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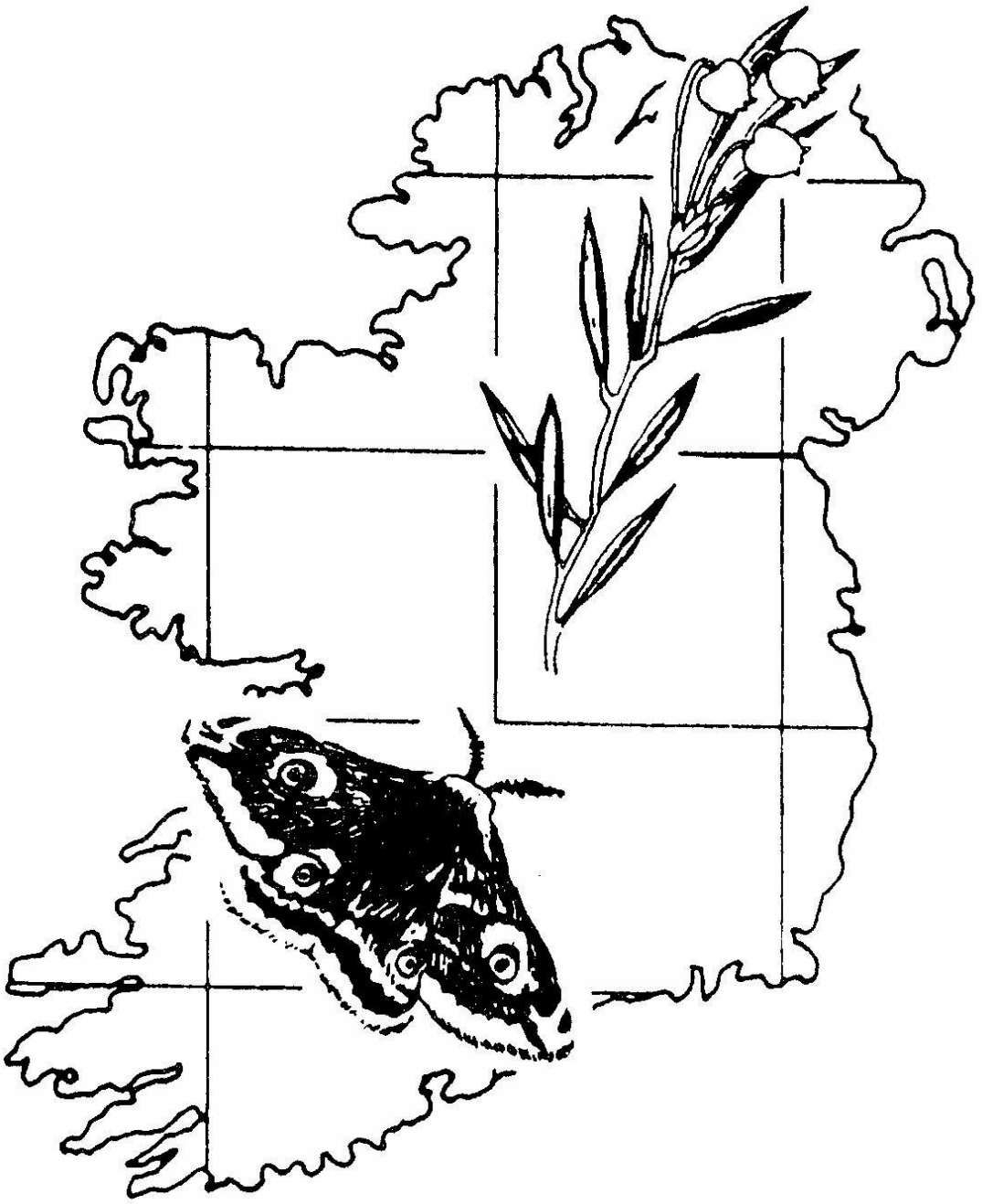

Bulletin No. 35

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EDITORIAL

The National Biodiversity Data Centre was launched officially in January 2007 as an initiative of the Heritage Council to serve as a national repository for biological data. The Centre makes good-quality, reliable data on Ireland's biological diversity freely and universally available *via* the Internet. It also implements a programme of biological recording initiatives and biodiversity research, supported by a network of recorders and researchers, to improve our knowledge of Ireland's biological diversity. The Centre promotes the training and professional development of the biological recording community in Ireland, thus raising standards of data collection, management and its presentation.

After the establishment of the National Biodiversity Data Cente, the Committee of the Irish Biogeographical Society decided to make its copyrighted published data available for free use by the Centre. The Society has become therefore an important Data Provider. Examples of its Data Sets, now available on the Centre's website, include *Anisopodidae and Thaumaleidae (Diptera: Nematocera) of Ireland*; *Craneflies of Ireland*; *Dixidae (Diptera) of Ireland*; *Neuroptera (Insecta) of Ireland* and *Pseudoscorpions of Ireland*. Since it plays such an important role in Irish biodiversity studies, we would like to encourage our members to help the Centre with its work.

Bulletin **35** contains an exciting mixture of papers. Readers will be surprised for example to read of the extraordinary contributions of Alexander Henry Haliday to our knowledge of the biodiversity of the Irish insect fauna. He described over 370 of the species recorded from Ireland. The Irish Biogeographical Society is very grateful to our contributors and to the referees for their excellent reports. On behalf of the Committee, I also wish to thank Dr Pat Wallace, Director of the National Museum of Ireland, Mr Raghnall Ó Floinn, Head of Collections and Mr Nigel Monaghan, Keeper of Natural History, for their wonderful support of the work of the Society. We are indebted to our sponsors for their financial contributions.

J. P. O'Connor, Editor, 31 October 2011

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1. Manuscripts should follow the format of articles in this *Bulletin*. The titles of journals should be given in full in the references.

2. Manuscripts may be sent as typed copy on A4 paper, using double-spacing and 2.5cm (one inch) margins with the text and any figures also on an accompanying compact disc to the Editor, Dr J. P. O'Connor, emeritus entomologist, National Museum of Ireland, Natural History, Merrion Street, Dublin 2, Ireland. Alternatively, mss may be submitted electronically *via* our Treasurerer Mr John Walsh at <ampersandwalsh@gmail.com>.

3. Word is preferred and Times New Roman 13pt should be used.

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FIRST IRISH RECORD OF *TALAVERA AEQUIPES* (O. P.-CAMBRIDGE, 1871) (ARACHNIDA, ARANEAE, SALTICIDAE), FROM A RAISED BOG IN CO. OFFALY

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Introduction

During a survey of the spider fauna of six raised bogs in Co. Offaly, a single specimen of a spider not previously noted from Ireland was caught in a pitfall trap on Ferbane Bog. *Talavera aequipes* (O. P.-Cambridge, 1871) belongs to the Salticidae (jumping spiders), a family represented in Ireland by fifteen other species. The survey was sponsored by a research grant from the Heritage Council of Ireland (Reference: R00662) and by the heritage section of Offaly County Council.

Raised bog and active raised bog are priority habitats under Annex 1 of the EU Habitats Directive (European Commission, 1996). The first Irish records of four other spider species, some distinctly rare, were recently obtained also from raised bogs (Nolan, 2007a, b, 2008, 2009) suggesting that this habitat, despite its management history, harbours a spider assemblage of significant interest.

Methods

Pitfall traps were set at two sites on Ferbane Bog, one characterised as central ecotope i.e. *Sphagnum* rich and actively peat-forming (Irish grid reference N107262) (or slightly declined from this quality) and the other marginal (N115258) i.e. set on high bog but close to vertical face-bank from which turf had been extracted by hand resulting in a quite heavily drained marginal area. Two lines of ten traps were set at both locations on 6 May 2010 and emptied twice, on 3 June and 1 July 2010. On the second occasion, the traps were completely dismantled and removed. On 6 May and 3 June, sweep-net samples were also taken from both locations.

The catch from the traps was filtered on-site from the antifreeze trap-fluid and preserved in 70% IMS. It was subsequently sorted and the spiders were separated from other trapped invertebrate specimens. Specimens were identified using Roberts (1985). The initial identification of *T. aequipes* was confirmed using Logunov and Kronestedt (2003).

The record of *Talavera aequipes* (O. P.-Cambridge, 1871)

A single male specimen of *Talavera aequipes* was identified from the second pitfall sample taken from one of the lines of traps set in the central ecotope. The species was only transferred to *Talavera* from *Euophrys* by Logunov (1992), and it appears under *Euophrys* in a number of the publications mentioned throughout this paper.

Preferred environment

The species is a predominantly thermophilous, ground-dwelling spider that occurs in a fairly limited range of habitats. It is an active (probably diurnal) cursorial species and this behaviour is reflected in the fact that many recorded specimens are from pitfall traps (Hänggi *et al.,* 1995). While the Irish record is from a wet *Sphagnum*/sedge dominated area of a raised bog, British records more obviously reflect the species' thermophilous nature: open sunny habitats with bare surfaces, short sward downs, sandy and stony banks, quarries and old rail embankments (Harvey *et al*., 2002). *Talavera aequipes* may remain to be discovered in such areas in Ireland. Its preferred habitat across Europe however is grassland of mesobromion and xerobromion type (Hänggi *et al.,* 1995). Other natural habitats in Europe where it frequently occurs are raised bog and coastal dune systems (Hänggi *et al.,* 1995; Logunov and Kronestedt, 2003; Peru, 2006). Braud (2007) records it from *Molinia* tussocks on moorland in Atlantic France where it is generally associated with well-draining habitats such as calcareous Garrigue or insolated slopes but also littoral and saline habitats (Peru, 2006). Almquist (2006) reports it from dune heath, meadows and bogs in Sweden. It is classed as a thermophilous species in the Czech Republic (Buchar and Růžička, 2002) where it can be abundant on rock steppe, xerothermic slopes and insolated forest glades. In Hungary, it occurs on dry, open sandy areas (Lajos and Vadkerti

(2004) citing Szita and Samu (1999)). Hänggi *et al.* (1995) shows the species to occur in a variety of other habitats in lesser numbers, especially on moist and dry heaths and other grassland types. In man-made habitats, its preferences again reflect its thermophilous nature, most records being from very dry-soiled situations such as vineyards and mining spoil-heap. It occurs primarily below 800m and not above 1500m in Europe (Hänggi *et al.,* 1995).

There appears to be relatively little information on the species' preferred microsites. In Sweden, *T. aequipes* was found amongst lichens on raised bogs (Lohmander (1956) cited by Logunov and Kronestedt (2003)) and amongst litter in meadows (Almquist, 2006). Since the spider is broadly thermophilous, drier microsites in the bogs that it frequents are probably preferred i.e. the upper areas of vegetation or patches of *Cladonia* lichen. While *Cladonia* lichens can be very abundant on drying areas of Irish raised bogs, and were abundant on Ferbane, they were not especially abundant in the immediate area of the central ecotope where the pitfall traps were set. The spider occurs only rarely on medium to tall vegetation.

Phenology and life-cycle

Talavera aequipes is most abundant from May to July in Britain, with a smaller number of specimens seen prior to this and up to November. However Almquist (2006) states that males are found in Sweden from May to September with females being found all year round. Little seems to be known about the spider's life-cycle and habits but it has been observed to make use of mollusc shells for the purpose of egg-laying (Almquist, 2006), although this is of little relevance in Irish bog habitats where shelled gastropods occur very infrequently.

Distribution

Talavera aequipes has a Palaearctic distribution but due to the somewhat restricted range of habitats that it occupies, the species tends to be rather local. In Britain, it is considered local and relatively uncommon with records strongly concentrated in England and especially in southern areas of that region (Harvey *et al.*, 2002). Lajos and Vadkerti (2004) remark that the species is found sporadically throughout Europe. It is less common in southern and northern parts. For

example in the Mediterranean area, *T. aequipes* is not recorded from Portugal, Turkey or from many of the Mediterranean islands including the Balearics, Malta and Sardinia (Helsdingen, 2009). It is confined to southern parts of Norway and Sweden (Almquist, 2006) and is not recorded from some Baltic countries. Further east, the species occurs through Eurasia to Yakutia (Logunov and Kronestedt, 2003) and also has populations in Hokkaido, Japan.

Determination

The spider is quite variable in colouration (Logunov and Kronestedt, 2003) and the palpal organs which allow its determination are pale and somewhat innocuous. The diagnostic corkscrew-like embolus is both pale and rather indistinct at 40x magnification in the Irish individual (the specimen may have recently moulted and this would have accentuated these qualities). In addition, the Irish specimen has the characteristic dark-brown eye field, a pale yellow abdominal ventrum and the sternum mostly pale but with dark lateral and posterior margins. The legs are yellow with brown mottled patches and annulations and only the prolateral/mesal areas of the femora, patellae and tibiae of leg I are predominantly dark-brown – these areas are usually somewhat darker.

Threat status

After the completion of a review of the status of spiders in Britain, *Talavera aequipes* was deemed to be of "Least Concern" (Dawson *et al*., 2008). In other areas of Europe, it is considered as "Vulnerable" *viz.* Flanders in Belgium (Maelfait *et al.*, 1998), the Czech Republic (Buchar and Růžička, 2002) and Norway (Kålås *et al.*, 2006). These assessments were made on the basis of the species' local or infrequent occurrence in threatened or vulnerable habitats.

It is obviously difficult to assess the species' threat status in Ireland since there is only the single record. Given that the species is a thermophile and that it occurs on raised bog, *T. aequipes* might be more reasonably expected to occur on drained areas of bog where bare soils may have developed, rather than in the wet area where it was recorded. However no other specimens were recorded throughout 2010 despite the thorough sampling of the partially

drained areas of six raised bogs. More important perhaps is the fact that the species' preferred habitat in Europe is xeric and mesic *Bromus* grasslands: the former of these arguably does not occur in Ireland but the latter or its closest Irish equivalent i.e. semi-natural dry (realistically probably moist) grasslands on calcareous substrate, is considered a threatened habitat. Under the EU Habitats Directive (European Commission, 1996), orchid rich calcareous grasslands have priority status (Fossitt, 2000). As a result, two of the habitats clearly preferred by *T. aequipes'* are of significantly threatened status in Ireland. This could be sufficient grounds for suggesting that it is at the very least vulnerable here.

While it might be the case that the species will be found to occur more widely in Ireland, as in Britain, in anthropogenically manipulated or managed habitats, this would not change the case for arguing that it may have undergone decline through loss of preferred habitat.

Acknowledgements

Thanks to the Heritage Council of Ireland for the grant to carry out the survey. Amanda Pedlow, Heritage Officer, Offaly County Council generously contributed to the survey at short notice. Ciara Flynn, District Conservation Officer, National Parks and Wildlife Service, assisted greatly by providing site photographs and reports. Fiona Devery offered advice on gaining botanical data from the sites. Nigel Monaghan, Keeper, Natural History Museum, Dublin, provided office space and laboratory facilities. Thanks also to Martin Cawley who read this note in an earlier draft and confirmed my identification of the spider.

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2011 NATTERJACK TOAD (*EPIDALEA CALAMITA* LAURENTI, 1768) BREEDING HABITAT SURVEY, NORTH DINGLE PENINSULA, CO. KERRY, IRELAND

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Abstract

Historic, natural natterjack toad (*Epidalea calamita* Laurenti) breeding sites on the north Dingle Peninsula, Co. Kerry, were surveyed in June 2011. Current habitat conditions and possible presence of toads were noted, and compared with the initial survey in 1997 by this author and others thereafter. The recent creation of new breeding ponds by the National Parks and Wildlife Service and their benefits are reviewed. Genetic data suggesting that the north Dingle toads share a common distant ancestor with those of southern Castlemaine Harbour are included. Comments on present taxonomic and systematic nomenclatural alternatives to designating the natterjack are offered.

Achomaireacht

I Mí an Mheithimh 2011 scrúdaíodh láithreáin síolraithe nádúrtha an chnádáin i dtuaisceart leithinis Chorca Dhuibhne, Contae Chiarraí. Tugadh faoi deara staid reatha na gnáthóige agus láithreacht fhéideartha na gcnádán agus cuireadh i gcomparáid iad leis an suirbhé tosaigh leis an údar seo agus le daoine eile ina dhiaidh sin. Déantar athbhreithniú ar chruthú deireanach na lochán nua, agus ar a mbuntáistí, ag an tSeirbhís Páirceanna Náisiúnta agus Fiadhúlra. Cuirtear ar fáil sonraí géiniteacha a thugann le fios go roinneann cnádáin tuaisceart Chorca Dhuibhne sinsearach coiteann le cnádáin Loch na dTrí gCaol deisceartach. Déantar trácht ar mhalairtí ainmníochta tacsanomaíthí agus sistéamaí faoi láthair ar ainmniú an chnádáin.

Introduction

The natural breeding sites of the natterjack toad (*Epidalea calamita* Laurenti, 1768) between Fermoyle and Tullaree on the north Dingle Peninsula of Co. Kerry, were surveyed during the first week of June 2011 in the middle of the breeding season. These historic sites do not include the 90 more recent ponds dug by farmers under the National Parks and Wildlife Service (NPWS) REPS 4 Toads option programme, with aid in part from The Heritage Council. Sites were visited under NPWS licence since both toads and their habitat are protected under European and Irish statutes. Maps of sites are provided by Korky and Webb (1999), Beebee (2002), Bécart *et al*. (2007a, b), May and Beebee (2008, Fig. 1; 2010) and Aubry *et al*. (2010).

The presence of Ireland's only toad was first reported in 1805 at Callanfersey, Co. Kerry, south of Castlemaine harbour by Mackay (1836). Disjunct natural breeding sites encircle the harbour from Inch to Glenbeigh. Toads on the north Dingle Peninsula were only recognized in the late 1960's (Gresson and O'Dubhda, 1971). Speculation as to their origin focused for a time on a relatively recent anthropogenic translocation. This was proven unlikely by May and Beebee (2008, 2010) using microsatellite nuclear DNA analysis that suggested the north Dingle and Castlemaine toads were equally old and derived from a distant common ancestor, not from human transport northwards. This ancestor likely survived the last glacial maximum in a north European Lusitanian refugium and recolonized Ireland and part of England as ice receded and melt water raised the sea level isolating Ireland and England (Beebee and Rowe, 2000; Rowe *et al*., 2006). Given that the north Dingle toads have been present for perhaps centuries, it is curious indeed their presence was not reported before the 1960's in spite of vocalizations by their breeding choruses that can be heard at evening's onset over a kilometer and a half away.

Another consideration prior to the molecular findings, was the off chance that the Castlemaine toads had migrated on their own northwards over the dales of the Slieve Mish mountains. The probability of this event is virtually zero because of their short hind legs and the totally unsuitable habitat between the coasts. One can confirm this by following the road sign east of Inch marked "scenic route" Camp and traversing the single lane gravel road across the mountains with steep drops and free roaming sheep. Not for the faint hearted or toads!

Materials and methods

I first surveyed toad sites across Kerry in 1997 (Korky and Webb, 1999) for the primary purpose of netting larvae (= tadpoles) to document occurrence and analyze geographic variation by morphometric methods (Korky and Webb, 2001). Those samples were preserved in 10% formalin rendering them unfit for molecular analysis. I returned to Kerry localities in 2007 (Korky, 2008) to obtain tail tissue samples in drierite dessicant that could be used for molecular techniques. Some sites that yielded larvae in 1997 were dry in 2007, hence no samples were taken. North Dingle 2007 sites that were productive included: the Castlegregory golf course ponds at Stradbally; the Maharees slack No. 25 north of Lough Gill; and Tullaree ponds. I also collected water samples in 2011 at all north Dingle localities for subsequent analysis. Evidence of toad presence at a site could include: egg strings (spawn); larvae (tadpoles); metamorphosed toadlets; adults; calling adults heard but not seen; dead remains; adult tracks in sand.

Localities

The north Dingle sites are given from west to east along with their Irish grid map references in brackets.

Fermoyle (Q550122). The three ponds here are accessible by the Fermoyle strand road from the west or Kilcummin strand road from the east by driving on the strand to a midway point between the roads. Ponds lie just inland of the sea defence wall in a fenced pasture. The oldest pond has steep sides and depth of a meter at its centre, and is free of barrier vegetation. The other two lie in a pasture with a stream flowing east to west flooding the area with shallow water but overgrown by *Phragmites*. No evidence of toads was present. Adults were first found there in 1970 (Gresson and O'Dubhda, 1971), and the last spawn strings there were reported in 2004 (Bécart *et al*., 2007a). These authors suggested that the site of an estimated nine breeding adults was near extinction, and Marnell (pers. comm.) advises that no breeding has occurred there for years. My observations confirm the above. While there is adequate fresh water to breed in, reed clearance of the two more recent pond areas would be prudent, and if no resident toads appear, a reintroduction from the Stradbally source may be warranted.

Stradbally (Q592137). The Castlegregory Fishing and Golf Club boasts ideal breeding conditions for the toads in its eight or so ponds and drains although all are not equally utilized. The nine hole course was developed in 1989-1991 and Beebee (2002) reported that hundreds of adults, much spawn and tadpoles were present immediately afterwards in 1991. Bécart *et al*. (2007a) called this population the second largest in Kerry after the slacks of the Maharees. But the latter area faces severe annual dessication issues to be noted later here while Stradbally does not, making it a stable breeding and source site for reintroductions or translocations. I noted that as usual the two ponds closest to the ninth hole and the car park are a delight, loaded with spawn and tadpoles. Their sloping sides devoid of vegetation, warm shallow depth, and surrounding dunes for adults, result in abundance. Nearby drains to other ponds showed no signs of toads present. A deep, fenced pond with a submersible pump near work sheds also had no signs, reflecting habitat preference when choice is possible. Other ponds had few larvae or none perhaps due to steeper slopes.

Lough Gill (Q612500). Beebee (2002) reported that much spawn and tadpoles were present in the early 1970's. Bécart *et al*. (2007a) termed breeding here successful, with fluctuating water level due to a damaged sluice in the eastern end being the limiting factor for the survival of the egg strings. Many toadlets were also annually observed here over three years prior to 2007. I surveyed the entire northwest boundary adjoining the Castlegregory golf course and found no signs. I noted that the sheer drop into deep water protected by a rock wall made it unsuitable. It is the eastern end of Lough Gill, extending north of the pier, that is suitable and where spawn has been noted 4m from the shore in the reeds. My several surveys have not proven as positive. Wading north of the pier, I stirred up a calling adult which was not seen. It probably originated in the dunes north of the Lough. I have yet to see egg strings or tadpoles there including this year. I did flush out from among the reeds, a large probable trout that slithered to the deeper water. Since eggs, larvae, and adults are protected by bufotoxins, a group of noxious secretions making them unpalatable to predators, presumably this trout was not foraging. Successful breeding appears likely here along the extensive northeast shore.

The Maharee slacks (Q550122). Potentially with miles of dunes and slack areas north of

Lough Gill, it could host the largest Kerry toad population. But the reality is that dessication due to rainfall fluctuation and grazing animal water usage, annually plagues the slacks whose numbers may vary from several dozen to usually less than half that. The latter still may be breeding dead ends if they dry out after the spawn is laid or before the larvae metamorphose. Conditions across the area in this survey were hot and humid with dry ground conditions. The wind, exacerbating evaporation, resulted in many dried slack bottoms, moist mud and algal mats as I transected the dunes. Even slack No. 25 (Beebee, 2002), that was a meter deep in my 2007 survey, was 95% gone with the tadpoles densely crowded into the remaining shallow northern part. The reproductive success is unknown here without continued monitoring. Any mechanical digger deepening of productive slacks to enhance water retention should increase the reproductive success of this large region that appears in decline after repeated surveys.

Lough Naparka (Q623170). Considered virtually permanent (Beebee, 2002) and noted as site 1 (Bécart *et al*., 2007a, Fig. 6.3), this "lough" suffers the same plight of decline as the Maharee slacks in general due to the lack of water. My survey in 1997 showed that it was quite viable with visible adults peering from the dune burrows by day. There were abundant tadpoles for sampling in the shallow and warm water paralleling Tralee Bay. There was also a sloping margin lacking vegetation and even a dry rock wall for adult hibernation just west of the water. Subsequent visits (unpublished) turned up numerous tadpoles, but conditions were markedly poorer there in 2007 with it being 80% dry with emergent irises. There were no tadpoles, adults or any sign of toad activity. Now, 2011 was equally negative for any sign of natterjacks although a rim of shallow water was present along the eastern margin. Whether toads have survived here is unknown. Any mechanical deepening would enhance breeding success if toads were found to be still present. If not, it represents another possible reintroduction site.

Tullaree (Q636124). The eastern terminus of the Dingle metapopulation with toads being discovered there in 1983 (Beebee, 2002), several ponds were deepened in 1999 to extend the hydroperiod, and subsequently additionally scrape ponds were created (Shaw, 2006). I collected tadpoles in 2007 that were abundant. This survey encountered numerous calling adults at 17:30 hours. The ponds had abundant water and tadpoles. Water is not the limiting factor as the

surrounding fields are quite wet. Vegetational overgrowth is the densest that I have found at any survey site and it certainly impedes toad movement. Grass hummocks are knee-high, irises hip-high, and reeds shoulder-high, the latter two especially at the ponds. No grazing animals were present or any signs of the same although NPWS erected fencing in 2006 to encourage the grazing of horses. Frankly, such animals would be in peril under present conditions especially near the ponds. The vegetation issue at this site has to be addressed to allow the continuation of successful and long term breeding.

Discussion

Bécart *et al.* (2007b) provided a comprehensive overview of contemporary and potential future natterjack conservation issues. Generally, amphibian breeding success is all about water being present for spawn deposition and larval metamorphosis, all else being in order. As noted, the Maharee complex in particular suffered in recent years. Met Éireann online data show a mean annual rainfall at Valentia Observatory of 1430.2mm, but only 1331.7mm for 2010. Not a long term climatic trend, but notable. A query to Met Éireann found that there are no rainfall reporting stations co-inciding with any of the north Dingle sites for specific comparisons. As anecdotal as it may be, naturalists and farmers did remark how dry that the 2011 spring was generally countrywide. Suffice to say, water for breeding season was reduced as field conditions reflect. Remediation of drier conditions then would involve the widening and deepening with bank sloping of older sites as needed to retain the critical water. Unfortunately, no easy solution applies to the last two severe Irish winters that likely increased toad mortality, reducing adult numbers for reproduction.

New pond creation is the next conservation step forward, and as noted the REPS4 Toad option (see NPWS.ie website) is in place. Farmers in designated Kerry areas enter a five year agreement with compensation to have ponds dug on their property with specific maintenance conditions that I feel should be applied as stringently to the older sites as well. Some 90 new ponds have been dug to date, and as important, a team of freshwater biologists will monitor all the older and newer sites during the breeding season over the next two years (Marnell, pers.

comm.). This will afford the opportunity to evaluate the scheme's effect on population dynamics and conservation status in real time. The additional ponds will increase site interconnectivity of presently fragmented populations thereby increasing gene flow, decreasing inbreeding depression, increasing allelic richness, permitting source populations to bolster sink ones, and reducing the probability of local or wider extinction. This is important as loss of genetic diversity in amphibians has been shown to amplify synergistically the detrimental effects of environmental pollutants and pathogens (Allentoft and O'Brien, 2010).

A major component of pond maintenance is managing the vegetational succession or not, as Tullaree comes to mind. There I can only envision intensive, manual labour as the solution, grazing being perilous, and the hummocks and water table not facilitating field mowing. Natterjacks as habitat specialists prefer low vegetational growth for ease of movement within and between populations. Even toadlets, the dispersal stage, were experimentally shown to prefer low resistance vegetational environments (Stevens *et al*., 2006). Therefore it is critical that by pruduent grazing, mowing or both, the optimal habitat be maintained. Less vegetation will also reduce water loss through uptake and transpiration.

Taxonomic/systematic commentary

Are natterjacks *Epidalea calamita* or *Bufo calamita*, or *Epidalea* (formerly *Bufo*) *calamita*? All appear in the formal herpetological literature or naturalists' accounts. This is tantamount to asking, is the Kerry town Dingle or An Daingean or Daingean Uí Chúis? Highly contentious points of view pro and con follow. The generic name change of natterjacks from *Bufo* to *Epidalea* is based on publication of *The Amphibian Tree of Life* (Frost e*t al*., 2006). These authors determined that molecular data warranted resurrecting *Epidalea* from the species synonomy to reflect sufficient differences from other Eurasian bufonids. The change is maintained in the *Amphibian Species of the World* 5. 5 an Online Reference (Frost, 2011, see *http://research.amnh.org/vz/herpetology/amphibia/*), the author Frost cited in 2006 and 2011 being the same authority. Extensive discussion of the widespread name changes of biological taxa is way beyond the remit of this survey. Such changes based on different systematic philosophies have led to conflict and confusion in the formal literature and in public museum

displays. The basis of the ongoing problem is that there are overlapping codes of nomenclature in use (Hillis, 2007). The traditional *International Code of Zoological Nomenclature* or ICZN (see *http://www.nhm.ac.uk/hosted-sites/iczn/code/*), currently fourth edition posted 1 January 2000, is based on typology and priority, the use of a type specimen, the first published valid binomial, in a non-evolutionary framework to set the names of animal taxa to nomenclatural hierarchical levels. The first ICZN edition was published in 1905, with precedents dating to Linnaeus's tenth edition of *Systema Naturae*, 1 January 1758. The *PhyloCode*, alternatively, (see *http://www.ohio.edu/phylocode/*), uses phylogenetic determinations for taxa above the specific level within the 2006 *Amphibian Tree of Life* without ranking them. Cogent arguments, sometimes involving charges and countercharges of deceptions, for their dual useage or incompatability (Hillis and Wilcox, 2005; Hillis, 2007; Crother (ed.), 2008; Frost *et al*., 2009) are an ongoing work in progress. The resultant taxonomic instability is something that we will have to accept until it is resolved.

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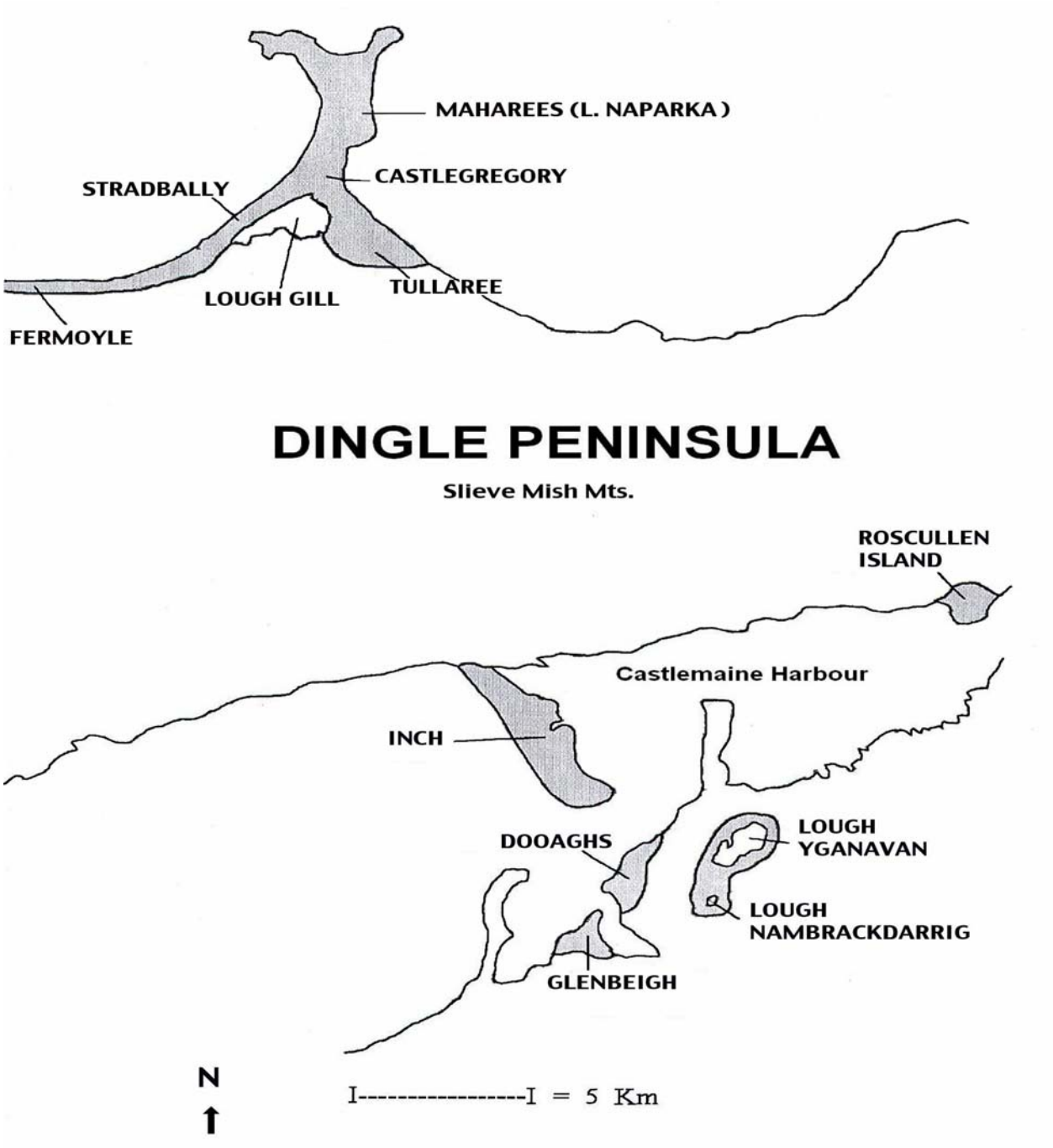
FIGURE 1. Distribution of *Epidalea calamita* Laurenti in Co. Kerry, 2007. Shaded areas = habitat with natterjacks present. Map after May and Beebee (2008).



