alucitidae (1)			
1288	Many-plume Moth *Alucita hexadactyla* Linnaeus, 1758	March 11 - May 13	(up to 5)
		Aug 12 - Sept 24	
Pyralidae (36)			
1289	*Euchromius ocellea* (Haworth, 1811)	Feb 18, 1998	
1293	*Chrysoteuchia culmella* (Linnaeus, 1758)	June 9 - July 18	(7, 2)
1294	*Crambus pascuella* (Linnaeus, 1758)	June 28 - Aug 11	(150, 55)
1297	*C. uliginosellus* Zeller, 1850	July 6	
1301	*C. lathoniellus* (Zincken, 1817)	June 25	
1302	*C. perlella* (Scopoli, 1763)	July 7 - 27	(22, 5)
		Oct 4	
1303	*Agriphila selasella* (Hübner, 1813)	July 22 - Aug 12	(16, 7)
1304	*A. straminella** (Denis & Schiffermller, 1775)	July 10 - Aug 30	(161, 35)
1305	*A. tristella** (Denis & Schiffermüller, 1775)	July 18 - Aug 30	(221, 75)
1309	*A. geniculea* (Haworth, 1811)	Aug 14, 17	
1314	*Catoptria margaritella* (Denis & Schiffermüller, 1775)	June 29 - July 19	(17, 6)
1330	*Donacaula mucronellus* (Denis & Schiffermüller, 1775)	July 7 - 27	(7, 2)

APPENDIX 1 (continued)

1332	*Scoparia subfusca* Haworth, 1811	not recorded (1991)	
1334	*S. ambigualis* (Treitschke, 1829)[1]	July 5 - Aug 8	(6, 2)
1336	*Witlesia pallida* (Curtis, 1827)	July 7, 10	(3, 2)
1338	*Dipleurina lacustrata* (Panzer, 1804)	June 28 - Aug 9	(196, 25)
1340	*Eudonia truncicolella* (Stainton, 1849)[1]	July 25	
1342	*E. angustea* (Curtis, 1827)	Sept 3 - Oct 15	(25, 5)
1343	*E. delunella* (Stainton, 1849)	July 21	
1344	*E. mercurella* (Linnaeus, 1758)	July 6 - Sept 8	(215, 25)
1345	Brown China-mark *Elophila nymphaeata* (Linnaeus, 1758)	July 5 - Aug 30	(28, 4)
1350	Beautiful China-mark *Nymphula nitidulata* (Hufnagel, 1767)	June 11 - Aug 2	(15, 2)
1356	Garden Pebble *Evergestis forficalis* (Linnaeus, 1758)	June 2 - July 27	(17, 3)
1358	*E. pallidata* (Hufnagel, 1767)	July 4 - Aug 14	(154, 25)
1376	Small Magpie *Eurrhypara hortulana* (Linnaeus, 1758)	May 26 - July 25	(43, 6)
1378	*Phlyctaenia coronata* (Hufnagel, 1767)	June 9 - July 25	(26, 7)
1385	*Ebulea crocealis* (Hübner, 1796)	July 10	
1388	*Udea lutealis** (Hübner, 1809)	June 25 - Aug 22	(45, 6)
1390	*U. prunalis* (Denis & Schiffermüller, 1775)	July 8 - Aug 14	(68, 8)
1392	*U. olivalis* (Denis & Schiffermüller, 1775)	June 6 - July 22	(27, 6)
1395	Rusty-dot Pearl *U. ferrugalis* (Hübner, 1809)	May 17, 18	
		Aug 9 - Sept 5	(7, 2)
		Oct 10 -Nov 28	(9, 5)
1398	Rush Veneer	March 12	
	Nomophila noctuella (Denis & Schiffermüller, 1775)	July 7 - Aug 1	(4)
		Feb 14 - 24, 1998	(26, 13)
1405	Mother of Pearl *Pleuroptya ruralis* (Scopoli, 1763)	July 7 - Aug 22	(46, 8)
1428	Bee Moth *Aphomia sociella* (Linnaeus, 1758)	July 8 - 25	(15, 5)
		Aug 24, Sept 8	
1439	*Trachycera advenella* (Zincken, 1818)	July 22 - Aug 14	(23, 6)
1454	*Dioryctria abietella* (Denis & Schiffermüller, 1775)	June 28 - Aug 11	(4)

Pieridae (7)

1541	Wood White *Leptidea reali* Reissinger[1]	May 13 - June 21	(up to 12)

APPENDIX 1 (continued)

1545	Clouded Yellow *Colias crocea* (Geoffroy, 1785)	not recorded (1992)	
1546	The Brimstone *Gonopteryx rhamni* (Linnaeus, 1758)	not recorded (1992)	
1549	Large White *Pieris brassicae* (Linnaeus, 1758)	May 1 - June 17	(up to 3)
		July 8 - Sept 7	(up to 6)
1550	Small White *P. rapae* (Linnaeus, 1758)	May 16 - Sept 27	(up to 5)
1551	Green-veined White *P. napi* (Linnaeus, 1758)	April 9 - June 17	(up to 50)
		July 4 - Oct 12	(up to 50)
1553	Orange-tip *Anthocharis cardamines* (Linnaeus, 1758)	April 7 - June 2	(up to 40)
Lycaenidae (2)			
1561	Small Copper *Lycaena phlaeas* (Linnaeus, 1761)	May 11 - June 9	(up to 13)
		July 28 - Sept 1	(up to 15)
		Sept 27	
1574	Common Blue *Polyommatus icarus* (Rottemburg, 1775)	May 24 - June 12	(up to 18)
		Aug 8 - Sept 3	(up to 8)
Nymphalidae (5)			
1590	Red Admiral *Vanessa atalanta* (Linnaeus, 1758)	March 16 - June 29	(up to 2)
		July 28 - Nov 10	(up to 10)
1591	Painted Lady *Cynthia cardui* (Linnaeus, 1758)	Aug 15 - Sept 23	(5)
1593	Small Tortoiseshell *Aglais urticae* (Linnaeus, 1758)	March 4 - Oct 18	(up to 12)
1597	The Peacock *Inachis io* (Linnaeus, 1758)	March 30 - May 16	(up to 2)
		July 31 - Sept 1	(up to 6)
1608	Silver-washed Fritillary *Argynnis paphia* (Linnaeus, 1758)	not recorded (1991)	
Satyridae (3)			
1614	Speckled Wood *Pararge aegeria* (Linnaeus, 1758)	April 7 - July 7	(up to 20)
		July 21 - Oct 10	(up to 50)
1626	Meadow Brown *Maniola jurtina* (Linnaeus, 1758)	May 28 - Aug 20	(up to 42)
1629	The Ringlet *Aphantopus hyperantus* (Linnaeus, 1758)	June 21 - Aug 2	(up to 23)
Lasiocampidae (1)			
1631	December Moth *Poecilocampa populi* (Linnaeus, 1758)	Nov 25 - 27	(4, 2)

APPENDIX 1 (continued)

Saturniidae (1)			
1643	Emperor Moth *Eudia pavonia* (Linnaeus, 1758)	April 1, 11, 30	
Drepanidae (1)			
1651	Chinese Character *Cilix glaucata* (Scopoli, 1763)	April 29, May 17, 26	
		July 25 - Aug 20	(37, 8)
Thyatiridae (3)			
1652	Peach Blossom *Thyatira batis* (Linnaeus, 1758)	May 26 - July 20	(12, 2)
1653	Buff Arches *Habrosyne pyritoides* (Hufnagel, 1766)	June 11 - July 17	(15, 2)
1657	Common Lutestring *Ochropacha duplaris* (Linnaeus, 1761)	June 30, July 8, 10	
Geometridae (101)			
1663	March Moth		
	Alsophila aescularia (Denis & Schiffermüller, 1775)	March 11 - April 9	(22, 5)
1665	Grass Emerald *Pseudoterpna pruinata* (Hufnagel, 1767)	July 7 - 21	(7, 2)
1666	Large Emerald *Geometra papilionaria* (Linnaeus, 1758)	July 7 - Aug 1	(8, 2)
1669	Common Emerald *Hemithea aestivaria* (Hübner, 1789)	July 7 - 25	(21, 8)
1674	Little Emerald *Jodis lactearia* (Linnaeus, 1758)	May 26 - June 27	(4)
1692	Lesser Cream Wave *Scopula immutata* (Linnaeus, 1758)	July 7 - 25	(10, 3)
1702	Small Fan-footed Wave *Idaea biselata* (Hufnagel, 1767)	July 9 - Aug 20	(89, 15)
1708	Single-dotted Wave *I. dimidiata* (Hufnagel, 1767)	July 4 - Aug 20	(88, 10)
1713	Riband Wave *I. aversata* (Linnaeus, 1758)	June 16 - Aug 14	(401, 48)
1715	Plain Wave *I. straminata* (Borkhausen, 1794)	not recorded (1991)	
1719	Oblique Carpet* *Orthonama vittata* (Borkhausen, 1794)	May 26 - July 7	(42, 11)
		July 27 - Sept 9	(47, 8)
1722	Flame Carpet* *Xanthorhoe designata* (Hufnagel, 1767)	April 13 - July 10[2]	(144, 10)
		July 18 - Oct 5	(200, 36)
1724	Red Twin-spot Carpet		
	X. spadicearia (Denis & Schiffermüller, 1775)	April 29; Aug 11	
1725	Dark-barred Twin-spot Carpet *X. ferrugata* (Clerck, 1759)	April 25 - May 27	(4)
		July 19 - Aug 22	(21, 5)

APPENDIX 1 (continued)

1727	Silver-ground Carpet*		
	X. montanata (Denis & Schiffermüller, 1775)	May 12 - June 17	(77, 10)
1728	Garden Carpet *X. fluctuata* (Linnaeus, 1758)	May 2 - July 19	(12)
		Aug 5 - Sept 25	(16, 2)
1732	Shaded Broad-bar*		
	Scotopteryx chenopodiata (Linnaeus, 1758)	July 18 - Aug 22	(80, 11)
1733	Lead Belle *S. mucronata* (Scopoli, 1763)[1]	May 26	(3)
1734	July Belle *S. luridata* (Hufnagel, 1767)[1]	July 10	
1738	Common Carpet* *Epirrhoe alternata* (Müller, 1764)	April 17 - June 30[2]	(41, 5)
		July 4 - Sept 21	(312, 30)
1742	Yellow Shell *Camptogramma bilineata* (Linnaeus, 1758)	June 17 - Aug 14	(6)
1746	Shoulder Stripe		
	Anticlea badiata (Denis & Schiffermüller, 1775)	March 15 - May 18	(14)
1747	The Streamer *A. derivata* (Denis & Schiffermüller, 1775)	March 31 - April 25	(7, 2)
1748	Beautiful Carpet *Mesoleuca albicillata* (Linnaeus, 1758)	June 8 - July 22	(8)
1750	Water Carpet		
	Lampropteryx suffumata (Denis & Schiffermüller, 1775)	April 7 - June 2	(46, 6)
1752	Purple Bar *Cosmorhoe ocellata* (Linnaeus, 1758)	July 19 - Aug 22	(8, 2)
1755	The Chevron *Eulithis testata* (Linnaeus, 1761)	July 25	
1758	Barred Straw *E. pyraliata* (Denis & Schiffermüller, 1775)	June 29 - Aug 2	(90, 13)
1760	Red-green Carpet *Chloroclysta siterata* (Hufnagel, 1767)	March 29, April 6, 22	
		Sept 24 - Nov 27	(15, 2)
1761	Autumn Green Carpet *C. miata* (Linnaeus, 1758)	Oct 14, 17, 18	
1762	Dark Marbled Carpet *C. citrata* (Linnaeus, 1761)	July 17 - Aug 29	(15, 2)
1764	Common Marbled Carpet* *C. truncata* (Hufnagel, 1767)	May 14 - June 30	(85, 12)
		Aug 12 - Oct 30	(185, 18)
1766	Blue-bordered Carpet		
	Plemyria rubiginata (Denis & Schiffermüller, 1775)	July 18, 21, Aug 15	
1767	Pine Carpet *Thera firmata* (Hübner, 1822)	Sept 22 - Oct 18	(11, 4)
1768	Grey Pine Carpet *T. obeliscata* (Hübner, 1787)	April 30 - July 13	(26, 4)
		Aug 15 - Nov 14	(96, 14)
1769	Spruce Carpet *T. britannica* (Turner, 1925)	May 16 - July 10	(10, 3)
		Aug 20 - Nov 27	(11, 3)

APPENDIX 1 (continued)

1773	Broken-barred Carpet		
	Electrophaes corylata (Thunberg, 1792)	May 17 - June 12	(6, 2)
1776	Green Carpet* *Colostygia pectinataria* (Knoch, 1781)	May 14 - July 9	(136, 19)
		Aug 29 - Sept 26	(37, 8)
1777	July Highflyer *Hydriomena furcata* (Thunberg, 1784)	June 30 - Aug 22	(17, 3)
1778	May Highflyer *H. impluviata* (Denis & Schiffermüller, 1775)	May 31	
1779	Ruddy Highflyer *H. ruberata* (Freyer, 1831)	May 26	
1794	Sharp-angled Carpet *Euphyia unangulata* (Haworth, 1809)	June 17 - Aug 2	(47, 6)
1795	November Moth		
	Epirrita dilutata (Denis & Schiffermüller, 1775)	Oct 15 - Nov 14	(14, 4)
1797	Autumnal Moth *E. autumnata* (Borkhausen, 1794)	Oct 5 - 30	(39, 12)
	Epirrita spp.[1] (including those specifically identified)	Oct 4 - Nov 14	(83, 21)
1799	Winter Moth *Operophtera brumata* (Linnaeus, 1758)	Nov 26 - Jan 2	(29, 14)
1803	Small Rivulet *Perizoma alchemillata* (Linnaeus, 1758)	July 7 - 22	(16, 6)
1804	Barred Rivulet *P. bifaciata* (Haworth, 1809)	Aug 1	
1809	Twin-spot Carpet *P. didymata* (Linnaeus, 1758)	July 9 - Aug 1	(19, 5)
1811	Slender Pug *Eupithecia tenuiata* (Hübner, 1813)	July 21	
1817	Foxglove Pug *E. pulchellata* Stephens, 1831	July 18	
1819	Mottled Pug *E. exiguata* (Hübner, 1813)	May 16 - June 4	(18, 4)
1830	Wormwood Pug *E. absinthiata* (Clerck, 1759)	July 7 - 21	(6)
1834	Common Pug *E. vulgata* (Haworth, 1811)	April 26 - June 17	(64, 9)
1835	White-spotted Pug *E. tripunctaria* (Herrich-Schäffer, 1852)	April 9 - May 31	(30, 5)
		July 19 - Aug 17	(21, 3)
1837	Grey Pug *E. subfuscata* (Haworth, 1809)	May 16 - July 7	(45, 7)
1840	Shaded Pug *E. subumbrata* (Denis & Schiffermüller, 1775)	June 29	
1846	Narrow-winged Pug *E. nanata* (Hübner, 1813)	Aug 11, 12, 14	
1849	Ash Pug *E. fraxinata* Crewe, 1863	July 21	
1851	Golden-rod Pug *E. virgaureata* Doubleday, 1861	July 20 - Aug 12	(16, 4)
1853	Oak-tree Pug *E. dodoneata* Guenée, 1857	April 25 - May 26	(20, 5)
1857	Dwarf Pug *E. tantillaria* Boisduval, 1840	April 30 - May 26	(12, 4)
1858	The V-pug *Chloroclystis v-ata* (Haworth, 1809)	April 1 - June 2	(10)
		June 28 - Aug 7	(17, 2)

APPENDIX 1 (continued)

1860	Green Pug *C. rectangulata*(Linnaeus, 1758)	June 12 - July 22	(19, 3)
1862	Double-striped Pug *Gymnoscelis rufifasciata* (Haworth, 1809)	March 15 - April 30	(24, 9)
		June 17 - July 22	(28, 5)
		Aug 22, 24, 30	
		Feb 24, 1998	
1870	Chimneysweeper *Odezia atrata* (Linnaeus, 1758)	June 3 - 29	(up to 5)
1879	The Seraphim *Lobophora halterata* (Hufnagel, 1767)	May 16	
1883	Yellow-barred Brindle *Acasis viretata* (Hübner, 1799)	March 29 - May 26	(6)
		July 22 - Aug 14	(6, 2)
1884	The Magpie *Abraxas grossulariata* (Linnaeus, 1758)	July 8 - Aug 14	(36, 6)
1887	Clouded Border *Lomaspilis marginata* (Linnaeus, 1758)	May 17 - Aug 14	(79, 7)
1888	Scorched Carpet *Ligdia adustata* (Denis & Schiffermüller, 1775)	May 27	
1893	Tawny-barred Angle *Macaria liurata* (Clerck, 1759)	May 31 - July 22	(32, 4)
1894	Latticed Heath *Chiasmia clathrata* (Linnaeus, 1758)	April 25 - July 13	(42, 4)
		Aug 15	(2)
1902	Brown Silver-line *Petrophora chlorosata* (Scopoli, 1763)	April 25 - June 17	(21, 4)
1904	Scorched Wing *Plagodis dolabraria* (Linnaeus, 1767)	May 17 - 27	(8, 3)
1906	Brimstone Moth *Opisthograptis luteolata* (Linnaeus, 1758)	April 29 - June 30[2]	(114, 29)
		July 5 - Sept 26	(135, 10)
1907	Bordered Beauty *Epione repandaria* (Hufnagel, 1767)	July 27 - Aug 20	(10, 2)
1910	Lilac Beauty *Apeira syringaria* (Linnaeus, 1758)	June 23	
1912	August Thorn *Ennomos quercinaria* (Hufnagel, 1767)	Aug 1 - Sept 28	(29, 5)
1913	Canary-shouldered Thorn *E. alniaria* (Linnaeus, 1758)	Aug 7 - Oct 5	(44, 5)
1917	Early Thorn *Selenia dentaria* (Fabricius, 1775)	March 12 - April 1	(39, 11)
		May 14	
		July 6 - Aug 12	(94, 13)
1920	Scalloped Hazel *Odontopera bidentata* (Clerck, 1759)	April 17 - June 14	(45, 8)
1921	Scalloped Oak *Crocallis elinguaria* (Linnaeus, 1758)	July 13 - Aug 20	(64, 9)
1922	Swallow-tailed Moth *Ourapteryx sambucaria* (Linnaeus, 1758)	June 29 - July 22	(46, 10)
1923	Feathered Thorn *Colotois pennaria* (Linnaeus, 1761)	Oct 5 - Nov 28	(30, 6)

APPENDIX 1 (continued)

1926	Pale Brindled Beauty	
	Apocheima pilosaria (Denis & Schiffermüller, 1775)	March 15
1930	Oak Beauty *Biston strataria* (Hufnagel, 1767)	March 11 - April 12 (5)
1931	Peppered Moth *Biston betularia* (Linnaeus, 1758)	April 25 - July 10 (45, 5)
1934	Dotted Border *Larerannis marginaria* (Fabricius, 1777)	March 12 - April 1 (10, 3)
1935	Mottled Umber *Erannis defoliaria* (Clerck, 1759)	Nov 24
1937	Willow Beauty	
	Peribatodes rhomboidaria (Denis & Schiffermüller, 1775)	June 19 - Aug 9 (13, 2)
1941	Mottled Beauty *Alcis repandata* (Linnaeus, 1758)	May 31 - July 25 (73, 6)
1945	Brussels Lace *Cleorodes lichenaria* (Hufnagel, 1767)	June 4 - Aug 14 (101, 12)
	Ectropis spp.	April 10, 11, 22
1948	Small Engrailed	
	E. crepuscularia (Denis & Schiffermüller, 1775)	May 2, 9
1954	Bordered White *Bupalus piniaria* (Linnaeus, 1758)	June 11 - Aug 7 (24, 7)
1955	Common White Wave *Cabera pusaria* (Linnaeus, 1758)	May 17 - Aug 17 (57, 6)
1956	Common Wave *C. exanthemata* (Scopoli, 1763)	May 15 - Aug 29 (39, 6)
1958	Clouded Silver	
	Lomographa temerata (Denis & Schiffermüller, 1775)	April 13 - June 12 (54, 15)
1960	Early Moth *Theria primaria* (Haworth, 1809)	Feb 15, 17, 1998
1961	Light Emerald *Campaea margaritata* (Linnaeus, 1767)	June 11 - Aug 1 (31, 3)
1962	Barred Red *Hylaea fasciaria* (Linnaeus, 1758)	June 8 - July 20 (11, 2)
1969	Grey Scalloped Bar *Dyscia fagaria* (Thunberg, 1784)	May 26

Sphingidae (4)

1972	Convolvulus Hawk-moth *Agrius convolvuli* (Linnaeus, 1758)	Sept 21
1981	Poplar Hawk-moth *Laothoe populi* (Linnaeus, 1758)	April 30 - Aug 7 (251, 19)
1984	Hummingbird Hawk-moth	
	Macroglossum stellatarum (Linnaeus, 1758)	not recorded (1995)
1991	Elephant Hawk-moth *Deilephila elpenor* (Linnaeus, 1758)	May 25 - Aug 9 (249, 23)

Notodontidae (10)

1994	Buff-tip *Phalera bucephala* (Linnaeus, 1758)	May 16 - July 25 (45, 4)

APPENDIX 1 (continued)

1995	Puss Moth *Cerura vinula* (Linnaeus, 1758)	April 12, 29, May 28	
1997	Sallow Kitten *Furcula furcula* (Clerck, 1759)	May 31, June 14	
2000	Iron Prominent *Notodonta dromedarius* (Linnaeus, 1767)	May 27, July 7; Aug 20	
2003	Pebble Prominent *Eligmodonta ziczac* (Linnaeus, 1758)	April 30 - Aug 14	(46, 3)
2006	Lesser Swallow Prominent *Pheosia gnoma* (Fabricius, 1777)	May 17 - 30	(5)
		July 25, Aug 22	
2007	Swallow Prominent *P. tremula* (Clerck, 1759)	July 10 - Aug 11	(6, 2)
2008	Coxcomb Prominent *Ptilodon capucina* (Linnaeus, 1758)	June 11 - Aug 20	(47, 9)
2011	Pale Prominent *Pterostoma palpina* (Clerck, 1759)	April 30 - June 15	(12)
		Aug 15	
2015	Lunar Marbled Brown *Drymonia ruficornis* (Hufnagel, 1766)	April 1 - May 17	(5)

Lymantriidae (2)

2026	The Vapourer *Orgyia antiqua* (Linnaeus, 1758)	Sept 3 - 23	(4)
2028	Pale Tussock *Calliteara pudibunda* (Linnaeus, 1758)	April 29 - June 17	(42, 7)

Arctiidae (11)

2035	Round-winged Muslin *Thumatha senex* (Hübner, 1808)	July 7 - 22	(10, 3)
2038	Muslin Footman *Nudaria mundana* (Linnaeus, 1761)	June 28 - July 20	(17, 4)
2039	Red-necked Footman *Atolmis rubricollis* (Linnaeus, 1758)	June 7, July 8	
2050	Common Footman *Eilema lurideola* (Zincken, 1817)	July 10 - Aug 7	(24, 5)
2051	Four-spotted Footman *Lithosia quadra* (Linnaeus, 1758)	July 8 - Aug 7	(7, 2)
2057	Garden Tiger *Arctia caja* (Linnaeus, 1758)	July 7 - Aug 15	(232, 51)
2060	White Ermine *Spilosoma lubricipeda* (Linnaeus, 1758)	May 1 - July 22	(281, 19)
		Aug 7, 30	
2061	Buff Ermine *S. luteum* (Hufnagel, 1766)	May 15 - July 10	(545, 59)
2063	Muslin Moth *Diaphora mendica* (Clerck, 1759)	April 23 - June 1	(241, 32)
2064	Ruby Tiger *Phragmatobia fuliginosa* (Linnaeus, 1758)	July 25	
2069	Cinnabar *Tyria jacobaeae* (Linnaeus, 1758)	April 30 - May 15	(7, 3)

Noctuidae (118)

2078	Least Black Arches *Nola confusalis* (Herrich-Schäffer, 1847)	April 26 - May 26	(10, 3)

APPENDIX 1 (continued)

2089	Heart & Dart *Agrotis exclamationis* (Linnaeus, 1758)	June 12 - Aug 2	(128, 15)
2091	Dark Sword-grass *A. ipsilon* (Hufnagel, 1766)	March 31 - June 8	(19, 4)
		July 5 - Aug 20	(10, 2)
		Feb 24, 1998	
2098	The Flame *Axylia putris* (Linnaeus, 1761)	May 16 - July 25	(144, 22)
		Sept 24, 26, Oct 4	
2102	Flame Shoulder *Ochropleura plecta* (Linnaeus, 1761)	May 17 - July 25	(133, 11)
		Aug 12 - 20	(5, 3)
2107	Large Yellow Underwing *Noctua pronuba* (Linnaeus, 1758)	June 8 - Sept 22	(1949, 237)
2109	Lesser Yellow Underwing *N. comes* (Hübner, 1809)	July 22 - Oct 17	(56, 8)
2111	Lesser Broad-bordered Yellow Underwing		
	N. janthina (Denis & Schiffermüller, 1775)	July 21 - Sept 27	(336, 38)
2112	Least Yellow Underwing *N. interjecta* Hübner, [1813]	Aug 7 - 14	(6, 2)
2114	Double Dart *Graphiphora augur* (Fabricius, 1775)	June 29 - July 20	(14, 3)
2118	True Lover's Knot		
	Lycophotia porphyrea (Denis & Schiffermüller, 1775)	July 8 - Aug 12	(24, 7)
2119	Pearly Underwing *Peridroma saucia* (Hübner, 1808)	July 20; Sept 8; Nov 27	
2120	Ingrailed Clay *Diasia mendica* (Fabricius, 1775)	July 17, 22	
2122	Purple Clay *D. brunnea* (Denis & Schiffermüller, 1775)	June 11 - July 22	(35, 4)
2123	Small Square-spot *D. rubi* (Vieweg, 1790)	April 29 - July 7	(311, 70)
		July 25 - Oct 22	(1057, 244)
		Nov 26-27	
2126	Setaceous Hebrew Character	June 12 - July 22	(4)
	Xestia c-nigrum (Linnaeus, 1758)	Sept 8 - Oct 25	(12, 2)
2128	Double Square-spot *X. triangulum* (Hufnagel, 1766)	June 17 - Aug 2	(57, 8)
2130	Dotted Clay *X. baja* (Denis & Schiffermüller, 1775)	July 22, 27, Aug 1	
2132	Neglected Rustic *X. castanea* (Esper, 1798)	not recorded (1995)	
2133	Six-striped Rustic *X. sexstrigata* (Haworth, 1809)	July 27 - Aug 15	(6, 2)
2134	Square-spot Rustic		
	X. xanthographa (Denis & Schiffermüller, 1775)	Aug 7 - Sept 18	(133, 31)
2139	Red Chestnut		
	Cerastis rubricosa (Denis & Schiffermüller, 1775)	April 1 - 23	(5)
2147	The Shears *Hada plebeja* (Linnaeus, 1761)	June 8, 19	

APPENDIX 1 (continued)

2150	Grey Arches *Polia nebulosa* (Hufnagel, 1766)	July 9 - 22	(8, 3)
2154	Cabbage Moth *Mamestra brassicae* (Linnaeus, 1758)	May 14, 30	
		July 25, Aug 2	
2155	Dot Moth *Melanchra persicariae* (Linnaeus, 1761)	May 31 - July 27	(74, 16)
2158	Pale-shouldered Brocade	April 30 - June 17	(62, 6)
	Lacanobia thalassina (Hufnagel, 1766)	Oct 15	
2160	Bright-line Brown-eye *L. oleracea* (Linnaeus, 1758)	May 13 - Aug 22	(493, 32)
		Sept 24, 25, 26	
2163	Broom Moth *Ceramica pisi* (Linnaeus, 1758)	May 25 - July 18	(15, 3)
2166	The Campion *Hadena rivularis* (Fabricius, 1775)	May 25 - 31	(7, 2)
		July 10, Aug 7, 17	
2173	The Lychnis *H. bicruris* (Hufnagel, 1766)	June 28	
2182	Small Quaker *Orthosia cruda* (Denis & Schiffermüller, 1775)	March 29 - April 14	(15, 3)
2186	Powdered Quaker *O. gracilis* (Denis & Schiffermüller, 1775)	March 29 - April 30	(32, 4)
2187	Common Quaker *O. cerasi* (Fabricius, 1775)	March 12 - May 2	(536, 84)
2188	Clouded Drab *O. incerta* (Hufnagel, 1766)	March 12 - May 17	(398, 53)
2189	Twin-spotted Quaker		
	O. munda (Denis & Schiffermüller, 1775)	March 23 - April 12	(16, 6)
2190	Hebrew Character *O. gothica* (Linnaeus, 1758)	March 12 - May 26	(1362,147)
2192	Brown-line Bright-eye		
	Aletia conigera (Denis & Schiffermüller, 1775)	July 22, 27	
2193	The Clay *A. ferrago* (Fabricius, 1787)	July 6 - 27	(19, 4)
2197	Southern Wainscot *A. straminea* (Treitschke, 1829)	July 25	
2198	Smoky Wainscot *A. impura* (Hübner, 1813)	June 29 - Aug 15	(259, 26)
2199	Common Wainscot *A. pallens* (Linnaeus, 1758)	June 11 - Aug 1	(47, 5)
		Sept 5 - Oct 14	(13, 3)
2205	Shoulder-striped Wainscot *Leucania comma* (Linnaeus, 1761)	June 29	
2214	Chamomile Shark		
	Cucullia chamomillae (Denis & Schiffermüller, 1775)	May 25	
2216	The Shark *C. umbratica* (Linnaeus, 1758)	May 30, July 5-27	(10, 3)
2225	Minor Shoulder-knot *Brachylomia viminalis* (Fabricius, 1777)	not recorded (1991)	
2227	The Sprawler *Brachionycha sphinx* (Hufnagel, 1766)	Nov 14	

APPENDIX 1 (continued)

2232	Black Rustic *Aporophyla nigra* (Haworth, 1809)	Sept 21 - Oct 30	(33, 7)
2236	Pale Pinion *Lithophane hepatica* (Clerck, 1759)	March 25 - April 16	(17, 3)
		Oct 14	
2241	Red Sword-grass *Xylena vetusta* (Hübner, 1813)	March 29, April 12	
		Sept 9, 22	
2243	Early Grey *Xylocampa areola* (Esper, 1789)	March 12 - May 15	(231, 43)
2245	Green-brindled Crescent		
	Allophyes oxyacanthae (Linnaeus, 1758)	Sept 24 - Oct 30	(55, 8)
2247	Merveille du Jour *Dichonia aprilina* (Linnaeus, 1758)	Oct 17, 18	
2256	The Satellite *Eupsilia transversa* (Hufnagel, 1766)	Oct 31	
2258	The Chestnut *Conistra vaccinii* (Linnaeus, 1761)	March 12 - April 7	(9, 3)
		Oct 14 - Nov 28	(31, 5)
2262	The Brick *Agrochola circellaris* (Hufnagel, 1766)	Oct 4 - Nov 6	(5)
2263	Red-line Quaker *A. lota* (Clerck, 1759)	Oct 4 - Nov 14	(41, 8)
2264	Yellow-line Quaker *A. macilenta* (Hübner, 1809)	Oct 25, 31, Nov 13	
2267	Beaded Chestnut *A. lychnidis* (Denis & Schiffermüller, 1775)	Sept 21 - Oct 30	(22, 4)
2269	Centre-barred Sallow *Atethmia centrago* (Haworth, 1809)	Aug 24, 30, Sept 4	
2273	Pink-barred Sallow *Xanthia togata* (Esper, 1788)	Aug 24 - Sept 27	(9, 2)
2278	Poplar Grey		
	Acronicta megacephala (Denis & Schiffermüller, 1775)	July 7 - 10	(4, 2)
2280	The Miller *A. leporina* (Linnaeus, 1758)	May 17, July 8	
2284	Grey Dagger *A. psi* (Linnaeus, 1758)[1]	May 29 - July 8	(6)
2289	Knot Grass *A. rumicis* (Linnaeus, 1758)	May 31 - July 21	(4)
2297	Copper Underwing *Amphipyra pyramidea* (Linnaeus, 1758)	Sept 4	
2299	Mouse Moth *A. tragopogonis* (Clerck, 1759)	not recorded (1991)	
2300	Old Lady *Mormo maura* (Linnaeus, 1758)	Aug 12	
2302	Brown Rustic *Rusina ferruginea* (Esper, 1785)	June 11	
2305	Small Angle Shades *Euplexia lucipara* (Linnaeus, 1758)	May 17 - July 6	(18, 3)
2306	Angle Shades *Phlogophora meticulosa* (Linnaeus, 1758)	June 1 - Aug 7	(7, 2)
		Aug 20 - Oct 31	(46, 12)
2318	The Dun-bar *Cosmia trapezina* (Linnaeus, 1758)	July 27 - Aug 8	(4, 2)

APPENDIX 1 (continued)

2321	Dark Arches *Apamea monoglypha* (Hufnagel, 1766)	June 13 - Aug 30 Sept 25	(330, 35)
2322	Light Arches *A. lithoxylaea* (Denis & Schiffermüller, 1775)	July 4 - 27	(18, 5)
2326	Clouded-bordered Brindle *A. crenata* (Hufnagel, 1766)	May 16 - July 5 Aug 1	(22, 3)
2327	Clouded Brindle *A. epomidion* (Haworth, 1809)	June 9, 17, July 6	
2330	Dusky Brocade *A. remissa* (Hübner, 1809)	June 13 - July 13	(12, 4)
2331	Small Clouded Brindle *A. unanimis* (Hübner, 1813)	May 13 - June 17	(56, 10)
2334	Rustic Shoulder-knot *A. sordens* (Hufnagel, 1766)	May 23 - June 9	(8, 2)
2336	Double-lobed *A. ophiogramma* (Esper, 1794)	June 23 - Aug 7	(64, 12)
2337	Marbled Minor *Oligia strigilis* (Linnaeus, 1758)[1]	May 26 - June 23	(5, 3)
2338	Rufous Minor *O. versicolor* (Borkhausen, 1792)[1]	June 11 - July 22	(10)
2339	Tawny Marbled Minor *O. latruncula* (Denis & Schiffermüller, 1775)[1]	June 9 - July 27	(52, 5)
2340	Middle-barred Minor *O. fasciuncula* (Haworth, 1809)	May 26 - July 10	(4)
2343x	'Common Rustic' *Mesapamea secalis* (Linnaeus, 1758) or *M. didyma* (Esper, 1788)[1]	July 5 - Aug 30	(929, 170)
2345	Small Dotted Buff *Chortodes minima* (Haworth, 1809)	July 18	
2350	Small Wainscot *P. pygmina* (Haworth, 1809)	July 21 - Sept 4	(30, 6)
2353	Flounced Rustic *Luperina testacea* (Denis & Schiffermüller, 1775)	Aug 8 - Sept 8	(23, 8)
2361	Rosy Rustic *Hydraecia micacea* (Esper, 1789)	July 25 - Oct 22	(136, 14)
2364	Frosted Orange *Gortyna flavago* (Denis & Schiffermüller, 1775)	Sept 5 - 26	(9, 2)
2367	Haworth's Minor *Celaena haworthii* (Curtis, 1829)	Aug 1 - Sept 27	(16, 2)
2368	The Crescent *C. leucostigma* (Hübner, 1808)	Aug 1 - Oct 5	(21, 6)
2369	Bulrush Wainscot *Nonagria typhae* (Thunberg, 1784)	Aug 8 - Sept 25	(7, 3)
2375	Large Wainscot *Rhizedra lutosa* (Hübner, 1803)	Sept 24, 28	
2379	Small Rufous *Coenobia rufa* (Haworth, 1809)	not recorded (1995)	
2381	The Uncertain *Hoplodrina octogenaria* (Goeze, 1781)	June 28 - July 25	(19, 7)
2382	The Rustic *H. blanda* (Denis & Schiffermüller, 1775)	July 7 - 25	(12, 3)
2387	Mottled Rustic *Caradrina morpheus* (Hufnagel, 1766)	June 14 - July 17	(7)

APPENDIX 1 (continued)

2389	Pale Mottled Willow *Paradrina clavipalpis* (Scopoli, 1763)	June 11 - July 21	(7, 2)
		Sept 24 - Oct 5	(5, 3)
2400	Scarce Bordered Straw		
	Helicoverpa armigera (Hübner, 1808)	Feb 14, 1998	
2410	Marbled White Spot *Protodeltote pygarga* (Hufnagel, 1766)	May 31 - July 25	(6)
2412	Silver Hook *Deltote uncula* (Clerck, 1759)	May 26	
2425	Nut-tree Tussock *Colocasia coryli* (Linnaeus, 1758)	May 16 - 31	(4, 2)
2434	Burnished Brass *Diachrysia chrysitis* (Linnaeus, 1758)	June 4 - Aug 15	(154, 17)
		Sept 21, 24	
2439	Gold Spot *Plusia festucae* (Linnaeus, 1758)	May 26 - Aug 1	(34, 4)
		Aug 12 - Sept 18	(19, 6)
2441	Silver Y *Autographa gamma* (Linnaeus, 1758)	May 13, 31	
		July 21 - Aug 20	(10, 2)
		Sept 25 - Nov 1	(13, 3)
2442	Beautiful Golden Y *A. pulchrina* (Haworth, 1809)	June 13 - Aug 8	(9, 2)
2443	Plain Golden Y *A. jota* (Linnaeus, 1758)	June 30 - Aug 7	(25, 4)
2444	Gold Spangle *A. bractea* (Denis & Schiffermüller, 1775)	July 20, 25	
2449	Dark Spectacle *Abrostola triplasia* (Linnaeus, 1758)	May 26 - Aug 20	(62, 7)
2450	The Spectacle *A. tripartita* (Hufnagel, 1766)	May 15 - Aug 2	(69, 6)
2469	The Herald *Scoliopteryx libatrix* (Linnaeus, 1758)	April 7 - May 30	(10)
		July 22, Aug 20	
2474	Straw Dot* *Rivula sericealis* (Scopoli, 1763)	June 17 - Aug 7	(106, 12)
		Sept 26	
2476	Beautiful Snout *Hypena crassalis* (Fabricius, 1787)	not recorded (1991)	
2477	The Snout *H. proboscidalis* (Linnaeus, 1758)	June 14 - Aug 11	(96, 14)
2489	The Fan-foot *Herminia tarsipennalis* (Treitschke, 1835)	June 11 - Aug 14	(29, 6)
2492	Small Fan-foot *H. grisealis* (Denis & Schiffermüller, 1775)	May 17 - July 25	(16, 3)

APPENDIX 2. Definition of butterfly transect compartments.

East Transect	Section	West Transect
Observatory to entrance by the beech hedge	**1**	G3 fence to bramble
to hawthorn on drive side of wall	**2**	to irises meeting fence
to entrance to East Ride	**3**	to corner of fence
to fallen pine	**4**	to bush sticking out
to first gorse of main ride	**5**	to start of raised grassland
to clump of rushes in ride	**6**	to marking post
to second pine tree (behind the screen)	**7**	to marking post
to the hide	**8**	to small pond
(not applicable)	**9**	to marking post
(not applicable)	**10**	to isolated willow

APPENDIX 3. Butterfly transect results (East Ride) for 1995-97.

1997	April			May			June			July		Aug				Sept
Date:	11	22	30	16	24	30	9	16	29	7	16	2	9	15	24	5
Wood White					1	3										
Large White				1		1		1					1			1
Small White				1												
Green-veined White	4	10	9	4	1	4	1	1			4	6	5	6		2
Orange-tip	5	8	5	4	1	1										
Common Blue						1										
Red Admiral									1			4	7	5		
Painted Lady														1		
Small Tortoiseshell			1	1											1	
Peacock		2		1										1	1	
Speckled Wood	2	6	3	2	9	15	11	7	1	1		6	7	19	29	20
Meadow Brown										2	3	4				
Ringlet										3	1	1				

1996	May			June		July			Aug			Sept			Oct.	
Date:	3	14	27	14	21	12	19	27	3	13	21	9	19	25	10	17
Wood White																
Large White				2	1	2				2	8	3	1	2		
Small White				2	3	4	1		1	4	2	1	2			
Green-veined White	5	21	17	10	8	6	3	11	10	23	6	8	3	1		1
Orange-tip	1	4	3	2												
Common Blue								1								
Red Admiral					2	2			3	5	3	4	2	1		
Painted Lady					4						2	1				
Small Tortoiseshell		3	1			2	5	2	5	35		9	5	4	3	2
Peacock		1	1		1				1	8	1	3				
Speckled Wood	2	5	3	7	6	1	2		1	1	14	12	21	20	4	
Meadow Brown						2	2	2	3	5						
Ringlet						2	2	2	1	2						

1995	May		June		July		Aug				Sept			Oct
Date:	3	7	11	28	7	30	2	7	15	30	5	16	19	9
Wood White														
Large White					1	1	1		6	2	5	2		
Small White						1				1	1		2	
Green-veined White	16	12	7	4	6	28	14	24	16	13	3	2	1	
Orange-tip	1	1												
Common Blue														
Red Admiral					1	10	18	12	3	6	2	4	2	12
Painted Lady								1						1
Small Tortoiseshell						1	2		1	12	1	2		
Peacock							5							
Speckled Wood	3	7	2	7	4	9	11	14	6	32	24	12	15	1
Meadow Brown				1	1			1						
Ringlet						1								

Bull. Ir. biogeog. Soc. No. 25 (2001)

DISTRIBUTION RECORDS FOR UNCOMMON SPIDERS (ARANEAE) INCLUDING FIVE SPECIES NEW TO IRELAND

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Introduction

The appearance of van Helsdingen (1996a) has allowed easy access for anyone wishing to study the distribution of spiders in Ireland. The current list, including additions by van Helsdingen (1996b, 1997), Smith (1999), Snazell *et al.* (1999), and Nolan (2000a, b) stands at 387 species. This may seem like a large number, however comparison with the British spider list of 645 species, growing at an annual 1.5 species, and with an exceptional seven additions in 1999, would suggest that a considerable amount of work remains to be done. Few sites in Ireland have been thoroughly surveyed for spiders. The following note comprises records for uncommon spiders which, according to van Helsdingen (1996a) and more recent publications, have been recorded from four or fewer Irish counties. Five of the species involved, *Microctenonyx subitaneus* (O. P. - Cambridge), *Araneus sturmi* (Hahn), *Tegenaria agrestis* (Walckenaer), *Nigma puella* (Simon) and *Diaea dorsata* (Fabr.) have not previously been reported from Ireland. Nomenclature and sequence follows Merrett and Murphy (2000). Where names differ from those given by van Helsdingen (1996a), synonyms are also given, in brackets. The author has retained voucher specimens and these will eventually be deposited at the National Museum of Ireland. New county records are denoted by an asterisk (*).

Oonops domesticus **Dalmas, 1916**

CORK: Douglas Street, Cork City, W6771, 28 September 1999. Single female on the inside wall of an apartment. Occasional individuals subsequently noted at this site.

*SLIGO: Sligo Docks, G6836, 2 October 1994, sieved from debris collected in an old building.

Hyptiotes paradoxus **(C. L. Koch, 1834)**

*KERRY: Reenadinna Yew Wood, V955858, 23 August 2001. A small number of specimens, mostly immature, but including one adult male beaten from yew *Taxus*.

This fascinating spider, which is usually associated with yew, is otherwise known in Ireland only from Glengarriff, Co. Cork. Because of the scarcity of preferred habit, it is likely to be very rare in Ireland. Listed as rare in Britain by Bratton (1991).

***Steatoda grossa* (C. L. Koch, 1838)**

CORK: Cork Docks, W6871, 12 September 1999, under rubbish adjacent to old stone buildings.

*DUBLIN: Trinity College, Dublin City, O1634, 29 October 1999. Mature male on a wall.

