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COLLECTIONS OF ICHNEUMONID WASPS (SUBFAMILIES DIACRITINAE, DIPLAZONTINAE, PIMPLINAE AND POEMENIINAE) FROM WOODLANDS NEAR YORK AND THEIR IMPLICATIONS FOR CONSERVATION PLANNING

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INTRODUCTION

Conservation planning is largely based on knowledge of the distribution and abundance of organisms. However, such knowledge is biased, taxonomically and hence functionally, particularly towards vertebrates and other large readily-identifiable organisms (Samways, 2005; IUCN, 2007). One possible consequence of this knowledge bias is that other taxa may be less well served by conservation planning. This situation is particularly problematic when it is considered that the latter category of organisms includes the majority of species, many of which provide essential ecosystem services (Samways, 2005).

Parasitic wasps comprise a sizeable component of terrestrial biodiversity, including 25% of all British insect species (Shaw & Hochberg, 2001). The vast majority develop as parasitoids, growing to maturity on the still-living body of another host arthropod, eventually killing it. Parasitoids are a substantial component of higher trophic levels in terrestrial ecosystems, and a major source of mortality in herbivorous insects (see Hawkins, 1994). Operating at higher trophic levels suggests an intrinsic vulnerability to extinction (Purvis *et al.*, 2000), and this may be exacerbated by the high degree of trophic specialization displayed by many species. Indeed, there is evidence that parasitoids are highly sensitive to several extinction threats, such as habitat fragmentation (Kruess & Tscharntke, 1994), and climate change (Stireman *et al.*, 2005). These facts collectively suggest a strong case for including parasitic wasps in conservation planning, but this has almost entirely failed to happen, a fact illustrated by the almost complete absence of any parasitoids from red data books in the UK or elsewhere (Shaw & Hochberg, 2001). Perhaps the greatest hindrance to this is a lack of species-level biological knowledge, for example on population status, detailed host ranges, habitat requirements, and geographic distribution, which has made it impossible to apply species-level conservation. This in turn may largely be due to a perceived lack of taxonomic tractability, something that is no longer the case for a number of groups (Shaw & Hochberg, 2001). Indeed, parasitic wasps, in addition to being highly collectable, provide excellent opportunities for amateur naturalists to make real advances in knowledge that could be of use to conservation.

In addition to the lack of species-level knowledge, is a general lack of knowledge of how parasitoid communities vary within and across habitats (Fraser *et al.*, 2007). In principle, such knowledge could enable parasitoids to be conserved effectively via the conservation of an appropriate range, quantity and connectivity of habitats. However, the relevance to parasitoid wasps of habitat classifications used in conservation, such as the National Vegetation Classification in the UK, is unknown, and even recent attempts to explicitly include insects in habitat classification schemes (e.g. Webb & Lott, 2006) fail to consider parasitoids or parasitic wasps. The above information suggests that there may be real problems with parasitoid conservation that are widely unappreciated. The limited data on population declines also suggests this; for example, Shaw (2006), reviewing

British Pimplinae and Poemeniinae (Ichneumonidae), noted a worrying absence of recent specimens of nine species (8% of British spp.), whilst Thirion (1981) was unable to find 32 (26%) spp. of Belgian Ichneumoninae during a 25-year collecting period, with another 30 species (25%) showing major declines.

The overall aim of our study was to provide some of the first information on habitat indicators of abundance and diversity for parasitoid wasps, which might hence allow parasitoids to be incorporated into conservation planning, particularly with respect to identifying priority habitats, to managing existing habitats, or to planning new habitat creation in appropriate ways. In order to accomplish this, we made extensive collections of four subfamilies of ichneumonids (Hymenoptera: Ichneumonidae) from 15 woods near York in 2003, and more intensive collections from two of the 15 in 2004.

Woodlands were chosen as the focus of our study for both practical and theoretical reasons. Practically, woodlands provide discrete and easily identifiable habitat patches to use as sampling units, which are relatively free from disturbance, with a broad range of vegetation types. Theoretically, they serve as major biodiversity reservoirs in agricultural landscapes (e.g. Petit & Usher, 1998), and are the subject of ongoing debate and change in conservation management practices (Forestry Commission, 2002, 2004; Rackham, 2006). We therefore felt that there was the potential to make immediate recommendations that might bring parasitoids into consideration. Although it was not the main focus of our study, our collections have provided information on the abundance, geographic distribution, and habitat preferences of many species. They may also have potential as baseline data for future monitoring. Our aim in this paper is to summarize the latter information.

METHODS

Taxa Studied

Four moderately related ichneumonid sub-families (cf. Wahl & Gauld, 1998) were chosen for study: Diacritinae, Diplazontinae, Pimplinae, and Poemeniinae. These sub-families show a variety of life histories and have useable species level keys (Beirne, 1941; Fitton *et al.*, 1988). They have also been used as biodiversity indicators in diverse geographic locations (see Thirion, 1994; Gaston & Gauld, 1993; Sääksjärvi *et al.*, 2004).

The Diplazontinae is a relatively small sub-family with 56 species in 12 genera in the British Isles (Broad, 2008). All species encountered in our study are thought to be endoparasitoids of aphidophagous Syrphidae (Diptera). For further details of species' biology, Kerrich (1949) gives some details on English distributions, and Beirne (1941) some brief information on distribution and abundance. Nomenclature changes mean that the latter need to be used in conjunction with Broad (2008). Thirion (1994) provides an overview on species' biology in Belgium and includes world distribution data, habitats, and lists host records from the literature, many of which are likely to be erroneous. A more reliable, but less complete, source for the latter is Fitton and Rotheray (1982), which gives some other biological details.

The sub-family Pimplinae exhibits a wider range of life histories and hosts than any other sub-family of the Ichneumonidae (Fitton *et al.*, 1988). In the British Isles, there are 107 species in 31 genera (Broad, 2008). The sub-families Poemeniinae and Diacritinae were previously grouped within the Pimplinae (Fitton *et al.*, 1988) and were included in this study for that reason, although they are now recognised as distinct sub-families (Wahl & Gauld, 1998; Gauld *et al.*, 2002). The Poemeniinae contain six species in the British Isles (Broad, 2008). Members of the Poemeniinae develop as ectoparasitoids and are most often collected in association with dead and standing timber (Fitton *et al.*, 1988). Details on biology and British distribution of Pimplinae and Poemeniinae are given in Fitton et al. (1988), and Shaw (2006), which should be used in conjunction. Global distributions of European species are given by Zwakhals (2004).

Diacritinae is one of the few sub-families of Ichneumonidae for which the hosts are completely unknown (Wahl & Gauld, 1998). In Europe only one species is known, *Diacritus aciculatus* (Vollenhoven) (Fitton *et al.*, 1988).

Study Area

Fifteen woodlands in the Vale of York were chosen for extensive sampling at the landscape-scale in 2003 (see Fraser *et al.*, 2007) and two of these were selected for intensive patch-scale analyses in 2004 (see Fraser *et al.*, 2008a) (Fig. 1). The chosen woodlands were all larger than 2 ha since smaller patches of habitat may not be capable of supporting insect communities distinct from surrounding habitats (Levenson, 1981). Although no maximum size was determined for the selection of woodlands, selection was limited to farm woodlands which are relatively small with none of those used here exceeding 20 ha (Table 1). As can be seen (Fig. 1), the woods sampled span a fairly wide geographic area, although some woods are separated by only a few tens of metres.

Sampling

Malaise traps are a form of flight interception trap which are generally considered to be the best means of obtaining large, general samples of Ichneumonidae from most habitats (Fitton *et al.*, 1988), and which have been used extensively for this purpose (Owen & Owen, 1974; Noyes, 1989a, 1989b; Owen, 1991; Bartlett *et al.*, 1999; Sperber *et al.*, 2004). These traps sample the field-herb layer and only provide data on assemblages using or flying through this part of the woodland. The trap operates continuously and may be left unattended (Fitton *et al.*, 1988) therefore allowing the collection of multiple samples over the same time period. The traps used in this study were supplied by Marris House Nets (Bournemouth, UK) and follow the design of Townes (1972). The Malaise traps were all black in colour, 1.8 m high at the collection head end, tapering to 1 m high at the opposite end, and were 1.8 m in length (Figs 2 & 3).