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A REVIEW OF THE IRISH JUMPING PLANT-LICE (HEMIPTERA: PSYLLOIDEA)

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Abstract

The Irish psyllid (Hemiptera) fauna is reviewed. A checklist is provided of the 50 known species with new distributional data. Five of the species (*Bactericera albiventris* (Foerster, 1848); *Cacopsylla* (*Hepatopsylla*) *hippophaes* (Foerster, 1848); *Neocraspedolepta subpunctata* (Foerster, 1848); *Psyllopsis distinguenda* Edwards, 1913 and *Spanioneura fonscolombii* Foerster, 1848) are new to Ireland while another one (*Cacopsylla* (*Thamnopsylla*) *alaterni* (Foerster, 1848)) requires confirmation. *Psylla* (*Psylla*) *betulae* (Linnaeus, 1758) is confirmed as an Irish species.

Key words: Psylloidea, Hemiptera, Ireland, jumping plant-lice, review, check list, new records, distribution.

Introduction

The suborder Sternorrhyncha of the Hemiptera contains four superfamilies viz. Aphidoidea, Aleyrodoidea, Psylloidea and Coccoidea, characterized by the position of the rostrum, which appears to arise from between the fore coxae. These superfamilies include many of the most serious pests of agricultural and horticultural plants. All the pest species cause direct feeding damage and some transmit plant diseases. The Psylloidea popularly known as psyllids or jumping plant-lice, comprise a group of around 3000 species that may be mistaken for leaf-hoppers belonging to the suborder Auchenorrhyncha. However the two-segmented tarsi, multi-segmented antennae and simplified wing venation will easily distinguish psyllids from leaf-hoppers (Martin and Webb, 1999). Reproduction is typically sexual although parthenogentic

reproduction has been recorded, or is suspected, for a small number of species (Hodkinson, 2009). Eggs are always laid, followed by five larval stages which are fully mobile. Some species develop within bud, flower, leaf, stem or root galls while others develop under a secreted protective cover called a lerp (Hodkinson, 2009).

Foerster (1848) recorded 18 species new to Ireland based on specimens sent to him by A. H. Haliday. Subsequent workers on the group are mentioned in the text. The present paper presents data on 50 species. Five species (*Bactericera albiventris* (Foerster, 1848); *Cacopsylla* (*Hepatopsylla*) *hippophaes* (Foerster, 1848); *Neocraspedolepta subpunctata* (Foerster, 1848); *Psyllopsis distinguenda* Edwards, 1913 and *Spanioneura fonscolombii* Foerster, 1848) are new to Ireland, while presence of another one (*Cacopsylla* (*Thamnopsylla*) *alaterni* (Foerster, 1848)) requires confirmation. *Psylla* (*Psylla*) *betulae* (Linnaeus, 1758) is confirmed as an Irish species. New distribution records are included for other species based on material collected by the senior author and on his identification of unnamed or misnamed specimens in the National Museum of Ireland. The identification of other historic material in NMI was confirmed and where of note, records are given. Eight species (16% of the Irish psyllid fauna) are non-native introductions that have become naturalized. Specimens were determined using Hodkinson (2007), Hodkinson and Hollis (1980, 1987), Hodkinson and White (1979), Martin and Malumphy (1995), Ossianilsson (1992) and White and Hodkinson (1982). Many of the Irish species are illustrated in an online identification guide to British bugs (http://www.britishbugs.org.uk/index.html) and in a pictorial key to European *Cacopsylla* species associated with Rosaceae (http://www.psyllidkey.eu/index.html). Where possible, the nomenclature of the plants follows Stace (1995). The authorities are given for plant species not in Stace (*op. cit.*).

The following abbreviations are used in the text: AHH – A. H. Haliday; AWS – A. W. Stelfox; CIC – C. I. Carter; CM – Chris Malumphy; CR - Colm Ronayne; EFB – E. F. Bullock; GHC – G. H. Carpenter; JNH – J. N. Halbert; JPOC – J. P. O'Connor; MAOC – M. A. O'Connor; MPC – M.-P. Chauzat; NMI – National Museum of Ireland; WFJ – W. F. Johnson. Square brackets [] indicate that the collector's identity has been recognised from the hand-writing on the data labels.

A collection of voucher specimens (pinned and spirit) will be presented to the National Museum of Ireland.

PSYLLOIDEA

PSYLLIDAE LATREILLE, 1807

***Aphalara exilis* (Weber and Mohr, 1804)**

Aphalara species are often difficult to identify reliably, and examination of the male genitalia is essential in some cases. The *A. exilis* species group was comprehensively revised by Burckhardt and Lauterer (1997).

CARLOW: St Mullins (S7238), ♀, 2 July 2011, along River Barrow, JPOC.

Aphalara exilis was recorded from Cos Cork, Dublin, Meath, Waterford and Wexford (Halbert, 1907; Helden *et al*., 2008). The following specimens are in NMI:- **KERRY**: Ardagh, Killarney, ♀, 1 November 1930, EFB; Castlemaine, ♂2♀♀, July 1932, EFB; **WICKLOW**: Bray, 2♂♂, JNH. The host plants are common sorrel *Rumex acetosa* and broad-leaved dock *R. obtusifolius* (Burckhardt and Lauterer, 1997). The species is widespread in Europe and Asia (Ossianilsson, 1992).

***Aphalara polygoni* Foerster, 1848**

Aphalara polygoni was recorded by Foerster (1848) based on Haliday material found on sheep's sorrel *Rumex acetosella*. The following specimens are in NMI:-**DUBLIN**: Howth, ♂, 2 May 1909, 2♀♀, 19 September 1909, JNH. The reported host plants are knotgrasses *Polygonum* spp. The species is widespread in Europe and also occurs in China (Ossianilsson, 1992; Burckhardt, 2009).

***Aphalara ulicis* Foerster, 1848** (Fig. 1)

Aphalara ulicis was recorded by Foerster (1848) based on a Haliday specimen (♀) found on gorse *Ulex*. Burckhardt and Lauterer (1997) also report the species from Ireland. The host plants are docks *Rumex* spp. (Burckhardt and Lauterer, 1997; Jerinić-Prodanović, 2010). The species has been reported from Austria, Belgium, Britain, Denmark, Finland, Germany, Norway, Romania, Russia, Slovakia, Sweden and the Czech Republic (Burckhardt, 2009).

***Arytaina genistae* (Latreille, 1804)** (Fig. 2)

Synonym: *Arytaena genistae* Latreille, 1804

WEXFORD: Ferrycarrig (T0022), ♀♀, 11 June 1990, swept from vegetation beside the River Slaney, JPOC; **WICKLOW**: Glendalough (T1196), 2♂♂, 11 September 1990, JPOC.

Arytaina genistae was recorded from Cos Kerry, Wexford and Wicklow by Halbert (1935). The following specimens are in NMI:- **WICKLOW**: Greystones, ♂3♀♀, 22 August 1938, JNH; Roundwood, 2♂♂2♀♀, September and 1 October 1909, JNH. The host plants are *Cytisus austriacus* L., *C. heufelli* Wierzb. ex Griseb. and Schenk, broom *C. scoparius*, Dyer's greenweed *Genista tinctoria*, and perhaps gorse *Ulex europaeus*. The species is widespread in Europe and has been introduced into North America (Ossianilsson, 1992).

***Arytainilla spartiophila* (Foerster, 1848)**

Synonym: *Psylla spartii* Guérin-Méneville, 1843

CARLOW: Bahana Woods (S7239), 2♂♂2♀♀, 14 June 1991, JPOC and MAOC; **WEXFORD:** Ferrycarrig (T0022), ♂♂, 11 June 1990, swept from vegetation beside the River Slaney, JPOC.

Arytainilla spartiophila was recorded as *Arytaina spartii* by Foerster (1848) based on Haliday material and subsequently as *Psylla spartii* by Halbert (1935). The following specimens are in NMI:- **WICKLOW**: Drumgoff, 2♂♂2♀♀, 31 May 1896, JNH; Glenmalure ♂♀, JNH. The host plant is broom *Cytisus scoparius*. The species occurs in southern and central Europe, Britain and Denmark. The species has been introduced into the Nearctic (Malumphy *et al.*, 2009).

***Baeopelma foersteri* (Flor, 1861)**

CARLOW: St Mullins (S7238), ♂, 19 June 1991 and 2♂♂3♀♀, 2 July 2011, off *Alnus*, JPOC; **LEITRIM:** Lough Melvin (G9250), ♀, 7 August 1989, JPOC; **WATERFORD:** Belle Lake (S6605), ♀, 11 June 1991, JPOC; **WEXFORD:** near Fethard (S7905), ♂♀, 10 June 1990, JPOC; John F. Kennedy Park (S7319) 2♂♂3♀♀, 29 June 2011, off *Alnus*, JPOC.

Baeopelma foersteri was recorded as either *Psylla foersteri* or *P. forsteri* from Coolmore, Co. Donegal, Bull Island, Co. Dublin and Westport, Co. Mayo (Johnson *et al.*, 1894; Halbert,

1912; Speight and Healy, 1977). The following specimens are in NMI:- **CORK**: Fermoy, ♂♀, July 1894, JNH; **GALWAY**: no locality, ♂, JNH; **WICKLOW**: Bray, 2♀♀, July 1894, JNH. The host plants are alders *Alnus* spp. The species is widespread in the Palaearctic region (Ossianilsson, 1992).

***Cacopsylla* (*Cacopsylla*) *mali* (Schmidberger, 1836)**

Synonyms: *Psylla aeruginosa* Foerster, 1848; *Psylla occulta* Foerster, 1848

DUBLIN: Trinity College (O1634), Dublin City, ♂♂♀♀, 19 May 2011, numerous adults and nymphs on *Malus* sp., JPOC.

Cacopsylla mali was recorded as *Psylla mali*, *P. aeruginosa* and *P. occulta* by Foerster (1848) based on Haliday material. Walker (1852) also recorded it as *Psylla aeruginosa.* Subsequently Carpenter (1909, 1913) reported *Psylla mali* from Cos Armagh, Dublin, Fermanagh, Kerry and Tyrone, stating that during the spring of 1908 and May 1912, complaints of damage were reported from many parts of the country and specimens were received from the listed counties. Halbert (1935) lists the species as *Psylla mali* Schindbg var. *viridissima* Scott. The following specimens are in NMI:- **MAYO**: Belclare, 3♂♂, JNH. The host plants are apples *Malus* spp. *C. mali* is distributed throughout the Palaearctic region and was introduced into the Nearctic region and Australia (Malumphy *et al.*, 2009).

***Cacopsylla* (*Cacopsylla*) *peregrina* (Foerster, 1848)**

CARLOW: Bahana Woods (S7239), ♀, 14 June 1991, JPOC and MAOC; **DUBLIN:** Castleknock (O0837), numerous ♂♂♀♀, 21 May and 20 June 2011, on *Crataegus monogyna* in a suburban garden, JPOC; North Bull Island (O2337), numerous ♂♂♀♀, 27 July 2011, swept off a stunted *C. monogyna* on the sand-dunes, JPOC; **WESTMEATH:** Lough Derravaragh (N4066), ♂, 30 May 1990, JPOC; **WEXFORD:** Baginbun Head (S8003), ♂♀, 13 August 2011, JPOC; Curracloe (T1127), ♂♀, 18 June 1991, JPOC.

Cacopsylla peregrina was recorded as *Psylla peregrina* from Coolmore, Co. Donegal, Lambay Island, Co. Dublin and Westport, Co. Mayo (Johnson *et al*., 1894; Halbert, 1907, 1912). The following specimens are in NMI:- **DONEGAL**: Coolmore, ♂♀, WFJ; **MAYO**: Wesport, ♂3♀♀, JNH (♂♀ seen by Edwards). The host plants are hawthorns *Crataegus* spp.

The species occurs throughout the Palaearctic region (Malumphy *et al*., 2009).

***Cacopsylla* (*Cacopsylla*) *sorbi* (Linnaeus, 1758)**

DUBLIN: Castleknock (O0837), numerous ♂♂♀♀, 28 May 2011, on a *Sorbus aucuparia* in a suburban garden, JPOC; **KERRY:** Galway's Bridge (V9180), Killarney, ♂, 9 September 1981, JPOC; **WEXFORD:** Curracloe (T1127), ♀, 18 June 1991, JPOC; Slieve Coiltia (S7319) near the John F. Kennedy Park, ♂♀♀, 14 June 1990, JPOC.

Cacopsylla sorbi was recorded as *Psylla sorbi* from Ireland by Hodkinson and White (1979) and from Cos Meath, Wexford and Wicklow by Helden *et al*. (2008). The following specimens are in NMI:- **DUBLIN**: Phoenix [Park], 3♂♂♀, JNH. The host plants are rowan *Sorbus aucuparia* and the Amur mountain ash *S. amurensis* Koehne. The species occurs in Austria, Britain, the former Czechoslovakia, Germany, Poland, Russia and Switzerland (Ossianilsson, 1992)

***Cacopsylla* (*Hepatopsylla*) *ambigua* (Foerster, 1848)**

CARLOW: St Mullins (S7238), 3♂♂6♀♀, 2 July 2011, off *Salix* sp. along River Barrow, JPOC; **CAVAN:** Deerpark Woods (N5987), Virginia, ♂4♀♀, 19 July 2011, off *Salix* sp., JPOC; **WEXFORD:** Ferrycarrig (T0022), ♂, 11 June 1990, swept from vegetation beside the River Slaney, JPOC; Oaklands Wood (S7125), 2♂♂6♀♀, 1 July 2011, off *Salix* sp., JPOC.

Cacopsylla ambigua was recorded as *Psylla ambigua* by Hodkinson and White (1979). The following specimen is in NMI:- **KERRY**: Muckross, ♂, JNH. The host plants are various species of willow *Salix*. The species is widespread in Europe and also occurs in Greenland (Ossianilsson, 1992; Burckhardt, 2009).

***Cacopsylla* (*Hepatopsylla*) *brunneipennis* (Edwards, 1896)**

Cacopsylla brunneipennis was recorded as *Psylla brunneipennis* by Hodkinson and White (1979). The host plants are various species of willow *Salix*. The species occurs in Austria, the former Czechoslovakia, Denmark, Hungary, Norway, Romania, Russia, Sweden, Switzerland and the Ukraine (Ossianilsson, 1992).

***Cacopsylla* (*Hepatopsylla*) *hippophaes* (Foerster, 1848)** **New to Ireland**

DUBLIN: North Bull Island (O2337), numerous ♂♂♀♀, 27 July 2011, swept off *Hippophae*

rhamnoides on the causeway, JPOC; **WEXFORD**: Rosslare (T1014), ♂♂♀♀, 12 August 2011 swept off *H. rhamnoides*, JPOC.

The host plant is sea-buckthorn *Hippophae rhamnoides*. The species occurs in Austria, Britain, Denmark, France, the Netherlands, Italy, Poland, Spain, Sweden, Switzerland, the Caucasus and Middle Asia (Ossianilsson, 1992).

***Cacopsylla* (*Hepatopsylla*) *pulchra* (Zetterstedt, 1838)**

Synonyms: *Psylla pineti* Flor, 1861; *Psylla nigrita* (Zetterstedt, 1828)

CLARE: Fanore (M1308), ♂, 1 June 1984, sand-dunes, JPOC; Kilshanny (R1292), ♂, 3 June 1992, JPOC; **DUBLIN**: Bull Island (O2438), ♂, 14 September 1985, JPOC; **WATERFORD:** Ballin Lough (S4403), Kill, ♀, 19 June 1991, JPOC; Belle Lake (S6605), ♀, 11 June 1991, JPOC; **WEXFORD:** Coolbawn House (S8237), ♂, 8 May 1991, JPOC and MAOC; Curracloe (T1127), ♀, 18 June 1991, JPOC; Killoughrim Forest (S8941), ♂, 4 April 1986, JPOC and MAOC.

Cacopsylla pulchra was reported as *Psylla pineti* by Halbert (1912) from Achill and Westport, Co. Mayo and as *Psylla nigrita* from Ireland by Halbert (1935). The following specimen is in NMI:- **CORK**: Glandore, ♂2♀♀, 12 June 1909 [JNH]; **WICKLOW**: Bray, ♂, September 1894, JNH. The host plants are various species of willow *Salix*. The species is widespread in Europe and also occurs in Japan (Ossianilsson, 1992).

***Cacopsylla* (*Hepatopsylla*) *pyri* (Linnaeus, 1758)**

Cacopsylla pyri was recorded as *Psylla pyri* by Foerster (1848) based on Haliday material. The host plants are pear *Pyrus communis* and *P. elaeagnifolia* Kotschyana. The species is widespread in Europe. It also occurs in the Caucasus, Georgia, the Middle Asia and China (Ossianilsson, 1992).

***Cacopsylla* (*Hepatopsylla*) *pyricola* (Foerster, 1848)**

Synonym: *Psylla apiophila* Foerster, 1848

Cacopsylla pyricola was reported as *Psylla apiophila* by Foerster (1848) based on Haliday material. The host plants are pear *Pyrus communis* and wild pear *P. pyraster*. The species is widespread in Europe and also occurs in Argentina, Canada, Iran, Israel, Japan, Korea and the

U.S.A (Ossianilsson, 1992).

***Cacopsylla* (*Hepatopsylla*) *saliceti* (Foerster, 1848)**

Synonym: *Psylla salicicola* Foerster, 1848 partim

CLARE: Kilshanny (R1292), 2♂♂, 3 June 1992, hedgerows, JPOC; Lough Bunny (R3696), ♂, 28 May 1998, JPOC; **WATERFORD**: Belle Lake (S6605), ♂ 11 June 1991, JPOC; **WEXFORD:** Baginbun Head (S8003), ♂♂♀♀, 13 August 2011, off *Salix*, JPOC; Ferrycarrig (T0022), ♂, 11 June 1990, swept from vegetation beside the River Slaney, JPOC.

Cacopsylla saliceti was recorded as *Psylla saliceti* by Foerster (1848) based on Haliday material. Subsquently Halbert (1912) reported it as *Psylla saliciicola* from Clare Island and Louisburgh, Co. Mayo. The following specimens are in NMI:- **GALWAY**: Ross, ♂, JNH; **MAYO**: Clare Island, ♂♀, 11 June 1909 [JNH] (labelled as *P. betulae*); **SLIGO**: Glencar, ♂, JNH; Lissadell, ♂, JNH. The host plants are various species of willow *Salix*. The species is found throughout Europe (Hodkinson and White, 1979).

***Cacopsylla* (*Thamnopsylla*) *alaterni* (Foerster, 1848) Requires confirmation as an Irish species**

Cacopsylla alaterni was recorded as *Psylla alaterni* by Foerster (1848) based on two ♂♂ sent by Haliday under the ms name *alaterni*. Walker (1852) also mentioned Haliday material. The host plant is *Rhamnus alaternus* popularly known as Mediterranean or Italian buckthorn. The species is known from the Balearic and Canary Islands, England, France and Italy including Sardinia and Sicily (Hodkinson and White, 1979; Burckhardt, 2009).

The host plant is a native of the Mediterranean region. Although it has been cultivated in British gardens since 1629, there appears to be only one subsequent record of *Cacopsylla alaterni* from it in the British Isles. It is known that Haliday spent most of the years 1841-1848 in Italy (Nash and O'Connor, 2011). It is significant that he sent the specimens with a ms name. The material was probably collected in Italy and recognized there as a new species. Haliday normally did not label his specimens with locality data and it is very likely that he included Italian *Cacopsylla alaterni* with Irish psyllids collected in 1848. It has been assumed by later workers that because they were sent from Ireland, they were actually Irish specimens. This

would explain the curious distribution. *Cacopsylla alaterni* requires confirmation therefore as an Irish species.

***Cacopsylla* (*Thamnopsylla*) *crataegi* (Schrank, 1801)**

Synonym: *Psylla costatopunctata* Foerster, 1848

CLARE: Lough Bunny (R3696), ♂, 21 May 1985, JPOC and MAOC.

Cacopsylla crataegi was recorded as *Psylla costatopunctata* and *P. crataegi* Scopoli by Foerster (1848) based on Haliday material. Halbert (1935) listed it as as *Psylla crataegi*. The host plants are hawthorns *Crataegus* spp. The species is widely distributed in Europe and also occurs in Morocco, the Russian Far East and northern India (Ossianilsson, 1992).

***Cacopsylla* (*Thamnopsylla*) *melanoneura* (Foerster, 1848)** (Fig. 3)

Synonym: *Psylla costalis* Flor (partim)

CARLOW: Bahana Woods (S7239), ♀, 14 June 1991, JPOC and MAOC; **DUBLIN:** Castleknock (O0837), numerous ♂♂♀♀, 21 May and 20 June 2011, on *Crataegus monogyna* in a suburban garden, JPOC; St Catherines Wood (O0136), ♂, 11 May 1991, JPOC; **WATERFORD**: hill near Passage East (S6910), ♂♀, 12 June 1991, JPOC; **WEXFORD**: Craywell, New Ross (S7228), ♂♀♀, 28 June 2011, JPOC; Curracloe (T1127), ♂, 18 June 1991, JPOC and MAOC.

Cacopsylla melanoneura was recorded as *Psylla melanoneura* by Foerster (1848) based on Haliday material and subsequently as *Psylla costalis* from Coolmore, Co. Donegal by Johnson *et al.* (1894). Helden *et al*. (2008) reported it from Co. Wexford. The host plants are hawthorns *Crataegus* spp., apples *Malus* spp. and pears *Pyrus* spp. The species occurs throughout the Palaearctic region (Malumphy *et al*., 2009).

***Cacopsylla* (*Thamnopsylla*) *pruni* (Scopoli, 1763)**

Synonym: *Psylla fumipennis* Foerster, 1848

WEXFORD: Mount Brandon House Hotel (S7126), New Ross, ♂, 5 July 2011, JPOC; **WICKLOW**: Knocksink Wood (O2117), ♀, 10 May 1984, JPOC.

Cacopsylla pruni was recorded as *Psylla fumipennis* by Foerster (1848) based on Haliday material. Subsequently, Halbert (1935) reported it as *Psylla pruni*. The following specimen is in

NMI:- **GALWAY**: Clonbrock, ♂, JNH. The host plants are plum *Prunus domestica*, bird cherry *P. padus* and blackthorn *P. spinosa.* The species is widespread in Europe and also occurs in the Caucasus, Georgia and Siberia in Russia (Ossianilsson, 1992).

***Cacopsylla* (*Thamnopsylla*) *rhamnicola* (Scott, 1876)**

Cacopsylla rhamnicola was recorded as *Psylla rhamnicola* by Hodkinson and White (1979). The host plant is buckthorn *Rhamnus cathartica*. The species occurs in Britain, the Caucasus, the former Czechoslovakia, Denmark, Georgia, Hungary, Kazakhstan, Mongolia, Russia, Spain, Sweden and Switzerland (Ossianilsson, 1992).

***Chamaepsylla hartigii* (Flor, 1861)**

DUBLIN: Castleknock (O0837), ♂, 16 June -6 July 1996, Malaise trap, JPOC; same locality, numerous ♂♂♀♀, 31 May 2011, on a *Betula* sp. in a suburban garden, JPOC; **KERRY:** Dinish (V9385), Killarney, ♂, 31 May 1995, JPOC; **WEXFORD:** near New Ross (S7125), ♂, 13 July 1991, JPOC.

Chamaepsylla hartigii was recorded as *Psylla hartigii* by Halbert (1912) from Belclare, Co. Mayo. The following specimens are in NMI:- **WICKLOW**: Drumgoff, ♀, 31 May 1896, JNH (misidentified as *Arytainilla spartiophila*); **MAYO**: Westport, ♀, June 1909, JNH. The host plants are birches *Betula* spp. The species is widely distributed in Europe and also occurs in Japan and North America (Ossianilsson, 1992).

***Craspedolepta flavipennis* (Foerster, 1848)**

Craspedolepta flavipennis was recorded by Foerster (1848) based on Haliday material. Hodkinson and White (1979) state that it is rare here and only known from the south of the island. The host plants are Compositae. The species occurs in central and northern Europe, Armenia, Georgia and Russia including Dagestan and Siberia (Hodkinson and White, 1979).

***Craspedolepta nebulosa* (Zetterstedt, 1828)** (Fig. 4)

Craspedolepta nebulosa was recorded from Virginia, Co. Cavan and Fiddown, Co. Waterford by O'Connor (2001). The host plant is rosebay willowherb *Chamerion angustifolium*. *C. nebulosa* is a trans-Palaearctic species that occurs from Western Europe to the Russian Far East, and has been introduced to North America (Ossianilsson, 1992).

***Craspedolepta nervosa* (Foerster, 1848)**

Synonym: *Aphalara nervosa* Foerster, 1848

KERRY: Banna (Q7522), numerous nymphs, 11 August 2004, on a swollen flower head of *Achillea* on the sand-dunes, JPOC.

Craspedolepta nervosa was recorded as *Aphalaria nervosa* from Cos Cork, Dublin, Meath and Wicklow by Halbert (1935). The following specimen is in NMI:- **MEATH**: Laytown, ♀, JNH. The host plants are yarrow *Achillea millefolium*, sneezewort *A. ptarmica* and creeping thistle *Cirsium arvense*. The species is widespread in Europe and also occurs in the Asiatic part of Russia, Iraq and Mongolia (Ossianilsson, 1992).

***Craspedolepta sonchi* (Foerster, 1848)**

Synonym: *Aphalaria picta* Zetterstedt, 1828

Craspedolepta sonchi was recorded from as *Aphalaria picta* from Castlebar and Westport, Co. Mayo by Halbert (1912). The following specimens are in NMI:- **LOUTH**: no locality, ♀, JNH (specimen was in the Edwards Collection); **MAYO**: Coolbarren, ♂, July 1911, JNH. The host plants are autumn hawkbit *Leontodon autumnalis*, crown daisies *Chrysanthemum* spp., hawk's-beards *Crepis* spp., ragworts *Senecio* spp., hawkweeds *Hieracium* spp., cat's-ears *Hypochoeris* spp. and sow-thistles *Sonchus* spp. The species has been reported from Armenia, Denmark, England, Georgia, Norway, Sweden and Russia including Dagestan and Siberia in Russia (Ossianilsson, 1992).

***Livia junci* (Schrank, 1789)** (Fig. 5)

Synonym: *Livia juncorum* (Latreille, 1798)

WICKLOW: Calary Lower (O2311), 2♂♂, 23 September 1989, JPOC and MAOC.

Livia junci was reported as *Livia juncorum* from Castlebar, Clare Island and Westport, Co. Mayo by Halbert (1912) and subsequently from the Kerry Way, Kenmare uplands, Co. Kerry by O'Connor *et al.* (2008). The following specimens are in NMI:- **DUBLIN**: Lucan, ♂, JNH; Raheny, ♂2♀♀, JNH; **GALWAY**: Woodford, ♂, JNH; **SLIGO**: Ballysadare, 2♀♀, JNH; Lissadell, ♀, JNH; **WICKLOW**: Lough Dan, ♀, 28 September 1909, JNH. The host plants are various species of rushes *Juncus*. The species is widespread in Europe and also occurs in

Algeria, Iran, India, the Middle East and Siberia (Ossianilsson 1992).

***Livilla ulicis* Curtis, 1836**

Livilla ulicis was recorded from Co. Wicklow by Halbert (1935). The following specimen is in NMI:- **WICKLOW**: Vale of Avoca, ♀, AHH. The food plants are greenweeds *Genista*, brooms *Cytisus* and gorses *Ulex* spp. The species occurs in Britain, central and southern Europe (Hodkinson and White, 1979).

***Neocraspedolepta subpunctata* (Foerster, 1848)** **New to Ireland**

Synonym: *Craspedolepta subpunctata* (Foerster, 1848)

CAVAN: Deerpark Woods (N5987), Virginia, ♂, 13 July 2011, off *Chamerion angustifolium*, JPOC; **WEXFORD:** Craywell (S7228), New Ross, 2♀♀, 28 June 2011, off *C. angustifolium* on a steep hill, JPOC; John F. Kennedy Park (S7319) 3♂♂6♀♀, 29 June 2011, off *C. angustifolium*, JPOC.

The host plant is rosebay willowherb *Chamerion angustifolium*. *Neocraspedolepta subpunctata* has been recorded from central Europe, England, Italy, Scandinavia and the former U.S.S.R. It also occurs in North America (Ossianilsson, 1992).

***Psylla* (*Psylla*) *alni* (Linnaeus, 1758)** (Figs 6-7)

Synonyms: *Psylla fuscinervis* Foerster, 1848; *Psylla heydeni* Foerster, 1848

CARLOW: St Mullins (S7238), 2♂♂♀, 2 July 2011, off *Alnus* beside the River Barrow, JPOC; **CAVAN:** Deerpark Woods (N5987), Virginia, ♂♂♀♀, 13 July 2011, JPOC; **DUBLIN**: Castleknock (O0837), ♂ and numerous nymphs, 21 May 2011, on planted *Alnus* sp. near St Brigid's GAA club, JPOC; Clondalkin (O0731), ♂, 7 June 1981, JPOC; **KERRY**: Ross Castle (V9488), Killarney, ♂, 16 September 1981, JPOC; **SLIGO**: Drumcliffe River near Rathcormack (G6742), 2♂♂, 28 August 1992, JPOC; **WEXFORD**: John F. Kennedy Park (S7319), ♂, 29 June 2011, JPOC.

Psylla alni was recorded as *Psylla heydeni* and *P. fuscinervis* by Foerster (1848) based on Haliday material. Subsequently, it was reported from Westport, Co. Mayo (Halbert, 1912). The following specimens are in NMI:- **CORK**: Fermoy, ♂, July 1894, JNH; **DONEGAL**: Ardara, 32♂♂♀, two of the males are dated 8 July 1892, WFJ; **DUBLIN**: no locality, ♀, 25 August

1895, JNH; Donabate, ♂, JNH; **MAYO**: Belclare, 2♀♀, July 1910, JNH; **WICKLOW**: Roundwood, ♂, 1 October 1909, JNH (misidentified as *Arytaina genistae*). The food plants are various species of alder *Alnus*. The species is widespread in the Palaearctic region (Ossianilsson, 1992).

***Psylla* (*Psylla*) *betulae* (Linnaeus, 1758)** **Confirmed as an Irish species**

KILKENNY: Woodstock (S6336), Inistioge, 2♀♀, 8 August 2011 and ♂6♀♀, 16 August 2011, off *Betula pubescens*, JPOC.

Psylla betulae was recorded from Clare Island, Co. Mayo by Halbert (1912). However, the named voucher specimens in the National Museum of Ireland both belong to *Cacopsylla saliceti*. Authentic Irish specimens have now been found as listed above. The host plants are silver birch *Betula pendula* and downy birch *B. pubescens*. The species has been recorded from Austria, Britain, Estonia, Latvia, Poland and the former U.S.S.R. It also occurs in Japan and Mongolia (Ossianilsson, 1992).

***Psylla* (*Asphagidella*) *buxi* (Linnaeus, 1758)** (Fig. 8)

CARLOW: Altamont Gardens (S8665), 2♂♂2♀♀, 9 July 2011, off *Buxus sempervirens*, JPOC; **DUBLIN**: Raglan Road (O1732), numerous ♂♂♀♀, 3 June 2011, on *B. sempervirens*, JPOC; **MONAGHAN**: Nuremore Hotel (H8502), 28 April 2011, cabbage galls and nymphs on *B. sempervirens* in the grounds of the hotel, JPOC.

Psylla buxi was recorded by Foerster (1848) based on Haliday material. Subsequently, it was reported from Muckross House, Killarney, Co. Kerry and Clare Island, Co. Mayo (Halbert, 1912; O'Connor *et al.*, 2008). The following specimens are in NMI:- **DOWN**: Donard Demense, 2♂♂2♀♀, August 1902, on box [JNH]; **DUBLIN**: Dundrum, 5♂♂♀, June 1900, GHC; **MAYO**: Westport, ♂3♀♀, JNH. The food plant is box *Buxus sempervirens*. The species is widespread in Europe (Ossianilsson, 1992).