*SLIGO: Sligo, G6935, 25 August 1999. Specimens noted on a number of subsequent occasions at this site, on the inside and outside walls of a house.

***Steatoda nobilis* (Thorell, 1875)**

*CORK: Eglington Street, Cork City, W6871, 29 August 2000. One male on a low wall. A mature female noted on a house wall in a nearby street, July 2001.

Recently added to the Irish fauna by Nolan (2000a). The species has the potential to inflict a painful bite, as described by Warren *et al.* (1991).

***Theridion mystaceum* L. Koch, 1870**

*WEXFORD: Ballyhack, S7010, 20 May 2001. Male beaten from gorse *Ulex* on dry, heathy, hillside.

*SLIGO: Curry village, G4906, 29 May 2000. Single male on a house wall.

***Theridiosoma gemmosum* (L. Koch, 1877)**

*SLIGO: Doonweelin Lake, G6440, 28 May 2000. Single female in a lakeshore marsh.

*KILKENNY: Fiddown Island, S4619, 29 July 2001. Two females collected from the base of marsh vegetation, among willow *Salix*.

***Hylyphantes graminicola* (Sundevall, 1830)**

KILKENNY: Fiddown Island, S4619, 23 May 2001, beaten from marsh vegetation among willow *Salix*.

WATERFORD: Cheekpoint, S6713, 20 June 2001. Beaten from oak *Quercus* at the edge of mixed woodland, adjoining a saltmarsh.

***Hypomma fulvum* Bösenberg, 1902**

*SLIGO: Doonweelin Lake, G6440, 28 May 2000. One female under pieces of plastic in a lakeshore marsh; Feenagh Lake, G6912, 14 June 2000. One female beaten from rough lakeshore grassland.

Metopobactrus prominulus **(O. P. - Cambridge, 1872)**

*WATERFORD: Ballyvoyle Bridge, X3394, 13 July 2000. One male beaten from rough vegetation on an eroding sea cliff.

Pelecopsis parallela **(Wider, 1834)**

*CORK: Redbarn, Youghal, X0874, 14 September 2000. Males and females frequent under pieces of wood on a sandy foreshore.

*WATERFORD: Ferry Point, X1177, 8 November 2000, in moss on vegetated coastal shingle.

Tapinocyba pallens **(O. P. - Cambrige, 1872)**

*SLIGO: Carns, G7034, 5 January 2001, sieved from beech *Fagus* leaf litter in a mixed woodland.

*WATERFORD: Carricknabrone, S2421, 25 October 2000. One male sieved from leaf litter in a mixed deciduous/coniferous hillside woodland.

Tapinocyba insecta **(L. Koch, 1869)**

*SLIGO: Carns, G7034, 5 January 2001, sieved from beech *Fagus* leaf litter in mixed woodland.

Microctenonyx subitaneus **(O. P. Cambridge, 1875)**

CORK: Cobh, W7867, 12 August 2001. Single male sieved from debris collected in a cowshed.

New to Ireland. This small linyphiid is mostly confined to the south in Britain, where it is usually collected from hayshed debris.

Thyreosthenius parasiticus **(Westring, 1851)**

*WATERFORD: Loughaniska, X2996, 7 November 2000. Collected from wet, dead wood in mixed deciduous woodland.

*LEITRIM: Cornagillagh, N0687, 1 October 2000. Single female collected from dead pine *Pinus* on blanket bog.

Mecynargus morulus **(O. P. - Cambridge, 1873) (=** ***Rhaebothorax morulus*****)**

*SLIGO: Slievemore, Ben Bulben, G7144, 20 August 2000. One male beaten from low vegetation on the mountain summit.

Hilaira frigida **(Thorell, 1872)**

*SLIGO: Kings Mountain, G7044, 20 August 2000. One male under a stone, gravel exposure on the mountain summit.

Asthenargus paganus **(Simon, 1884)**

*WATERFORD: Carricknabrone, S2421, 25 October 2000. Single female sieved from leaf litter in mixed woodland.

Ostearius melanopygius **(O. P. - Cambridge, 1879)**

*CORK: Churchtown, W9173, 6 October 1999, sieved from debris collected in stone cowshed; Redbarn, Youghal, X0874, 24 June 2000. Single mature female among vegetation on a sandy foreshore.

*WEXFORD: The Raven, T1123, 28 July 1999. One specimen collected under a stone on a sandy foreshore.

*SLIGO: Grange, G6549, 11 October 1993, sieved from debris collected in an old cowshed / stable.

A comparatively recent addition to the Irish list, but now recorded from seven counties, and clearly widespread here. This is a very distinctive spider which must surely be a relatively recent arrival in Ireland.

Aphileta misera **(O. P. - Cambridge, 1882)**

*SLIGO: Doonweelin Lake, G6440, 28 May 2000. Single male sieved from damp moss at the edge of a common reed *Phragmites* swamp.

The presence of this species, together with *T. gemmosum* and *H. fulvum* suggests that Doonweelin supports an interesting community of wetland spiders. This site is already known to be of considerable zoological and botanical importance.

Taranucnus setosus **(O. P. - Cambridge, 1863)**

*CORK: Father Matthew Street, Cork City, W6771, 13 June 2001. Single male climbing on a house wall; Kennel, Ballyvergan, X0776, 25 June 2001. Female collected from among debris in a marsh.

Allomengea scopigera **(Grube, 1859)**

*WATERFORD: Ballynamuck, X2494, 26 September 1999. One female in a clump of rushes *Juncus* on the banks of the Colligan River.

***Araneus sturmi* (Hahn, 1831)**

Kerry: Reenadinna Yew Wood, V955858, 23 August 2001. Numerous near adult specimens beaten from yew *Taxus*. A second visit in late September revealed one female and numerous males, again all subadults. One male collected alive however reached maturity within a few days, allowing the species to be readily identified.

New to Ireland. Similar in general appearance to *Araneus triguttatus* (Fabr.), but unlike that species normally associated with evergreen trees. Said to be widely but locally distributed in Britain.

***Larinioides sclopetarius* (Clerck, 1757) (synonym *L. sericatus* (Clerck, 1757))**

*TIPPERARY: Clonmel, S1922, 16 October 2000. One male and one female, on the inside wall of a public house toilet. Also numerous immatures, one of which was raised to maturity, on railings along the River Suir.

***Neoscona adianta* (Walckenaer, 1802)**

WATERFORD: Muggorts Bay, X3087, 10 August 1999. Subadults beaten from gorse *Ulex* on coastal heath; Ballyvoyle Bridge, X3394, 13 July 2000. Subadults beaten from rough vegetation on sea bank.

***Mangora acalypha* (Walckenaer, 1802)**

CORK: Halfway, W5961, 22 May 2001. Females beaten from gorse *Ulex* on a dry hillside.

***Pardosa purbeckensis* F. O. P. - Cambridge, 1895**

*CORK: Belvelly, W7970, 17 June 2001. Frequent on bare ground and low vegetation in a saltmarsh.

*WATERFORD: Cheekpoint, S6713, 20 June 2001, frequent at the edge of a saltmarsh.

Treated as a variety of *P. agrestis* (Westring) by Roberts (1985) but retained as a separate species by Merrett and Murphy (2000), and this latter approach is followed here.

***Tegenaria saeva* Blackwall, 1844**

CORK: Bandon, W4954, 27 August 1995, under a stone on waste ground; Inchydoney, W4038, 16 May 2000, a small population present in a sand dune trench; Douglas Street, Cork City, W6771, 28 September 1999, wandering male trapped in a bath.

*WATERFORD: Mountcongreve, S5309, 5 October 1999. One specimen among grass growing on a dry stone wall. This record, and that from Inchydoney, suggest that *T. saeva* can survive away from the immediate vicinity of human habitations in the southern parts of Ireland.

***Tegenaria parietina* (Fourcroy, 1785)**

*CORK: Cork Docks, W6871, 12 September 1999. Single female under rubbish adjacent to an old stone building.

***Tegenaria agrestis* (Walckenaer, 1802)**

CORK: Ballyvolane, Cork City, W6873, 15 October 2000, under stones on an area of open waste ground. A fair number of females noted at this site, many with egg sacs.

New to Ireland. A typical site for this species which, unlike most *Tegenaria*, is usually found away from houses. Known to be increasing its range in Britain, and likely to turn up with increased frequency in Ireland, especially in urban waste ground sites.

***Hahnia helveola* Simon, 1875**

*WATERFORD: Carricknabrone, S2421, 25 October 2000. One female sieved from leaf litter in a mixed deciduous/coniferous hillside woodland.

***Nigma puella* (Simon, 1870)**

TIPPERARY: Caher Park Wood, S055224, 2 July 2000. Male beaten from rank vegetation on the east bank of River Suir. A second male was collected here in July 2001.

WEXFORD: Ballyhack, S7010, 16 July 2000. Female, with eggs, under a dead leaf on sloe *Prunus spinosa* L. in a hedgerow.

New to Ireland. This small but distinctive spider is said to be very local in Britain, and with a southern distribution.

***Scotina celans* (Blackwall, 1841)**

*CORK: Carrigshane Hill, W8973, 13 June 2001. Immatures sieved from moss collected from among exposed limestone.

***Liocranum rupicola* (Walckenaer, 1830)**

*WEXFORD: Ballyhack, S7010, 20 May 2001. Immatures among dry rubble and rock fragments on a low sea cliff.

***Clubiona subtilis* L. Koch, 1867**

*CORK: The Long Strand, Rosscarbery, W3234, 9 May 2001. Males and females under pieces of wood in the sand dunes.

Philodromus dispar **Walckenaer, 1826**

CORK: Cook Street, Cork City, W6771, 8 May 2001. Single male noted on a shop wall; Douglas Street, Cork City, W6771, 10 May 2001. Occasional males and females on the inside walls of an apartment; Belvelly, W7970, 17 June 2001. Male swept from vegetation adjacent to saltmarsh.

Diaea dorsata **(Fabricius, 1777)**

KERRY: Reenadinna Yew Wood, V955858, 23 August 2001. Numerous subadult specimens beaten from yew *Taxus*.

New to Ireland. This very distinctive crab-spider is usually associated with yew *Taxus* and oak *Quercus*. An uncommon spider with a southern distribution in Britain.

The presence of this species, together with *H. paradoxus* and *A. sturmi* suggests that Reenadinna is a site of considerable arachnological interest. The author is hopeing to carry out a more thorough study of the spiders of this fascinating and unique site, which represents the only native coniferous woodland of any size in Ireland.

Ozyptila sanctuaria **(O. P. - Cambridge, 1871) (=** ***Oxyptila sanctuaria*****)**

*KILKENNY: Lough Macask, S4957, 10 March 2001. Single female collected from moss on an old stone wall at the edge of a field.

Marpissa nivoyi **(Lucas, 1846)**

WATERFORD: Tramore Burrow, S6100, 16 August 2001. Females frequent in sand dunes, on marram *Ammophila* and under stones etc.

A single male collected by J. N. Halbert at this site constituted the first Irish record for this distinctive jumping spider (Pack-Beresford, 1909). *M. nivoyi* is regarded as being a rare spider, so I have included it in this account although recorded from five Irish counties.

Pseudeuophrys lanigera **(Simon, 1871) (=** ***Euophrys lanigera*****)**

*CORK: Douglas Street, Cork City, W6771, 13 August 1999, and subsequently. Individuals noted on the inside and outside walls of an apartment.

DUBLIN: Dominic Street, Dublin City Centre, O1534, 31 March 2000. One specimen on the inside wall of an apartment.

*SLIGO: St Patrick's Terrace, Sligo, G6935, 1 January 2000. Mature male climbing on the ceiling of an inside room. Noted during the course of New Year's Eve celebrations (!).

Only previously reported from Dublin, but clearly widespread in Ireland. Apparently associated with the upper echelons of buildings, including roofs.

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GEOGRAPHIC VARIATION IN LARVAE OF *BUFO CALAMITA* LAURENTI (ANURA: BUFONIDAE) IN THE REPUBLIC OF IRELAND

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Abstract

Bufo calamita Laurenti larvae from five different localities in Ireland, n = 20 each, were analyzed for 19 external morphological characters by means of descriptive and multivariate statistical analyses. A prioritized list of the variables best suited to be predictors of location was determined by a stepwise discriminant analysis. Correct assignment of tadpoles to locality by discriminant function analysis averaged 96.547%. Variables P-1 gap and P-3 length were most often missing, while developmental stage 28 was most common. Principal component analysis was used to determine which variables account for most of the variance in the data. Scanning electron micrographs and X-ray analysis of chemical elements of the oral apparatus were prepared. The effect of phenotypic plasticity on growth, developmental rates, size at metamorphosis, and length of larval period is discussed.

Key words: tadpoles, morphological variation, oral apparatus, phenotypic plasticity, Ireland.

Introduction

Three amphibian species are found in Ireland (smooth newt, *Triturus vulgaris* Linnaeus, 1758, common frog, *Rana temporaria* Linnaeus, 1758 and natterjack toad, *Bufo calamita* Laurenti, 1768). The toad has unquestionably generated the most attention from zoologists over time. Korky and Webb (1999) provided a primer on Irish populations that largely dealt with adult toads, but included observations on larval habitat preferences, behaviour, and morphology. They dealt with the species' past and present distribution of both natural and translocated populations, its provenance in Ireland, and steps for conservation. They concluded that a land bridge route from north-west England into Ireland thousands of years ago was the most plausible explanation of the ancestral origin based on available data. Rowe *et al.* (1998) examined the genetic diversity of British populations using microsatellite analysis that divided 40 sample sites into three regional clades. Their phylogeographic data supported a land bridge hypothesis from mainland Europe into Britain thousands of years ago, followed by subsequent genetic isolation. Beebee and Rowe (2000), using microsatellite analysis of Irish, British, and continental European populations, concluded derivation of all extant populations from a Pleistocene refugium in Iberia (Velez, south-east Spain) that involved a northward post-glacial expansion and subsequent isolation of land masses by rising sea level. Data analysis demonstrated the Kerry populations as most closely related genetically to the north-west England (Cumbria/Merseyside) clade, which were separated by inundation of a land-bridge about 10,000 years ago. Their conclusions are consonant with the scenario offered by Korky and Webb (1999).

The compendium of anuran larval characteristics of Altig and Johnston (1986) attributed the original description of tadpoles of *B. calamita* to Angel (1946). His limited morphological description noted only their red brown colour, total length of 20-30mm, and that they are the smallest tadpoles in all of Europe. No further larval observations or illustrations (notably the mouthparts) were provided. The best description of the tadpole is by Boulenger (1897), who provided a lateral view of the tadpole and an illustration of its oral disc with a labial tooth row formula (LTRF) of 2(2)/3. He later produced (1898) a lengthy discussion of the species taxonomy, adult morphology, osteology, behaviour, eggs, tadpole, and hybridization; his considerable description of the oral apparatus included mouth width, tooth rows and gaps, body pigmentation, and morphometric body measurements for the largest of several hundred specimens examined.

The purpose of this study is to:- (1) document geographic variation of 19 external morphological characters of larvae from five sites in Ireland (Co. Kerry) using descriptive statistics; (2) determine if larvae could be correctly assigned to a given site by discriminant function analysis using selected variables; (3) determine which variables were most critical in determining location by a discriminant function analysis with stepwise selection; (4) determine which variables account for the majority of the variance in the selected morphometric character states utilizing principal component analysis; (5) utilize a Hitachi S2460N scanning electron microscope (SEM) to provide electron micrographs of the oral disc, and X-ray microanalysis data of chemical elements in selected structures of the oral disc (teeth, jaws).

Materials and methods

Field activities during spawning in 1997 by one of us (JKK) resulted in the collection of 100 tadpoles (sample size n = 20) under license from five Kerry localities. The terms "larvae" and "tadpoles" are used interchangeably. Larvae were staged according to Gosner (1960). Descriptive features follow Altig (1970).

Larvae were seined with a mesh hand-net, and preserved in 10% buffered formalin. Larvae are in the custody of the senior author. Specimens will be placed in the systematic collection of the National Museum of Ireland, Dublin, at the conclusion of this study.

All morphometric variables were measured using binocular dissecting microscopes and ocular micrometers calibrated to the nearest 0.1mm.

Specimens for SEM study were prepared as a whole body mount for viewing external features and for X-ray microanalysis. They were post-fixed, dehydrated, and critical point dried from liquid CO_2. Dried specimens were sputter-coated with gold-palladium and examined using a Hitachi S2460N scanning electron microscope with a Princeton Gamma Tech (PGT) X-ray analysis system IMIX software (ver. 8.29).

Data analyses

Statistical procedures were performed with SAS for Windows (ver. 6.12). Descriptive statistical analysis utilized 19 variables for the pooled larvae, 20 for each of the five localities (n = 100), and separately for each locality (n = 20). Multivariate analyses were also utilized. Variables were tested for normality and several were found to have non-significant distributions. As a result, the non-parametric Kruskal-Wallis test was employed and P-values adjusted for Bonferonis inequalities. Also a discriminant function analysis with location as the single independent variable, produced a matrix showing the number of tadpoles that could be correctly or incorrectly assigned to a given locality. Further analysis was confined to the four localities (Lough Yganavan excluded), from which the majority of tadpoles (59 of 80) were in developmental stage 28, in order to eliminate differences due primarily to size differential related to stage. Also, the variables P-1 gap and P-3 length were eliminated from further analysis due to the large number of tadpoles lacking these features, 36 and 14, respectively. Additionally, a discriminant function analysis by stepwise selection with an entry and exit level of 0.15 determined the most important variables in discriminating between localities, and provided a prioritized list of such predictor variables based on partial correlation coefficients (r^2). Next, a principal component analysis was used to produce a data matrix for all 16 variables. This procedure generated principal components by use of a correlation matrix. Each component is a weighted linear function of the original variables that accounts for the maximum amount of variance remaining after all variance accounted for by preceding principal components has been removed. Lastly, the first and second principal components were tested for significant differences among locations with Kruskal-Wallis tests.

Localities and samples

The date of collection (all 1997) and brief habitat description of the five (Co. Kerry) localities are noted below (numbers refer to Figure 1). Additional information (pH, water and air temperatures, salinity, and other ecological factors) for each is provided in Korky and Webb (1999). Irish grid map reference and altitude are included for each site.

10. Castlegregory Golf Course at Stradbally, Q592137, 3m, 18 May. Interconnected man-made ponds among costal dunes on golf course developed from 1989-91. Habitat pictured in Figure 2.

3. Dooaghs Golf Links, V680944, 10-20m, 17 May. Shallow water hazards adjacent to fifteenth tee.

9. Dune Slacks North of Lough Gill, Q606152, 3-5m, 18 May. Shallow slacks among dunes inland of Brandon Bay. Habitat pictured in Figure 3.

7. Lough Naparka, Q623170, 4m, 18 May. Shallow bodies of water just inland of the eastern shore dunes on the peninsula.

1. Lough Yganavan, V705955, 11m, 16 May. Open lake with little emergent vegetation. Tadpoles seined along northeastern shore.

Results

Descriptive statistics

Table 1 shows the descriptive statistics for the pooled larvae (n = 100) from all five localities. Table 2 shows the descriptive statistics for each locality separately. Sample size (n) in both tables is less in some cases due to missing or damaged features, specifically, the variables P-1 gap, and P-3 length. The P-1 gap is present in 64 of 100 (64%) specimens, and P-3 length in 86 of 100 (86%), while 63 of 100 (63%) share common developmental stage 28. An undetermined amount of variance of the variables is attributable to sample size. A further discussion of variability is discussed below.

Table 3 displays the results of univariate analyses for 16 selected variables, with location as the single independent variable using the Kruskal-Wallis test with P values adjusted for Bonferoni's inequalities. Analysis was confined to four localities (Lough Yganavan excluded) with the variables P-1 gap and P-3 length eliminated (see Data Analyses). P values of 13 of 16 variables are significant.

Multivariate analyses

Table 4 shows the results of discriminant function analysis for assignment of larvae to a given locality. All larvae (100%) were correctly assigned to Castlegregory and Dooaghs, while 13 of 14 (92.86%) were assigned to Lough Gill, and 14 of 15 (93.33%) to Lough Naparka. The high percentage of larvae correctly assigned greatly exceeded what would occur by chance alone (1 of 4 probability, 25%). The average correct assignment for the four localities was 96.54% with a range of 92.86% to 100%.

Table 5 is a prioritized listing of the nine variables best suited to be predictors of location (see Data Analyses). Body dimensions as well as tooth row variables comprise the listing.

Table 6 shows the eigenvalues of the correlation matrix for principal components one through four that account for 83.4% of the cumulative variability of the data, and are size related. The first principal component axis (PC1) accounts for 54.3% of the variance. The second axis (PC2) individually accounts for 17.2% of the total variance, cumulative = 71.6%. The eigenvectors (= vector loadings) of PC1 through PC4 are listed in Table 7 relative to each of the 16 variables. They show PC1 was related to a combination of body dimension and tooth row variables, while PC2 was restricted to tooth row variables alone. We detected significant differences among locations with respect to PC1 and PC2 (Tables 8, 9).

Scanning electron microscopy

Figures 4, 6, and 7 show details of the oral disc and aspects of the papillary borders, tooth rows, and jaw sheaths. Figures 5 and 9 show morphological variation in labial teeth, and Fig. 8 details of the serrated upper jaw sheath.

Figure 9 shows variation in labial teeth of a locality 1 specimen at 3000X magnification, and that individual teeth may be moderately curved, short-cusped and non-cusped, or spatulate.

X-ray analysis

So far as we can determine this is the first time the X-ray analysis capability of a scanning electron microscope has been used to investigate the variability in chemical composition of keratinized features of the oral apparatus. In Figs 10 and 11 gold and palladium derived from the gold-palladium sputter coating process used in specimen preparation, have been removed.

Different chemical elements and frequencies in a labial tooth (Fig. 10, decreasing frequency of copper, sulfur, then calcium) and the upper jaw sheath (Fig. 11, calcium most frequent, then phosphorous) permit us to conclude that different keratinized structures from one oral apparatus have differing chemical compositions, and that further investigation in this area is warranted before broader conclusions can be drawn.

Discussion

Bufonids worldwide are a highly conserved group of 217 species regarding their larval morphology, and natterjacks in Ireland are unremarkable, other than exceptionally small total length (n = 100, mean = 12.825, range 10.2 - 17.4mm). Larvae are exotrophic-herbivorous, and lentic-benthic as recognized by Altig and Johnston (1989), McDiarmid and Altig (1999). As such they exhibit depressed, globular bodies, dorsal eyes with flattened corneas, low fins, reduced tail musculature, and an anteroventral oral apparatus. As we reported (1999) our field collected specimens were positively thermophilic, had jet black bodies, and tail fins with diffuse black flecks and dispersed orchid iridophores.

Equally conserved and predictable are the features of the oral apparatus. They exhibit the most common LTRF of 2/3 shown by Altig and Johnston (1989) to occur in 51% of 627 species surveyed. This formula has a balance value (BV) of −1, indicating more rows on the lower labium, and is associated with slow water current habitats of "pond forms" and reduced oral apparatus complexity. We suggest a LTRF for Co. Kerry larvae of 2(2)/3[1] indicative of two upper rows, a gap in A-2, 3 lower rows, with or without a gap in P-1. Although the function of tooth row gaps or their development controls have not been determined, they may increase the forward extension of jaws in abrasion-grazing feeding of a soil-mucilage-diatom mix off a substrate.

Altig and Johnston (1989) termed the 2/3 arrangement the prime formula, as it is the basis for more complex formulae larger than 2/3 by additions on the upper and lower labia. They determined the ontogenetic sequence of development to be A-1, P-2, P-1, A-2, P-3 during stages 22-24, and that after stages 25-26 the number and arrangement of tooth rows are stable and diagnostic of species. Oral atrophy is the reverse of ontogenetic gain: last attained (P-3), first lost (P-3). Our data (Table 1 and 2) confirm the presence or absence of the P-1 gap, and that of the P-3's reduced occurrence in some specimens of stage 27 or later as atrophy proceeds. Data also permit an assessment of variability of other larval traits within and between localities. Altig and McDiarmid (1999) noted that the understanding of oral ontogeny and atrophy is based on relatively few studies, and cautioned that the assumed tight correlation between oral development and the criteria used for staging is false. A multitude of factors have been shown to induce interspecific and intraspecific larval variation, and are too numerous to review here. Presumably, much of the variance of our data for body morphology and particularly oral apparatus, represents ecological specialization for efficient resource acquisition in their designated lentic-benthic environment. An unknown part of the variance probably is due to non-adaptive variation due to undetermined factors.

Perhaps foremost among factors known to effect larval morphology is the phenotypic plasticity that exists for growth and developmental rates. This is related to amphibian attempts to exploit two vastly different ecological universes by means of a dual phase life cycle: aquatic and terrestrial. Warkentin (1999) discussed the ontogenetic niche shift theory and "cost-benefit paradigm" related to plasticity. Alford (1999) also cogently discussed the topic of plasticity citing ecological models, as well as experiments with field collected and laboratory reared larvae. Harris (1999) extensively reviewed the topic also, with particular attention to the effect of changing food level relative to size at metamorphosis and length of larval period. His review of numerous models and live studies of anuran metamorphosis determined that developmental rate can respond to changes in growth rate early in the larval period (first 60%), but not later in the larval period. This period of sensitivity exists prior to stages 35-37. Thus, our specimens of this study are well within the sensitive period and plasticity is no doubt a major, but not quantified, factor in the variability of our data. Other environmental influences that may affect the variable characteristics used in this study were reviewed by Webb and Korky (1977).

Conclusion

Field collected larvae of *Bufo calamita* from Co. Kerry, Ireland, express typical bufonid, larval, external morphology, but are notable for their very small size. Larvae may be statistically distinguished by locality based on the variables of this study. Those variables which account for most of the variance in the data are identified.

Tadpoles exhibit the prime LTRF of 2(2)/3[1], with variables P-1 gap and P-3 length often missing. SEM analysis shows most labial teeth to be short-cusped, moderately curved, but non-cusped, spatulate teeth also occur. The upper jaw sheath is generally of medium width and wide arch, but some larvae display an M-shaped arch. The chemical composition and frequency of elements found in the labial teeth and serrated jaw sheaths differ. These larvae exhibit considerable phenotypic plasticity related to their metamorphic niche shift that results in adaptive and non-adaptive morphological variation.

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TABLE 1. Descriptive statistics of selected character states for pooled larvae of five localities showing: n = number of specimens; Mean = mean value; Median = median value; SD = one standard deviation; Range = minimum value-maximum value. Number of specimens (n) may vary owing to missing or damaged features. Developmental stage is shown by locality in Table 2. Measurements in mm.

Variable	n	Mean	Median	SD	Range
Body Length	100	5.572	5.1	1.02347	4-7.8
Tail Length	100	7.256	7	0.93423	5.7-9.6
Total Length	100	12.825	12.2	1.908216	10.2-17.4
Tail Height	100	2.612	2.5	0.502173	1.7-3.7
Tail Muscle Height	100	0.907	0.8	0.247515	0.5-1.5
Dorsal Fin Height	100	0.976	0.9	0.205539	0.5-1.4
Ventral Fin Height	100	0.893	0.9	0.189766	0.5-1.3
Interocular Distance	100	0.962	0.9	0.172785	0.7-1.5
Internarial Distance	100	0.730	0.7	0.107778	0.6-1.0
A-1 Length	100	0.955	0.9	0.190361	0.6-1.4
Left A-2 Length	100	0.385	0.4	0.05	0.3-0.5
Right A-2 Length	100	0.386	0.4	0.051286	0.3-0.5
A-2 Gap	100	0.298	0.3	0.063532	0.2-0.5
A-2 Gap Ratio	100	1.306	1.3	0.170454	0.8-2.0
P-1 Length	100	0.904	0.9	0.169324	0.6-1.2
P-1 Gap	64	0.114	0.1	0.039308	0.1-0.3
P-2 Length	100	0.78	0.7	0.203505	0.3-1.2
P-3 Length	86	0.382	0.4	0.097247	0.2-0.7

TABLE 2. Descriptive statistics of selected character states for each locality showing: ṅ = number of specimens; Mean = mean value; Median = median value; SD = one standard deviation; Range = minimum value-maximum value. Number of specimens (n) may vary owing to missing or damaged features. Developmental stage included. Measurements in mm.

		Castlegregory	**Dooaghs**	**L. Gill**	**L. Naparka**	**L. Yganavan**
Body Length	n	20	20	20	20	20
	Mean	6.41	4.785	4.96	4.89	6.815
	Median	6.55	4.8	4.9	4.9	7.05
	SD	0.515956	0.303098	0.506172	0.445917	0.862234
	Range	5.4-7.1	4.3-5.2	4.2-6.8	4-6	4.3-7.8
Tail Length	n	20	20	20	20	20
	Mean	7.89	6.755	6.81	6.645	8.18
	Median	7.9	6.8	6.7	6.6	8.35
	SD	0.697288	0.46052	0.744029	0.49255	0.929969
	Range	6.9-9	6-7.3	5.8-9	5.7-7.7	6-9.6
Total Length	n	20	20	20	20	20
	Mean	14.3	11.525	11.77	11.535	14.995
	Median	14.35	11.55	11.6	11.4	15.55
	SD	1.11968	0.713682	1.172088	0.879758	1.764407
	Range	12.5-15.9	10.4-12.5	10.5-15.8	10.2-13.6	10.3-17.4
Tail Height	n	20	20	20	20	20
	Mean	3.055	2.39	2.2	2.3	3.115
	Median	3	2.45	2.15	2.25	3.2
	SD	0.330032	0.204939	0.282843	0.299122	0.433195
	Range	2.5-3.6	1.9-2.7	1.8-3.2	1.7-3.1	2-3.7
Tail Muscle	n	20	20	20	20	20
Height	Mean	1.175	0.755	0.71	0.765	1.13
	Median	1.2	0.8	0.7	0.7	1.2
	SD	0.111803	0.099868	0.129371	0.153125	0.205452
	Range	1-1.4	0.5-0.9	0.6-1.1	0.6-1.2	0.6-1.5

TABLE 2 (continued)

Dorsal Fin	n	20	20	20	20	20
Height	Mean	1.14	0.9	0.81	0.84	1.19
	Median	1.1	0.9	0.8	0.8	1.2
	SD	0.114248	0.097333	0.116529	0.150088	0.174416
	Range	1-1.4	0.7-1	0.7-1.2	0.5-1.2	0.7-1.4
Ventral Fin	n	20	20	20	20	20
Height	Mean	1.06	0.805	0.745	0.785	1.07
	Median	1.1	0.8	0.7	0.8	1.1
	SD	0.10463	0.088704	0.088704	0.142441	0.18666
	Range	0.9-1.3	0.7-0.9	0.6-1	0.5-1.1	0.6-1.3
Interocular	n	20	20	20	20	20
Distance	Mean	1.125	0.815	0.845	0.885	1.14
	Median	1.1	0.8	0.8	0.9	1.2
	SD	0.125132	0.058714	0.099868	0.074516	0.127321
	Range	1-1.5	0.7-0.9	0.8-1.2	0.8-1.1	0.8-1.3
Internarial	n	20	20	20	20	20
Distance	Mean	0.725	0.7	0.66	0.68	0.885
	Median	0.7	0.7	0.65	0.7	0.9
	SD	0.07864	0.045883	0.068056	0.061559	0.098809
	Range	0.6-0.8	0.6-0.8	0.6-0.8	0.6-0.8	0.7-1
A-1 Length	n	20	20	20	20	20
	Mean	1.18	0.77	0.855	0.91	1.06
	Median	1.2	0.75	0.85	0.9	1.1
	SD	0.132188	0.080131	0.105006	0.129371	0.153554
	Range	1-1.4	0.7-0.9	0.7-1.2	0.6-1.1	0.6-1.2

TABLE 2 (continued)

Left A-2	n	20	20	20	20	20
Length	Mean	0.415	0.345	0.385	0.385	0.395
	Median	0.4	0.3	0.4	0.4	0.4
	SD	0.036635	0.051042	0.036635	0.058714	0.039403
	Range	0.4-0.5	0.3-0.4	0.3-0.4	0.3-0.5	0.3-0.5
Right A-2	n	20	20	20	20	20
Length	Mean	0.42	0.345	0.385	0.385	0.395
	Median	0.4	0.3	0.4	0.4	0.4
	SD	0.041039	0.051042	0.036635	0.058714	0.039403
	Range	0.4-0.5	0.3-0.4	0.3-0.4	0.3-0.5	0.3-0.5
A-2 Gap	n	20	20	20	20	20
	Mean	0.35	0.255	0.29	0.3	0.295
	Median	0.3	0.25	0.3	0.3	0.3
	SD	0.068825	0.060481	0.030779	0.064889	0.051042
	Range	0.3-0.5	0.2-0.4	0.2-0.3	0.2-0.4	0.2-0.4
A-2 Gap	n	20	20	20	20	20
Ratio	Mean	1.21	1.375	1.305	1.3	1.34
	Median	1.3	1.4	1.3	1.3	1.3
	SD	0.197084	0.168195	0.094451	0.162221	0.181804
	Range	1-1.6	0.8-1.5	1-1.5	0.8-1.5	1-2
P-1 Length	n	20	20	20	20	20
	Mean	1.04	0.75	0.83	0.855	1.045
	Median	1.1	0.7	0.8	0.9	1.1
	SD	0.135336	0.068825	0.121828	0.109904	0.160509
	Range	0.8-1.2	0.7-0.9	0.6-1.2	0.6-1	0.6-1.2

TABLE 2 (continued)

P-1 Gap	n	8	11	17	15	13
	Mean	0.125	0.1	0.1	0.12	0.130769
	Median	0.1	0.1	0.1	0.1	0.1
	SD	0.070711	0	0	0.041404	0.048038
	Range	0.1-0.3	0.1-0.1	0.1-0.1	0.1-0.2	0.1-0.2
P-2 Length	n	20	20	20	20	20
	Mean	1.015	0.65	0.73	0.605	0.9
	Median	1.1	0.6	0.7	0.6	0.9
	SD	0.166307	0.068825	0.121828	0.143178	0.148678
	Range	0.7-1.2	0.6-0.8	0.5-1.1	0.3-0.9	0.5-1.1
P-3 Length	n	20	20	20	8	18
	Mean	0.455	0.325	0.33	0.35	0.438889
	Median	0.45	0.3	0.3	0.35	0.4
	SD	0.114593	0.055012	0.065695	0.053452	0.077754
	Range	0.3-0.7	0.2-0.4	0.2-0.5	0.3-0.4	0.3-0.6

Location	**Castlegreg.**	**Dooaghs**	**L. Gill**	**L. Naparka**	**L. Yganavan**	
Develop. Stage	n	n	n	n	n	Total
27	0	1	5	4	0	10
28	11	19	14	15	4	63
29	7	0	0	1	0	8
30	2	0	1	0	4	7
31	0	0	0	0	11	11
33	0	0	0	0	1	1
Total	20	20	20	20	20	100
Collection date	18 May	17 May	18 May	18 May	16 May	

TABLE 3. Results of Kruskal-Wallis (K-W) test with location as the single independent variable, and P-value adjusted for Bonferonis' inequalities. Variables are means ± one SD. All measurements in mm. Developmental stage 28 only.

Locality	**Castlegregory**	**Dooaghs**	**L. Gill**	**L. Naparka**	**K-W Test**	
Variable	**n=11**	**n=19**	**n=14**	**n=15**	**X[Chi]²**	**P**
Body Length	6.136364±0.496533	4.810526±0.288472	4.907143±0.284103	4.906667±0.345309	26.527	0.0016
Tail Length	7.418182±0.437763	6.789474±0.445838	6.835714±0.565151	6.66±0.495407	14.477	0.0368
Total Length	13.55455±0.815308	11.58421±0.680901	11.74286±0.708969	11.56667±0.781634	24.535	0.0016
Tail Height	2.845455±0.196792	2.4±0.20548	2.157143±0.174154	2.326667±0.198086	31.085	0.0016
Tail Muscle Height	1.1±0.07746	0.757895±0.101739	0.671429±0.082542	0.753333±0.150555	30.037	0.0016
Dorsal Fin Height	1.063636±0.050452	0.905263±0.097032	0.8±0.078446	0.853333±0.10601	29.647	0.0016
Ventral Fin height	1.009091±0.083121	0.810526±0.087526	0.75±0.065044	0.806667±0.10328	26.512	0.0016
Interocular Distance	1.090909±0.151537	0.821053±0.05353	0.835714±0.063332	0.893333±0.070373	34.662	0.0016
Internarial Distance	0.718182±0.087386	0.705263±0.040465	0.671429±0.061125	0.68±0.56061	4.9109	>0.99
A-1 Length	1.118182±0.125045	0.773684±0.080568	0.842857±0.064621	0.926667±0.12228	34.009	0.0016
Left A-2 Length	0.4±0	0.347368±0.051299	0.385714±0.036314	0.393333±0.059362	11.586	0.1424
Right A-2 length	0.4±0	0.347368±0.051299	0.385714±0.036314	0.393333±0.059362	11.586	0.1424
A-2 Gap	0.336364±0.050452	0.247368±0.051299	0.292857±0.026726	0.313333±0.063994	18.750	0.0048
A-2 Gap Ratio	1.190909±0.151357	1.405263±0.102598	1.292857±0.099725	1.273333±0.170992	18.242	0.0064
P-1 length	0.990909±0.122103	0.752632±0.069669	0.828571±0.072627	0.853333±0.112546	25.151	0.0016
P-2 length	0.945455±0.163485	0.652632±0.069669	0.728571±0.072627	0.626667±0.138701	26.587	0.0016

TABLE 4. Matrix of performance of a classification criterion from discriminant function analysis showing assignment of stage 28 larvae to localities. Upper number for each entry is the number of tadpoles and the number below the percent of sample correctly assigned.

	Locality Assigned by D. F. A.				
Actual Locality	**Castlegregory**	**Dooaghs**	**L. Gill**	**L. Naparka**	**Total**
Castlegregory	11	0	0	0	11
	100.00	0.00	0.00	0.00	100.00
Dooaghs	0	19	0	0	19
	0.00	100.00	0.00	0.00	100.00
L. Gill	0	0	13	1	14
	0.00	0.00	92.86	7.14	100.00
L. Naparka	0	0	1	14	15
	0.00	0.00	6.67	93.33	100.00
Total	11	19	14	15	59

Error Count Estimates:

	Castlegregory	**Dooaghs**	**L.Gill**	**L.Naparka**	**Total**
Rate	0.0000	0.0000	0.0714	0.00667	0.0345
Priors	0.2500	0.2500	0.2500	0.2500	

TABLE 5. Results of stepwise discriminant analysis with an entry and exit level significance of 0.15 showing prioritized list of variables useful as predictors of location of stage 28 larvae.

Step	Variable	Partial r^2	F Statistic	Prob > F
1	Body length	0.6843	39.747	0.0016
2	Tail Height	0.3282	8.795	0.0016
3	A-1 length	0.3228	8.423	0.0016
4	P-2 length	0.2885	7.030	0.008
5	Internarial Distance	0.2486	5.625	0.0336
6	Interocular Distance	0.3051	7.317	0.0064
7	Total Length	0.2064	4.161	0.1696
8	Tail Muscle Height	0.1462	2.796	0.7984
9	A-2 Gap Ratio	0.1316	2.375	1.312

TABLE 6. Eigenvalues of the correlation matrix for PC 1 through PC 4 accounting for 83.4% of the cumulative variability of stage 28 larvae.

	Eigenvalue	Difference	Proportion	Cumulative
PC1	8.69813	5.93041	0.543633	0.54363
PC2	2.76772	1.74524	0.172983	0.71662
PC3	1.02248	0.16396	0.063905	0.78052
PC4	0.85852	0.08742	0.053657	0.83418

TABLE 7. The eigenvectors of PC 1 through PC 4 relative to 16 morphological characters of stage 28 larvae.

Variable	PC1	PC2	PC3	PC4
Body Length	0.299817	-.122809	0.007167	0.027053
Tail Length	0.259694	-.044127	0.142844	-.057039
Total Length	0.309708	-.090280	0.080369	-.014856
Tail Height	0.281910	-.264906	0.111033	-.015936
Tail Muscle Hgt.	0.288408	-.208335	0.128452	-.051063
Dorsal Fin Hgt.	0.267208	-.256622	0.290677	0.087246
Ventral Fin Hgt.	0.276567	-.223604	0.239539	-.092588
Interocular Dist.	0.271919	-.028603	-.233310	0.040658
Internarial Dist.	0.175607	-.126982	-.071482	0.319927
A-1 Length	0.276533	0.161883	-.303630	0.111733
Left A-2 Lgth.	0.160892	0.458267	0.258151	0.369174
Right A-2 Lgth.	0.160892	0.458267	0.258151	0.369174
A-2 Gap	0.204272	0.417777	0.171349	-.313167
A-2 gap Ratio	-.183761	-.286594	-.057361	0.699324
P-1 Length	0.243686	0.159583	-.555497	0.017180
P-2 length	0.261360	0.009077	-.419688	0.015994

TABLE 8. Results of Kruskal-Wallis test for significant difference among locations for PC1. $X[Chi]^2 = 26.838$, df = 3, P >0.0001.

Location	n	Mean	SD
Castlegregory	11	4.865514	2.06547
Dooaghs	19	-1.49712	1.90724
L. Gill	14	-1.23417	1.425838
L. Naparka	15	-0.5198	1.722888

TABLE 9. Results of Kruskal-Wallis test for significant difference among locations for PC2. $X[Chi]^2 = 24.407$, df = 3, P >0.0001.

Location	n	Mean	SD
Castlegregory	11	-0.49987	0.588278
Dooaghs	19	-1.14163	1.492195
L. Gill	14	0.949289	1.124778
L. Naparka	15	0.926631	1.842624

FIGURE 1. Co. Kerry natterjack localities (1, 3, 7, 9, 10) discussed in this study (after Korky and Webb, 1999).

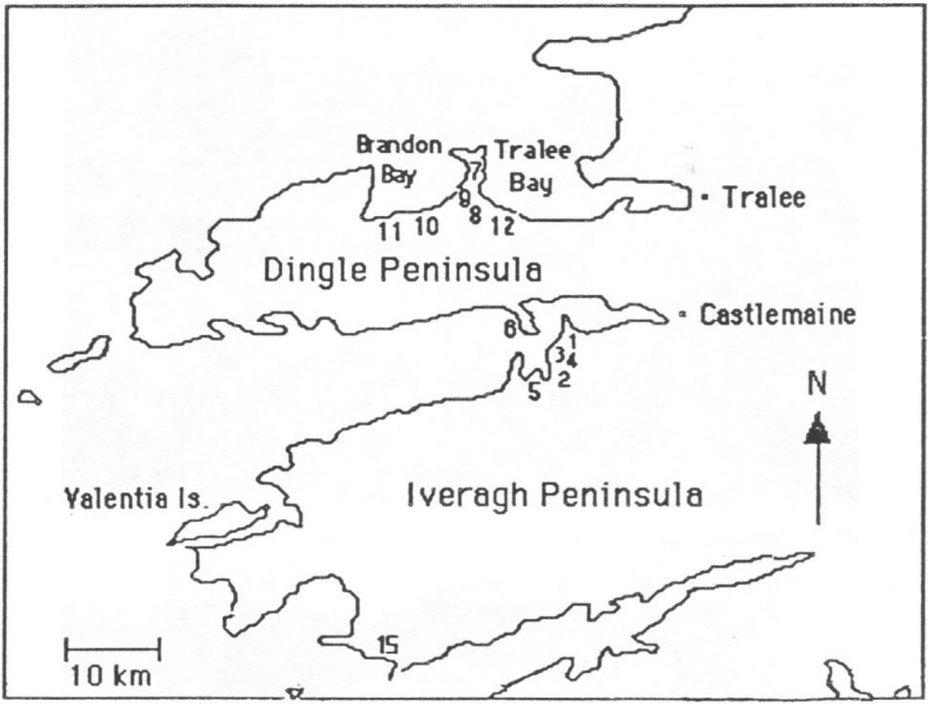


FIGURE 2. Habitat locality 10, Castlegregory Golf Course, man-made ponds among natural dune system stabilized by marram grass, *Ammophila arenaria*. Spawn, tadpoles, and breeding adults present along with submerged vegetation.