In the extensive sample (2003), two Malaise traps, a minimum of 20 m apart, were set up 10-20 m in from the southern woodland edge either side of the midpoint of the edge of each wood (see Fraser *et al.*, 2007 for details). Fifteen woodlands (see Fig.1, Table 1) were sampled. In the intensive sample (2004), 16 and 14 Malaise traps

respectively were used in two woodlands (Copmanthorpe Wood and New Covert, see Fig. 1), and these traps were divided into peripheral (southern edge as in 2003) and core locations (40-50 m from the woodland centre) (see Fraser *et al.*, 2008a for details). Again, traps were a minimum of 20 m apart. Traps were open for two weeks in July and two weeks in August, an important part of the flight season, in both 2003 and 2004. Samples were stored at room temperature in the dark in 70% ethanol. They were sorted by decanting the sample into a white tray and removing all ichneumonoids by eye: when no new individuals were observed in the sample for about 15 minutes, it was assumed that all individuals had been extracted. Ichneumonids were then keyed out to subfamily and finally all those in the four target subfamilies were individually dry mounted and keyed to species. Voucher specimens are deposited at the National Museums of Scotland, Edinburgh. The locations, numbers, sex and dates of each species collected are listed below. Species are said to be recorded "throughout the British Isles" if records for England, Scotland, Wales, Ireland and the Isle of Man all exist (i.e. covering all five of the distributional categories used by Broad, 2008). Sex ratio was not noted prior to the collection being dispersed. Subsequently (ix/08) the sex of all traceable specimens was recorded, but, because not every specimen could be traced, this does not always sum to the total number of specimens collected. Nevertheless, the number of untraceable specimens was a relatively small proportion of the total.

Habitat Survey

In order to identify possible habitat indicators of parasitoid abundance and diversity, a suite of habitat variables were measured for comparison with parasitoid data. The vegetation survey was carried out in late July/early August 2003 and 2004. Vegetation was sampled at the site of the Malaise trap and then more widely across each woodland using quadrats on two scales: 20 m x 20 m for the canopy trees and shrub layer and 2 m x 2 m for the field and herb layer. Each Malaise trap was at the centre of a 20 m quadrat to give a detailed record of the vegetation present around the trap. At random co-ordinates within this quadrat, five 2 m quadrats were surveyed. In 2003, two more 20 m quadrats were surveyed per wood, their location being determined by generating random co-ordinates within the north-east and north-west quarters of the woodland and using these

as the south-west corner of a quadrat. Again, at random co-ordinates within the larger quadrats, five 2 m quadrats were surveyed.

In the 20 m quadrats all tree and woody shrub species taller than 1 m were counted and identified to species. All woody shrubs less than 1 m in height and herbs within the 2 m quadrats were identified to species. Ferns, fungi, (grasses + sedges), and (mosses + lichens + liverworts) were not identified to species level but were grouped thus. A visual estimate of the percentage total vegetation cover for the herb layer was made. An estimate of canopy cover was taken from the south-west corner of each 2 m quadrat. Canopy cover was estimated visually using a gridded acetate. The acetate was held up to the canopy and the number of grid squares in which canopy cover was seen were counted. This number was then divided by the total number of squares on the grid.

Plant height diversity and plant architectural diversity were measured within the field-herb layer using the method of Southwood *et al*. (1979). A 2 m high sampling pin was marked at height intervals of 5 cm, 5 cm, 10 cm and successive 20 cm until 1 m and 25 cm intervals thereafter. The total number of touches in each height category was recorded and used to provide a measure of plant height diversity. Plant architectural diversity was measured by recording the number and types of plant structures which were touching the pin. Five samples were taken using the pin at random co-ordinates within each 2 m quadrat. The diversity of both plant height and plant architectural diversity was estimated using the log series diversity index α, following Southwood *et al.* (1979). A summary of the vegetation characteristics for each wood is given in Table 1.

RESULTS

Over the two years we collected 2,854 individuals in the target subfamilies representing one species of Diacritinae, 22 species of Diplazontinae, 41 species of Pimplinae and four species of Poemeniinae.

Systematic List

Subfamily Diacritinae

Diacritus aciculatus (Vollenhoven) (Fig. 4) – 327 (199♀♀, 128♂♂).

2003: 210 from all 15 sites, Copmanthorpe Wood 1-8/vii (3), 8-15/vii (25), 29/vii-5/viii (4), 5-12/viii (3); Fox Covert 1-8/vii (2), 8-15/vii (2); Grimstone 1-8/vii (2), 8-15/vii (1); Greenland Wood 1-8/vii (7), 8-15/vii (14), 29/vii-5/viii (5), 5-12/viii (3); Harrop's Plantation 1-8/vii (2), 8-15/vii (9); Hacking Wood 1-8/vii (2), 8-15/vii (10); Melbourne Hall 1-8/vii (4), 8-15/vii (24), 29/vii-5/viii (2), 5-12/viii (1); Many Gates Plantation 8-15/vii (2); Naburn Wood 8-15/vii (4); New Drive Plantation 8-15/vii (2); New Covert 1-8/vii (10), 8-15/vii (8); Park Wood 1-8/vii (4), 8-15/vii (4); Rush Wood 1-8/vii (11), 8-15/vii (31), 29/vii-5/viii (2); Wilson's Plantation 1-8/vii (1), 8-15/vii (2), 29/vii-5/viii (1); Wigman Wood 1-8/vii (1), 8-15/vii (2).
2004: 117, with 57 at Copmanthorpe Wood, occurring in 14/16 traps, 15-29/vii (40); 29/vii-13/viii (17), and 60 at New Covert, occurring in all 14 traps, 15-29/vii (50), 29/vii-13/viii (10).
Described as "Rare but widely distributed" in Britain by Fitton *et al.* (1988), but Shaw (2006) notes that it is "much commoner than suggested by [Fitton *et al*., 1988]".

Subfamily Diplazontinae

Diplazon laetatorius (Fabricius) – 14 ♀♀.

2003: Nine ♀♀, from 5 sites. Copmanthorpe Wood 29/vii-5/viii (1); Grimstone 8-15/vii (5), New Drive Plantation 8-15/vii (1); Park Wood 5-12/viii (1); Wilson's Plantation 5-12/viii (1).
2004: Five ♀♀, from both sites. Copmanthorpe Wood, 4, with 3 from a core trap and 1 from a peripheral trap, all 29/vii-13/viii. New Covert, 1 from a peripheral trap 29/vii-13/viii.
Recorded throughout the British Isles (Broad, 2008).

Diplazon pectoratorius (Thunberg) – Nine (6 ♀♀, 3♂♂)

2003: Six from 4 sites. Grimstone 5-12/viii (1); Greenland Wood 8-15/vii (2); Wilson's Plantation 8-15/vii (1), 29/vii-5/viii (1); Wigman Wood 8-15/vii (1).
2004: Three, from both sites. Copmanthorpe Wood, 1, core trap, 29/vii-13/viii. New Covert, 1, peripheral trap, 15-29/vii, 1, core trap, 29/vii-13/viii.
Recorded throughout the British Isles (Broad, 2008).

Diplazon scutatorius Teunissen.

2004: 1♀ Copmanthorpe Wood, 29/vii-13/viii, peripheral trap (det. Seraina Klopfstein).
Added to the British list by Thirion (1987), and so not mentioned by Beirne (1941), indeed at the time it would have been included in the concept of *D. tetragonus*. New record for Yorkshire.

Diplazon tetragonus (Thunberg) - 46 (12♀♀, 32♂♂).

2003: 37, from 9 sites. Fox Covert 29/vii-5/viii (2); Greenland Wood 29/vii-5/viii (1); Harrop's Plantation 5-12/viii (1); Hacking Wood 29/vii-5/viii (1), 5-12/viii (1); Melbourne Hall 29/vii-5/viii (5), 5-12/viii (5, 1) ; Park Wood 8-15/vii (1), 5-12/viii (1); Rush Wood 29/vii-5/viii (6), 5-12/viii (4); Wilson's Plantation 29/vii-5/viii (3), 5-12/viii (5); Wigman Wood 8-15/vii (1).

2004: Nine, from both sites. Copmanthorpe Wood, 8, 6 from 3 peripheral traps, 2 from 2 core. 15-29/vii (1), 29/vii-13/viii (7). New Covert, 1, core trap, 15-29/vii.

Recorded throughout the British Isles (Broad, 2008).

Enizemum ornatum (Gravenhorst) – 43 (9♀♀, 33♂♂).