***Psyllopsis discrepans* (Flor, 1861)** (Fig. 9)

CARLOW: Bahana Woods (S7239), 3♀♀, 14 June 1991, JPOC and MAOC.

Psyllopsis discrepans was recorded from Co. Wexford by Helden *et al.* (2008). The following specimen is in NMI:- **WICKLOW**: Avoca, ♀, JNH. It had been misidentified as

Psyllopsis fraxinicola. The host plants are ashes *Fraxinus* spp. The species occurs in central and eastern Europe, Armenia, Britain, Georgia, Scandinavia and Tajikistan. It has been introduced into the Nearctic region (Malumphy *et al.*, 2009).

***Psyllopsis distinguenda* Edwards, 1913** **New to Ireland**

DUBLIN: no locality, 2♂♂ (NMI) (misidentified as *Psyllopsis fraxini*); **GALWAY:** Clonbrock, ♂, JNH (NMI) (misidentified as *Psyllopsis fraxini*); **KERRY**: Killarney, 3♂♂, 3 July 1930, lake side, EFB (NMI); **WEXFORD:** John F. Kennedy Park (S7319), ♂♀, June 1991, JPOC.

The food plants are ashes *Fraxinus* spp. and the species is widely distributed in central and western Europe (Hodkinson and White, 1979; Burckhardt, 2009).

***Psyllopsis fraxini* (Linnaeus, 1758)**

CAVAN: Deerpark Woods (N5987), Virginia, ♂, 19 July 2011, JPOC; **MEATH**: Kilmessan (N8858), nymphs, 26 May 2011, on *Fraxinus excelsior*, JPOC; **WEXFORD**: John F. Kennedy Park (S7319) ♂2♀♀, 29 June 2011, off *Fraxinus*, JPOC; **WICKLOW**: Knocksink Wood (O2117), ♂♂♀♀, 6-10 July 1995, CR.

Psyllopsis fraxini was recorded as *Psylla fraxini* by Foerster (1848) based on Haliday material. Subsequently it was recorded from Westport, Co. Mayo by Halbert (1912). The galls of *Psyllopsis fraxini* were found at Ailwee Cave and Mullagh More, Co. Clare, Coole Park near Gort, Co. Galway and Templenoe near Kenmare, Co. Kerry (O'Connor *et al*., 2008). Hodkinson and White (1979) stated that it was common throughout Ireland. The following specimens are in NMI:- **CORK**: Fermoy, ♂, JNH; **KERRY**: Killarney, ♂, 22 September 1930, lake side, EFB. The food plants are ashes *Fraxinus* spp. The species occurs in Europe and Asia Minor. It has been introduced into North America (Ossianilsson, 1992).

***Psyllopsis fraxinicola* (Foerster, 1848)**

CAVAN: Deerpark Woods (N5987), Virginia, 3♂♂2♀♀, 13 and 19 July 2011, JPOC; **WEXFORD:** Craywell (S7228), New Ross, ♀, 29 June 2011, JPOC; Mount Brandon House Hotel (S7126), New Ross, ♂♀, 5 July 2011, JPOC; Oaklands Wood (S7125), ♂3♀♀, 28 June 2011, swept off *Fraxinus excelsior*, JPOC; Stoneyford (T1009) near Broadway, ♂, 18 August

2011, JPOC; **WICKLOW:** Knocksink Wood (O2117), ♂♂♀♀, 6-10 July 1995, CR.

Psyllopsis fraxinicola was recorded from Ireland by Hodkinson and White (1979). The following specimens are in NMI:- **DONEGAL**: Portmore, ♂♀, JNH. The host plants are ashes *Fraxinus* spp. The species occurs in Europe, North Africa, Armenia, Kazakhstan, Georgia and Turkey. It has been introduced into the Nearctic region (Malumphy *et al.*, 2009).

***Spanioneura fonscolombii* Foerster, 1848** (Fig. 10) **New to Ireland**

CARLOW: Altamont Gardens (S8665), ♂, 9 July 2011, off *Buxus sempervirens*, JPOC; **DUBLIN:** Raglan Road (O1732), numerous ♂♂♀♀, 3 June 2011, on *B. sempervirens*, JPOC.

The food plant is box *Buxus sempervirens*. The discovery of *Spanioneura fonscolombii* in Ireland is interesting as it has spread northwards in Britain and become much more common in England in recent years. Indeed, it is often now more common on box than *P. buxi*. The species has been recorded from Belgium, Britain, France, Italy, Luxembourg, Spain and Switzerland (Hodkinson and White, 1979; Burckhardt, 2009).

***Strophingia ericae* (Curtis, 1835)** (Fig. 11)

WATERFORD: Mahon Falls area (S3009), ♂♂♀♀, 3 July 1989, JPOC; Nier Valley (S2417), ♀, 13 August 1987, JPOC; **WEXFORD**: Slieve Coiltia (S7319) near the John F. Kennedy Park, ♂2♀♀, 4 July 2011, JPOC.

Strophingia ericae was recorded as *Rhinocola ericae* by Foerster (1848) based on Haliday material and subsequently by Halbert (1912) from Croaghpatrick, Co. Mayo. The following specimens are in NMI:- **MAYO**: Cromaglaun, 4♀♀, JNH; **WICKLOW**: no locality, 2♀♀; Lugnaquilla, ♀, 30 May 1896 [GHC]. The food plants are heather *Calluna vulgaris* and heaths *Erica* spp. The species is widely distributed in Europe (Ossianilsson, 1992).

SPONDYLIASPIDAE

***Ctenarytaina eucalypti* (Maskell, 1890)** (Figs 12 and 13)

Ctenarytaina eucalypti was recorded by Hodkinson and White (1979). Subsequently, it was reported on silver-leaved mountain gum *Eucalyptus pulverulenta* Sims from Co. Kerry where it had began to threaten economically a newly developing ornamental foliage production industry

based in the south west (Murphy *et al.*, 1999; Purvis *et al.*, 2002). The life cycle of the psyllid was studied at three field sites in that county (Purvis *et al*., 2002). In order to reduce the psyllid's deleterious impact, an Australian parasitoid wasp *Psyllaephagus pilosus* (Noyes) (Hymenoptera: Encyrtidae), was introduced as a control agent (Chauzat *et al.*, 2002). The following specimens are in NMI:- **KERRY**: Kilgarvan, ♂♂♀♀ and nymphs, 2000, MPC; **WEXFORD**: John F. Kennedy Park, 2♀♀ and 2 nymphs, 4 November 1974, on shining gum *Eucalyptus nitens* Deane and Maiden, CIC. Native to Australasia, *C. eucalypti* is also known from England, the Isle of Man, Channel Islands, France, Spain including Tenerife Island, Italy and Portugal including Madeira. Outside Europe, it has been reported from New Zealand, Ethiopia, South Africa and Sri Lanka (Franquinho Aguiar and Martin, 1999).

***Ctenarytaina peregrina* Hodkinson, 2007** (Fig. 14)

Ctenarytaina peregrina was described from both Ireland and Britain by Hodkinson (2007). The species was discovered on small-leaved eucalyptus *Eucalyptus parvula* L. A. S. Johnson and K. D. Hill at Salterbridge, Cappoquin, Co. Waterford.

***Ctenarytaina spatulata* Taylor, 1997**

Ctenarytaina spatulata was recorded from Swords, Co. Dublin by Helden (2009). A native of Australia, its food plants are a range of eucalypt species. It has been introduced to a number of counties including New Zealand, Uruguay and the U.S.A. Since 2002, the species has spread to Europe and now also occurs in France, Italy Portugal and Spain (Helden, 2009)

TRIOZIDAE LÖW, 1879

***Bactericera albiventris* (Foerster, 1848)** **New to Ireland**

DUBLIN: Furry Glen (O0935), Phoenix Park, ♀, 25 July 2011, off *Salix* beside the lake, JPOC; **WEXFORD**: Mount Brandon House Hotel (S7126), New Ross, numerous ♂♂♀♀, 17 August 2011, off *Salix*, JPOC.

The following specimens are in NMI:- **DUBLIN**: Donabate, 2♂♂2♀♀, JNH. One of these males is dated September 1894. The food plants are white willow *Salix alba*, crackwillow *S. fragilis*, bay willow *S. pentandra*, almond willow *S. triandra* and purple willow *S. purpurea*. *Bactericera albiventris* is widely distributed in Europe. The species also occurs in Anatolia,

Mongolia, the Caucasus, Russia (Far East and Siberia) and Turkmenistan (Ossianilsson, 1992).

***Bactericera crithmi* (Low, 1877)**

WEXFORD: Grange Strand (S8005) near Fethard, ♂♀, 10 August 2011, off *Crithmum maritimum* growing on the coastal cliffs, JPOC.

Bactericera crithmi was recorded as *Trioza* by Hodkinson and White (1979). The food plant is rock samphire *Crithmum maritimum*. The species has been recorded from Britain, France, Italy, Malta and Spain (Hodkinson and White, 1979; Burckhardt, 2009).

***Bactericera curvatinervis* (Foerster, 1848)**

CAVAN: Deerpark Woods (N5987), Virginia, ♂2♀♀, 19 July 2011, off *Salix* sp., JPOC.

Bactericera curvatinervis was recorded as *Trioza* by Hodkinson and White (1979). The host plants are various species of willow *Salix*. The species is widespread in Europe and also occurs in Japan (Ossianilsson, 1992).

***Trioza alacris* Flor, 1861** (Fig. 15)

CORK: Cork City, 30 August 1994, abundant leaf galls on *Laurus nobilis*, CM; **WATERFORD:** Portlaw Estate (S4415), ♂♀, 1 April 1991, JPOC and MAOC.

Trioza alacris was recorded from various localities in Dublin City, Co. Dublin and Muckross House, Killarney, Co. Kerry by O'Connor *et al.* (1997, 2008). These published records were based on galls and nymphs. Adults were collected in Castleknock and on Raglan Road (all Co. Dublin) on 26 July 2010 and 3 June 2011 respectively. The host plants are bay *Laurus nobilis* and Azores laurel *L. azoricus* (Seub.). The species occurs in the northern Mediterranean area, Austria, Britain, the former Czechoslovakia, France, Germany, Holland, Norway, Poland, Sweden, Switzerland, the Caucasus, Crimea and Georgia. It has also been introduced into North America (Ossianilsson, 1992).

***Trioza galii* Foerster, 1848**

Synonym: *Trioza velutina* Foerster, 1848

WEXFORD: Ballyteige Burrow (S9603) near Kilmore Quay, ♂, 7 July 2011, swept off the sand-dunes where lady's bedstraw *Galium verum* is present, JPOC; Curracloe (T1127), ♀, 21 August 2011, swept off sand-dunes, JPOC.

Trioza galii was reported as *T. galii* and *T. velutina* by Foerster (1848) based on Haliday material. It was also listed by Halbert (1935). Helden *et al.* (2008) recorded the species from Co. Kilkenny. The following specimens are in NMI:- **MAYO**: Mountbrown Lake near Westport, ♀, July 1911, JNH; Westport, ♂, July 1911, JNH; **WICKLOW**: Lugnaquilla, ♂♀, 30 May 1895, JNH. The food plants are bedstraws *Galium* spp. The species is widely distributed in Europe and also occurs in the Caucasus, Japan, Kazakhstan, Siberia and Turkmenistan (Hodkinson and White 1979).

***Trioza munda* Foerster, 1848**

Trioza munda was recorded by Foerster (1848) based on a Haliday specimen. The host plants are field scabious *Knautia arvensis*, *K. silvatica* Duby, devil's-bit scabious *Succisa pratensis* and *Scabiosa lucida* Vill. The species has been reported from Austria, Britain, France, Germany, Italy, Poland, Romania and Switzerland. It also occurs in the Caucasus, Crimea, Amur, Mongolia and Japan (Ossianilsson, 1992).

***Trioza remota* Foerster, 1848** (Fig. 16-17)

Trioza remota was reported from the Phoenix Park, Co. Dublin and Inistioge, Co. Kilkenny by O'Connor (2007, 2010) based on the nymphs and galls. The following specimen is in NMI:- **WESTMEATH**: Mullingar, ♀, JNH. The host plants are oaks *Quercus* spp. *T. remota* is found throughout Europe, Algeria, Georgia and Japan (Malumphy *et al*., 2009).

***Trioza urticae* (Linnaeus, 1758)**

CARLOW: St Mullins (S7238), ♀ 2 July 2011, along River Barrow, JPOC; **CAVAN:** Deerpark Woods, Virginia (N5987), ♂♂ 13 July 2011, JPOC; **DUBLIN:** Castleknock (O0837), nymphs and galls 5 September 1996, on common nettle *Urtica dioica*, JPOC; **KERRY**: Killarney National Park (V9490), ♂ 8 September 1981, swept from vegetation in the Kenmare Estate, JPOC; **KILDARE**: Louisa Bridge (N9936), ♀ 24 February 1992, JPOC and MAOC; **MEATH**: Batterjohn Big (N8953), ♀ 28 October 1991, sand-pit, JPOC; **WATERFORD**: Dunmore East (X6999), ♂, 9 August 2006, swept from vegetation on marine cliffs at Black Knob, JPOC; near Passage East (S6910), 2♂♂, 17 July 1989, JPOC; **WESTMEATH:** Lough Ennell (N4146) at Inchacrone, ♀, 19 April 2006, JPOC; **WEXFORD**: Coolbawn House

(S8237), ♂♀, 8 May 1991, JPOC and MAOC; Craywell (S7228), Craywell (S7228), New Ross, numerous ♂♂♀♀, 28 June 2011, JPOC; Curracloe (T1127), ♂, 18 June 1991, JPOC and MAOC; Stoneyford (T1009) near Broadway, ♂♂♀♀, 18 August 2011, JPOC; **WICKLOW**: Glendalough (T1196), ♀, 11 September 1990, JPOC.

Trioza urticae was reported from Ireland by Foerster (1848) and from Cos Cork, Dublin, Waterford and Wexford by Halbert (1907), Curry (1976a, 1976b) and Helden *et al.* (2008). The following specimens are in NMI:- **DUBLIN**: Howth, ♂♀, 2 May 1909, JNH; Ireland's Eye, ♀, 30 July 1941, AWS; Portmarnock, 2♀♀, JNH; **MAYO**: Westport, ♂♀, June 1909, JNH; **SLIGO**: Lough Gill, ♀, JNH; Strandhill, ♀, JNH; **WESTMEATH**: Athlone, ♂, JNH. The host plants are nettles *Urtica* spp. The species is found throughout the Palaearctic region and India (Malumphy *et al.*, 2009).

***Trioza vitreoradiata* (Maskell, 1879)** (Figs 18-20)

Trioza vitreoradiata was recorded from Salterbridge, Cappoquin, Co. Waterford by O'Connor *et al.* (2004). The food plants are pittosporums *Pittosporum* spp. The species, which originated in New Zealand, also occurs in Britain and France (Cocquempot, 2008). It has recently been expanding its geographical range in Britain and is likely to do so in Ireland (Salisbury *et al.*, 2011).

Acknowledements

The authors wish to thank Colm Ronayne for providing the specimens from Knocksink. The senior author also wishes to thank his wife Mary for her help with field-work and Nigel Monaghan, Keeper of the Natural History Division, National Museum of Ireland, for his support. We are indebted to Tristan Bantock, Joe Botting and Fera for supplying the superb figures of the psyllids.

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FIGURE 1. Adult of *Aphalara ulicis* Foerster, 1848 © Tristan Bantock.

FIGURE 2. Adult of *Arytaina genistae* (Latreille, 1804) © Tristan Bantock.

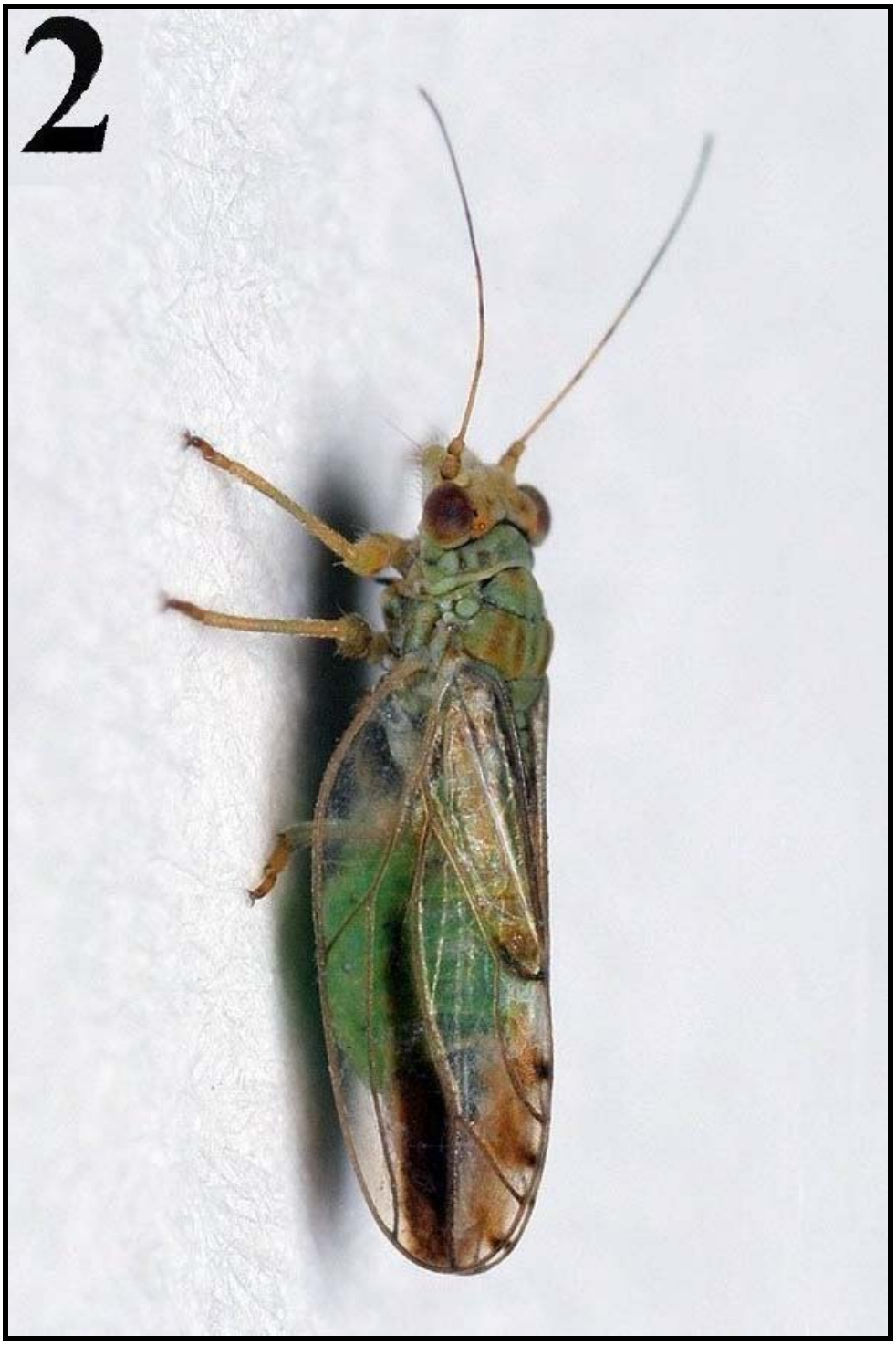

FIGURE 3. Adult of *Cacopsylla* (*Thamnopsylla*) *melanoneura* (Foerster, 1848) © Joe Botting (britishbugs.org.uk).

FIGURE 4. Adult of *Craspedolepta nebulosa* (Zetterstedt, 1828) © Joe Botting (britishbugs.org.uk).

FIGURE 5. Adult of *Livia junci* (Schrank, 1789) © Joe Botting (britishbugs. org. uk).

FIGURE 6. Adult of *Psylla* (*Psylla*) *alni* (Linnaeus, 1758) © Tristan Bantock.

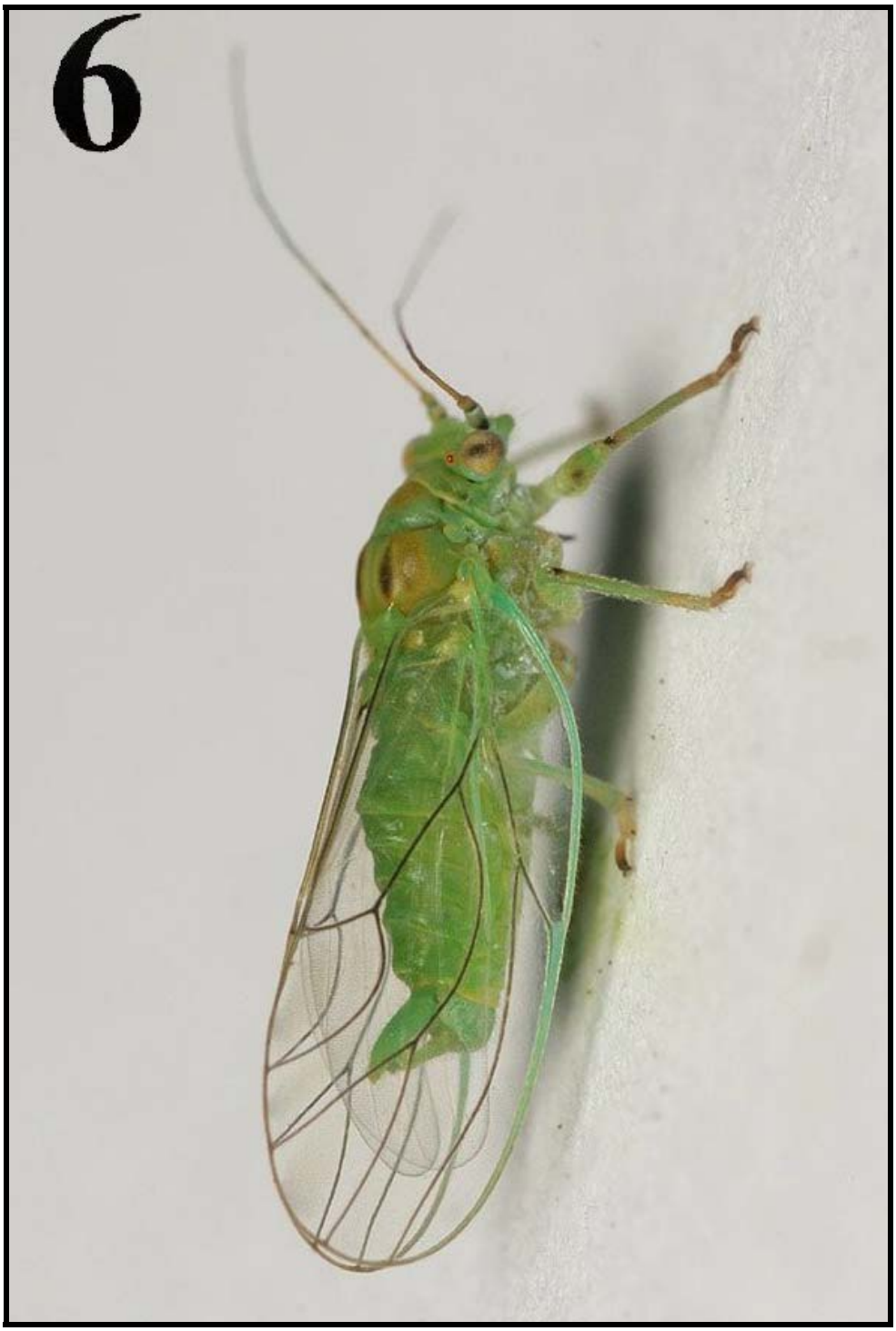

FIGURE 7. Nymphs of *Psylla* (*Psylla*) *alni* (Linnaeus, 1758) © Joe Botting (britishbugs.org.uk).

FIGURE 8. Adult of *Psylla* (*Asphagidella*) *buxi* (Linnaeus, 1758) © Tristan Bantock.

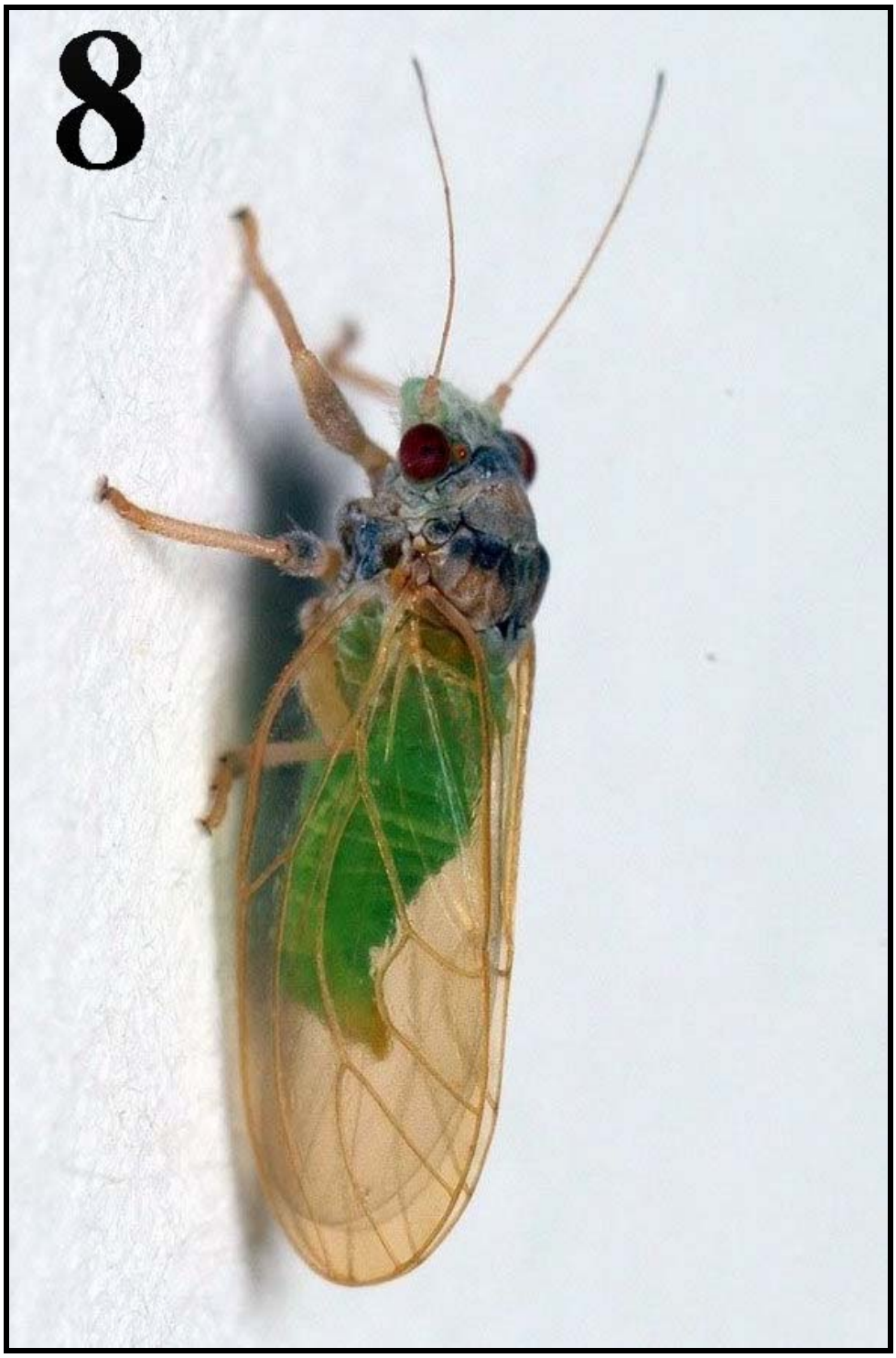

FIGURE 9. Adult of *Psyllopsis discrepans* (Flor, 1861) © Joe Botting (britishbugs.org.uk).

FIGURE 10. Adult of *Spanioneura fonscolombii* Foerster, 1848 © Tristan Bantock.

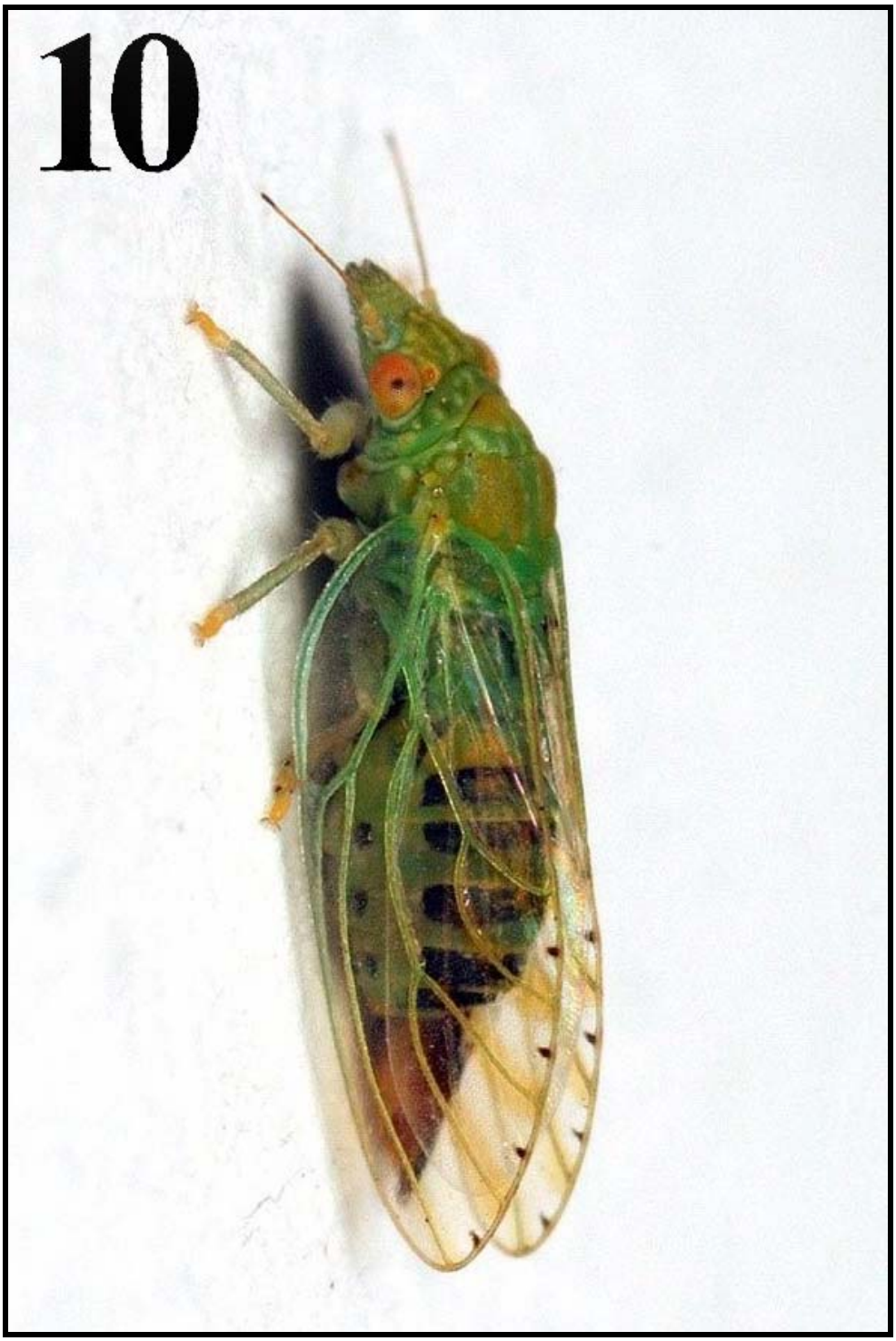

FIGURE 11. Adult of *Strophingia ericae* (Curtis, 1835) © Joe Botting (britishbugs.org.uk).

FIGURE 12. Adult of *Ctenarytaina eucalypti* (Maskell, 1890) © Fera.

FIGURE 13. Nymph and eggs of *Ctenarytaina eucalypti* (Maskell, 1890) © Fera.

FIGURE 14. Nymph of *Ctenarytaina peregrina* Hodkinson, 2007 © Fera.

FIGURE 15. Leaf galls of *Trioza alacris* Flor, 1861on bay laurel © Fera.

