Species dossier, range and distribution data for the Hairy Wood Ant, *Formica lugubris,* in Ireland

Irish Wildlife Manuals No. 68

ISSN 1393 – 6670

An Roinn
Ealaíon, Oidhreachta agus Gaeltachta
Department of
Arts, Heritage and the Gaeltacht

Species dossier, range and distribution data for the Hairy Wood Ant, *Formica lugubris,* in Ireland

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Citation: Breen, J. (2014) Species dossier, range and distribution data for the Hairy Wood Ant, *Formica lugubris,* in Ireland. *Irish Wildlife Manuals*, No. 68. National Parks and Wildlife Service, Department of the Arts, Heritage and the Gaeltacht, Ireland.

Keywords: *Formica rufa*-group; wood ant; Formicidae; *Cinara*; *Lachnus*; conservation; Ireland

Site list: Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment SAC [000365]

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Irish Wildlife Manuals Series Editors: F. Marnell & R. Jeffrey

ISSN 1393 – 6670

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Executive Summary

The Hairy Wood Ant, *Formica lugubris*, is classified as Near Threatened on the IUCN global red list and has been in serious decline in Ireland in recent decades. The species is an iconic keystone woodland species with conspicuous large nests, which are easy to locate during the active season. Nests are now confined to five localities, three in Coillte properties in Tipperary and Galway, one in Killarney National Park and one on privately owned cut-over bog in Tipperary. A genetics study has shown that the Irish population is distinct from populations in England and is an ancient colonization which was not introduced by humans. The genetics study also shows that in the Irish population there is just one queen per nest and one nest per colony and this has implications for conservation; for example, the effective population size is now very low. The species has known requirements which include suitable trees which support aphids that excrete honeydew, the major food item of adult worker ants. Conservation of the species in Ireland will require the implementation of carefully considered processes in the high priority areas where the species is still found: this should include reduced coupe size at felling, and the planting of suitable tree species, native birches and oaks, Scots Pine and spruces but not Lodgepole Pine, to encourage the development of a species mosaic of mixed-aged trees which is more likely to encourage the development of new nests.

Acknowledgements

Dr. Brian Nelson for general advice on the production of this Species Dossier and his editorial skills; Dr Hannaleena Mäki-Petäys (University of Oulu, Finland) for discussion on the origin of the species in Ireland; Chris Wilson, Dermot Cunniffe and Eamon Drohan for reporting nests in Cappamurra, Woodford and Kilcoran. Aileen O'Sullivan and Pat Neville (Coillte) and Dr Ken Byrne (University of Limerick) for useful discussion and Marie Roche for help with maps. Micheál MacGiollaCóda, Alison Byron, Bill Quirke, Sam Kelly and Pascal Dower have all contributed to finding nests in the past.

Dr H.L.G. Stroyan (Ministry of Agriculture, Fisheries and Food, UK) and Dr P.M. Hammond (Natural History Museum, London) helped with the identification and confirmation of species of aphids and myrmecophilous beetles, respectively, during the 1970s.

Introduction

Formica lugubris is a species of mound-building wood ant with an extensive range across northern Eurasia from Ireland to Japan. In Europe the distribution extends from the boreal zone into the temperate and alpine zones as far south as the Pyrenees in northern Spain and central Italy (Collingwood, 1979). These species of wood ant are ecologically dominant in the boreal coniferous forests in northern Eurasia but all the species are threatened by degradation, fragmentation and loss of forests (Mäki-Petäys & Breen, 2007). *Formica lugubris* is classified as Near Threatened by the IUCN (Social Insects Specialist Group 1996) and information gathered over the last decade and documented here suggests that the species is in serious decline in Ireland.

The taxonomy of the *Formica rufa* ants is complex. Prior to 1955, wood ants present in Britain and Ireland were considered to be a single species and all records before then were referred to as *Formica rufa*. However, it was recognized by Yarrow (1955) that there were four distinct species in Britain and Ireland. Further morphological and genetic work has confirmed this analysis and currently the *Formica rufa*-group is regarded as comprising six species (Goropashnaya *et al.* 2004). Of these species, two occur in Ireland – *F. aquilonia* Yarrow and *F, lugubris* Zetterstedt. The former, referred to in Britain as the Scottish Wood Ant, occurs at one site in Co. Armagh; the latter, the Hairy Wood Ant (occasionally referred to as the Northern Wood Ant in Britain), is found in southern Ireland.

This document provides a species dossier providing an introduction to its biology relevant to its conservation, a summary of the historic range and distribution of the Hairy Wood Ant and a discussion of its current status in Ireland. Finally, I make suggestions on its future management for conservation purposes.

Biology of Hairy Wood Ant

In Ireland, *Formica lugubris* inhabits native and non-native woodland as it does in Britain (Breen 1977; Robinson *et al.* 2008). It excavates underground chambers usually in sunny locations along rides and clearings and builds a mound nest with a thatch of vegetation fragments on top (Plate 1). Where it occurs, *F. lugubris* is a dominant predator of other invertebrates (Robinson *et al.* 2008). It is also a scavenger but the most significant food item is honeydew which it collects from aphids (Breen 1979a). In Ireland and Britain, *F. lugubris* foragers collect honeydew from aphids on both native and non-native species of tree (Breen 1979a, Robinson *et al.* 2008).

Identification

Identification of an ant as a wood ant is relatively simple especially if the ant is seen at the nest. The insects have a dark brown abdomen and a red head and thorax with dark brown markings (see Plates 2-6). Some individuals may have the red on the upper side suffused with black. They are also large ants, the workers typically being up to 10mm in length. There are two other Irish species of *Formica* in Ireland *lemani* and *fusca*, but these are fully black and unicolourous. In addition, these two species do not construct the distinctive mound nests of the wood ants. Separating *lugubris* from *aquilonia* is more difficult but the characteristics given in Appendix 1 (adapted from Hughes 2006) will allow for identification of most individuals. Range is a reliable indicator of the identity of the two wood ant species in Ireland as *aquilonia* has only ever been seen at the single locality in Co. Armagh.

Genetics study, 2007

A genetics study (Mäki-Petäys & Breen 2007) made important conclusions about the Irish population of the Hairy Wood Ant which have significant implications for the conservation of the Irish population.

(1) The Irish population is separated by a single unique haplotype from the English population. This suggests that the Irish population is distinct, and more likely to be an ancient colonization than a recent introduction by humans.
(2) The Irish population has one queen per nest (monogynous) and one nest per colony (monodomous).