FIGURE 3. Habitat locality 9, Dune Slacks North of Lough Gill, only tadpoles present. Slack area about one half original area due to dessication, adjacent slacks completely dried.

FIGURE 4. Oral apparatus of Castlegregory specimen (locality 10), 125X, showing emarginate lateral border and posteromedial interruption of the marginal papillae by the P-3 tooth row.

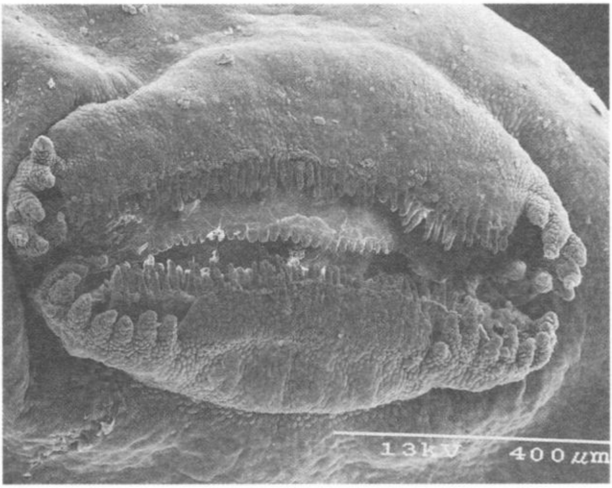


FIGURE 5. Short-cusped, moderately curved labial teeth of Castlegregory specimen (locality 10), 3000X.

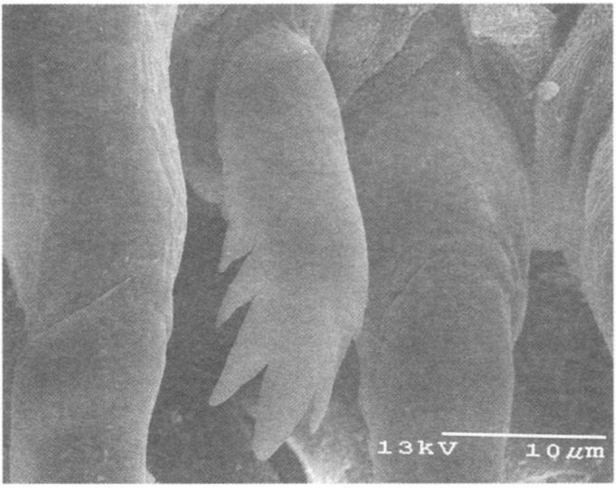


FIGURE 6. Oral apparatus of L. Yganavan specimen (locality 1), 125X, depicting A-1 tooth row, broad dorsal interruption of the papillary border equal to A-1 length, and serrated upper jaw sheath.

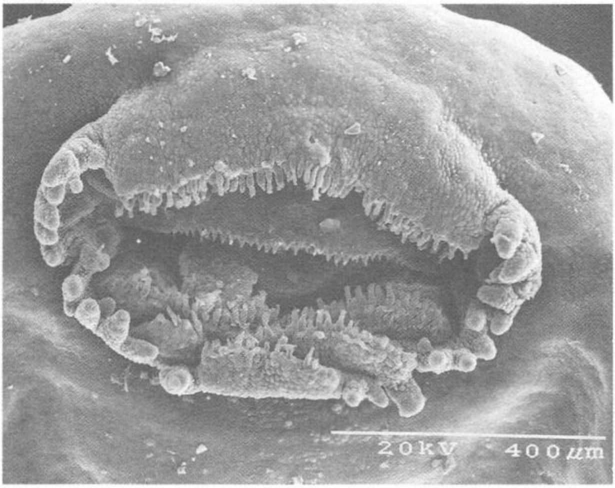


FIGURE 7. Oral apparatus of L. Yganavan specimen (locality 1), 125X, reclined dorsally to shown A-2 tooth rows, broad A-2 gap, and M-shaped upper jaw sheath.

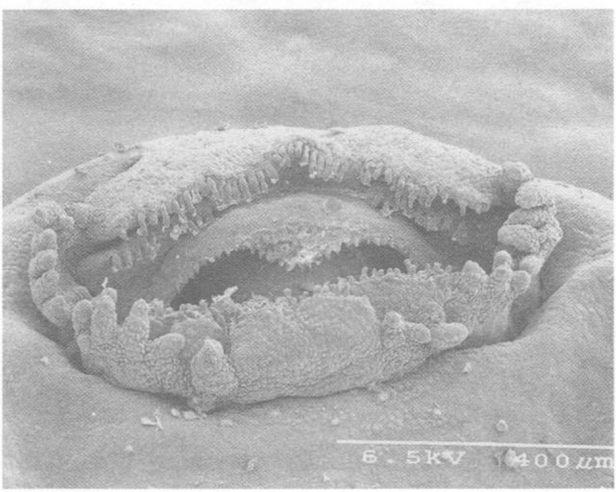


FIGURE 8. Straight serrations of the upper jaw sheath of a L. Yganavan specimen (locality 1), 3000X.

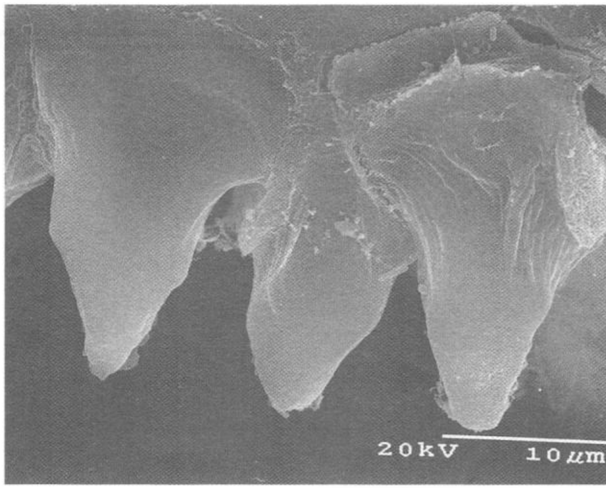


FIGURE 9. Variation in labial teeth of L. Yganavan speciman (locality 1), 3000X, showing moderately curved, short-cusped and non-cusped, spatulate teeth.

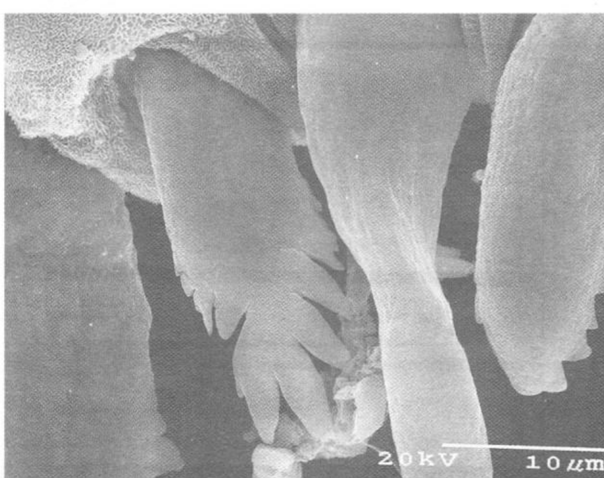


FIGURE 10. Chemical element display for a labial tooth (Castlegregory specimen, locality 10) with highest peak for copper, followed by sulfur and calcium.

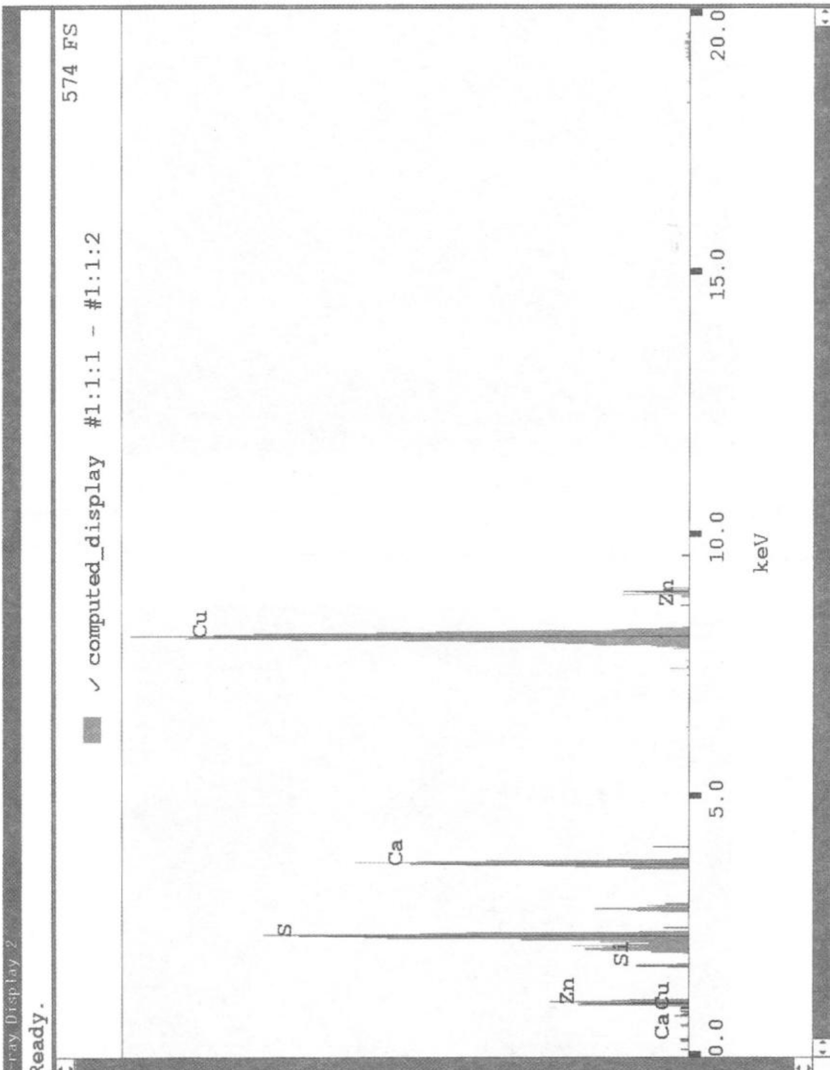
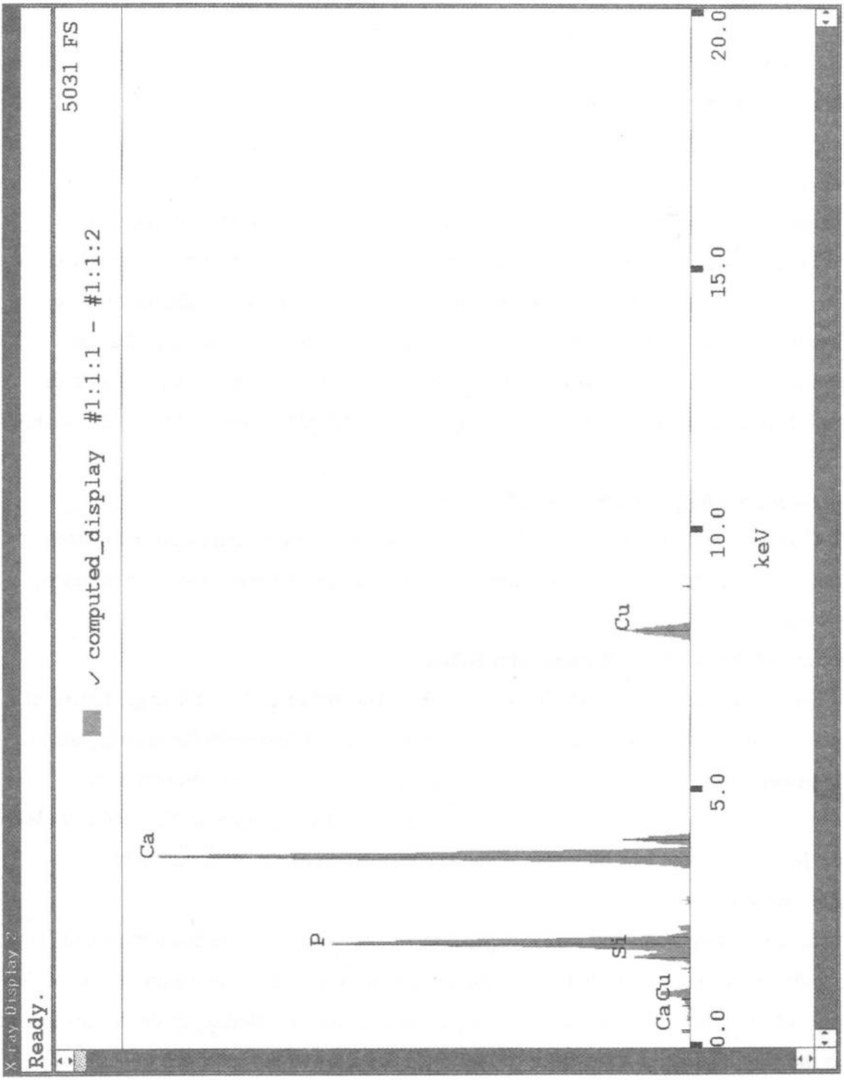


FIGURE 11. Chemical element display for upper jaw sheath (Castlegregory specimen, locality 10) with highest peak for calcium, followed by phosphorous.



Bull. Ir. biogeog. Soc. No. 25 (2001)

RECORDS FOR UNCOMMON CENTIPEDES (CHILOPODA) INCLUDING *BRACHYSCHENDYLA DENTATA* BRÖLEMANN AND RIBAUT AND *CRYPTOPS ANOMALANS* NEWPORT NEW TO IRELAND

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Introduction

Although a small group, and not presenting any undue difficulty of identification, the centipedes have received comparatively little attention from Irish naturalists. A minor upsurge in interest over recent years however means that they are not as grossly under recorded as has traditionally been the case. The following note contains information on some of the less common centipedes, including two species not previously reported from Ireland. The Irish centipede fauna, including additions contained in Cawley (in press), now stands at 28 species.

Schendyla peyerimhoffi Brölemann and Ribaut

WEST CORK: Whitecastle Creek, W6150, 3 October 1999. One specimen collected from inter-tidal rock fissure. *Geophilus fucorum seurati* present under stones embedded in nearby sharp shingle.

Brachyschendyla dentata Brölemann and Ribaut

MID CORK: Glasheen, W654707, 14 January 2001. The author collected a single female at this site, in leaf litter which had accumulated beneath Japanese knotweed *Reynoutria japonica* Houtt., growing on a bank in an area of waste ground. Other centipedes present were *Geophilus insculptus* Attems, *Cryptops parisi* Newport, *Lithobius forficatus* (L.) and *Lithobius microps* Meinert and the leaf litter also supports a population of the alien millipede *Cylindroiulus vulnerarius* (Berlese).

B. dentata is a very small and easily overlooked animal. The Cork specimen measured *circa* 9mm, with 39 leg bearing segments, and was initially dismissed as an immature of one of the larger geophilomorphs. On a closer examination however the tiny metatarsus on the last leg, as well as the very distinctive appearance of the forcipules allowed the specimen to be readily determined using Barber and Jones (1999). *B. dentata* is almost certainly a naturalized alien in Ireland, and is likely to be present elsewhere, especially in urban areas along the south and east coasts. Males are unknown, the species being presumed to reproduce by parthenogenesis. This would facilitate the chance establishment of isolated populations. *B. dentata* has a scattered distribution in Great Britain, where it has a reputation of being a difficult animal to find and with an affinity for churchyards and waste ground. According to Barber and Jones (1999) it has also been found in France, Denmark and the Netherlands.

***Henia brevis* (Sylvestri)**

MID CORK: Deerpark, Cork City, W670709, 9 March 2000, where it occurs with *Geophilus osquidatum* Brölemann.

WATERFORD: Waterford City, S604115, 12 March 2000, single specimen under a stone in abandoned garden.

DUBLIN: Blackrock, Dublin City, O211296, 3 April 2001, under a stone at base of wall in a suburban park.

KILKENNY: Kilkenny City, S5055, 19 April 2001, a number of specimens collected at this site, under stones at the edge of a school football field.

This small synanthrophic geophilomorph is otherwise recorded only from Cos Kerry and Cork (Jones, 1999; Cawley, in press), however it is clearly widespread in the south east of Ireland.

***Geophilus fucorum seurati* Brölemann**

WEST CORK: Reenour, Bantry, V9949, 15 July 1999, under a stone embedded in sharp shingle; Glandore Harbour, W2036, 16 September 1999, under stones at about the mid shore.

***Cryptops anomalans* Newport**

One specimen under rubbish in the grounds of Kilmainham Courthouse, Dublin City, O126337, 17 March 2000. Present in association with *L. forficatus*. The characteristic cruciform structure on the first tergite became quite obvious when the specimen was allowed to dry out a little. This Dublin individual was a reasonably large animal, of approximately similar size to typical *C. parisi* from Co. Cork, and distinctly larger than the more widespread *Cryptops hortensis* Donovan. Animals up to 50mm long have been recorded, and, as with *Lithobius pilicornis*, these can apparently inflict a painful bite.

C. anomalans has a scattered distribution in southern England and south Wales, where it is usually associated with urban areas (Barber and Keay, 1988). Dublin is a relatively northern location for this centipede, which might have been expected from urban areas along the south coast. All three scolopendromorphs recorded from Great Britain have now been noted from Ireland, and of these *C. anomalans* and *C. parisi* are naturalized aliens here.

***Cryptops parisi* Brölemann**

WATERFORD: De La Salle school, Waterford City, S6111, 12 March 2000, single specimen among rubble on a small disturbed area; Lismore, X0498, 23 September 2001, under debris at the base of a hedgerow in a schoolyard.

All other Irish records for *C. parisi* are from Co. Cork. This is a frequent centipede of synanthrophic sites in Cork City.

***Lithobius pilicornis* Newport**

EAST CORK: Ballyvolane, Cork City, W6873, 10 December 2000, a single female noted at this site, under a stone on an area of open waste ground. Also present were numerous *L. forficatus*.

The only other Irish record is also from Cork City (Cawley, 1999).

Acknowledgement

I would like to thank Tony Barber for confirming the identities of *B. dentata* and *C. anomolans*, and for helpful comments made on an initial draft of this note.

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Bull. Ir. biogeog. Soc. No. 25 (2001)

SOME RECORDS FOR UNCOMMON IRISH MILLIPEDES (DIPLOPODA), INCLUDING *ADENONEMERIS GIBBOSA* MAURIÈS, 1960 AND *NOPOIULUS KOCHII* (GERVAIS, 1847)

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Introduction

Irish millipedes have been reviewed by Doogue *et al.* (1993). They have also been the subject of a preliminary distribution atlas (British Myriapod Group, 1988), and the anticipated second edition of this should show a good improvement in the state of recording of this group in Ireland. The following are records of some of the less commonly encountered millipedes and can be considered as a follow up to a similar article which appeared some years ago (Cawley, 1997). Some of these records have been incorporated into the European distribution maps contained in Kime (2001). New vice-county records are denoted by an asterisk (*).

Polyxenus lagurus (L.)

*MID CORK: Douglas Street, Cork City, W6771, 17 February 1998. Subsequently noted on numerous occasions at this site, apparently grazing on the inside, painted walls of an old stone building which has been converted into apartments.

*EAST CORK: Ballycotton, W9963, 6 March 1998, under stones on coastal heath; Fermoy, W8198, 14 March 2000, grazing on the inside wall of a public toilet.

*WATERFORD: Passage East, S7009, 10 June 2001, among lichen on rock exposure.

*SOUTH TIPPERARY: Caher Park Wood, S0522, 24 June 2001, beaten from the lower branches of yew *Taxus baccata* L., in a narrow band of mixed woodland along the River Suir.

*WEXFORD: Ballyhack, S7010, 20 May 2001, frequent among stonecrop *Sedum* / lichen on rock exposure adjacent to heath, and under ivy *Hedera* on a sea wall.

There are surprisingly few Irish records for this small millipede, which is usually associated with old lichen-rich walls. It is most likely under-recorded here, at least along the east and south coasts.

Adenomeris gibbosa **Mauriès**

DUBLIN: Military Road, Kilmainham, O134339, 21 February 2000. Six specimens under embedded stones, in what appears to be an abandoned garden, now overgrown with sycamore *Acer pseudoplatanus* L. and ivy *Hedera helix* L.

This small pill millipede is unrecorded from Great Britain, and the few Irish sites are all from the vicinity of Dublin City (Blower, 1985; Doogue *et al.*, 1993). It would seem clearly to be a naturalized alien here.

Brachychaeteuma melanops **Brade-Birks**

MID CORK: Myrtleville, W797590, 27 January 2000. One male in leaf litter collected from under Japanese Knotweed *Reynoutria japonica* Houtt. which was growing on stable shingle; Bawnafinny Bridge, W5975, 28 February 2000. One male under a stone at the base of an old stone bridge.

Two interesting natural sites for this small millipede. The few additional Irish records, all from Co. Cork, are from gardens and waste ground. This animal is relatively frequent on waste ground sites in Cork City.

Brachychaeteuma bagnalli **Verhoeff**

*EAST CORK: Meenane, W7784, 30 November 1999. Two females under stones on gravelly bank.

*WATERFORD: Ballynacourty, X2992, 1 December 1999. Two specimens under pieces of wood, inside the ruins of an old cottage.

*FERMANAGH: Enniskillen, H2344, 24 April 2000. A few specimens, including mature males, under stones on a gravelly area in a carpark.

Chordeuma proximum **Ribaut**

*NORTH KERRY: Muckross House Arboretum, V9685, 2 December 1999, frequent under stones and in leaf litter.

*WATERFORD: Mountcongreve, S5310, 24 March 1999, scattered in leaf litter under *Rhododendron*, and along nearby road verges; Loughaniska, X2996, 7 November 2000, frequent in leaf litter, deciduous woodland.

*CARLOW: Corrabut Gap, S8356, 22 November 1997, under a stone on a sandy area at the edge of an upland conifer plantation.

Previously reported in Ireland from a handful of scattered sites (Jones, 1992; Cawley, 1997; Anderson, 2000). In addition, I have a fair number of records from Co. Cork, where *C. proximum* is a common woodland millipede, with records coming also from non woodland sites, including waste ground.

***Melogona scutellare* (Ribaut)**

*WATERFORD: Kilcullen, S6811, 13 November 1996, frequent in beech *Fagus* leaf litter, mixed woodland.

*KILKENNY: Sionhermitage, S5254, 9 March 2001, under a stone, in the ruins of a building at the River Nore.

*WEXFORD: Bunclody, S9157, 23 November 1997, in beech *Fagus* leaf litter, mixed woodland along the east bank of the River Slaney.

*CARLOW: Bunclody, S8957, 22 November 1997, present in leaf litter, mixed deciduous woodland along the west bank of the River Slaney.

A small and easily overlooked millipede, most easily collected by sieving beech *Fagus* leaf litter. Probably widespread in Ireland.

***Thalassisobates littoralis* (Silvestri)**

*MID CORK: Paddys Point, Ringaskiddy, W7964, 7 November 1999, under pieces of driftwood on stable shingle.

*WATERFORD: Ballyvoyle Bridge, X336949, 13 September 1998, under a large rock, embedded in shingle; Templeyvrick, Bunmahon, X4298, 17 September 1998, frequent under pieces of driftwood, on coarse sand and rock fragments, at the tide line.

The only other Irish record for this littoral millipede is from a site in West Cork (Cawley, 1997).

***Nemasoma varicorne* C. L. Koch**

*SLIGO: Union Wood, G6828, 24 November 1993, under bark in oak *Quercus* woodland. Subsequently found at a handful of other woodland sites in Co. Sligo.

*WATERFORD: D'Loughtane, X0983, 22 September 1998. One specimen under a log at the edge of a deciduous woodland.

***Choneiulus palmatus* (Nemec)**

*MID CORK: Cork Docks, W6871, 28 March 1999, frequent under pieces of dumped carpet in a car park.

*EAST CORK: Youghal, W1076, 29 April 1999. A few specimens under sleepers at an abandoned railway station.

*DUBLIN: Dublin Docks, O1734, 11 April 1999. One specimen under a piece of wood on waste ground.

Otherwise recorded in Ireland from single sites in Cos Kildare and Wicklow (Doogue *et al.*, 1993), with a possible record also from Ireland's Eye, Co. Dublin (Cawley, 2000).

***Nopoiulus kochii* (Gervais)**

*DUBLIN: Drumcondra, O155360, 17 March 1999. A single male collected at this site, under cardboard on a disturbed gravelly verge, at the base of the perimeter wall of Mountjoy Prison. Associated with the following millipedes: *Blaniulus guttulatus* (Fabr.), *Ophyiulus pilosus* (Newport) and *Brachyiulus pusillus* (Leach).

This millipede has recently been added to the Irish list by Anderson (2000). Older records have apparently been based on misidentifications of *Proteroiulus fuscus* (Am Stein) (Blower, 1985). The European distribution of *N. kochii* is mapped by Kime (1999).

***Cylindroiulus londinensis* (Leach)**

*NORTH KERRY: Muckross House, V9685, 2 December 1999. One specimen under a stone in the arboretum.

*WEST CORK: Inchanadreen, W1954, 14 December 2000. The author was initially surprised to find this alien millipede at this site, in association with the Irish botanical speciality St Patrick's-cabbage *Saxifraga spathularis* Brot., in a small fringe of deciduous woodland adjacent to a conifer plantation. However it soon emerged that most of the population occurred under dumped plastic and other rubbish at the edge of the woodland. Subsequently found along a roadverge at Derrynasafagh, W2153, and frequent in a small shrubby area at Darkwood, W2253. Clearly very well established in this area.

*WATERFORD: Mountcongreve, S5310, 24 March 1999, much the commonest millipede in *Rhododendron* gardens, and present also under pieces of wood along adjacent roadverges, just outside the gardens at Knockanagh, S5309.

Otherwise reported in Ireland from single sites in Cos Mayo, Galway, Roscommon and Donegal (Selbie, 1912; Cawley, 1995; Anderson, 2000).

Cylindroiulus caeruleocinctus **(Wood)**

*MID CORK: Ballyphehane, W6869, 8 March 1998. A few specimens under rubbish in a refuse tip; Fitzgerald Park, W6571, 7 May 1998, scattered under stones in a public park.

DUBLIN: Dun Laoighre, O2428, 13 August 1997, flower border in town park.

*WICKLOW: Rathnew, T2994, 26 October 1997. One specimen under rubbish in a disturbed hedgerow.

The only other Irish records are from single sites in Dublin and Wexford (Doogue *et al.*, 1993; Cawley, 1997).

Cylindroiulus vulnerarius **(Berlese)**

*MID CORK: Glasheen, W6570, 6 April 1998. Frequent under embedded stones, and in leaf litter which had accumulated beneath Japanese knotweed *Reynoutria japonica* Houtt., on an area of waste ground.

*EAST CORK: Tivoli, Cork City, W702722, 13 April 2001. Scattered under *Reynoutria* on waste ground.

*WATERFORD: Clonmel, S2022, 16 October 2000. One male under a stone in a town park, along the south bank of the River Suir.

*SOUTH TIPPERARY: Clonmel, S1922, 16 October 2000. One male under a stone at the base of an old stone wall in a housing estate.

DUBLIN: Bushy Park, O1329, 4 May 1999, under an embedded stone, in a disturbed shrubby area in a suburban park; Palmerstown Park, O1630, 17 May 1999, a single specimen under leaf litter in a suburban park.

*DOWN: Castlewellen Arboretum, J341370, 4 April 2000. Several under dead leaves and bricks in the soil of an unheated glasshouse. This record was kindly supplied by Dr Roy Anderson.

The only previous record for this distinctive blind julid, which is a naturalized alien in Ireland and Britain, is from an urban site in Dublin (Blower, 1985; Doogue *et al.*, 1993). The above records suggest that it might be anticipated from urban areas, at least in the south and east of the country.

Polydesmus denticulatus **C. L. Koch**

*WATERFORD: Portlaw, S4515, 22 May 1996, in moss on a log in oak *Quercus* woodland.

*LEITRIM: Balloor, G7554, 4 January 1994, oak *Quercus* woodland.

The author has a few additional records from Co. Sligo. Apparently there are no previous records from Munster or south Leinster. Otherwise widely but rather locally scattered in Ireland. Possibly overlooked elsewhere or, like many other woodland invertebrates, scarcer in Ireland than might be expected.

***Stosatea italica* (Latzel)**

EAST CORK: Middleton, W8873, 15 May 2001. A single specimen among leaves at the base of a wall in a town park. There is a previous record from a garden in Middleton, suggesting that this alien millipede may be established in this area.

Acknowledgement

I would like to thank Dr Roy Anderson for allowing the inclusion of his record of *C. vulnerarius*.

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THE IRISH SPECIES OF LESSER DUNG FLIES (INSECTA: DIPTERA, SPHAEROCERIDAE) INCLUDING A LIST OF TYPE SPECIMENS DESCRIBED BY ALEXANDER HENRY HALIDAY IN HUMBOLDT UNIVERSITY MUSEUM, LA SPECOLA AND THE NATIONAL MUSEUM OF IRELAND

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Abstract

The Irish species of lesser dung flies (Diptera: Sphaeroceridae) are reviewed. Eight of these species are new to Ireland:- *Apteromyia claviventris* (Strobl, 1909), *Herniosina bequaerti* (Villeneuve, 1917), *Ischiolepta scabricula* (Haliday, 1836), *Leptocera (Leptocera) oldenbergi* (Duda, 1918), *Spelobia (Spelobia) parapusio* (Dahl, 1909), *Spelobia (Spelobia) pseudosetaria* Duda, 1918, *Trachyopella (Nudopella) leucoptera* (Haliday, 1836) and *Trachyopella (Trachyopella) lineafrons* Spuler, 1925. In addition, a list is provided of the species described by Alexander Henry Haliday in the Haliday Collection (National Museum of Ireland, Dublin, Ireland), the Loew Collection (Humboldt University Museum, Berlin, Germany) and the Rondani Collection (La Specola, Florence, Italy).

Introduction

There are over 700 species of Sphaeroceridae of which at least 290 are recorded from the Palaearctic region (Pitkin, 1988). They are small flies, the majority being *circa* 2 to 4mm long. A few species are very tiny indeed (0.8mm). Although most species are winged, adults fly only rarely, instead they run or jump (having elongated hind legs). A good introductory account of the Sphaeroceridae is given by Colyer and Hammond (1968). Richards (*op. cit.*) provides a good key (although out of date), an interesting account of biology and habits, and a very full bibliography. This work is the basis of Pitkin's excellent monograph which contains usable and up to-date keys. The Sphaeroceridae are difficult to identify and help may be sought from Séguy (1934) and Duda (1938). Kim and Cook (1966) is essential reading before embarking on keys. Floren (1989) provides much information on biotopes and microhabitats. Chandler (1998) gives synonyms: only species described by Haliday are repeated here.

Aside from a seminal monograph by Haliday (1836) in which 25 species are described mainly from Irish material, Irish records of Sphaeroceridae are scattered and few in number. Richards' (1930) monograph of the Sphaeroceridae makes no mention of Ireland and Pitkin's (1988) references are occasional and brief. Nash and O'Connor (1982), and Good and Sleeman (1988) refer to the medically important *Leptocera caenosa* (Rondani) and Nash (1989) adds 11 species to the Irish list. Valentine *et al.* (1991) add a further seven and Blackith *et al.* (1991) one. The collections of Sphaeroceridae in the Ulster Museum and The National Museum of Ireland have been wholly revised since the appearance of Pitkin (*op. cit.*). These form the bulk of records in the present paper. The remainder are in private collections or in the Smithsonian Institution, Washington D. C., U. S. A. The types of Sphaeroceridae in the Haliday Collection (National Museum of Ireland, Dublin, Ireland), Rondani Collection (La Specola, Florence, Italy) and in the Loew Collection (Humboldt University, Berlin, Germany) are listed.

Abbreviations

The following abbreviations are used in the text:- * and NMI = National Museum of Ireland; ** = Ulster Museum; AGI = A. G. Irwin; JMOC = J. P. and M. A. O'Connor; JNH = J. N. Halbert; JPOC = J. P. O'Connor; PJC = P. J. Chandler. With the few noted exceptions, the material in the Ulster Museum was collected by R. Nash and M. R. Boston.

List of species and records of Irish Sphaeroceridae

Copromyzinae

***Borborillus uncinatus* (Duda, 1923)**

DUBLIN: North Bull (O2528), salt marsh proper, 3.vii.1962, B. Healy, det. J. C. Deeming* (Speight and Healy, 1977). **TYRONE**: Teal Lough (H7389), 1.viii.1987, on horse dung**.

Widespread in Europe; also recorded from Mongolia. On horse dung, sometimes in mouse runs, bird droppings, brook ravine, wet glen, lake shore, potato field (Floren, 1989).

***Borborillus vitripennis* (Meigen, 1830)**

synonym *Borborus longipennis* Haliday, 1836

The lectotype and seven paralectotypes (the lectotype and four paralectotypes British, three paralectotypes Irish) of *B. longipennis*, designated by Norrbom (Norrbom and Kim, 1985) are in the Haliday Collection in NMI. Another two Irish specimens and one British were not sent to Norrbom but are part of the type series. Collin (1914) found two males and three females in Haliday's Collection in NMI; one of these was subsequently determined by Norrbom as *Crumomyia (Borborillus) nitidifrons* (Duda). "On the sea coast of Ireland; in various parts of England; not rare" (Haliday, 1836).

DOWN: Newcastle (J4-3-), a Haliday specimen, in the Rondani Collection, La Specola, Florence, is part of the type series and should be considered a paralectotype. **GALWAY**: Oughterard (M1242)*. **WICKLOW:** unlocalised (Pitkin, 1988).

Europe. Not common but taken in various habitats, mainly on dung: marsh, damp mixed forest, garden, potato field (Floren, 1989). Ex *Boletus edulis* (Chandler, 1990).

***Copromyza equina* Fallén, 1820**

A common and widely distributed species throughout Ireland probably occurring wherever there are horses or cattle. Collin (1914) found "many" in the Haliday Collection in NMI. "Everywhere; the most abundant species of this tribe, swarming about cattle yards" (Haliday, 1836 as *Borborus*).

ANTRIM: Aghalee (J1265), 19.vi.1970, horse dung**; Hilden (J2865), 10.vi.1990 and 20.viii.1986, cow dung**; Barnett's Park (J3268), 23.viii.1971, horse droppings**; Rea's Wood (J1485), 3.vi.1979, dead badger, marshy deciduous woodland; Dixon Park (J3067), 21.vi.1992 and 23.vii.1991, horse dung, lightly wooded hillside**; Doonfin (D1434), 29.viii.1987, decaying fungus**; Craigagh Wood (D2232), 1.ix.1987, cow dung**; Crumlin (J1576), 15.viii.1979, horse dung**. **ARMAGH**: Ballnery Bog (J0260), 3.ix.1979, pitfall trap**. **CLARE**: Bridge of Ross (Q737500), ♀ 10.vii.1981, coastal marshland, JPOC*. **CORK**: Tobar Ghobnatan, ♀ 28.vi.1969, PJC. **DONEGAL**: Verdin River, Dunlewy, 2.iv.1969, AGI**. **DOWN**: Holywood (J4-7-)* (Haliday, 1833 as *Borborus*); Rostrevor (J1920), 14.vi.1974, cow dung**; Bloody Bridge (J0746), 19.viii.1972, dead crow**; Mourne Wood (J2712), 11.viii.1979 and 26.vii.1975, by water-filled hole in rotten log**; Montalto

Estate (J3651), 30.vi.1979, horse dung**; Clandeboye (J4980), 15.vii.1979**; Cairn Wood (J4577), 7.vii.1979, fox dung**; Bohill National Nature Reserve (J4046), 7.v.1987, badger sett**; Belvoir Park (J4046), 23.vii.1979, horse dung**; Castle Park, Bangor (J5081), 16.v.1975, pitfall trap**. **DUBLIN**: Dublin (O1-3-), 25.vi.1893*; Baldoyle (O2440)*; Lambay (O1-3-), June 1906 (Grimshaw, 1907). **FERMANAGH**: Boho Caves (H1242), 19.viii.1986**; Aghatirourke, Cuilcagh Plateau (H1430), 6.vi.1980**; Correl Glen National Nature Reserve (H0754), 6.vi.1997**; Doagh Lough (H0852), 29.viii.1986**; Brookhill Bog (H0765), 14.vi.1990**. **LONDONDERRY**: Castlerock (C7730), 14.v.1987**; Annagh (H9694), 19.vi.1970**; Ardboe Point, Lough Neagh (H9675), 10.vii.1970**; Toome (H9790), 16.vi.1973**. **MAYO**: Hollymount (M2668), 25.iii.1923, Ruttledge*; Clare Island (L6-8-), 8.vi.1909, JNH and August 1911* (Grimshaw, 1912). **TYRONE**: Altadavan (H6065), 19.vi.1970, fox dung**; Altamullen (H1682), 9.viii.1987, cattle dung**; Moneygal Bog (H2489), 3.ix.1979**; Fintona (H4265), 5.vii.1978**. **WATERFORD**: Tramore (S5701)*. **WEXFORD**: Stoneyford (T1009), ♂ 19.iv.1987, JPOC*. **WICKLOW**: Killoughter Fen (T3199), 1.vi.1988, dunes, det. J. Valentine* (Valentine *et al.*, 1991).

Cosmopolitan. Synanthropic, chiefly coprophagous, on various kinds of droppings; cattle droppings, cow house, pasture, potato and rape fields, deciduous forest (Floren, 1989).

***Copromyza nigrina* (Gimmerthal, 1847)**

A common and widely distributed species throughout Ireland.

ANTRIM: Rea's Wood (J1485), 28.iv.1987, bred from decomposed leaf litter**; Shane's Castle (J1289), 13.vi.1987, cow pasture**; Dunseverick (C9943), 27.vii.1979, pitfall trap**; Doonfin (D1434), 29.viii.1987, cow dung**; Garry Bog (C9432), 14.v.1987, swept, bogland**; Straidkelly (D3016), 29.viii.1987**; Torr Head (D2340), 12.vi.1975, dead mouse**; **CAVAN**: Bellananagh Lake (H4000), ♀ 3.v.1982, JPOC*; **CLARE**: unlocalised (Pitkin, 1988); **DOWN**: Bloody Bridge (J0746), 19.viii.1972, baited trap (dead mouse)**; Mourne Wood (J2712), 11.viii.1979, deer droppings**; Strangford (J5849), 9.vii.1972, on cow dung, pastureland (Nash, 1989)**; Montalto Estate (J3651), 21.vii.1979, cow dung**; Murlough National Nature Reserve (J4036), 21.v.1977, baited trap (dead shrew)**; Stormont (J3974), 27.v.1968, rotted grass cuttings**; Cairn Wood (J4577), 7.ix.1979, deer droppings**; Millisle (J6075), 3.vi.1970, dead lesser black-backed gull**; Castle Park, Bangor (J5081), 1.vi.1979, dead pigeon**; **DUBLIN**: Baldoyle (O2440)*; Howth (02839), 1910*; Dublin, Clondalkin (O065310), 2♂♂ 14-16.iii.1982 and 2♀♀ 16-29.iii.1982, Malaise trap, JMOC*; **FERMANAGH**: Marble Arch (Claddagh River Glen) (H1235), 14.vi.1990, dead fox**; Correl Glen National Nature Reserve (H0754), 6.vi.1987, dead chaffinch**; Ross Lough (near Carr's Bridge) (H1447), 9.vi.1980, horse dung**; Boa Island (H0862), 7.ix.1979**; Tawnawanny (north-west of Boa Island) (H0763), 8.vi.1980, dead crow**; north-east of Monawilkin Lough (H0953), 6.vi.1980, pitfall trap baited with dead mouse**; Conagher Forest (H0652), 3.vi.1973, baited pit fall trap (mouse corpse)**; **KILDARE**: Grand Canal (N9427), ♂ 11.iv.1982, JPOC*; **LONDONDERRY**: Annagh (H9694), 13.ix.1972, cut-over bog, dead blackbird**; **MAYO**: Hollymount (M2668), 17.ix.1922 and 25.iii.1923, stable windows, Ruttledge*; **TYRONE**: Altadavan (H6065), 18.vii.1987**; Teal Lough (H7389), 1.viii.1987**; Knockmany Forest Nature Reserve (H5455), 1.viii.1979, deciduous forest**; **WICKLOW**: Killoughter Fen (T3199), January 1988, dunes* (Valentine *et al.*, 1991); unlocalised (Pitkin, 1988).

Palaearctic and widespread. Coprophagous, chiefly in dung from large mammals: horse droppings, pastures, cow house, potato and rape fields (Floren, 1989).

***Crumomyia fimetaria* (Meigen, 1830)**

synonym *Borborus suillorum* Haliday, 1836

There are four type specimens of *B. suillorum* are in the Haliday Collection in NMI. All are labelled "Ireland". These are the four specimens mentioned by Collin (1914). "Inhabits fungi in England and Ireland, but is rather uncommon" (Haliday, 1836).

ANTRIM: Barnett's Park (J3268), 6.vi.1973, swept from rank vegetation by stream**; Massereene (J1485), 17.vi.1978, sap run (spruce). **DOWN**: Bangor (J5-8-), 15.iii.1966, AGI**; Seaforde (J4041), 26.vii.1975, baited trap (dead mouse)**; Holywood (J4-7-), Haliday*; Newcastle (J4-3-); Rostrevor (J1817), 19.vii.1995, tree stump (in sap)**. **FERMANAGH**: Boho (H1146), 19.viii.1986, rotten fungi**. **LONDONDERRY**: Castlerock (C7730), 14.v.1987, on dead seal**. **OFFALY**: Charleville Woods (N3122), 2♂♂ 27.v.1984, PJC. **TIPPERARY**: unlocalised. **WESTMEATH**: Lough Derravaragh (N4066), ♀ 16.iii.1982, JPOC*. **WEXFORD**: Rosslare Harbour (T1312), ♂ 2.iv.1991, JPOC*.

Widespread in Europe. A polysaprophagous species: wet deciduous forest, mountain birch forest, peat bog, marshes, moose dung, tree stump in sap, kitchen refuse, pasture, on snow (Floren, 1989). On decaying fungi (genera listed) and fungus-impregnated wood (Chandler, 1990).

***Crumomyia nigra* (Meigen, 1830)**

Collin (1914) found six correctly named specimens in the Haliday Collection in NMI. The authors have traced only three of these (all British). "Not common in Ireland" (Haliday, 1836 as *Borborus niger*). Haliday's (1836) comment "generally on mountain heaths" is interesting since this is a northern and western species in Britain. The authors have also found *C. nigra* commoner at higher altitude.

ANTRIM: Aghalee (J1265), 19.vi.1970**; Glenariff (D2019), 16.viii.1987, sheep dung**. **ARMAGH**: Ardmore Point, Lough Neagh (J0264), 31.viii.1974. **DOWN**: Bloody Bridge (J0746), 24.vi.1972, pitfall trap**; Larchfield (J3058), 16.vi.1987, piggery**; Broomhedge (J2061), 13.vi.1984, stable refuse (horse)**; Leitrim (J2326), 12.v.1984**. **FERMANAGH**: Boho (H1146), 3.vi.1984, rotten birch log**; Aghagrefin (H2167), 8.vi.1980, sheep dung**; Aghatirourke (H4130), 6.vi.1980, rotted cow dung**; Bolusty Beg (H0557), 21.vi.1984**; Drumlish (H1250), 21.vii.1979**. **LONDONDERRY**: Annagh (H9694), 13.ix.1972, rotten fungus**. **SLIGO**: Ben Bulben (G6846), July 1904*. **TYRONE**: Altamullen (H1682), 9.viii.1987, sheep dung**; Moneygal Bog (H2489), 3.ix.1979**. **WICKLOW**: Blackditch Wood (O3103), May 1990, det. J. Valentine; Blackditch Wood (O3103), June 1988, bred from rotten birch; Killoughter Fen (T3199), January 1988* (Valentine *et al.*, 1991).