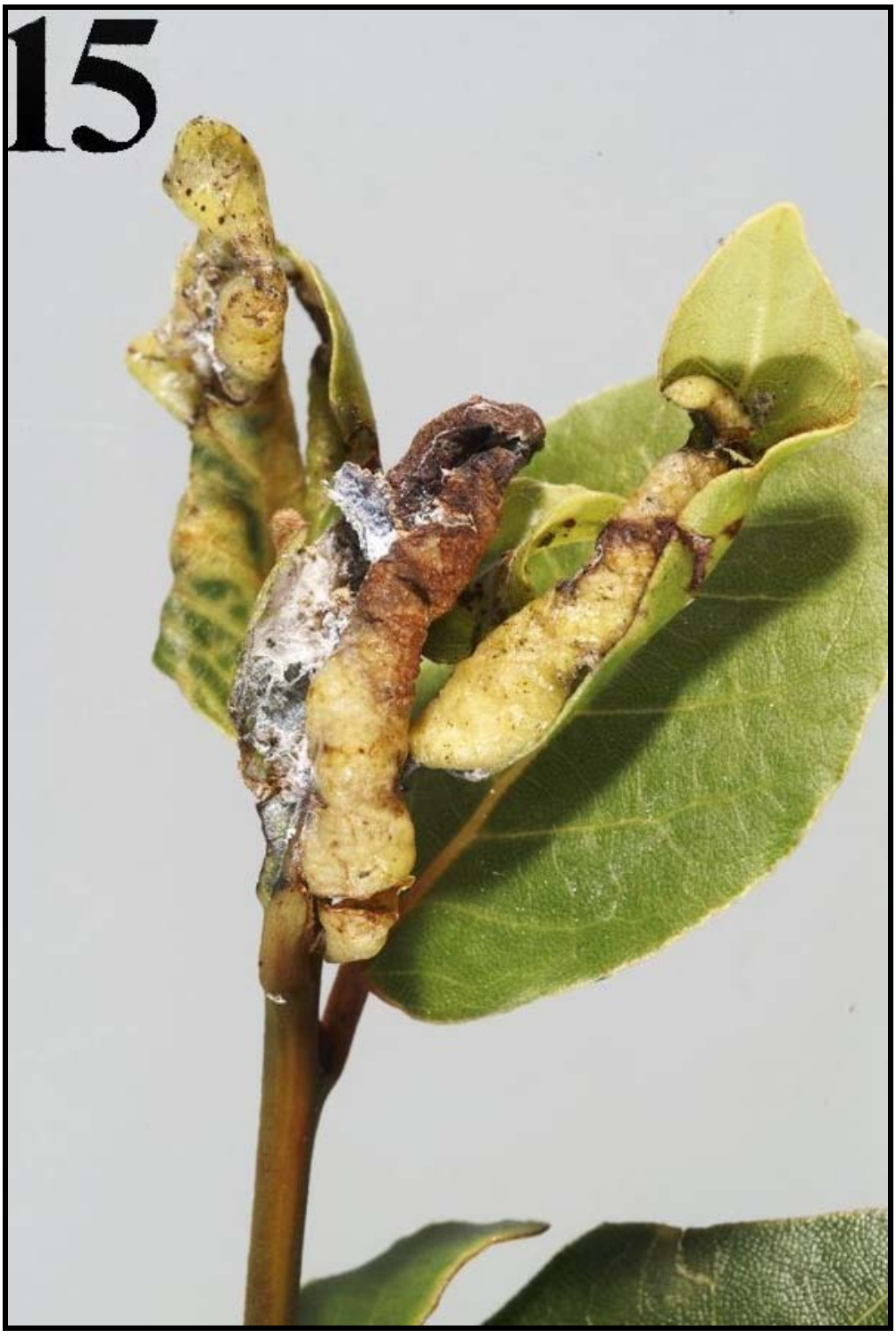

FIGURE 16. Adult of *Trioza remota* Foerster, 1848 © Joe Botting (britishbugs. org.uk).

FIGURE 17. Nymphs of *Trioza remota* Foerster, 1848 © Fera.

FIGURE 18. Galling of *Trioza vitreoradiata* (Maskell, 1879) on pittosporum © Fera.

FIGURE 19. Nymph of *Trioza vitreoradiata* (Maskell, 1879) © Fera.

FIGURE 20. Adult of *Trioza vitreoradiata* (Maskell, 1879) © Fera.

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NOTES ON THE IRISH ENTOMOLOGIST ALEXANDER HENRY HALIDAY (1806–1870)

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Abstract

Alexander Henry Haliday (1806-1870) is the most famous of the Irish entomologists. Information is provided *inter alia* on his family, education, time in Dublin and Italy, membership of societies, the man, the collection, contacts, major achievements and important works. There are sections on Haliday and the Linnean Collection, and Charles Darwin. His entomological techniques and preferences are described. Haliday's contributions to the biology of insects, the type concept and synonymy are also discussed. Valid Haliday genera and species occurring in Ireland are listed along with the valid species named after him. A comprehensive bibliography of his published works is included.

Key words: Haliday, Linnean, Darwin, entomology, Ireland, collection, types, history, bibliography.

Introduction

This paper is mainly based on Nash, O'Connor and Hughes (2005), Nash (1983, 2011), O'Connor (1997) and O'Connor and Nash (1982) with some additions, amendments and corrections. Further information will be found in those articles.

Alexander Henry Haliday, also known as Enrico Alessandro Haliday and Alexis Heinrich Haliday (1806–1870), was an Irish entomologist. He is primarily known for his work on the Hymenoptera, Diptera and Thysanoptera, but Haliday worked on all insect orders and on many

aspects of entomology.

Haliday was born in Holywood, County Down, Ireland. A boyhood friend of Robert Templeton, he divided his time between Ireland and Lucca (now part of Italy) where he was a co-founder with Camillo Rondani and Adolfo Targioni Tozzetti of the Italian Entomological Society. He was also a Member of the Galileiana Academy of Arts and Sciences, Microscopical Society of London, Royal Irish Academy, Royal Dublin Society and the Belfast Natural History Society as well as a Fellow of the (now Royal) Entomological Society of London.

With Hermann Loew (1807–1879), Alexander Haliday was among the greatest dipterists and hymenopterists of the 19th century and one of the most renowned entomologists of his day. His achievements were in four main fields: description, higher taxonomy, synonymy and biology. Most of Haliday's correspondence with British and Continental entomologists is in the library of the Royal Entomological Society, other parts are in the Hope Library at the Oxford University Museum of Natural History. Haliday died in Lucca in 1870.

The family

Alexander Henry Haliday was born at "Clifden" (also known as "Clifton"), Holywood, a small seaside town in County Down, Ireland, on 21 November 1806, the eldest child of Dr William Haliday and Marian Webster. He was the son of one of Belfast's best known physicians. The Haliday family was Protestant, although not religious, and clearly well-placed, holding 3,228 acres (13.06km^2) of farmland in County Antrim valued at £3,054.00 in 1820. The family also owned property in Holywood and in Dublin and had a cloth merchant business. In addition, they had shipping interests. Haliday's brother, William Robert, was at sometime a Lieutenant-General in the 36th Regiment of Foot quartered at Windsor. Aside from a collection of parrots from Australia, Malacca and Malabar, collected in the 1840s, William Haliday, whose name on the army register is spelled Halliday, is not known as a naturalist. Interestingly, A. H. Haliday's surname is also sometimes given as Halliday on legal documents. Haliday's sister was named Hortense. She was interested in botany. Little is known of Hortense except that she suffered from tuberculosis as did the rest of the family. She is charmingly enshrined in

the text accompanying Curtis's plate 596 of *British Entomology; being illustrations and descriptions of the genera of insects found in Great Britain and Ireland May 1, 1836* which states "For the beautiful drawing of *Rosa hibernica* (the Belfast Rose), I am indebted to Miss Haliday" (Fig. 1). Alexander Haliday was a cousin of the historian Charles Halliday M.R.I.A. (also spelt Haliday) (1789-1866), who, despite antiquarian studies which resulted in the publication of a history of *The Scandinavian Kingdom of Dublin*, made a large fortune in business.

The Haliday family had relatives in Lucca, Italy - the Pisanis – "I have been a long time about writing to you but the return of my sister and some other relatives from Italy who had not been home for many years has filled our house and occupied my thoughts mostly ie my cousin Mme Pisani, her husband and three nieces with myself" he wrote. The Pisanis were a prominent Lucca family and Haliday a frequent visitor to "Campagna bella e chiamate di Tuscanys a Firenze, a Lucca, a Pisa ed al Cinque Terre che la campagna della Toscana allunga dall'aria croccante e libera del Apennines ad alcune delle linee costiere più belle dell'Italia". The frequent presence of the Pisani family led to, according to Camillo Rondani, "Alessandro's" learning Italian as a child "al suo ginocchio delle madri, come un nativo".

Haliday's education

Haliday and his life-long friend Robert Templeton (though they were to see nothing of each other after 1833) began their education at the Belfast Academical Institution. Opened in 1814, the school had strong leanings towards Natural History. Haliday, aged twelve, studied Classics first, then two years later took up Arithmetic and then two years after that, Mathematics. Both boys were taught drawing by an Italian master whose talents evidently lay in teaching skill and as a result, became skilled illustrators. The Natural History lessons from George Crawford Hyndman, were not a part of the curriculum but formal. Hyndman was an avid insect collector and one of the founding members of the Belfast Natural History Society which had a Museum and Library. Haliday left the Belfast Academical Institution, and the family home in nearby Holywood, for Dublin where he entered Trinity College in 1822 at sixteen, graduating in 1827.

He was awarded a gold medal in Classics. He was called to the Irish Bar but soon retired from practice. Haliday went to Paris in late 1827 staying for most of a year. However by then, the young man had received the first impetus to his entomological career after meeting John Curtis, one of the foremost entomologists of his day (see Nash, 1983).

Haliday's time in metropolitan Dublin 1825-1840

Haliday in the years 1825-1840 spent most of his time in Dublin. From 1833, he lived at No. 3, North Cumberland Street (in later years his Dublin address was No. 8, Harcourt Street). However, he returned frequently to his home "Clifden" in Holywood and also spent much time in London. More than occasionally, he visited Lucca, staying with the Pisanis.

Aside from its modern, metropolitan pleasures, Dublin had competing attractions for Haliday: the Royal Dublin Society housing the Leske Collection, the Marsh Library and that of Trinity College, the Linnaean Garden (a garden presenting the 24 classes of Carolus Linnaeus' Systema), the Opera and the Theatre Royal. In 1835, John Curtis made an entomological tour of Ireland with Haliday. An account of this venture is given in Nash (1983).

Italy 1841-1848

In 1842, Haliday was appointed High Sheriff of Antrim but between the years of 1841 and 1848, he seems to have spent most, if not all, of his time away from Ireland mainly in the Pisani family home in Lucca. During this period, the Great Famine had commenced in 1845. In these years, Europe was also riven by conflict culminating in the Revolutions of 1848.

More settled times

In the 1850s, Haliday, once more resident in Dublin where from 1854-1860 he edited parts of the *Natural History Review*, gave lectures at meetings of the Dublin University Zoological Association (Trinity College) and curated the insect collections at the same University. Here he renewed his interest in Geology (Haliday, as did most educated people, had a well-read copy of Charles Lyell's three volume book, *Principles of Geology*, published between 1830 and 1833).

He became a member of the Dublin University Geological Society on its foundation, not only attending meetings but reading papers of geologists unable to attend in person. Presumably his language skills were also useful. A manuscript in the Royal Irish Academy proves that Haliday gave a series of talks on fossil insects to the Dublin geologists, illustrating this with specimens from his own and the University's collections. In these years, he made regular visits to London, usually staying with Henry Tibbats Stainton. The visits coincided with the more important meetings of the Entomological Society of London. Visits to the continent included two trips to Switzerland staying near Monte Rosa with entomological friends.

Italy 1862-1870 and his travels

In 1862 (February), Haliday took up residence in Villa San Cordeo in Lucca, staying in Paris *en route* to study the important Johann Wilhelm Meigen collection. Changes of address in Lucca became the rule in March, "Casa Pelosi", May, "Monte Bonelli" and in 1863 "Villa Buia". Then following a trip to Sicily, he moved into Villa Pisani, with his cousin Mme. Pisani and her family (husband and three nieces). Visits to see entomologists and expeditions became much more frequent. Haliday travelled widely in Italy, mainly in the North (Emilia-Romagna, Liguria, Lombardy, Piedmont, Trentino-Alto Adige/Südtirol, Aosta Valley and in Tuscany) although he made two trips to Sicily. Various trips to Switzerland, France and Bavaria followed and in 1865, with Edward Perceval Wright, he made an entomological expedition to Portugal. In May and June 1868, he toured Sicily also with Wright.

This excerpt from a letter gives a flavour of these trips "I am back but a few days from an excursion in the Apennines cut short by unfavourable weather. I took a horse and man from baths of Lucca and found myself at Abetone the pass between Tuscany and Modena — ascending Gione the highest point of the central Apennines which lies a little detached from the chain so commanding a more extensive view including both seas Adriatic and Tyrrhenum but I saw on the top only fog, rain and rock. Rondinago (Monte Rondinaio) the next highest (in the main chain) was little better as to view and in the mist my guide who had never been at the summit took me up the most precipitous side really a perilous climb in fog — I had intended

going on to some of the Apuan Alps (or Carrara range) but this experience discouraged me — also I found that the season was too far advanced in respect to vegetation and consequently insects". The second tour of Sicily with Wright in 1870 was his last. He died in Lucca on 12 July 1870 after a short illness..

Some of his collection localities included Emilia-Romagna, Comacchio and Tuscany.

Societies

Haliday was a Member of the Belfast Natural History Society, the Dublin University Geological Society, the Dublin University Zoological Association, the Entomological Society of London, the Italian Galileiana Academy of Arts and Sciences, the Linnean Society of London, the Microscopical Society of London, the Royal Dublin Society, the Royal Irish Academy and the Stettin Entomological Society. He was a Member and co-founder of La Società Entomologica Italiana (the Italian Entomological Society). Although a Member of the Irish Bar, he never practiced law.

Haliday joined the first Alpine Club in the year of its foundation in 1857. It was *a club of English gentlemen devoted to mountaineering, first of all in the Alps, members of which have successfully addressed themselves to attempts of the kind on loftier mountains.*

Haliday the man

A cultured man, Haliday was quite at home at the opera and was an avid concert and theatre-goer in both Dublin and Lucca and, occasionally Rome. Various literary references point to his liking of the novel, and naturally the classics and we know of family visits especially with Madame Pisani (of whom he appears to have been extraordinarily fond) "to view the paintings". He was, presumably, culturally no different to any other highly educated European gentleman. Invitations are to be found among his papers in the Royal Irish Academy:- to M. Gounod's "Sappho", first performed in Paris in 1851; Verdi's "Rigoletto", "Il trovatore", "La traviata" and "Les vêpres siciliennes"; Schumann's "Manfred"; Donizetti's "Lucia di Lammermoor" and Berlioz's "The Infant Christ". Such advanced musical tastes and opportunities usually come

early in life and were presumably instilled in Hortense and Henry by the Pisanis rather than by Haliday's provincial and decidedly dour family. It is worth noting, but no more, that Giacomo Puccini, the Italian opera composer, was born in Lucca, Haliday's other home town in 1859. Business, or rather lack of it, did not occupy Haliday. There is no reference in his will to other than minor amounts. He died without leaving property or significant sums of money. As to personality, there is much humour in Haliday's writing - all of it good natured and he was very tolerant of failings although not always. Modesty was not a virtue; Haliday was by no means self-effacing. Far from it, as this quotation from a letter reveals:- "A seafog, beyond the headland of Piombino, obscured the Mediterranean with the islands Elba, Corsica etc. But on that side the wild serrated coast of the Apeninne Alps was distinctly drawn and before us, from the one extremity where it first rises out of the Lunigiana valley, to the other where it ends in the half detached group of the Pisan mountains whereby the Pisans cannot see Lucca". The quotation, which, in full is, in English, "Hunting the wolf and whelps upon the mountain for which the Pisans cannot see Lucca" is from Dante's *Inferno* Canto 23. No matter what the context, Haliday simply could not resist showing his literary and other prowess whenever the opportunity presented itself. Haliday was not a religious man. Religion did not interest him although a regular attender at the Protestant church in Lucca and an opponent of Transcendentalism. His political views were less progressive, at least in respect of the American Civil War and the Risorgimento. Despite the disordered nature of much of Haliday's life and suggestions that he suffered from nervous dyspepsia, this is belied by much of his writing and by and large he was in robust health.

Major achievements

Contributions to the species concept through the designation of type specimens which would be suitably housed: this was suggested in a letter to *The Entomological Magazine* in 1833 and the idea was approved by the editor, Francis Walker.

Contributions to the concept of synonymy.

Establishing rules for systematics and nomenclature: Haliday's refined analysis of the

history of names and the natural groupings the names identified was a model of perfection and the rules that Haliday suggested were taken up by all important Continental and most British authors.

Haliday's description of the genus *Orphnephila* (Diptera: Thaumalaeidae) and his plate 2 (Haliday, 1856) set a new standard of descriptive taxonomy far in advance of anything of its time.

Haliday's "Essay on the classification of parasitic Hymenoptera" is a seminal work of higher taxonomy and he was one of the pioneers of the group. The higher classification of the parasitic Hymenoptera is unstable but many of Haliday's higher taxa have survived.

Haliday was a specialist, working full-time on Diptera in the families Sphaeroceridae and Dolichopodidae and, on the Hymenoptera and Thysanoptera (excepting the area of synonymy).

Important works

The following are the more important works of Haliday. However a full bibliography is given further on in this article.

1832 The characters of two new dipterous genera with indications of some generic subdivisions and several species of Dolichopodidae. *Zoological Journal* **5**: 350-368, 1 plate.

1833 with Francis Walker, *Monographia Chalciditum*, London, 1833–1842. Much of this work was collaborative with Haliday who was the sole author of the sectional diagnoses.

1833-1838 An essay on the classification of the parasitic Hymenoptera of Britain which correspond with the Ichneumones minuti of Linnaeus. *The Entomological Magazine* **1**: 259-276, 333-350, 480-491; **2**: 93-106, 225-259; **4**: 92-106, 203-221; **5**: 209-248.

1836 British species of the dipterous tribe Sphaeroceridae. *The Entomological Magazine* **3**: 315-336.

1836 An epitome of the British genera in the order Thysanoptera with indications of a few of the species. *The Entomological Magazine* **3**: 439-451.

1837 with John Curtis, James Charles Dale and Francis Walker, Second edition of *A guide to the arrangement of British insects being a catalogue of all the named species hitherto*

discovered in Great Britain and Ireland.

1838 New British Insects indicated in Mr. Curtis's Guide. *Annals of Natural History* Series 1, **2**: 112-121.

1838 New British Insects indicated in Mr. Curtis's Guide. *Annals of Natural History* Series 1, **2**: 183-190.

1839 *Hymenoptera Britannica: Oxyura.* Fascicule **1.** Hippolytus Balliére, London.

1839 *Hymenopterorum synopsis ad methodum clm. Fallenii utplurimum accommodata. Addendum to Hymenoptera Britannica: Alysia.* Hippolytus Balliére, London. 4pp.

1851-1856 *in* Walker, F. *Insecta Britannica Diptera* 3 volumes. Reeve and Benham, London. [the characters and synoptical tables of **(a)** the order (**Volume I**: 1-9); **(b)** the Empidae (**Volume I**: 85-88); **(c)** the Syrphidae (**Volume I**: 234-237)]; [chapters on **(a)** the Dolichopidae (**Volume I**: 144-221); **(b)** the Borborides (**Volume II**: 171-184); **(c)** the Hydromyzides (**Volume II**: 247-269)]; [the addenda and corrigenda (**Volume III**: xi-xvi)]; [contributions to the plates of J. O. Westwood]; [separates the "Britannic" Diptera into those from England, Scotland, Wales and Ireland e.g. (E.S.W.I.)].

1851 with C. A. Dohrn. Wissenschaftliche Mittheilungen Sendschreiben von Alexis H. Haliday an C. A. Dohrn über die Dipteren der in London befindlichen Linnéischen Sammlung. Aus dem Englischen überstezt von Anna Dohrn. *Stettiner Entomologische Zeitung* **12**: 131-145.

1857 [Review] Zoonomische Briefe: Allgemeine Darstellung der thierischen Organisation Von Dr. Hermann Burmeister, Professor der Zoologie zu Halle. Erster und Zweiter Theil. 8vo. Otto Wigand: Leipzig. 1856. *Natural History Review* (including the Proceedings of the Irish Natural History Societies) **4**: 69-77.

Haliday and the Linnean Collection

In the winter of 1847-1848, Carl August Dohrn joined Haliday in London for a study of the Linnean collection later to be published in the *Stettiner Entomologische Zeitung* for 1851 (Volume **12**: 131-145) under the German title "Wissenschaftliche Mittheilungen Sendschreiben

von Alexis H. Haliday an C. A. Dohrn über die Dipteren der in London befindlichen Linnéischen Sammlung. Aus dem Englischen überstezt von Anna Dohrn". Dohrn, with his daughter Anna was staying with Henry Tibbats Stainton in Lewisham at the time. It was she, on a later visit to London, who translated the account. This is the only known early account of the Diptera collection of Carl von Linné, examined 64 years after its acquisition by the Linnean Society.

Haliday, Charles Darwin and the National Museum of Ireland

Charles Darwin's interest in Entomology began in his childhood and he spent much of his spare time at Cambridge (1828-1831) collecting beetles. Subsequently, while Entomology was not the major preoccupation of the Beagle voyage, he collected insects in many localities. Indeed, some of his captures were important and played their part in the formulation of his later theories.

After Darwin's return to England, he was faced with the problem of getting his material identified, lamenting in 1836 that "I have scarcely met anyone who seems to wish to possess any of my specimens". In March 1837, Francis Walker wrote to Haliday "Mr Darwin...has lately returned to England with his collections...He is at a loss what to do with the *Muscidae*, *Ichneum adscits* [probaby adsciti,] *Thrips* (of which there are some Titans half an inch long) etc –and wishes me to offer them to you to describe in whatever Ent work you please, he would like to have an answer soon. I think you will find them very interesting and we can easily send them to you." Specimens were sent in 1837 and 1838 and consisted mainly of small Diptera and Hymenoptera taken by general sweeping in Bahia, Brazil; Chiloe Island, Chile; the Galapagos Islands; Hobart; Tasmania; King George's Sound and Sydney, Australia; New Zealand and St Helena.

Haliday never managed to do much with the material. However in July 1839, Walker wrote to him:- "My descriptions of Darwins Chalcides are printed and will be published immediately. I have all the specimens in my possession and I will forward them to you together with all my own collection and they will be speedily followed by the few remnants that I have left. You are

quite welcome to retain mine as long as you feel inclined and what I ask of you is in plain words that you will point out my errors, supply my omissions, reunite the species that I have cut up and divide into groups the overpopulous and disordered genera. Your drawings of the genera would be most suitably accompanied by such an essay". As a result, Haliday supplied drawings of some of the Darwin insects which appeared as Plate P in *The Entomologist* **1** (see Haliday 1840-1844 in the bibliography). Haliday's authorship is indicated by a shamrock.

The Darwin insects retained by Haliday were acquired by the National Museum of Ireland in 1882 when the Haliday Collection was donated by Trinity College, Dublin. They remained scattered in various store-boxes until 1977-1982. Ken Smith was then working on his classic work *Darwin's Insects* and expressed his wish to examine the material. As a result J. P. O'Connor had the specimens photographed in their original store-boxes. They were then extracted, staged, labelled and carried in batches by hand to the Natural History Museum, London, where they were examined by Ken Smith and other experts. After their return to the National Museum of Ireland, they were housed in a new entomological cabinet and now occupy three drawers. Further information concerning the specimens will be found in Smith (1987, 1996) and in a bound ms (O'Connor, 1988) which accompanies the specimens and is entitled "Darwin's insects".

Haliday's techniques of studying insects (Figs 2-4)

"The minute Hymenoptera are best collected by beating into, and sweeping with, a net made of fine gauze, and Mr. Haliday recommends me to collect them into quills (shaft of a bird feather with the ends sealed by tiny corks), and afterwards to empty their contents into hot water, by which means their wings are naturally expanded; then by introducing a card under them to take them out of the water, arranging the legs and wings when necessary with a camel's hair pencil, and leaving them upon the card till they are dry, they may afterwards be taken off with a penknife, and gummed upon the points of small pieces of drawing - or card-paper of a long triangular form" - Curtis *British Entomology* July 1st 1830.

Haliday worked mainly with very small insects. Study of the tiny parts required dissection,

glass slide mounting and a very high quality microscope. The equipment was obtained from the London microscopist Andrew Pritchard. Whole specimens were mounted on card using gum, the card being transfixed by an entomological pin of German manufacture (Figs 2-4). Since the descriptions were necessarily based on more than one specimen, they may sometimes be ambiguous (based on more than one species). Collecting and general methodology followed the instructions given by George Samouelle in *The entomologist's useful compendium; or, An introduction to the knowledge of British insects, comprising the best means of obtaining and preserving them, and a description of the apparatus generally used*. He also used Abel Ingpen's (1839) manual *Instructions for collecting, rearing, and preserving British & foreign insects: also for collecting and preserving crustacea and shells.* On collecting trips, he used a Coddington lens. He was also an excellent artist (Figs 5-7).

Coleoptera and Lepidoptera *versus* Hymenoptera and Diptera

The standard works on the Coleoptera of the northern parts of Europe were in Haliday's time mostly in French, Latin and German, and these were indispensable for monographic study. Haliday possessed copies of Gyllenhal's *Insecta Suecica: Coleoptera sive Eleuterata* (1808-27), Erichson's *Die Kafer der Mark Brandenburg* (1837) and later works by Schaum, Kraatz, von Kiesenwetter, Redtenbacher, Fairmaire and Laboulbène. He had a comprehensive collection of Coleoptera and sought authoritatively named specimens from English and Continental authorities. However he wrote very little on this group. In Lepidoptera, he lacked the essential Continental literature. In Ireland, the microscopic Hymenoptera and Diptera were not only very little known and therefore offering more scope for taxonomic study, especially of higher taxa, but were more diverse and more readily collected in the often wet and windy weather.

Haliday and the biology of insects

The term Biology was coined (independently by Lamarck and Treviranus) in 1802 as the science of life. There is no better description for Haliday's studies of insect life histories and behaviour. Excepting the phraseology, the observations that Haliday details could easily come

from a modern pen. The acuteness of observation and style are reminiscent of the celebrated French behavioural entomologist Jean Henri Fabre (1823-1915).

"*Bethylus*.- The insects of this genus seem fond of the flowers of *Sygenesia*, but their principal haunts are in dry sandy districts near the sea. The low tufts of *Rosa spinosissima*, flourishing among the sand-cliffs, support numerous larvae of *Tineidae*, which when full fed, often fall into the little pits of loose sand formed at the foot of the cliffs, by the gradual scaling of the bank and the eddies of wind. These pits are complete traps for various insects, to which *Myrmica rubra* and other predaceous species resort, and among these our *Bethyli* will be seen prowling. On the fifth of last June, I observed a female of the largest size occupied with one of those larvae which was full fed, and, I should think, about six times its own weight. It had seized this by the mouth, and was with great perseverance endeavouring to transport it up the sliding sides of the pit. Perceiving that though apparently not discouraged after ten minutes' ineffectual exertion, it had no chance of succeeding, and wishing to trace its proceedings, I placed a fragment of straw in the hollow within its reach. The moment it had touched this railway the state of affairs was changed ─ taking a firm hold with its hind feet, it swung its prey round, and set off with it at a smart pace, walking backwards and dragging the body after it. From this time it was constantly endeavouring to ascend the face of the sand cliff, availing itself with admirable adroitness of the morsels of grass, twigs, &c., imbedded in it, not seeming to care how obliquely they lay, if they enabled it to gain a little elevation; so that its track was a zigzag. Frequently it chose stems which, rising nearly erect, receded from the bank above: I at first thought it was losing its labour, but it was at no loss how to act: after ascending a few inches with the whole weight suspended in the air from its mandibles, it would poise itself and its burden across the stem, with its head towards the bank, then throw itself off, at the same time extending its wings, which though incapable of raising it from the ground, were able to give it some impulse towards the bank, on which it thus alighted, at a spot someway above the springing of the stem. If, on ascending one of these twigs, it discovered that it was bent the wrong way, or receded too far from the cliff, it lost no time in hesitation, but stopping short of a sudden, commenced the descent again. It may be guessed that, dragging a gross, slimy body

over twigs, &c., close to or half buried in the sand, frequent impediments would occur, which its extreme activity in walking indifferently, sideways or backwards, and main exertion of muscular force, generally enabled it to overcome; but sometimes it had drawn its burden under or between two twigs, which arrested its course: after a violent tug or two without effect, it would retrace its steps, dragging the *larva* in the opposite direction, till it was extricated, then disposing it so as to keep clear of the obstacles, start again. On every occasion when it had left its hold, it made for the same part, and spent some time fastening its mandibles on the mouth of the prey beneath, so that the *larva* should be dragged on its back: once where this was not the case, it was impeded by the latter grappling with its feet the twigs over which it was drawn, and its captor quickly finding the error, let go and took a new hold in the usual position. When it had ascended about two feet, it came upon a fragment of reed partly imbedded in the sand, the stem of which was broken off and open below, a few dry elastic shreds of the leaf only remaining. Having reached the part where these grew, it by a strong pull drew its burden about half through, till its body was grasped between two of these as in a vice: then letting go, it began to explore the bank on each side to some distance, tapping with its antennae the conspicuous objects: in a few minutes seeming to be satisfied, it hastily descended the reed, and entered its stem at the lower end; it did not remain long in the interior, and on its reappearance, set off for the spot where it had left the larva, which, after pulling it out of the holdfast, it seized by the mouth as usual, and began to descend the reed again: it did not complete the journey this time, but taking advantage of the same kind of security to detain its prey, it repeated the *reconnaissance*, then returning, dragged it to the opening, and leaving it there, plunged in itself, but immediately reappearing, drew in the *larva* head foremost, speedily disappering in the interior; so that I could not observe its subsequent proceedings, and being obliged to turn homewards, I left them undisturbed. I think, however, it will seem probable that the bore of the reed was employed instead of an artificial funnel, for the cells which should contain the progeny of the *Bethylus*, with its store of provision. If these insects select only full grown caterpillars, I can scarcely imagine one of the smaller individuals managing these unwieldy bodies" (Haliday, 1834).

Haliday and the type concept

Today, the concept of species descriptions being supported by type specimens is a familiar one to taxonomic zoologists. The idea is that descriptions and illustrations alone are insufficient to unequivocally characterise a species and that the descriptor must choose a specimen to carry the species name - a holotype. In the event of confusion over the way in which a name should be applied, for instance, following the discovery of closely similar species the separation of which is based on characters not mentioned in the species description, the type is called into play to settle the issue. Whilst this is not specifically stated in Haliday's paper in *The Entomological Magazine* for 1833 the implication is obvious and would have been so to those familiar with the problem (note the editor's response). It reads:- "57. *Public Entomological Collection.*- SIR, May I venture a suggestion, which perhaps may appear futile or impracticable? In justice to those who undertake the elucidation of some extensive branch of entomology, or the more arduous labour of a *Fauna*, as one of the irregulars of the camp, I feel it imperative on us, if we do nothing in clearing, at least not to contribute towards encumbering the Augean stable. [the task of clearing this immensely dung-ridden stable was one of the seven labours of Hercules - child's play compared with the problems of name application confronting entomologists then as now]. Were there any public collection in which the describers of new genera and species might deposit examples, labelled with the names, adding to their lucubrations a reference to such cabinet, or enumerating in the Entomological Magazine the deposits made; it would, I imagine, prove a facility to future enquirers, at least with regard to such species as are not rare, and therefore of most importance. [Haliday does not say why but name problems particularly afflict the most common species which were in the Eighteenth and Nineteenth centuries described and given different names in a multiplicity of publications - see Haliday and synonomy]. I doubt not that the possessors, even of unique specimens, although they may be unwilling to transfer them to other private collections with equal risk of dispersion, would in many cases cheerfully yield them for the sake of more permanent utility. In order to put this idea into practice, it would be necessary to find some depôt where such would obtain room, and be generally accessible; and being unacquainted with the state and economy of the

musea of the metropolis [London], I do not know if these requisites could be fulfilled."

"[The establishment of the Entomological Society exactly supplies the *desideratum*; if it will be any convenience to our correspondents to transmit through our hands any contributions to the general collection now forming by the Society, we shall feel gratified in obliging both the donors and the Society.—ED.]" [Francis Walker]

So far as we are aware, this is the first mention of such a practice in entomological or other zoological literature and Haliday may be said to be the first proponent of type practice.

Haliday and synonymy

The explosion of species descriptions in the first three-quarters of the nineteenth century had an unfortunate consequence. The difficulties of language, delays in publication, small runs, an ever increasing number of journals, inadequate descriptions not to mention occasional rivalries were compounded by sheer quantity. To add to this, the disruption caused by warfare, for instance the War of Liberation in Italy which eventually led to unity, the Prusso-Danish War and political turmoil in the Germanic States, caused endless problems. Travel became difficult and indeed dangerous while outbreaks of cholera and typhoid precluded it all together from time to time. Visits to foreign capitals such as Vienna, Copenhagen, Berlin and Paris where important collections were housed were often unwise and, of course, the combatants did not welcome each other's nationals.