Elsewhere in its range, *Formica lugubris* tends to be both polygynous and polydomous with multiple queens per nest and many nests per colony as, for example, in Shropshire (England), which are the nearest British populations of this species (personal observation). *F. lugubris* is also polygynous in Scotland (Collingwood, C.A. quoted by Hughes 2006).

Each of these conclusions of the genetics study has important implications for the conservation of the species in Ireland. One important constraint is that the number of nests is effectively equal to the breeding population of females and this number is precariously low. Secondly, it is not easy to attempt increasing the number of nests by splitting them.

Nest site requirements

Breen (1979c) summarized the nest site characteristics of 184 nests in the South Tipperary area. These nests were mostly located in Ardane, Kilcoran or Glengarra Woods (Figure 2) The maximum density observed was 33 nests in an area of 15.2 hectare (= 2.2 nests per ha). Scots Pine *Pinus sylvestris* was the most frequent overhead tree and it occurred at 71% of nest sites and was the only species at 19% of

sites. In contrast, while Lodgepole Pine *P. contorta* occurred at 55% of sites, it occurred alone at only 4% of sites. Two species of spruce, Sitka *Picea sitchensis* and Norway *P. abies*, occurred at 29% of sites, but alone at only 5%. This information should be read in conjunction with the requirements for the presence of aphids (see below), as Lodgepole Pine does not support the required species of aphids. The data also showed that the majority of small nests (less than 30 cm diameter) were found in plantations less than 10 years old. As the tree ages increase, so do the nest diameters (and presumably the colony ages). Hence, it seems that nests appear within a few years after the trees are planted and grow in size with their surrounding trees. As the canopy closes, especially in spruce plantings, the colonies tend to migrate to the margins (roads and ride-lines). Hence, the large mature nests tend to occur on the sunny side of roads and ride-lines. The canopy is less dense and the colonies tend to migrate less when under Scots Pine. The data also suggested a maximum age of nests of 28 to 38 years.

Taken together, all of this information suggests a strategy for forest management for Hairy Wood Ant conservation. I propose that the optimal habitat consists of mosaics of different ages of trees with a predominance of Scots Pine and spruce. Lodgepole Pine should not be planted in these areas.

How new nests are produced

The nests of Hairy Wood Ant are formed in two ways: existing nests may produce new nests by splitting, or "budding", or, secondly following the mating swarms. The young winged males and females of this species fly from the parent nests ("swarm") on sunny mornings (about 08:00am) towards the end of May/early June (Breen 1979b). Swarming takes place over a number of days. After mating, the young females ("queens") bite off their wings and the newly mated "deälate queens" can be seen walking on the ground. Some may enter a nest of a species of black *Formica* ant, *F. lemani*, which is not a mound building wood ant, and usurp the position of queen of that colony. I have seen such mixed colonies on three occasions. This form of colony founding is referred to as "temporary social parasitism". Temporary social parasitism might account for the appearance of nests some distance from previously known colonies (e.g. Cappamurra Bog, Co. Tipperary and the newly discovered sites at Woodford, Co. Galway). Given the right combination of trees (e.g. Scots Pine and birch), the "correct" species of aphids are likely to colonize by aerial dispersal of winged parthenogenetic females in the vicinity of a fledgling wood ant colony.

Feeding biology of Hairy Wood Ant

The main food items of the Hairy Wood Ants are honeydew (about 80% of returning loads from May to September) and insect prey (about 60% of loads March – April and 15% for other times in the year; Plates 2 and 3; Breen, 1976). Honeydew is the excreta of aphids (Homoptera; Aphidoidea). The aphids attended by Hairy Wood Ants in Ireland were documented by Breen (1979a). In coniferous

plantations, the important species are *Cinara* species of the family Lachnidae. In the order of importance, the host trees for *Cinara* species are Scots Pine, Norway and Sitka Spruce (Plates 4 and 5), and European *Larix decidua* and Japanese Larch *L. kaempferi*. It is should be noted that aphids do not occur on Lodgepole Pine and that Hairy Wood Ants do not collect honeydew from the widespread and common Green Spruce Aphid, *Elatobium abietinum*.

In native woodland, the Hairy Wood Ant collects honeydew from *Lachnus roboris* which occurs on oak in Killarney and from *Symydobius oblongus* (Plate 6) which is more widely distributed on birch (e.g. at Cappamurra Bog).

While the *Cinara* species occurring on Scots Pine may be native (depending on whether, or not, Scots Pine became extinct in Ireland), the other conifer aphids are certainly introduced. However, it is likely that the aphids on oak and birch are native species.

Other species associated with Hairy Wood Ant

Myrmecophiles are species which occur in the nests of ants and are at least partially dependent on the ants. Breen (1976) listed the myrmecophiles associated with Hairy Wood Ants in Ireland. These include fifteen species of beetles (Coleoptera), mainly family Staphylinidae, and two species of spider (Araneae) (Appendix 2). Three species of the beetles and one species of spider were additions to the Irish lists and most of the species of the other beetles have only been reported in association with either the Scottish or Hairy Wood Ant in Ireland.

Summary of important points on the biology of Hairy Wood Ant

- The Irish population is genetically distinct from the English population and can be considered to be an ancient colonization rather than introduced by humans;
- The colonies are both monogynous and monodomous in Ireland; hence it is difficult to intervene to produce new nests simply by dividing them;
- The number of colonies is almost exactly the effective breeding size of the population;
- The colonies have a major requirement for the correct aphids to provide honeydew;
- The most suitable tree species for aphids is Scots Pine. The two species of spruce (Sitka and Norway) also provide suitable hosts for aphids. Lodgepole Pine does not support aphids.
- Scots Pine is also the most suitable species for providing an open canopy, and the canopy in spruce woodland is more dense and less favourable for the nests;
- The colonies are top predators in a complex forest ecosystem which includes ant-aphid, ant-myrmecophile, predator-prey interactions;

Distribution in Ireland

Historically, the Hairy Wood Ant was known from sites in Wicklow, Wexford, Waterford, Tipperary, Limerick, Kerry and Galway (Figure 1). The history of the known distribution was summarized by Breen (1977). The main sources for the information in this updated account are: Stelfox (1927), Collingwood (1958), Breen (1977), Breen (2002) and the present study. The species was last seen in Wicklow in 1929, Wexford in 1896, Waterford in 1927 (Table 1; the information for these three counties is based on published records and specimens in the National Museum of Ireland, Dublin) and Limerick, during the late 1970s by me. In some cases, it is likely that the actual number of nests at these sites was low. However, nests of the Hairy Wood Ant still occur in Tipperary, the species' main stronghold, in Kerry and in Galway. Pre-1960, the known records for Ireland were from ten hectads, though the species was probably present in sixteen hectads at that time. During the mid-1970s, the species was recorded from seven hectads, of which five were in Tipperary and with one each in Kerry (Killarney) and Galway (Woodford). Post-2000, the species distribution has contracted further, to just two hectads in both Tipperary and Galway and one in Kerry (Breen 1977; Breen 2002; Mäki-Petäys & Breen 2007; unpublished data). An updated distribution map is in Figure 1.