2003: 21, from 9 sites. Copmanthorpe Wood 29/vii-5/viii (1), 5-12/vii (2); Grimstone 29/vii-5/viii (1), 5-12/vii (1); Greenland Wood 5-12/vii (2); Harrop's Plantation 5-12/vii (2); Hacking Wood 29/vii-5/viii (1), 5-12/vii (2); Naburn Wood 5-12/vii (1); Rush Wood 29/vii-5/viii (1); Wilson's Plantation 5-12/vii (6), Wigman Wood 5-12/vii (1).

2004: 22, all from Copmanthorpe Wood: 2 from 2 core , 20 from 7 peripheral traps, 15-29/vii (2), 29/vii-13/viii (20).

Recorded throughout the British Isles (Broad, 2008).

Promethes bridgmani Fitton.

2003: Two (1♀, 1♂) from Greenland Wood, 29/vii-5/viii. Both individuals recorded from the same site in which its congener *P. sulcator* was most common, suggesting similar habitat requirements or hosts.

Recorded from England, Scotland, Wales and Ireland (Broad, 2008). Hosts not known. Described (under *P. scutellaris*) by Beirne (1941) as "a rather rare species". Thirion (1994) notes only two Belgian records.

Promethes sulcator (Gravenhorst) – 32 (5♀♀, 27♂♂).

2003: 31, from 5 sites. Copmanthorpe Wood, 8-15/vii (1), Grimstone 5-12/viii (7); Greenland Wood 8-15/vii (11), 29/vii-5/viii (7), 5-12/viii (2); Melbourne Hall 8-15/vii (1). 29/vii-5/viii (1); Naburn Wood 29/vii-5/viii (1).

2004: One from Copmanthorpe Wood, peripheral trap, 29/vii-13/viii.

Recorded throughout the British Isles (Broad, 2008).

Sussaba cognata (Holmgren) – 143 (112♀♀, 26♂♂)

2003: 60, three from 14 sites. Copmanthorpe Wood 29/vii-5/viii (2), 5-12/viii (2); Fox Covert 29/vii-5/viii (1); Grimstone 1-8/vii (1), 8-15/vii (1); Greenland Wood 29/vii-5/viii (2), 5-12/viii (2); Harrop's Plantation 5-12/viii (3); Melbourne Hall 8-15/vii (4), 29/vii-5/viii (10), 5-12/viii (8); Many Gates Plantation 8-15/vii

(1), 29/vii-5/viii (1), 5-12/viii (1); Naburn Wood 8-15/vii (1), 29/vii-5/viii (1); New Drive Plantation 8-15/vii (1), 29/vii-5/viii (6); New Covert 8-15/vii (1), 29/vii-5/viii (1), 5-12/viii (2); Park Wood 8-15/vii (2), 29/vii-5/viii (3); Rush Wood 29/vii-5/viii (2), 5-12/viii (1); Wilson's Plantation 8-15/vii (1), 29/vii-5/viii (1), Wigman Wood 5-12/viii (1).

2004: 80. Copmanthorpe Wood: 52, 8 from 3 peripheral traps and 44 from 8 core traps, 15-29/vii (15), 29/vii-13/viii (37). New Covert: 28, 4 from 2 peripheral, 24 from 5 core traps, 15-29/vii (10), 29/vii-13/viii (18).

Recorded throughout the British Isles (Broad, 2008).

Sussaba flavipes (Lucas) – 178 (97♀♀, 81♂♂)

2003: 159, from 15 sites. Copmanthorpe Wood 29/vii-5/viii (2); Fox Covert 1-8/vii (1), 29/vii-5/viii (1); Grimstone 1-8/vii (1), 8-15/vii (5); Greenland Wood 1-8/vii (2), 8-15/vii (10), 29/vii-5/viii (1), 5-12/viii (2); Harrop's Plantation 8-15/vii (1), 5-12/viii (1); Hacking Wood 8-15/vii (1); Melbourne Hall 29/vii-5/viii (4), 5-12/viii (1); Many Gates Plantation 29/vii-5/viii (1); Naburn Wood 1-8/vii (1), 8-15/vii (8), 29/vii-5/viii (5); New Covert 29/vii-5/viii (4), 5-12/viii (2); New Drive Plantation 8-15/vii (1); Park Wood 8-15/vii (1); Rush Wood 8-15/vii (3), 29/vii-5/viii (10), 5-12/viii (5); Wilson's Plantation 8-15/vii (52), 29/vii-5/viii (14), 5-12/viii (10); Wigman Wood 1-8/vii (5), 8-15/vii (4).

2004: 19. Copmanthorpe Wood, 17, 12 from 4 peripheral traps, 5 from 3 core traps. 15-29/vii (8), 29/vii-13/viii (9). New Covert 2, peripheral and core trap, 29/vii-13/viii.

Recorded from England, Scotland, Wales and Ireland (Broad, 2008).

Sussaba placita Dasch

2003: 1♀, Harrop's Plantation, 29/vii-5/viii (det. Seraina Klopfstein).

2004: 1♀, Copmanthorpe Wood, 29/vii-13/viii, core trap (det. Seraina Klopfstein).

New to the British Isles; also recorded from Belgium, Austria, California and Canada (Thirion, 1994).

Sussaba pulchella (Holmgren) – 28 (1♀, 27♂♂)

2003: 27, from 7 sites. Fox Covert 8-15/vii (4) Grimstone 1-8/vii (1), 8-15/vii (1); Greenland Wood 1-8/vii (2), 8-15/vii (4); Many Gates Plantation 1-8/vii (1), 29/vii-5/viii (1); Rush Wood 5-12/viii (1); Wilson's Plantation 8-15/vii (3), 29/vii-5/viii (3), 5-12/viii (1); Wigman Wood 8-15/vii (5).

2004: One, Copmanthorpe Wood, core trap, 29/vii-13/viii.

Recorded throughout the British Isles (Broad, 2008).

Syrphoctonus crassicrus (Thomson) – 25 (25♀♀, 3♂♂).

2003: 13, from 10 sites. Copmanthorpe Wood 29/vii-5/vii (1); Greenland Wood 29/vii-5/viii (1); Harrop's Plantation 5-12/viii (1); Hacking Wood 29/vii-5/viii (1), 5-12/viii (1); Melbourne Hall 29/vii-5/viii (2); Naburn Wood 29/vii-5/viii (1), 5-12/viii (1); New Drive Plantation 5-12/viii (1); New Covert 29/vii-5/viii (1); Rush Wood 5-12/viii (1); Wilson's Plantation 5-12/viii (1).
2004: 12. Copmanthorpe Wood, 4 from 3 peripheral traps. 15-29/vii (2), 29/vii-13/viii (2). New Covert, 8, 5 from 3 peripheral, 3 from 2 core traps. 15-29/vii (5), 29/vii-13/viii (3).
Recorded from England, Scotland and Wales (Broad, 2008),

Syrphoctonus longiventris (Thomson) (Fig. 5) – 118 (43♀♀, 69♂♂)
2003: 102, from 15 sites. Copmanthorpe Wood 1-8/vii (4) 8-15/vii (7) 29/vii-5/viii (6) 5-12/viii (3); Fox Covert 8-15/vii (1), 29/vii-5/viii (1); Grimstone 8-15/vii (1); Greenland Wood 29/vii-5/viii (1); Harrop's Plantation 1-8/vii (2), 8-15/vii (9), 29/vii-5/viii (1); Hacking Wood 1-8/vii (4), 8-15/vii (2), 29/vii-5/viii (1); Melbourne Hall 1-8/vii (1), 8-15/vii (6), 29/vii-5/viii (1), 5-12/viii (2); Many Gates Plantation 1-8/vii (1), 8-15/vii (4), 29/vii-5/viii (2), 5-12/viii (1); Naburn Wood 8-15/vii (4) 5-12/viii (2); New Drive Plantation 8-15/vii (1), 5-12/viii (1); New Covert 1-8/vii (4), 8-15/vii (3), 29/vii-5/viii (1); Rush Wood 8-15/vii (1), 29/vii-5/viii (6), 5-12/viii (1); Wilson's Plantation 8-15/vii (2), 29/vii-5/viii (3); Wigman Wood 1-8/vii (5), 8-15/vii (6), 5-12/viii (1).
2004: 16: Copmanthorpe Wood, 4, 1 from core, 3 from 3 peripheral traps, 15-29/viii (2), 29/vii-13/viii (2). New Covert, 12, 4 from 4 core, 8 from 4 peripheral traps, 15-29/vii (3),29/vii-13/viii (9).
Recorded from England, Scotland and Ireland (Broad, 2008).