Europe. Common on dung from sheep, cattle and horse: cowpats (Floren, 1989).

***Crumomyia nitida* (Meigen, 1830)**

synonym *Borborus hamatus* Haliday, 1833

Four Haliday paralectotypes of *B. hamatus*, labelled "Ireland", are in the Haliday Collection in NMI, designated by Norrbom (Norrbom and Kim, 1985) but there is no lectotype. Haliday (1833 as *B. hamatus*) states "In woods; not common" while Haliday (1836 as *Borborus nitidus*) notes "Inhabits fungi; not abundant in England and Ireland".

ANTRIM: Crumlin (J1576), 5.vi.1982, leaf litter, wooded stream side**. **CLARE**: near Ennis (R292796), ♂ 30.v.1984, JPOC*; Lisdoonvarna (R134979), 2♂♂ 21.iv.1982, JMOC*; Lough Derg, ♂ 18.v.1970, PJC. **DOWN**: Holywood (Haliday, 1833); Leitrim (J2326), 12.v.1984, damp woodland**; Strangford (J5849), 9.viii.1972, on cow dung, pastureland**; Clandeboye (J4980), 15.vii.1979, on fern, damp deciduous woodland**; Millisle (J6075), 6.vi.1970, on wrack, sea-shore**; Belvoir Park (J4046), 23.vii.1979, deciduous woodland**; Begny Lake (J3049), 11.v.1985**. **DUBLIN**: Dublin (O1-3-), 28.vii.1895*; Slade of Saggart (O033245), ♂ 7.viii.1981 and ♂ 1.vi.1981, JMOC*; Portmarnock, ♂ 17.vii.1971, sycamore woods, PJC. **FERMANAGH**: Aghagrefin (H2167), 8.vi.1980, sycamore stump**; Conagher Forest (H0652), 12.vi.1990, "needle" leaf litter, conifer forest**; Corry Point Wood Forest Nature Reserve (H1037), 30.vii.1979**. **GALWAY**: Leenane (L8862), March 1927*. **LAOIS**: Emo (N538052), ♂♀ 3.x.1982, JMOC*. **LONDONDERRY**: Toome (H9790), 16.vi.1973, deciduous woodland**; north-east of Monawilkin Lough (H0953), 6.vi.1980, dead frog. **LOUTH**: Drogheda (O0874), June 1894*. **MAYO**: Hollymount (M2668), 4.viii.1911*; Braddon Wood. **MEATH**: Laytown (O1671), 16.vi.1894*. **MONAGHAN**: Lough Egish, 21.v.1976, willow scrub by lake, J. H. Cole*. **TYRONE**: Altadavan (H6065), 18.vii.1987, acid grassland with reeds**; Teal Lough (H7389), 18.viii.1987**; Fairy Water (H7389), 26.v.1984, peat bog**. **WICKLOW**: Blackditch Wood (O3103), January 1988 and April 1989, bred from rotten birch (Valentine *et al.*, 1991); Enniskerry (O2417), 17.ix.1893*; Roundwood (O1903), 1.ix.1909; Avondale (T1985), ♂ 5.vi.1989, JPOC*.

Europe. A woodland species in shady places, adults occur during the whole year, damp deciduous forest by streams, wooded marshland (Floren, 1989). On fungi but not reared (i.e. accidentals) (Chandler, 1990).

***Crumomyia pedestris* (Meigen, 1830)**

DUBLIN: Slade of Saggart (O0324), 26.ii.1922, 700ft altitude, A. W. Stelfox*. **GALWAY**: Clifden (L6351), Haliday*. **WICKLOW**: Killoughter Fen (T3199), January and March 1988, bred from beef bait, det. J. Valentine (Valentine *et al.*, 1991).

North and Central Europe. Terricolous, mainly in lowlands on wet meadows, macropterous form extremely rare: a dried up reedy canal (Floren, 1989).

***Crumomyia roserii* (Rondani, 1880)**

CARLOW: Altamont Gardens (S8665), ♂ 31.iii.1991, JPOC*. **DOWN**: Rowallane (J4057), 3.v.1987, deciduous woodland, tree stump with old fungi**; Rostrevor (J1817), 12.v.1984, fungus-infested rotten log, oak woodland** (Nash, 1989). **WICKLOW**: Derrybawn (T1495), ♀

13.xi.1984, PJC; Glendalough (T1196), 11.x.1970, pair *in copula* on *Armillaria mellea*, PJC.

Europe (in South and Central Europe at higher altitudes). Collected on decaying fungi, mouse droppings, in caves and in rabbit holes: wooded marshland (Floren, 1989). Common on decaying fungi: on *Armillaria mellea* and reared from it (Chandler, 1990).

***Lotophila atra* (Meigen, 1830)**

synonym *Borborus geniculatus* Macquart, 1835

There are specimens, labelled "Ireland", in the Haliday Collection in NMI. Haliday (1836: as *Borborus ater*) "Every where common". "I have found this species near Holywood [Co. Down], and Mr Walker has taken it in England; but it seems very uncommon" (Haliday, 1836 as *L. geniculata*).

ANTRIM: Aghalee (J1265), 19.vi.1970, bog**; Newtown-Crommelin (D1417), 3.ix.1989, baited pitfall trap in pasture**. **ARMAGH**: Ballnery (J0260), 3.ix.1979, peat bog**. **CLARE**: unlocalised (Pitkin, 1988); Ballynalacken Castle woods, ♂ 19.v.1979, PJC. **CORK**: Glengarriff (V9256), 20.vii.1924, JNH*. **DONEGAL**: Dunfanaghy (C0237)*. **DOWN**: Bangor (J5-8-), 9.iv.1966, AGI**; Bloody Bridge (J0746), 24.vi.1972, pitfall trap baited with dead mouse**; Larchfield J3058, 16.vi.1987, cow-dung, pasture**; Rowallane J4057, 12.vii.1987, swept from cattle-grazed field**; **DUBLIN**: Santry (O1640), 12.iv.1895*; Blackrock, ♀ 4.vii.1973, C. E. Dyte, PJC Collection. **FERMANAGH**: Boho (H1146), 3.vi.1984, decomposed log (ash)**; Aghagrefin (H2167), 8.vi.1970**; Agatirourke (H1430), 6.vi.1980**; North-east of Monawilkin Lough (H0953), 2.vi.1985**; Conagher Forest (H0652), 30.vi.1973**; Lough Achork (H0455), 13.vi.1990**; Clyhannagh (Marlbank) (H1035), 2.viii.1986**; Lough Navar Forest Park (H0654), 7.vi.1980, dead crow on moorland**. **LONDONDERRY**: Annagh (H9694), 13.ix.1972**. **LOUTH**: Blackrock, ♂ 16.vii.1971, saltmarsh, PJC. **MAYO**: Hollymount (M2668), 17.ix.1922 and 26.iii.1923, grass tuft, Ruttledge*; Clare Island (L6-8-), July 1910* (Grimshaw, 1912); Clogher, near Westport (L9783), 7.viii.1911* (Grimshaw, 1912); Creggan, Clare Island (L6/7-8-), June 1909, JNH*; Westport Demesne (L9984), 29.vii.1911* (Grimshaw, 1912); Louisburgh (Grimshaw, 1912); unlocalised (Pitkin, 1988). **TYRONE**: Knockmany Forest Nature Reserve (H5455), 1.viii.1979**; Moneygal Bog (H2489), 3.ix.1979**; Fintona (H4265), 5.vii.1978, baited (dead mouse) pitfall trap**; Favour Royal (H6253), 1.viii.1987**. **WICKLOW**: Blackditch Wood (O3103), August 1988

(Valentine *et al.*, 1991); Bray, ♀ 30.vii-1.viii.1970, C. E. Dyte, PJC Collection.

Coprophilous; chiefly breeding in cow dung: cow houses, pastures, meadow with bushes, grass compost, potato fields, a watered pile of pulp-wood (Floren, 1989). On decaying fungi (Chandler, 1990).

***Norrbomia costalis* (Zetterstedt, 1847)**

synonym *Borborus vitripennis* Haliday, 1836 preoccupied

"On sandy coasts of Ireland; shores of Cornwall" (Haliday, 1836 as *Borborus vitripennis* Meigen).

ANTRIM: Portrush (C8540), 2.vi.1987, sand dunes, rabbit dung** (Nash, 1989).

WICKLOW: Blackditch Wood (O3103), April 1989, bred from rotten birch (Valentine *et al.*, 1991). Collin (1914) found three specimens in the Haliday Collection in NMI and a fourth very immature probably representing a variety described by Haliday, "Varies with the legs less hairy and much longer, the second joint of the hind feet not thickened" (Haliday, 1836).

Palaearctic. Coprophilous, larvae chiefly in horse dung: horse and cow droppings, pastures, marshes (Floren, 1989).

Limosininae

***Apteromyia claviventris* (Strobl, 1909)**

New to Ireland.

KILDARE: Newbridge Fen (N7616), ♂ 27.v.1984, PJC.

A fairly uncommon species in Britain (Pitkin, 1988). Not included in Floren (1989).

***Chaetopodella scutellaris* (Haliday, 1836)**

Limosina scutellaris Haliday, 1836

Collin (1914) found three specimens in the Haliday Collection in NMI but actually there are four. These (three Irish and one British) are evidently syntypes (mentioned as not examined by Roháček (1983)). "With No. 6 [*crassimana*], but not common; north of Ireland" (Haliday, 1836 as *Limosina*).

CLARE: unlocalised (Pitkin, 1988); Corkscrew Hill (M202028), ♂ 21.iv.1984, JMOC*.

WICKLOW: Bray, 2♂♂ 30.vii.1970, C. E. Dyte, PJC Collection.

Widespread in Europe. Also recorded from Africa. Common, chiefly coprophagous, classified as pasture symbovilous: pasture lands, cow houses, lake and river shores, damp deciduous forest, grass compost, potato and rape fields, tree stump in sap. Most specimens were collected in grazed meadows (Floren, 1989). On decaying fungi; a series on *Coprinus micaceus* (Chandler, 1990).

Coproica ferruginata **(Stenhammar, 1854)**

ANTRIM: Portrush (C8540), 21.vi.1992, sand dunes**; Antrim Bay, Lough Neagh (J1386), 5.vi.1973, cattle-grazed woodland**; Shane's Castle (J1188), 5.vi.1973, on horse dung, parkland** (Nash, 1989). **DOWN**: Seaforde (J4041), 26.vii.1975, pasture**; Mourne Wood (J2712), 23.vi.1975, baited (dead house sparrow) pit-fall trap**; Murlough National Nature Reserve (J4036), 1.vii.1974, grass-cuttings, garden**; Castle Park, Bangor (J5081), 1.xiii.1979, grass-cuttings; Cultra (J4080), 7.vi.1985, pasture**. **FERMANAGH**: Boho (H1146), 19.viii.1986, moss-covered partly decomposed tree stump**; Florencecourt (H1834), 3.viii.1986**. **LONDONDERRY**: 14.v.1987**. **MAYO**: Hollymount (M2668), 2.iv.1923, dung heap, Ruttledge*. **TYRONE**: Fintona (H4265), 3.vi.1973, cattle droppings, pasture**; Moy (H8456), 6.vi.1980, cattle droppings, pasture**. **WICKLOW**: Blackditch Wood (O3103), 5.vi.1990, det. J. Valentine* (Valentine *et al.*, 1991).

Cosmopolitan. Common on decaying matter and excrement, synanthropic, but also in natural habitats: cow houses, cattle droppings, pastures, potato and rape fields, maple in sap (Floren, 1989). Reared from many agarics and boleti but this is doubted by Roháček as no other data confirm it (Chandler, 1990).

Coproica lugubris **(Haliday, 1836)**

Limosina lugubris Haliday, 1836

Collin (1914) found "a number" of specimens in the Haliday Collection in NMI. There are, in fact, twelve (ten Irish and two British) and they are syntypes. "Common in the same situations with No. 6" [*Limosina crassimana*] (Haliday, 1836 as *Limosina*).

Palaearctic, in all parts of Europe. Pasture, symbovilous, pastures, cow houses, grass compost, potato fields (Floren, 1989).

Coproica vagans **(Haliday, 1833)**

Borborus vagans Haliday, 1833

Four syntypes from "Ireland" in the Haliday Collection in NMI. "Not rare on sea-weed"

(Haliday, 1833; 1836 as *Borborus*).

ANTRIM: Rea's Wood (J1485), 17.vi.1978, bred from rot-hole debris**. **DOWN**: Mourne Wood (J2712), 23.vi.1975, deciduous woodland**.

Cosmopolitan. On excrement and decaying matter: cow fields, pastures, grass compost, potato and rape fields (Floren, 1989). One male on fungus (not a true fungus feeder) (Chandler, 1990).

***Elachisoma aterrimum* (Haliday, 1833)**

Borborus aterrimus Haliday, 1833

synonym *Limosina nigerrima* Haliday, 1836

There are nine syntypes (two British and seven Irish) of *Limosina nigerrima* in the Haliday Collection in NMI. Collin (1914 under *L. nigerrima*) found only seven specimens. "Occurs along with No. 6 [*crassimana*], but very rare" (Haliday, 1836). Haliday appears not to have distinguished *L. nigerrima* and *B. aterrimus* in his Collection although describing both.

ANTRIM: Hilden (J2865), 4.vii.1987; Crumlin (J1576), 5.vi.1982, cattle droppings, pasture**; Botanic Gardens, Belfast, 30.vi.1980, latrine**.

Palaearctic. On excrement from large herbivores and in decaying vegetation, cow houses, cow pat, dung hill, pastures, grass compost, rotten tree stump (Floren, 1989).

***Gigalimosina flaviceps* (Zetterstedt, 1847)**

WICKLOW: Derrybawn (T1495), 2♀♀ 13.xi.1984, PJC; Glendalough (T1396), ♂♀ 10.xi.1986, PJC; Glendalough (T1196), ♀ 13.xi.1984, PJC. These records relate to the county cited by Chandler (1990).

A shade-loving species recorded from limestone caves, but also caught in light traps in woodland where it probably lives on wet leaves and fungus (Pitkin, 1988). Rarely recorded and not in Floren (1989).

***Gonioneura spinipennis* (Haliday, 1836)**

Limosina spinipennis Haliday, 1836

There are a lectotype and two paralectotypes (one British, two Irish), designated by Roháček (1983), in the Haliday Collection in NMI. There is a further British specimen in NMI and it should also be considered a paralectotype. "Occurs but rarely, in company with No. 6" [*Limosina crassimana*] (Haliday, 1836 as *L. spinipennis*).

ANTRIM: Hilden (J2865), 4.vii.1987**; Portrush (C8540), 2.vi.1987, dead Herring Gull, sand dunes**; Crumlin (J1576), 5.vi.1982, cattle droppings, pasture**; Botanic Gardens, Belfast, 30.vi.1980, latrine**. **CLARE**: unlocalised (Pitkin, 1988). **DOWN**: Newcastle (J3730), 30.viii.1991, wrack, sea-shore**; Broomhedge (J2061), 21.viii.1988, stable (horse)**; Castle Park, Bangor (J5081), 21.vi.1990, decayed grass-cuttings**. **LONDONDERRY**: Cromore, (C8337), 21.viii.1982**. **TYRONE**: Fintona (H42655), 6.vii.1978, pasture**. **WICKLOW**: Blackditch Wood (O3103), June 1990, det. J. Valentine* (Valentine *et al.*, 1991).

Holarctic. A common, polysaprophagous species. Cow houses, dung hills and grass compost, refuse dump, pastures, latrine, potato and rape fields, maple in sap, lake and sea shores (Floren, 1989). Four reared from decaying tree fungi; on fungi (Chandler, 1990). An occasional pest found on the windows of houses.

***Herniosina bequaerti* (Villeneuve, 1917)**

New to Ireland.

MAYO: Hollymount (M2668), 7.vi.1923, mouth of rabbit burrow, Ruttledge*.

Widespread in Europe. Cavernicolous, living in caves, cellars and burrows of various animals (although the Swedish record is from a potato field) (Floren, 1989).

***Leptocera (Leptocera) caenosa* (Rondani, 1880)**

ANTRIM: Royal Victoria Hospital, Belfast (J3172), 21.vi.1997, blocked drain, RN**; Belfast in flour mill, 4♂♂ November 1978, PJC** (Chandler, 1990). **CORK**: Cork City (W6570), 24.ix,1984 (Good and Sleeman, 1988). **DOWN**: Stormont (J3974), 16.v.1974**; Downpatrick (J4844), July 1979, blocked drain**. **DUBLIN**: Dublin (O1432), June 1980, P. Reilly, det. B. R. Pitkin, milk solids in blocked drain* (Nash and O'Connor, 1982); Rathgar, a window ledge inside a shop.

A common synanthropic species which breeds in human sewage; frequently found associated with cracked soil pipes and blocked foul water manholes, often noticed on and around windows in buildings, rarely found outdoors (Pitkin, 1988). Cosmopolitan, synanthropic, breeding in human sewage: latrine, cow houses, poultry farm, potato fields, grass compost (Floren, 1989).

***Leptocera (Leptocera) finalis* (Collin, 1956)**

SLIGO: Ballysadare Bay, ♂ 13.v.1970, saltmarsh, PJC (county record in Chandler, 1990).

A rare species; recorded from four sites in England and one in Scotland (Pitkin, 1988). Not in Floren (1989).

Leptocera (Leptocera) fontinalis **(Fallén, 1826)**

There are five specimens, labelled "Ireland", in the Haliday Collection in NMI. Collin (1914) also found five Haliday specimens under *L. arcuata* in NMI but the series included *L. nigra* Olivier. "Every where rather common in shady situations, on fungi, &c." (Haliday, 1836 as *Limosina arcuata* Macquart).

CLARE: Lough Derg, ♀ 18.v.1970, PJC. **DUBLIN**: Howth, 3♀♀ 17.vii.1971, PJC; Slade of Saggart, Lugg Hill (O0324), ♀ 26.ix.1999, PJC. **FERMANAGH**: Lough Achork (H0455), 10.vii.1973**. **MAYO**: Hollymount (M2668), 24.ix.1922 and 7.iv.1923, decaying fungus and mouth of rabbit burrow, Ruttledge*; Westport Demesne (L9984), 20.vii.1911, garden*; Clare Island, Westport and Belclare (Grimshaw, 1912). **WESTMEATH**: shore of Lough Derravaragh, ♀ 14.v.1970, PJC; Lough Derravaragh (N400660), ♂ 16.iii.1982, JPOC*. **WICKLOW**: Blackditch Wood, (O3103), May 1989, coll. and det. P. Withers, also January 1988 (Valentine *et al.*, 1991); near Dunlavin, ♀ 11.vii.1971, beechwood, PJC; Powerscourt, ♀ 10.vii.1971, shaded stream, PJC.

Widespread in Europe (also recorded from Tunisia, Central Asia, Far East, the Nearctic, Neotropical and Afrotropical Regions) (Floren, 1989).

Leptocera (Leptocera) nigra **Olivier, 1813**

Collin (1914) found three specimens, two labelled *[Limosina] arcuata* in the Haliday Collection in NMI. These are extant and are from Ireland.

ANTRIM: Rea's Wood (J1485), 20.ii.1974, bred from rot-hole debris**. **DUBLIN**: Strawberry Beds, River Liffey (O0635), 2♂♂ 26.ix.1999, PJC. **LONDONDERRY**: Annagh (H9694), 13.ix.1972, rotten fungus**. **TYRONE**: Altamullen (H1682), 9.vii.1987**.

Temperate areas of the Palaearctic Region. Thermophilous, common in damp places: wet meadows, marshes, grass compost, maple in sap, cow house, potato and rape fields (Floren, 1989).

Leptocera (Leptocera) oldenbergi **(Duda, 1918)**

New to Ireland.

OFFALY: Charleville Woods (N3122), ♂ 15.vi.1985, PJC.

A rare species known from rabbit burrows, on grass and on cow dung in woods (Pitkin, 1988). Not in Floren (1989).

***Leptocera* (*Rachispoda*) *cryptochaeta* (Duda, 1918)**

OFFALY: Charleville Woods (N3122), ♂ 27.v.1984, PJC. **WESTMEATH**: Lough Ballynafid (N4160), ♂ 10.vi.1985, PJC. **WICKLOW**: Blackditch Wood (O3103), May 1989 and June-July 1990, coll. and det. P. Withers, det. J. Valentine* (Valentine *et al.*, 1991).

Known from Europe. Rare, poorly known, found in wet places in coastal as well as in inland habitats: marshes and wet meadows (Floren, 1989).

***Leptocera* (*Rachispoda*) *fuscipennis* (Haliday, 1833)**

Borborus fuscipennis Haliday, 1833

Collin (1914) found six specimens in the Haliday Collection. There are now five (all Irish) - a lectotype and four paralectotypes designated by Roháček (1991b). The Haliday specimen (from Holywood, Co. Down) in La Specola, Florence, should also be considered a paralectotype. "Common on marine rejectamenta" (Haliday, 1833 as *B. fuscipennis*). "Inhabits seaweeds drying on the shore" (Haliday, 1836 as *Limosina fuscipennis*).

WICKLOW: Blackditch Wood (O3103), April 1989, bred from rotten birch and from birch litter (Valentine *et al.*, 1991).

Widely distributed in the Holarctic region. Common, halophilous, larvae develop in saline mud: seaweed on seashore, salty marshes and meadows behind sea-wall (Floren, 1989).

***Leptocera* (*Rachispoda*) *limosa* (Fallén, 1820)**

Haliday's (1836) records of *Limosina limosa* probably refer to *L. lutosa* q.v.

MAYO: Castlebar Lough (M1491), 3.vi.1911*; Castlebar Lough, Westport and Clogher (Grimshaw, 1912).

Widespread in the Holarctic and Afrotropical Regions. In various wet and boggy places, sometimes on manure, larvae develop in mud and wet soil; on sea and lake shores, wet meadows behind sea wall, damp deciduous forests, potato fields, cow houses (inland) (Floren, 1989).

***Leptocera* (*Rachispoda*) *lutosa* (Stenhammar, 1854)**

Holywood (Haliday, 1833 as *Borborus limosus*) and "Very abundant on putrescent vegetable matter in most situations" (Haliday, 1836 as *Limosina limosa*). Collin (1914) says Haliday's records probably refer to *L. lutosa*: he found no *L. limosa* in his Collection in NMI and *L. lutosa* was unknown until 1854.

ARMAGH: Peatlands National Nature Reserve (H9061), 13.viii.1985, dead rabbit, birch woodland at edge of bog**. **DOWN**: Holywood (J4-7-) (Haliday, 1833 as *Borborus limosus*). **KILDARE**: Newbridge Fen (N7616), ♂ 27.v.1984, PJC. **OFFALY**: Cloghan Dam, ♂ 22.vi.1987, oak and beechwood, PJC. **WESTMEATH**: Lough Coosan (N050544), ♂2♀♀ 2.vii.1980, JPOC*. Lough Derravaragh (N400660), ♂ 16.iii.1982, JPOC*. **WICKLOW**: Blackditch Wood (O3103), May-June 1989, det. J. Valentine* (Valentine *et al.*, 1991); Killoughter, 15.viii.1951, sea coast (Smith, 1952); Bray, 5♂♂ 30.vii-1.viii.1970, C. E. Dyte, PJC Collection.

Holarctic. In various wet and boggy places, larvae develop in mud: marshland with pond, muddy sea and lake shores, by streams, grass compost, potato fields (Floren, 1989).

***Leptocera* (*Rachispoda*) *lutosoidea* (Duda, 1938)**

ANTRIM: Larchfield (J3058), 16.vi.1987, leaf litter sample, mixed woodland (Nash, 1989).

Holarctic. In wet and boggy places, larvae develop in mud: marshland with pond, muddy sea and lake shores, by streams, grass compost, potato fields (Floren, 1989).

***Limosina silvatica* (Meigen, 1830)**

Collin (1914) found "several" in the Haliday Collection in NMI. In fact, there are ten specimens, five of which are Irish. "Abundant, particularly on fungi; the variety with limpid wings on sandy coasts" (Haliday, 1836). In reality, this species is rarely on fungi. Instead, it is usually swept over leaf litter in woods in the authors' experience.

ANTRIM: Barnett's Park (J3268), 27.vii.1994, muddy edge of stream**. **ARMAGH**: Brackagh Bog National Nature Reserve (J0251), 30.vi.1979, leaf litter**. **CLARE**: near Spa, Lisdoonvarna (R134979), ♂ 8.vii.1981, JPOC*. **DOWN**: Holywood (J4-7-) (Haliday, 1833 as *Borborus sylvaticus*); Murlough National Nature Reserve (J4036), 2.viii.1972, leaf litter, light deciduous woodland**; Mourne Wood (J2712), 23.vi.1975, leaf litter, deciduous woodland**. **DUBLIN**: Slade of Saggart (O0324), 1937, emerged from a dead dog during March 1937, A. W. Stelfox*. **FERMANAGH**: Marble Arch (Claddagh River Glen) (H1235), 14.vi.1990**; Rossergole Peninsula, Castle Caldwell (H0160), 7.vi.1988, leaf litter, deciduous woodland**. **KILDARE**: Maynooth (N9437), May 1984*. **GALWAY**: "West Galway"*. **LAOIS**: Emo

(N538052), ♂ 3.x.1982, JMOC*. **MAYO**: Louisburgh, ♀ (Grimshaw, 1912). **WATERFORD**: Glasha River (S3022), ♂ 8.vii.1989, JMOC*. **WICKLOW**: Killoughter Fen (T3199), April 1988* (Valentine *et al.*, 1991); unlocalised (Pitkin, 1988).

Widespread in Europe. There are records also from Tunisia. Chiefly phytosaprophagous, developing in decayed vegetation in woodland areas: by streams in damp deciduous forest (Floren, 1989).

***Minilimosina (Minilimosina) fungicola* (Haliday, 1836)**

Limosina fungicola Haliday, 1836

The lectotype and a paralectotype of *M. fungicola* (labelled "Ireland"), designated by Roháček (1983), are in the Haliday Collection in NMI. Haliday (1836 as *Limosina*) states "Inhabits fungi, Holywood" [Co. Down]. *M. fungicola* is easily confused with similar species and Collin (1956) found that three species had been included under the name by Haliday, the others being *M. vitripennis* (Zetterstedt) and *M. v-atrum* (Villeneuve). More recently Roháček found that most authors had also confused *M. parvula* (Stenhammar) with *M. fungicola*.

DUBLIN: Stepaside (O1924) (Blackith and Blackith, 1993). **MAYO**: Hollymount (M2668), 17 and 24.ix.1922, 7.vi.1923, mouth of rabbit burrow, decaying fungus and prey of small empid fly, Ruttledge*.

Holarctic, common in the northern regions. Synanthropic. Chiefly saprophagous, in spite of its specific name rarely found on fungi: meadows, deciduous forests, by streams, grass compost, cow houses, potato and rape fields, piles of wood in coniferous forest (Floren, 1989). Due to the confusion with *M. parvula* (commonly associated with fungi), records of *M. fungicola* bred from fungi require confirmation.

***Minilimosina (Svarciella) v-atrum* (Villeneuve, 1917)**

There is one specimen, labelled "Ireland" in the Haliday Collection in NMI, det. J. E. Collin as *M. guestphalica* (Duda). Collin (1956) found that three species were confused under *M. fungicola* in the Haliday Collection, this being the third one.

Central and North Europe. Boreo-Alpine, collected on peat bogs, and in mixed forests: damp deciduous forests, marshes and peat bogs, muddy lake shores, potato and wheat fields, grass compost, pile of watered pulpwood (Floren, 1989).

***Minilimosina (Svarciella) vitripennis* (Zetterstedt, 1847)**

There are four specimens (labelled "Ireland") in the Haliday Collection in NMI.

GALWAY: Oughterard (M1242). **WICKLOW**: Blackditch Wood (O3103), April 1989, bred from soil at birch base* (Valentine *et al.,* 1991).

Palaearctic, widespread in Europe. In woods and woodland meadows, in Central Europe restricted to mountains: mountain birch forests, damp deciduous forest, lake shores, moorland, garden, cow house, potato and rape fields, maple (in sap) (Floren, 1989).

***Opacifrons coxata* (Stenhammar, 1854)**

Limosina quisquilia Verrall, 1888 nec Haliday, 1836

Collin (1914) found no specimens in the Haliday Collection in NMI but he located six individuals of *O. coxata* which Verrall had synonymized with *L. quisquilia*. One specimen is labelled "Ireland". However, Verrall's *quisquilia* is a misidentification: Haliday's *quisquilia* a nomen dubium. "Has [*quisquilia*] occurred once or twice along with *L. crassimana*" (Haliday, 1836).

FERMANAGH: Rossergole Peninsula, Castle Caldwell (H0160), 7.vi.1988, wet stones on lough shore** (Nash, 1989). **WICKLOW**: Blackditch Wood (O3103), January 1990, det. J. Valentine, and March and June 1988* (Valentine *et al.*, 1991).

Palaearctic, Oriental and Afrotropical. Common in boggy and marshy habitats, larvae develop in mud: wet meadows, marshy land, on river and lake shores, potato and rape fields, cow houses (Floren, 1989).

***Opalimosina* (*Opalimosina*) *mirabilis* (Collin, 1902)**

ANTRIM: Hilden (J2865), 17.vi.1993, in factory storehouse**; Crumlin (J1576), 5.vi.1986, in farm building, on window**. **DOWN**: Broomhedge (J2061), 10.vi.1986, stable (horse) refuse**; Murlough National Nature Reserve (J4036), 2.viii.1972, decayed fungus, light deciduous woodland** (Nash, 1989). **LONDONDERRY**: Toome (H9790), 16.vi.1973, deciduous woodland**.

Cosmopolitan. Polysaprophagous, chiefly coprophagous: cow houses, dung hills, grass compost, potato and rape fields, wooded marsh land, emerged from reeds (Floren, 1989).

***Phthitia* (*Alimosina*) *empirica* (Hutton, 1901)**

WICKLOW: Blackditch Wood (O3103), March-May 1989, bred from soil around birch and March 1989, bred from pigeon and March 1989, bred from crow; Killoughter Fen (T3199), April 1989, bred from *Phragmites* stem bases* (Valentine *et al.*, 1991).

Cosmopolitan. Necrophagous species associated with human settlements: cow houses (Floren, 1989).

***Phthitia (Kimosina) longisetosa* (Dahl, 1909)**

DOWN: Mourne Wood (J2712), 23.vi.1975, mouse run, deciduous woodland** (Nash, 1989). **MAYO**: Hollymount (M2668), 26.iii.1923, grass tuft, Ruttledge*.

Widespread but rare in Europe. In damp deciduous forest and meadows, under cut sedge. In runs and nests of small mammals; damp woodlands and meadows, reeds along lake shores, marshes, potato and rape fields (Floren, 1989).

***Pseudocollinella humida* (Haliday, 1836)**

Limosina humida Haliday, 1836

Collin (1914) found "a number" of specimens in the Haliday Collection in NMI. However, there are ten (eight labelled "Ireland", two "British") and all syntypes. "Ireland", unlocalised (Pitkin, 1988).

ANTRIM: Barnett's Park (J3268), 27.vii.1994, muddy edge of stream**. **CLARE**: near Rathborney River, Burren (M210052-202049), 2♂♂ 16.vii.1981, JMOC*. **DOWN**: "Not rare about muddy drains near Holywood" (Haliday, 1836 as *Limosina*). **FERMANAGH**: Ross Lough (near Carr's Bridge) (H1447) 17.ix.1973, muddy edge of pool. **KERRY**: Torc stream (V962847), ♀ 10.ix.1981, JPOC*; **KILDARE**: Newbridge Fen (N767166), ♀ 11.ix.1985, JPOC*; Rye water (O005363), 3♀♀ 9.viii.1981, JMOC*. **LIMERICK**: Lough Gur (R627414), ♂ 7.vii.1987, JPOC*. **MAYO**: Hollymount (M2668), 21.ix.1922, on stagnant rain water, Ruttledge*. **SLIGO**: unlocalised (Pitkin, 1988). **WEXFORD**: Wexford (T0519), ♀ 2.ix.1980, JPOC*. **WICKLOW**: Blackditch Wood (O3103), May-June 1990, det. J. Valentine* (Valentine *et al.*, 1991); Glen of the Downs (O263110), ♂ 27.viii.1981, JPOC*; Russellstown Park (N964109), 2♂♂4♀♀ 16.vii.1981, JMOC*.

Widespread in the Old World. In boggy places with pools, larvae develop in sub-aquatic mud; marshes, wet meadows, by lakes and streams, potato fields, piles of watered pulpwood, cow house, on snow (Floren, 1989).

***Pteremis fenestralis* (Fallén, 1820)**

synonym *Borborus nivalis* Haliday, 1833

synonym *Limosina erratica* Haliday, 1836

There is a specimen labelled "Type" in the Haliday Collection in NMI, presumably by J. E. Collin. This despite his (1914) statement that he failed to find this species in Haliday's Collection. The type series of *L. erratica* has not been traced. "Not uncommon during the winter about the roots of trees in the north of Ireland: leaps very actively" (Haliday, 1836 as *L. nivalis*).

DOWN: Holywood (J4-7-), "About the roots of trees during the winter; leaping far" (Haliday, 1833 as *B. nivalis*).

Europe. Terricolous, with wing dimorphism, brachypterous forms common only in North Europe: wet forest, marshes, peat bog, potato, wheat, oat and rape fields, cow houses, tree stump (in sap) (Floren, 1989).

***Pullimosina* (*Pullimosina*) *heteroneura* (Haliday, 1836)**

Limosina heteroneura Haliday, 1836

Collin (1914) found several specimens in the Haliday Collection in NMI. In fact, there are the lectotype (labelled "Holywood") and six paralectotypes (three Irish and three British) of *L. heteroneura* (Haliday, 1836), designated by Roháček (1983), in NMI. "In the same situations" [as *L. spinipennis*] (Haliday, 1836 as *Limosina*).

DUBLIN: Stepaside (O1924) (Blackith and Blackith, 1993). **FERMANAGH**: Marble Arch (Claddagh River Glen) (H1235), 14.vi.1990**.

Larvae infesting cultivated mushrooms; ex *Leccinum scabrum* group (Chandler, 1990).

***Pullimosina* (*Pullimosina*) *moesta* (Villeneuve, 1917)**

WICKLOW: Blackditch Wood (O3103), June 1990, det. J. Valentine* (Valentine *et al.*, 1991).

Seems to be widely spread in Europe. Terricolous, probably phytosaprophagous: potato and rape fields, grass compost, damp deciduous forest with stream, stump of alder tree (Floren, 1989). On decaying fungi (Chandler, 1990).

***Spelobia (Bifronsina) bifrons* (Stenhammar, 1854)**

Borborus clunipes Meigen, 1830 sensu Haliday, misidentified Haliday (1833) as *Borborus clunipes*.

Haliday's *B. crassimana* is the true *B. clunipes*. Collin (1914 as *Limosina clunipes*) found five specimens of *S. bifrons* in the Haliday Collection in NMI. There are now four (all labelled "Ireland").

ANTRIM: Rea's Wood (J1485), 28.iv.1987, bred from decomposed leaf litter**; Barnett's Park (J3268), 6.vi.1973, swept, rank vegetation by stream**. **DOWN**: Murlough National Nature Reserve (J4036), 2.viii.1972, light deciduous woodland**. **FERMANAGH**: Kesh (H1863), 6.vii.1986, woodland edge**. **KILDARE**: Newbridge Fen (N767166), ♀ 11.ix.1985, JPOC*.

A fairly uncommon species in Britain; mostly southern and not Scotland (Pitkin, 1988). Not given in Floren (1989).

***Spelobia (Eulimosina) ochripes* (Meigen, 1830)**

Collin (1914) found eight specimens in the Haliday Collection in NMI. However, ten are actually present. Of these, three are labelled "Ireland", two "Ptmarnock" and five "British". "Not rare on sandy coasts of Ireland": Holywood (Haliday, 1833 as *Borborus*; 1836 as *Limosina*).

ANTRIM: Barnett's Park (J3268), 6.vi.1973, swept, rank vegetation by stream**. **DOWN**: Holywood (J4-7-), Haliday, Rondani Collection, Florence; Murlough National Nature Reserve (J4036), 2.viii.1972, light deciduous woodland. **DUBLIN**: Portmarnock (O2441)*.

Holarctic. Typical meadow species, living under grass: meadows and pastures, marshes, by streams and rivers, cow houses and cowpats, potato wheat and rape fields (Floren, 1989).

***Spelobia (Spelobia) baezi* (Papp, 1977)**

CLARE: unlocalised (Pitkin, 1988). **WICKLOW**: Blackditch Wood (O3103), June 1990, bred from mud in waterhole under roots of prostrate birch* (Valentine *et al.*, 1991).

Known in Britain from only eight males collected from rushes and silverweed or caught in Malaise or light traps (Pitkin, 1988). Not given in Floren (1989).

***Spelobia (Spelobia) cambrica* (Richards, 1929)**

CLARE: unlocalised (Pitkin, 1988). **WICKLOW**: Avondale Forest Park (T1986), ♂ 4.x.1980, on *Grifola gigantea* (record cited in Chandler, 1990).

A rare species (Pitkin, 1988). Not given in Floren (1989).

***Spelobia (Spelobia) clunipes* (Meigen, 1830)**

synonym *Limosina crassimana* Haliday, 1836

"A number" in the Haliday Collection in NMI (Collin, 1914). There are now the lectotype (labelled "Ireland") and six paralectotypes (four labelled "Ireland" and two "British") of *L. crassimana* (Haliday, 1833), designated by Roháček (1983), in NMI. "In profusion every where on dunghills and hotbeds, more rarely on fungi" (Haliday, 1836 as *L. crassimana*).

ANTRIM: Slievananee (D1621), 24.v.1975, sheep droppings, moorland, coll. AGI, det. J. W. Ismay and J. P. Dear**; Crumlin (J1576), 5.vi.1982, leaf litter, wooded stream side**. **FERMANAGH**: Castle Caldwell (H0260), 7.vi.1988. **LEITRIM**: Lough Rinn, ♀ 10.v.1970, PJC. **LONDONDERRY**: Toome (H9790), 16.vi.1973, deciduous woodland**. **MAYO**: Hollymount (M2668), 24.iv.1922, decaying fungus, Ruttledge*; Rocky Valley (O2314)*; Lough Conn (G1904), ♂ 13.vi.1985, PJC; Westport House (L9884), ♂♀ 14.vi.1985, PJC*. **OFFALY**: Charleville Woods (N3122), ♂ 27.v.1984, ♂ 15.vi.1985, PJC. **WATERFORD**: Mahon Falls (S3009), ♂ 20.vi.1991, JMOC*. **WICKLOW**: Blackditch Wood (O3103), January 1998, coll. Blackith, det. J. Valentine* (Valentine *et. al.*, 1991); Bray, ♂ 30.vii.1970, C. E. Dyte, PJC Collection; near Carrigower, ♂ 20.v.1984, birch scrub, PJC; Derrybawn (T1495), ♂ 13.xi.1984, PJC.

Widespread in the Holarctic Region. Common, polysaprophagous species with wide ecological tolerance: cow houses, dung hills, cow and sheep droppings, faeces, pastures and meadows, potato fields, ant hills, tree stumps in sap, rotting apples (Floren, 1989).

***Spelobia (Spelobia) luteilabris* (Rondani, 1880)**

ANTRIM: Hilden (J2865), 23.vi.1987, stable (horse)**. **DUBLIN**: Blackrock, ♀ 4.viii.1970, C. E. Dyte, PJC Collection. **MAYO**: Westport House (L9884), ♀ 14.vi.1985, PJC. **WICKLOW**: Blackditch Wood (O3103), September 1988, bred from crow (Blackith *et al.*, 1991).

Widespread in North America and Europe. Polysaprophagous, wide ecological tolerance with synanthropic as well as wild populations, cow houses, pastures, potato and rape fields, grass compost, meadow with bushes, meadow birch forest, marsh lake and stream shores (Floren, 1989). Ex *Leccinum scabrum* group; on *Meripilus giganteus* and *Armillaria mellea* (Chandler, 1990).

***Spelobia (Spelobia) manicata* (Richards, 1927)**

ANTRIM: Hilden (J2865), 7.v.1983, mouse nest in garden and 23.vi.1990, baited (dead mouse) pitfall trap** (Nash, 1989).

Not separated from *S. clunipes* in Pitkin (1988). Not in Floren (1989).

***Spelobia (Spelobia) nana* (Rondani, 1880)**

WICKLOW: Killoughter Fen (T3199), January 1988 (Valentine *et al.*, 1991).

Recorded from Central and North Europe. Little known polysaprophagous meadow species: wet meadows, marshes, peat bog, a watered pile of pulpwood, alder forest, maple (in sap), potato fields, emerged from dead beetle (*Hylobius abietis* (L.)) (Floren, 1989).

***Spelobia (Spelobia) palmata* (Richards, 1927)**

KERRY: Drominahassig waterfall, ♀ 15.x.1973, PJC. **MAYO**: Lough Conn (G1904), ♂ 13.vi.1985, PJC. **OFFALY**: Charleville Woods (N3122), ♂ 27.v.1984, PJC. **WICKLOW**: Blackditch Wood (O3103), May-July 1990* (Valentine *et al.*, 1991).

Known only from the Western Palaearctic region. Common, chiefly necrophagous: damp deciduous forest with pools and streams, meadow with bushes, marl pit, rotting apples, tree stump in sap, grass compost, elk droppings (Floren, 1989). Decayed fungi; tree fungus; decayed *Lactarius*, *Lentinus*, *Phallus*, tree fungi (Chandler, 1990).

***Spelobia parapusio* (Dahl, 1909)**

New to Ireland.

WICKLOW: Avondale (T1986), ♂ 4.x.1980, on *Grifola gigantea*, PJC.

Common in wet shady places, grass compost, maple in sap, cow house, cowpats, potato fields (Floren, 1989). On fungi (Haliday, 1836). On *Pholiota squarrosa* (Chandler, 1990). Not listed in Floren (1989). Pitkin (1989), gives southern Britain.

***Spelobia pseudosetaria* Duda, 1918**

New to Ireland.

ANTRIM: Hilden (J2865), 6.viii.1986, fermenting brewery waste; Rea's Wood (J1485), 28.iv.1987, bred from decomposed leaf litter**.

Widespread in the Palaearctic Region. Polysaprophagous, synanthropic, often indoors: cow houses, grass compost, potato fields, deciduous forest, meadow birch forest, on cheese (Floren, 1989).

***Spelobia (Spelobia) rufilabris* (Stenhammar, 1854)**

Collin (1914) found two males of the dark-legged form described by Haliday as *Limosina erratica* (Haliday, 1836) in the Haliday Collection in NMI. The specimens are labelled as British.

CLARE: Black Head (M155122), ♀ 2.viii.1988, JMOC*. **DOWN**: Murlough National Nature Reserve (J4036), 2.viii.1972, decayed fungus, light deciduous woodland**. **MAYO**: Hollymount (M2668), 17.ix.1922*; Achill (F6-0-), June 1909, JNH*; Achill (F6-0-), ♀ (Grimshaw, 1912). **WATERFORD**: Glasha River (S3022), ♂ 8.vii.1989, JMOC*. **WEXFORD**: Heritage Park, Ferrycarrig (T0122), ♂ 19.iv.1987, JPOC*.

Eurosiberia. In wet and shady places under decayed vegetation: damp deciduous forests, wet meadows, marshes, peat bogs, potato fields, cowpats, maple in sap (Floren, 1989). On *Meripilus giganteus* (Chandler, 1990).