Table 1 Summary of the occurrence of *Formica lugubris* at localities in Irish counties where the species has not been seen since 2000 based on Breen (1977) and, where listed, the original source literature. NMI = National Museum of Ireland.

County	Last county record	Former sites	Source of record
Kerry	Still extant in Killarney National Park	Rossbehy (V69); Lough Caragh (V79). Records from Parknasilla and Valentia in Stelfox (1927) do not refer to this species (Breen, 1977)	Bouskell (1905); Stelfox (1927)
Limerick	1970s	Galtee Forest (R8818)	O'Flanagan & Moloney (1973); Breen pers. obs.
Waterford	1927	"two miles south of Clonmel" (Delap) (S11); Russellstown Wood (S11) (specimen in NMI collected 1927)	Delap (1896);
Wicklow	1929	Annamoe (T19), Clara (T19),	Stelfox (1924, 1927)

		Devil's Glen (T29)	
Wexford	1896	Ballyhyland Wood (S84), Killoughrim (S84)	Moffat (1896)

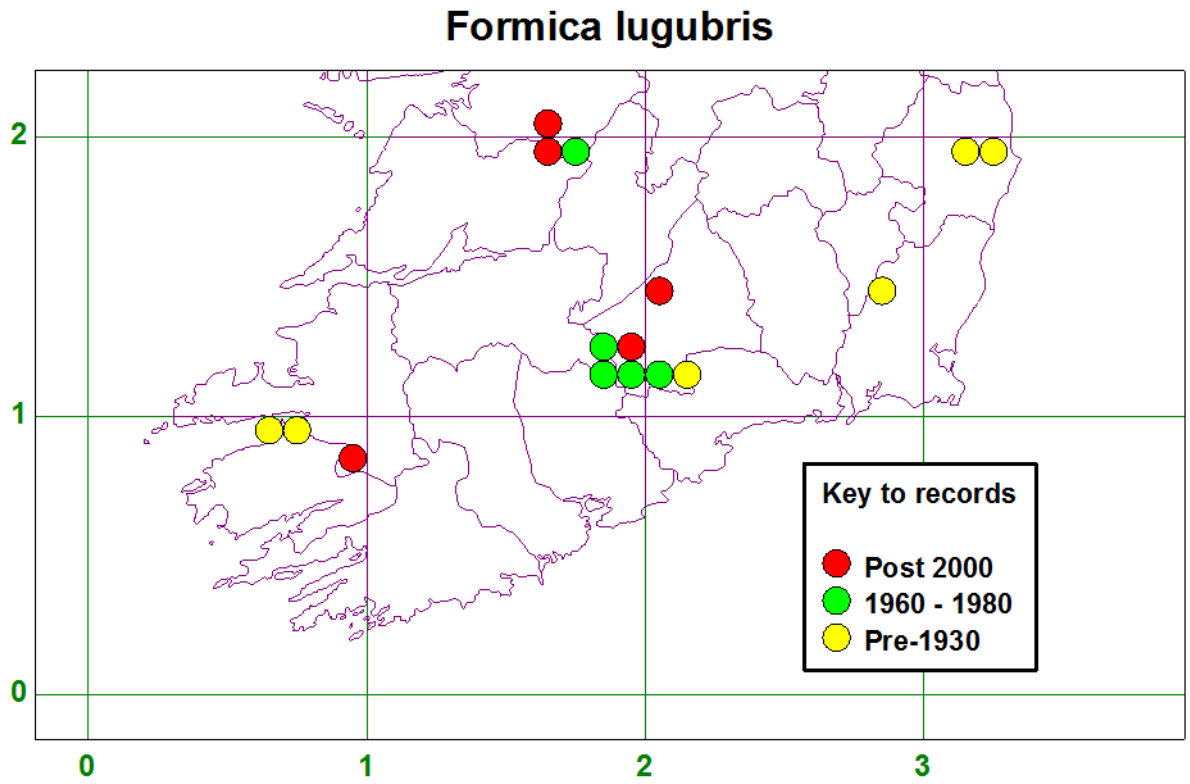

Figure 1: Distribution of the Hairy Wood Ant in Ireland. The plotted hectads have been updated from earlier publications (e.g. Breen 1977) and the reduced number of symbols and their placing reflects a more accurate assessment of the previous records.

Distribution 1970s – 2002

I completed my PhD on *Formica lugubris* in 1976 (Breen 1976) and visited the sites regularly until 1980, and less frequently since then. During the 1970s, access to local workers in each of the woods meant that it was possible to compile maps which were reasonably complete; about 200 nests were known to me. During Summer 2002, the Heritage Council, with supplementary funding from Coillte, funded a mapping of the nests of the Hairy Wood Ant in South Tipperary (Breen 2002). This study concluded that there was a serious decline in numbers of nests during the period since the mid-1970s. Since the survey was largely the work of one person (Alison Byron, with some added days by me) during one summer season, it could not have been as complete as the 1970s mapping, and only about 50 nests were reported, mostly in Kilcoran and Scartnaglorane, with none found in woods where they were frequent during the 1970s, e.g. Ardane (see Breen 1979c) and only a few in Glengarra (see below, for a map showing these localities). Nevertheless, the main stronghold of the species was, and continues to

be, in Coillte properties in South Tipperary (Figure 2). Woodlands where nests are known, or were known, are colour-coded in one of three ways. Blue shading indicates formerly occupied woodlands with no records since the 1970s. Yellow shading indicates woods that had nests in 2002 but not since and red shading shows the woods with active nests in 2012 and 2013. These are referred to later as High Priority localities. I will refer to these colour codes again when discussing management options.

Since 1970 the species has only been recorded from three areas in Ireland, near Woodford in Co. Galway, Killarney National Park, Co. Kerry and the Galtee/Knockmealdown Mountains, south Co. Tipperary. Nests were present in Co. Limerick but this was an outlier of the Tipperary population. The distribution and status of the species in these three areas will now be described.

Co. Tipperary

The species was first found during the 1940s in Tipperary by Stelfox and Morris in Ballinacourty Wood, Glen of Aherlow on Slievenamuck (O'Rourke 1950). The species has not been seen on Slievenamuck since. However the main range of the species in Tipperary is in the woods on the Galtee and Knockmealdown Mountains (Breen, 1977).