Thus, it is hardly surprising that many species, especially common ones, were described more than once. The staphylinid beetle, *Staphylinus maxillosus* Linnaeus, 1758, constitutes something of a record, including generic transfers, this beetle had received 35 names by 1874. The reasons for insect species coming to possess more than one name are various and it is sometimes the case that there is genuine confusion about the biological species. However, overlooked or unobtainable literature is by far the commonest cause especially in the nineteenth century.

Haliday's expertise in the complex arena of synonymy was such that he was consulted by most leading authorities of the day especially Loew. One can see why in this excerpt from

Haliday's (1855) reviews of "1. Zetterstedt, Insecta Lapponica, etc. I Tom. Foliae; Lipsiae, 1840" and "2. Zetterstedt, Diptera Scandinavae, etc. II Tomi, 8vo. Lundae, 1842-1852": "Zetterstedt is not one of the writers who are content to make a parade of erudition, by transcribing synonyms one after the other, without the pains of critical discrimination. The authorities he cites have evidently been collated with scrupulous care, while he has not thought it necessary, in general, to go back to the older authorities, with the exception of Linnaeus, Fabricius, and Degeer. But he has not had access to all the recent sources, especially those of the English literature, so that some portions of his matter will turn out to have been anticipated. The admirable BRITISH ENTOMOLOGY, of Curtis, is not once referred to, and thus, amongst other things, the genus *Dolichopeza* is attributed, without remark, to Meigen, who had omitted to cite from Curtis, the original author. Hence, also, the representatives of other modern genera, in the Swedish fauna lie disguised under alias names─*Diadocidia ferruginosa* as *Sciara testacea*─*Catocha* under *Lestremia*─*Corynoneura* among the *Chironomi* of Zetterstedt. Having inserted, for completeness' sake, the descriptions from other pens of some species, the originals of which he had not an opportunity of collating, he has, consequently, been led, in one or two instances, to give the same insect twice over; thus, the genus *Cordyla* appears among the *Rhyphii*, and again, as *Pachypalpus* (Macquart), amongst the *Mycetophilinae*, and *Ditomyia annulata* is twice described as *Ceroplatus flavus*, and as *Mycetobia annulata*. He has not constantly regarded the strict law of priority to which we have been accustomed to defer, in the application of generic and trivial names. Fallen and Fabricius seem to weigh more with him sometimes than age or usage, and rules are made to yield to predilection. We will let the dates stand, instead of statements of detail, for judgement of the principal instances of this sort, which affect the generic nomenclature. Zetterstedt has adopted (1) Hirtea Fb. (1798) for Bibio Geoffroy (1764); Hirtea Scopoli (1763) being a different genus.─(2) Chenesia Macq. (1834) for Orphnephila Haliday (1831), or Thamalea Ruthe (same year).─(3) Sicus Fb. (1798) for Coenomyia Latr. (1797); Sicus of Scopoli (1763) being Myopa.─(4) Eristalis Fallen (1810) for Chilosia Mg.; whereas Eristalis was first named and characterized by Latreille in 1804, while Eristalis of Fb. Antl. (1805) is made up of species of the genera Chilosia, Eristalis, Helophilus,

Merodon, Mallota, Milesia, Eumerus, Pipiza and Chrysogaster.—(5) Syrphus Fallen, for Eristalis Latr.; Meigen having defined the genus Syrphus otherwise in 1803, and Syrphus of Fb. Antl. including Volucella and Sericomyia along with part of Eristalis.—(6) Scaeva Fb. (1805) for Syrphus, previously applied by Meigen as above.—(7) Scatomyza Fallen (1810) for *Scatophaga* Mg. (1803)—and (8) Scatophaga Fallen for Psila Mg. (1803), being four years before Jurine applied the name of Psilus to the Hymenopterous genus Diapria Latr. (1797).—(9) Oxyrhina Mg. (1838) for Trigonometopus Macq. (1835).—(10) Ulidia Mg. (1826) for Mosillus Latr. (1804), or Chrysomyza Fallen (1817). But Ulidia also may be retained, being limited, according to Loew's suggestion (Beytr.i. 27), to U. erythrophthalma and the allied species."

The Haliday collection

Most of the Haliday collection is housed in the National Museum of Ireland, Dublin, Ireland and it is described in O'Connor and Nash (1982). After Haliday's death, seventy-eight boxes were donated in 1882 to the Museum by Trinity College, Dublin. The contents of some of the boxes were by then completely destroyed for the material had suffered greatly during Haliday's travels: "During the last three years I was not able to give any attention to the preservation of my collection which had to undergo two removals of domicile without my superintendence to the packing and transport and I find that they have suffered largely by mould and Anthreni". The material is in the main Irish but insects from England, France, Italy, Norway, Scotland and Sicily are also present. There are specimens from Curtis, Darwin, Rondani, Walker and other collectors. Most of the Haliday Collection has now been incorporated into the Museum's main collection but many boxes remain as Haliday left them (Fig. 2).

Additional Haliday material is in the John Curtis Collection of Insects, Museum Victoria, Australia; the Oxford University Museum of Natural History, England; Museo di Storia Naturale "La Specola", Florence (Firenze), Italy (Rondani Collection); Museo Museo Regionale di Scienze Naturali di Torino, Turin, Italy (Spinola Collection); Nationaal Natuurhistorische Museum Naturalis, Leiden, The Netherlands (eg. types of species described later by Gustav Mayer) (1830-1908)); The Natural History Museum, London and the Museum für Naturkunde

(Humboldt Museum), Berlin, Germany (Loew).

After Haliday's death, his surviving library was donated to the Royal Irish Academy by his friend Edward Percival Wright in March 1871. This is the finest collection of early entomological books (1634-1864) and reprints in Ireland, containing numerous rare items. Since Haliday was an adept linguist, many works are in French, German, Italian or Latin. The book bequest can be searched on line using the main catalogue (O'Connor, 2009).

Contacts

Haliday was a very influential figure in Entomology as his contacts and correspondence show. They included: **Jacques-Marie-Frangile Bigot** (1818–1893) France; **Émile Blanchard** (1819–1900) France; **Carl Gustav Alexander Brischke** (1814–1897) Germany; **Emil von Brück** (1807–1884) Germany; **Jean Baptiste Lucien Buquet** (1807–1889) France; **Carl Herman Conrad Burmeister** (1807–1892) Germany; **Achille Costa** (1823-1899) Italy; **George Robert Crotch** (1842–1874) England; **John Curtis** (1791–1862) England; **James Charles Dale** (1792–1872) England; **Sylvain Auguste de Marseul** (1812–1890) France; **Henri de Saussure** (1829–1905) Switzerland; **Michel Edmond de Selys-Longchamps** (1813–1900) Belgium; **Achille Deyrolle** (1813–1865) France; **Carl August Dohrn** (1806–1892) Germany; **John William Douglas** (1814–1905) England; **Jean Antoine Dours** (1824–1874) France; **Henri Milne-Edwards** (1800–1885) France; **Alexei Pavlovich Fedchenko** (1844–1873) Italy and Russia; **Johann Angelo Ferrari** (1806–1876) Italy; **Arnold Förster** (1810–1884) Germany; **Heinrich Frey** (1822–1890) Switzerland; **Vittore Ghiliani** (1812–1878) Italy; F. Giraud for **Joseph-Étienne Giraud** (1788–1859) France; **Hermann August Hagen** (1817–1893) Germany; **August Emil Holmgren** (1829–1888) Sweden; **Johann Friedrich Jaennicke** (1831–1907) Germany; **Giorgio Jan** (1791–1866) Italy; **Charles Georges Javet** (1802–1882) France; **Johann Heinrich Kaltenbach** (1807–1876) Germany; **Friedrich Kipp** (1814–1869) England; **Leopold Anton Kirchner** (?–1879) Germany; **Ernst Gustav Kraatz** (1831–1909) Germany; **Hermann Loew** (1807–1879) Germany; **Edmond de Sélys Longchamps** (1813–1900) Belgium; **Hippolyte Lucas** (1814–1899) France; **Thomas Ansell Marshall** (1827–1903)

England; **Gustav Mayr** (1830–1908) Austria; **Robert McLachlan** (1837–1904) England; **Francois Jean-Paul Gervais** (1816–1879) France; **Étienne Mulsant** (1797–1880) France; **Andrew Murray** (1812–1878) Scotland; **Edward Newman** (1801–1876) England; **Karl Robert Osten-Sacken** (1828–1906) U.S.A.; **Giovanni Passerini** (1816 or 1819–1893) Italy; **Fernandino Maria Piccioli** (1821–1900) Italy; **Odorado Pirazzoli** (1815–1884) Italy; **Oktavij Ivanovitsch Bourmeister Radoszkowski** (1820-1895) Poland and Russia; **Hermann Reinhard** (1860–1869) Germany; **Camillo Rondani** (1807–1879) Italy; **G. T. Rudd** (?–?) London; Otho Ruthe enclosures for **Johann Friedrich Ruthe** (1788–1859) Germany; **William Wilson Saunders** (1809–1879) England; **Hermann Rudolph Schaum** (1819–1865) Germany; **Ignaz Rudolph Schiner** (1813–1873) Austria; **Frédéric Jules Sichel** (1802–1868) France; **Frederick Smith** (1805–1879) England; **Maximilian Spinola** (1780–1857) Italy; **Henry Tibbats Stainton** (1822–1892) England; **Rasmus Carl Staeger** (1800–1875) Denmark; **Pietro Stefanelli** (1834–1919) Italy; **Adolfo Targioni Tozzetti** (1823–1902) Italy; **Samuel Constantinus Snellen van Vollenhoven** (1816–1880) The Netherlands; **Georg Ritter von Frauenfeld** (1807–1873) Austria and Germany; **Ernest August Hellmuth von Kiesenwetter** (1820–1880) Germany; **Peter Fredrik Wahlberg** (1800–1877) Sweden; **Francis Walker** (1809–1874) England; **John Obadiah Westwood** (1804–1893) England; **Thomas Vernon Wollaston** (1822–1878) England; **Philipp Christoph Zeller** (1808–1883) Germany.

Valid Haliday genera occurring in Ireland

DIPTERA

***Anarete* Haliday, 1833** (Cecidomyiidae); ***Antichaeta* Haliday, 1838** (Sciomyzidae); ***Aphrosylus* Haliday *in* Walker, 1851** (Dolichopodidae); ***Atissa* Haliday, 1839** (Ephydridae); ***Axysta* Haliday, 1839** (Ephydridae); ***Camilla* Haliday, 1838** (Camillidae); ***Campsicnemus* Haliday *in* Walker, 1851** (Dolichopodidae); ***Canace* Haliday, 1839** (Canacidae); ***Catocha* Haliday, 1833** (Cecidomyiidae); ***Chersodromia* Haliday *in* Walker, 1851** (Hybotidae); ***Clunio* Haliday, 1855** (Chironomidae); ***Clusia* Haliday, 1838** (Clusiidae); ***Epidapus* Haliday *in* Walker, 1851** (Sciaridae); ***Geranomyia* Haliday, 1833** (Limoniidae); ***Glenanthe* Haliday, 1839** (Ephydridae);

***Hecamede* Haliday, 1839** (Ephydridae); ***Heleodromia* Haliday, 1833** (Brachystomatidae); ***Hyadina* Haliday, 1839** (Ephydridae); ***Ilythea* Haliday, 1839** (Ephydridae); ***Machaerium* Haliday, 1832** (Dolichopodidae); ***Malacomyia* Haliday *in* Westwood, 1840** (Coelopidae); ***Oecothea* Haliday *in* Curtis, 1837** (Heleomyzidae); ***Pelina* Haliday, 1839** (Ephydridae); ***Peplomyza* Haliday *in* Curtis, 1837** (Lauxaniidae); ***Pericoma* Haliday *in* Walker, 1856** (Psychodidae); ***Schoenomyza* Haliday, 1833** (Muscidae); ***Sycorax* Haliday *in* Curtis, 1839** (Psychodidae); ***Tachytrechus* Haliday *in* Walker, 1851** (Dolichopodidae); ***Tethina* Haliday, 1838** (Canacidae); ***Trichomyia* Haliday *in* Curtis, 1839** (Psychodidae); ***Ula* Haliday, 1833** (Pediciidae).

HEMIPTERA

***Atheroides* Haliday, 1838** (Aphididae).

HYMENOPTERA

***Acrodactyla* Haliday, 1839** (Ichneumonidae); ***Adelius* Haliday, 1833** (Braconidae); ***Ademon* Haliday, 1833** (Braconidae); ***Aegilips* Haliday, 1835** (Figitidae); ***Alloea* Haliday, 1833** (Braconidae); ***Anagrus* Haliday, 1833** (Mymaridae); ***Anaphes* Haliday, 1833** (Mymaridae); ***Baeus* Haliday, 1833** (Scelionidae); ***Brachythops* Haliday, 1839** (Tenthredinidae); ***Centistes* Haliday, 1835** (Braconidae); ***Chaenusa* Haliday, 1839** (Braconidae); ***Charmon* Haliday, 1833** (Braconidae); ***Chasmodon* Haliday, 1838** (Braconidae); ***Chorebus* Haliday, 1833** (Braconidae); ***Chremylus* Haliday, 1833** (Braconidae); ***Clinocentrus* Haliday, 1833** (Braconidae); ***Colastes* Haliday, 1833** (Braconidae); ***Cteniscus* Haliday, 1832** (Ichneumonidae); ***Dacnusa* Haliday, 1833** (Braconidae); ***Diospilus* Haliday, 1833** (Braconidae); ***Ephedrus* Haliday, 1833** (Braconidae); ***Epiclerus* Haliday, 1844** (Tetracampidae); ***Ericydnus* Haliday, 1832** (Encyrtidae); ***Euderus* Haliday, 1844** (Eulophidae); ***Eustochus* Haliday, 1833** (Mymaridae); ***Gnamptodon* Haliday, 1833** (Braconidae); ***Gyron* Haliday, 1833** (Scelionidae); ***Helictes* Haliday, 1837** (Ichneumonidae); ***Heptamelus* Haliday, 1855** (Tenthredinidae); ***Inostemma* Haliday, 1833** (Platygastridae);

***Iphitrachelus* Haliday, 1835** (Platygastridae); ***Ismarus* Haliday, 1835** (Diapriidae); ***Melanips* Haliday, 1835** (Figitidae); ***Meteorus* Haliday, 1835** (Braconidae); ***Mirax* Haliday, 1833** (Braconidae); ***Omphale* Haliday, 1833** (Eulophidae); ***Ooctonus* Haliday, 1833** (Mymaridae); ***Opazon* Haliday, 1857** (Diapriidae); ***Orgilus* Haliday, 1833** (Braconidae); ***Periope* Haliday, 1839** (Ichneumonidae); ***Polynema* Haliday, 1833** (Mymaridae); ***Praon* Haliday, 1833** (Braconidae); ***Pygostolus* Haliday, 1833** (Braconidae); ***Telenomus* Haliday, 1833** (Scelionidae); ***Tetrastichus* Haliday, 1844** (Eulophidae); ***Thoron* Haliday, 1833** (Scelionidae); ***Toxares* Haliday, 1840** (Braconidae); ***Trachionus* Haliday, 1833** (Braconidae); ***Triaspis* Haliday, 1838** (Braconidae); ***Trioxys* Haliday, 1833** (Braconidae).

THYSANOPTERA

***Aptinothrips* Haliday, 1836** (Thripidae); ***Belothrips* Haliday, 1836** (Thripidae); ***Chirothrips* Haliday, 1836** (Thripidae); ***Heliothrips* Haliday, 1836** (Thripidae); ***Limothrips* Haliday, 1836** (Thripidae); ***Phlaeothrips* Haliday, 1836** (Phlaeothripidae); ***Sericothrips* Haliday, 1836** (Thripidae).

Valid Haliday species occurring in Ireland

COLEOPTERA

Actidium coarctatum (Haliday, 1855).

DIPTERA

Achalcus cinereus (Haliday *in* Walker, 1851); *Allopiophila luteata* (Haliday, 1833); *Anarete candidata* Haliday, 1833; *Anopheles plumbeus* Haliday *in* Stephens, 1828; *Aphrosylus celtiber* Haliday, 1855; *Aphrosylus ferox* Haliday *in* Walker, 1851; *Aphrosylus raptor* Haliday *in* Walker, 1851; *Apiloscatopse bifilata* (Haliday *in* Walker, 1856); *Atissa pygmaea* (Haliday, 1833); *Aulagromyza populicola* (Haliday *in* Walker, 1853); *Axysta cesta* (Haliday, 1833); *Azelia cilipes* (Haliday, 1838); *Beris geniculata* Haliday *in* Curtis, 1830; *Bezzia calceata* (Haliday *in* Walker, 1856); *Bezzia taeniata* (Haliday *in* Walker, 1856); *Bibio nigriventris*

Haliday, 1833; *Boletina nasuta* (Haliday, 1839); *Campiglossa plantaginis* (Haliday, 1833); *Campsicnemus alpinus* (Haliday, 1833); *Campsicnemus loripes* (Haliday, 1832); *Canace nasica* (Haliday, 1839); *Catocha latipes* Haliday, 1833; *Ceratinostoma ostiorum* (Haliday *in* Curtis, 1832); *Chaetopodella scutellaris* (Haliday, 1836); *Chalarus exiguus* (Haliday, 1833); *Chamaemyia flavipalpis* (Haliday, 1838); *Chersodromia arenaria* (Haliday, 1833); *Chersodromia incana* Haliday *in* Walker, 1851; *Chersodromia speculifera* Haliday *in* Walker, 1851; *Clanoneurum cimiciforme* (Haliday, 1855); *Clinocera fontinalis* (Haliday, 1833); *Clinocera stagnalis* (Haliday, 1833); *Clunio marinus* Haliday, 1855; *Coelopa pilipes* Haliday, 1838; *Colobostema infumatum* (Haliday, 1833); *Conicera similis* (Haliday, 1833); *Conisternum decipiens* (Haliday *in* Curtis, 1832); *Coproica lugubris* (Haliday, 1836); *Coproica vagans* (Haliday, 1833); *Diamesa tonsa* (Haliday *in* Walker, 1856); *Dicraeus raptus* (Haliday, 1838); *Dicranota pavida* (Haliday, 1833); *Docosia gilvipes* (Haliday *in* Walker, 1856); *Dolichocephala guttata* (Haliday, 1833); *Dolichopus clavipes* Haliday, 1832; *Dolichopus diadema* Haliday, 1832; *Dolichopus festivus* Haliday, 1832; *Dolichopus phaeopus* Haliday *in* Walker, 1851; *Dolichopus rupestris* Haliday, 1833; *Dolichopus sabinus* Haliday, 1838; *Dolichopus signifer* Haliday, 1838; *Dolichopus trivialis* Haliday, 1832; *Drosophila cameraria* Haliday, 1833; *Elachisoma aterrimum* (Haliday, 1833); *Euthyneura myricae* Haliday *in* Walker, 1851; *Eutropha fulvifrons* (Haliday, 1833); *Fannia mollissima* (Haliday *in* Westwood, 1840); *Fannia monilis* (Haliday, 1838); *Fucellia maritima* (Haliday, 1838); *Geranomyia unicolor* Haliday, 1833; *Glenanthe ripicola* (Haliday, 1839); *Gonioneura spinipennis* (Haliday, 1836); *Heleodromia immaculata* Haliday, 1833; *Hyadina scutellata* (Haliday, 1839); *Hydrellia cardamines* Haliday, 1839; *Hydrellia cochleariae* Haliday, 1839; *Hydrellia porphyrops* Haliday, 1839; *Hydrellia ranunculi* Haliday, 1839; *Hydrellia tarsata* Haliday, 1839; *Hydrellia thoracica* Haliday, 1839; *Ilythea spilota* (Haliday *in* Curtis, 1832); *Kowarzia bipunctata* (Haliday, 1833); *Lamproscatella sibilans* (Haliday, 1833); *Machaerium maritimae* Haliday, 1832; *Malacomyia sciomyzina* (Haliday, 1833); *Melanum laterale* (Haliday, 1833); *Metopina galeata* (Haliday, 1833); *Metopomyza flavonotata* (Haliday, 1833); *Minilimosina fungicola* (Haliday, 1836); *Muscidideicus praetextatus* (Haliday, 1855); *Neoempheria pictipennis* (Haliday,

1833); *Neoleucopis obscura* Haliday, 1833; *Notiphila uliginosa* Haliday, 1839; *Ochlerotatus detritus* (Haliday, 1833); *Opomyza punctata* Haliday, 1833; *Palpomyia distincta* (Haliday, 1833); *Paradelphomyia senilis* (Haliday, 1833); *Paramormia ustulata* (Haliday *in* Walker, 1856); *Parydra fossarum* (Haliday, 1833); *Parydra hecate* (Haliday, 1833); *Pelomyiella cinerella* (Haliday, 1837); *Peripsychoda auriculata* (Haliday *in* Curtis, 1839); *Philygria interrupta* (Haliday, 1833); *Pseudocollinella humida* (Haliday, 1836); *Psilopa pulicaria* (Haliday, 1839); *Pullimosina heteroneura* (Haliday, 1836); *Rachispoda fuscipennis* (Haliday, 1833); *Scatella lutosa* (Haliday, 1833); *Scathophaga calida* Haliday *in* Curtis, 1832; *Scatophila despecta* (Haliday, 1839); *Schoenophilus versutus* (Haliday *in* Walker, 1851); *Sepsis duplicata* Haliday, 1838; *Setacera micans* (Haliday, 1833); *Sphaerocera monilis* Haliday, 1836; *Stilobezzia gracilis* (Haliday, 1833); *Stilpon lunatus* (Haliday *in* Walker, 1851); *Stiphrosoma cingulatum* (Haliday, 1855); *Stiphrosoma sabulosum* (Haliday, 1837); *Sycorax silacea* Haliday *in* Curtis, 1839; *Sympycnus cirripes* (Haliday *in* Walker, 1851); *Syntormon monile* (Haliday *in* Walker, 1851); *Tachydromia umbrarum* Haliday, 1833; *Tachytrechus consobrinus* (Haliday *in* Walker, 1851); *Tethina illota* Haliday, 1838; *Themira minor* (Haliday, 1833); *Themira superba* (Haliday, 1833); *Thinophilus ruficornis* (Haliday, 1838); *Thoracochaeta zosterae* (Haliday, 1833); *Trachyopella leucoptera* (Haliday, 1836); *Trachyopella melania* (Haliday, 1836); *Threticus lucifugus* (Haliday *in* Walker, 1856); *Trichina elongata* Haliday, 1833; *Trichomyia urbica* Haliday *in* Curtis, 1839; *Ula mollissima* Haliday, 1833; *Xanthochlorus ornatus* (Haliday, 1832).

HEMIPTERA

Atheroides hirtellus Haliday, 1838; *Atheroides serrulatus* Haliday, 1838; *Kaltenbachiella pallida* (Haliday, 1838); *Siphoninus phillyreae* (Haliday, 1835).

HYMENOPTERA

Acanopsilus heterocerus (Haliday, 1857); *Acrodactyla degener* (Haliday, 1839); *Adelius germanus* Haliday, 1834; *Adelius subfasciatus* Haliday, 1833; *Adelurola florimela* (Haliday, 1838); *Aleiodes nobilis* (Haliday, 1834); *Alloea contracta* Haliday, 1838; *Allurus lituratus*

(Haliday, 1835); *Allurus muricatus* (Haliday, 1833); *Alysia atra* Haliday, 1838; *Alysia fuscipennis* Haliday, 1838; *Alysia lucicola* Haliday, 1838; *Alysia sophia* Haliday, 1838; *Amblyaspis roboris* (Haliday, 1835); *Amblyaspis scelionoides* (Haliday, 1835); *Amyras clandestina* (Haliday, 1839); *Anaphes fuscipennis* Haliday, 1833; *Anteon fulviventre* (Haliday, 1828); *Anteon infectum* (Haliday, 1837); *Apanteles contaminatus* (Haliday, 1834); *Apanteles infimus* (Haliday, 1834); *Apanteles sodalis* (Haliday, 1834); *Apanteles xanthostigma* (Haliday, 1834); *Aphidius avenae* Haliday, 1834; *Aphidius ervi* Haliday, 1834; *Aphidius matricariae* Haliday, 1834; *Aphidius rosae* Haliday, 1834; *Apodesmia aemula* (Haliday, 1836); *Aristelix phoenicura* (Haliday, 1839); *Aspilota fuscicornis* (Haliday, 1838); *Atormus victus* (Haliday, 1836); *Atractodes albovinctus* Haliday, 1839; *Atractodes arator* Haliday, 1839; *Atractodes citator* Haliday, 1839; *Atractodes croceicornis* Haliday, 1839; *Atractodes cultellator* Haliday, 1839; *Atractodes exilis* Haliday, 1839; *Atractodes fumatus* Haliday, 1839; *Atractodes piceicornis* Haliday, 1839; *Baeus seminulum* Haliday, 1833; *Biosteres haemorrhoeus* (Haliday, 1837); *Biosteres placidus* Haliday, 1837; *Biosteres rusticus* (Haliday, 1837); *Biosteres sylvaticus* (Haliday, 1837); *Biosteres wesmaelii* (Haliday, 1837); *Blacus ambulans* Haliday, 1835; *Blacus hastatus* Haliday, 1835; *Blacus paganus* Haliday, 1835; *Blacus pallipes* Haliday, 1835; *Blacus tripudians* Haliday, 1835; *Bracon delibator* Haliday, 1833; *Centistes cuspidatus* (Haliday, 1833); *Centistes edentatus* (Haliday, 1835); *Chaenusa lymphata* (Haliday, 1839); *Chaenusa naiadum* (Haliday, 1839); *Chaenusa nereidum* (Haliday, 1839); *Charmon cruentatus* Haliday, 1833; *Chilotrichia blanda* (Haliday, 1837); *Chorebus albipes* (Haliday, 1839); *Chorebus cinctus* (Haliday, 1839); *Chorebus foveolus* (Haliday, 1839); *Chorebus lateralis* (Haliday, 1839); *Chorebus leptogaster* (Haliday, 1839); *Chorebus posticus* (Haliday, 1839); *Chorebus pulverosus* (Haliday, 1839); *Chorebus talaris* (Haliday, 1839); *Chorebus uliginosus* (Haliday, 1839); *Chorinaeus talpa* (Haliday, 1839); *Chremylus elaphus* Haliday, 1833; *Clinocentrus cunctator* (Haliday, 1836); *Clinocentrus excubitor* (Haliday, 1836); *Clinocentrus umbratilis* Haliday, 1833; *Clinocentrus vestigator* (Haliday, 1836); *Coelinidea podagrica* (Haliday, 1839); *Colastes braconius* Haliday, 1833; *Cotesia praepotens* (Haliday, 1834); *Cotesia ruficrus* (Haliday, 1834); *Cotesia vestalis* (Haliday, 1834); *Cratospila circe* (Haliday,

1838); *Cryptoserphus aculeator* (Haliday, 1839); *Ctenochira haemosterna* (Haliday, 1839); *Dacnusa abdita* (Haliday, 1839); *Dacnusa adducta* (Haliday, 1839); *Dacnusa lugens* (Haliday, 1839); *Dacnusa macrospila* (Haliday, 1839); *Dacnusa stramineipes* (Haliday, 1839); *Dacnusa temula* (Haliday, 1839); *Dapsilarthra sylvia* (Haliday, 1839); *Diachasma fulgidum* (Haliday, 1837); *Diaeretellus ephippium* (Haliday, 1834); *Dicladocerus euryalus* (Haliday, 1844); *Dinotrema concinnum* (Haliday, 1838); *Dinotrema nervosum* (Haliday, 1838); *Dinotrema speculum* (Haliday, 1838); *Diolcogaster flavipes* (Haliday, 1834); *Diospilus oleraceus* Haliday, 1833; *Disogmus areolator* (Haliday, 1839); *Dolichogenidea annularis* (Haliday, 1834); *Dolichogenidea candidata* (Haliday, 1834); *Dolichogenidea decora* (Haliday, 1834); *Dolichogenidea dilecta* (Haliday, 1834); *Dolichogenidea exilis* (Haliday, 1834); *Dolichogenidea hilaris* (Haliday, 1834); *Dolopsidea indagator* (Haliday, 1836); *Entomacis perplexa* (Haliday, 1857); *Entomacis platyptera* (Haliday, 1857); *Ephedrus lacertosus* (Haliday, 1833); *Eridolius aurifluus* (Haliday, 1839); *Eridolius curtisii* (Haliday, 1839); *Eubazus flavipes* (Haliday, 1835); *Eubazus tibialis* (Haliday, 1835); *Euceros serricornis* (Haliday, 1839); *Eurytenes caelatus* (Haliday, 1837); *Exallonyx brevicornis* (Haliday, 1839); *Exochus lictor* Haliday, 1839; *Exotela gilvipes* (Haliday, 1839); *Foersteria puber* (Haliday, 1835); *Glyptapanteles callidus* (Haliday, 1834); *Glyptapanteles fulvipes* (Haliday, 1834); *Glyptapanteles lateralis* (Haliday, 1834); *Gonatocerus litoralis* (Haliday, 1833); *Gonatopus bicolor* (Haliday, 1828); *Gyron misellum* Haliday, 1833; *Helictes varius* (Haliday, 1839); *Heterocola linguaria* (Haliday, 1839); *Heterogamus dispar* (Haliday, 1833); *Hygroplitis russata* (Haliday, 1834); *Idiasta maritima* (Haliday, 1838); *Idiotypa maritima* (Haliday, 1833); *Iphitrachelus lar* Haliday, 1835; *Ismarus dorsiger* (Haliday, 1831); *Labolips innupta* Haliday, 1857; *Laotris striatula* (Haliday, 1839); *Leiophron apicalis* Haliday, 1833; *Lysephedrus validus* (Haliday, 1833); *Macroglenes chalybeus* (Haliday, 1833); *Macroglenes eximius* (Haliday, 1833); *Macroglenes gramineus* (Haliday, 1833); *Macroglenes microcerus* Haliday, 1844; *Macroglenes varicornis* (Haliday, 1833); *Megaetaira madida* (Haliday, 1839); *Mesochorus arenarius* (Haliday, 1839); *Mesoleptus incessor* (Haliday, 1839); *Metaclisis areolatus* (Haliday, 1835); *Meteorus colon* (Haliday, 1835); *Meteorus filator* (Haliday, 1835); *Meteorus jaculator*

(Haliday, 1835); *Meteorus micropterus* (Haliday, 1835); *Meteorus vexator* (Haliday, 1835); *Microgaster meridiana* (Haliday, 1834); *Microgaster messoria* Haliday, 1834; *Microplitis mediator* (Haliday, 1834); *Microplitis spectabilis* (Haliday, 1834); *Mirax rufilabris* Haliday, 1833; *Misaphidus brevicornis* (Haliday, 1833); *Misaphidus centaureae* (Haliday, 1833); *Misaphidus letifer* (Haliday, 1833); *Monelata cincta* (Haliday, 1857); *Omphale salicis* (Haliday, 1833); *Ontsira imperator* (Haliday, 1836); *Ooctonus hemipterus* Haliday, 1833; *Ooctonus insignis* Haliday, 1833; *Ooctonus vulgatus* Haliday, 1833; *Opazon parvulum* (Haliday, 1857); *Opius lugens* Haliday, 1837; *Opius pendulus* Haliday, 1837; *Orthostigma maculipes* (Haliday, 1838); *Oxylabis armata* (Haliday, 1831); *Panerema fulvicornis* (Haliday, 1838); *Paracodrus apterogynus* (Haliday, 1839); *Parthenocodrus elongatus* (Haliday, 1839); *Pentapleura angustula* (Haliday, 1838); *Pentapleura fuliginosa* (Haliday, 1838); *Perilitus brevicollis* Haliday, 1835; *Perilitus cerealium* Haliday, 1835; *Periope auscultator* Haliday, 1839; *Phaedrotoma aethiops* (Haliday, 1837); *Phaedrotoma caesa* (Haliday, 1837); *Phaedrotoma pacta* (Haliday, 1837); *Phaedrotoma tacita* (Haliday, 1836); *Phaneroserphus calcar* (Haliday, 1839); *Phaenoserphus fuscipes* (Haliday, 1839); *Phaenocarpa conspurcator* (Haliday, 1838); *Phaenocarpa eugenia* (Haliday, 1838); *Phaenocarpa eunice* (Haliday, 1838); *Phaenocarpa flavipes* (Haliday, 1838); *Phaenocarpa galatea* (Haliday, 1838); *Phaenocarpa livida* (Haliday, 1838); *Phaenocarpa maria* (Haliday, 1838); *Phaenocarpa nina* (Haliday, 1838); *Phaenocarpa picinervis* (Haliday, 1838); *Phaenocarpa pullata* (Haliday, 1838); *Phaenoserphus viator* (Haliday, 1839); *Platygaster elongata* Haliday, 1830; *Platygaster laricis* Haliday, 1835; *Polynema atratum* Haliday, 1833; *Praon abjectum* (Haliday, 1833); *Praon dorsale* (Haliday, 1833); *Praon volucre* (Haliday, 1833); *Proclitus comes* (Haliday, 1839); *Proclitus paganus* (Haliday, 1839); *Proclitus praetor* (Haliday, 1839); *Proclitus socius* (Haliday, 1839); *Protapanteles immunis* (Haliday, 1834); *Protapanteles popularis* (Haliday, 1834); *Rasivalva calceata* (Haliday, 1834); *Rhysipolis meditator* (Haliday, 1836); *Rhyssalus clavator* Haliday, 1833; *Shawiana catenator* (Haliday, 1836); *Stenomacrus laricis* (Haliday, 1839); *Syncrasis fucicola* (Haliday, 1838); *Synelix semirugosa* (Haliday, 1839); *Syntretus idalius* (Haliday, 1833); *Tanycarpa rufinotata* (Haliday, 1838); *Telenomus brachialis* Haliday, 1833; *Telenomus*

heteropterus Haliday, 1833; *Telenomus othus* Haliday, 1833; *Thoron metallicus* Haliday, 1833; *Toxares deltiger* (Haliday, 1833); *Trachionus ringens* (Haliday, 1839); *Trachyusa aurora* (Haliday, 1838); *Tretoserphus laricis* (Haliday, 1839); *Trioxys auctus* (Haliday, 1833); *Xenarcha lustrator* (Haliday, 1836); *Zele caligatus* (Haliday, 1835).