Syrphoctonus nigritarsus (Gravenhorst) – Five (4♀♀, 1♂)
2003: Three from 3 woods: Hacking Wood, 5-12/viii; Naburn Wood, 29/vii-5/viii; Rush Wood 5-12/viii.
2004. Two from Copmanthorpe Wood, 1 peripheral, 1 core, 29/vii-13/viii.
Recorded throughout the British Isles (Broad, 2008).

Syrphoctonus pallipes (Gravenhorst) – 27 (20♀♀, 3 ♂♂)
2003: 21, from 6 woods. Fox Covert 8-15/vii (1), 29/vii-5/viii (2), 5-12/viii (1); Naburn Wood 8-15/vii (1), 5-12/viii (1); New Covert 29/vii-5/viii (5), 5-12/viii (3); Park Wood 29/vii-5/viii (1), 5-12/viii (1); Rush Wood 8-15/vii (1), 5-12/viii (1); Wilson's Plantation 8-15/vii (1), 5-12/viii (2).
2004: Six. Copmanthorpe Wood: 5, 15-29/vii (2 from 1 peripheral, 1 core), 29/vii-13/viii (2 from 2 core). New Covert: 29/vii-13/viii (1 peripheral).
Recorded from England, Scotland, Ireland and the Isle of Man (Broad, 2008).

Syrphoctonus pictus (Gravenhorst) – 70 (23♀♀, 44♂♂).

2003: 63, from 10 woods. Fox Covert 8-15/vii (1), 29/vii-5/viii (1); Grimstone 8-15/vii (3); Greenland Wood 29/vii-5/viii (1), 5-12/viii (1); Hacking Wood 8-15/vii (2), 29/vii-5/viii (2), 5-12/viii (3); Many Gates Plantation 8-15/vii (3); Naburn Wood 8-15/vii (2); New Drive Plantation 29/vii-5/viii (1); Park Wood 29/vii-5/viii (1); Wilson's Plantation 1-8/vii (1), 8-15/vii (2), 29/vii-5/viii (8), 5-12/viii (3); Wigman Wood 1-8/vii (1), 8-15/vii (10), 29/vii-5/viii (14), 5-12/viii (3).
2004: Seven. Copmanthorpe Wood 29/vii-13/viii (6 from 5 peripheral, 1 from core trap).
Recorded throughout the British Isles (Broad, 2008).

Syrphoctonus signatus (Gravenhorst) – Nine (8♀♀, 1♂)
2003: Six, from 5 woods. Copmanthorpe Wood 8-15/vii (1); Hacking Wood 5-12/viii (1); Naburn Wood 29/vii-5/viii (1); New Drive Plantation 5-12/viii (1); Wilson's Plantation 29/vii-5/viii (1), 5-12/viii (1).
2004: Three: Copmanthorpe Wood 29/vii-13/viii (1, peripheral trap); New Covert 29/vii-13/viii (2 from 2 core traps).
Recorded from England, Scotland, Ireland and the Isle of Man (Broad, 2008).

Syrphoctonus tarsatorius (Panzer) – 29 (17♀♀, 12♂♂).
2003: 22, from 9 woods. Copmanthorpe Wood 29/vii-5/viii (1); Greenland Wood 29/vii-5/viii (2); Harrop's Plantation 29/vii-5/viii (2); Hacking Wood 29/vii-5/viii (1); Melbourne Hall 29/vii-5/viii (1); Naburn Wood 5-12/viii (1); Park Wood 29/vii-5/viii (1), 5-12/viii (1); Rush Wood 29/vii-5/viii (1), 5-12/viii (1); Wilson's Plantation 29/vii-5/viii (4), 5-12/viii (6).
2004: Seven. Copmanthorpe Wood 29/vii-13/viii (1, 3 and 2 from 3 periferal traps); New Covert 29/vii-13/viii (1, core trap).
Recorded throughout the British Isles (Broad, 2008).

Syrphophilus tricinctorius (Thunberg) – 13 (8♀♀, 2♂♂)
2003: 11, from 7 woods. Copmanthorpe Wood 8-15/vii (1); Greenland Wood (29/vii-5/viii (1); Hacking Wood 8-15/vii (3), 29/vii-5/viii (1); Naburn Wood 5-12/viii (1); Rush Wood 8-15/vii (1), 5-12/viii (1); Wigman Wood 8-15/vii (1); Wilson's Plantation 5-12/viii (1).
2004: Two. Copmanthorpe Wood 29/vii-13/viii (1, core trap); New Covert 15-29/vii (1, core trap).
Recorded throughout the British Isles (Broad, 2008).

Tymmophorus obscuripes (Holmgren). – 83 (at least 3♀♀, 7♂♂; it was difficult to establish the sex of most specimens because the abdomen was mis-shapen on drying and the oviposition apparatus of females and genital capsule of males was concealed).

2003: 81, from 10 woods. Fox Covert 29/vii-5/viii (1); Grimstone 8-15/viii (4); Greenland Wood 8-15/vii (30), 29/vii-5/viii (22); Hacking Wood 8-15/vii (2); Many Gates Plantation 29/vii-5/viii (1); Naburn Wood 8-15/vii (1); Park Wood 8-15/vii (1); Rush Wood 8-15/vii (1); Wilson's Plantation 8-15/vii (1), 29/vii-5/viii (4); Wigman Wood 8-15/vii (10), 29/vii-5/viii (3).
2004: Two: New Covert 29/vii-13/viii (2 from 2 core traps).
Recorded throughout the British Isles (Broad, 2008).

Woldstedtius citropectoralis (Schmiedeknecht) – 46 (38♀♀, 5♂♂)
2003: 34, from 14 woods. Copmanthorpe Wood 29/vii-5/viii (1); Fox Covert 8-15/vii (1); Grimstone 1-8/vii (1), 8-15/vii (2), 5-12/viii (1); Hacking Wood 29/vii-5/viii (1); Harrop's Plantation 8-15/vii (1); Melbourne Hall 8-15/vii (2), 29/vii-5/viii (4), 5-12/viii (1); Many Gates Plantation 8-15/vii (2); Naburn Wood (29/vii-5/viii (2); New Covert 29/vii-5/viii (1); New Drive Plantation 1-8/vii (1); Park Wood 8-15/vii (1); Rush Wood 8-15/vii (2), 5-12/viii (2); Wilson's Plantation 29/vii-5/viii (3), 5-12/viii (5).
2004: 12. Copmanthorpe Wood 15-29/vii (2 from 2 core traps), 29/vii-13/viii (1 each from core and peripheral trap). New Covert 15-29/vii (3 from 2 peripheral traps), 29/vii-13/viii (1 & 3 from 2 peripheral traps, 1 from core trap).
Recorded from England, Scotland and Ireland (Broad, 2008).

Woldstedtius flavolineatus (Gravenhorst) – Eight (1♀, 7♂♂)
2003: Four, from 3 woods. Copmanthorpe Wood 5-12/viii (1); Melbourne Hall 5-12/viii (2); Wilson's Plantation 5-12/viii (1).
2004: Four. Copmanthorpe Wood 15-29/vii (1, core trap), 29/vii-13/viii (3 from 3 core traps).
Recorded from England, Scotland and Wales (Broad, 2008).

Subfamily Pimplinae
Tribe Delomeristini
Delomerista novita (Cresson)
2003: One ♀, Naburn Wood 8-15/vii.
Recorded from England, Scotland and Ireland (Broad, 2008). Described by Fitton *et al*. (1988) as rare, previous English specimens from Devon and Cheshire. First record for Yorkshire. Hosts unknown (Shaw, 2006).

Perithous albicinctus (Gravenhorst)
2004: One ♀, New Covert, 15-29/vii (peripheral trap).

Added to the British list by Brock and Shaw (1997), and well established in S. England. This is the most northerly English record, new to Yorkshire (Shaw, 2006). Note that Shaw (2006) mistakenly dates this capture as 2003 not 2004.

Perithous septemcinctorius (Thunberg)

2003: Two ♀♀: Hacking Wood 29/vii-5/viii (1); Melbourne Hall 8-15/vii (1).

2004: One ♀, New Covert 15-29/vii.

Recorded from England and Ireland (Broad, 2008). Described by Fitton *et al*. (1988) under *Hybomischos septemcinctorius*, as uncommon, widely distributed in S. England as far north as Cambs, probably commonest in wetlands. Hosts probably sphecids, especially those nesting in twigs; first records for Yorkshire (Shaw, 2006).

Tribe Ephialtini

Acrodactyla carinator (Aubert)

2004: One ♂. Copmanthorpe Wood 29/vii-13/viii (1, peripheral trap).