The South Tipperary woodlands that have contained Hairy Wood Ant nests since 1970 can be listed, as follows, clockwise on the Galtee Mountain range (Figure 2, see figure legend for colour code): Rossbog (blue), Rossadrehid (blue), Ardane (blue), Scartnaglorane (red), Kilcoran (red), Boolakennedy (yellow), Glengarra (yellow), Coolagarranroe (blue), Galtee (blue). Two woods on the Knockmealdown Mountains, just south of Clogheen are: Shanrahan (blue) and Killballyboy (now Mountanglesby) (blue). An indication of the decline in the numbers of nests known in South Tipperary can be seen in Table 2.

Table 2: The numbers of nests of Hairy Wood Ants in four Co. Tipperary woodlands, 1977 and 2002.

Wood	**Breen (1977)**	**2002 survey**
Kilcoran	93	33
Glengarra	47	3
Ardane	43	0
Boulakennedy	3	5

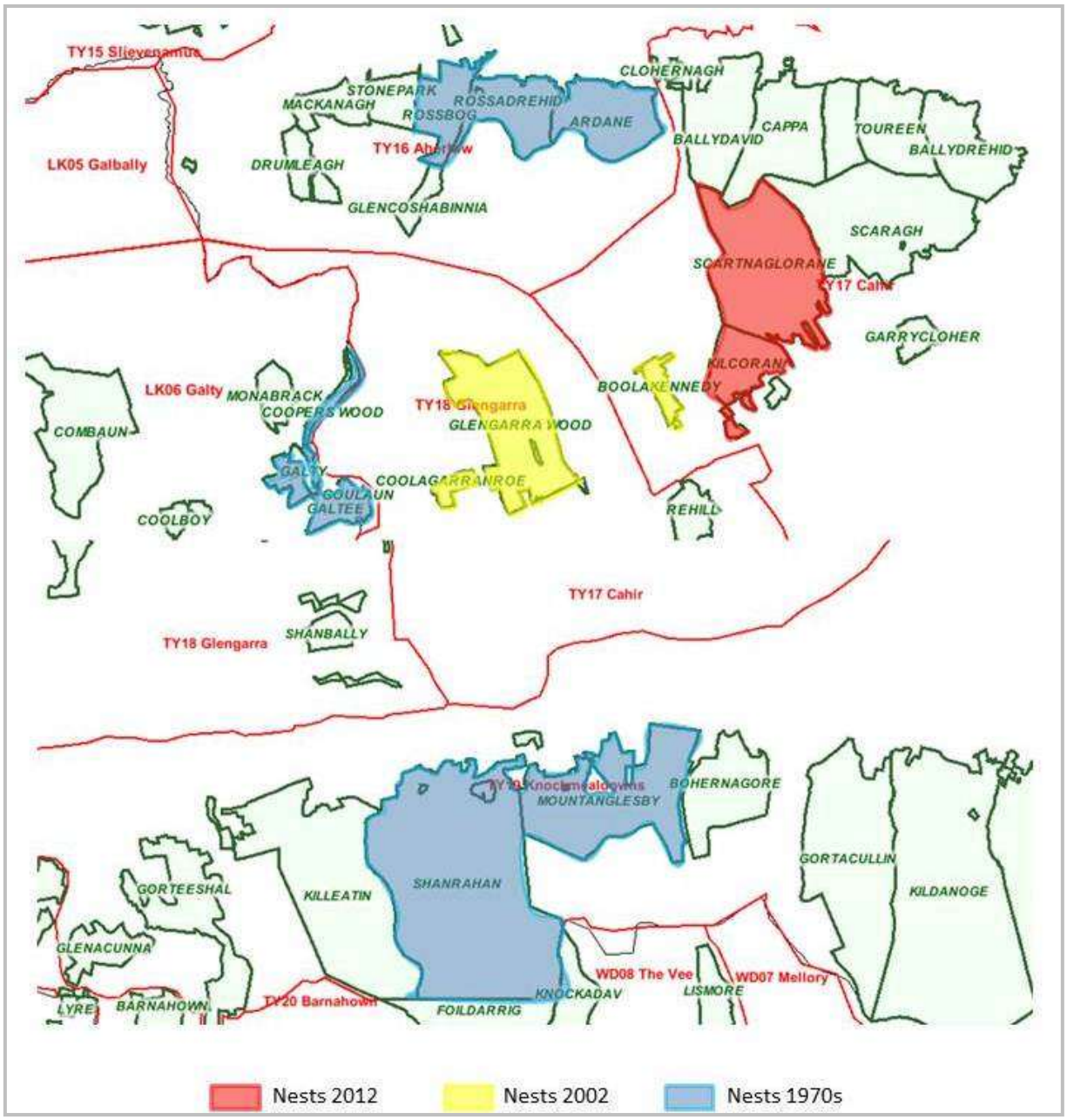

Figure 2: Distribution of Hairy Wood Ant in Coillte properties in South Tipperary. The occupied properties are colour coded according to when nests were last seen in the property.

Distribution in 2012

The timescale for the present report only allowed a small number of days in the field, so, it is not possible to give an accurate number of nests for 2012/2013. An attempt was made to visit sites where nests were found in 2002. As of August 2013, the following numbers of nests are known: Scartnaglorane and Kilcoran (33), but no nests are now known in Boulakennedy (0). The distribution of the 33 nests is Scartnaglorane and Kilcoran is shown in Figures 3 and 4. Figure 3 is overlain on ortho photographs, Figure 4 on the 1:50000 OS Discovery maps.

Elsewhere in Tipperary, four nests are confirmed at Cappamurra Bog, about 2.5km east of Dundrum, Co. Tipperary (Figure 5). These nests were discovered by Christopher Wilson about 1990 and reported to me in 2006. The site is cut-over bog with Scots Pine and birch. These nests are in private property.