THYSANOPTERA

Aptinothrips rufus Haliday, 1836; *Baliothrips dispar* (Haliday, 1836); *Belothrips acuminatus* Haliday, 1836; *Ceratothrips ericae* (Haliday, 1836); *Chirothrips manicatus* Haliday, 1836; *Haplothrips statices statices* (Haliday, 1836); *Hoplothrips pedicularius* (Haliday, 1836); *Limothrips cerealium* Haliday, 1836; *Limothrips denticornis* Haliday, 1836; *Odontothrips loti* (Haliday, 1852); *Odontothrips phaleratus* (Haliday, 1836); *Odontothrips ulicis* (Haliday, 1836); *Oxythrips ulmifoliorum* (Haliday, 1836); *Sericothrips staphylinus* Haliday, 1836; *Thrips atratus* Haliday, 1836; *Thrips corymbiferarum* Haliday, 1836; *Thrips discolor* Haliday, 1836; *Thrips fuscipennis* Haliday, 1836; *Thrips vulgatissimus* Haliday, 1836.

Orders and families erected by Haliday

Aphidiidae Haliday, 1833 (Hymenoptera); **Bethylidae** Haliday, 1839 (Hymenoptera); **Ceraphronidae** Haliday, 1833 (Hymenoptera); **Diapriidae** Haliday, 1833 (Hymenoptera); **Dryinidae** Haliday, 1833 (Hymenoptera); **Mymaridae** Haliday, 1833 (Hymenoptera); **Pelecinidae** Haliday, 1840 (Hymenoptera); **Thysanoptera** Haliday, 1836; **Scelionidae** Haliday, 1839 (Hymenoptera).

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1833 Essay on the classification of parasitic Hymenoptera, &c. *Entomological Magazine* **1**: 480-491.

1833 Generic names should be of Greek derivation. *Entomological Magazine* **1**: 515-516.

1833 Burrowing Hymenoptera. *Entomological Magazine* **1**: 516.

1833 Public Entomological Collection. *Entomological Magazine* **1**: 518-519.

1833-1842 with Walker, F. *Monographia Chalciditum*. London [Much of this work was collaborative with Haliday who was the sole author of the sectional diagnoses. In the M. W. R de V. Graham collection of Francis Walker papers, there is an annotated (by Walker) copy of this work. Formerly this was the property of Haliday and he had gummed into it proof copies of his figures of Chalcidoidea (*Entomologist* Volume 1), plates A-P. Reproduced and dated in O'Connor, Nash and Boucek (2000)) [The work was earlier known as Monographia Chalcidum.] **(See also entry for 1840-1842)**.

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1834 Notes on the Bethyli and on *Dryinus pedestris*. *Entomological Magazine* **2**: 219-221.

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1,500 generic and 15,000 specific names. Ireland and Britain are not separated].

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Examples of valid insect species named after Haliday

Antlemon (*Antlemon*) *halidayi* (Loew, 1871) (Diptera: Keroplatidae); *Apanteles halidayi* Marshall, 1872 (Hymenoptera: Braconidae); *Campsicnemus halidayi* Dyte, 1975 (Diptera: Dolichopodidae); *Dendrocerus halidayi* (Curtis, 1829) (Hymenoptera: Megaspilidae); *Euthyneura halidayi* Collin, 1926 (Diptera: Hybotidae); *Gigantothrips halidayi* (Newman, 1856) (Thysanoptera: Phlaeothripidae); *Ismarus halidayi* Foerster, 1850 (Hymenoptera: Diapriidae); *Lelaps halidayi* Ashmead, 1804 (Hymenoptera: Pteromalidae); *Lissonota* (*Lissonota*) *halidayi* Holmgren, 1860 (Hymenoptera: Ichneumonidae); *Oxythrips halidayi* Bagnall, 1924 (Thysanoptera: Thripidae); *Polynema halidayi* Debauche, 1948 (Hymenoptera: Mymaridae); *Psyttalia halidayi* Wharton, 2009 (Hymenoptera: Braconidae); *Sapromyza halidayi* Shatalkin, 2000 (Diptera: Lauxaniidae); *Syncrasis halidayi* (Foerster, 1862) (Hymenoptera: Braconidae); *Tachydromia halidayi* (Collin, 1926) (Diptera: Hybotidae); *Tetrastichus halidayi* (Graham, 1961) (Hymenoptera: Eulophidae); *Triaspis halidayi* Martin, 1956 (Hymenoptera: Braconidae); *Heterocoelia halidaii* (Westwood, 1874) (Hymenoptera: Bethylidae); *Micridium halidaii* (Matthews, 1868) (Coleoptera: Ptiliidae).

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FIGURE 1. Plate 596 from Curtis (1824-1840) showing the Belfast Rose, published 1836.

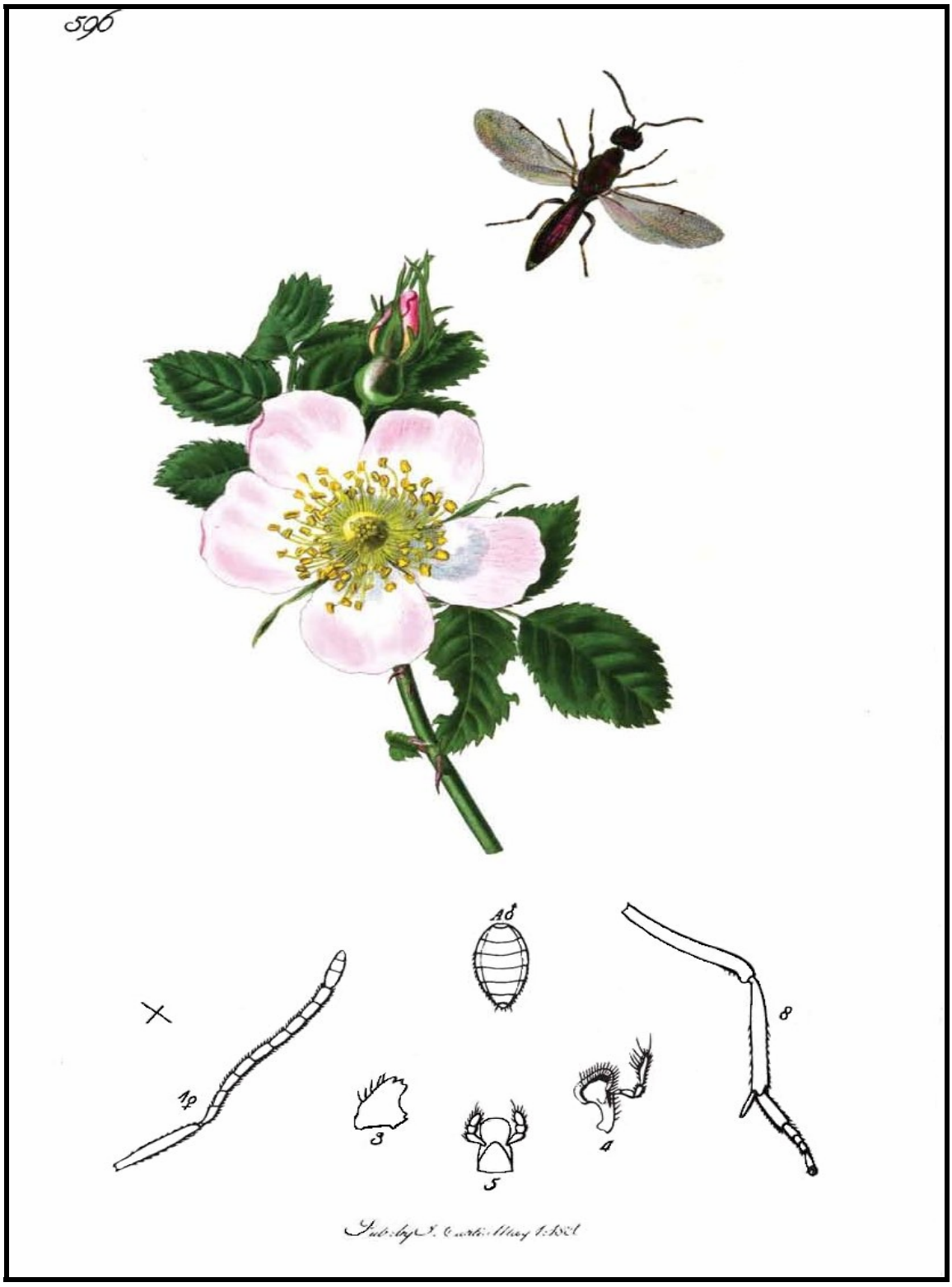


FIGURE 2. Haliday specimens in a store-box in the National Museum of Ireland.

FIGURE 3. Detail from a Haliday store-box showing different shapes of card mounts.

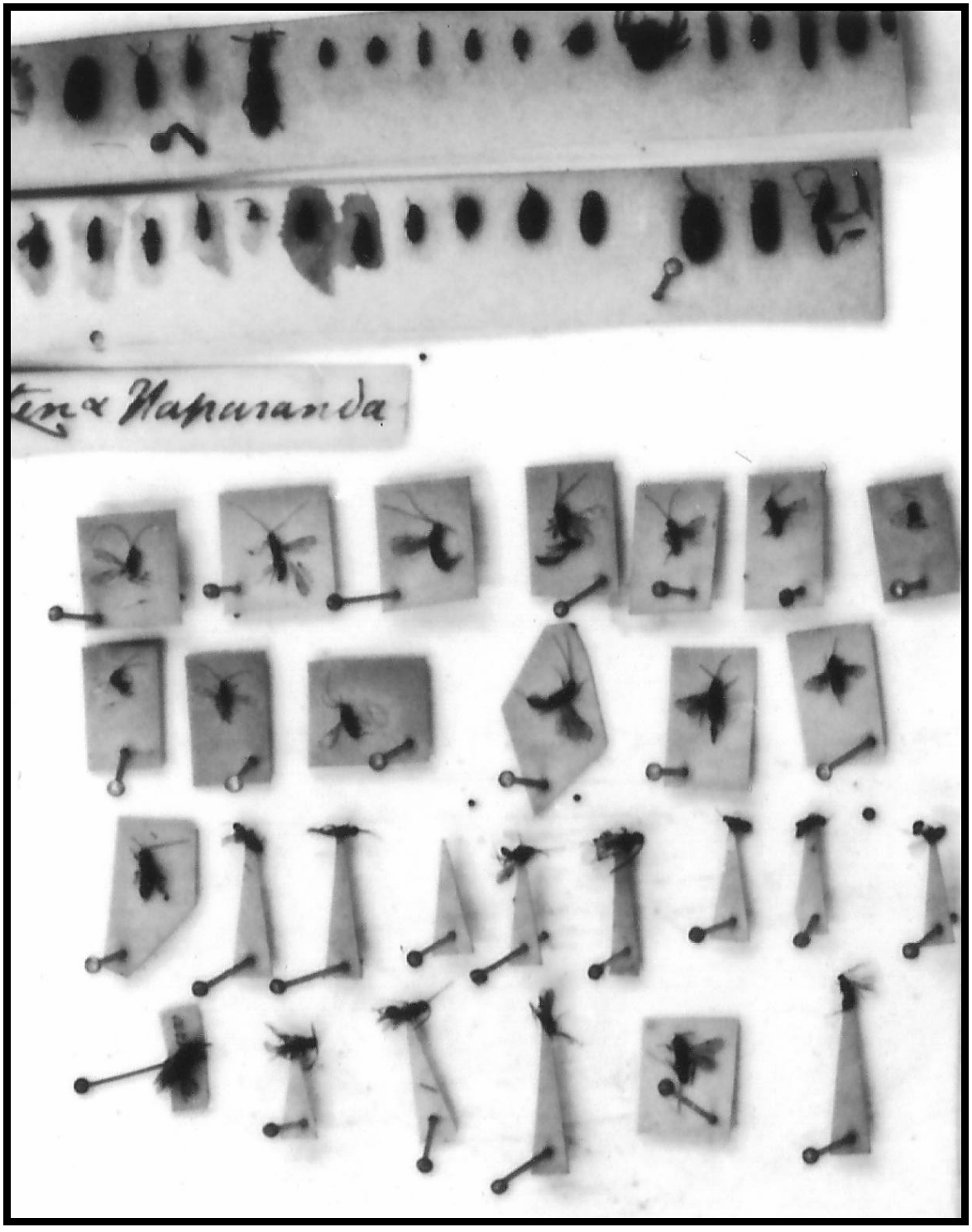


FIGURE 4. Examples of card from which Haliday specimens have been cut.

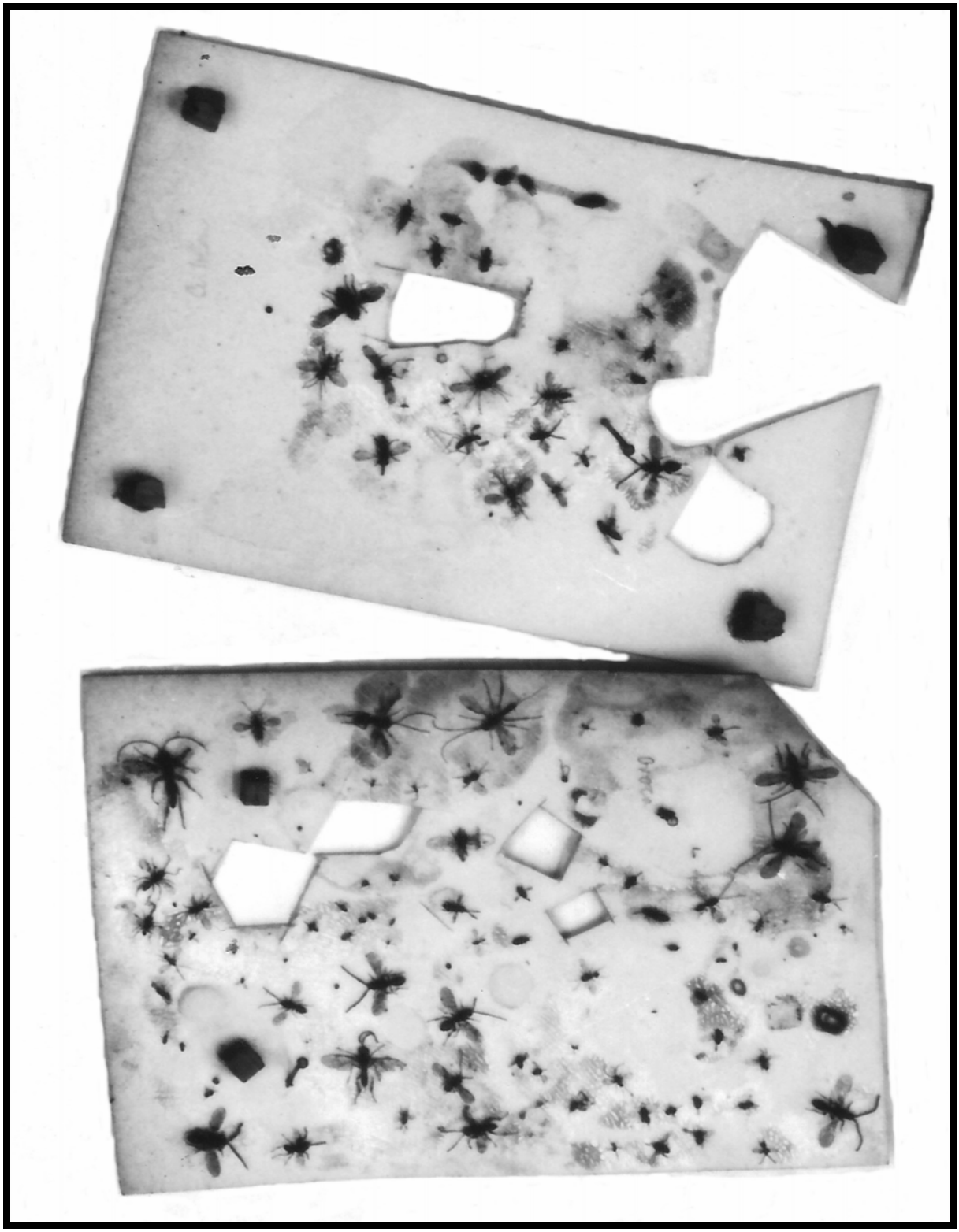


FIGURE 5. Examples of figures by Haliday. These are taken from Plate V *in* Walker, F. (1852) *List of the specimens of homopterous insects in the collection of the British Museum*. Part IV and show the larvae of *Thrips ulmi*. 1 = the young larva; 1a = its antenna; 1b = the end of its abdomen; 2 = the larva; 2a = its head; 2b = its mouth. Certain lines have been enhanced to faciltate reproduction of the figures.

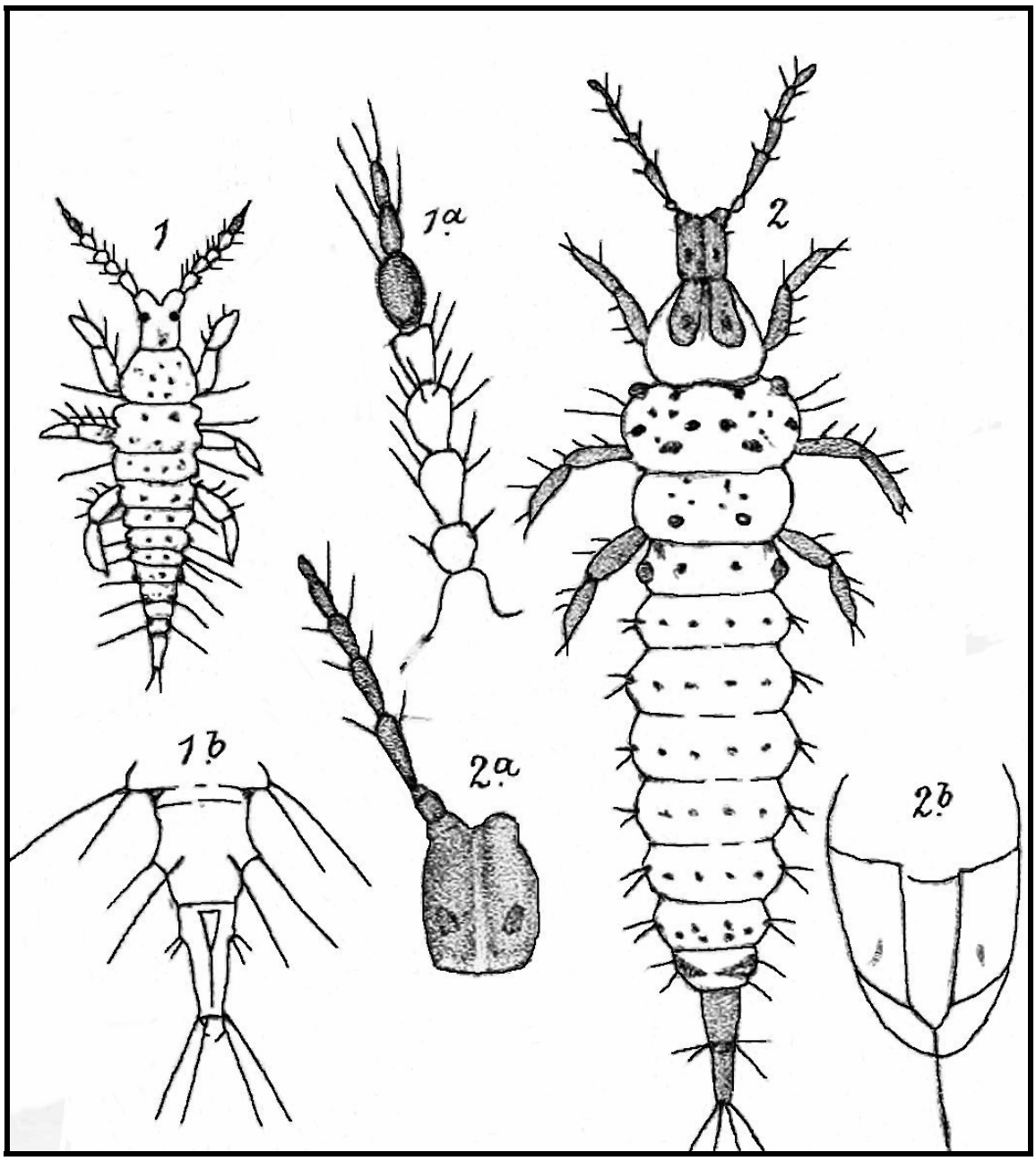


FIGURE 6. Examples of figures by Haliday. Detail from Plate VI *in* Walker, F. (1852) *List of the specimens of homopterous insects in the collection of the British Museum*. Part IV.

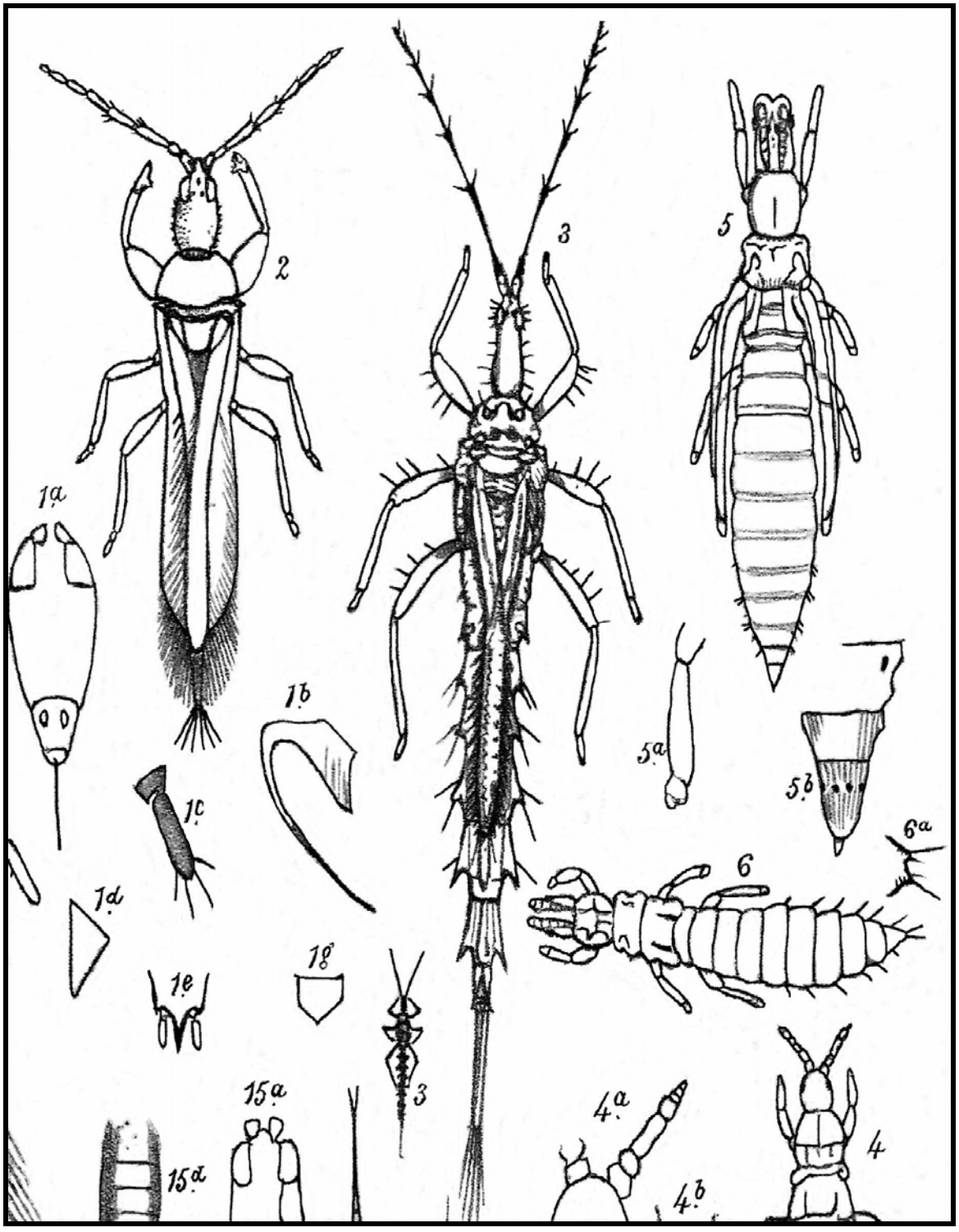
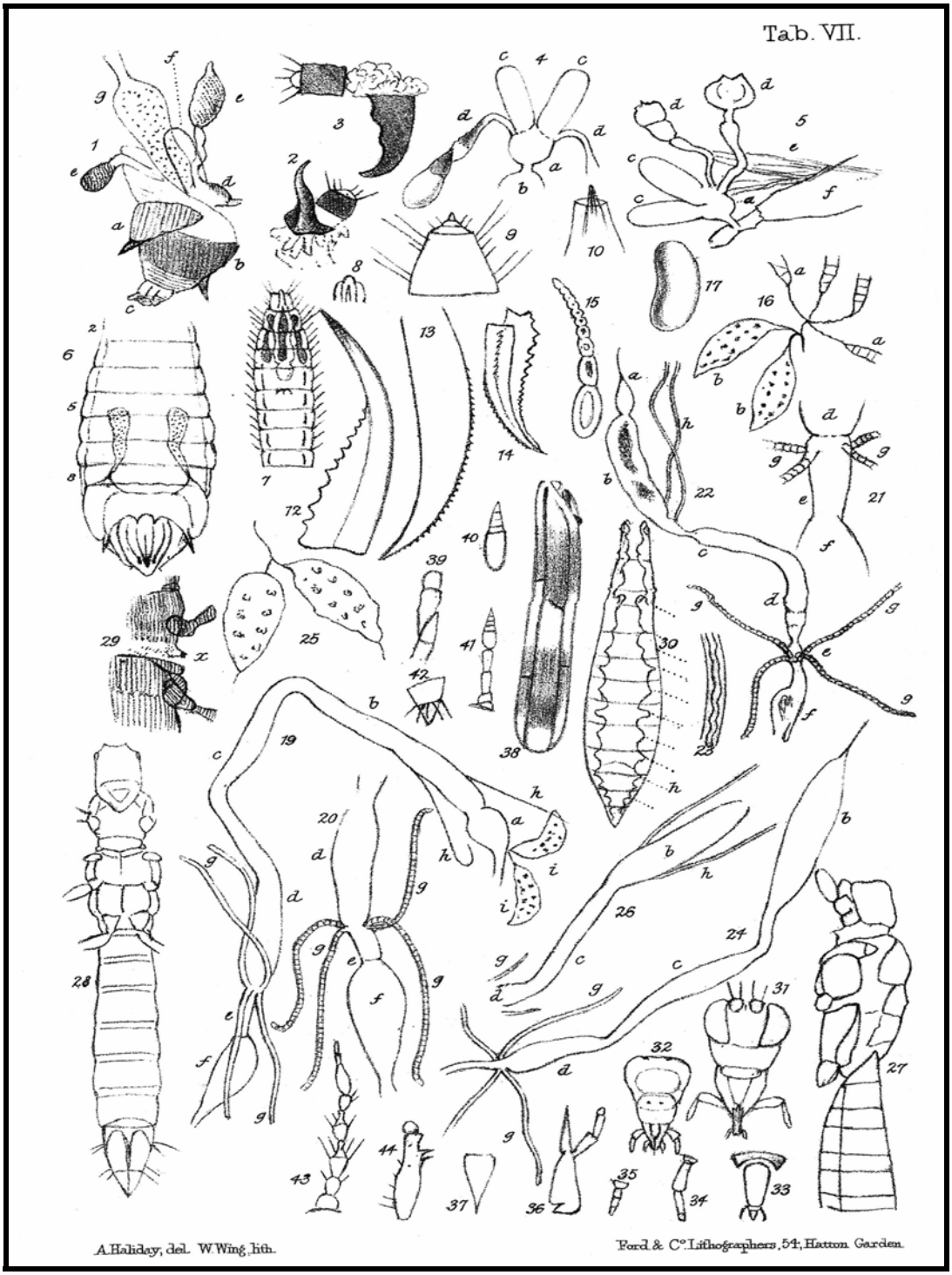


FIGURE 7. Examples of figures by Haliday. Plate VII *in* Walker, F. (1852) *List of the specimens of homopterous insects in the collection of the British Museum*. Part IV showing drawings of dissections.



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DISPERSAL AND COLONISATION BY ROVE-BEETLES (COLEOPTERA: STAPHYLINIDAE) AT A MINE TAILINGS GRASSLAND NEAR NAVAN, CO. MEATH, IRELAND

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Dedicated to the memory of Derek Lott (1953-2011) in recognition of his great contribution to our knowledge of the Irish Staphylinidae

Abstract

A total of 109 species of staphylinid beetle (Coleoptera: Staphylinidae) was recorded in an intensive survey of recently created mine tailings grassland, mostly sheep pasture, in a large tailings impoundment near Navan, Co. Meath between 1991 and 1993. The recorded species were divided into two groups, based on their relative abundance and percentage of singletons per sample: (a) probable dispersing species (mainly aerial plankton) (n=64); and (b) probable established species breeding on-site (n=45). Relatively large numbers of *Oxypoda haemorrhoa* (Mannerheim) were recorded. Small numbers of the flightless *Metopsia clypeata* (Müller) and *Geostiba circellaris* (Gravenhorst) were also recorded, raising questions as to how they dispersed into the tailings grassland.

Introduction

Of all rural land uses, mining can have the most profound local impact, completely obliterating the pre-existing vegetation, soil and topography with excavated overburden spoil and processed rock wastes (tailings), the latter often deposited in constructed impoundments. Yet, unless there are extreme physical or chemical conditions on the surface of the spoil or tailings, an ecosystem can re-establish, especially if maintenance of favourable soil water

conditions, nutrient amendment and establishment of a primary stage vegetation cover is carried out. In the case of the largest zinc mine in Europe, near Navan, Co. Meath, part (*circa* 22ha) of a tailings impoundment was dewatered and sheep pasture established on its surface in 1990 and 1991 (Sassoon, 1999; Johnson, 2009). Between 1991 and 1993, an intensive survey of the staphylinid fauna of the developing soil in the grassland field-blocks was carried out using pitfall traps and a suction sampler. The surrounding landscape was largely agricultural, with the land around the impoundment consisting of rough grassland, stream margins, scrub and landscaped native tree planting (Dallas, 1987). The species results are reported here, and an attempt made to distinguish the breeding fauna of the developing soil from dispersing species (mostly in the aerial plankton).

The results also add several dozen species to the Co. Meath list, which is chiefly based on early twentieth century records by the then resident entomologist G.W. Nicholson (1910, 1911, 1913, 1914, 1917).

Methods

Two areas of sheep pasture, established on dewatered zinc tailings, were sampled between 1991 and 1993 at Randalstown, near Navan, Co. Meath (N8471). The pasture, sown in 1990 and 1991, consisted, with varying dominance, of red fescue *Festuca rubra* L., creeping bent *Agrostis stolonifera* L., common bent *A. capillaris* L., flattened meadow-grass *Poa compressa* L. and white clover *Trifolium repens* L., and received organic amendments and NPK fertilizer (Sassoon, 1999). In addition a number of ungrazed large-scale (1000m^2) field plots with different organic and inorganic amendments (described in Sassoon, 1999) were sampled, as well as one set of suction samples taken in ungrazed grassland on limestone-derived soil adjacent to but outside the impoundment.