Shaw (2006) notes that this species was overlooked amongst *A. quadrisculpta* recorded in Fitton *et al*. (1988). He describes it as widely distributed in England north to Yorkshire, and also Wales, commonest in wetlands and waterside habitat, and gives rearing records from tetragnathid spiders.

*Acrodactyla degene*r (Haliday) – 37 (36♀♀, 1♂)

2003: 18, from 8 sites. Fox Covert 1-8/vii (1), 8-15/vii (1), 29/vii-5/viii (5); Greenland Wood 5-12/viii (2); Hacking Wood 5-12/viii (1); Melbourne Hall 5-12/viii (1); Park Wood 29/vii-5/viii (1); Rush Wood 29/vii-5/viii (2), 5-12/viii (1); Wilson's Plantation 29/vii-5/viii (1♂); Wigman Wood 29/vii-5/viii (1), 5-12/viii (1).

2004: 19. Copmanthorpe Wood 15-29/vii (1 from peripheral trap), 29/vii-13/viii (10, 7 from 4 peripheral traps, 3 from 3 core traps). New Covert 15-29/vii (4 from 4 core traps), 29/vii-13/viii (4, 3 from 2 peripheral traps and 1 from a core trap).

Fitton *et al*. (1988) note that this morphospecies may comprise more than one biological species, and that some populations may be thelytokous. Recorded throughout the British Isles (Broad, 2008). Described by Fitton *et al*. (1988) as probably the commonest British polysphinctine, with hosts as linyphiid spiders.

Clistopyga incitator (Fabricius) - 39 ♀♀.

2003: 25, from 12 sites. Copmanthorpe Wood 29/vii-5/viii (1); Fox Covert 29/vii-5/viii (1); Greenland Wood 5-12/viii (1); Grimstone 29/vii-5/viii (1); Harrop's Plantation 1-8/vii (1), 29/vii-5/viii (1), 5-12/viii (1); Melbourne Hall 8-15/vii (1), 29/vii-5/viii (1); Many Gates Plantation 29/vii-5/viii (1), 5-12/viii (2); New Covert 8-15/vii (1), 5-12/viii (2); New Drive Plantation 5-12/viii (1); Rush Wood 29/vii-5/viii (1), 5-12/viii (2); Wilson's Plantation 29/vii-5/viii (2), 5-12/viii (1); Wigman Wood 29/vii-5/viii (1), 5-12/viii (2).
2004: 14. Copmanthorpe Wood 29/vii-13/viii (8 from 5 peripheral traps); New Covert 15-29/vii (1, peripheral trap), 29/vii-13/viii (5, 3 from 2 peripheral, 2 from 2 core).

Recorded throughout the British Isles (Broad, 2008). Fitton *et al*. (1988) describe it as common and widely distributed, citing a host record from *Segestria* spider egg sacs, though those of other spiders in crevices may also be used.

Dolichomitus ?agnoscendus (Roman)

2004: One ♀: New Covert, 15-29/vii (peripheral trap)

The specimen is somewhat less slender than usual, but the structure on the ovipositor is as for *D. agnoscendus* (K. Zwakhals, *pers. comm.*). Recorded from England, Wales and Ireland (Broad, 2008). Fitton *et al.* (1988) describe it as rare but widely distributed north to Norfolk. First Yorkshire record. Hosts are beetles boring in woody stems and thin branches (Shaw, 2006).

Dolichomitus pterelas (Say)

2004: One ♀. Copmanthorpe Wood 15-29/vii (peripheral trap).

Recorded from England and Ireland (Broad, 2008). Fitton *et al.* (1988) describe it as rare, recorded north to Hereford & Worcester. New record for Yorkshire (Shaw, 2006). Fitton *et al.* (1988) record a specimen reared from the cerambycid beetle *Stenostela ferrea*.

Dolichomitus terebrans (Ratzeburg)

2004: One ♀: Copmanthorpe Wood 29/vii-13/viii (peripheral trap).

Recorded from England, Scotland and Wales (Broad, 2008). New record for Yorkshire. Fitton *et al.* (1988) describe it as uncommon but widely distributed among conifers, in which it attacks wood boring beetles.

Dolichomitus tuberculatus (Geoffroy)

2003: One ♀. Harrop's Plantation 29/vii-5/viii.

Recorded from England, Scotland, Wales and Ireland (Broad, 2008). Fitton *et al.* (1988) describe it as uncommon but widely distributed, reared from wood-boring beetles of conifers and *Betula*, and also a sesiid moth *Synanthedon culiciformis* (Shaw, 2006).

Endromopoda detrita (Holmgren)

2003: Two ♀♀. Park Wood 1-8/vii (1); New Covert 8-15/vii (1).

2004: Two. Copmanthorpe Wood 29/vii-13/viii (1♀, peripheral trap); New Covert 29/vii-13/viii (1♂, peripheral trap).

Recorded throughout the British Isles (Broad, 2008). Fitton *et al.* (1988) describe it as common and widespread in fertile grassy habitat, with diverse hosts including sawflies, eurytomid wasps, noctuid moths and chloropid flies, all living internally in grasses.

Endromopoda nigricoxis (Ulbricht)

2003: One ♀, New Drive Plantation 8-15/vii.

Recorded throughout the British Isles (Broad, 2008). Fitton *et al.* describe it as uncommon but widely distributed in grassland habitat, particularly in the north. Hosts unknown.

Ephialtes manifestator (L.)

2003: Two ♀♀. New Covert 29/vii-5/viii (1), 5-12/viii (1).

Recorded from England and Wales (Broad, 2008). Fitton *et al.* (1988) describe it as uncommon, found as far north as Staffs and Suffolk. New records for Yorkshire (Shaw, 2006). Hosts probably always wood-inhabiting aculeate Hymenoptera, including those nesting in old beetle holes in wood (Fitton *et al*., 1988; Shaw, 2006).

Exeristes ruficollis (Gravenhorst)

2003: One ♀. Fox Covert 29/vii-5/viii.

Recorded from England, Scotland and Wales (Broad, 2008). Fitton *et al.* (1988) describe it as uncommon but widely distributed amongst *Pinus* in mainland southern Britain as far north as Gwynedd, with Scottish populations centred on native *Pinus sylvestris* woods.

New record for Yorkshire. Hosts are endophytic tortricid Lepidoptera on *Pinus* including *Rhyacionia buoliana* and *Petrova resinella* (Fitton *et al.*, 1988).

Gregopimpla inquisitor (Scopoli)

2004: One ♂. New Covert 29/vii-13/viii (peripheral trap).

Recorded from England and Scotland (Broad, 2008). Fitton *et al.* (1988) describe it as rare but widespread, and hosts including a wide range of cocooned Lepidoptera.

Liotryphon crassiseta (Thomson)

2004: Four ♂♂. Copmanthorpe Wood 29/vii-13/viii (1, core trap); New Covert 15-29/vii (3, 2 from 2 peripheral traps, 1 from core trap).

In the absence of females, species determination here is tentative. Recorded from England and Ireland (Broad, 2008). Fitton *et al.* (1988) describe it as uncommon but widely distributed in southern England as far north as Cumbria, with hosts mainly sesiids and other Lepidoptera in twigs and bark.

Megaetaira madida (Haliday) – 36 (16♀♀, 18♂♂)

2003: 19, from 9 sites. Greenland Wood 5-12/viii (1); Harrop's Plantation 29/vii-5/viii (1), 5-12/viii (1); Hacking Wood 29/vii-5/viii (3); Melbourne Hall 8-15/vii (3), 29/vii-5/viii (1), 5-12/viii (2); Naburn Wood 8-15/vii (1); New Drive Plantation 5-12/viii (1); Rush Wood 29/vii-5/viii (1); Wilson's Plantation 29/vii-5/viii (1), 5-12/viii (1); Wigman Wood 1-8/vii (2).

2004: 17. Copmanthorpe Wood 15-29/vii (2 from 2 core traps); New Covert: 15-29/vii (11, 10 from 5 core traps, 1 from a peripheral trap), 29/vii-13/viii (4 from 3 core traps).

This species was treated by Fitton *et al*. (1988) in the genus *Acrodactyla* but Gauld and Dubois (2006) erected a new genus, *Megaetaira*, to receive it (Shaw, 2006). Recorded from England, Scotland and Ireland (Broad, 2008). Fitton *et al.* (1988) describe it as uncommon but widely distributed, found in wooded habitats and parasitizing *Metellina* spiders.