***Spelobia (Spelobia) talparum* (Richards, 1927)**

DOWN: Rostrevor (J1817), 12.v.1984**. **FERMANAGH**: Castle Caldwell (H0260), 7.vi.1988, base of reed**. **WICKLOW**: Blackditch Wood (O3103), May-June 1990, det. J. Valentine* (Valentine *et al.*, 1991).

Widespread in Europe. Microcavernicolous, polysaprophagous. Gravid females frequently collected during migration searching for new burrows for oviposition: potato, wheat, oats and rape fields, mountain birch forests, deciduous forests, wet meadows and marshes, heather, moss, ruderal land (Floren, 1989).

***Telomerina flavipes* (Meigen, 1830)**

WICKLOW: Blackditch Wood (O3103), March 1989, bred from pigeon and March 1989, bred from crow; Killoughter Fen (T3199), May 1989, bred from crow* (Valentine *et al.*, 1991).

Cosmopolitan. Common, chiefly necrophagous but also on excrements: cow houses and grass compost, latrine, urinal, deciduous forest, potato field (Floren, 1989). Males have been found on a dead rabbit, on a dead sheep on sand dunes and in decomposing waste material at a bakery (Chandler, 1990).

***Thoracochaeta brachystoma* (Stenhammar, 1855)**

There are seven specimens (four Irish, three British) in the Haliday Collection in NMI. Haliday (1836) mentions (under *Limosina zosterae*) "There is a variety scarcely a third that size [of *L. zosterae*], but differing so little in other respects, that I cannot consider it a distinct species". Collin (1914) found seven specimens of *T. brachystoma*, which represent this variety, in the Haliday Collection in NMI but these bear no indication that they are Irish.

ANTRIM: Giants Causeway (C9444), 8.xii.1992, wrack seashore**. **DOWN**: Holywood (J4-7-), Haliday, Rondani Collection, La Specola, Florence; Murlough National Nature Reserve (J4036), 29.vi.1998, on wrack, seashore**.

Cosmopolitan. On seashores, rarely inland: seashores with seaweed, potato field, pile of watered pulpwood, cow house (Floren, 1989).

***Thoracochaeta zosterae* (Haliday, 1833)**

Borborus zosterae Haliday, 1833

There are a lectotype and a paralectotype (both Irish), designated by Roháček and Marshall (2000), in the Haliday Collection in NMI. Another two specimens, which were not sent to him, should also be considered paralectotypes. These are the four specimens found by Collin (1914). Haliday (1833 as *Borborus*) states "Common upon Zostera, drying on the shore". However no locality is given (although Holywood, Co. Down, is implicit). Haliday (1836 as *Limosina*) says "Common on sea-weed" but cites only British localities.

ANTRIM: Portrush (C8540), 23.viii.1984, wrack, seashore**; Giant's Causeway (C9444), 8.xii.1992, wrack, seashore**; Ballycastle (D1140), 12.viii.1970, wrack, seashore**; Rathlin Island (D1451), 5.vii.1973**. **CORK**: Sherkin Island, near Baltimore, ♂ 4.ix.1968, Broomfield and Seal (BMNH) (Roháček and Marshall, 2000). **DONEGAL**: Dooey, ♀ 10.v.1967, E. C. M. d'Assis-Fonseca (Roháček and Marshall, 2000). **DOWN**: Newcastle (J4-3-), 30.viii.1991**; Strangford (J5849), 9.viii.1972, wrack, seashore**; Murlough National Nature Reserve (J4036), 29.vi.1988, wrack, seashore**; Bangor (J5081), 14.iii.1971**; Killard (J6143), 9.vii.1975, seashore with seaweed**; Ballyquentin Point (J6245), 19.v.1974, wrack, rocky shore**; Portaferry (J5952), 10.viii.1972, wrack, rocky shore**. **DUBLIN**: Lambay (O1-3-), June 1906; Killiney Bay, 2♂♂3♀♀ 31.vii.1970, C. E. Dyte, PJC Collection. **GALWAY**: Roundstone (L6938), ♀ 6.vii.1938. **WEXFORD**: Fethard (S7905), ♂ 16.vi.1990, JPOC*. **WICKLOW**: Broad Lough (T3196), May 1988, bred from wrack; Bray, 7♀♀31.vii.1970, C. E. Dyte, PJC Collection.

Europe. On seashores, rarely inland: seashores with seaweed, cow houses, potato fields (Floren, 1989).

***Trachyopella* (*Nudopella*) *leucoptera* (Haliday, 1836)**

Limosina leucoptera Haliday, 1836

New to Ireland.

A specimen (lectotype) from "Ireland" and one British paralectotype, designated by Roháček and Marshall (1985), are in the Haliday Collection in NMI. The lectotype designation is however erroneous since this Irish specimen could not be a syntype (because the species was described only from England). These authors refer to "Dublin" male and female "Type" specimens in the Loew Collection, Humboldt University, Berlin. Described from near London by Haliday.

A rare, southern species in Britain (Pitkin, 1988). Not listed in Floren (1989).

***Trachyopella* (*Trachyopella*) *atomus* (Rondani, 1880)**

DOWN: Murlough National Nature Reserve (J4036), 29.vi.1988, on rabbit dung, sand dune system** (Nash, 1989).

Tends to be cosmopolitan (spread by man). Thermophilous, in various decaying matter: cow houses, grass compost, potato fields (Floren, 1989).

***Trachyopella* (*Trachyopella*) *lineafrons* Spuler, 1925**

New to Ireland.

LONDONDERRY: Coleraine, Broughshane Creamery (C8-3-), 15.i.1995, milk waste, creamery**. Thousands emerged from a cavity wall into which milk had spilt from a cracked sink pipe in a quality control laboratory (a large amount of milk over many years). Presumably a very substantial permanent population had existed in the cavity wall for some time, fed by daily flushings of tested waste milk.

Widely distributed in the Holarctic Region. On various decaying matter: cow houses, potato and rape fields, grass compost (Floren, 1989). A male was found in a drain conveying effluent from a factory (Chandler, 1990).

***Trachyopella* (*Trachyopella*) *melania* (Haliday, 1836)**

Limosina melania Haliday, 1836

There are the lectotype and two paralectotypes (labelled "Ireland") designated by Roháček and Marshall (1985) in the Haliday Collection in NMI. "Found with the last [*Limosina nigerrima*], but still more uncommon" (Haliday, 1836 as *Limosina*).

ANTRIM: Barnett's Park (J3268), 6.vi.1973, swept, rank vegetation by stream**.

Probably widespread in the Palaearctic (the only extra European record is from Mongolia). Breeding in various decaying matter: grass compost, potato and rape fields, cow houses and dung-hill, wet pasture (Floren, 1989). Both sexes were found on damp bonfire ashes and a female in bonfire smoke (Chandler, 1990).

Sphaerocerinae

***Ischiolepta nitida* (Duda, 1920)**

DOWN: Holywood (J4-7-), Haliday, det J. E. Collin*. **DUBLIN**: Santry, 12.iv.1895**. **FERMANAGH**: Kesh (H1863), 6.vii.1986, on badger carcase, woodland edge** (Nash, 1989).

Europe. Taken in small mammal burrows and in waterbirds' nests, sandy lake shores (Floren, 1989).

***Ischiolepta pusilla* (Fallén, 1820)**

There has been much confusion between this species and Meigen's *denticulata*. Collin (1914) considers specimens of *Sphaerocera pusilla* in the Haliday Collection represent Haliday's concept of *S. denticulata*. Although Kim found both species in the Haliday Collection, Haliday makes no reference to *pusilla*, lending support to Collin's contention. There are five specimens (labelled "Ireland"), determined by Kim, in the Haliday Collection in NMI. "In the same localities with the 1st species [*Sphaerocera subsultans*], but much less abundant" ((Haliday, 1836 as *Sphaerocera denticulata*).

ANTRIM: Aghalee (J1265), 19.vi.1970, bog**; Rea's Wood (J1485), 30.vi.1979, bred from rot-hole debris**. **ARMAGH**: Ballnery Bog (J0260), 3.ix.1979**; Brackagh Bog National Nature Reserve (J0251), 30.vi.1979. bog**. **DOWN**: Rostrevor (J1817), 12.v.1984; Killard (J6143), 9.vii.1975, beneath dead seagull**; Castle Park, Bangor (J5081), 14.vii.1979, sap run on conifer**. **DUBLIN**: Stepaside (O1924), 13-14.vii.91 (Blackith and Blackith, 1993); Portmarnock, ♂ 17.vii.1971, dunes*. **FERMANAGH**: Castle Caldwell (H0260), 7.vi.1988, base of reed**; Boho (H1146), 19.viii.1986, sap-run on damaged ash**; Bolusty Beg (H0557), 7.vi.1980**; Boa Island (H0862), 27.v.1984, deciduous woodland**; Lough Navar Forest Park (H0654), 7.vi.1980, moorland**; Castle Caldwell (H0260), 7.vi.1988, swept reed bed**. **LONDONDERRY**: Castlerock (C7735), 8.vii.1979, fox dung**; Ardboe Point, Lough Neagh (H9675), 23.v.1975, reeds, lake shore**. **MONAGHAN**: Lough Egish, 21.v.1976, willow scrub by lake, J. H. Cole, J. H. Cole Collection. **TYRONE**: Favour Royal (H6253), 1.viii.1987**; Killeter Bog (H0980), 5.viii.1979, bogland.

Common, developing in various matter: cow houses, dung hills, pastures, grass compost, urinal, maple in sap, wet meadows, lake shores, collected on snow (Floren, 1989). Ex compost for cultivated mushrooms; on *Polyporus squamosus* etc. (Chandler, 1990).

***Ischiolepta scabricula* (Haliday, 1836)**

Sphaerocera scabricula Haliday, 1836

New to Ireland.

"Two specimens in the box containing the *Borboridae* and some more in another part of the Collection" (Collin, 1914). There are five specimens (labelled "Ireland"), determined by Kim, in the Haliday Collection in NMI. Three of these bear Collin's "scabricula" labels. Haliday (1836) described *S. scabricula* from material taken "near London". Not listed as Irish in Chandler (1998).

Europe, Afrotropical, Asia and Oriental Regions. Rare, collected on dung possibly terricolous, grass compost, potato field, cow house (Floren, 1989).

***Ischiolepta vaporariorum* (Haliday, 1836)**

Sphaerocera vaporariorum Haliday, 1836

There are three type specimens (all labelled "Ireland") of *S. vaporariorum*, determined by Kim, in the Haliday Collection in NMI. Collin (1914) reports five specimens, four labelled "cucumbers". "I find it [presumably at Holywood, Co. Down] commonly on deliquescent cucumbers" (Haliday, 1836 as *Sphaerocera*).

ANTRIM: Rea's Wood (J1485), 14.vi.1973**. Not listed as Irish in Chandler (1998) since some doubts, now resolved, attached to the identity of the specimens in NMI.

Europe and North Africa, Coprophagous. Cow house (Floren, 1989).

***Sphaerocera curvipes* Latreille, 1805**

Sphaerocera subsultans: authors, misidentification

Collin (1914) found "Several" (actually there are four Irish and six British specimens) in the Haliday Collection in NMI. "Every where abundant on dunghills, hotbeds, &c" (Haliday, 1836 as *Sphaerocera subsultans* (Fabr.)).

ANTRIM: Lisnagunogue Bog (C9842), 22.vi.1976, on dead snipe**; Rea's Wood (J1485), 28.iv.1987, bred from decomposed leaf litter**; Crumlin (J1576), 5.vi.1982, leaf litter, wooded stream side**. **CAVAN**: Virginia Woods (N5987), ♂ 2.x.1989, JMOC*. **DOWN**: Holywood (J4-7-)* (Haliday, 1833 as *B. subsultans*); Murlough National Nature Reserve (J4036), 6.vii.1973, compost heap**; Cultra (J4080), 7.vi.1985, pasture**; Mourne Wood (J2712), 23.vi.1975, leaf litter, deciduous woodland**; Castle Park, Bangor (J5081), 14.vii.1979, sap run on conifer**. **FERMANAGH**: Corry Point Wood Forest Nature Reserve (H1037), 30.vii.1979**. **KERRY**: Mangerton (V9681)*. **LONDONDERRY**: Ardboe Point, Lough Neagh (H9675), 22.v.1995. **MAYO**: Castlebar Lough (M1491)* (Grimshaw, 1912); Hollymount (M2668), 25.iii.1923, stable windows, Ruttledge*; Westport Demesne (L9984), 20.vi.1911, garden*. **WATERFORD**: Mahon Falls (S3009), ♂ 5.vii.1988, JPOC*. **WEXFORD**: The Raven (T110260), ♂ 4.vi.1986, JPOC*.

A cosmopolitan species having wide ecological tolerance with larvae mainly coprophagous. It is also reported from cow houses, cow dung, pastures, potato fields, maple in sap, grass compost and on nettles (Floren, 1989). Decaying fungi, rotting tree fungi and *Polyporus squamosus* (Chandler, 1990).

***Sphaerocera monilis* Haliday, 1836**

Described from England (the New Forest and near London) (Haliday, 1836). There are no Haliday specimens in NMI.

LONDONDERRY: Ardboe Point, Lough Neagh (H9675), 22.v.1995, on decaying horse dung** (Nash, 1989).

Europe. Terricolous, occurring in decayed fungi and leaf litter, grass compost, gardens, potato fields, meadows with bushes (Floren, 1989). Decaying fungi, fungus on beech (*Fagus*) (Chandler, 1990).

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NOTES AND RECORDS ON THE IRISH WOODLICE (CRUSTACEA: ISOPODA), INCLUDING NEW SITES FOR *HALOPHILOSCIA COUCHI* (KINAHAN)

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Introduction

Relative to most invertebrate groups, woodlice have received a good deal of attention from Irish naturalists, beginning with John Templeton, who recorded the group around Belfast in the early years of the 19th century. Doogue and Harding (1982) provided an Irish distribution atlas which included a bibliography of over 130 references. Nevertheless, it is clear that much remains to be discovered. The following records, coupled with information from Cos Sligo and Leitrim (Cawley, 1996) suggest that some species, notably *Haplophthalmus danicus*, *Trichoniscoides saeroeensis* and *Porcellio dilatatus*, are significantly more widespread than the current information would suggest. New vice-county records are denoted by an asterisk (*).

Androniscus dentiger Verhoeff

*EAST DONEGAL: Bundoran, G8259, 7 September 1989, under rubbish on a road-side verge.

This distinctive woodlouse has now been recorded from all 40 Irish vice-counties.

Haplophthalmus danicus Budde-Lund

*NORTH KERRY: Killarney, V9590, 2 November 1995, a few specimens in and under a well-rotted log, at the edge of mixed planted woodland; Tralee, Q8415, 8 September 1996, under a log in disturbed planted woodland.

*MID CORK: Cork Docks, W6971, 27 November 1994, under a piece of wood on waste ground.

*EAST CORK: Cobh, W7966, 27 November 1994, under rubble on waste ground; Cork Docks, W7072, 24 April 2000, under a piece of dumped wood on a roadverge.

*WATERFORD: Waterford City, S6211, 30 June 1996, numerous specimens under a piece of wood on damp soil beside a ruined building; Lismore, X0498, 22 September 2001. Frequent under dead bark in disturbed riverside woodland, and present also under debris at the base of a hedge in a nearby schoolyard.

*WEXFORD: New Ross, S7127, 13 April 1998, one specimen under a piece of wood in a town park.

Clearly widespread in disturbed woodland and synanthrophic sites in Munster and south Leinster, but quite local and much less in evidence than *Haplophthalmus mengei*.

***Haplophthalmus mengei* (Zaddach)**

*LAOIS: Abbeyleix, S4282, 3 May 1996, one male under a stone in mixed woodland.

*CAVAN: Blacklion, H0737, 5 November 1996, hazel *Corylus* woodland.

***Miktoniscus patiencei* Vandel**

WEST CORK: Dunlough Bay, V7326, 9 May 1996, under stones on a coastal erosion bank; Trawleagaigh, Clear Island, V9521, 18 August 1996, frequent under stones on vegetated shingle beach; Pointabullaun, Clear Island, V9419, 19 August 1996, exposed grassy sea cliff. Present in association with *Trichoniscoides saeroeensis* at both Cape Clear sites.

Searched for elsewhere along the east Cork and Waterford coasts without success.

***Orithoniscus flavus* (Budde-Lund)**

*EAST CORK. Carrickabrick, W825991, 5 March 1999, a small population located under stones on riverbank.

NORTH EAST GALWAY: Tuam, M4351, 13 December 1993, waste area at abandoned railway station; Claregalway, M3733, 9 November 1996, scarce under stones along the banks of the Clare River.

The status of this species in Ireland is rather suspicious, especially in view of its recent discovery in Wales (Morgan, 1994). It is usually associated with areas near rivers and streams, and this has been taken as evidence of its likely native status in Ireland. I have however a small number of more questionable records, e.g. from waste ground sites. Also I have quite a number of new 10km square records, many from Co. Limerick, as well as some from the Co. Waterford coast, including from shingle. Overall I am of the view that *O. flavus* is probably a long established alien in Ireland, which has become thoroughly naturalized in damp habitats, generally avoiding synanthrophic localities. Other undoubted aliens which usually turn up in natural habitats include the land planarian *Kontikia andersoni* Jones and the land nemertean *Argonemertes dendyi* (Dakin). Possibly it is slowly expanding its range away from the south-east.

Trichoniscoides albidus **(Budde-Lund)**

*LIMERICK: Ringmoylan Quay, R4057, 30 November 1998, one specimen under a stone on an estuarine erosion bank. Also present were *Trichoniscus pusillus* Brandt, *Porcellio scaber* Latreille, *Porcellionides cingendus* (Kinahan), and a few *O. flavus*.

Possibly this inconspicuous animal is under-recorded in Ireland. The above record would suggest that it is a native species here, however the few other occurrences have all been from disturbed sites.

Trichoniscoides saeroeensis **Lohmander**

*WEST CORK: Dunmanus Bay, V8839, 17 April 1996, frequent under stones embedded in a shingle beach.

*MID CORK: Fountainstown, W7958, 24 November 1996, under stones on a sandy sea bank.

CLARE: Inishmore, L7711, 19 July 1996, under a stone near a brackish drain.

*EAST DONEGAL: Pollarock, G8565, 4 June 1996, coastal erosion bank.

WEST DONEGAL: Tory Island, B8645, 1 September 1996, exposed coastal grassland.

This woodlouse is probably widespread along the Irish coast. It is certainly frequent along the two sections of coast with which I am most familiar, namely Cork/Waterford and Sligo/Leitrim. It is usually found under stones on cliffs and erosion banks.

Trichoniscoides sarsi **Patience**

DUBLIN: Under stones and rubbish beneath Japanese Knotweed *Reynoutia japonica* Houtt., behind houses on the south bank of the Royal Canal near Mountjoy Prison, O156360, 25 October 1999.

Trichoniscus pygmaeus **Sars**

*WATERFORD: Dungarvan, X2692, 18 November 1994, under stones in a graveyard.

*WEST GALWAY: Barna, M2423, 29 February 1996, under stones in oak *Quercus* - beech *Fagus* woodland.

Halophiloscia couchi **(Kinahan)**

*WATERFORD: Templeyvrick, Bunmahon, X429982, 4 May 1998. About 20 specimens present in deep fissures of a shaded sea cliff, in the splash zone. Also present were numerous *Ligia oceanica* (L.) and a few specimens of *P. scaber* and *P. cingendus*; Ballyvoyle Bridge, X335949, 13 September 1998. About 30 immature specimens noted at this site, on the underside of large boulders embedded in a shingle beach. The only other woodlouse present was *L. oceanica*. Numerous immatures also located here in August 2001.

Otherwise known in Ireland only from Howth Head, Co. Dublin, where it was first collected by Pack-Beresford (1908).

***Platyarthrus hoffmannseggi* Brandt**

*LAOIS: Durrow, S4077, 3 May 1996. In nests of the ant *Lasius niger* (L.), under stones on a gravelly scrape in a field.

I have noted the ant species with which *P. hoffmannseggi* occurred at 46 sites, mostly along the Co. Cork (23 sites) and Co. Waterford (15 sites) coasts, but with a few records also from Cos Laois (1), Wexford (3), Kilkenny (3) and Dublin (1). It was usually found in the nests of either *L. niger* (28 sites) or *L. flavus* (Fabr.) (23 sites). In fact at 13 sites, *P. hoffmannseggi* was found in the nests of both species. The remaining records were from the nests of *Myrmica ruginodis* Nylander (6) and *M. scabrinodis* Nylander (3). I have no records from the nests of *Tetramorium caespitum* (L.) or *Formica* sp., although these ants were present at some of the *P. hoffmannseggi* sites. Information plotted by Hames (1987) shows that *Lasius* sp. are the usual associates throughout the British Isles, however very little information is included from Ireland.

***Porcellio dilatatus* Brandt**

*WEST CORK: Ballyroge, V7826, 8 May 1996, one specimen under damp wood on a grassy roadverge, near a farmhouse; Ballyieragh, Clear Island, V9520, 20 August 1996, sieved from debris collected in an old cowshed.

*EAST CORK: Churchtown, W9173, 6 October 1999, frequent in debris collected from inside an old stone cowshed.

WATERFORD: Faithlegg, S6712, 16 September 2001, a few specimens under pieces of wood in a farmyard.

***Porcellio spinicornis* Say**

*LIMERICK: Croom, R5141, 18 November 1998, single specimen on a shop wall.

*WEXFORD: Enniscorthy, S9739, 16 September 1996, under rubble at the ruins of an old stone building.

*WEST DONEGAL: Letterkenny, C1610, 29 September 1995, frequent under builders' rubble on a small patch of waste ground.

***Porcellionides cingendus* (Kinahan)**

*KILKENNY: Kilkenny Castle, S5155, 17 September 1995, a few specimens under stones at the edge of a mixed woodland.

*EAST MAYO: Claremorris, M3474, 5 November 1993, one specimen under a stone on a grassy bank along the railway track.

***Porcellionides pruinosus* (Brandt)**

*MID CORK: Ballyphehane, W6869, 8 March 1998, frequent under rubbish in a refuse tip.

*EAST CORK: Youghal, X0979, 27 July 1997, frequent under stones etc. in town refuse tip.

*WATERFORD: Ballynamuck, X2494, 26 September 1999. A small population noted at this site, under rubbish and pieces of wood on Dungarvan town refuse tip.

In my experience, small populations of this distinctive woodlouse are almost invariably present on large public refuse tips, and it is probably present on such sites in all parts of the country.

***Armadillidium album* Dollfus**

WEXFORD: The Raven, T1122, 10 October 1994, under drift wood, sand dune foreshore.

Searches along the Cork and Waterford coasts have failed to reveal any new populations, however the amount of available sand dune habitat is very limited and invariably much disturbed. Possibly new sites could yet turn up, especially in Co. Kerry.

***Armadillidium pulchellum* (Zencker)**

WESTMEATH: Tudenham Park, Lough Ennell, N4146, 31 May 1995, among lichen and moss on rocks in short lakeshore grassland.

***Armadillidium depressum* Brandt**

WATERFORD: Passage East, S7009, 10 June 2001, under debris on disturbed sea cliff, near village.

KILKENNY: Kilkenny City, S5156, 18 April 2001, numerous specimens under stones etc., in old graveyard at the railway station.

*WEXFORD: Ballyhack, S7010, 20 May 2001. Frequent in this area, and much the largest population so far discovered in Ireland. Present under stones in graveyard, with a few individuals spreading onto adjacent gorse *Ulex*-covered hillside. Common on low sea cliff adjacent to this, under ivy *Hedera*, and among stones at high water mark.

Otherwise reported in Ireland only from Waterford City (Cawley, 1997). Clearly well established in the south west, and possibly under recorded among abundant *Armadillidium vulgare*. It must have been present in Ireland for many years previous to its recent discovery.

***Armadillidium vulgare* (Latreille)**

*EAST MAYO: Charlestown, G4701, 15 November 1993, a few specimens under ballast on the disused Sligo-Limerick railway line. Additional colonies along this railway line in Co. Sligo are listed by Cawley (1996).

***Cylisticus convexus* (De Geer)**

*NORTH KERRY: Tralee, Q8213, 8 September 1996, under rubbish on waste ground.

MID CORK: Cork City, W6471, 6 April 1998, disturbed gravelly area along the River Lee.

EAST CORK: Cobh, W7966, 4 May 1995, under rubble on waste ground at the railway station.

KILKENNY: Newrath, S5913, 22 September 1996, waste ground at the railway line; Kilkenny City, S5156, 18 April 2001, a few specimens under stones in an old graveyard.

WATERFORD: Dungarvan, X2593, 26 September 1999, one specimen under a stone in a disturbed field; Abbeyside, X2793, 22 October 1999, under dumped rubbish behind sandy foreshore; Dungarvan, X2692, 25 March 2001, under stones in a graveyard.

WEXFORD: Wexford, T0521, 9 October 1994, under rubble on waste ground; Rosslare, T1312, 25 October 1994, waste area; Enniscorthy, S9739, 16 September 1996, waste ground; New Ross, S7127, 13 April 1998, town park.

*OFFALY: Tullamore, N3424, 26 July 1995, one specimen under a stone on disturbed rank grassland near the railway station.

DUBLIN: Bray, O2619, 30 June 1995, waste ground; Howth, O2739, 29 October 1998, under a piece of wood, boundary wall at the edge of a small sandy area.

WEST MAYO: Belmullet, F7032, 26 August 1997, disturbed field.

EAST DONEGAL: Bundoran, G8258, 7 December 1993, one specimen under a piece of wood at abandoned railway station.

C. convexus is widespread but quite local in Ireland, with a high proportion of records, as in the above list, coming from synanthrophic sites. None of the more natural occurrences, e.g.

road verges and coastal sites near human habitations are entirely convincing, and it seems to me that *C. convexus* should probably be regarded as being a well naturalized alien in Ireland.

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ON THE PRESENCE OF *TIPULA (PLATYTIPULA) LUTEIPENNIS* MEIGEN (DIPTERA: TIPULIDAE) IN IRELAND

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In the checklist of Irish aquatic insects (Ashe *et al.*, 1998), *Tipula (Platytipula) luteipennis* Meigen is mentioned as only known from nineteenth century records and therefore in need of confirmation. These older records are Haliday (1833) and Walker (1856). The former lists the species from Holywood in Downshire (i.e. Co. Down) but with a question mark. The latter only includes a general reference to Ireland.

As a result, it is appropriate to report here material collected in the west of Ireland in 1974 by the author and one of his students. The records are as follows:-

GALWAY: Roundstone, 200m, blanket bogs, ♂ 22.ix.-3.x.1974, P. Oosterbroek.

MAYO: Cross, 4km east of Cong, ♂ 25-27.ix.1974, M. Dirks; Cong, meadows and ditches, ♂ 25-27.ix.1974, P. Oosterbroek.

The first two males are deposited in the Zoological Museum, Amsterdam while the third one has been presented to the National Museum of Ireland, Dublin.

The species has also been recorded from County Kerry by Hancock (1990). In addition, Northern Ireland is mentioned by Stubbs (1992). To-date, the known localities suggest that *T. (P.) luteipennis* is well distributed over the island but the scarcity of records may indicate that it is a local species. Abroad, *T. (P.) luteipennis* is a widespread tipulid, known from all over temperate Eurasia as far east as Mongolia. Adults are present from late August to the end of October, and can be found in all kinds of marshy and boggy habitats. The larvae are not strictly aquatic but live in wet soils.

Collected material, as well as material mentioned in the literature, usually has many more males than females. This imbalance arises because, despite the females having well developed wings (although somewhat shorter that in the males), they do not fly. Their flight muscles are largely atrophied (Dufour and Brunhes, 1984; Dufour, 1986) and part of the thorax can even be filled with eggs (Brunhes and Dufour, 1984). By contrast, south of the Alps, females are fully capable of flight. This material, known from Corsica, Italy, Sardinia and southern Switzerland, has been described as a subspecies (*agilis*) by Dufour and Brunhes (1984).

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FARMS AS BIOGEOGRAPHICAL UNITS: 1. HABITATS AND FAUNAL CHANGES AS INFLUENCED BY FARMER DECISION-MAKING ON A MIXED FARM IN SOUTH CORK, IRELAND

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Summary

Farms are proposed as functional biogeographical units, because of differences in land-owner and land-user decision-making between farms, and the effects of these differences on the flora and fauna surviving on individual farms. As a case study, the changes in management, habitat and species over a *circa* 65 year period, and the factors influencing the decisions causing these changes, were examined for a typical farm in south Cork. Although 75 species of bird, mammal, butterfly and dragonfly were recorded breeding or regularly utilising the 41.8ha farm in 2000, at least 12 species in these groups had been extirpated from the farm since the 1930s and 1940s. In addition, a habitat type (acidic or poor fen/flush) with a number of typical plant species had also been extirpated since the 1970s. The loss in biodiversity was mainly attributed to socio-economic factors, which caused changes in grassland management, and to generational socio-cultural changes (high yield ethic; part-time farming), which caused both an increased specialisation in winter cereals, and partial drainage and subsequent cessation of grazing of the area originally supporting the acidic fen/flush habitat. Since these processes operate at different times and with different intensities on adjacent farms, then it is likely that many habitats will survive as increasingly discrete, isolated entities on individual farms, rather than as contiguous areas of habitat encompassing neighbouring farms.

Introduction

As field biologists and naturalists, we familiarly use land areas defined by regional or ecological boundaries, such as counties, river catchments, mountains, lakes, fens, salt-marshes, etc. Reinforcing these ecological divisions of land are formal land designations, such as Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Natural Heritage Areas

(NHAs), and Areas of Special Scientific Interest (ASSIs) (Hickie, 1997; Bohnsack, 1997). Of course, land areas also have a socio-economic structure independent of the ecological fabric in which they exist, occurring as units of property from which land-owners and land-users earn a living by farming, forestry, tourism, fishing, quarrying and mining.

Socio-economic and socio-cultural factors, influencing the decision-making of land-users and land-owners, are of major importance in determining the distribution and local survival of our fauna and flora, arguably as important as climate and geochemistry, for instance. This is implicit to the objectives of EU-funded schemes to maintain biodiversity, particularly to those relating to the farming sector. Conservation-priority Irish habitats dependent on extensive farming practices include limestone pavement, calcareous grassland, machair, sand dunes, turloughs, fens, sea-cliff grasslands used by the chough (*Pyrrhocorax pyrrhocorax*), and wet or heathy grassland used by the marsh fritillary (*Euphydryas aurinia* Rottemburg). Yet, the functional link between farm or property unit structure and ecological concepts of land is not frequently made by biologists. There are obvious practical reasons for this, such as the difficulties of obtaining the land-use history of an individual farm and discovering a land-user's priorities, within the constraints of a biological survey. But there is also the divide between natural and social sciences instilled during training and by cultural tradition. Nevertheless, the question of how the distribution of land, as property units, relates to land areas defined by ecological boundaries is critical, because it is the land-users who will determine whether biodiversity is successfully maintained in a coherent spatial manner throughout a given landscape. Recent research on the Environmentally Sensitive Area (ESA) scheme in the Lake District (UK) has addressed this issue. MacFarlane and Smith (1997) surveyed farmers to assess their willingness to accept a third tier of ESA payments for inter-farm management co-operation between adjacent farms, with the objective of harmonizing land management for ecological benefit at the landscape scale.

The thesis is presented here that farms are biogeographical units, from a functional point of view, and therefore should be the subject of study as much as any ecologically-defined land unit. Here, a typical mixed (livestock + arable) farm in south Cork is taken as a case study of changes in farm habitats and fauna over a *circa* 65-year period, together with the decision-making processes which caused these changes. The farm is typical of those farms with both productive improved land and an area of semi-natural habitat which has not been completely reclaimed, or subject to long-term disuse.

At no stage in this text is any attempt made to ascribe values to decisions by farm owners or users. The aim of this account is to contribute to the objective understanding of a land property unit as a typical ecological-economic-cultural system. No conservationist criticism is intended in describing the impacts of farm practices as negative; this is simply stating how the system has behaved.

Methods

Vertebrate, butterfly and dragonfly species were recorded by regularly and frequently walking all areas of the farm during 2000. Bird species were considered to be breeding if individuals were heard calling or singing throughout the breeding season (probable), or observed carrying nest materials, or represented by young birds or active nests (confirmed). Mammals were considered to be breeding on the farm if they were observed or heard during the breeding season, or represented by active or recently-used nests or burrows. Bats were identified using an ultrasound bat detector. Butterflies and dragonflies were considered to breed on the farm if they were represented by individuals consistently present after expected emergence times.

Records of birds from years prior to 2000 were based on actual reliable observations of species present in the farm during the breeding season, or using criteria as above, by the author, or from anecdotal records provided by the then landowner during the 1940s and 1950s. Birds calling or displaying over a period of years were also included as probably breeding. A specific year was not used as the 'baseline' for species being present, because information was not available for any particular year in the 1930s or 1940s, and because the Economic War and the Emergency (World War II) influenced farming practice considerably between 1930 and 1950. It is therefore assumed that species present in the 1970s, but not recorded in the period from 1935-1950, were present in the latter period because the habitats present in the 1970s were also present in the 1940s.

Because the microhabitats of soil and decomposer faunal components of ecosystems are often not well represented by vertebrates, vascular plants or butterflies and dragonflies, they are included below as microhabitats. The presence of these microhabitats was observed by the author during the 1970s, or deduced from the occurrence of farming practices which supported them, as recorded by the then landowner during the 1940s and 1950s.

Nomenclature follows Stace (1997) for vascular plants, Whilde (1993) for vertebrates, Bradley (1998) for butterflies, and Hammond (1997) for dragonflies. Authors have been included for invertebrate names only.

Results and discussion

The following description of the site and its history are given in some detail, because of the relevance of this information to the subsequent parts of this series (Speight, 2001; Speight and Good, 2001), where the responses of the syrphid and sciomyzid faunas are discussed.

1. Site Description

The 41.8ha case study farm (referred to here as Glinny-Boulaling Farm) is in Glinny (*Glinne*) and Boulaling (*Buaile áilghean*) townlands, near Riverstick (*Áth an mhaide*) (Cullen D.E.D.; W6658 and W6659), south Co. Cork. It is located in an undulating topography of grassland and arable farmland, on upper Devonian Old Red Sandstone (Sleeman and Pracht, 1994, 1995), overlain by glacial till. Much of the farm is situated on the south- or west-facing gentle slope of an anticline, with brown podzolic soils on the slope, and gley soils occupying the basin at the foot of the slope (Gardiner and Radford, 1980) (Fig. 1). These two soil categories roughly define a similar division of the farm into well-drained agricultural land with improved grassland and cereal crops (on the podzolic soils), and poorly-draining land with semi-natural rough wet grassland, flushes, scrub and carr vegetation (on the gley soils) (Fig. 1). The upper horizons of the soils are naturally acid (pH *circa* 5.5), requiring the addition of ground limestone to increase soil fertility.

Hydrologically, the farm includes a watershed between two small tributary streams within the catchment of the River Stick. Springs arise at the base of the slope (at the margin of the gley soil), and some are tapped by underground French (stone) drains or surface drains. A number, however, arise as flushes in *Molinia caerulea* grassland and *Alnus* carr, although there is virtually no standing water in this area during the summer. Thus, the farm originally possessed a hydrologically isolated upstream wetland which, unlike riparian wetlands downstream, is, with the exception of one field, only affected by surface runoff (and runoff nutrient loads) from within the farm itself.

The three habitat divisions of the farm used by Speight (2001) are followed here: productive land, infrastructure habitats, and an area with semi-natural vegetation cover (referred to by Speight (2001) as disused land). Habitat types (following Fossitt, 2000) and their associated dominant or characteristic plant species are given in Table 1 (Many of the vegetation types characteristic of this part of south Cork were described by Browne (1999)). Most of the field boundaries are constructed of a double dry stone wall made from the local sandstone, filled with earth and small stones in the centre, which support rough grass and scrub along their crests. As habitats they encompass both the stone wall and earth bank categories of Fossitt (2000), and are therefore treated together in Table 1.

The semi-natural area includes alder carr (with some oak and holly), *Molinia* and *Deschampsia* wet grassland with flushes, and, in the absence of grazing and cutting, an annually increasing area of *Salix*, *Alnus*, *Ulex*, *Betula* and *Rubus* scrub (Table 1). Alder woodlands, often with a transitional oak-beech component, are characteristic of the south Cork landscape (Browne and Doyle, 1997). For this reason, *Quercus*, *Ilex* and *Blechnum* are included in the wet woodland class in Table 1. The habitat types acidic fen (see definition in Speight (2001)) and poor fen and flush (*sensu* Fossitt, 2000) are similar, and are referred to here as acidic/fen/flush. The area does not form part of any designated site.

The productive part of the farm (31.6ha in 2000) is utilised for winter cereal production, grass production for silage and pasture by beef and dairy replacement cattle, as well as less intensive hay and spring cereal production in three fields. Two fields were set-aside from cereal cropping in 2000. There were three separate land-users in 2000: the winter cereal land was leased, forming part of a large tillage enterprise; the beef and dairy replacement cattle were also grazed on lease, forming an out-farm for a dairy enterprise, and the remainder of the farm was managed by the land-owner family, who had an off-farm income during 2000. Average productive field size was 2.46ha (range 1.2-7.2ha) in 2000.

2. Site history

The original natural vegetation cover of the farm is likely to have been *Quercus petraea*-dominated forest (Bennett, 1989; Cross, 1998) on the brown podzolic soils, and probably *Alnus glutinosa* carr on the gley soils (Mitchell, F., 1976; Mitchell, F. J. G., 1995).

There are few historical records to hand which could reveal the landscape history of the area prior to the 19th century. Reliable anecdotal records suggest that wild boar, wolves and pine martens were hunted in the area in the 16th and 17th century, and became extinct in the area in the latter half of the 17th century, after which foxes were imported from Great Britain, even up to the 1890s (Daunt, undated). The above extirpated mammal species suggest that some form of woodland was still extensive in the landscape prior to the 17th century, during which extensive deforestation occurred in the Kinsale area (McCracken, 1971). However, heathland is also suggested by townland (Slieveroe) and estate (Heathburn Hall) names in the vicinity. Non-planted dry woodland is now absent from the local landscape.

Evidence for the presence of pasture on the farm during the historical period may come from one of the farm townland names, Boulaling, (*Buaile áilghean*) probably meaning a 'pleasant booley' (temporary milking place). The presence of burnt stone and timber, in the upper soil horizons of three areas of the farm near reclaimed springs or flushes, may possibly be the remains of summer camps for milch cow herders. The buaile pastures were improved to permanent dairy farms during the 18th century in south Cork (Whelan, 1997), a change which is likely to have included the Glinny-Boulaling area. It therefore appears, albeit on the basis of very meagre information, that there was little or no woodland or grassland habitat continuity in the immediate area from the early 17th century to the present day.

When enclosure occurred is not clear, but the farm appears to have been totally restructured in the first half of the 19th century, with construction of buildings, stone fences, etc. from locally quarried stone, and planting of beech, oak, elm and Scots pine, the latter also in the area now occupied by alder carr. However, there is no evidence that the part of the semi-natural area containing fen species in the 1970s was drained, or planted, and it was probably retained in its natural state as a 'snipe bog' for shooting. Thus, it is probable that open wetland habitat continuity was maintained through the 19th and 20th centuries.

The productive part of the farm always included grassland and cereals during the 20th century, but the enterprises have varied over the years, with a trend of increasing specialisation between 1935 and 2000. Eleven types of crop (spring barley, spring oats, spring wheat, sugar beet, turnips/mangolds, fodder rape, potatoes, hay, gorse, apples and top-fruits) and eight types of livestock (dairy cows, beef cattle, pigs, horses, egg-laying hens, geese, turkeys, honey-bees) were kept on the farm in 1930s, compared to three types of crop (winter barley, silage, hay) and three types of livestock (beef cattle, dairy replacement heifers, greyhounds) in 2000. Dairy, beef, sheep and cereals were produced up to 1978, when the dairy enterprise was discontinued, and sheep were discontinued in 1992.

Records are not available to enable an accurate estimate of stocking densities in the 1930s. Even if they were available, the relevance of such figures may be little more than general. Stock use of the semi-natural habitats (including acidic/fen/flush) is of particular importance in understanding traditional management and its impact, but stocking rates may not be relevant below a given threshold, in that these areas were not separated from productive grazing fields, and were used to provide a water supply and cool lying areas for cattle and horses during the summer. Thus, average stocking rates provide only a crude, general picture, and at the stocking rates likely to have occurred in the 1930s and 1940s, the impact of the stock on the wet habitats may have depended more on seasonal livestock behaviour and associated field use, than on overall stocking rate. In the 1970s, certain watering areas were preferred, and access to these areas regularly used and trampled, whereas excursions into other wet parts of the wet fen/flush area were less frequent. As pointed out by Aughney and Gormally (1999), livestock units also need to be interpreted according to the different breeds of cattle and horses that would have been present in the 1930s and 1940s.

The above-mentioned reduction in the diversity of farm crops and livestock produced on the farm is also reflected spatially, in that the cereals are grown on the same fields continuously, and other fields produce silage and pasture on the same land year after year. Rotations of grass and arable crops occur in three fields only. Combined with this trend was the development in the 1990s of a 'polarisation' of the farm into intensive management of the productive area, and cessation of agriculturally productive use of the semi-natural area, a characteristic of land management in western Europe with considerable ecological impacts (Hindmarch and Pienkowski, 2000; Asher *et al.*, 2001).

3. Changes in fauna and habitats

Major changes in farming practices during the period 1935-2000 are listed in Table 2, with a list of species and habitat (acidic/fen/flush) extirpated from the farm during this period, and the possible cause(s) of their loss. This is not a definitive list of species extirpated. For instance, it is possible that lapwing (*Vanellus vanellus*) and marsh fritillary (*Euphydryas aurinia*) bred on the farm in the 1930s or 1940s; because the available records are selective, this is not known. Also, a number of typical wetland plant species are likely to have been extirpated from the farm; the three listed in Table 2 are given as examples.

The species listed in Table 2 are considered to be extirpated from the farm because they are unlikely to re-establish under present management as a result of their habitat requirements, or their infrequent occurrence in the surrounding landscape. However, there is a further set of species which bred on the farm between 1960 and 1995 for which it is not possible to predict the potential for re-establishment, since they either regularly feed on the farm (*Carduelis cannabina* (linnet), *Meles meles* (badger)), or bred only occasionally (*Asio otus* (long-eared owl), *Turdus viscivorus* (mistle thrush)), or have fluctuating populations (*Argynnis paphia* (L.) (silver-washed fritillary), *Inachis io* (L.) (peacock butterfly)). Birds which regularly fed on the farm, but not recorded recently, are excluded from the list, because their loss is due to off-farm causes (*Larus ridibundus* (black-headed gull), *Turdus pilaris* (fieldfare)). Birds occasionally feeding on the farm during winter, recorded from 1970-1999 but not during 2000, are also excluded from Table 2 (e.g. *Anser* sp. (grey geese), *Carduelis flammea* (redpoll), *Circus cynaeus* (hen harrier), *Corvus corax* (raven)), *Larus argentatus* (herring gull), *Larus canus* (common gull), *Larus marinus* (greater black-backed gull), *Lymnocryptes minimus* (jack snipe), and *Pluvialis apricaria* (golden plover)).

A small number of the species recorded in 2000 are additions to the farm fauna since the 1980s, and probably did not occur on the farm in the 1935-50 period. These fall into two groups; those that responded to greater scrub and cover due to lack of use of infrastructural areas (*Anas platyrhynchos* (mallard) and *Sylvia atricapilla* (blackcap)), and those which have recently expanded their range locally (*Columba livia* (feral pigeon) and *Clethrionomys glareolus* (bank vole)).

Despite losses of species, 75 species of 'wildlife' (i.e. easily seen and identified vertebrates, butterflies and dragonflies) were recorded breeding, or regularly feeding, on the farm during 2000 (Tables 3 and 4). Of these 75 species, eleven are restricted to the semi-natural area (Tables 3 and 4). This compares with 19 species restricted to the infrastructure habitats, and seven species restricted to the productive habitats (although most of the latter are non-breeding) (Tables 3 and 4). A glance at these tables will also show the relative importance of the infrastructure habitats in terms of the total number of species supported.