Open water still existed adjacent to the pasture in the centre of the tailings up to 1992. The impoundment slopes on dams (constructed of glacial till etc.), both inside and outside, had rough (ungrazed) grass established on them for several years before the pasture was sown. Also, the land surrounding the tailings impoundment had been partially planted with trees and had, in

the absence of grazing, areas of rough grassland and scrub.

Another sheep pasture site was also sampled using a suction sampler near Rathcore, Co. Meath (N8047) on 20 July 1993. This was on limestone soil with perennial rye-grass *Lolium perenne* L. and *Trifolium repens* dominating.

Sampling was carried out using plastic cup pitfall traps with ethylene glycol preservative (n=4 traps per sample), and two types of suction sampler: a D-vac (Dietrick vacuum insect sampler (Dietrick, 1961)) and an S-vac (Stihl® BR400 leaf-blower modified for suction using a D-vac net (see Good and Butler, 1998)). Each set of suction samples consisted of approximately $2m^2$. Sampling was carried out using both techniques in July/August 1991, June and October 1992, and April/May and October 1993.

Species were divided into two groups in an attempt to understand their origin:
(a) those with a greater probability of breeding in the developing pasture ecosystem, represented by species with a maximum number of individuals of >3 in any one sample, and/or with <60% singletons in the samples in which they were recorded (n>3 samples);
(b) those with a greater probability of either originating from aerial plankton or being ground-dispersing individuals, represented by species with a maximum number of individuals of <4 in any one sample, and/or with ≥60% singletons in the samples in which they were recorded (n>3 samples).

Results

In total, 109 species of staphylinid were recorded from the Randalstown tailings sheep pasture, of which 45 species were considered to have a greater probability of breeding in the developing soil (Table 1) and 64 species were considered to have a greater probability of originating from aerial plankton or by overland dispersal (Table 2). The origin of two flightless species (*Geostiba circellaris*(Gravenhorst) and *Metopsia clypeata* (Müller)) is uncertain and discussed further below.

Of the 19 species recorded in rough grassland outside but near the tailings impoundment, three were not recorded from the tailings grassland (Table 3). Of the 26 species recorded from

an agricultural sheep pasture in Co. Meath, four were not recorded from the tailings grassland (Table 4). Details of notable species from the sampled sites are given below.

Geostiba circellaris: Randalstown, Co. Meath (N845719), 17 July - 8 August 1991, **2** (individuals), pitfall trap, ungrazed *Festuca/Trifolium* sward on high organic amendment plot on mine tailings; (N848717), 17 July - 7 August 1991, **1**, pitfall trap, sparse grass tailings pasture.

Three individuals were recorded of this species, in plots and pasture on tailings in 1991, but not again during more intensive sampling in 1992 and 1993. As these specimens were brachyelytrous, they cannot have flown onto the tailings grassland. Being small (2.2-2.9mm), short-legged and soil-dwelling, it is also unlikely that they arrived from the embankment (>30m away in the case of the plot) by walking. They could possibly have been imported into the plot with organic material if this was stored on source habitat outside the tailings. However, the occurrence of this species in the sparse grass pasture is more difficult to explain, unless the specimen was passively blown in from the embankment grass.

Metopsia clypeata: Randalstown, Co. Meath (N845719), 9 October 1992, **4** (individuals), D-vac suction sampler, ungrazed *Festuca/Trifolium* sward on high organic amendment plot on tailings; (N848717), 28 October 1993, **1**, S-vac suction sampler, *Agrostis stolonifera* tailings pasture.

This species is known to have rudimentary wings, at least in Italy (De Marzo, 2010). Unfortunately, voucher specimens from Navan were not retained as it is an easily recognisable species; however, specimens dissected from Clorhane, Co. Offaly, also had rudimentary wings. The species can therefore be concluded to be flightless in Ireland. So, like *Geostiba circellaris*, the question is how four individuals could occur in an isolated rough grass plot (0.5ha), surrounded initially only by bare tailings and other plots. The other individual recorded in the *Agrostis* sheep pasture could possibly have walked out from the embankment, but it is unlikely that a founder beetle could have walked across the bare tailings surface to the plot (assuming the four individuals were belonging to a second generation). Like *G. circellaris*, it is possible that the species was introduced with organic amendments. But this would have been a chance event.

***Oxypoda haemorrhoa* (Mannerheim)**: *inter alia* Randalstown, Co. Meath (N848716), 12 May - 3 June 1992, **45** (individuals), pitfall traps, grazed *Festuca rubra*-dominated sheep pasture; 13

May - 2 June 1993, **44**, same habitat; (N848718), 13 May - 2 June, **24**, same habitat.

The habitat of this species is described as wood-ant nests (*Formica* species), as well as hay, chaff, stable, conifer and wood refuse (Fowler, 1888; Horion, 1967; Palm, 1972). Although the species is known to swarm (Lohse, 1974), the relatively large numbers in the same area in successive years strongly indicate a breeding population rather than individuals dispersing from surrounding habitat. Large numbers of staphylinid species can concentrate while dispersing (e.g. 110 *Philonthus cognatus* Stephens were found in the gut of a single garfish, offshore of agricultural land (Good and Dorman, 1992)); however, these are quite unusual circumstances and unlikely to be repeated in successive years. Furthermore, *O. haemorrhoa* has been also recorded as occurring in numbers in coastal salt-meadows and reclaimed polders in Germany (Heydemann, 1963), a habitat not dissimilar to the tailings *Festuca* sward.

***Stenus nanus* Stephens**: *inter alia* Randalstown, Co. Meath (N848717), 28 October 1993, **352** (individuals), S-vac suction sampler, *Agrostis* tailings pasture; (N842717), 28 October 1993, **115**, same habitat; (N848716), 29 October 1993, **139**, same habitat.

The exceptional abundance of this species at this pasture demonstrates that it is an ideal habitat for this species. The species habitat is known to include agricultural grassland (Lott and Anderson, 2011), but also, aptly, "litter of rough pasture on warmer sandy/calcareous substrates" (Anderson, 1984), and "banks of ... ponds from the plant layer at dry sandy sites" (Horion, 1963).

***Stenus juno* (Paykull)**: this species, which occurred in both the sample outside the tailings impoundment (Table 3) and in sheep pasture at Rathcore (Table 4), was not recorded on the tailings grasslands. It is a species of wetland (Horion, 1963; Anderson, 1984), including open habitats of seasonally dewatered lake shores (Good, 1999). Although it has fully developed wings, it may rarely fly (like, for example, the common earwig (*Forficula auricularia* L.)), and this may account for its absence.

***Stenus formicetorum* Mannerheim**: Rathcore, Co. Meath (N8047), 20 July 1993, 3 sets of **7** individuals each (Table 4), limestone soil with *Lolium perenne/Trifolium repens* pasture.

In Central Europe this species is considered tyrphophile ('peat-loving') (Koch, 1989), where

it occurs in marshes and bogs and on the margins of ditches and ponds in acidic meadows (Horion, 1963). In Finland, Great Britain and Ireland it is associated with fens, lake shores and riparian habitats (Renkonen, 1934; Anderson, 1984; Lott, 2003), although recently Lott and Anderson (2011) also reported the species from wet meadows and grass heaps in farmland. Its occurrence, evenly distributed in significant numbers, in two grassland fields at Rathcore (Table 4) is nevertheless surprising, given that this field was >150m metres from residual bog soils.

Discussion

It appears incredible that 109 species of staphylinid beetle should be recorded in one of the most disturbed ecosystems in Ireland within four years of establishment of an agricultural grassland. However, this may be as much a sample of the species composition of the aerial plankton as it is representative of the developing soil fauna. Although it is somewhat arbitrary to divide species on relative abundance into those likely to be breeding on the site (45 spp.; Table 1), and those likely to be dispersing through the landscape ('tourists') (64 spp.; Table 2), nevertheless the probability of any rare species likely to be breeding is low, given the sampling intensity and the uniformity of habitat.

Of the species likely to breed in the developing grassland (Table 1), only two are surprising as the others are known to colonise grassland relatively quickly. These two are *Oxypoda haemorrhoa* and *Metopsia clypeata*, and their occurrence raises several questions. Although Heydemann (1963) recorded *O. haemorrhoa* in abundance in reclaimed polders, a habitat not dissimilar to revegetated tailings, what microhabitat is it associated with in this type of ecosystem? Mushroom compost or decaying grass? Unlike *O. haemorrhoa*, *M. clypeata* is apparently flightless, so how did it colonise an isolated old grass plot? Was it imported with compost or did it walk across bare tailings?

Further questions arise from the species more likely to be 'tourists' (Table 2). While most are more probably derived from the aerial plankton (i.e. by flight), how did a small flightless soil species like *Geostiba circellaris* arrive on two separate locations in the tailings grassland? Was it passively blown from the grass tussocks on the embankment? Is this species susceptible

to passive wind dispersal like some Collembola (e.g. Hawes *et al*., 2007)?

There is often a particular calm sunny day or set of days in spring, usually in April, when the temperature rises above previous levels and staphylinid life emerges from the soil in open habitats, with beetles in flight everywhere. A similar type of circumstance was noticed on a day in October 1992, with mild calm conditions and much staphylinid flight activity, presumably in search of overwintering habitat. These dispersal events could explain the relatively large numbers of species in some samples, but there is still no evidence that large numbers recorded for some species (e.g. *Oxpoda haemorrhoa*) are purely dispersing and not breeding, and this is very unlikely given their frequent occurrence in more than one year.

Acknowledgements

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TABLE 1. Staphylinidae recorded between 1991 and 1993 from mine tailings grassland at Randalstown (Co. Meath) (N8471) which have a high probability of breeding in the developing pasture ecosystem. These are represented by species with a maximum (max.) number of individuals of >3 in any one set of samples (pitfall traps or suction samples), and/or with <60% singletons in the samples in which they were recorded (n>3 samples) (n = no. sets of samples). Nomenclature follows Lott (2008).

Species	***Total***	***Max.***	***No. singles (n)***	***%***
Aleochara bipustulata (L.)	12	6	1 (4)	25%
Aloconota gregaria (Erichson)	179	37	5 (26)	19%
Amischa analis (Gravenhorst)	423	74	7 (26)	27%
A. decipiens (Sharp)	22	6	6 (12)	50%
A. nigrofusca (Stephens)	17	8	4 (7)	57%
Cypha laeviuscula (Mannerheim)	135	25	5 (17)	29%
Datomicra nigra (Kraatz)	8	4	2 (4)	50%
Dinaraea angustula (Gyllenhal)	13	7	2 (4)	50%
Gyrohypnus angustatus Stephens	8	3	0 (3)	0%
G. fracticornis (Müller, O.F.)	9	6	1 (3)	33%
Megalinus glabratus (Gravenhorst)	15	9	2 (5)	40%
Megarthrus denticollis (Beck)	4	4	0 (1)	0%
Metopsia clypeata (Müller, P.W.J.)	5	4	1 (2)	50%
Mocyta amplicollis (Mulsant & Rey)	975	100	1 (48)	2%
M. fungi (Gravenhorst)	480	115	7 (40)	17%
Ocypus olens (Müller, O.F.)	13	7	2 (5)	40%
Oxypoda exoleta Erichson	45	10	9 (17)	53%
O. haemorrhoa (Mannerheim)	213	45	11 (25)	44%
O. brevicornis (Stephens) [= *umbrata*]	23	6	7 (11)	63%
Philonthus carbonarius (Gravenhorst)	138	31	7 (22)	32%
P. cognatus Stephens	106	40	4 (14)	29%

TABLE 1 (Continued).

Species	***Total***	***Max.***	***No. singles (n)***	***%***
Philonthus cognatus Stephens	106	40	4 (14)	29%
P. laminatus (Creutzer)	45	19	6 (13)	46%
Quedius nitipennis (Stephens)	4	4	0 (1)	0%
Q. schatzmayri Gridelli	63	8	5 (18)	28%
Q. semiaeneus (Stephens)	14	8	3 (5)	60%
Q. levicollis (Brullé) [= *tristis*]	16	5	3 (8)	37%
Sepedophilus nigripennis (Stephens)	15	12	0 (2)	0%
Stenus brunnipes Stephens	151	54	3 (16)	19%
S. canaliculatus Gyllenhal	108	31	6 (10)	60%
S. clavicornis (Scopoli)	56	9	11 (20)	55%
S. fulvicornis Stephens	97	52	2 (8)	25%
S. impressus Germar	9	7	2 (3)	67%
S. nanus Stephens	898	352	6 (29)	21%
S. ossium Stephens	307	150	6 (16)	37%
S. picipes Stephens	106	21	3 (18)	17%
S. similis (Herbst)	10	5	5 (6)	83%
Tachinus laticollis Gravenhorst	28	20	1 (5)	20%
T. rufipes (L.) [= *signatus*]	205	66	6 (17)	35%
Tachyporus chrysomelinus (L.)	63	10	11 (23)	48%
T. dispar (Paykull)	47	11	10 (17)	59%
T. hypnorum (Fabricius)	686	153	5 (41)	12%
T. nitidulus (Fabricius)	101	38	8 (23)	35%
T. pusillus Gravenhorst	245	41	7 (35)	20%
Xantholinus linearis (Olivier)	43	27	1 (4)	25%
X. longiventris Heer	19	5	11 (13)	85%

TABLE 2. Staphylinidae recorded between 1991 and 1993 from mine tailings grassland near Navan (Co. Meath) (N8471) which have a high probability of either originating from aerial plankton or being ground-dispersing individuals. These are represented by species with a maximum number of individuals of <4 in any one set of samples, and/or with ≥60% singletons in the samples in which they were recorded (n>3 samples). Nomenclature follows Lott (2008).

Species	***Total***	***Max.***	***No. singles (n)***	***%***
Acrotona aterrima (Gravenhorst)	14	5	5 (8)	62%
Alaobia trinotata (Kraatz)	3	1	3 (3)	–
Aleochara lanuginosa Gravenhorst	5	1	5 (5)	100%
Anotylus rugosus (Fabricius)	6	4	2 (3)	–
A. tetracarinatus (Block)	12	2	6 (9)	67%
Acrotona pygmaea (Gravenhorst)	1	1	1 (1)	–
Atheta graminicola (Gravenhorst)	2	1	2 (2)	–
A. hypnorum (Kiesenwetter)	1	1	1 (1)	–
A. triangulum (Kraatz)	18	4	7 (11)	64%
Autalia impressa (Olivier)	1	1	1 (1)	–
A. rivularis (Gravenhorst)	2	1	2 (2)	–
Bessobia occulta (Erichson)	3	1	3 (3)	–
Bisnius fimetarius (Gravenhorst)	2	1	2 (2)	–
B. sordidus (Gravenhorst)	3	3	0 (1)	–
Callicerus obscurus Gravenhorst	1	1	1 (1)	–
Chaetida longicornis (Gravenhorst)	1	1	1 (1)	–
Carpelimus pusillus (Gravenhorst)	1	1	1 (1)	–
C. corticinus (Gravenhorst)	5	3	2 (3)	–
Datomicra celata (Erichson)	4	2	2 (3)	–

TABLE 2 (Continued).

Species	***Total***	***Max.***	***No. singles (n)***	***%***
Datomicra zosterae (Thomson)	3	3	0 (1)	–
Dimetrota atramentaria (Gyllenhal)	1	1	1 (1)	–
D. nigripes (Thomson)	1	1	1 (1)	–
Gabrius appendiculatus Sharp	1	1	1 (1)	–
G. breviventer (Sperk)	4	2	2 (3)	–
G. nigritulus (Gravenhorst)	1	1	1 (1)	–
Geostiba circellaris (Gravenhorst)	3	2	1 (2)	–
Gnypeta carbonaria (Mannerheim)	1	1	1 (1)	–
Lordithon thoracicus (Fabricius)	1	1	1 (1)	–
Meotica sp.	1	1	1 (1)	–
Microdota amicula (Stephens)	2	1	2 (2)	–
M. indubia (Sharp)	4	1	4 (4)	100%
Micropeplus porcatus (Paykull)	2	1	2 (2)	–
Mocyta clientula (Erichson)	4	2	2 (3)	–
M. orbata (Erichson)	1	1	1 (1)	–
Mocyta sp.	4	3	1 (2)	–
Ischnosoma splendidum (Gravenhorst)	8	3	3 (5)	60%
Mycetota laticollis (Stephens)	1	1	1 (1)	–
Ocypus aeneocephalus (DeGeer)	5	2	3 (4)	75%
Oligota inflata (Mannerheim)	18	4	11 (13)	85%
Olophrum piceum (Gyllenhal)	1	1	1 (1)	–
Omalium caesum Gravenhorst	5	1	5 (5)	100%
O. excavatum Stephens	1	1	1 (1)	–
O. rivulare (Paykull)	1	1	1 (1)	–

TABLE 2 (Continued).

Species	***Total***	***Max.***	***No. singles (n)***	***%***
Othius angustus Stephens	5	2	3 (4)	75%
Oxypoda brachyptera (Stephens)	3	2	1 (2)	–
Philhygra elongatula (Gravenhorst)	4	2	2 (3)	–
Philonthus concinnus (Gravenhorst)	3	2	1 (2)	–
P. addendus Sharp	3	3	0 (1)	–
P. longicornis Stephens	1	1	1 (1)	–
P. marginatus (Müller, O.F.)	6	2	4 (5)	80%
P. varians (Paykull)	6	3	1 (3)	–
Proteinus brachypterus (Fabricius)	2	1	2 (2)	–
Quedius persimilis Mulsant & Rey	1	1	1 (1)	–
Q. boops-agg	2	1	2 (2)	–
Q. molochinus (Gravenhorst)	4	1	4 (4)	100%
Q. semiobscurus (Marsham)	1	1	1 (1)	–
Rugilus orbiculatus (Paykull)	1	1	1 (1)	–
Staphylinus dimidiaticornis Gemminger	2	1	2 (2)	–
Stenus cicindeloides (Schaller)	11	3	4 (7)	57%
S. incrassatus Erichson	1	1	1 (1)	–
S. tarsalis Ljungh	3	3	0 (1)	–
Sunius propinquus (Brisout)	2	1	2 (2)	–
Tachyporus obtusus (L.)	5	2	4 (5)	80%
Tinotus morion (Gravenhorst)	6	1	6 (6)	100%

TABLE 3. Staphylinidae recorded on 13 May 1992 from old (ungrazed rough) grassland outside the tailings impoundment at Randalstown (Co. Meath) (N851711) using a D-vac suction sampler. Nomenclature follows Lott (2008). Species not recorded in Tables 1-2 marked with an asterisk.

Species	***No.***
Amischa analis (Gravenhorst)	13
Anotylus tetracarinatus (Block)	1
**Encephalus complicans* Stephens	1
**Liogluta microptera* Thomson	5
Metopsia clypeata (Müller, P.W.J.)	12
Mocyta amplicollis (Mulsant & Rey)	2
Mocyta clientula (Erichson)	27
Mocyta fungi (Gravenhorst)	78
Sepedophilus nigripennis (Stephens)	76
Stenus brunnipes Stephens	1
Stenus clavicornis (Scopoli)	4
Stenus impressus Germar	55
**Stenus juno* (Paykull)	1
Stenus similis (Herbst)	2
Tachyporus chrysomelinus (Linnaeus)	14
Tachyporus dispar (Paykull)	10
Tachyporus hypnorum (Fabricius)	8
Tachyporus nitidulus (Fabricius)	2
Tachyporus obtusus (Linnaeus)	1

TABLE 4. Staphylinidae from limestone soil sheep pasture (20 July 1993) near Rathcore (Co. Meath) (N807478) using an S-vac suction sampler (nos. 1-4 are half a set of samples each). Species marked with an asterisk were not recorded from Randalstown (Tables 1 and 2). Nomenclature follows Lott (2008).

Species	***1***	***2***	***3***	***4***	***Total***
Aloconota gregaria (Erichson)	1	5	1	–	7
Amischa analis (Gravenhorst)	–	–	–	2	2
A. nigrofusca (Stephens)	–	–	–	1	1
**Badura macrocera* (Thomson)	1	–	–	–	1
Mocyta amplicollis (Mulsant & Rey)	14	18	26	28	86
M. fungi (Gravenhorst)	5	3	6	3	17
Mocyta sp.	–	1	1	–	2
Oxypoda brevicornis (Stephens)	1	1	–	–	2
Philonthus cognatus Stephens	1	–	–	–	1
Stenus brunnipes Stephens	1	–	1	–	2
S. cicindeloides (Schaller)	–	1	1	–	2
S. clavicornis (Scopoli)	6	4	3	2	15
**S. formicetorum* Mannerheim	7	7	–	7	21
S. fulvicornis Stephens	1	1	–	–	2
**S. juno* (Paykull)	1	–	–	–	1
S. nanus Stephens	2	–	1	1	4
S. picipes Stephens	8	4	4	28	44
S. similis (Herbst)	–	1	–	–	1
Tachinus rufipes (L.)	–	–	–	1	1
Tachyporus chrysomelinus (L.)	–	1	–	–	1
T. dispar (Paykull)	3	–	–	1	4
T. hypnorum (Fabricius)	–	1	–	2	3

TABLE 4 (Continued).

Species	***1***	***2***	***3***	***4***	***Total***
Tachyporus obtusus (L.)	1	–	–	1	2
T. pusillus Gravenhorst	–	–	–	1	1
**T. solutus* Erichson	–	–	–	2	2
Tinotus morion (Gravenhorst)	1	–	1	1	3

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A SURVEY OF THE ORIBATIDA AND MESOSTIGMATA (ACARINA) OF IRISH PEATLANDS

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Abstract

Peatlands represent 16.2% of the land surface of Ireland. While a lot of work has been done to investigate some aspects of the biodiversity of these systems, relatively little is known of the soil fauna. In this study, we examine the mites from the orders Oribatida and Mesostigmata occurring in a range of peatland types. Fifty seven species were found - 43 belonging to the Oribatida and 14 to the Mesostigmata. With the exception of species from the genus *Limnozete*s, most of the species have been recorded in other habitats. This lack of mite species found specifically on peatland is perhaps related to the organic nature of the soil which is similar to stands of coniferous forestry in terms of organic profile and the acid nature of the soils.

Key words: Acarina, Oribatida, Mesostigmata, Ireland, peatland

Introduction

Peatlands are an important part of the Irish landscape and provide habitats for a diverse range of plants and animals. They occupy 16.2 % of the land surface of the island (Hammond, 1979; Taylor, 1983) which represents a higher proportion than in any other European country with the exception of Finland (Keane and Daly, 1994).

In Ireland, peatland is classified either as raised bog, which is found mainly in the central lowlands with some very small areas also occurring in the south-west of the country (National

Parks and Wildlife Service, 2008), as blanket bog of the Western seaboard and the upland regions, or fen peats. Raised and blanket bogs are known as ombrogenous mires because their development is caused by atmospheric precipitation, fen peats are known as topogenous mires because the development is controlled by topography and the groundwater table (Hammond, 1979). The majority of the bogs in Ireland are blanket bogs (774,990 hectares), with raised bog (311,300 hectares) and fen (92,508 hectares) being less extensive (Foss, 1996).

The flora of peatlands, in particular vascular plants, have been studied extensively (Feehan and O'Donovan, 1996), but relatively little is known of the biodiversity of terrestrial fauna and specifically of the soil fauna. These groups are the most biodiverse component of most terrestrial ecosystems and are an important component of the decomposition system in the soil (Petersen and Luxton, 1982). Therefore, in order to comprehend the complex interactions in peatland ecosystems, it is essential that soil dwelling organisms be studied in detail.

In virgin peatlands the dominant soil fauna are enchytraeids (Oligochaeta), but in systems impacted by human activities, such as the harvesting of peat, different species become more important. Tipulidae (Diptera) are present in high numbers in drier peat and earthworms are more apparent as the nutrient status of the peat improves. However, earthworms, which are responsible for aerating and the mixing in mineral soils, are essentially absent in undisturbed peat and Isopoda only occur in low numbers. At low pH, enchytraeids take the place of the earthworms in aerating and mixing the soil. Acari (mites) and Collembola (springtails) inhabit the top few centimetres of the peat, but do not occur deeper in the soil because of water-logging (Speight and Blackith, 1983). Even in the top few centimetres, the food supply for the Collembola may be limited because of the high acidity. However, microarthropods, such as mites and Collembola, account for as much as 95% of the soil mesofauna in some edaphic habitats, therefore they are an important component of the soil food webs because of their influence over other decomposers in the soil system (Petersen and Luxton, 1982).

Acari (mites) are one of the most abundant and diverse group of microarthropods in terrestrial habitats (Belanger, 1976). The population densities of mites can reach several hundred thousand per square metre (Dindal, 1990) and it is estimated that there could be more

than 100,000 mites per square metre within Sphagnum bogs (Rydin and Jeglum, 2006).

Oribatida are the most numerous mites in the organic horizons of the majority of soils (Dindal, 1990; Houck, 1994). There are presently 9000 described species of Oribatida, representing approximately 1204 genera in more than 169 families (Subías, 2004).

Mesostigmata are predatory mites that live in the soil and soil litter, on the surface of soil or on plants. Soil-dwelling species prey on nematodes, Collembola and some insect larvae (Harris and Usher, 1976) and some groups are considered to be fungivorous (Krantz and Ainscough, 1990). They can reach densities as high as 10,000 individuals per square metre.

While a relatively extensive literature exists on the fauna of continental European peatlands and a number of studies on the fauna of peatlands have been carried out in the United Kingdom (e.g. Macfayden, 1952; Cragg, 1961; Springett and Latter, 1977; Latter and Howson, 1978), relatively little research has been carried out in Ireland (e.g. Blackith, 1974; Whelan, 1976; Higgins, 1984; Good, 1985; Bolger, 1985; Reynolds, 1990; McCormack *et al.*, 2009 McDonnell *et al*., 2002; Nolan, 2002, 2007, 2009) and it was therefore decided to survey the acari (mites) occurring in Irish peatlands. This paper reports the result of a baseline survey of oribatid and mesostigmatid mites from eleven Irish peatland sites

Materials and methods

Study sites

This study is part of the BOGLAND project which had an objective of investigating the sustainable peatland management in Ireland. In order to provide baseline information on different aspects of peatland biodiversity, eleven sites were selected as representatives of the four different peatland types, i.e. raised bog, fen, Atlantic and mountain blanket bog. The names, locations, bog type and conservation status of these sites are given in Table 1. These sites were selected to include essentially pristine peatland sites that were designated under NATURA 2000 as Special Areas of Conservation (SAC) but this was not the case for all sites (Renou-Wilson and Bolger, 2010). Within these sites, there were areas that were intact or restored and these were sampled when they were available.

Sampling and extraction of mites

At each site, six soil cores (18cm in diameter and 20cm in depth) were taken using a soil corer. These were taken in both pristine and disturbed habitats if these were present. The cores were transported to the laboratory in plastic buckets similar in size to the cores to prevent squashing or damage. Mites were extracted using a Kempson thermostatically controlled infrared extractor for one week (Kempson *et al.*, 1963). Following removal from the extractor, the extracts were sieved through a 53µm mesh to collect the invertebrates which were then stored in 70% industrial methylated spirits (IMS). The mites were later mounted on slides in lactic acid as a temporary mountant and, when identified, permanent mounts were prepared using Hoyer's solution.

Statistical analysis

Ordination analysis was used to illustrate the patterns of variation in the species data and to determine whether these were related to peatland type. In the ordination plots, the sites, samples and species are ordered based on the similarity or dissimilarity of their distributions, i.e. those that are furthest apart are most dissimilar. All of these analyses were carried out using CANOCO for windows, Version 4.53 (ter Braak and Šmilauer, 2002).

Redundancy analysis (RDA) was used because the amount of variation and turnover in species was small (length of gradient of first axis of DCA was 2.91). In order to take into account the fact that some sites had both intact and restored subsites, the statistical comparison of peatland type was carried out using peatland condition (intact/restored) as a co-variable (blocking factor).

Results

Fifty seven species of mite were found among the 5,265 individuals identified. Forty-three of these were oribatid mites (Oribatida) and fourteen were species of Mesostigmata (Table 2). The numbers of species found at individual sites varied from eleven in the Atlantic blanket bog at Ballygisheen to 42 from a raised bog at Sharavogue (Table 3). However, there was no consistent difference in the richness of the fauna in the various peatland types.

Oribatids were more numerous and species rich in all samples and five species (*Hypochthonius rufulus* C. L. Koch, *Heminothrus peltifer* (C. L. Koch), *Nanhermannia dorsalis* (Banks), *Ceratoppia bipilis* (Hermann) and *Chamobates schuetzi* (Oudemans)) occurred at all the sites. Three others (*Carabodes willmanni* Bernini, *Banksinoma lanceolata* (Michael) and *Parachipteria punctata* (Nicolet)) occurred at ten sites.

By contrast, the genus *Limnozetes* occurred in relatively small numbers, but it is worth noting because it is hygrophilous and is a characteristic genus of moors and bogs (Weigmann, 2006; Schatz and Behan-Pelletier, 2008). Two species from this genus were recorded: *Limnozetes amnicus* (Behan-Pelletier) and *L. ciliatus* (Schrank). *L. amnicus* occurred in five sites and *L. ciliatus* in four sites.

None of the Mesostigmata were found in abundance but *Paragamasus robustus* (Oudemans), *Pergamasus crassipes* (L.) and *Cilliba cassidea* (Hermann) were the most frequently encountered species, occurring at six, four and four sites respectively.

Redundancy analysis showed that the assemblages in raised bog were most different, but not significantly so, from those occurring in the other peatland types (Table 4). These differed particularly from the assemblages occurring in Mountain Blanket Bog.

Discussion

Fifty seven species of mite were identified in this study. These represented a broad range of Oribatida species but few Mesostigmata. This was expected as the organic matter found in peatlands is favourable as a habitat for oribatids since they contribute to its decay (Behan-Pelletier, 1999) and they also constitute the main part of acarine populations in the soil (Luxton, 1996). The lack of mite species found specifically on peatland is perhaps related to the organic nature of the soil which makes them very similar to stands of coniferous forestry in terms of organic profile and the acid nature of the soils. It has been shown that mite communities represent more typically the species found in coniferous forestry when a peatland is drained and that overall diversity of species increases (Laiho *et al*., 2001).

This is in general agreement with the literature which suggests that few oribatid species are

found solely in peatland (Behan-Pelletier and Bissett, 1994) and, according to Willmann (1931) and Karg (1993), a number of the species found here are known to be common in peat but are also found in other habitats. These include *Peloptulus montanus* Hull, *Peloptulus phaenotus* (C. L. Koch), *Carabodes labyrinthicus* (Michael), *Carabodes marginatus* (Michael), *Adoristes poppei* (Oudemans), *Fuscozetes fuscipes* (C. L. Koch) and *Minunthozetes semirufus* (C. L. Koch).

However, the genus *Limnozetes*, of which two species were found in this study, *L. amnicus* and *L. ciliatus*, is found frequently in peats (Markkula, 1986) and is thus a good indicator of peatlands. In fact, these are the earliest records of *L. amnicus* from Ireland and all of the other records of this species come from peatland habitats (Arroyo *et al*., in press). Interestingly, the species *Hydrozetes lacustris* (Michael) always occurs in association with species of *Limnozetes* (Willmann, 1931).

Studies in northeastern North America have found that species from the genus *Nanhermannia* are the most common species of oribatid mites in peatland habitats whereas the Oppiidae and Suctobelbidae, which are amongst the most numerous species in other habitats, occur in low numbers (Behan-Pelletier and Bissett, 1994; Arroyo and Bolger, 2008). *Nanhermannia dorsalis* was present in large numbers in nearly all sites and only two species of Suctobelbidae and three of Oppiidae were collected.

Only 14 species of Mesostigmata were found in this survey and none of these are found solely in peat habitats.

The fauna of raised bogs appeared to be somewhat different from the three other peatland types. For example, *Acrotritia duplicata* (Grandjean) and *Carabodes marginatus* were not found on any other peatland type.

A recent study of the acarine diversity of Irish habitat types suggested that peatlands had lower numbers of species than other habitat types (Arroyo *et al.*, in press). The largest average numbers of species per site were found in coniferous forests (approximately 15 per site) and, overall, the greatest diversity was found in pasture where 68 species were found. This contrasted with 11 species being recovered from the peatland sites sampled. However, the more

extensive sampling carried out in the current study shows that the diversity of the peatland sites is higher with an average of approximately 15 species per site which is almost identical to the richness found in coniferous forests by Arroyo *et al.* (in press). The overall diversity found is similar to those found in other studies, e.g. Longworth (1973) and Black *et al*. (2003).