Polysphincta tuberosa Gravenhorst

2004: One ♀. New Covert 15-29/vii (core trap).

Recorded throughout the British Isles (Broad, 2008). Fitton *et al.* (1988) describe it as common and widely distributed in bushy places and heathland, giving as hosts spiders in the genera *Araniella*, *Araneus* and *Zygiella*.

Scambus "*annulatus* group" ?*inanis* (Schrank)

Fitton *et al.* (1988) recognized that *S. annulatus* probably represented a species aggregate, and more recently Shaw (2006), following Horstmann (2005), listed overlapping characters that separate 80-90% of specimens into *S. inanis*, *S. signatus* and *S. tenthredinium*. Although it is possible that our specimens are *S. signatus*, on balance we believe them to be *S. inanis*.

2004: Two. New Covert 29/vii-13/viii (2♀♀, 1 from peripheral, 1 from core trap).

S. inanis is recorded from England, Scotland, Wales and Ireland (Broad, 2008). Shaw (2006) reports it as a common and widespread parasitoid of fairly small arboreal hosts, especially lepidopterous leaf-miners and rollers, including Gracillariidae and Tortricidae. *S. signatus* is also widespread (British records from England and Scotland), with hosts mainly in the field layer (Shaw, 2006).

Scambus brevicornis (Gravenhorst)

2003: One ♀. New Drive Plantation 5-12/viii.

Recorded throughout the British Isles (Broad, 2008). Fitton *et al.* (1988) describe it as common and widely distributed, parasitizing a large number of Lepidoptera and other species concealed in field layer vegetation, notably Asteraceae flower and seed heads.

Scambus foliae (Cushman)

2003: 1♀ New Covert 5-12/viii

2004: 1♀ New Covert 15-29/vii (peripheral trap).

Recorded from Scotland, the Isle of Man, and, as a result of present records, England (Broad, 2008). New records for Yorkshire and England (Shaw, 2006), only the third and fourth records for the British Isles. Hosts are leaf-mining *Heterarthrus* sawflies (Fitton *et al.*, 1988; Shaw, 2006).

Scambus pomorum (Ratzeburg)

2004: One ♀, Copmanthorpe Wood 29/vii-13/viii (core trap).

Recorded from England, Scotland and Ireland (Broad, 2008). Fitton *et al.* (1988) describe it as an uncommon but widely distributed parasitoid of the apple blossom weevil *Anthonomus pomorum* (see also Shaw, 2006).

Scambus vesicarius (Ratzeburg)

2003: One ♀, Wigman Wood 1-8/vii.

Recorded from England, Scotland and Ireland (Broad, 2008). Shaw (2006) describes it as moderately common and widespread, especially where *Salix* is plentiful as it attacks primarily *Pontania* and *Euura* sawfly galls.

Schizopyga circulator (Panzer)

2003: One ♂, New Covert 5-12/viii.

Recorded from England, Scotland, Wales and Ireland (Broad, 2008). Fitton *et al.* (1988) remark that it is largely restricted to marshy habitats, becoming commoner in the north and give rearing records from *Clubiona* spiders.

Schizopyga frigida Cresson – 101 ♀♀.

2003: 46, from 13 sites. Fox Covert 8-15/vii (2), 29/vii-5/viii (1); Grimstone 8-15/vii (1), 5-12/viii (1); Greenland Wood 5-12/viii (1); Harrop's Plantation 8-15/vii (2); Hacking Wood 8-15/vii (1); Many Gates Plantation 8-15/vii (1), 29/vii-5/viii (1); Naburn Wood 8-15/vii (3) 29/vii-5/viii (1); New Drive Plantation 8-15/vii (5), 29/vii-5/viii (1); New Covert 1-8/vii (1), 8-15/vii (2), 29/vii-5/viii (1); Park Wood 8-15/vii (3); Rush Wood 8-15/vii (2), 29/vii-5/viii (2), 5-12/viii (2); Wilson's Plantation 8-15/vii (9); Wigman Wood 8-15/vii (3).

2004: 55. Copmanthorpe Wood 15-29/vii (7, 5 from 3 peripheral, 2 from 1 core trap), 29/vii-13/viii (4, 3 from 2 peripheral, 1 from core trap). New Covert: 15-29/vii (29, 18 from 5 peripheral, 16 from 6 core traps), 29/vii-13/viii (15, 5 from 1 peripheral, 10 from 3 core traps).

Recorded from England, Scotland, Wales and Ireland (Broad, 2008). Fitton *et al.* (1988) describe it as uncommon but widely distributed, seemingly a woodland species with rearings from *Clubiona terrestris* and *C. lutescens* spiders.

Townesia tenuiventris (Holmgren)

2003: One ♀, Wilson's Plantation 5-12/viii.

Recorded in England, Scotland and Ireland (Broad, 2008), in England from Somerset to Cheshire and Norfolk (Fitton *et al.* 1988), also Perthshire in Scotland (Shaw, 2006). New record for Yorkshire. Described as rare by Fitton *et al*. (1988), although Shaw (2006) lists it with several other species that have more recently proved to be more widespread and abundant in suitable habitat (woodland). Hosts are aculeate Hymenoptera in dead wood (cf. Fitton *et al.*, 1988).

Tromatobia lineatoria (Villers).

2003: One ♀, Rush Wood 5-12/viii.

This species was previously referred to as *T. oculatoria*. Recorded throughout the British Isles (Broad, 2008). Fitton *et al.* (1988) describe it as a common parasitoid of spider egg sacs on bushes, herbs and buildings.

Zaglyptus multicolor (Gravenhorst) (Fig. 6) – Nine ♀♀

2003: Two. Copmanthorpe Wood 5-12/viii (1); Melbourne Hall 5-12/viii (1)

2004: Seven. Copmanthorpe Wood 29/vii-13/viii (5, 4 from 3 peripheral, 1 from core trap); New Covert 15-29/vii (1, core trap), 29/vii-13/viii (1, core trap).

Recorded only from England in the British Isles (Broad, 2008). Fitton *et al*. (1998) describe it as uncommon but widespread in southern England as far north as Norfolk and Cheshire, as a parasitoid of the egg nests of spiders.

Zatypota albicoxa (Walker) – Six ♀♀

2003: Five. Fox Covert 5-12/viii (1); Harrop's Plantation 8-15/vii (1), 5-12/viii (1); New Covert 5-12/viii (1); Rush Wood 5-12/viii (1).

2004: One. Copmanthorpe Wood 29/vii-13/viii (core trap).

Recorded from England (Broad, 2008). Fitton *et al.* (1988) describe it as a rare parasitoid of *Achaearanea* spiders, although Shaw (2006) lists it with several other species that have more recently proved to be reasonably widespread and frequent in suitable habitat (woodland). New records for Yorkshire (Shaw, 2006).

Zatypota bohemani (Holmgren)

2003: Two. Fox Covert 29/vii-5/viii (1♂); Wigman Wood 8-15/vii (1♀).

2004: Copmanthorpe Wood 29/vii-13/viii (1♀, core trap).

Recorded from England, Scotland and Wales (Broad, 2008). Fitton *et al.* (1988) describe it as uncommon but widely distributed as far north as the central lowlands of Scotland, occurring on tree trunks, walls and hedges where it parasitizes *Theridion mystaceum* spiders.

Zatypota percontatoria (Müller) – Nine ♀♀

2003: Four. Fox Covert 1-8/vii (1); Hacking Wood 8-15/vii (1); Melbourne Hall 8-15/vii (1); Wilson's Plantation 8-15/vii (1).

2004: Five. New Covert 15-29/vii (4, 3 from 1 peripheral, 1 from core trap), 29/vii-13/viii (1 from core trap).

Recorded from England, Scotland and Wales (Broad, 2008). Fitton *et al.* (1988) describe it as moderately common and widely distributed on bushes where it parasitizes *Theridion* spiders.

Tribe Pimplini

Apechthis compunctor (L.)

2003: One ♀. Greenland Wood 29/vii-5/viii.

2004: Three ♀♀. Copmanthorpe Wood 29.vii-13/viii (3 from 2 peripheral traps).

Recorded from England and Wales (Broad, 2008). Fitton *et al.* (1988) describe it as uncommon, occurring in more open situations than other congeners; widely distributed in S. Britain. Reared from a range of Lepidoptera pupae including butterflies.

Apechthis quadridentata (Thomson) – Five (4♀♀, 1♂)

2003: Two. Naburn Wood 8-15/vii (1); New Drive Plantation 29/vii-5/viii (1).