Of the 11 recorded breeding vertebrate species extirpated from the farm during the last 65 years (Table 2), only two (common snipe and water rail) were restricted to the semi-natural area, even when fen/flush habitat was present. Of the 12 bird species occasionally utilising the farm, but not recorded during the last seven years, only two (long-eared owl (breeding) and jack snipe (winter feeding)) were restricted to the semi-natural area. None of the four breeding bird species restricted to the semi-natural area (Table 3) are particularly local in distribution in south Cork (Gibbons *et al.*, 1993). Furthermore, if the combined attributes of localised distribution and habitat specificity are considered (using descriptions from Cramp and Simmons (1977-1983), Cramp (1985-1988), Cramp and Brooks (1992), and Cramp *et al.* (1993-1994), and data from Gibbons *et al.* (1993), and even taking common snipe and water rail into account, the semi-natural area appears no more valuable than the infrastructural area. The occurrence of treecreeper and blackcap in the infrastructural habitats, for instance, could be seen to be equally valuable in local (south Cork) biodiversity terms. In terms of vertebrate species richness alone, then, the semi-natural area in its present state would not be regarded as the most important part of the farm.

But this is an incomplete interpretation of total biodiversity because:-

(1) it does not take ecosystem-level diversity into account (Perlman and Adelson, 1997); and (2) vertebrate species utilise a larger spatial scale than plants and invertebrates. If biodiversity is interpreted as ecological integrity (i.e. representing the autonomy of ecosystems (Norton, 1988, 1991)), then this semi-natural area with its characteristic species assumes much greater relative importance. Furthermore, wetlands have greater local historical continuity (see above), and are much scarcer than they were historically in the same landscape, compared to the habitats of species utilising the infrastructure and productive parts of the farm (The latter conclusion is based on the presence of wetland areas indicated in O.S. 1:10560 maps, combined

with a re-examination of selected examples of these areas within the catchment of the River Stick, many of which have been drained or reclaimed).

The greater relative biodiversity importance of the semi-natural area for invertebrates is indicated from an analysis of the syrphid and sciomyzid faunas of the farm, described in parts 2 and 3 of this series (Speight, 2001; Speight and Good, 2001). The specialisation in farming activities over the *circa* 65 year period, as well as habitat changes (Table 2), have also resulted in the loss of a number of decomposer microhabitats (Table 5). These are almost entitely associated with wetland habitat, or the diversity of now superceded farming practices (Table 5), the latter which provided habitats for mostly synanthropic species.

Taking the farm as an industry, the productivity per labour unit has increased greatly (estimated as 0.08 units/ha in 1935, and 0.01 units/ha in 2000), as has the standard of living and reduction in drudgery of work for those working on the farm. However, as these figures show, it required 100ha to make a full-time living from the farm in 2000, given the nature of the enterprises and facilities on the farm. Thus the farm as a unit was only viable as a part-time income source in 2000. This compares with *circa* 12ha to make a full-time living in 1935, when three families were supported by the farm, albeit in difficult economic conditions, on a full-time basis.

Selected socio-economic and socio-cultural factors influencing decision-making in relation to habitat change on the farm are indicated in Table 6. In this table, a number of terms have been used with specific meanings which require explanation. The term 'wildlife ethic' is used to mean 'conservation of wildlife habitat where feasible', where 'wildlife' refers to vertebrates, butterflies and dragonflies only. Obviously, this is only part of a biological conservation ethic, which encompasses other fauna, flora and landscape also, but it is 'wildlife' in the above sense that influenced land-user decisions on this farm, independent of any external agri-environmental scheme. The term 'progressive farming' is used in contradistinction to 'intensive farming', although these differences originate as much in terms of attitude (of a 1960s farmer compared to a 1990s farmer) with regard to the extent of use of inputs (e.g. fertiliser, machinery, pesticides, etc.). For instance, the introduction of lime application to soil was progressive farming; the use of maximum fertiliser applications was not; continuous arable cropping would be considered intensive, rotational cropping would have been preferred by progressive, but non-intensive farmers. The 'maximum yield ethic' was particularly important in decision-making on the farm in the early 1980s; it provides young farmers with a competitive measure, although it does not always result in the most profitable decisions being made in the medium- or long-term.

While there was always the necessity to maintain or increase income from efficient (i.e. in terms of labour costs) land use, it can be seen from Table 6 that land reclamation and major crop changes were strongly influenced by socio-cultural factors, in particular by generational change ('old ways giving way to new'). For instance, mechanisation (and machinery contracting) coincided with a new generation of farm manager, and the first drainage event occurred at the beginning of the family cycle. The second drainage event occurred at the next generation change, and cessation of grazing of the semi-natural area at the beginning of the second family cycle. However, although socio-cultural factors will modify the way in which land is used for income generation, it is important to note that a 'wildlife ethic' will be over-ruled by financial requirements during periods of low income generation. The sale of a field including an area of wet pasture, resulting in the extirpation of the butterfly *Coenonympha pamphilus* from the farm (Table 2), proceeded despite an appreciation of the habitat value of this area. Because of the investment in its purchase by the buyer, the sold land was reseeded for more productive pasture.

The latter observation raises a point which is critical during times of high land prices (as in 2000), namely that sale, or lease, of land will nearly always result in intensification of its use, because of the necessity for return on the high level of investment in its purchase. This has occurred not only on the case study farm, but also in a number of nearby farms in the landscape. It is likely to exert pressures in areas of designated habitat value, especially with tourist potential, despite the increasing division of the country (and European regions) into environmentally-supported zones and competitively-productive zones, as a result of possible changes in agricultural policies (Matthews, 2001).

Table 7 is the result of taking this consideration a step further, and predicts the results of habitat changes which could occur as a result of sale of the farm to a farmer specialising in tillage, who does not participate in the Rural Environment Protection Scheme. To recoup the considerable cost of investment in land, the output of the farm would have to be maximised, thus intensive cereal/maize/sugar beet cropping, and afforestation of the semi-natural area, would be predicted. From the habitat changes predicted, it is estimated that 32% of the breeding 'wildlife' fauna (recorded in 2000) could be extirpated as a result of such changes (Table 7 cf. Tables 3 and 4).

4. Interaction between semi-natural and productive areas

The division of the case study farm into semi-natural, productive and infrastructure sub-units provides a simplified description of how a farm works in relation to biodiversity. A great number of farms will only have productive + infrastructure subunits, but many will have all three subunits, and it is the latter type which is of interest here. The interaction between the semi-natural area and the productive area, in the case study farm, includes four generally feasible possibilities:-

(1) Cessation of productive use of the semi-natural area, because of the high cost-to-benefit ratio of maintaining it in production. This is what has happened in this case study farm, because the cost of fencing off the tillage land was not justified in terms of the low grazing value of the *Molinia*, *Deschampsia* and *Holcus* swards to cattle (Note that the tillage area is furthest from the farmyard, while the livestock areas are closest).

(2) Reclamation of the semi-natural area for a non-agricultural use, such as forestry or recreational tourism. In the case study farm, there are two feasible potential forestry developments:-

(2a) Planting sitka spruce (*Picea sitchensis*), an option which has been implemented on a number of similar soils and topographic areas in the same landscape. The potential acreage involved (5ha) also makes this feasible in terms of the economy of scale for timber extraction and marketing, especially for thinnings, where small quantities may be difficult to market. However, if this plan was implemented, the farm would be precluded from participation in the national agri-environmental scheme (Rural Environmental Protection Scheme (REPS)), because of the requirement to retain a viable proportion of semi-natural habitat (DAFRD, 2000).

(2b) Planting of alder and oak for forestry, based on the semi-natural occurrence of these species in this part of the farm. This could arguably be permitted under REPS throughout most of the semi-natural area (if carried out so that flushes were not disturbed during forestry operations), on the grounds that this was probably the original natural vegetation, and that the open wetland components of the area have been lost due to the previous drainage operations. The higher value of the timber of these tree species may also make selective harvesting and natural regeneration feasible commercial operations (However, as based on predictions of the response of the syrphid fauna (Speight, 2001), it appears that the open residual wetland areas are more important than the *Alnus* carr, for invertebrate biodiversity at least).

(3) Reclamation of the semi-natural area for a dairy enterprise, where the reclamation costs would be covered by economies of scale, due to maximising the number of dairy cows on a milking farm, while using out-farms for replacement heifers, dry cows and other cattle. This is the opposite of what has occurred in the case study farm, part of which is an out-farm for another dairy enterprise. The dairy option would probably not be feasible in this case, because of the scale of capital investment required to develop the farmyard to modern standards for a dairy herd.

(4) Extensive summer grazing of the semi-natural area, fencing costs for which will be offset by payments under agri-environmental schemes, such as REPS (or, if the semi-natural habitats were of conservation rating, under SAC or NHA management agreements), or the proposed Farm Habitat Management Scheme (Hickie *et al.*, 1999). The REP Scheme requires that grazing be carried out, if it is "required to retain the special qualities of the habitat" (DAFRD, 2000: 33). Unlike the other three categories above, this option requires that an extensive form of management be integrated into the management regime operating on the productive part of the farm. On the case study farm, this will be beneficial in a dry summer, when there may be a shortage of grass on the podzolic soils, but where grass growth will continue in the wetter gley soils. On the other hand, in the present configuration of the farm where the semi-natural area adjoins tillage land rather than pasture, this will not be a preferable option for dairy replacements which are in calf, because the forage quality of *Holcus lanatus*, *Molinia caerulea* and *Deschampsia caespitosa* is low relative to the productive land grasses. It may be an option for dry cows and weanling replacements, however, as part of their grazing rotation on productive fields.

It is noteworthy that, of the options mentioned above, it is only the latter option, which maintains existing habitat value, that requires a direct management interaction between the semi-natural and productive sub-units of the farm, without eliminating the former. Because the productive part of the farm is currently intensively managed, this inevitably means that the semi-natural areas will be managed in the context of the productive area, which will differ subtly from the traditional management of the combined productive and semi-natural areas historically. For instance, traditionally, cattle and sheep had access to the semi-natural area all year round, albeit with the absence of cattle outside in winter. Because of a more rotational paddock system, and the provision of piped water, for more intensive beef and dairy production, cattle would only be allowed into the semi-natural area as part of this rotation, and probably for short intensive periods. Thus it is not clear whether modified productive systems can provide the same habitat quality that traditional systems did, at least on this farm.

For biodiversity maintenance and restoration on the case study farm, there are two other related issues to which the two sub-unit concept applies. The first is restoration of habitats to bring back species extirpated from the farm. The second is the limitation on their return and future viability due to the isolated nature of the small semi-natural area, when it is taken on its own, independant of the landscape. Here again, the farm sub-unit concept requires us to realise that even if the semi-natural areas of a number of adjacent farms were linked, their productive sub-units may also have to act in harmony to some degree, in order that all the inter-farm semi-natural land could be managed in the same way. In practice, this is extremely unlikely. It is much more likely that the different options mentioned above will be selected by different farms, at least where the semi-natural land cover is located outside an NHA or SAC.

Conclusion

Examination of species and habitat changes on the case study farm, and the decisions made leading to those changes, shows how different farms can have different impacts on fauna, flora and habitats, depending upon socio-economic processes (e.g. full-time to part-time, owner-operated to leased) or socio-cultural factors (e.g. stage in family cycle, perception of wildlife value). In particular, the historical continuity of habitat management necessary for biodiversity maintenance (Kirby, 1992; Bignal, 1998) will be broken on many farms as a result of these processes. Outside designated areas, it is likely that many habitats will exist as increasingly discrete, isolated entities on individual farms, rather than as contiguous areas of habitat encompassing neighbouring farms. This may also occur within designated areas if pressures of return on investment in land, generational changes, and cessation of productive use of marginal land, cannot be countered by habitat conservation schemes. This means in effect that individual farms will increasingly act as biogeographical units. The implication for biodiversity maintenance is that habitat management of adjacent farms will need to take into account the practical economic and socio-cultural processes operating at farm level, which are responsible for the emergence of these biogeographical units.

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TABLE 1. List of habitats (with dominant or characteristic species) occurring on the case study farm, following the habitat classification of Fossitt (2000). Plant nomenclature follows Stace (1997). S = semi-natural area; I = infrastructure; P = productive land.

	S	I	P
Freshwater			
Artificial ponds (*Lemna*)	-	+	-
Drainage ditches (*Veronica*; Jungermanniineae (liverwort))	+	+	-
Grassland and marsh			
Improved agricultural grassland (*Agrostis*; *Cirsium a.*; *Lolium*; *Ranunculus*; *Rumex*; *Trifolium*)	-	-	+
Dry meadows and grassy verges (*Arrhenatherum*; *Conopodium*; *Dactylis*; *Festuca*; *Heracleum*; *Lathyrus*)	+	+	+
Wet grassland (*Agrostis*; *Alopecurus*; *Cirsium p.*; *Deschampsia*; *Galium*; *Holcus*; *Iris*; *Juncus e*; *Molinia*; *Potentilla a.*; *Ranunculus*; *Succisa*)	+	-	+
Marsh (*Filipendula*; *Juncus e*; *Lychnis*; *Mentha*; *Valeriana*)	+	-	-
Peatlands			
Poor fen and flush (residual) (*Carex*; *Juncus a*; *Molinia*; *Potentilla e/p*; *Sphagnum*)	+	-	-
Woodland and scrub			
Wet willow-alder-ash woodland (*Alnus*; *Betula*; *Blechnum*; *Ilex*; *Pinus*; *Quercus*; *Salix*)	+	-	-
Scattered trees and parkland (*Acer*; *Hippocastaneum*; *Quercus i.*; *Malus*)	-	+	-
Scrub (*Prunus*; *Myrica*; *Pteridium*; *Rubus*; *Sambucus*; *Ulex*)	+	+	-
Ornamental/non-native shrub (*Berberis*; *Fuchsia*; *Rhododendron*; *Symphoricarpos*)	-	+	-
Hedgerows (*Crataegus*; *Hyacinthoides*; *Ilex*; *Ligustrum*; *Lonicera*; *Prunus*; *Sambucus*; *Ulex*)	+	+	-
Treelines (*Acer*; *Fagus*, *Fraxinus*; *Pinus*; *Quercus*; *Ulmus* m/g)	-	+	-
Disturbed ground			
Refuse and other waste (*Arctium*; *Urtica*)	-	+	-
Cultivated and built land			
Arable crops, tilled land (*Anisantha*; *Chenopodium*; *Fumaria*; *Hordeum*)	-	-	+
Horticultural land (*Brassica*; *Phaseolus*)	-	+	-
Stone walls/earth banks (*Asplenium*; *Digitalis*; *Hedera*; *Primula*; *Pteridium*; *Umbilicus*)	+	+	-
Buildings and artificial surfaces	-	+	-

TABLE 1 (continued)

Species referred to above

Acer pseudoplatanus; *Agrostis stolonifera*; *Alnus glutinosa*; *Anisantha sterilis*; *Arctium minus*; *Arrhenatherum elatius*; *Asplenium ruta-muraria*; *Betula pendula*; *Berberis darwinii*; *Blechnum spicant*; *Brassica oleracea*; *Carex viridula*; *Chenopodium album*; *Cirsium arvense*; *Cirsium palustre*; *Conopodium majus*; *Crataegus monogyna*; *Dactylis glomerata*; *Deschampsia caespitosa*; *Digitalis purpurea*; *Fagus sylvatica*; *Festuca* sp(p); *Filipendula ulmaria*; *Fraxinus excelsior*; *Fuchsia magellanica*; *Fumaria officinalis*; *Galium palustre*; *Hedera helix*; *Heracleum sphondylium*; *Holcus lanatus*; *Hordeum distichon*; *Hyacinthoides non-scriptus*; *Ilex aquifolium*; *Iris pseudacorus*; *Juncus articulatus; J. effusus*; *Lathyrus pratensis*; *Lemna minuta*; *Ligustrum vulgare*; *Lolium perenne*; *Lonicera periclymenum*; *Lychnis flos-cuculi*; *Malus domestica*; *Mentha aquatica*; *Molinia caerulea*; *Myrica gale*; *Phaseolus coccineus*; *Pinus sylvestris*; *Potentilla anserina*; *Potentilla erecta*; *P. palustris*; *Primula vulgaris*; *Prunus spinosa*; *Pteridium aquilinum*; *Ranunculus repens*; *Rhododendron* sp.; *Rubus fruticosus* agg.; *Rumex crispus*; *R. obtusifolius*; *Quercus ilex*; *Quercus* x *rosacea*; *Salix cinerea*; *Sambucus nigra*; *Sphagnum* sp.; *Succisa pratensis*; *Symphoricarpos albus*; *Trifolium repens*; *Ulex europaeus*; *Ulmus minor*; *U. glabra*; *Umbilicus rupestris*; *Urtica dioica*; *Valeriana officinalis*; *Veronica beccabunga*.

TABLE 2. Major management changes in the case study farm in south Cork between 1935 and 2000, on each of the main soil types occurring on the farm, with examples of confirmed (*) or probable breeding species and habitats extirpated from the farm, and possible reasons for their loss.

Brown podzolic soils (productive land cover - improved pasture and cereals)

c. 1950	Tractor replaced horses
	Ground limestone applications began (to ameliorate soil acidity)
1964	Silage replaced hay and turnips/mangolds as main winter fodder
1979	Intensively managed winter cereals introduced
1984-92	Extensive grazing of sheep and cattle practised during this period
1993	Intensive (reseeded, regular fertiliser use) cattle grazing/silage replaced extensive (old pasture, little fertiliser use) grazing

Species extirpated	***Possible reason for loss***
Alauda arvensis (meadow pipit)*	Changes in meadow management throughout landscape
Anthus pratensis (skylark)	Changes in meadow/cereal management throughout landscape
Corvus frugilegus (rook)*	Persecution after introduction of winter cereals
Crex crex (corncrake)*	Changes in meadow management throughout landscape
Cuculus canorus (cuckoo)	Loss of meadow pipit hosts
Delichon urbica (house martin)*	Not known
Lacerta vivipara (vivip. lizard)	?-scrub encroachment of south-facing banks
Passer domesticus (ho. sparrow)*	Lack of outdoor poultry and cattle feeding
Tyto alba (barn owl)*	Changes in farmyard buildings; ?-rodenticide use

Gley soils (semi-natural land cover - *Molinia*, *Deschampsia*, *Alnus*, *Salix*)

1959	Partially drained and some scrub cleared
1981	Further partial drainage (main watercourse opened) and vegetation clearance
1991	One wet pasture field sold and reclaimed
1994	Cessation of extensive grazing

Habitat or species extirpated	***Possible reasons for loss***
Acidic fen (poor fen)	Drainage & associated vegetation clearance (1981)
Rallus aquaticus (water rail)	Drainage (1959)
Gallinago gallinago (snipe)	Drainage & associated vegetation clearance (1981)
Coenonympha pamphilus (small heath)	Sale, drainage & reclamation of wet pasture
Narthecium ossifragum (bog asphodel)	Drainage & associated vegetation clearance (1981)
Dactylorhiza maculata (heath spotted orchid)	Drainage & associated vegetation clearance (1981)
Scutellaria minor (lesser skull-cap)	Drainage & associated vegetation clearance (1981)

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TABLE 3. List of confirmed (*) or probable breeding birds (summer feeding refers to breeding adults), and other birds regularly utilising the case study farm for feeding or overwintering, recorded during 2000. Occasional, passage or singing male birds are excluded. Nomenclature follows Whilde (1993).

Breeding	*Parts of farm used for breeding/summerfeeding*		
	Semi-natural	*Infrastructure*	*Productive*
Acrocephalus schoenobaenus (sedge warbler)	+	-	-
Aegithalos caudatus (long-tailed tit)*	+	-	-
Emberiza schoeniclus (reed bunting)	+	-	-
Phylloscopus trochilus (willow warbler)	+	-	-
Anas platyrhynchos (mallard)*	-	+	-
Carduelis carduelis (goldfinch)*	-	+	+
Carduelis chloris (greenfinch)	+	+	-
Certhia familiaris (treecreeper)	+	+	-
Columba livia (feral pigeon)*	-	+	+
Columba palumbus (wood pigeon)*	+	+	+
Corvus monedula (jackdaw)*	-	+	+
Emberiza citrinella (yellowhammer)	-	+	+
Erithacus rubecula (robin)*	+	+	-
Falco tinnunculus (kestrel)*	-	+	+
Fringilla coelebs (chaffinch)	+	+	-
Gallinula chloropus (moorhen)*	-	+	-
Hirundo rustica (swallow)*	-	+	+
Motacilla alba (pied wagtail)	-	+	+
Muscicapa striata (spotted flycatcher)	-	+	-
Parus ater (coal tit)	+	+	-
Parus caeruleus (blue tit)	-	+	-
Parus major (great tit)*	-	+	-
Phasianus colchicus (pheasant)*	+	+	+
Phylloscopus collybita (chiffchaff)	+	+	-
Pica pica (magpie)*	+	+	+
Prunella modularis (dunnock)	-	+	-
Pyrrhula pyrrhula (bullfinch)	-	+	-
Regulus regulus (goldcrest)	+	+	-
Sturnus vulgaris (starling)*	-	+	+
Sylvia atricapilla (blackcap)	-	+	-
Troglodytes troglodytes (wren)*	+	+	+
Turdus merula (blackbird)*	+	+	-
Turdus philomelos (song thrush)*	+	+	-

Feeding/overwintering	*Parts of farm used for overwintering/ feeding*		
	Semi-natural	*Infrastructure*	*Productive*
Carduelis spinus (siskin)	+	-	-
Gallinago gallinago (snipe)	+	-	-
Scolopax rusticola (woodcock)	+	-	-
Accipiter nisus (sparrowhawk)	+	+	+
Ardea cinerea (grey heron)	-	+	-
Saxicola torquata (stonechat)	-	+	-
Turdus iliacus (redwing)	-	+	+
Turdus viscivorus (mistle thrush)	-	+	+
Falco peregrinus (peregrine falcon)	-	-	+
Carduelis cannabina (linnet)	-	-	+
Corvus corone (hooded crow)	-	-	+
Corvus frugilegus (rook)	-	-	+

TABLE 4. List of breeding vertebrates other than birds (summer feeding refers to breeding adults), regularly feeding vertebrates (other than birds), and butterflies and dragonflies, recorded on the south Cork farm during 2000. Occasional species are excluded. Nomenclature follows Whilde (1993) for vertebrates, and Bradley (1998) and Hammond (1997) for butterflies and dragonflies, respectively.

VERTEBRATES (OTHER THAN BIRDS)

Breeding	*Parts of farm used for breeding/summer feeding*		
	Semi-natural	*Infrastructure*	*Productive*
Rana temporaria (common frog)	+	-	-
Apodemus sylvaticus (wood mouse)	+	+	+
Clethrionomys glareolus (bank vole)	-	+	-
Erinaceus europaeus (hedgehog)	?	+	-
Mus musculus (house mouse)	-	+	-
Mustela erminea (stoat)	-	+	+
Nyctalus leisleri (Leisler's bat)	-	+	-
Oryctolagus cuniculus (rabbit)	-	+	+
Pipistrellus pipistrellus (pipistrelle)	+	+	+
Rattus norvegicus (common rat)	-	+	+
Sorex minutus (pygmy shrew)	+	+	-
Vulpes vulpes (fox)	+	+	+

Feeding	*Parts of farm used for overwintering/ feeding*		
	Semi-natural	*Infrastructure*	*Productive*
Anguilla anguilla (European eel)	-	+	-
Meles meles (badger)	+	+	+
Lepus timidus (Irish hare)	+	-	+

BUTTERFLIES & DRAGONFLIES

	Parts of farm used for breeding/summer feeding		
	Semi-natural	*Infrastructure*	*Productive*
Anthocharis cardamines (L.) (orange-tip)	+	-	-
Aphantopus hyperantus (L.) (ringlet)	+	-	-
Sympetrum striolatum (Charpentier) (common darter)	+	-	-
Aglais urticae (L.) (small tortoiseshell)	-	+	-
Celastrina argiolus (L.) (holly blue)	-	+	-
Maniola jurtina (L.) (meadow brown)	+	+	-
Lasiommata megera (L.) (wall)	-	+	-
Lycaena phlaeas (L.) (small copper)	-	+	+
Pararge aegeria (L.) (speckled wood)	-	+	-
Pieris brassicae (L.) (large white)	-	+	-
Pieris napi (L.) (green-veined white)	+	+	+
Pieris rapae (L.) (small white)	-	+	-
Pyronia tithonus (L.) (gatekeeper)	-	+	-
Vanessa atalanta (L.) (red admiral)	-	+	-
Polyommatus icarus (Rott.) (common blue)	-	-	+

TABLE 5. Decomposer microhabitats recorded from a mixed farm in south Cork in 2000 (2000), and those microhabitats (interpreted from habitats and practices) present in 1935, but no longer extant on the farm (1935 only). Microhabitats present in 2000, but not in 1935 are in square brackets.

Microhabitat type	2000	1935 only
Dung/manure	Cattle dung	Horse dung[1]
	Farmyard manure	Sheep dung[2]
		Goose dung[2]
Decaying wood	Decaying pine wood	
	Decaying broadleaf wood	
	Deciduous rot-holes	
	Bark of recently dead trunks/branches	
	Loose tree bark	
	Decaying large tree stumps	
Wetlands	Flushes under tree cover	Oligotrophic springs in open[3]
	Seasonal flushes	Permanent fen pools[3]
	Seasonally wet laneway surface	Sedge peat soil litter[3]
	Temporary streams	Muddy water margins[4]
	Woody debris in streams	Temporarily aquatic hoof-marks[4]
Grass/rush tussocks	*Molinia* & *Deschampsia*	
	Dactylis & *Arrhenatherum*	
	Seasonally wet *Juncus*[5]	
Unimproved grasslands	[Ungrazed *Festuca* sward litter]	Ant mounds[4]
	Wet meadow soil litter layer	Flooded meadow soil litter layer[5]
		Old hay meadow soil litter layer[6]
		Wet pasture soil litter layer[4]
Dried crop residues	Straw	Hay-ricks[6]
		Stable and loft grain/chaff[1]
Cultivated crops	Cereal (with weeds) litter	Root crops with decaying weeds[2]
	[Silage litter]	Gorse crop litter[1]
Stone features	Old wall cavity humus	
	Surface stone wells	

Reasons for loss of habitat between 1935 and 2000:

[1] Mechanisation
[2] Specialisation of farm enterprise
[3] Drainage of land
[4] Cessation of grazing and/or scrub invasion
[5] Reseeding to grass
[6] Change from hay to silage

TABLE 6. Socio-economic and socio-cultural factors influencing farm management and development decisions affecting farm biodiversity.

Decision	*Socio-economic*	*Socio-cultural*
Mechanisation (1950)	Labour costs; income from contracting	Elimination of physical drudgery; generational change-use for out-contracting to other farms
Drainage (1959)	Farm income; employment	Beginning of family cycle; progressive farming ethic
Silage introduction (1964)	Labour costs; risk of crop loss to weather considerably less	Beginning of family cycle; progressive farming ethic
Continuous winter cereals (1979)	Higher yields	Generational change; maximum yield ethic
Drainage (1981)	Reclamation grant; spreading overhead costs; farm income	Generational change; maximum yield ethic
Sale of wet pasture (1991)	Bank repayments	Wildlife ethic overruled
Cessation of grazing of semi-natural area (1994)	Negative return on investment in fencing, in absence of reseeding	Most of landowners income off-farm; wildlife ethic precluded reclamation; avoidance of risk of cattle damage to cereals

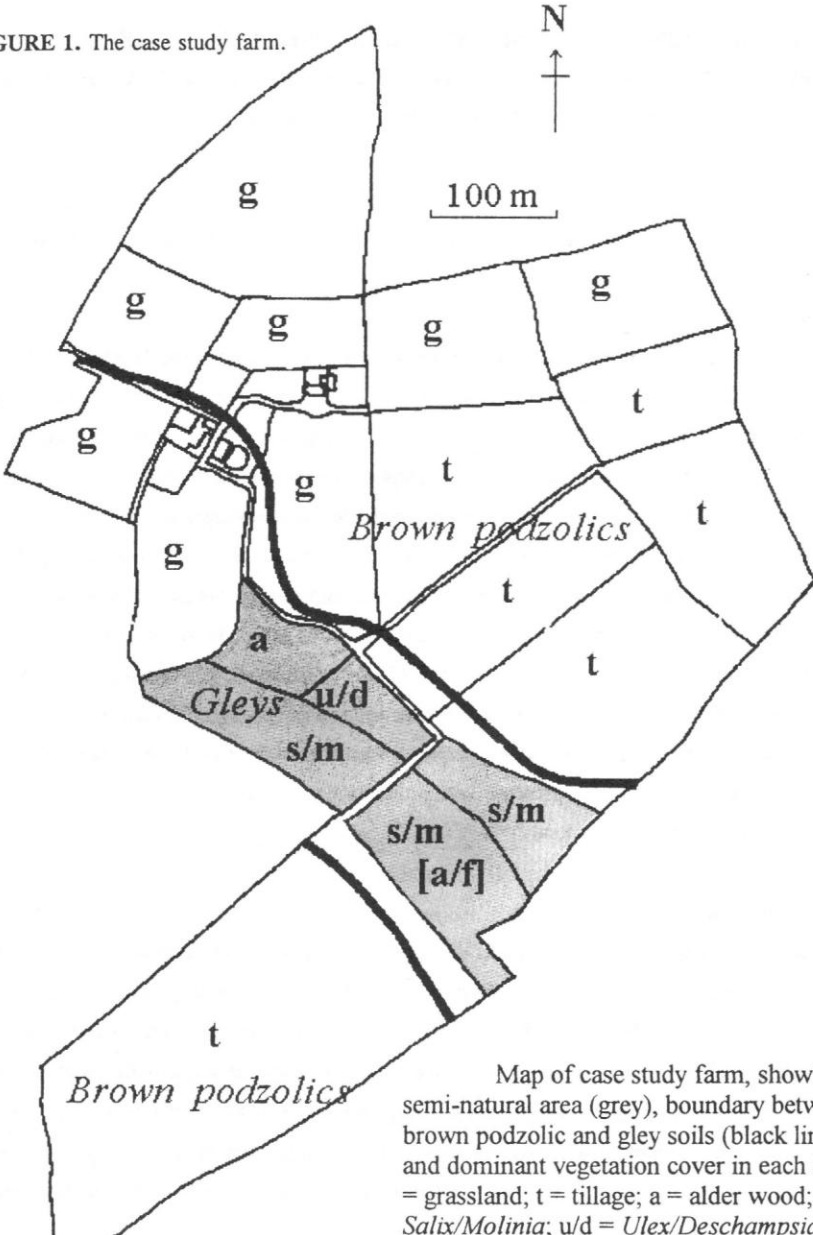
TABLE 7. Breeding vertebrate, butterfly and dragonfly species (recorded in 2000) which could be eventually extirpated from, or added to, the farm under an intensive arable/forestry management regime (and not participating in REPS), after sale of the farm. Predictions based on current breeding areas within the farm (for extripated species) and from data in Gibbons *et al.* (2000) and Walsh *et al.* (in press) (for species added).

POTENTIALLY EXTIRPATED	
Vertebrates	
Acrocephalus schoenobaenus (sedge warbler)	Reclamation of semi-natural area for spruce plantation
Aegithalos caudatus (long-tailed tit)	Reclamation of semi-natural area for spruce plantation
Anas platyrhynchos (mallard)	Infilling of ponds with demolition rubble
Carduelis carduelis (goldfinch)	Weed control in cultivated land by herbicides
Certhia familiaris (treecreeper)	Removal of significant proportion of mature trees
Emberiza schoeniclus (reed bunting)	Reclamation of semi-natural area for spruce plantation
Falco tinnunculus (kestrel)	Removal of trees and grassland
Gallinula chloropus (moorhen)	Infilling of ponds with demolition rubble
Hirundo rustica (swallow)	Sealing access to old buildings
Muscicapa striata (spotted flycatcher)	Removal, of ivy from walls, and of sheltered feeding areas
Nyctalus leisleri (Leisler's bat)	Sealing access to old buildings
Parus major (great tit)	Removal of significant proportion of mature trees
Phylloscopus trochilus (willow warbler)	Reclamation of semi-natural area for spruce plantation
Rana temporaria (common frog)	Reclamation of semi-natural area for spruce plantation
Sylvia atricapilla (blackcap)	Reclamation of infrastructure scrub and semi-natural area

TABLE 7 (continued)

Butterflies	
Anthocharis cardamines (L.) (orange-tip)	Reclamation of semi-natural area for spruce plantation
Aphantopus hyperantus (L.) (ringlet)	Reclamation of semi-natural area for spruce plantation
Celastrina argiolus (holly blue)	Removal of ivy from walls and trees
Lycaena phlaeas (L.) (small copper)	Cultivation of unfertilised pasture
Polyommatus icarus (Rott.) (common blue)	Cultivation of unfertilised pasture
Sympetrum striolatum (common darter)	Reclamation of semi-natural area for spruce plantation
POTENTIALLY ADDED	
Vertebrates	
Asio otus (long-eared owl)	Development of mature spruce plantation
Carduelis spinus (siskin)	Development of mature spruce plantation
Butterflies and dragonflies	
None	

FIGURE 1. The case study farm.



Map of case study farm, showing semi-natural area (grey), boundary between brown podzolic and gley soils (black line), and dominant vegetation cover in each field: g = grassland; t = tillage; a = alder wood; s/m = *Salix/Molinia*; u/d = *Ulex/Deschampsia*; [a/f] = area of original acid/poor fen. Details of infrastructural habitats are omitted.

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FARMS AS BIOGEOGRAPHICAL UNITS: 2. THE POTENTIAL ROLE OF DIFFERENT PARTS OF THE CASE-STUDY FARM IN MAINTAINING ITS PRESENT FAUNA OF SCIOMYZIDAE AND SYRPHIDAE (DIPTERA)

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Summary

The results are presented of a comprehensive survey of the Sciomyzidae (Diptera) and Syrphidae (Diptera) of the case-study farm, which yielded 90 species. A habitat survey of the farm was also conducted. From a knowledge of the habitat associations of the recorded species, their probable disposition among the various parts of the farm is considered. This makes it possible to predict the potential consequences, to the fauna, of changes in management of the farm. The potential significance of the non-productive parts of the farm in maintaining its present fauna is highlighted by this process. So is the capacity of intensification of farm use, occurring on farms in the surrounding landscape, to totally eradicate sciomyzids from the farm and reduce the syrphid fauna to less than 10% of its present total. It is concluded that even if farms cannot be expected to host threatened organisms, their potential to maintain the majority of a regional fauna gives them a biogeographical role of singular significance, albeit largely dependent upon the continued presence within the farmland landscape of a significant proportion of non-productive land.

1. Introduction

There are various studies of syrphids that have been carried out in farmland in Europe. By and large, they focus on particular species or particular crops, usually from the viewpoint of using syrphids with aphidophagous larvae as agents for biological control of plant bug infestations. The resultant literature has been reviewed in different ways by different authors, a recent, and comprehensive, example being incorporated into Barkemeyer (1994). There are a few studies (e.g. Hondelmann, 1998) that are concerned more generally with which species can be caught as adults in farmland, but without focussing much attention on whether the species recorded could be resident within farmland. The situation of sciomyzids is more extreme, there being very little published on farm faunas of these flies. Faunistic studies of any invertebrates, that could be construed as carried out with a view to considering the extent to which farmland in Atlantic parts of Europe may provide a biodiversity maintenance function, have been almost non-existent until recently (Usher, 1986; Goldsmith, 1991), and have largely been focussed on individual landscape features, e.g. hedges (Pollard *et al.*, 1974) or upon the use of ground beetles (see, for example Foster *et al.*, 1997) or butterflies (e.g. Erhardt, 1985) as tools to this end.

In the present text, the results of inventorising the sciomyzid and syrphid faunas of a case study farm, taken as a landscape unit, are presented. The observed fauna is then considered in relation to the potential role of the farm and its component habitats in supporting the regional fauna of these taxonomic groups. For this purpose, the region is taken to be Co. Cork, the county in which the case-study farm is located. A description of this farm is provided in Part 1 of this series (Good, 2001). Whether rightly or wrongly, species are not all perceived as equal in their conservation value, those species that can be classified as being to some extent under threat being regarded as more significant targets for conservation action than more ubiquitous species, and some way of incorporating this reality into the process of considering the role of farmland in maintaining faunas requires to be found. This has been attempted here by employing a rough measure of the threat status of the species observed on the farm.

2. Methods

Syrphids (hoverflies) and sciomyzids (snail-killing flies) were collected on the farm intermittently, over the period 1994-2000, by hand net, from flowers, vegetation and by sweeping. During 2000, a comprehensive sampling programme was carried out, using 27 Malaise traps, which were in operation for a series of 20-day periods between April and September. These were augmented in some fields by emergence traps (20 in all), which were operated over month-long sample periods from April to August. The location of the Malaise trap installations is shown in Figure 1. During 2000, a comprehensive survey of the habitats present on the farm was also undertaken, to allow prediction of its expected sciomyzid and syrphid fauna, for comparison with the observed fauna. In carrying out the syrphid predictions, the Syrph the Net files detailing the Macrohabitat associations of, and Range and status data for, the observed species were employed, from the 2000 version of the database (Speight and Castella, 2000; Speight *et al.*, 2000a), in conjunction with the Co. Cork syrphid list (Speight, 2000a) and following the basic procedures outlined in Speight *et al.* (2000b). Unpublished information on sciomyzid habitats and distribution in Ireland was employed in predicting the expected sciomyzid fauna of the farm and in gauging its potential conservation value.

3. Results

The habitats observed will be considered first, followed by the species observed and their relationships to the habitats observed.

3.1 Habitats observed on the farm

The habitats observed on the farm fall into three main groups, when considered in relation to the role they play in the farm economy:- productive sector habitats, infrastructural habitats and disused sector habitats.

Productive sector land is the *raison d'etre* of farming and can be regarded as omnipresent on farms, even if not in the configuration (i.e. field size and use combination) found on the farm studied here. Essentially, it comprises the surfaces of the fields.

Infrastructural land includes features like hedges, ditches, orchards, ponds etc, which have been introduced to the farm landscape deliberately, because of their utility as adjuncts to farming, although they do not directly produce a cash crop. Many of these features are today no longer required in support of the farm economy and have to be viewed as primarily historical inclusions in the farm landscape, now being progressively removed, except where farm managers are prevailed upon to leave them in place (usually by provision of some form of financial compensation) through the intervention of external influences.

Disused sector land is not necessarily a feature of farmland, being land that is not currently regarded as economical to use in its present condition and not worth conversion to some more economically useful state (it may never have been regarded as economical to use). Obviously, disused sector habitats are not normally deliberately introduced to farmland and they owe their presence either to natural (i.e. non-human) factors or to cessation of management, or a combination of these two. The history of the disused sector land occurring on the case study farm is detailed in Part 1 of this series.

Land consigned to a set-aside role has been excluded from the three sectors delimited above. It is on the one hand part of the area available for productive use, but on the other is deliberately excluded from productive use for the duration of one or more annual cycles. It is technically disused land, in that it is excluded from use and may be unmanaged, but its disuse is short-term and the requirement to re-absorb it into the productive sector is integral to its disuse in the first place. In that it is neither in productive use nor long disused, it could even be regarded as a part of the farm infrastructure. It is for these reasons that set-aside is considered separately in the present text, as an additional, if minor, sectoral category.

Disused sector habitats (*circa* 5ha):

- Atlantic thickets with flushes
- *Alnus* forest (general) with flushes and brook
- unimproved, oligotrophic *Molinia* grassland with flushes and temporary pools/acid fen

Farm infrastructure habitats (*circa* 5ha):

- scattered trees in open ground (tree lines of *Fagus* and *Acer pseudoplatanus*)
- hedges, with and without associated drainage ditches and/or canalised, seasonal brooks
- old walls
- field margins
- orchard
- farmyard organic waste
- pond
- farm buildings

Productive sector habitats (*circa* 30ha):

- improved grassland
- intensive grassland
- crops
- cow dung

Set-aside

- fallow land (set-aside)

Definitions of these habitats are provided in Appendix 2. The disused sector *Molinia* grassland/acid fen habitat is essentially an area of oligotrophic, unimproved, seasonally-flooded *Molinia* grassland incorporating a residuum of acid fen species around the few remaining flushes/seasonally-flooded pools. As has been demonstrated in Part 1 of this account of the farm, acid fen probably predominated in this area within the last 50 years, but partial drainage and associated soil disturbance, plus subsequent cessation of all grazing, has resulted in expansion of the *Molinia* grassland to such an extent that acid fen has all but vanished from the site.

3.2 The sciomyzids and syrphids observed on the farm

The 17 species of Sciomyzidae and 73 species of Syrphidae observed on the farm 1994-2000 are listed, with their authorities, in Appendix 1, together with the numbers of specimens of each that were collected using Malaise traps and emergence traps in 2000. As can be seen from that list, all but five of the species were collected using the Malaise traps. The additional species were syrphids added by hand collecting. Three of those five (*Leucozona laternarius*, *Neoascia tenur*, *Platycheirus scambus*) were collected in 1994, but not subsequently. The other two (*Helophilus trivittatus* and *Scaeva pyrastri*) were present in 2000.

Emergence traps were only installed in some of the productive sector habitats (fields used for grazing and fields used for silage production) and in set-aside. The 14 syrphid species which were collected within them thus provide only a very truncated record of syrphids confirmed as breeding on the farm, and from habitats which would be predicted to have a restricted fauna. All that can be said is that the species bred from the traps are all species predicted to occur on the farm and collected also by Malaise traps on the farm. The eight species which were collected by emergence traps within the productive sector were all predicted to occur within the productive sector, but the 13 species similarly collected in the set-aside traps included two (*Platycheirus manicatus* and *Syrphus vitripennis*) not predicted to occur in productive sector habitats.

Each emergence trap covers only 1m^2 of ground surface. Of the 20 emergence traps used, 12 were installed in fields under grass and the other eight in set-aside. Even one specimen collected in one of these emergence traps thus suggests a potential for prodigious numbers of that species to emerge from the total area of the field in which that emergence trap was located, during the time that the emergence traps were in use. For instance, given that each field in which emergence traps were located had a surface area of substantially more than 1ha, and 1ha comprises 10,000m^2, a naive estimate of the number of specimens produced would be 2,500 per hectare, for a species collected just once in one emergence trap. Looked at in this way, the solitary specimen of one sciomyzid species (*Tetanocera elata*), collected from an emergence trap in one of the fields used as pasturage, is potentially indicative of a large population of this insect developing there.

There are 51 species of Sciomyzidae known from Ireland, 28 of which have been recorded from Co. Cork. The observed farm fauna, of 17 species, represents one third of the known Irish sciomyzid fauna, or 60% of the Cork fauna. The list of Syrphidae observed on the farm also now includes 60% of the syrphid species recorded from Co. Cork (Speight, 2000a), and 40% of the known Irish syrphid fauna. At first glance, these data might seem to suggest farmland can be expected to play a significant role in maintenance of the Irish sciomyzid and syrphid faunas. But this farm is not all one habitat, and in order to establish what contribution might realistically be expected from farmland, in maintaining the species observed on this farm, it is necessary to consider their relationship to the habitats observed and the extent to which these habitats can also be expected to occur on farms.

3.2.1 The syrphids observed, their habitat associations and their conservation value

From the array of habitats observed on the farm, and the habitat associations of the observed species, all but three (*Helophilus trivittatus*, *Sphegina elegans* and *Xylota sylvarum*) of the species observed would also be predicted to occur on the farm. So 96% of the syrphid species observed on the farm would also be predicted to occur there. A small number of additional Co. Cork species would be predicted to occur as well, but were not observed. The present text is concerned with maintenance of the observed fauna, so these predicted but not observed species will not be considered here.