Seventy-one species of Oribatida are listed as occurring in Canadian peatland (Behan-Pelletier and Bissett, 1994) and, although only eleven species were found in common with this study, there were a number of families and genera that were common to both. Given the large differences in area and the extent of the studies, it is remarkable that the total numbers of species found in Irish and Canadian peatlands are so similar and suggests that this study has recovered a large proportion of the species occurring in this habitat.

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TABLE 1. Name, location, bog type and conservation status of the eleven sites sampled.

Name	County	Latitude	Longitude	Bog type	Status
Pollardstown	Kerry	54°09'N	9°30'W	Fen	NHA, SAC
Bellacorick flush	Mayo	53°11'N	6°50'W	Fen	NHA, SAC
Sharavogue	Offaly	53°02'N	7°56'W	Raised bog	NHA, SAC
Clara	Offaly	53°19'N	7°38'W	Raised bog	NHA, SAC
Carrowbehy	Roscommon	53°47'N	8°49'W	Raised bog	NHA, SAC
Knockmoyle	Mayo	54°09'N	9°34'W	Atlantic blanket bog	NHA, SAC
Owenirragh	Mayo	54°16'N	9°37'W	Atlantic blanket bog	LIFE
Ballygisheen	Kerry	51°58'N	9°53'W	Atlantic blanket bog	LIFE, NHA, SAC
Fiddandary	Mayo/Sligo	53°09'N	6°17'W	Mountain blanket	NHA, SAC
Kippure	Wicklow	54°08'N	8°56'W	Mountain blanket	NHA, SAC
Glenlahan	Offaly	53°00'N	8°32'W	Mountain blanket	LIFE, NHA, SAC

TABLE 2. Species occurring at each site.

Site	**Clara**	**Clara**	**Sharavogue**	**Sharavogue**	**Carrowbehy**	**Fiddendary**	**Fiddendary**	**Kippure**	**Kippure**
Condition (I= Intact site, R=Restored)	I	R	I	R	I	I	R	I	R
ORIBATIDA									
Family Brachychthoniidae									
Liochthonius simplex (Forsslund)									
Family Hypochthomiidae									
Hypochthonius rufulus C. L. Koch	+	+	+	+	+	+	+	+	+
Family Euphthiracaridae									
Rhysotritia duplicata (Grandjean)				+					
Family Phthiracaridae									
Phthiracarus affinis (Hull)									
Phthiracarus anonymus Grandjean									
Phthiracarus clavatus Parry				+	+				
Steganacarus magnus (Nicolet)			+	+	+	+			
Steganacarus michaeli Bernini and Avanzati			+						
Family Camisiidae									
Heminothrus (*Platynothrus*) *peltifer* (C. L. Koch)	+	+	+	+	+	+	+	+	+
Family Nothridae									
Nothrus silvestris Nicolet	+	+	+	+		+	+		
Family Nanhermannidae									
Nanhermannia dorsalis (Banks)	+	+	+	+	+	+	+	+	+
Family Carabodidae									
Carabodes labyrinthicus (Michael)				+					
Carabodes marginatus (Michael)				+					
Carabodes ornatus Štorkán				+					
Carabodes willmanni Bernini	+	+	+	+	+		+		+

TABLE 2 (Continued).

Family Tectocephidae									
Tectocepheus minor Berlese			+	+	+	+			
Tectocepheus velatus (Michael)	+		+						
Family Ceratoppiidae									
Ceratoppia bipilis (Hermann)	+		+	+	+	+	+	+	+
Family Liacaridae									
Adoristes ovatus (C. L. Koch)						+			
Adoristes poppei (Oudemans)	+		+					+	
Family Hydrozetidae									
Hydrozetes lacustris (Michael)			+			+	+		
Hydrozetes lemnae (Coggi)								+	
Family Limnozetidae									
Limnozetes amnicus (Behan-Pelletier)		+	+		+				
Limnozetes ciliatus (Schrank)			+	+					
Family Oppiidae									
Medioppia subpectinata (Oudemans)									
Oppiella (*Oppiella*) *nova* (Oudemans)			+	+	+	+	+	+	+
Ramusella (*Insculptoppia*) *elliptica* (Berlese)			+						
Family Suctobelbidae									
Suctobelbella longicuspis Jacot			+						
Suctobelbella subcornigera (Forsslund)					+				
Family Thyrisomidae									
Banksinoma lanceolata (Michael)		+		+	+	+	+	+	+
Family Ceratozetidae									
Fuscozetes fuscipes (C. L. Koch)				+					
Latilamellobates incisella (Kramer)									
Family Chamobatidae									
Chamobates cuspidatus (Michael)			+						
Chamobates schuetzi (Oudemans)	+	+	+	+	+	+	+	+	+
Family Punctoribatidae									
Minunthozetes semirufus (C. L. Koch)			+						

TABLE 2 (Continued).

Family Galumnidae								
Pergalumna nervosa (Berlese)			+	+				
Family Achipteriidae								
Parachipteria punctata (Nicolet)	+	+	+	+	+	+	+	+
Family Oribatulidae								
Liebstadia similis (Michael)				+		+	+	
Oribatula tibialis (Nicolet)	+		+	+	+		+	
Family Phenopelopidae								
Eupelops acromios (Hermann)						+		+
Eupelops plicatus (C. L. Koch)			+	+				
Peloptulus montanus Hull			+		+			
Peloptulus phaeonotus (C. L. Koch)				+				
MESOTIGMATA								
Family Ascidae								
Platyseius italicus (Berlese)								
Platyseius subglaber (Oudemans)			+					
Family Macrochelidae								
Geholaspis (*Longicheles*) *mandibularis* (Berlese)			+					
Macrocheles submotus Falconer								
Family Parasitidae								
Lysigamasus celticus (Bhattacharyya)			+					
Paragamasus robustus (Oudemans)			+		+			
Paragamasus similis (Willmann)					+			
Pergamasus crassipes (Linnaeus)			+	+				
Pergamasus septentrionalis (Oudemans)								
Family Veigaiidae								
Veigaia cerva (Kramer)								
Veigaia kochi (Trägårdh)			+					
Veigaia transisalae (Oudemans)							+	
Family Zerconidae								
Zercon zelawaiensis Sellnick			+					
Family Uropodidae								
Cilliba cassidea (Hermann)	+	+	+					

TABLE 2 (Continued).

Site	**Glenlahan**	**Glenlahan**	**Ballygisheen**	**Ballygisheen**	**Owenirragh**	**Owenirragh**	**Knockmoyle**	**Pollardstown**	**Bellacorick**	**Bellacorick**
Condition (I= Intact site, R=Restored)	I	R	I	R	I	R	I	I	I	R
ORIBATIDA										
Family Brachychthoniidae										
Liochthonius simplex (Forsslund)								+		
Family Hypochthomiidae										
Hypochthonius rufulus C. L. Koch	+	+	+	+	+	+	+	+	+	+
Family Euphthiracaridae										
Rhysotritia duplicata (Grandjean)										
Family Phthiracaridae										
Phthiracarus affinis (Hull)							+			
Phthiracarus anonymus Grandjean							+			
Phthiracarus clavatus Parry										
Steganacarus magnus (Nicolet)		+			+					
Steganacarus michaeli Bernini and Avanzati					+					
Family Camisiidae										
Heminothrus (*Platynothrus*) *peltifer* (C. L. Koch)		+	+	+	+	+	+	+	+	+
Family Nothridae										
Nothrus silvestris Nicolet		+			+		+	+	+	+
Family Nanhermannidae										
Nanhermannia dorsalis (Banks)		+	+	+	+	+	+	+	+	+
Family Carabodidae										
Carabodes labyrinthicus (Michael)										
Carabodes marginatus (Michael)										
Carabodes ornatus Štorkán										
Carabodes willmanni Bernini				+	+	+	+	+	+	+

TABLE 2 (Continued).

Family Tectocephidae									
Tectocepheus minor Berlese	+	+				+			
Tectocepheus velatus (Michael)						+			
Family Ceratoppiidae									
Ceratoppia bipilis (Hermann)	+	+		+	+	+	+	+	+
Family Liacaridae									
Adoristes ovatus (C. L. Koch)									
Adoristes poppei (Oudemans)	+			+					
Family Hydrozetidae									
Hydrozetes lacustris (Michael)									
Hydrozetes lemnae (Coggi)		+							
Family Limnozetidae									
Limnozetes amnicus (Behan-Pelletier)					+				+
Limnozetes ciliatus (Schrank)					+	+		+	
Family Oppiidae									
Medioppia subpectinata (Oudemans)						+			
Oppiella (*Oppiella*) *nova* (Oudemans)		+		+		+	+		
Ramusella (*Insculptoppia*) *elliptica* (Berlese)									
Family Suctobelbidae									
Suctobelbella longicuspis Jacot						+			
Suctobelbella subcornigera (Forsslund)	+								
Family Thyrisomidae									
Banksinoma lanceolata (Michael)		+	+		+	+	+		+
Family Ceratozetidae									
Fuscozetes fuscipes (C. L. Koch)							+		
Latilamellobates incisella (Kramer)	+						+		+
Family Chamobatidae									
Chamobates cuspidatus (Michael)									
Chamobates schuetzi (Oudemans)	+		+	+	+	+	+	+	+
Family Punctoribatidae									
Minunthozetes semirufus (C. L. Koch)							+		

TABLE 2 (Continued).

Family Galumnidae										
Pergalumna nervosa (Berlese)										
Family Achipteriidae										
Parachipteria punctata (Nicolet)		+	+	+	+	+	+			+
Family Oribatulidae										
Liebstadia similis (Michael)							+	+		
Oribatula tibialis (Nicolet)		+			+	+			+	
Family Phenopelopidae										
Eupelops acromios (Hermann)					+		+		+	
Eupelops plicatus (C. L. Koch)					+				+	+
Peloptulus montanus Hull							+			
Peloptulus phaeonotus (C. L. Koch)					+		+		+	
MESOTIGMATA										
Family Ascidae										
Platyseius italicus (Berlese)								+		
Platyseius subglaber (Oudemans)										
Family Macrochelidae										
Geholaspis (*Longicheles*) *mandibularis* (Berlese)								+		
Macrocheles submotus Falconer	+									
Family Parasitidae										
Lysigamasus celticus (Bhattacharyya)							+	+		
Paragamasus robustus (Oudemans)					+		+		+	
Paragamasus similis (Willmann)										
Pergamasus crassipes (Linnaeus)		+					+	+		
Pergamasus septentrionalis (Oudemans)	+									
Family Veigaiidae										
Veigaia cerva (Kramer)								+		
Veigaia kochi (Trägårdh)										
Veigaia transisalae (Oudemans)									+	
Family Zerconidae										
Zercon zelawaiensis Sellnick										
Family Uropodidae										
Cilliba cassidea (Hermann)					+	+	+			

TABLE 3. Number of species of mite recorded at each site.

Site Name	**Bog type**	**Oribatida**	**Mesostigmata**
Fiddandary	Mountain blanket	17	1
Kippure	Mountain blanket	12	0
Glenlahan	Mountain blanket	13	3
Sharavogue	Raised bog	34	8
Clara	Raised bog	13	1
Carrowbehy	Raised bog	16	2
Knockmoyle	Atlantic blanket bog	21	4
Owenirragh	Atlantic blanket bog	19	2
Ballygisheen	Atlantic blanket bog	11	0
Pollardstown	Fen	14	5
Bellacorrick	Fen	16	2

TABLE 4. RDA statistics for the comparison of mite assemblages in peatlands using automatic selection of environmental variables and restored/intact as the blocking factors. Environmental factors are listed in the order of their inclusion in the model, together with the additional variance each variable explains (λ-A) and the significance of the variable (P-value).

	Conditional Effects		
Variable	λA	F	P
Raised Bog	0.14	2.81	0.062
Fen	0.06	1.22	0.274
Mountain Blanket Bog	0.02	0.33	0.842

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THE DISTRIBUTION AND HABITAT OF THE PEARL-BORDERED FRITILLARY BUTTERFLY *BOLORIA EUPHROSYNE* (LINNAEUS) (LEPIDOPTERA: NYMPHALIDAE) IN IRELAND

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Abstract

Boloria euphrosyne (Linnaeus), the pearl-bordered fritillary, is arguably Ireland's rarest and most endangered butterfly. However, there is very little information on its Irish distribution, habitats or ecology. A survey of *B. euphrosyne* was undertaken in May and June 2011. All records generated from that survey and known recent records of the species were brought together in one database and mapped. Sites were classified by macro-habitat type. The Irish populations of *B. euphrosyne* are restricted to the karst areas of Co. Clare, southeast Co. Galway and the Aran Islands, Co. Galway. There are two main macro-habitats used by *B. euphrosyne* in Ireland: (1) a mosaic of limestone pavement, calcareous grassland and scrub; (2) woodland with open areas. However, it appears to be the warm micro-habitats that are found in the karst landscapes that are important for the species rather than the macro-habitat. Since there is very little information on the ecology of *B. euphrosyne* in Ireland, further research, in particular of the larval stage, as well as close monitoring of the population is required to inform its conservation.

Introduction

The pearl-bordered fritillary, *Boloria euphrosyne* (Linnaeus), is one of 34 resident and regular migrant butterfly species in Ireland. It was first recorded in Ireland from the Burren in 1922 by R. A. Philips (Phillips, 1923) and is confined to the karst landscapes of the Burren in

Co. Clare, southeast Co. Galway and the Aran Islands, Co. Galway (Regan *et al.*, 2010). *B. euphrosyne* was assessed as Endangered in the 2010 Red List of Irish butterflies under the criteria B2ab (ii, iii, iv), i.e. that its area of occupancy is less than 500km^2, is severely fragmented, and continuing decline in area of occupancy, area, extent and/or quality of habitat and in number of locations (Regan *et al.*, 2010). In Great Britain, this butterfly is considered Endangered with a 10-year population decline of 51% (Fox *et al.*, 2010). It is considered Least Concern in the European Red List of butterflies (van Swaay *et al.*, 2010) but has undergone serious declines in Belgium, Denmark, Germany, Lithuania, Luxembourg and The Netherlands, (Asher *et al.* 2001).

B. euphrosyne occurs in the following habitats in Europe: dry siliceous grasslands, humid grasslands and tall herb communities, broad-leaved deciduous forests, coniferous woodland, mixed woodland and raised bogs (van Swaay *et al.*, 2006). In Great Britain, the butterfly breeds in three main habitat types *viz*. woodland clearings; well-drained grassland habitats with scrub or bracken; and open deciduous woodland in the north (Barnett and Warren, 1995). While in Ireland, Bond and Gittings (2008) describe the macrohabitats of this species as grassy forest clearings, unimproved dry calcareous grassland and limestone pavement.

The adult flight period is about six weeks and it flies from the end of April to the beginning of June with some variation depending on the weather (Oates, 2004; Thomas and Lewington, 2010). The egg hatches after about a fortnight and the caterpillar feeds until September when it hibernates. The adult usually reappears in early March to embark on a month of feeding (Thomas and Lewington, 2010). The most widely used larval foodplant is the common dog-violet *Viola riviniana* Reichb. although it can use other violets such as the heath dog-violet *V. canina* Linnaeus and marsh violet *V. palustris* Linnaeus (Asher *et al.*, 2001; Thomas and Lewington, 2010). It appears that the ecological requirements of the adults are fairly broad but those of the early stages are highly specific (Barnett and Warren, 1995).

Despite being the most geographically restricted Irish butterfly and under threat of extinction, there is very little known about the species in Ireland. There has been no comprehensive survey of its distribution, with very little known about its habitat requirements.

Research is therefore needed into its ecology.

The aim of this survey therefore was to: (1) determine the distribution of the pearl-bordered fritillary in Ireland and (2) gather information on the habitat utilised.

Methods

Fieldwork was carried out in May and June 2011 to determine the current distribution of *B. euphrosyne* in Ireland and the habitats used. For each site visited, presence/absence of the butterfly was noted as well as the habitat. A call was also put out through the Irish Butterfly Monitoring Scheme network for modern records of the butterfly.

All modern records (2005-2011) were then brought into one database. For each *B. euphrosyne* site, the main habitats were documented either from notes from the site visit, from descriptions from the recorders and/or from aerial photographs.

Results

Forty-four sites are listed in Table 1 for *B. euphrosyne* in Ireland. Most of the sites are situated in Co. Clare with some sites in the Aran Islands and southeast Co. Galway (Figure 1). The main population occurs between Kinvarra in Co. Galway and Corofin in Co. Clare. Most of the sites are relatively close to each other with the exception of the Aran Islands' population. For this population, the next nearest site is on the mainland over 20km away.

All the sites are located on limestone bedrock and within the karst landscape of the Burren and southeast Galway and consist of a mosaic of habitats. In terms of these habitats, 37 sites have a mosaic of limestone pavement, dry calcareous grassland and scrub. While seven of the sites are within a woodland complex (Table 1).

All of the sites, except for three, are within Special Areas of Conservation (SACs). Those that are outside SACs are Tarrea near Kinvarra, Co. Galway, Drummeer and Ballygriffy near Ruan, Co. Clare (Table 1).

Discussion

Habitat

There are two main habitat types used by the Irish populations: (1) a mosaic of limestone pavement, calcareous grassland and scrub, and (2) woodland complex (consisting of woodland with open areas and/or clear-felled areas) – with the majority of the population using the former (Table 1). This is in contrast to the populations in Great Britain, the majority of which (70%) occur in woodlands or pasture woodlands (Oates, 2004). Also the list of European habitats by van Swaay *et al.* (2006) does not include calcareous grassland or limestone pavement.

Within woodland clearings, research in Great Britain has clearly shown that populations of *B. euphrosyne* require open habitat and decline rapidly if the clearing becomes overgrown (*inter alia* Greatorex-Davies *et al.*, 1992; Clarke and Robertson, 1993; Barnett and Warren, 1995; Thomas and Lewington, 2010). However, there is much less information on this butterfly within limestone pavement/calcareous grassland/scrub habitats (Barnett and Warren, 1995). Although the requirements in these types of habitats are poorly known, a preliminary study recorded eggs in areas where there was a high violet cover (5-25%), sparse grass (0-50%), and high cover of dead litter (40-100%) (Barnett and Warren, 1995). These authors and Thomas and Lewington (2010) suggest that the larvae need a very warm micro-climate in the spring when they are developing. It appears that while the habitat requirements of the adults are fairly broad, the caterpillar stage is highly specific and it is this stage that should be researched further in terms of habitat requirements in Ireland.

In terms of the Irish habitats, there is a distinction to be made between macro- and micro-habitats as recommended by Speight *et al.* (1997). As the caterpillar is highly specific in needing a warm micro-climate in spring, this may be the over-riding factor for the species rather than the macro-habitat. This is similar to the wood white *Leptidea sinapis* (Linnaeus) which, in Ireland, lives only in the warmest micro-habitats provided by the karst landscape in Cos Clare and Galway (Nelson *et al.*, 2011). This has implications for the management of the woodland sites for *B. euphrosyne*. At Ballyeighter, Cahermacrea, Castletaylor/Cregmore, Ballygriffy and Attyslanty, it was the clearings that were used by the butterflies rather than the woodland areas.

At Cahermacrea, Ballygriffy, and Ballyeighter, these clearings were becoming encroached by the woodland while at Castletaylor/Cregmore and Attyslanty, the clearings were as a result of clear-felling. Therefore at all of the woodland sites, the clearings are in a state of flux and action will be needed to make sure open areas are retained on site.

Fragmentation

B. euphrosyne has been shown to be susceptible to fragmentation of its habitat with even a 100m-wide stand of ten year old coppice acting as a barrier to females. As a result, recommendations for woodland habitat management include providing a network of open habitats to allow adults to disperse (Thomas and Lewington, 2010; Clarke *et al.*, 2011). However it has also been shown that when population densities are high, *B. euphrosyne* will disperse particularly during sustained hot weather and can move at least 4.5km (Clarke *et al.*, 2011). A high number of the Irish populations appear to be fragmented, in particular the population on the Aran Islands. This population needs to be closely monitored and appropriate habitat management put in place.

Where the butterfly occurs in open and unfragmented habitats, it may exist as metapopulations which breed over a network of habitats (Barnett and Warren, 1995). A metapopulation is a collection of local populations, connected by occasional dispersal, in which there are local extinctions and colonisations (Hanski and Gilpin, 1991). This needs to be studied more for the Irish populations and may have further implications for the conservation of this species.

Conservation

As the majority of sites are within SACs, there is some protection afforded to *B. euphrosyne* in Ireland as long as the management of these sites is compatible with the management for the conservation of the species. Limestone pavement is an Annex I habitat under the EU Habitats Directive and is one of the reasons that these SACs have been selected (see www.nwps.ie). The conservation objectives of these sites include to maintain or restore a favourable conservation

condition of the limestone pavement, semi-natural dry calcareous grassland, and scrubland facies on calcareous substrates. However the rapid expansion of scrub in recent times is a real threat to species-rich calcareous grassland in the Burren (Dunford and Feehan, 2001; Heritage Council, 2006; Deenihan *et al.*, 2009; Parr *et al*., 2009), reducing potential habitat for *B. euphrosyne* (Harding, 2008). Thomas and Lewington (2010) and Harding (2008) describe this butterfly as very sensitive to its breeding area becoming overgrown. Spring grazing is considered important for the species in the Burren, inducing fresh growth and germination of the food plants (Jesmond Harding, pers. comm.).

For the woodland sites at Attyslany (within the East Burren Complex SAC) and Castletaylor (within the Castletaylor Complex SAC), woodlands are not listed under the conservation objectives of the sites. At both sites, it appears that the population has increased as a result of the clear-felling (as has been shown for many sites in Great Britain). Open areas with new growth of violets need to be retained to ensure the continued use of these sites by *B. euphrosyne*.

Given the restricted distribution of the butterfly in Ireland with its isolation from the British population and weekly sensitivity to habitat fragmentation, the populations need to be closely monitored. The most effective way to do this would be to use the Irish Butterfly Monitoring Scheme methodology. The scheme currently has over 150 volunteers weekly monitoring butterflies across the country but only one of the transects records *B. euphrosyne* (Regan and Fleischer, 2011). Because of this deficiency, single-species transects should be established at a number of sites within its current range.

Conservation actions needed:

- Research into the ecology and habitat requirements of the species (especially in the limestone pavement/calcareous grassland/ scrub mosaic and in particular of the caterpillar stage)
- Establish single-species monitoring transects at least ten sites so that the populations are regularly monitored
- Maintenance of open areas within current woodland complex sites

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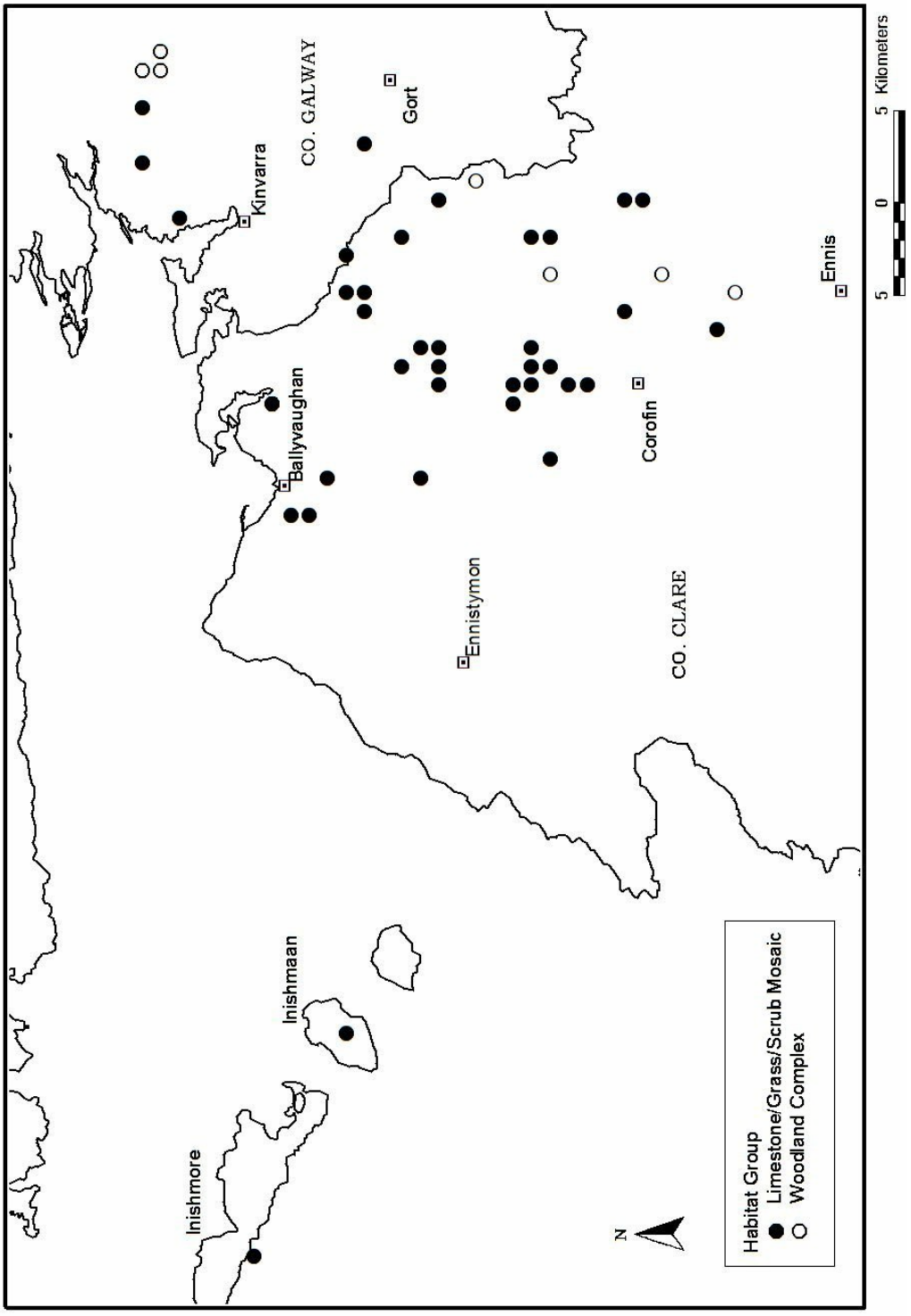
TABLE 1. Summary of modern (2006-2011) 1km square records for *Boloria euphrosyne* (Linnaeus) in Ireland with the macro-habitat types. Abbreviations: LP = Limestone Pavement; CG = Calcareous Grassland; Scr = Scrub; SAC = Special Area of Conservation.

Grid Reference	Townland	County	SAC	Habitat Group
L8109	Kilmurvy	Galway	Yes	Lp/CG /Scr
L9304	Carrowntemple	Galway	Yes	Lp/CG /Scr
M2106	Newtown	Clare	Yes	Lp/CG /Scr
M2107	Newtown	Clare	Yes	Lp/CG /Scr
M2300	Poulnabrone	Clare	Yes	Lp/CG /Scr
M2305	Ballycahill	Clare	Yes	Lp/CG /Scr
M2708	Moneen	Clare	Yes	Lp/CG /Scr
M2901	Termon	Clare	Yes	Lp/CG /Scr
M3000	Fahee North	Clare	Yes	Lp/CG /Scr
M3203	Pullagh	Clare	Yes	Lp/CG /Scr
M3303	Keelhilla	Clare	Yes	Lp/CG /Scr
M3304	Keelhilla	Clare	Yes	Lp/CG /Scr
M3504	Cappaghmore	Galway	Yes	Lp/CG /Scr
M3601	Derreenatloghtan	Clare	Yes	Lp/CG /Scr
M3713	Tarrea	Galway	No	Lp/CG /Scr
M4015	Cuildooish	Galway	Yes	Lp/CG /Scr
M4103	Garryland	Galway	Yes	Lp/CG /Scr
M4315	Carraghadoo	Galway	Yes	Lp/CG /Scr
M4514	Cregmore	Galway	Yes	Woodland Complex
M4515	Cregmore	Galway	Yes	Woodland Complex
M4614	Castletaylor South	Galway	Yes	Woodland Complex
R2493	Leamaneh North	Clare	Yes	Lp/CG /Scr
R2795	Clooncoose	Clare	Yes	Lp/CG /Scr
R2891	Commons South	Clare	Yes	Lp/CG /Scr
R2892	Commons South	Clare	Yes	Lp/CG /Scr
R2894	Clooncoose	Clare	Yes	Lp/CG /Scr

TABLE 1 (Continued).

Grid Reference	Townland	County	SAC	Habitat Group
R2895	Clooncoose	Clare	Yes	Lp/CG /Scr
R2899	Ballyconry	Clare	Yes	Lp/CG /Scr
R2993	Rinnamona	Clare	Yes	Lp/CG /Scr
R2994	Poulnalour	Clare	Yes	Lp/CG /Scr
R2999	Termon	Clare	Yes	Lp/CG /Scr
R3094	Knockaunroe	Clare	Yes	Lp/CG /Scr
R3099	Fahee North	Clare	Yes	Lp/CG /Scr
R3184	Drummeer	Clare	No	Lp/CG /Scr
R3289	Caherlough	Clare	Yes	Lp/CG /Scr

FIGURE 1. Distribution map of *Boloria euphrosyne* (Linnaeus) in Ireland (2006-2011) and a classification of the macro-habitats that it occurs in.



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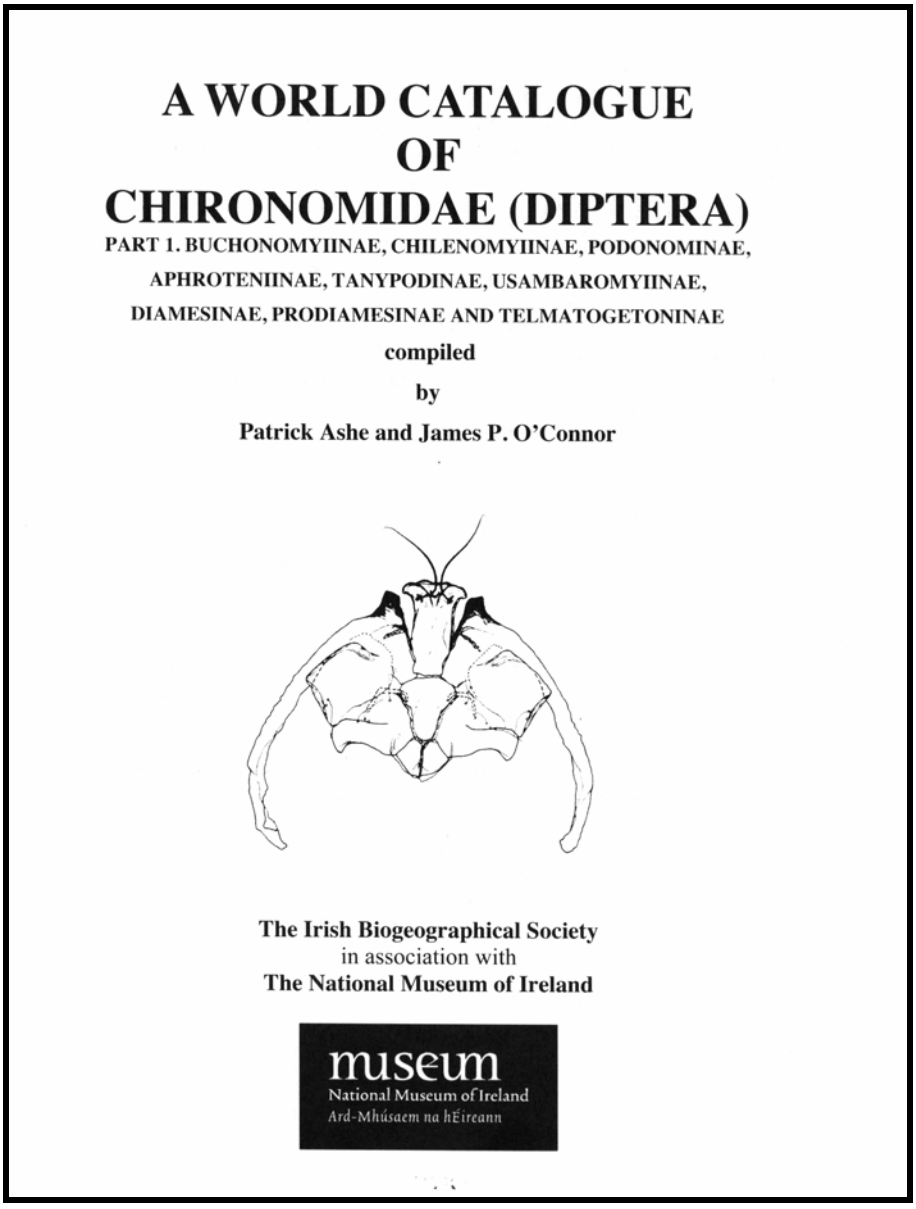

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