Figure 3: Distribution of Hairy Wood Ant nests known to exist in 2012 and 2013 in Kilcoran and Scartnaglorane properties, South Tipperary. 1:20000 scale

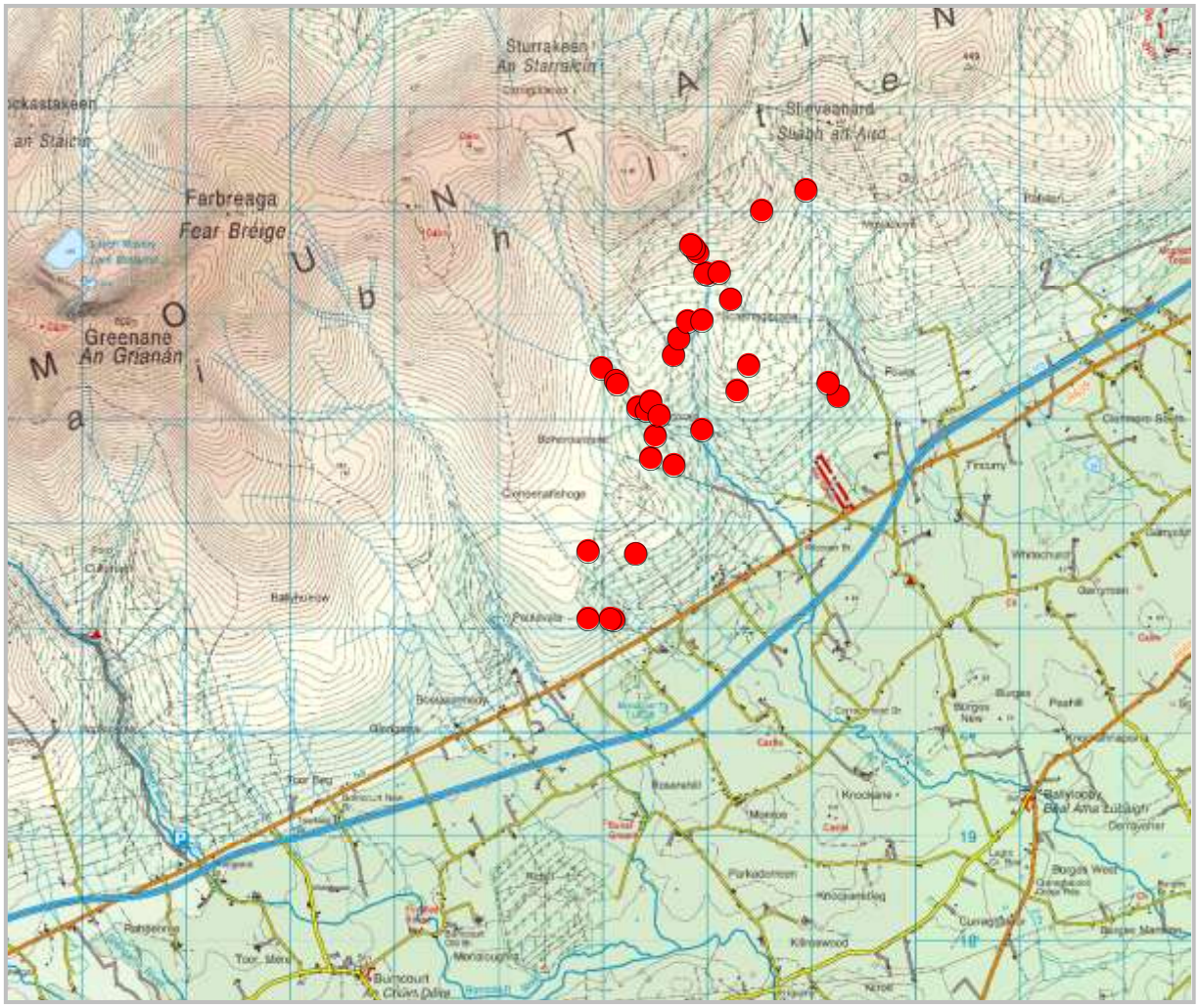

Figure 4 Distribution of Hairy Wood Ant nests known to exist in 2012 and 2013 in Galtee Mountains, South Tipperary overlain on 1:50000 OS map.

Figure 5: Distribution of Hairy Wood Ant nests known to exist in 2012 and 2013 at Cappamurra, Co Tipperary overlain on 1:50000 OS map.

Co. Galway

In Galway, four nests were known in Derrycrag and Derrygill woods (Figure 5, blue shading), just south of the village of Woodford, until about 1980. Subsequent searches in the area did not yield any nests and the species was presumed extinct in the area. However, in 2010 three nests were reported from a different property, Toorleitra Farrans, to the west of Woodford (Dermot Cunniffe and Aileen O'Sullivan, Coillte, personal communication 2010) and a fourth nest was here confirmed in 2012 (Figure 6 colour coded red; Plate 1). Three nests occur at one locality (M6700) and a single nest occurs at a separate locality about 1.5km distant (R6798) (Figure 7). Between them, the two sites are in two hectads, which is generous considering the actual number of nests (1 and 3 nests in each hectad, respectively).