The expected distribution of the observed syrphid species, among the habitats observed on the farm, can be considered at the level of individual habitats or groups of habitats. Here, the three broad groups of habitats defined earlier have been used, namely productive sector habitats, infrastructural habitats and disused sector habitats.

Starting with the productive sector, 46% of the observed syrphid species (32 species) would be predicted to survive in productive sector habitats (see Appendix 1), whereas the other 54% would not. More than half of the observed fauna may, then, be dependent on the presence of other habitats. Some (15) of the species falling into this latter group would be predicted to occur in both infrastructural and disused sector habitats, but most would not. Seven of them would be expected to be dependent on the presence of the infrastructural habitats alone and 16 of them on the disused sector habitats. It follows that, were the entire area of farm infrastructure habitats added to the productive sector, to maximise production, a net reduction of 10% would be predicted to occur in the observed syrphid fauna of the farm. But, if the disused sector habitats were lost from the farm, for instance through the disused sector land being brought back into the productive sector, the reduction would be more than 20%. And, if both the disused sector land and the infrastructural sector land were converted to productive use, more than half of the observed syrphid fauna would be expected to disappear from the farm, leaving only 46% of the species *in situ*.

The prediction that 46% of the existing syrphid fauna would persist, if the entire farm were converted to productive land, is dependent upon the continued presence of all of the productive sector habitats occurring on the farm at the moment. It should be recognised that this scenario is highly unlikely. The presence of the existing productive sector habitats on the farm is due to the concurrent practice of different management regimes within the *circa* 30ha of productive area of the farm in the same year. Some fields are used for grazing, others for silage production, or a combination of silage production and grazing, a third group of fields is used for crop production and one field is used for production of hay. On the hillside across the valley from this farm, within 1km from its boundary, there is an area of 25ha of land on another farm that has recently been converted from a group of hedged fields to one large field. Within this converted area there are now no hedges or field boundaries of any sort and the entire 25ha is managed as a unit, for one form of intensive use: crop production. Were a similar conversion to be carried out on the entire area of Glinny House Farm (and fields of unit size greater than 40ha are no longer unknown in the farmed landscape in Ireland), the predicted reduction in its observed syrphid fauna would not be 50%, but more than 80%, the fauna being reduced to 12 species. This is because of loss not only of disused sector and infrastructural habitats, but also of all but one of the productive sector habitats. It is debatable whether even these 12 species could survive on the farm under these conditions, because cropland is subject to annual cultivation and, during the time that the ground is ploughed, no syrphid species can be expected to survive there - it would be necessary to assume the availability of habitat for these 12 species somewhere else than on the ploughed area, but within its immediate vicinity, in order for populations of them to be available to colonise the ploughed field once it again carried a crop.

The productive sector land can thus be seen to have a potential to support at most less than half of the existing fauna of the farm and at worst virtually no species at all, dependent upon the management regimes put in place on the farm and on other farms in the vicinity. But from the emergence trap results it can be deduced that the species which can be supported by productive sector land may be produced there in considerable numbers, due to the large area of the surfaces involved and the forced homogeneity of the habitats they carry. Taking the two species collected most numerously in the grassland emergence traps, and given that the area of productive sector grassland available on the farm in 2000 was *circa* 7.5ha, a crude estimate of the population of *Platycheirus albimanus* produced by productive sector grassland in that year would be in excess of 450,000 individuals, and for *P. clypeatus* the figure would be more than 500,000 individuals. The total available hectarage of alternative habitats for these two species on the farm would be more-or-less the same as the hectarage of productive sector grassland, but would be more heterogenous in character. Data are not available to show whether the numbers of specimens of these two species potentially produced by these alternative habitats would be greater or smaller than potentially produced by the productive sector grasslands. But it has to be recognised that, for these species at least, the productive sector may, at present, provide the bulk of the population produced by the farm per annum.

Given that disused sector habitats might be deemed impractical to convert to productive land and thus remain disused, even if the land occupied by the existing farm infrastructure was nearly all converted to productive use, it is apposite to consider what is the potential contribution of the disused sector to maintenance of the present syrphid fauna. The disused sector habitats would be predicted to support 55 of the syrphid species observed on the farm, or three quarters of the existing fauna. A further nine of the observed farm species would be predicted to occur in productive sector habitats. So, in the scenario that the existing productive sector and disused sector habitats remain on the farm, but the infrastructural elements are lost, the farm syrphid fauna might be expected to diminish by seven species, or 9%.

By contrast, were the existing productive sector habitats to be somehow lost, leaving only the disused sector and infrastructural habitats present on the farm, the existing farm fauna would be predicted to change hardly at all. There is only one species, *Rhingia campestris* (which has cow-dung inhabiting larvae), that would be predicted to disappear from the farm under these circumstances, being the only syrphid species observed on the farm that would not be predicted to occur in any of the disused sector or infrastructural habitats.

The observed, disused sector habitats are identified here as potentially supporting as much as 75% of the syrphid species recorded from the farm, so it is worthwhile to consider how the species predicted to be supported by these habitats would be expected to be partitioned between them. In simple numerical terms, the *Molinia* grassland would be expected to support more (32) of the observed farm species than any of the other disused sector habitats. Acid fen would come next, supporting 20 species, followed by the *Alnus* wood (19), with Atlantic scrub supporting the fewest species (15). But, given the presence of other habitats on the farm, the contribution of any one of these disused sector habitats to maintenance of the farm fauna requires also to be viewed in terms of the extent to which its faunal complement is unique to that habitat i.e. not shared with other habitats occurring on the farm. Viewed in this way, the Atlantic scrub makes no contribution to the farm fauna, beyond providing additional habitat for species expected to be supported by other habitats represented on the farm at the moment. Indeed, it would be expected that all species predicted to occur within the Atlantic scrub would be supported by productive sector and/or infrastructural habitats represented on the farm, so the presence of the scrub would not be expected to be instrumental in supporting any species at present confined to disused sector habitats. The other disused sector habitats all have associated with them species that would be expected to be dependent upon the existing disused sector, four with the *Alnus* wood, ten with the *Molinia* grassland and 12 with acid fen. Only two of the disused sector species associated with the *Alnus* wood, *Criorhina berberina* and *Sphegina clunipes*, would not be shared with other disused sector habitats, so the *Alnus* wood would be perceived as playing only a minor role in adding to the farm's fauna, given the array of habitats occurring there at the moment. By contrast, the mosaic of *Molinia* grassland/acid fen habitats would be expected to support 14 of the disused sector species between them (eight shared, two only in the *Molinia* grassland and four only in the acid fen), 12 of which would not be expected to occur in other disused sector habitats. So, then, considering the species probably dependent on disused sector habitats for their presence on the farm, the largest contingent of species would seem to require *Molinia* grassland/poor fen, which would also be expected to be uniquely responsible for maintenance of some 16% of the farm's observed syrphid fauna.

The potential role of set-aside, in maintaining the farm syrphid fauna, remains to be considered. None of the species observed on the farm would be predicted to be dependent upon set-aside for their survival on the farm. And all of the species collected from set-aside in the emergence traps were also collected on the farm by Malaise traps. However, comparison between the species collected by emergence trap in the productive sector and in set-aside (see Appendix 1) shows differences:- eight species collected in productive sector traps and 13 species in set-aside traps. With the small quantity of data available, it is difficult to come to any conclusions, but these data do suggest that the presence of set-aside on a farm may well provide for additional species than would otherwise be supported by productive sector land - so long as there is a nearby population source of those additional species, from which to colonise the set-aside. In the case of the farm studied here, both disused sector and infrastructural habitats would be predicted to have provided species that were collected in the set-aside emergence traps, in addition to those species that could have been derived from productive sector land. Given the transitory nature of set-aside, all of the species that might occur there would, of necessity, have to have an alternative and more permanent habitat in the immediate vicinity, in order to be able to use set-aside during those periods when it was available. But, when it is available, it clearly has the potential to produce enormous numbers of specimens of the species it can support, to judge from the emergence trap results.

Turning to the question of the potential conservation value of maintaining the syrphid fauna of the various habitats present on the farm, at the international level of Europe in general, none of the syrphids recorded from the farm would be regarded as threatened (Speight and Castella, 2000), though *Orthonevra geniculata* would be signalled as decreasing within the Atlantic and continental zones of its European range and as approaching threatened status within both the Atlantic and Alpine zones.

The number of 50km UTM squares in which each species is known (Speight, 2000a) can be used as a basis for comparison of the frequency of syrphid species in Ireland. The average number of grid squares from which each of the observed farm syrphid species are known is 34. The average number of grid squares from which the other syrphid species recorded for Co. Cork (Speight, 2000b) are known is 17. Since the maximum number of these grid squares from which a species can be recorded in Ireland is 50, it can thus be said that, on average, the farm species are species that are widely distributed (in that they would be found in more than 50% of the available grid squares) in Ireland, whereas the other species known from Co. Cork are not. Indeed, only 14 of the observed farm species are known from fewer than 26 of the 50km UTM squares. If degree of threat is to be used as a measure of the conservation value of a species, it would be upon these 14 species that any potential conservation value of the farm fauna would be largely dependent.

While there are syrphid species that have been found in Ireland only in one 50km UTM square, none of those species is known from Co. Cork. However, there are species known from Co. Cork that have been found in five or less of these grid squares in Ireland. There are three of these among the species observed on the farm, and seven of them among the other species known from Co. Cork. In this sense then, the three farm species in this group represent the least frequent of the syrphid species observed on the farm. The species involved are *Helophilus trivittatus*, *Orthonevra geniculata* and *Sphegina elegans*. *H. trivittatus* is a wetland species that was until recently very localised in Ireland, but now seems to be experiencing a phase of rapid expansion (Speight and Nelson, 2000). To consider it as under threat simply on the basis of the number of grid squares from which it is known is thus not very realistic, and in Ireland it has to be regarded more as a species that is progressively occupying new habitat than one retreating from existing habitat. Its presence on the farm is thus largely an irrelevance, in considering the potential conservation value of the fauna. Further, *H. trivittatus* is not predicted to occur in association with any habitat present on the farm, so its occurrence there may well be due to flight into the farm from elsewhere. Indeed, *H. trivittatus* is recognised as one of a small group of European syrphids that characteristically undertake long distance movements as adults (Speight, 2000b). The two specimens collected on the farm came from flowers within one of the fields. Both were collected by hand net, on the same day. *O. geniculata* is a crenal species, judged to be vulnerable to extinction in Ireland, whose habitat is arguably becoming increasingly scarce as a consequence of intensification of farming activities (Speight, 2000a). So its presence on the farm can be regarded as having some conservation interest. The single specimen collected on the farm came from a Malaise trap in the fen/oligotrophic *Molinia* grassland, immediately adjacent to a wet flush, the habitat combination with which it would be predicted to occur on the farm. *S. elegans* is a deciduous forest insect whose larvae are known to live in sap-runs on the trunks of living, overmature trees. It is scarce, but not regarded as threatened, in Ireland (Speight, 2000a). The two specimens collected from the farm came from a Malaise trap located within the *Alnus* woodland, but it is a moot point whether this species is associated with *Alnus* woodland. However, *S. elegans* is not noted as a "migrant" species, so the suspicion must remain that it may be surviving on the farm, even if it would not be predicted to do so.

There are 11 other species recorded from the farm that are known in Ireland from no more than 25 grid squares. While none of them can reasonably be regarded as under threat in Ireland they could be viewed as having some conservation value as less frequent species, so it is worthwhile considering which of the habitats observed on the farm would be expected to support them. Disused sector habitats would be expected to support all but four of these species, the exceptions being *Cheilosia semifasciata*, *Eumerus strigatus*, *Orthonevra nobilis* and *Sphaerophoria scripta*. These four would all be expected to occur in association with the infrastructural habitats. The productive sector habitats present could be expected to support three of these 11 species: *E. strigatus*, *Meliscaeva auricollis* and *Sphaerophoria scripta*.

C. semifasciata offers an extreme case of potential dependency upon infrastructural habitat for its survival within the farmed landscape, since it is associated with old walls, where its larvae mine the tissues of *Umbilicus*. Its natural habitats are scree and cliffs, neither of which occur in the countryside surrounding the farm studied here. It is difficult to see how this insect could have extended its range into the farmland of this part of Co. Cork until field walls and the small quarries from which the wall stone (plus the stone for farm building construction) was derived were introduced to the landscape. Similarly, with removal of the network of old field walls there would be no other habitat to sustain this species, except where disused stone buildings, or disused quarries not overgrown by vegetation, occur.

Today, *S. scripta* is archetypally a productive sector habitat syrphid, almost throughout the Atlantic zone of Europe. It is regarded as highly migratory and a tide of millions of specimens of this species is perceived as surging northwards through the continent in most summers. It is a polyvoltine species with a generation time of only a few weeks, and larvae aphid-feeding on low-growing plants in open ground. On the farm it would be expected to occupy field margins, set-aside and crop land. But its situation on the farm is equivocal, in that only one specimen of this species has been collected there. To any continental syrphidologist this situation would probably seem impossible - if the species is present (and it is nearly always present in grassland on the continent) the expectation would be that it would occur in large numbers. In Ireland, *S. scripta* is rarely found away from low-altitude land close to the coast, and there is no evidence that it ever builds up large numbers in cropland here. Whether it survives the winter months in Ireland is unclear, but the presumption is that it must do so, in favoured locations (Speight, 2000a). Certainly, if this species is dependent upon annual immigration from elsewhere to maintain its presence in Ireland, there is little indication of successful breeding by the immigrant population. And the farm data gathered in this study is a case in point - the solitary specimen collected was derived from a Malaise trap catch in the first half of August, in set-aside. Was this a migrant specimen? If it originated from a local population, why was the species not recorded more abundantly, and earlier in the year as well? The emergence traps located in set-aside on the farm produced no specimens of *S. scripta*. Given the propensity of this species to build up populations rapidly, within the types of habitat represented over large surfaces in the productive sector of the farm, but the lack of any indication that it did so, despite being apparently able to reach the farm, suggests that *S. scripta* may not be a resident species there, even though predicted to occur.

Essentially, then, of the 14 syrphid species observed on the farm which might be regarded as having some conservation value, in that they are known from no more than half of the 50km UTM grid squares in Ireland, eight would be expected to occur in association with disused sector habitats on the farm, and the rest with infrastructural habitats, with the exception of two (*H. trivittatus* and *S. elegans*) that may not be resident on the farm. The productive sector habitats would be expected to support a few of these species, all of which would be supported by either infrastructural or disused sector habitats as well. Among these 14 species, the one which might be singled out as of some particular conservation interest is *O. geniculata*, because of its status both nationally and internationally. This syrphid would not be expected to survive on the farm other than in the disused sector, where it would be predicted to occur in association with acid fen.

3.2.2 The Sciomyzidae observed, their habitat associations and their conservation value

All of the sciomyzid species observed would be predicted to occur on the farm, on the basis of the habitats observed, if it is accepted that some sort of fen is present on the farm. However, many more sciomyzid species would be predicted to occur than have been observed, if it is accepted that fen is present. If the alternative interpretation, of humid, flooded grassland is used (i.e. fen is regarded as absent) a much closer approximation to the observed farm sciomyzid fauna is predicted, but three of the observed species (*Elgiva solicita*, *Renocera pallida* and *Tetanocera punctifrons*) would not then be predicted to occur. One of these three species, *R. pallida*, is also associated with wet woodland and would be predicted to occur if the *Alnus* woodland were to be classed as *Alnus* swamp. However, it clearly is not swamp woodland and, running the prediction of the farm sciomyzid fauna on the assumption that wet woodland is present would predict also the presence of a large number of species that have not been observed on the farm. Nonetheless, it has to be recognised that the *Alnus* woods may be wet enough to allow the presence of *R. pallida* there, even if they are not swamp woodland. Certainly, from examination of the Malaise trap results, it is apparent that *R. pallida* was collected on a number of occasions in both parts of the disused sector land, the wet grassland/fen and the *Alnus* woodland, not just in the wet grassland/fen. This species was not collected in any Malaise trap outside the disused sector.

If the disused sector land was brought into production on the farm, it would be predicted that the sciomyzid fauna would be reduced to eight species. If the infrastructural land were also converted to productive use, a further reduction to five species would be expected, if the current mix of management regimes were maintained on the productive sector land. However, were the entire farm area converted to crop production, all sciomyzids would be predicted to disappear from the farm. For the sciomyzids, then, the disused sector land is the farm's most significant feature, with more than half of the observed fauna probably dependent upon it, the infrastructural habitats also have some species dependent upon them and the management regimes that are used within the productive sector would be expected to determine the survival of the rest of the farm sciomyzid fauna.

The status in Ireland of the various sciomyzid species recorded from the farm is less certain than the status of syrphid species, due to less emphasis having been placed on the study of sciomyzids. However, it can be said that two of the species observed on the farm, *E. solicita* and *T. punctifrons*, are among the least frequently encountered sciomyzids known in Ireland and, when considered in this light, are potentially of some "conservation value". They are both species of fen habitats and their loss from the farm would be predicted to accompany conversion of the disused sector land to productive use.

Discussion

The sciomyzid situation parallels what has been found for the syrphids, namely that regarding the wet grassland as unimproved, seasonally-flooded, oligotrophic *Molinia* grassland provides a close agreement between observed and predicted faunas, except for a few species whose presence would not be predicted unless it were accepted that the wet grassland represents also a residual acid fen. So, using both syrphid and sciomyzid data, the grassland of the disused sector land appears to be most reasonably interpreted as faunistically somewhat intermediate between Molinia grassland and acid fen, assuming the observed species are resident. Further, the entire observed sciomyzid fauna of the farm would be predicted to occur in association with the disused sector *Molinia* grassland/acid fen habitats, and most of the observed sciomyzid species would be expected to disappear from the farm were the disused sector land converted to productive use, emphasising the potential significance of the disused sector land in maintaining the existing fauna of the farm. Consideration of other elements of the farm fauna, in Part 1 of this series, identified the infrastructural land as supporting more dependent species than any other part of the farm. That assessment was based on taxonomic groups whose total observed fauna on the farm amounted to 75 species. The sciomyzids and syrphids observed on the farm together comprise 95 species. If the 170 species covered in Parts 1 and 2 of this series are considered together, the disused land habitats would be identified as the part of the farm potentially supporting a marginally greater number of dependent species than any other part of the farm. Of perhaps rather greater significance is the fact that, whether taken together or separately, the disused sector land and the infrastructural land would seem to be of far greater significance in maintaining the existing farm fauna than the productive sector land, whichever of these taxonomic groups are considered and in whatever combination. And this is so despite the fact that the productive land hectarage on the farm is three times as great as is the hectarage of disused and infrastructural land combined.

The significance of the disused sector habitats, and the *Molinia* grassland/acid fen area in particular, as a "refugium" for species not otherwise likely to survive on the farm, has been highlighted at various points in the preceding paragraphs. That this area is in a transitional condition is apparent from its fauna, suggesting that without some sort of active management it may well not remain in its present condition. But identifying its interest does not ensure its survival, in the face of pressures to intensify use of farmland. Neither does identifying its interest ensure appropriate management will occur, even in the event that the area was retained in its disused state, as apparently having some conservation value. These issues are considered in more detail in Part 3 of this series).

The case study farm is entirely ringed about by other farms. On most of them the infrastructural habitats observed on the case study farm are, to a greater or lesser extent, still in place. The surrounding farms exhibit a range of conditions, in terms of the degree to which their management is oriented to production of one or more outputs. But in all cases, the surrounding farms are operating intensive farming regimes. As to disused sector land carrying natural/semi-natural habitats, within 1km of the boundary of the case study farm several enclaves of scrub are present, there are two areas of *Molinia* grassland and one area of acid fen, plus one area of mixed deciduous woodland (trees include *Quercus*, *Fraxinus*, *Acer* and *Betula*) and some riparian *Alnus*/*Salix* woodland along a river. There is also one additional productive sector habitat, in the form of approximately 1ha of *Picea* plantation. Viewed in this light, the case study farm is a microcosm of the landscape in which it is located, lacking only *Quercus*/*Betula* woodland, a river and conifer plantation, of the habitat types occurring in its surround. Given the extent to which the range of habitats observed on the case study farm is also present elsewhere, in its vicinity, how confident can one be that the syrphids collected on the farm are derived from the farm, rather than its vicinity - especially since adult syrphids are fully flighted and highly mobile and survey of the farm syrphid fauna has been largely dependent upon trapping of the adult flies? Without more extensive use of emergence traps, to demonstrate which species are hatching within the farm boundaries, there is no direct answer to this question. What can be said is that the relationship between the species observed and the habitats observed remains the same, whether the farm is considered as a unit or as a proxy for the landscape in which it is situated. Viewed in this light, what is said of the farm in the preceeding pages also highlights the importance of the presence of both infrastructural habitats, and disused sector habitats, in the surrounding farmland landscape.

Conclusions

One reality suggested by this study is that it may be unreasonable to expect farms to play much of a role in maintenance of seriously threatened species (e.g. species classified as endangered), since such organisms are unlikely to be present on farmland. This may be regarded as a matter of minor significance, if farms could nonetheless support more than half (in this case 60%) of the species known from the region in which they are located, given sympathetic management of whatever infrastructural and disused sector land is included within their area. Sympathetic management is clearly critical to the achievement of any such level of species representation - failure to retain and maintain existing patches of disused land within the farm studied here would be predicted to reduce the proportion of the regional fauna supported by the farm to 45% for the syrphids and to 30% for the sciomyzids. And failure to retain and maintain farm infrastructural habitats (in particular hedges, field margins and open ditches) as well would be expected to cause a further reduction of 15% in the syrphid fauna, from loss of species shared by disused land and infrastructural habitats but not found in productive land, plus a reduction of 5% due to species dependent upon the infrastructural habitats themselves. So the farm would then support only some 25% of the regionally occurring syrphid fauna. For the sciomyzids, a further loss of 10% of the regional fauna would be expected, following from loss of infrastructural habitats.

The use to which the productive land on the farm is put could evidently cause additional shrinkage in the fauna, subjection of the entire area of the farm to a single management regime like crop production producing the most extreme scenario, resulting in the farm being predicted to support no more than 10% of the present regional syrphid fauna and no sciomyzids at all.

Further, the remaining syrphids would probably be reduced to the status of only temporary residents, dependent upon adjacent land for survival when the surface of the case study farm was at a stage in the crop production cycle that rendered it unsuitable for sustaining their populations. And if the land of the surrounding farms was in the same condition at the same time, there would no population source available, from which this 10% of the original syrphid fauna could recolonise the farm.

A summary of these percentage decreases is shown in Table 1.

TABLE 1. The proportion of the observed fauna of the farm predicted to survive there in the event of loss of particular habitats from the farm, expressed as a percent of the Co. Cork fauna. Abbreviations: DS lost = loss of disused sector habitats; IS lost = loss of infrastructural habitats; grass lost = conversion of all grassland to crop production.

Taxonomic group	**Percentage of Co. Cork list present on farm**				
	observed	predicted to remain in event of habitat loss			
		DS lost	IS lost	DS, IS lost	DS, IS & grass lost
Sciomyzidae	60	30	60	20	0
Syrphidae	60	45	5	25	10

There are clearly grounds for concluding that, whatever manipulation of productive sector land may be achieved by attempts to make farming more "eco-friendly", little may be gained by such efforts, that would not be as easily achieved by effective maintenance of farm infrastructural habitats, notably field margins and associated hedges and ditches. Similarly, where there are areas of what has been termed here "disused land" included within the perimeter of a farm, efficient maintenance of these disused areas can have the potentiality to further increase the size of the fauna surviving in the farmland landscape by more than one third. These conclusions are based on a study of one farm, two families of flies and the particular habitat strata they inhabit - the grass-root zone (inclusive) upwards - so the extent to which they can be extrapolated to other groups of organism and farmland in general is uncertain. The taxonomic groups considered in Part 1 of this series gave a somewhat different result from the taxonomic groups considered here, and it may only be because a greater number of species have been covered in the present (Part 2) account, that considering the species covered by both Parts 1 and 2 together produces a result more akin to the findings of Part 2 than Part 1. All together, the taxonomic groups covered in Parts 1 and 2 probably represent little more than 2-3% of the total faunal diversity of the farm and this could also be deemed an insufficient sample. However, the conclusions drawn here are very much in line with what is known of the ecological effects of present-day farming regimes in general and prescriptions offered for managing biodiversity on farms (see, for example, Hill *et al.*, 1995). So there are good grounds for assuming that what we have found on this farm does reflect the general situation existing in equivalent farmland landscapes elsewhere in Ireland, not just for the taxonomic groups we have investigated, but for many other taxonomic groups as well. Even so, it would be helpful if equivalent studies of other taxonomic groups of invertebrates were carried out.

The numbers of species associated with different habitats have been used here as a basis for looking at which parts of a farm may be the most important to the maintenance if its fauna. This is arguably a rather simple-minded approach to a very complex issue. However, it does result in predictions which can easily be tested and involves a methodology that could be applied on almost any farm in Ireland. It is hoped that the veracity of at least some of the predictions relating to the fauna of the test-case farm can be investigated by further work there, now on-going.

Recent studies, in parts of Atlantic Europe that are subject to the same forms of intensive farming as those occurring in the part of Co. Cork studied here, have shown an alarming decrease in many of the more traditional components of farmland fauna (see, e.g. Gregory *et al.*, 2001), so it would seem a valid objective to attempt to identify mechanisms that would ensure the survival of existing farmland faunas, whatever may be the perceived conservation value of the constituent species. Once again, on the basis of what has been found on the farm studied here, the potential role of infrastructural and disused sector habitats is thrust to the fore in any such initiative - these components of the farmland landscape would seem to hold the key to survival of existing farm faunas, much more so than the land actually used for production. In the case of the case study farm (see Part 1), it is also from these habitats that most recorded species losses have already occurred, during the last 50 years.

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APPENDIX 1. Sciomyzids and syrphids observed on the farm 1994-2000, plus the sectoral habitat groups with which the syrphid species are known to be associated.

Numbers of specimens collected are not recorded for species collected only by hand net.

Association between a species and habitat(s) occurring in a particular sector on the farm is indicated by a "1" opposite the name of the species, in the relevant Habitat Assocations column.

Abbreviations used: no specs = number of specimens; t = traps; Grass = improved/intensive grassland used for grazing and/or silage production; Seta = set-aside; Prod = productive sector habitats; Infra = infrastructural habitats; disuded = disused sector habitats.

	Numbers of specimens collected			Habitat Associations			
				Prod	Infra	Disused	Seta
	Malaise traps	Emergence traps					
SPECIES OBSERVED		Grass	Seta				
Syrphidae (Diptera)							
Anasimyia lineata (Fabricius, 1787)	1					1	
Baccha elongata (Fabricius, 1775)	11				1	1	
Cheilosia albipila Meigen, 1838	3					1	
Cheilosia albitarsis (Meigen, 1822)	17			1	1	1	
Cheilosia antiqua (Meigen, 1822)	1				1	1	
Cheilosia bergenstammi Becker, 1894	2			1	1		
Cheilosia illustrata (Harris, 1780)	3				1		
Cheilosia pagana (Meigen, 1822)	85			1	1		
Cheilosia semifasciata Becker, 1894	15				1		
Cheilosia vernalis (Fallén, 1817)	1			1	1		
Chrysogaster solstitialis (Fallén, 1817)	1				1	1	
Chrysotoxum bicinctum (L., 1758)	18			1	1	1	
Criorhina berberina (Fabricius, 1805)	3					1	
Dasysyrphus albostriatus (Fallén, 1817)	3				1	1	
Epistrophe eligans (Harris, 1780)	94			1	1		
Episyrphus balteatus (DeGeer, 1776)	87	2	6	1	1	1	1
Eristalinus sepulchralis (L., 1758)	13			1	1	1	
Eristalis abusivus Collin, 1931	6					1	
Eristalis arbustorum (L., 1758)	31			1	1	1	
Eristalis horticola (DeGeer, 1776)	5			1		1	
Eristalis interruptus (Poda, 1761)	20			1	1	1	
Eristalis intricarius (L., 1758)	9			1		1	
Eristalis pertinax (Scopoli, 1763)	77			1	1	1	

APPENDIX 1 (continued)

Eristalis tenax (L., 1758)	7			1	1	1	
Eumerus strigatus (Fallén, 1817)	121		1	1	1		
Eupeodes corollae (Fabricius, 1794)	40	1	18		1	1	1
Eupeodes latifasciatus (Macquart, 1829)	631		49	1		1	1
Eupeodes luniger (Meigen, 1822)	2			1	1		
Helophilus hybridus Loew, 1846	10					1	
Helophilus pendulus (L., 1758)	292			1	1	1	
Helophilus trivittatus (Fabricius, 1805)							
Lejogaster metallina (Fabricius, 1781)	86					1	
Leucozona laternaria (Müller, 1776)					1		
Leucozona lucorum (L., 1758)	11				1		
Melangyna lasiophthalma (Zetterstedt, 1843)	1				1	1	
Melanogaster hirtella (Loew, 1843)	38				1	1	
Melanostoma mellinum (L., 1758)	1010	22	16	1	1	1	1
Melanostoma scalare (Fabricius, 1794)	505	2	4	1	1	1	
Meligramma cincta (Fallén, 1817)	10				1		
Meliscaeva auricollis (Meigen, 1822)	9			1	1	1	
Meliscaeva cinctella (Zetterstedt, 1843)	1				1	1	
Myathropa florea (L., 1758)	2			1		1	
Neoascia podagrica (Fabricius, 1775)	56		2	1	1	1	
Neoascia tenur (Harris, 1780)						1	
Orthonevra geniculata (Meigen, 1830)	1					1	
Orthonevra nobilis (Fallén, 1817)	1				1		
Platycheirus albimanus (Fabricius, 1781)	1146	79	73	1	1	1	1
Platycheirus ambiguus (Fallén, 1817)	4				1	1	
Platycheirus angustatus (Zetterstedt, 1843)	23					1	
Platycheirus clypeatus (Meigen, 1822)	1310	91	5	1		1	
Platycheirus granditarsus (Forster, 1771)	547	156	18	1		1	
Platycheirus manicatus (Meigen, 1822)	21		1			1	
Platycheirus occultus Goeldlin, Maibach and Speight, 1990	8					1	
Platycheirus rosarum (Fabricius, 1787)	23					1	
Platycheirus scambus (Staeger, 1843)						1	
Platycheirus scutatus (Meigen, 1822)	160				1	1	
Rhingia campestris Meigen, 1822	305	1		1			
Riponnensia splendens (Meigen, 1822)	10				1	1	
Scaeva pyrastri (L., 1758)				1	1	1	1
Sericomyia silentis (Harris, 1776)	52					1	
Sphaerophoria interrupta (Fabricius, 1805)	14			1	1	1	
Sphaerophoria scripta (L., 1758)	1			1	1		1

APPENDIX 1 (continued)

Sphegina clunipes (Fallén, 1816)	8					1	
Sphegina elegans Schummel, 1843	2						
Syritta pipiens (L., 1758)	18		3	1	1	1	
Syrphus ribesii (L., 1758)	56			1	1	1	1
Syrphus torvus Osten-Sacken, 1875	1				1	1	
Syrphus vitripennis Meigen, 1822	26		1		1	1	
Trichopsomyia flavitarsis (Meigen, 1822)	4					1	
Volucella bombylans (L., 1758)	31				1	1	
Volucella pellucens (L., 1758)	3				1		
Xylota segnis (L., 1758)	44				1	1	
Xylota sylvarum (L., 1758)	4						
number of species:	68	8	13	32	47	55	8
number of specimens:	7161	354	197				
Sciomyzidae (Diptera)							
Coremacera marginata (Fabricius, 1775)	1			1		1	
Elgiva solicita (Harris, 1780)	1					1	
Hydromya dorsalis (Fabricius, 1775)	14					1	
Ilione albiseta (Scopoli, 1763)	1					1	
Ilione lineata (Fallén, 1820)	39					1	
Limnia paludicola Elberg, 1965	1					1	
Pherbellia cinerella (Fallén), 1820	2			1		1	
Pherbellia dubia (Fallén), 1820	3				1	1	
Pherbellia scutellaris (von Roser, 1840)	1				1	1	
Pherbellia ventralis (Fallén, 1820)	2				1	1	
Renocera pallida (Fallén, 1820)	11					1	
Tetanocera arrogans Meigen, 1830	9					1	
Tetanocera elata (Fabricius, 1781)	61	1		1		1	
Tetanocera ferruginea Fallén, 1820	17			1		1	
Tetanocera fuscinervis (Zetterstedt, 1838)	9					1	
Tetanocera punctifrons Rondani, 1868	1					1	
Tetanocera robusta Loew, 1847	9			1	1	1	
number of species:	17	1	0	5	4	17	0
number of specimens:	182	1					

APPENDIX 2. Definitions of habitat categories referred to in text.

These definitions include repeatedly reference to numbered CORINE "habitat" categories. For explanation, see the entry under "**corine**". Where a habitat category used here more-or-less corresponds with a habitat category referred to in *A Guide to Habitats in Ireland* (Fossitt, 2000), this is indicated at the end of the definition provided for it here, by the letters GHI, followed by the code number allocated to the corresponding category by Fossitt (*loc. cit.*). Where there is no such indication, the categories do not correspond. For instance, the term "flush" is used by Fossitt (2000) to denote only a part of the spectrum of helocrene features and the flushes recognised in the present text gain no expression in Fossitt's work. Similarly, the category "dry meadows and grassy verges", recognised by Fossitt, is an amalgam of different habitats dependent upon different forms of management lumped together, which does not provide a functional category that may be used here, because field margins require to be treated separately and defined separately from field surfaces. In all, less than half of the habitat categories recognised here are given separate identity in Fossitt (2000).

acid fen, fen: CORINE 54.4: ACIDIC FENS; *Caricetalia fuscae*, *Caricion fuscae*; topogenous or soligenous valley, basin or spring mire systems fed by waters poor in bases. As in the rich fens, the water level is at or near the surface of the substratum and peat formation is infra-aquatic. The mire communities themselves, dominated by small sedges and brown mosses or sphagnum, belong to the *Caricetalia fuscae*, but, in large fen systems, they are accompanied by acidocline wet grasslands (*Molinietalia caeruleae*), large sedge beds (*Magnocaricion*) and reed or related communities (*Phragmition*). Sphagnum hummocks (51.11) from locally and transition mires (54.5) or aquatic (22.3), amphibian (22.2) and spring (54.1) communities colonize small depressions. Thus, codes from all the above categories may need to be used in conjunction to completely describe the fen. The general category in any case includes, as understood here, beside strict mire communities, their transitions to humid grasslands; and groupings phytosociologically affiliated with *Molinia* associations, but rich in species of the *Caricion fuscae*, provided they are integrated in a fen system. Acidic fen communities also occur on small surfaces or within mosaics in other ecosystems, in particular in typical humid grasslands (37), humid woodlands and thickets (44), decalcified dune slacks (16.3) and spring systems

APPENDIX 2 (continued)

(54.1). Their presence can be indicated by codes from this unit used in conjunction with the relevant main codes. Characteristic species of acidic mire communities are *Carex canescens*, *C. echinata*, *C. nigra*, *Eriophorum angustifolium*, *E. scheuchzeri*, *Scirpus cespitosus*, *Juncus filiformis*, *Agrostis canina*, *Viola palustris*, *Cardamine pratensis*, *Ranunculus flammula* and the mosses *Calliergeon sarmentosum*, *C. stramineum*, *C. cuspidatum*, *Drepanocladus exannulatus*, *D. fluitans*, *Sphagnum recurvum*, *S. auritum*, *S. cuspidatum*, *S. subsecundum*, *S. apiculatum*, *S. papillosum*, *S. russowii*.
GHI: PF2

Alnus, deciduous forests: alder (*Alnus*) woods, with stands of overmature, mature and young (saplings/scrub) trees. CORINE 41.C.
CORINE 41.C: ALDERWOODS; non-riparian, non-marshy formations dominated by *Alnus* spp.
GHI: WN6

atlantic thickets, scrub/thickets: CORINE 31.83 and 31.85, excluding *Cytisus* formations.
CORINE 31.83: ATLANTIC POOR SOIL THICKETS; *Prunetalia p.*: *Pruno-Rubion fruticosi p.*: *Frangulo-Rubenion* (*Rubion subatlanticum*; *Franguletalia*); thickets of *Rubus* spp., *Frangula*, *Alnus*, *Sorbus aucuparia*, *Corylus avellana*, *Lonicera periclymenum*, *Cytisus scoparius*, characteristic of forest edges, hedges and (mostly *Quercion*) woodland recolonization developed on soils relatively poor in nutrients, usually acid, mostly under climates with strong Atlantic influence.
CORINE 31.85: GORSE THICKETS; *Ulex europaeus* thickets of the Atlantic domain (including British *Ulex europaeus-Rubus fructicosis* scrub *p.*)
GHI: WS1

brook, running freshwater: the bottom and aquatic vegetation of small, permanently running, freshwater bodies with a channel sufficiently narrow that the marginal bushes or herb layer

APPENDIX 2 (continued)

vegetation can form a closed canopy above the water. Included in this category are both natural brooks and permanently flowing drainage ditches. See also "brook edge".

brook edge, edge of running freshwater: the banks of small, freshwater, running water bodies, i.e. that part of a brook channel not permanently submerged in water and its immediate environs.

corine: the CORINE "habitats" classification system; a hierarchical, numerical categorisation of "habitat" categories, each of which is defined in the "CORINE Biotopes Manual, Data specifications", Part 2, published by the Office for Official publications of the European Communities, 1991. (ISBN 92-826-3211-3). Most CORINE "habitat" categories are defined entirely in terms of flowering-plant communities. Macrohabitat categories which co-incide with numbered CORINE "habitat" categories have their corresponding CORINE code numbers given in this glossary, followed, word for word, by the definitions of those CORINE categories as provided in the CORINE Biotopes Manual mentioned above. The references provided in the CORINE Biotopes Manual, to published sources of information on the different CORINE categories, are not included here.

cow dung: dung of cows/cattle, produced *in situ*, by grazing livestock (this does not include manure, imported from elsewhere and spread mechanically, as fertiliser).

crop: CORINE 82: Crops; fields of cereals, beets, sunflowers, leguminous fodder, potatoes and other annually harvested plants. Faunal and floral quality and diversity depend on the intensity of agricultural use.
GHI: BC1

drainage ditch: intermittently-flooded, man-made drainage channels dug in cultures.

APPENDIX 2 (continued)

fallow: farmland in its first year (or at most second year) after cultivation that has been left unsown with any crop (including grass-crops) for the duration of at least one growing season. Fallowing is normally carried out as part of an arable rotation system and as defined here includes unsown "set-aside" land (now employed within the EU as a standard mechanism for crop production control).

farmyard organic waste: accumulations of solid farmyard livestock waste (manure) and/or seepages of either slurry (liquid livestock waste) or silage (preserved grassland vegetation) from holding facilities.

field margin/hedge bank: permanently uncultivated, linear strip of land along the boundary of a cropland or intensive grassland, usually less than 2m wide and covered in herbaceous vegetation in which grasses predominate, and frequently backed by a hedge or fence. Coding of this habitat category assumes there is an electric fence separating the field margin from the field itself, in fields used for stock grazing. There is otherwise no definable field margin in fields used for stock grazing.

flush: helocrene groundwater outflows emerging over a diffuse area to produce seepages or flushes.

hedge: linear strips of deciduous trees and/or shrubs, planted along field margins, roadsides etc., frequently spinose (e.g. *Crataegus*, *Prunus spinosus*) and maintained, usually by mechanical cutting, to regulate height and width, so forming a dense and continuous band of woody vegetation a few metres high, with an associated herb layer and, frequently, isolated, emergent treees at irregular intervals.
CORINE 84.2: HEDGEROWS
GHI: WL1

APPENDIX 2 (continued)

improved grassland: improved pasture and meadow: CORINE 38.1, 38.2.
CORINE 38.1: MESOPHILE PASTURES; *Cynosurion*; regularly grazed mesophile pastures, fertilised and on well-drained sites, with *Lolium perenne*, *Cynosurus cristatus*, *Poa* ssp., *Festuca* ssp., *Trifolium repens*, *Leontodon autumnalis*, *Bellis perennis*, *Ranunculus repens*, *R. acris*, *Cardamine pratensis*; they are most characteristic of the Euro-Siberian zone, butextend to Atlantic Iberia and the Cordillera Central, the Apennines and the supra-Mediterranean zone of Greece.
CORINE 38.2: LOWLAND HAY MEADOWS; *Arrhenatherion*, *Brachypodio-Centaureion nemoralis*; mesophile hay meadows of low altitudes, fertilized and well-drained, with *Arrhenatherion elatius*, *Trisetum flavescens*, *Anthriscus sylvestris*, *Heracleum sphondylium*, *Daucus carota*, *Crepis biennis*, *Knautia arvensis*, *Leucanthemum vulgare*, *Pimpinella major*, *Trifolium dubium*, *Geranium pratense*; they are most characteristic of the Euro-Siberian zone, but extend to Atlantic Iberia, the Cordillera Central and Montseny, to the Apennines and to the supra-Mediterranean zone of Greece.

intensive grassland: intensively used pasture and meadow. CORINE 81.
CORINE 81: IMPROVED GRASSLANDS; heavily fertilised or reseeded grasslands, subjected to periodic cultivation and frequently alternated with crops in rotational systems; sometimes treated by selective herbicides and with very impoverished flora and fauna.
GHI: GA1

old walls: walls made from blocks of natural rock, that have been *in situ* long enough to gather a partial covering of vegetation e.g. *Sedum*, *Umbilicus*, thus providing a secondary habitat for some moraine and scree organisms.
GHI: BL1

oligotrophic *Molinia*, humid/flooded, unimproved grassland: nutrient-poor purple moorgrass (*Molinia coerulea*) grassland, developed on peat. CORINE 51.2.

APPENDIX 2 (continued)

CORINE 51.2: PURPLE MOORGRASS BOGS; *Ericion tetralicis p.*; drying, mowed or burned bogs invaded by *Molinia caerulea*.

orchard: CORINE 83.1: HIGH-STEM ORCHARDS; tree crops of standards, cultivated for fruit production.

permanent pond/pool: small, permanent water body of man-made or natural origin with standing water. This term is used here in contradistinction to lakes, reservoirs and temporary pools.