2004: Three. Copmanthorpe Wood 15-29/vii (1, core trap); New Covert 15-29/vii (1, peripheral trap), 29/vii-13/viii (1, peripheral trap).

Recorded from England, Scotland, Wales and Ireland (Broad, 2008). Fitton *et al.* (1988) describe it as locally common in deciduous woods and parks with rearing records from several tortricid and butterfly pupae.

Apechthis rufata (Gmelin) – 13 (5♀♀, 8♂♂)

2003: Two. Copmanthorpe Wood 1-8/vii (1); Fox Covert 8-15/vii (1).

2004: 11. Copmanthorpe Wood 15-29/vii (3, 1 from peripheral, 2 from 1 core trap), 29/vii-13/viii (6, 4 from 4 peripheral, 2 from 2 core traps); New Covert 15-29/vii (2, 1 from peripheral, 1 from core trap).

Recorded from England, Scotland, Wales and Ireland (Broad, 2008). Fitton *et al.* (1988) describe it as locally common in deciduous woods and parks as a parasitoid of the pupae of especially Oecophoridae and Tortricidae.

Itoplectis alternans (Gravenhorst) – 69 (66♀♀)

2003: 28, from 11 sites. Copmanthorpe Wood 8-15/vii (1) 29/vii-5/viii (1), 5-12/viii (1); Harrop's Plantation 5-12/viii (1); Hacking Wood 8-15/vii (1) 29/vii-5/viii (1); Melbourne Hall 8-15/vii (1), 29/vii-5/viii (1), 5-12/viii (1); Naburn Wood 5-12/viii (2); New Covert 8-15/vii (2), 29/vii-5/viii (1); New Drive Plantation 5-12/viii (1); Park Wood 8-15/vii (1), 5-12/viii (1); Rush Wood 8-15/vii (1), 29/vii-5/viii (3), 5-12/viii (1); Wilson's Plantation 8-15/vii (3); Wigman Wood 1-8/vii (1), 8-15/vii (1), 29/vii-5/viii (1).

2004: 41. Copmanthorpe Wood 15-29/vii (11, 5 from 4 peripheral, 6 from 4 core sites), 29/vii-13/viii (18, 15 from 6 peripheral, 3 from 2 core traps); New Covert 15-29/vii (6 from 3 peripheral traps), 29/vii-13/viii (6, 2 from 2 peripheral, 4 from 3 core traps).

Recorded from England, Scotland, Wales and Ireland (Broad, 2008). Fitton *et al.* (1988) describe it as widespread, becoming rarer northwards. Found especially in open bushy habitat and tree canopy, but also other habitats. Reared from many poorly concealed or exposed smallish Lepidoptera pupae, also sometimes occurring as a pseudohyperparasitoid.

Itoplectis maculator (Fabricius) – 13 (2♀♀, 10♂♂)

2003: One, Copmanthorpe Wood 29/vii-5/viii.

2004: 12. Copmanthorpe Wood 15-29/vii (1 from core trap), 29/vii-13/viii (10, 8 from 2 peripheral, 2 from 2 core traps); New Covert 29/vii-13/viii (1 from core trap).

Recorded throughout the British Isles (Broad, 2008). Fitton *et al.* (1988) describe it as very common, found in many habitats but exploiting particularly the spring flush of tortricid pupae from deciduous trees, but they also record it from many other Lepidoptera pupae, and Hymenoptera cocoons (as a pseudohyperparasitoid with respect to Lepidoptera) as well as one of Coleoptera.

Pimpla contemplator (Müller) – 315 (119♀♀, 187♂♂)

2003: 142, from 14 sites. Copmanthorpe Wood 8-15/vii (5), 29/vii-5/viii (6), 5-12/viii (9); Fox Covert 8-15/vii (8), 29/vii-5/viii (2), 5-12/viii (3); Grimstone 29/vii-5/viii (2); Greenland Wood 29/vii-5/viii (1), 5-

12/viii (1); Harrop's Plantation 8-15/vii (1), 29/vii-5/viii (4); Hacking Wood 8-15/vii (2), 29/vii-5/viii (1), 5-12/viii (4); Melbourne Hall 8-15/vii (4), 29/vii-5/viii (2), 5-12/viii (2); Naburn Wood 5-12/viii (1); New Covert 8-15/vii (3), 29/vii-5/viii (2), 5-12/viii (3); New Drive Plantation 8-15/vii (1), 29/vii-5/viii (1); Park Wood 1-8/vii (1), 8-15/vii (1); Rush Wood 1-8/vii (1), 8-15/vii (26), 29/vii-5/viii (20), 5-12/viii (15); Wilson's Plantation 8-15/vii (1), 29/vii-5/viii (4), 5-12/viii (1); Wigman Wood 8-15/vii (2), 29/vii-5/viii (1), 5-12/viii (1).

2004: 173. Copmanthorpe Wood 15-29/vii (54, 30 from 8 peripheral traps, 24 from 6 core traps), 29/vii-13/viii (67, 48 from 7 peripheral, 19 from 6 core traps); New Covert 15-29/vii (40, 24 from 5 peripheral, 16 from 4 core traps), 29/vii-13/viii (12, 11 from 5 peripheral, 1 from 1 core trap).

Recorded from England, Scotland, Wales and Ireland (Broad, 2008). Fitton *et al.* (1988) describe it as common and widely distributed in wooded areas north to Gwynedd and Cumbria. Attacks smallish Lepidoptera pupae concealed in soil and litter.

Pimpla flavicoxis Thomson – 231 (43♀♀, 184♂♂)

2003: 51, from 12 sites. Copmanthorpe Wood 8-15/vii (1); Fox Covert 1-8/vii (1), 8-15/vii (6), 29/vii-5/viii (1), 5-12/viii (1); Grimstone 5-12/viii (1); Greenland Wood 5-12/viii (1); Hacking Wood 8-15/vii (1); Harrop's Plantation 1-8/vii (1), 29/vii-5/viii (1), 5-12/viii (2); Melbourne Hall 8-15/vii (4), 29/vii-5/viii (2), 5-12/viii (4); New Covert 1-8/vii (2), 8-15/vii (2), 5-12/viii (2); New Drive Plantation 8-15/vii (1); Park Wood 29/vii-5/viii (1); Rush Wood 1-8/vii (2), 8-15/vii (6), 29/vii-5/viii (1), 5-12/viii (2); Wigman Wood 1-8/vii (2), 8-15/vii (2), 29/vii-5/viii (1).

2004: 180. Copmanthorpe Wood 15-29/vii (49, 4 from 2 peripheral, 45 from 7 core traps), 29/vii-13/viii (24, 3 from 3 peripheral, 21 from 6 core traps); New Covert 15-29/vii (75, 30 from 5 peripheral, 45 from 8 core traps), 29/vii-13/viii (32, 13 from 4 peripheral, 19 from 5 core traps).

Recorded throughout the British Isles (Broad, 2008). Shaw (2006) states it to be common and widespread in Britain, apparently attacking Lepidoptera pupae near the ground. Previously compounded with *P. insignatoria*.

Pimpla insignatoria (Gravenhorst) – 529 (232♀♀, 290♂♂)

2003: 171, from 15 sites. Copmanthorpe Wood 8-15/vii (7), 29/vii-5/viii (4), 5-12/viii (9); Fox Covert 8-15/vii (4), 29/vii-5/viii (8), 5-12/viii (5); Grimstone 29/vii-5/viii (1); Greenland Wood 8-15/vii (3), 5-12/viii (1); Harrop's Plantation 8-15/vii (8), 29/vii-5/viii (3), 5-12/viii (5); Hacking Wood 8-15/vii (8), 29/vii-5/viii (4), 5-12/viii (3); Melbourne Hall 1-8/vii (1), 8-15/vii (8), 29/vii-5/viii (1), 5-12/viii (3); Many Gates Plantation 29/vii-5/viii (1); Naburn Wood 1-8/vii (1), 8-15/vii (1), 29/vii-5/viii (2); New Covert 1-8/vii (1), 8-15/vii (8), 29/vii-5/viii (3), 5-12/viii (2); New Drive Plantation 8-15/vii (2), 29/vii-5/viii (2); Park Wood 1-8/vii (2), 8-15/vii (1), 29/vii-5/viii (4), 5-12/viii (2); Rush Wood 1-8/vii (1), 8-15/vii (13), 29/vii-5/viii

(13), 5-12/viii (11); Wilson's Plantation 8-15/vii (4), 29/vii-5/viii (4), 5-12/viii (1); Wigman Wood 1-8/vii (3), 8-15/vii (2), 29/vii-5/viii (1).