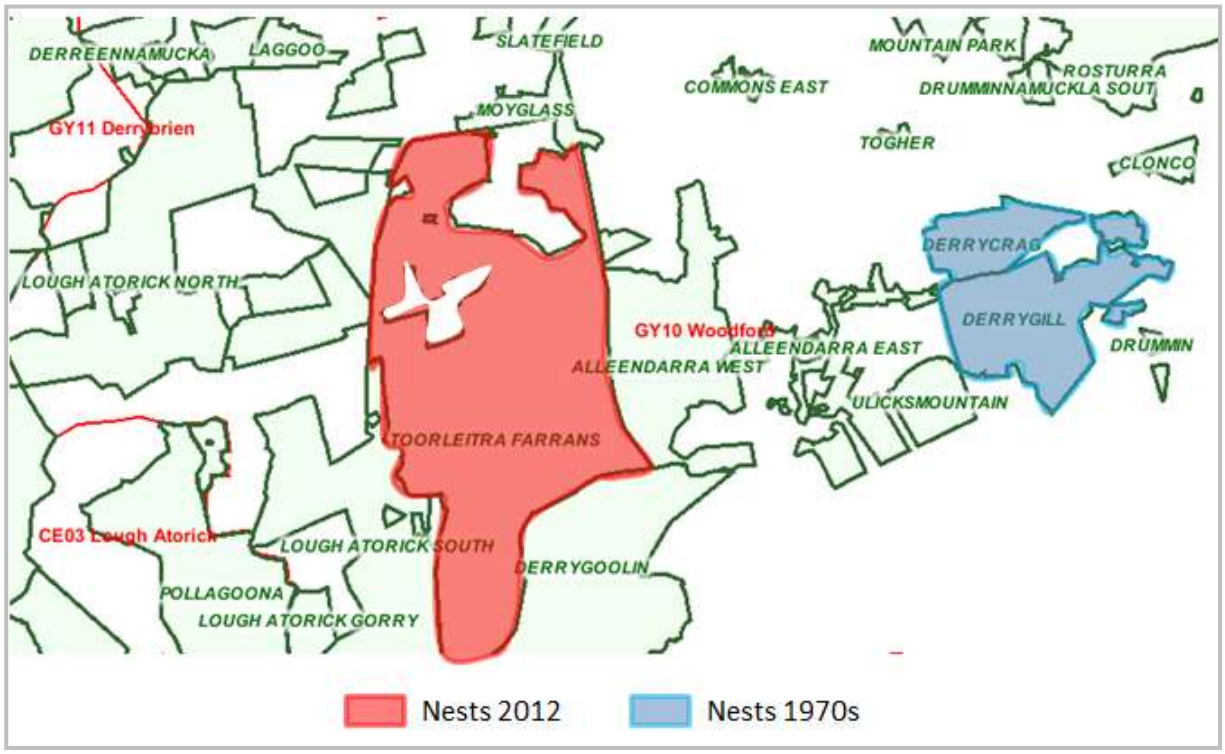

Figure 6: Distribution of Hairy Wood Ant in Coillte properties, Woodford, Co. Galway. The occupied properties are colour coded according to when nests were last seen in the property.

Figure 6: Distribution of Hairy Wood Ant nests known to exist in 2012 and 2013 at Woodford, Co. Galway overlain on 1:50000 OS map.

Co. Kerry

Formica lugubris has been known from Kerry since the mid nineteenth century when it was listed from Rossbehy by Haliday. Three nests were reported at Long Range and on Cromaglaun Mtn in Cuthbert (1898). Records from Parknasilla and Valentia in Stelfox (1927) do not refer to this species. A single nest was found in the Lough Caragh catchment in 1903, but none have been seen since. All the records since 1927 have been within the current boundaries of the Killarney National Park in the woodlands to the south and west of Muckross Lake (Figure 7). The nests are widely scattered in native oak woodland and in inaccessible locations. Eight nests were known in 2002. Based on enquiries, I believe the species is still present in some of the known localities mainly in Glena, Glasheenamarrive, Long Range and Cloghfune (V98).

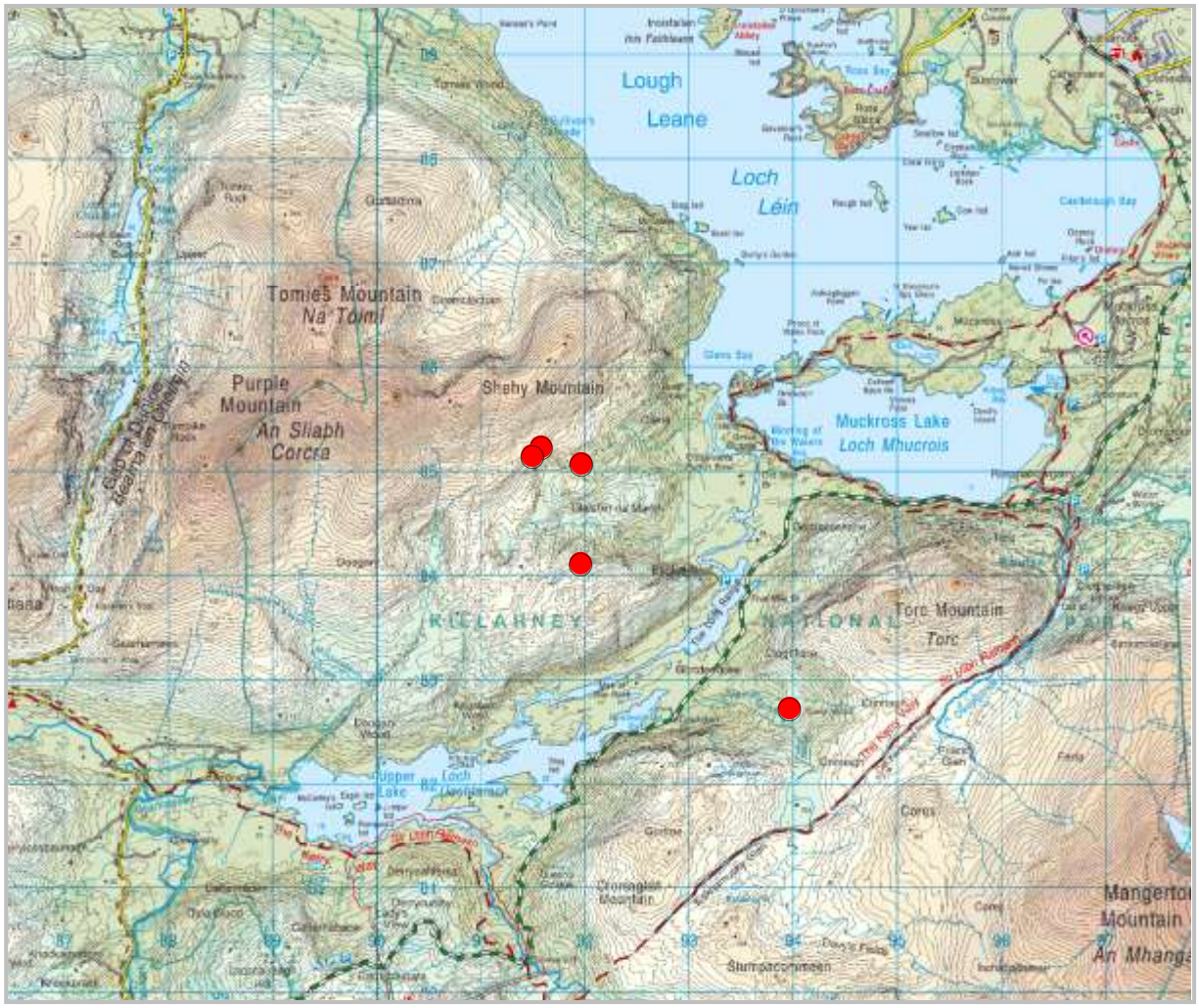

Figure 7: Distribution of Hairy Wood Ant nests in Killarney National Park, Co. Kerry overlain on 1:50000 OS map. The red symbols indicate the approximate position of the known nests.

Summary of current distribution

- Two woodlands, Kilcoran and Scartnaglorane on the southern slopes of the Galtee Mountains, Co. Tipperary
- Cappamurra Bog, Co. Tipperary
- Killarney National Park, Co. Kerry
- Near Woodford, Co. Galway

Woods, especially in South Tipperary, where the species were found in 2002 (shaded yellow in Figure 2) should be searched for possible nests and their status upgraded immediately to High Priority sites (red shading) if nests are found.

Recommendations for the conservation of Hairy Wood Ant

Processes to be put in place

There is an urgent need for processes to be put in place to ensure that the management recommendations in this report are carried out and are passed to new personnel whenever management personnel change in the woodlands mentioned in this report.