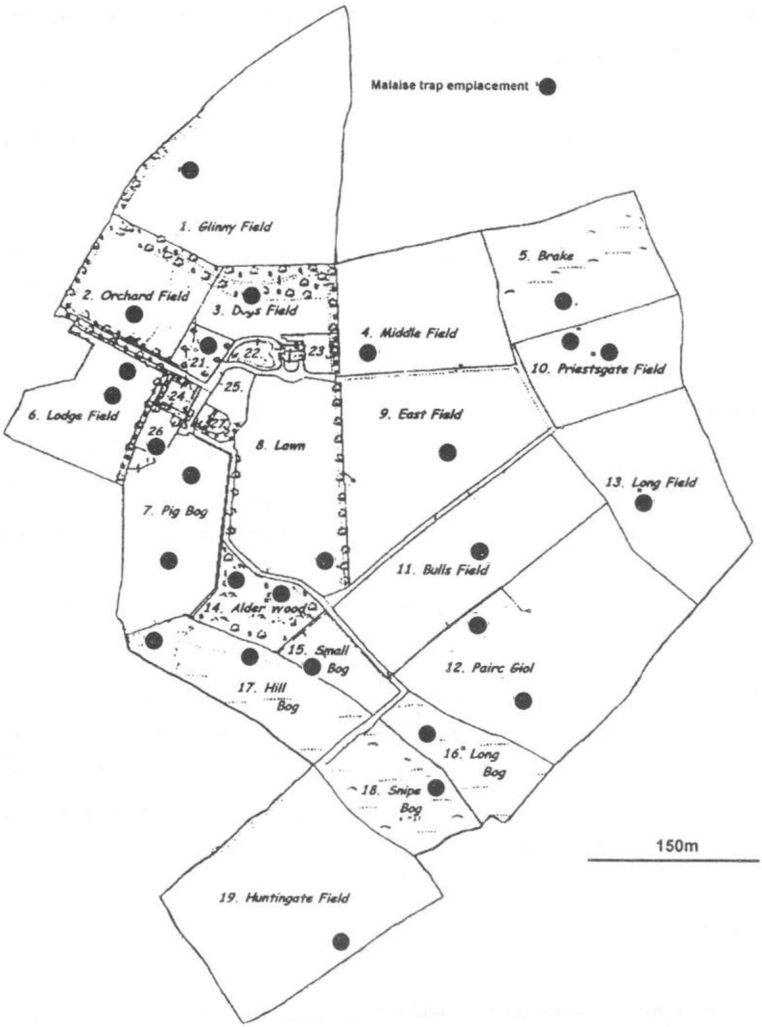
scattered trees in open ground: individual mature or overmature trees, isolated from one another, or occurring only in scattered clumps or lines, or as occasional outstanding trees in hedgerows. These trees mostly require consideration according to their genera so that they appear as a series of categories: *Fagus*, *Quercus*, *Fraxinus*, other hardwood genera, *Populus*, *Salix*, conifers.
GHI: WD5

seasonal brook in cultures: shallow, ground-water fed brooks flowing autumn/spring, when the ground-water levels are high, but not usually throughout the year (presence of these features may be difficult to detect when they are not flowing). In cultures, seasonal brooks are normally canalised and resemble ditches. They differ from ditches in that they flood from groundwater sources as well as from surface run-off.

set-aside: see fallow.

temporary pool in open ground, open ground supplementary habitats: small temporary water bodies of natural origin, flooded by river overflow, fluctuation in ground-water level, and/or rain or snow melt, and not shaded by a tree canopy.

FIGURE 1. The case study farm, showing location of Malaise trap emplacements.



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FARMS AS BIOGEOGRAPHICAL UNITS: 3. THE POTENTIAL OF NATURAL/ SEMI-NATURAL HABITATS ON THE FARM TO MAINTAIN ITS SYRPHID FAUNA UNDER VARIOUS MANAGEMENT REGIMES

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Summary

The potential for gain to and loss from the syrphid fauna of the farm is explored, as caused by subjecting the natural/semi-natural habitat area on the farm to different forms of management consistent with the demands of the farm economy. It is concluded that nearly all probable forms of management, including continued disuse, would be likely to lead to a net reduction in the fauna. It is also concluded that the management alternatives least damaging to the fauna are also the least viable, financially, for the farmer, even given the existence of schemes encouraging "eco-friendly" farming. It is pointed out that there is a close resemblance between the character of the studied farm and the surrounding farmland landscape, suggesting that these conclusions probably relate not just to this farm, but to a much wider segment of the countryside.

Introduction

In parts 1 and 2 of this series (Good, 2001; Speight, 2001), it was pointed out that part of the area of the case-study farm is occupied by what is essentially disused land, when looked at in terms of the function served by different sectors of the farm in engendering an economic product, and semi-natural/natural habitat when looked at in terms of the habitats present on the farm. Evidence has also been presented to show that most of this area has been natural/semi-natural habitat throughout the history of the farm, and that, until partial drainage changed its character recently, a significant part of it supported acid fen (see Good, 2001), a habitat type now almost lost from the farm. At present, this area comprises slightly more than 5ha and supports:

- Atlantic scrub,
- seasonally-flooded, oligotrophic, unimproved *Molinia/Deschampsia* grassland with a residual acid fen component (and scattered *Salix* scrub),
- *Alnus* woodland.

Definitions of these habitat categories are provided in Part 2 of this series. Also in Part 2, in its present condition, the disused sector land on the farm has been identified as capable of supporting nearly all of the sciomyzid and syrphid species observed on the farm and as being the only part of the farm capable of supporting most of the sciomyzids and a third of the syrphid fauna. It has also been identified as extremely susceptible to loss, in the event that socio-economic and socio-cultural factors caused change in the management regimes operated on the farm (see Part 1).

In Part 3 of this series, the observed syrphid fauna of the farm (see part 2) is used, in conjunction with the Macrohabitats file of the Syrph the Net database (Speight *et al.*, 2000), to predict potential changes in the syrphid fauna of the disused sector under various management regimes to which it could become subject.

Methods

Based on the arguments presented in Part 1 of this series, a list of potential alternative futures for the disused sector land on the case study farm may be assembled:

- continued disuse (i.e. no management),
- maintenance of present condition (light grazing, scrub clearance),
- conversion to improved grassland (drainage, ploughing, nutrient addition, reseeding),
- conversion to conifer plantation (felling, drainage, replanting),
- conversion to oak/alder plantation (felling, drainage, replanting),
- rehabilitation of wetland (reflooding, scrub clearance, blocking of existing drains, light grazing).

Through use of the habitat association data coded into the syrphid database, it is possible to review the effects of adopting these various management regimes in terms of a "gain and loss" account for the existing fauna of the farm i.e. to see how many species are likely to be gained or lost to the farm as a result of adoption of particular management regimes in the disused land. It is also possible to consider the extent to which these different regimes will provide "support", from the area of disused land, to the fauna elsewhere on the farm i.e. to establish what numbers of species occurring in infrastructural and/or productive sector habitats on the farm will be supported by populations of the same species in the disused land under different management regimes, presenting this information in terms of whether a particular regime would be expected to result in a net "gain or loss" of support. Finally, an overview can also be gained of the predicted effects of each alternative regime on the existing fauna of the disused sector, using this same "gain and loss" approach.

To simplify matters in carrying out the predictions outlined above, it is assumed here that each alternative management regime considered applies to the entire disused sector i.e. that the oligotrophic *Molinia* grassland, the residual acid fen, the Atlantic scrub and the *Alnus* wood are all subject to the same regime. Given the small area of land involved this is, in any case, a realistic assumption - it is much more likely that the entire area of disused land would be converted to some form of use at the same time, than that only part of it would. The only exception is in the case that an attempt is made to maintain the existing situation - under those circumstances it is assumed that the presence is maintained of all habitats currently observed in the disused sector land. The predictions are initially confined to consideration of the syrphids which have been observed on (i.e. which are known to reach) the farm. Thus species known from Co. Cork and which might take advantage of changes in management on the farm to colonise it, are not considered at this stage of the exercise. They are, however, brought into play later on. Other assumptions made, in respect of particular management regimes, are detailed below. Finally, it is assumed that, where drainage is undertaken as part of the process of conversion of the disused land area to serve some specified use, the drainage results in cessation of seasonal flooding of the ground surface (which occurs at present) and drying up of remaining seepages/flushes, such that canalised, seasonal streams become the only form of surface water present.

Continued disuse

Under this *laissez faire* management option it is assumed that the process of scrub encroachment, already well-advanced, will continue. The logical conclusion to this process is elimination of the existing open areas of *Molinia* grassland/acid fen, and prediction of the effects of this management option are based on the situation reached when only scrub and *Alnus* wood remain in the disused sector land. This would be the likely fate of the disused sector land under the Rural Environmental Protection Scheme (REPS, see Anon., 2000) as it is operated at present (Hickie *et al.*, 1999) since this could be expected to ensure that the disused sector natural/semi-natural habitats are retained, but not that they are managed to maintain their current interest.

Maintenance of present condition

The assumption made here is that scrub encroachment in, and any further drying out of, the *Molinia* grassland/residual acid fen can be arrested. The continued presence of the *Alnus* woodland is also assumed. This is quite possibly one of the least realistic of the options considered, since it requires active management but without increasing the profitability of the farm, either in the form of production of some saleable commodity or in the form of financial recompense for adoption of "ecologically-friendly" farm management. Current schemes provide recompense for leaving areas of natural/semi-natural habitat on farmland unused, but do not provide targeted finance for the active management of these areas, even if recommending such management.

Conversion to improved grassland

This is effectively the minimum option, in bringing the disused sector land into productive use as fields. It would involve at least the removal of existing vegetation (including trees ands their roots), improving drainage, use of fertiliser and reseeding. It would very probably also involve ploughing, but it is in this instance assumed that ploughing does not occur.

Conversion to conifer plantation

In line with current forestry practice, it is assumed that the conifers introduced to the disused sector would be sitka spruce. It is further assumed that conversion of the entire disused sector land area to conifer plantation would occur at the same time, rather than as a process of progressive replacement of the existing habitats by conifers. This would be normal practice, in order that current grants for planting of conifers might be availed of to the maximum, the scale of grant being dependent upon area planted. Clearance of existing tree and scrub cover, and increased drainage, are assumed to occur as part of the phase of establishment of the conifer crop.

Conversion to oak plantation

The assumptions made here are similar to those made in relation to conifer plantation installation: conversion of the entire disused sector area is carried out at one time; and the conversion process involves increased drainage and removal of at least existing tree and scrub cover. In this instance, the sapling and mature phases of the tree-crop cycle are considered separately. There are two schemes currently providing financial support for establishment of small plantations of deciduous trees on farmland in Ireland, making this disused land management option financially viable.

Rehabilitation of wetland

Here it is assumed that acid fen is re-established on the disused area, the areas of Atlantic scrub and alder wood being removed as part of the process, though oligotrophic *Molinia* grassland is assumed to remain, as part of an acid fen/*Molinia* grassland mosaic. The mechanism for re-establishment of the acid fen is taken to include blocking of surface drains introduced during the last 30 years, re-introduction of light grazing by cows and the creation of a shallow, permanent, standing-water body. This option carries with it the same air of unreality as accompanies the option to maintain the disused sector in its present condition, and for the same reasons: it involves active management without financial reward.

Results

The predicted results of adopting various alternative management regimes on the area of disused sector land are shown in Table 1. From that table, it is immediately obvious that all forms of active management considered are likely to result in loss of some species from the existing farm fauna and that conversion to conifer plantation would seem no better than conversion to improved grassland in this respect. Further, conversion to oak plantation would be expected to lead to reduction in the farm fauna on a similar scale to that resultant from conversion to conifer plantation, though this would not become fully apparent until the oak plantation reached maturity.

However, when the capacity of the habitats introduced by these management regimes to support the fauna of other parts of the farm is brought into consideration, as shown in Table 2,

TABLE 1. Changes predicted in the present syrphid fauna of the farm under different management options for the disused sector land.

Management option	**Change in fauna (no spp.)**			
	Disused sector		Farm in general	
	gain	loss	gain	loss
Continued disuse		21		13
Maintenance in present condition				
Conversion to improved grassland	7	30		16
Conversion to conifer plantation		45		16
Conversion to oak plantation	2	43	2	15
saplings	10	30		15
closed canopy/mature	2	43	2	15
Rehabilitation of wetland	0 or 4	2	0 or 4	2
assuming acid fen now present		2		2
assuming acid fen now absent	4	2	4	2

TABLE 2. Changes predicted in the number of syrphid species occurring in both disused sector land and other sectors on the farm (i.e. in the capacity of the disused sector to support populations of species occurring elsewhere on the farm), under different management options for the disused sector land (based on the observed syrphid fauna of the farm).

Management option	**Support of fauna**			
	Infrastructure		Productive sector	
	gain	loss	gain	loss
Continued disuse		8		8
Maintenance in present condition				
Conversion to improved grassland	7	12	7	
Conversion to conifer plantation		18		22
Conversion to oak plantation				
saplings	11	7	6	13
closed canopy/mature		11		14
Rehabilitation of wetland		15		
assuming acid fen now present		15		
assuming acid fen now absent		15		

it is clear that conversion to conifer plantation represents the least useful alternative, faunistically. It would result in a maximal loss of species from the farm. It would also provide least support for species occurring elsewhere on the farm, both through causing a maximal reduction in the number of species existing in both the disused area and other parts of the farm at the moment and through providing a minimal replacement of those species by others.

In Part 1 of this series, acid fen is alluded to as now lost from the case study farm, whereas in Part 2 it is regarded as still represented, but only in a residual condition. In the present (Part 3) text, acid fen has so far been discussed as though it occurs on the farm, but only as a residuum. Four of the syrphid species observed on the farm (see Part 2), *Anasimyia lineata*, *Eristalis abusivus*, *Orthonevra geniculata* and *Platycheirus scambus*, would not be predicted to occur in association with any habitat observed on the farm except acid fen. But it is in any case debateable whether these species could be expected to occur on the farm, in association with the small flushes which constitute the remaining manifestation of acid fen there. At least one other relictual patch of acid fen also occurs within the surrounding landscape, within 1km of the case study farm (see Part 2). In these circumstances, it is only practical to consider acid fen both as though it is a part of the farm and as though it is not. If it is regarded as part of the farm, then its dependent species would be eradicated by all forms of change in the disused sector land that have been considered here, except for maintaining it in its present condition or rehabilitation of wetland there. It would also be expected that these species would be lost if the current *laissez faire* regime remains in place for the disused sector land. If acid fen is regarded as absent from the farm, then so too are the four acid fen-dependent syrphids mentioned above, as resident species. It is in these circumstances that rehabilitation of wetland (i.e. acid fen) on the farm would result in an expected increment of four species to the farm syrphid fauna (see Table 1). But perhaps more importantly, whether these acid fen species are resident on, or visitors to, the case study farm at the moment, their presence there in the future would seem to be dependent upon adoption of a management option for the disused sector land on the farm that is not financially viable - away from sites recognised as having national/international significance for conservation there is no provision for funding the active management of natural/semi-natural habitat within farmland, for conservation purposes.

Leaving aside the complications caused by whether or no acid fen has to be regarded as present on the farm, species gains to the farm syrphid fauna would seem to be almost non-existent, whatever management regime is introduced to the disused sector land, to judge from the data presented in Table 1. This is because prediction of which species might colonise the farm, by becoming established in habitats introduced to the farm, is in this instance based on which species are known to reach the farm at the moment, but are not known to be associated with any of the habitats there already. All but three of the syrphid species observed on the farm would be expected to occur in association with one or more of the habitats found there now (see Part 2 of this series), if it is assumed acid fen is present. This would mean there are apparently only three species "available" to colonise the farm if appropriate habitat were provided there for them. Of these three, one, *Helophilus trivittatus*, would remain unaffected by the management options considered - appropriate habitat supposedly remains unavailable on the farm whichever option is adopted. In the case of the other two, *Sphegina elegans* and *Xylota sylvarum*, mature oak plantation might be expected to provide appropriate habitat, so that were mature oak plantation to become established upon the farm these two syrphids could then establish themselves there. At least, they might do so assuming that at that point in time they continued to reach the farm from elsewhere. So the prediction that availability of mature oak plantation on the farm would result in a two species increment to the farm syrphid fauna (as shown in Table 1) is dependent upon the assumption that *S. elegans* and *X. sylvarum* will continue to reach the farm from elsewhere in more than 50 years time, which may or may not be realistic. If, alternatively, it were to be argued that both of these species are resident on the farm at present, but that knowledge of their habitat associations is insufficient for their residency to be predicted by the database, then their establishment in mature oak plantation on the farm would not represent an increment to the fauna. And, were these species to be dependent upon the alder wood for their presence on the farm, clearance of the alder woodland, in order to establish an oak plantation, would result in their disappearance long before the oak plantation could have grown to a maturity that could provide them with appropriate habitat. In the latter circumstance they would not be available to colonise mature oak plantation on the farm, once it became available.

The interpretation of results provided in the previous paragraphs is virtually dependent upon the premise that species reaching the case study farm during the course of the year 2000 can be regarded as the sum total of species potentially available for colonisation of the farm. This may well represent an inadequate perception of reality, the species complement reaching the farm from elsewhere varying somewhat from year to year. This could only be established by repeated survey carried out over a number of years, which has not been carried out for any farmland landscape in Ireland. In these circumstances, it has to be recognised that there may be a greater potential for colonisation of these habitats than has been assumed in the previous paragraphs, even if there are no directly relevant data to support that argument. So, if there are species intermittently reaching the farm from elsewhere, but not detected during course of our survey, where would they be coming from? Realistically, they are most likely to be derived from some other part of Co. Cork, given the location of the farm within that county. They would otherwise have to originate either from somewhere in Ireland outside Co. Cork or even further afield - some part of the Atlantic zone of Europe other than Ireland. On the basis that most such potential colonisers would be derived from Co. Cork rather than further away, potential gains to the farm fauna, from adoption of these various alternative managements, can be reconsidered. The result is shown in Table 3.

Clearly, if species from elsewhere in Co. Cork can be assumed to reach the farm intermittently, even if we are unable to demonstrate this, then there is an increased possibility for the farm fauna to be augmented by adoption of most of the alternative approaches to management of the disused sector land. But the greatest gains would once more result from either maintaining the disused sector in its present condition, or re-instatement of wetland there, and the relative utility of the other alternatives also remains much as before. The exception is continued disuse, which in these circumstances would appear less beneficial than establishment of either conifer or oak plantations.

TABLE 3. Predicted changes in syrphid fauna under different management options for the disused area of the farm, based on the Co. Cork species pool.

Management option	gain to farm (from Cork list)
Continued disuse	3
grassland/fen	
scrub	1
alder wood	2
Maintenance in present condition	13
grassland/fen	10
scrub	1
alder wood	2
Conversion to improved grassland	
grassland/fen	
scrub	
alder wood	
Conversion to conifer plantation	7
grassland/fen	
scrub	
alder wood	
Conversion to oak plantation	9
saplings	
closed canopy/mature	9
Rehabilitation of wetland	14 or 18
assuming acid fen now present	14
assuming acid fen now absent	18

Discussion and conclusions

In Part 1 of this series, it was demonstrated that the character of the disused sector land on the case study farm was dependent upon the use history of the farm, and that it has remained as semi-natural/natural habitat up to the present because it was not worthwhile to do otherwise with it, except in that part of its area was planted with *Pinus sylvestris* during the 19th century. In Part 2, it was shown that this relatively small enclave within the farm area is probably uniquely responsible for maintenance of more than 20% of the farm's syrphid fauna and, in Part 3, it has been shown that the very factor responsible for survival of the disused sector as semi-natural/natural habitats (i.e. lack of management) is now likely to result in loss of nearly 20% of the farm's syrphid fauna, from those disused sector habitats (due to uncontrolled scrub encroachment). Further, if there are changes in its status, evoked by the sort of socio-cultural and socio-economic forces detailed in Part 1, these will almost inevitably result in an even greater net loss to the farm's present syrphid fauna, without counterbalancing gains. And, in most instances, the only gains which would be predicted are dependent upon the supposition that there is a greater capacity for species to reach the farm from the surrounding countryside than we have been able to demonstrate during the course of this study. Finally, the only management options identified as likely to maintain the existing fauna of the disused sector land - which are also the options identified as likely to lead to the greatest increments in the farm's syrphid fauna - are not financially viable, even bringing into consideration schemes currently in existence for promoting "environmentally friendly" farming.

There is no reason to suppose that the disused sector land on the case study farm is atypical of land that has gone out of use on other farms, either in the vicinity of the case-study farm or in Ireland in general. The potential role of the disused sector habitats in maintaining the fauna of the farmed landscape is highlighted by all three texts in this three Part series, as is their vulnerability to change and as are the difficulties of maintaining them. Our efforts here have been focussed on considering the potential role of enclaves of disused sector land at present, and their possible fate in the immediate future. We have not attempted to address issues of long-term survival by species within these enclaves, that for many of their dependent species are fast becoming biogeographical islands within an otherwise uninhabitable farmland landscape. Even if it might be felt that the long-term survival of a species in such enclaves is questionable; the potential for their loss to impact upon the biogeography of Ireland would seem to be considerable.

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FARMS AS BIOGEOGRAPHICAL UNITS: 4. CONCEPT AND REALITY

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Summary

From the review of the material presented in parts 1-3 of this series it is concluded that, while an individual farm may be a functional unit for management of local biogeographical features, it is less likely to be a functional unit for their maintenance, because of the impact upon the farm of events in the surrounding landscape. For effective maintenance, it is concluded that complementary management would have to be instituted in chains of farms, targeted to maximise landscape permeability through them as well as appropriate habitat management on them. It is noted that existing schemes aimed at promoting "eco-friendly" farm management have no built-in capacity to "network" farms in this fashion, but develop individual farm management plans in isolation from one another.

Introduction

In Part 1 of this series (Good, 2001), it is demonstrated how socio-cultural and socio-economic imperatives modify the physical and ecological character of the various parts of the land surface of a farm, integrating them all into a functional unit, economically. The fact that this essentially economic relationship between the various parts of a farm has repercussions on elements of the insect fauna of the farm is explored in Parts 2 and 3 of this series (Speight, 2001; Speight and Good, 2001). Part 2 demonstrates that while nearly all the species capable of survival on productive land can be expected to occur on other parts of the farm, the converse is not true and the species least likely to be shared with other parts of the farm are liable to occur on disused land found within the farm boundary. In Part 3 the potential faunistic implications of the vulnerability of disused land to economy-dictated change in its status are investigated, showing that the more financially-viable management options would all be expected to lead to a net loss of fauna. Given that the case-study farm is not atypical of farms elsewhere in Ireland, and certainly not atypical of the landscape within which it is located, the need to consider farms as units, when attempting to understand the impact of farming on the biogeography of farmed landscapes, seems incontestable. But, even if the socio-economic objectives driving the management of a farm dictate what can survive on all parts of that farm, and determine the extent to which the fauna of one part of it will differ from or overlap with the fauna of another part of it, the species themselves do not necessarily respond to farm boundaries as barriers, or as corridors, or at all.

The need to relate the farm to the landscape in which it is situated has been alluded to a number of times in this series. The present text represents an attempt to look more directly at that issue, based upon the material presented in Parts 1-3. As such it is more of an addendum to the three previous texts and is perhaps best viewed as a brief discussion of the concept of a farm as a biogeographical unit, and has been titled accordingly.

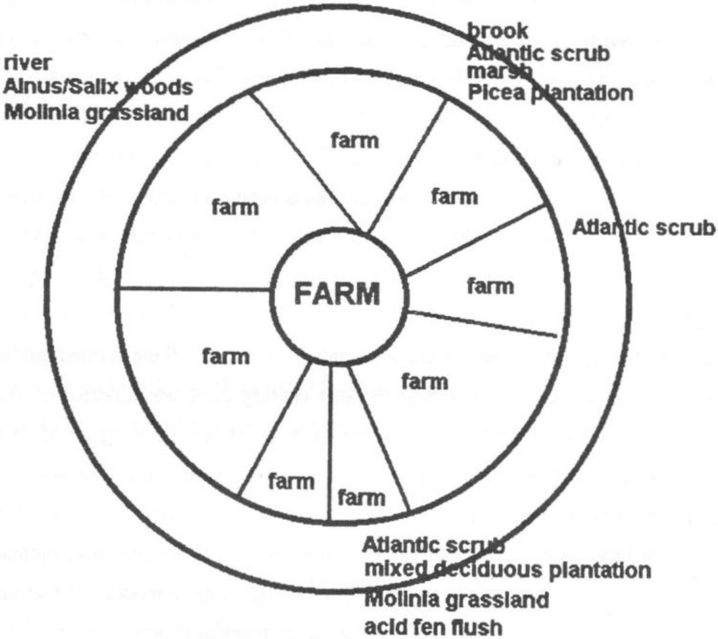
The farm as a biogeographical unit: a discussion.

The summary of the first paper in this series opens with the statement "Farms are proposed as functional biogeographical units". But no definition of what is meant by a "functional biogeographical unit" is given at that stage.

A farm is clearly a de facto functional unit of *management* of local biogeographical features, both geomorphologically and biologically, in that the farmer essentially dictates much of the surface topography of the farm and its biological content. But is a farm a functional unit of *maintenance* of those biogeographical features? Examining the potential fate of elements of the existing fauna of the case study farm under various management regimes, past, present and potential, as has been done in Parts 1-3 of this series, would suggest that management of the case study farm has not necessarily maintained either the species or the habitats known to have been there during the past 50 years. Further, existing and likely future management would be predicted to result in further reduction in the fauna and habitats on the farm. It could be argued that this problem is largely one of mechanics, in the sense that if money suddenly became available to pay the farmer to actively manage disused and infrastructural components of the case study farm for purposes of nature conservation, relevant management could then be carried out. But is this problem entirely mechanical, or are there other elements involved as well, and, in particular, the problem of scale? In other words, can the existing species and habitats on the farm be maintained there by appropriate management, however the surrounding landscape is managed? After all, if it is to be argued that the case study farm is a functional unit for management of local biogeographical features, then so is every other farm in the surrounding landscape. Which means that, were the case study farm to be managed explicitly for maintenance of its species and habitats, but the farms in the surrounding landscape were not, then given the existing socio-economic and socio-cultural pressures upon farmers, the most likely result would be that species and habitats maintained on the case study farm would progressively disappear from the surrounding landscape.

A biogeographical unit could be defined in a number of ways. Within the context of this series of texts, there would seem to be two levels at which such definitions could operate - management and maintenance. At the management level an individual farm could, indeed, be the functional biogeographical unit. But, at maintenance level, a functional biogeographical unit would have to be a piece of the farmed landscape in which all of the habitats represented locally occur, on a scale sufficient to ensure the survival of their constituent biodiversity, given appropriate management, and where the farms occupying that piece of landscape *are* being managed in a fashion which would sustain that biodiversity. The case study farm is itself surrounded by other farms, as shown diagrammatically in Fig. 1. On those farms the infrastructure is mostly intact and disused land is also present on some of them. The disused land habitats present in the landscape, within 1km of the case study farm, are also indicated in Fig. 1, showing that the case study farm is fairly typical of the landscape in which it is situated, but lacks at least marsh, river and brook, of the habitats represented locally. This suggests that, in the vicinity of the case study farm at least, to obtain a landscape unit in which all of the habitats represented locally occur, there would be need to combine the area of several farms together. Another element worthy of consideration is whether there is a minimum viable area available, of each of the habitats involved. Certainly, in the sense that habitats are, in part, complexes of species and it is recognised that species require a minimum viable population in an area (Henle *et al.*, 1996), in order to survive there, there must be a minimum viable area for each habitat. But there is no convenient source of information detailing minimum viable areas for habitats and it is unlikely that such data will become available in the foreseeable

FIGURE 1. Diagrammatic representation of the case-study farm (in central position) and its surrounding landscape, showing the general location of disused land habitats within 1km (the outer ring) of the outer edge of the case-study farm.



future. In these circumstances, in order to take this element into consideration there is little option other than to err on the side of caution, when attempting to identify landscape units of a scale appropriate to maintain local biodiversity, and take large units in preference to smaller units, when in doubt.

During the historic period, from the early subsistence farmers onward, farming in Ireland has invariably involved livestock production (Mitchell, 1986), providing hundreds of years for accommodation of the local biota to livestock farming conditions; i.e. it is reasonable to conclude that the indigenous organisms which could survive in association with livestock would all have become established within the farmland landscape during this period and those which could not survive in association with livestock would have gone from the farmland landscape during the same period. Farm infrastructural elements like hedges may well not have been commonplace until enclosure was introduced on a large scale in the 1750s (Orme, 1970). And the change in farm unit size, precipitated by the appalling conditions which existed around the middle of the 19th century, also exerted a considerable impact on the farmed landscape. But, from the mid 19th century to the start of the 20th century there was a period of relative stability in the structure of the farmed landscape (Orme, 1970). Farming could, indeed, be perceived as an engine "driving" many farms in more-or-less the same direction, such that there was high probability for management of adjacent farms to be compatible, in respect of maintenance of local biogeographical features. In other words, a significant, though unsung, virtue of what is loosely referred to as the "traditional farming practices" of that period is that they resulted in farms operating in tandem to produce functional biogeographical *maintenance* units within the landscape. With the advent of the dramatic changes that occurred in farming during the 20th century, the farmed landscape has increasingly been in a state of flux. An example of the previous and present situations is illustrated diagrammatically in Figs 2a and 2b. Any farm (such as farm 3 in Fig. 2b) which is today maintaining habitat by default (no drainage or eutrophication, scrub control and low intensity grazing), will be functioning as an isolated management unit, rather than as part of a set of connected management units, and the biogeographical maintenance unit of landscape has disintegrated.

FIGURE 2a. Diagrammatic representation of the condition of a semi-natural habitat (the example chosen is a wetland), part of which occurs within each of a string of four contiguous farms, under "traditional" farming conditions.

Sector	Farm 1	Farm 2	Farm 3	Farm 4
Productive land	**Mixed farming**	**Mixed farming**	**Mixed farming**	**Mixed farming**
Semi-natural sub-unit	***Wetland***	***Wetland***	***Wetland***	***Wetland***

FIGURE 2b. Diagrammatic representation of the same farms, under the more specialised farming conditions occurring today, showing accompanying change in the area of semi-natural habitat.

Sector	Farm 1	Farm 2	Farm 3	Farm 4
Productive land	**Tillage**	**Tillage**	**Suckler cattle**	**Dairy cows**
Semi-natural habitat	Drained *Forestry*	Disused *Scrub*	No change *Wetland*	Drained & reseeded *Impr. pasture*

Any attempt to reimpose management suitable for maintenance of biodiversity at landscape unit level, across strings or clusters of farms like that shown diagrammatically in Fig. 2b, would have to overcome a number of practical obstacles, including *inter alia*:

(1) Production systems (e.g. tillage) which do not have the livestock needed to halt scrub invasion;

(2) Fencing costs which currently preclude extensive grazing (as for the case study farm, and described in Part 1 of this series - see Good, 2001);

(3) Changes in livestock systems, such as cessation of suckler cow enterprises due to BSE impact, or reductions in suckler cow premia;

(4) Restoration of habitat converted to another condition for purposes of giving greater return on investment (e.g. forestry) or for construction works (e.g. infilled for road widening).

It would be unlikely that, in the present socio-cultural climate of western Europe, landscape units that have disintegrated in this way would be reinstated. In consequence, any attempt to maintain the existing biodiversity of farmland would seem to depend on:

a) Identification of groups of farms where management is still compatible at the biogeographical maintenance unit scale,

b) The use of mechanisms like "eco-friendly farming" schemes throughout such groups of farms, taken together as landscape units.

The need for landscape permeability, to allow for maintenance of populations of organisms by recolonisation following local extinction, and to maintain genetic diversity within populations by gene flow mediated by individuals passing from one population to another, is well-recognised and currently the topic of much debate. This is particularly the case in Europe, where concern about the geographical isolation of sites supporting threatened habitats and species is engendering attempts to develop systems for "networking" these sites. We do not intend to reopen that debate here. Suffice it to say that consideration of the situation in Ireland (Good, 1998) gives rise to some disquiet. In the present text we have already argued that an individual farm, operating as a functional management unit within the landscape, can only play a limited role in maintaining the flora and fauna of that landscape, but that complementary management of a chain or contiguous group of farms would be expected to have a synergistic effect, giving rise to the concept of a functional biographical maintenance unit within the landscape. Chains of farms targeted for maintenance of their species and habitats should also have the potential to increase landscape permeability, i.e. contribute to "networking" of the farmed landscape. The extent to which this might, or might not, aid in the survival of threatened habitats and species is not at issue here. In the present context, its significance lies in its potential to play a role in maintenance of the flora and fauna still existing within the farmland landscape (which, as demonstrated earlier in this series, can comprise more than half of the regionally-represented species, at least for some taxonomic groups).

At the moment, schemes aimed at encouraging "eco-friendly farming", like REPS (Anon., 2000), treat farms individually, and there is no requirement under these schemes to consider the situation of adjacent farms, when compiling a farm management plan. From the preceding discussion this can be seen as a limitation with considerable, and adverse, biogeographical implications. These schemes have no built-in capacity to engender complementary management of habitats in farms with common boundaries, or to consider the impact of the REPS regime instituted on one farm upon the REPS regime instituted on another. So it would only be by happenstance that such schemes would at present operate usefully at the landscape unit scale, either for maintenance of habitats shared between farms or to aid in other components of landscape "networking", such as increasing landscape permeability to dispersal by the biota occurring within farmland.

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ROBERT EDMUND BLACKITH (1923-2000)

This issue of the *Bulletin* is dedicated to the memory of Professor Robert Blackith, a leading figure in Irish biology for three decades. His entomological specialisations included insecticide bioassays and the biology and systematics of orthopteroids and Diptera, but Robert had also much broader interests - he was a leading biostatistician, and a campaigner in environmental issues long before this became fashionable in Ireland.

Robert entered Imperial College, London, but after one year he was seconded to a three-year break for wartime research in tropical entomology. He graduated in 1948 with a degree in Chemistry and Geology, and in the same year had a paper accepted by *Nature*. His unusual combination of expertise and experience led to a Ph.D. on the stability and assay of contact insecticides, and more than 30 publications. In the late 1950s, Robert started to publish on orthopterans - his work on the biology of locusts was again of economic importance - and on social insects. In both of these areas his flair for statistical analysis was allowed to flourish, with studies on taxonomy and polymorphisms, multivariate analyses of growth, and methods for population estimations. Robert became a Fellow of the Institute of Statisticians in 1962, and received his D.Sc. (London) for research in multivariate mathematical modelling in 1971. In that year, he was a co-author with R. A. Rayment of a major text on multivariate morphometrics. By this time he was translating from and publishing in French and German, as well as in English, and in 1964 he even published a multivariate analysis of Latin elegiac verse.

In the late 1960s Robert was a senior research fellow in Melbourne University, and around this time he was active on collecting expeditions in New Guinea and the Solomon Islands. He married Ruth in 1964 and started publishing on orthopteroids with her in 1966, and this fruitful collaboration was to continue right up to his death. In 1968, Robert received a C.N.R.S. grant to study locusts in the Laboratoire d'Evolution des Etres Organisés in Paris. This included an expedition with Ruth to Eritrea, where locusts were swarming at the time. However, travel was so restricted by the Eritrea - Ethiopia conflict, that access to the swarms was impossible. During the student protests in Paris in May 1968, Robert was only allowed into the laboratory building to service the locust cultures - perhaps it was at this time that he picked up his colourful fluency in French! In 1969 he drove from Dublin to Sri Lanka and back, collecting tridactyloids and eumasticids (primitive orthopterans) and in September 1969, he took up a research position with the International Biological Programme in Dublin University. By this time he had produced almost 90 international publications, in both French and English. His total list was close to 200. Robert was elected a Fellow of Trinity College in 1971, and in 1974 he produced his first publication in Irish - "Daortha chun tomhaltais" in *Comhar*.

In Ireland, Robert developed specialisations in two new areas. His expertise in mathematical ecology led him to study the interactions within communities of small detritivores, particularly collembolans, and with their peatland habitat. At this time, most peatland ecologists were looking at vegetation dynamics rather than functional ecology; but he, Ruth and his students and colleagues drew attention to the important role of peatland invertebrates. He also recognised that Ireland's rapid development was occurring without a strong basis of conservation thinking, and had much to lose both in the natural environment and in human terms. He was a founder member of the Irish Conservation Society at a time when such things were viewed with deep suspicion, and his forays in the early 1970s into hidden sides of Irish life in terms of human population and birth control earned him some unchristian responses from representatives of the churches. He was an expert witness to the Windscale enquiry from 1977, and helped to set the seeds for Ireland's present anti-nuclear stance, with publications like *The power that corrupts: the threat of nuclear power promotion in Ireland* (1976). His public health work included studies of the potential contribution of susceptible sub-populations in radio-sensitive disease incidence, and in 1987 he was able to comment authoritatively on Chernobyl and its aftermath.

All this time, Robert continued to undertake collecting expeditions - he was an advocate of Citroen cars in severe conditions, and used to describe how he once had to bargain with goats for a spare part which arrived by camel train in the desert. Robert was a wonderful racconteur - the essence of the situation was always there although there was often a bit of poetic licence. He had another story about his war-time research, which included exposing his arm in a cage of yellow fever mosquitos to provide them with a blood meal. In time, he developed a violent allergy and had to have his clothes cut off - but in those days, there was no compensation, not even new clothes.

As a supervisor, Robert could be relied on to question accepted thinking, and he was also an inspirational lecturer in quantitative ecology. Once, when lecturing in Tropical Ecology in T.C.D.'s lofty Botany lecture theatre, he was explaining how the cathedral-like architecture of tropical forest enhanced the travel of sounds of suitable pitch. His vocal illustrations of its effectiveness for communication by monkeys and birds was startling and electrifying, coming from this formal, begowned figure, and indeed, following a series of loud shrieks, the Chief Technician burst in - an unheard-of occurrence during the sacrosanct 50 minutes of a lecture - but Robert was quite unperturbed.

He became an Associate Professor of Zoology in 1982, but continued to devote time to his entomological specialisations, particularly orthopteroids. From 1987, Robert and Ruth started to publish the results of their collaboration on sarcophagids, and their dipterological investigations of the Murrough wetland in Wicklow. In 1994 he collaborated with other experts on a check-list of Irish fleshflies, and in 1995 and 1998 on the craneflies of Ireland, in this *Bulletin*.

In 1988 Robert took part in the Royal Entomological Society's "Operation Wallacea" expedition to study the insects of the rainforests of Sulawesi and, while delayed in Jakarta, contracted a virus which caused nerve damage and extreme pain. While he remained active in research, Robert's health never fully recovered, and in 1992 he was diagnosed as having Parkinson's disease. Sadly, he died in the summer of 2000. Robert will be greatly missed as a major intellectual driving force in Irish science from the 1970s, as an inspirational supervisor, but as importantly, as a gentle, courteous and modest human being. His legacy of around 200 publications is too long to repeat here, but I have made a personal selection from his works, which I hope illustrate the breadth of his ideas and expertise.

JULIAN D. REYNOLDS

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BOOK REVIEWS

THE LIVERWORT FLORA OF THE BRITISH ISLES by Jean A. Paton. Harley Books, Martins, Great Horkesley, Colchester, Essex CO6 4AH, England. 1999. ISBN 0 946589 60 7. Hardback. 290 x 210 mm. 626 pp. including 314 text figures. Price £52.50 Sterling net.

This book was written to help amateur and professional bryologists recognise liverwort species and name them accurately. The liverwort flora of the British Isles consists of 296 species, 2 subspecies and 5 varieties.

In this magnificent book, the most immediate feature is each full page figure containing an extraordinary wealth of line illustrations for every species. Each species figure often contains from fifteen to twenty individual complex line drawings which depict the shapes of leafy shoots, leaves, underleaves, reproductive organs and essential microscopical features for identification. The illustrations alone make this book an atlas of hepatic morphology. By browsing through a genus, studying and absorbing detail from each of the images, one can become familiar with the forms that define each species.

The introduction has sections providing sensible advice on the collection and preservation of specimens, making measurements and examination of material. The section on habitats and distribution considers amongst other things morphological adaptations and lists species characteristic of specialised habitats. The conservation message is put across succinctly. The function and use of keys is described. This is followed by a clear explanation of the text and figures and all abbreviations and symbols used. The systematic section begins with a conspectus of classification, followed by accounts of genera with keys and full species descriptions. The work concludes with a glossary, a map of vice-counties, bibliography and liverwort name index.

The keys are uncompromising to the reader with extensive use of the specialised vocabulary for describing the structures and shapes of liverworts. This provides a stern examination for the observer to ensure that each part of the sample under scrutiny is studied with logical understanding of each feature.

Looking through a stereoscope at a freshly gathered collection of liverwort shoots is a most pleasant activity. One study method is to put wet shoots dorsally and ventrally under the weight of a glass slide on a white background. If you observe the magnified sample uninterrupted for several minutes, thinking in turn about each biological component in view, then for most cases you should have assembled all the visual information needed to make the correct species identification. However, if one is interested by morphological variation within populations of living hepatics in a reserve, each individual shoot is unique in its own way, and then species identification is only a convenient starting point! As an occasional observer of epiphytic hepatics, with the motive of screening them as hosts for bryophilous ascomycetes, this book has already helped me with identifications of *Frullania* and *Plagiochila*.

This volume will be a standard text for the forthcoming century. All is not over for aspiring authors who wish to contribute to the discipline - several other smaller works are needed to promote study and encourage observation of liverworts in Britain and Ireland. Regard for the colour and beauty of liverworts will still have be communicated to best effect throughout the 21st century. Digital scanned colour images of a series of wet living shoots are necessary. Also there is a need for a small book to relay information that field bryologists recall when they hold a shoot up to the sky observing from below with the aid of a large-field x20 handlens. Observing a wet living *Frullania* shoot by transmitted light on a bright day after rain in south west Ireland is one of those special hepatological experiences. This meticulously prepared book comes highly recommended for all who regard liverworts. In fact, anyone, who wishes to see a magnum opus on any biological group, ought to cast an eye over this tome.

H. FOX

Bull. Ir. biogeog. Soc. No. 25

A GUIDE TO THE DRAGONFLIES OF IRELAND by Brian Nelson, Robert Thompson and Damian McFerran. MAGNI Publication No. 005. ISBN 0 900761 44X. Price £2.95 Sterling plus post and packing (£0.57 Sterling in the United Kingdom and £1.14 Sterling elsewhere in Europe). Available from the Ulster Museum Shop, Botanic Gardens, Belfast BT9 5AB, Northern Ireland.

Sponsored by the Heritage Council, this guide is an aid to the identification of the Irish damselflies and dragonflies (Odonata). All the resident and migrant species which have been recorded in Ireland since 1970 are included. It is a highly unusual publication, consisting of ten loose plastic-covered sheets contained in a transparent plastic wallet. As such, it is intended for use in the field and should be able to survive the wettest day.

The cover is very attractive, with a beautiful photograph of the Blue-tailed Damselfly by Robert Thompson. The loose sheets are designed for ease of use in the field. There are excellent illustrations, in colour, depicting two species on each of fourteen pages. The mature males and females are shown. While the drawings are not to the same scale, the length of each insect is given. Brief notes are provided to highlight diagnostic features. In addition, the flight period of each species is indicated. Habitat preferences and Irish distributions are briefly described. There are also short sections on how to use the guide, a species index, anatomy and glossary, fieldcraft, recording observations and habitat preferences.

The guide does have its limitations. For example, many species have different female colour forms and these are not illustrated. Sometimes, the differences between species are not clear. It would be impossible for example to distinguish between the Emerald Damselfly and the Scarce Emerald Dragonfly using this guide. Nevertheless, this is an extremely useful publication and it will enable the correct determination of most specimens encountered in the field. Representing excellent value for money, it is highly recommended as an essential item to be carried in a pocket on field-work or while out on a walk.

J. P. O'CONNOR

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INSTRUCTIONS TO CONTRIBUTORS

1. Manuscripts should follow the format of articles in this *Bulletin*.

2. Manuscripts should be submitted as typed copy on A4 paper, using double-spacing and 2.5cm (1 inch) margins. Whenever possible, also submit the text on diskette. Wordperfect 5.1 is preferred.

3. Figures should be submitted in a size suitable for reduction to A5 without any loss of detail.

4. Records: please ensure that, when possible, the following information is incorporated in each record included in a manuscript:-
(a) latin name of organism.
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(d) collector's name and determiner's name (where different from collector's name), and
(e) altitude data should be included where relevant.

(5). Manuscripts should be submitted to the Editor, Dr J. P. O'Connor, at the following address:- National Museum of Ireland, Kildare Street, Dublin 2, IRELAND.

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NOTICES

ROYAL IRISH ACADEMY
PRAEGER COMMITTEE FOR FIELD NATURAL HISTORY

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Grants are available for field work relevant to the natural history of Ireland. Grantees need not be based in Ireland.

Applications are particularly welcome from amateur natural historians. Grants could be considered as a contribution to the cost of the project. Awards cannot be made in support of undergraduate or postgraduate student programmes, for school projects or for any part of the applicants' professional work.

Applicants should ensure that the proposed work, or work closely resembling the proposal, has not already been carried out in the same geographical area. A catalogue of previous Praeger reports can be accessed through the Academy Library.

A representative set of any material collected must be deposited in the National Museum, Dublin, or the National Herbarium, Dublin, or the Ulster Museum, Belfast or any other recognised institution in Ireland.

Application forms, which should be returned by **15th February**, are now available from:

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