The recommendations are given as follows under headings of survey and monitoring; management around nest sites; management of wider forest area; public participation; legislation and future research:

Survey and monitoring

- The distribution of nests should be monitored regularly; locations of nests should be recorded accurately using GPS. All data on nest location should be deposited as soon as possible in the NBDC and made fully available to appropriate staff in National Parks and Wildlife Service, Forest Service and Coillte.
- Nest surveys should be carried out periodically and at least once every 10 years at all High Priority sites.
- If nests are found in any new locations or rediscovered in old locations, a thorough survey should be conducted to assess extent and population size
- Thorough surveys should be done around Cappamurra to determine if the species is present in plantation woodland.
- NPWS should conduct a repeat and comprehensive survey in Killarney National Park.

Management around nest sites

- All nests should be marked appropriately so that they can be avoided in routine maintenance work.
- Herbicides, fungicides, insecticides and fertilizers should not be used within 100m of active nests.
- Trees should be thinned selectively around all nests so that the risk of shading is avoided.
- Tree surveys should be done with 500m of active nests to ensure that there is sufficient potential host trees for aphid colonies.

Management within forest compartments

- Appropriate management of rides in Kilcoran and Scartnaglorane should be implemented to ensure that they are kept more open especially on the south-facing sides and that tree species which can support aphid colonies are planted or allowed to grow.
- Use of fertilizers, insecticides, herbicides and fungicides should be strictly controlled within occupied rides.
- This management should be implemented also in the occupied compartments at Woodford and in the conifer plantation adjacent to Cappamurra (dependent on survey results) to encourage the spread of the species through forest areas.
- In Killarney National Park similar management should be implemented to create warm glades within woodland and appropriate edge habitat. All occupied areas in Killarney should be kept free of Rhododendron.
- The requirements of the species should be given full consideration in all planting and felling applications submitted to Forest Service. This to include timing of felling and the species mix when replanting.
- In the small number of High Priority sites large stands of trees should be replaced, over an agreed time span, with a mosaic of smaller plots of suitable tree species which, in turn, will lead to smaller coupe sizes at the felling stage. The felling and planting regimes should be planned to encourage the development of a mosaic of plantings e.g. of 1-hectare size, which in turn will mature at different times to allow a mosaic pattern at felling.
- Appropriate felling procedures, especially in the High Priority areas (red shading in Figures 2 and 3) need to be put in place. These will include the identification, clear marking and retention of aphid trees (which can be done easily during the active season) and sufficient other trees to provide protection e.g. from wind damage; this is likely to be in a radius of 80 metres from nests. Wherever possible, a policy of continuous cover management should be implemented in the immediate vicinity (50 metre radius) of known nests.

Publicity and public participation

- A wood ant website should be set up in collaboration of the relevant organisations to highlight the species in Ireland.
- Naturalists, walkers and other members of the public should be asked to submit records of nests.
- Links with local schools should be encouraged.

Research and legislation

- Research should be done on how to increase the population away from core areas including aspects such as generating mated queens.
- There should be a long-term aim of reintroducing the species into its former range including the Caragh catchment in Co. Kerry, Killoughrim in Co. Wexford and Clara in Co. Wicklow. In known localities such as Killarney National Park and Woodford, Co. Galway there should be specific aims of expanding the species within its core areas.
- The species should be added to Schedule 5 of the Wildlife Act and specific NHAs should be designated for the species within its core range.

Classification of "High Priority" habitat

For the present, all localities where the nests are known to occur in 2012 should be considered as High Priority areas. These are marked with red shading in Figures 2 and 6. These are:

- The entire properties of Kilcoran and Scartnaglorane;
- Parts of the woods in Toorleitra Farrans property, Woodford within a 500 metre radius of existing nests. This can be updated if further nests are discovered in this area;
- Parts of the cut-over bog at Cappamurra, near Dundrum, Co. Tipperary within a 500 metre radius of existing nests. This can be updated if further nests are discovered in this area.
- Oak woodland in Killarney National Park in areas where nests have been found since 2000;
- Other areas adjacent to where Hairy Wood Ants are known to occur, especially those where nests were found in the 2002 Survey (yellow shading in Figure 2) should be checked at intervals. These sites are adjacent to current High Priority sites. If nests are discovered, these sites should then be treated as High Priority sites.

Conclusion

A national management strategy is needed urgently for the conservation of the remnant population of Hairy Wood Ant in Ireland. The effective population size is very small. However, this population is unique to Ireland and it deserves every chance to ensure its survival. I believe that pro-active intervention just might be still in time to save the species in Irish woodland.

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Plates

All photographs are © John Breen but may be used for publicity associated with the conservation of Hairy Wood Ant in Ireland.

Plate 1: Nest of Hairy Wood Ant *Formica lugubris*, Woodford, Co. Galway, 2012.

Plate 2: Worker Hairy Wood Ant returning to nest with sawfly caterpillar as prey, Scartnaglorane, Sept. 2012.

Plate 3: Hairy Wood Ant workers returning to nest with sawfly caterpillar as prey, Scartnaglorane, Sept. 2012.

Plate 4: *Formica lugubris* workers attending *Cinara pruinosa* on Sitka Spruce, Scartnaglorane, 2013.

Plate 5: Hairy Wood Ant workers attending *Cinara pruinosa* on Sitka Spruce, Scartnaglorane, September 2012.

Plate 6: Hairy Wood Ant workers attending *Symydobius oblongus* on Birch, Cappamurra, 2013.

Plate 7: Hairy Wood Ant workers attending *Cinara kochiana* on European Larch, Scartnaglorane, 2013. An aphid excreting honeydew is seen at lower left of the picture.

Plate 8: *Formica lugubris* workers attending *Cinara piceae* on Sitka Spruce, Scartnaglorane, 2013.

Appendices

Appendix 1 Key differences between the worker castes of Northern Wood Ant *F. aquilonia* and Hairy Wood Ant *F. lugubris,* (based on Hughes, 2006). The five characteristics are all variable and it is advisable to examine a number of individuals from the same colony.

Northern Wood Ant *Formica aquilonia*	Hairy Wood Ant *Formica lugubris*
1. Long hairs on the mesopleuron almost entirely restricted to lower anterior part so that when the insect is viewed from above its sides do not appear conspicuously hairy. Hairs shorter than in *F. lugubris* and mainly on the promesonotum (1 on Figure 8 below).	1. Long hairs on mesopleuron arise over the whole surface so that when viewed from above the sides of the insect appear very hairy. Hairs longer and extending over the whole alitrunk dorsum (see below 1).
2. Temples usually with short outstanding hairs which rarely form a conspicuous fringe around the back of the head and are sometimes wanting (smaller workers) (2 on Figures 8 & 9 below).	2. Temples usually with copious long outstanding hairs forming a conspicuous fringe which extends forward beneath the eyes ((2 on Figures 8 & 9 below).
3. Dorsal surface of petiole without long hairs.	3. Dorsal surface of petiole with long hairs.
4. Workers are smaller and less polymorphic than *F. lugubris*.	4. Workers polymorphic, generally larger and often more aggressive than *F. aquilonia*.
5. Tend to build larger, steeper mounds than *F. lugubris*, in denser shade.	5. Tend to build flattish, often more loosely thatched mounds away from shade.

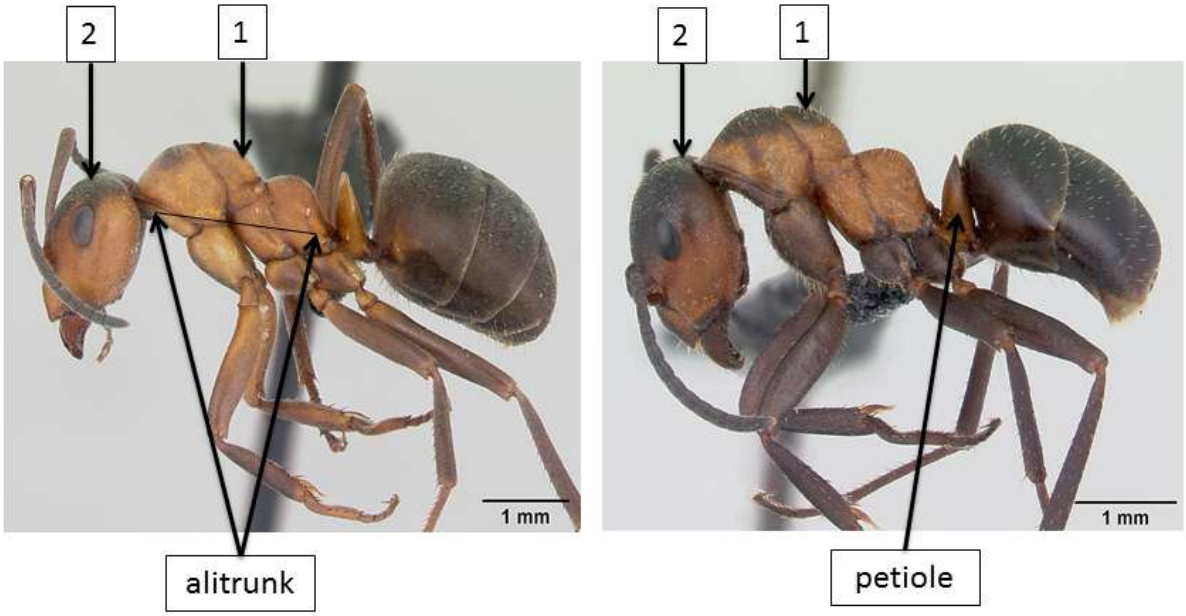

Figure 8: Side view of workers of *Formica aquilionia* (left) and *Formica lugubris* (right). Images by April Nobile from www.antweb.org, accessed 1 December 2013

Figure 9: View of head of *Formica aquilonia* (top) and *F. lugubris* (bottom) showing the differences in the hairiness of the head. Images by April Nobile from www.antweb.org, accessed 1 December 2013.

Appendix 2. Records of myrmecophiles associated with wood ants in Ireland. The Armagh records are published records taken with *Formica aquilonia*, and all the other records are from *Formica lugubris* nests. The locality numbers are as follows:

Locality Number	Irish Grid Square	Location
1	V98	North Kerry: Glena, Cromaglaun
2	R81	Limerick: Galtee Forest
3	R91	South Tipperary: Glengarra
4	S01	South Tipperary: Kilballyboy
5	R92	South Tipperary: Rossbog
6	R82	South Tipperary: Kilcoran, Boulakennedy, Rossadrehid, Ardane (one wood renamed to be consistent with name in maps above)
7	R79	South Galway: Derrycrag Wood, Woodford.

Species	Previous Irish records*	Breen (1976) (locality numbers)
Staphylinidae		
Oxypoda formiceticola Märkel	Woodford, Armagh, (b, c)	Not seen
O. haemorrhoa (Mannerheim)	Armagh (b) + Others (d)	Not seen
Thiasophila angulata (Erichson)	Armagh (b), Woodford (c)	1,2,4,6,7
Nototheca flavipes (Gravenhorst)	Armagh (c)	1,2,4,6,7
Lyprocorrhe anceps (Erichson) (e)	-	1,4,6,7
Othius subuliformis Stephens (f)	Others (d)	1,2,3,4,6,7
Quedius brevis Erichson	Caragh Lake (a), Armagh (b)	Not seen
Geostiba circellaris (Gravenhorst) (g)	-	1,2,6,7
Amidobia talpa (Heer) (h)	Armagh (c)	Not seen
Scydmaenidae		
Stenichnus collaris (Müller)	Others (d)	1,6,7
Rhizophagidae		
Monotoma conicicollis Guérin-Méneville (i)	Woodford and Armagh (c)	Not seen
M. angusticollis (Gyllenhal)	Caragh Lake (a), Armagh (c)	Not seen
Chrysomelidae		
Clytra quadripunctata L.	Caragh Lake (a)	Not seen
Ptiliidae		
Acrotrichis montandoni (Allibert.)	Armagh (c)	6,7
Ptenidium sp. (? *pusillum* (Gyllenhal))		6

Diplopoda		
Proteroiulus fuscus (Am Stein)	Others (d)	1,2,6,7
Cylindroiulus punctatus (Leach)	Others (d)	1,2,6,7
Pseudoscorpiones		
Neobisium carcinoides (Hermann) (i)	Others (d)	7
Araneae		
Thyreosthenius biovatus O.P-Cambridge	-	4,6,7
Hahnia helveola Simon	Others (d)	6

Notes (a) = Bouskell (1905); (b) = Collingwood (1959); (c) = Collingwood (1965); (d) Others = other records not associated with wood ants; (e) = formerly known as *Nototheca anceps;* (f) = formerly known as *Othius myrmecophilus* Kiesenwetter; (g) = formerly known as *Sipalia circellaris* (Gravenhorst); (h) formerly known as *Atheta talpa* (Heer); (i) = formerly known as *Neobisium muscorum* (Leach).