2004: 358. Copmanthorpe Wood 15-29/vii (75, 31 from 8 peripheral, 44 from 5 core traps), 29/vii-13/viii (130, 75 from 8 peripheral, 55 from 8 core traps); New Covert 15-29/vii (96, 53 from 6 peripheral, 43 from 7 core), 29/vii-13/viii (57, 39 from 6 peripheral, 18 from 6 core).

Previously compounded with *P. flavicoxis* (cf. Shaw, 2006). Recorded from England, Scotland and Wales (Broad, 2008). Common especially in deciduous woodland and reared from a wide range of Lepidoptera pupae on exposed shrubs and trees (Shaw, 2006).

Pimpla rufipes (Miller) – 40 (6♀♀, 33♂♂)

2003: 8, from 4 sites. Copmanthorpe Wood 8-15/vii (1), 29/vii-5/viii (2), 5-12/viii (1); New Covert 8-15/vii (2); Park Wood 8-15/vii (1); Rush Wood 5-12/viii (1).

2004: 32. Copmanthorpe Wood 15-29/vii (1, peripheral trap), 29/vii-13/viii (9, 7 from 3 peripheral, 2 from 2 core traps); New Covert 15-29/vii (19, 7 from 3 peripheral, 12 from 6 core traps), 29/vii-13/viii (3 from 2 peripheral traps).

Previously known as *P. hypochondriaca* (cf. Shaw, 2006). Recorded throughout the British Isles (Broad, 2008). Fitton *et al.* (1988) describe it as very common, especially in hedgerows and gardens. Attacks a wide range of Lepidoptera pupae above ground.

Pimpla turionellae (L.) – Four (2♀♀, 2♂♂)

2003: Three, from three sites. Grimstone 5-12/viii (1♂); Wilson's Plantation 8-15/vii (1♀); Wigman Wood 29/vii-5/viii (1♀).

2004: One ♂ Copmanthorpe Wood 29/vii-13/viii, peripheral trap.

Recorded from England, Scotland, Wales and Ireland (Broad, 2008). Fitton *et al.* (1988) describe it as common, particularly where there are trees. Attacks a wide range of Lepidoptera pupae on trees and bushes.

Subfamily Poemeniinae

Deuteroxorides elevator (Panzer) – 39 (38♀♀)

2003: 20, from 9 sites. Copmanthorpe Wood 8-15/vii (1), 29/vii-5/viii (4), 5-12/viii (2); Grimstone 5-12/viii (1); Melbourne Hall 29/vii-5/viii (3), 5-12/viii (2); Naburn Wood 29/vii-5/viii (1); New Covert 29/vii-5/viii (2); New Drive Plantation 8-15/vii (1); Park Wood 8-15/vii (1); Rush Wood 29/vii-5/viii (1); Wigman Wood 8-15/vii (1).

2004: 19. Copmanthorpe Wood 15-29/vii (5, 1 from peripheral, 4 from 4 core traps), 29/vii-13/viii (3, 2 from 1 peripheral, 1 from core trap); New Covert 15-29/vii (7 from 3 peripheral traps), 29/vii-13/viii (4 from 1 peripheral trap).

Recorded from England and Ireland (Broad, 2008). Described as rare by Fitton *et al.* (1988), but Shaw (2006) includes it as one of several species that have since proved to be more common in suitable habitat (woodland). First records for Yorkshire. Hosts are beetles in dead wood.

Poemenia collaris (Haupt) – 21 ♀♀

2003: 16, from 7 sites. Fox Covert 8-15/vii (2); Grimstone 8-15/vii (1); Hacking Wood 8-15/vii (1), 5-12/viii (1); Melbourne Hall 8-15/vii (2); Rush Wood 5-12/viii (1); Wilson's Plantation 8-15/vii (3), 29/vii-5/viii (1), 5-12/viii (2); Wigman Wood 8-15/vii (2).

2004: Five. Copmanthorpe Wood 15-29/vii (2 from 1 peripheral trap), 29/vii-13/viii (1 from 1 peripheral trap). New Covert 15-29/vii (1 from peripheral trap), 29/vii-13/viii (1 from peripheral trap).

Recorded from England (Broad, 2008). Fitton *et al.* (1988) mention only a single British record from Kent, but it has since proved to be widespread and sometimes abundant in southern England, parasitizing sphecid wasps nesting in dead wood (Shaw, 2006). New records for Yorkshire (Shaw, 2006).

Poemenia hectica (Gravenhorst) – 37 ♀♀

2003: 31, from 11 sites. Copmanthorpe Wood 8-15/vii (1), 29/vii-5/viii (2), 5-12/viii (1); Fox Covert 8-15/vii (1); Grimstone 8-15/vii (1); Harrop's Plantation 8-15/vii (1), 5-12/viii (2); Hacking Wood 1-8/vii (1), 8-15/vii (1); Melbourne Hall 8-15/vii (3), 29/vii-5/viii (2), 5-12/viii (1); Many Gates Plantation 29/vii-5/viii (1); Naburn Wood 8-15/vii (3); New Covert 29/vii-5/viii (1); Wilson's Plantation 8-15/vii (2), 29/vii-5/viii (3), 5-12/viii (2); Wigman Wood 8-15/vii (2).

2004: Six. Copmanthorpe Wood 15-29/vii (2 from 2 peripheral traps), 29/vii-13/viii (1 from peripheral trap); New Covert 15-29/vii (2 from 2 peripheral traps), 29/vii-13/viii (1 from peripheral trap).

Recorded from England and Ireland (Broad, 2008). Described as rare by Fitton *et al.* (1988), but Shaw (2006) lists it as one of several species that have since proved to be reasonably common in suitable habitat (woodlands), and gives rearing records from the sphecid wasp *Passaloecus monilicornis*. Found as far north as Cumbria, new records for Yorkshire (Shaw, 2006).

Poemenia notata Holmgren (Fig. 7)

2003: Three ♀♀ from 2 sites. Hacking Wood 29/vii-5/viii (1); Wilson's Plantation 8-15/vii (2).
Recorded from England (Broad, 2008). Fitton *et al.* (1988) describe only a single British record, but Shaw (2006) lists it as one of several species that have since proved to be more common, especially in woodland. New records for Yorkshire. Shaw (2006) gives rearing records from dead wood containing cells of the sphecid wasp *Passaloecus eremite* and suggests that the spread of this host in Britain may have led to a recent increase in abundance of *P. notata*.

DISCUSSION

Our results have several distinct implications for conservation. First, our collection has extended the distribution records of several British species, with 17 species new to Yorkshire, including one new to England, and one new to the British Isles. This is a large proportion of the total species we collected (25%) and suggests that the county as a whole is considerably under-recorded with respect to these taxa, particularly the Pimplinae and Poemeniinae. Some of the species recorded for the first time in Yorkshire were quite abundant in our samples, suggesting that the national status of several other species, such as they are known, may need to be revised after further collecting (see also Shaw, 2006).

Second, we have recorded, within a comparatively small area and in a narrow sampling window, a large proportion of British species, and the true species richness in the landscape is likely to be higher because the species accumulation curves fail to asymptote, especially for the Pimplinae (Fraser et al. 2007, 2008a). Specifically, we caught 68 species over the landscape as a whole, making 40% of British species in the taxa surveyed. In Copmanthorpe Wood alone, 46 species were collected, 27% of British species, and in New Covert, 43 species, 25% of British species.If such proportions are generally representative of parasitic Hymenoptera, a single wood might contain over 1500 species of parasitic Hymenoptera alone, and the landscape we have considered might contain over 2400 (assuming 6000 British species). This highlights the richness of insect life in woodlands in the agricultural landscape, and their value in biodiversity terms; something that is often underappreciated by focusing on more charismatic but species-poor taxa (see also Fraser *et al*., 2008a).

Third, there was considerable variation in species' abundance and occupancy in our collections. Our previous analyses of the collections have shown that species that were collected from only a few sites or traps tended to be found in low abundance there, such that rare species (in our samples) tend to be rare in both senses (see Fraser *et al*., 2008b). This is a small-scale illustration of the more widely known phenomenon of extinction-risk double-jeopardy whereby low abundance and restricted distributions can make species vulnerable to extinction from different sources of threat (Gaston, 1999). Parasitoid wasps are already expected to be especially vulnerable to extinction due to their host specificity and high trophic status (Shaw & Hochberg, 2001), and the double-rarity indicated in our data may add to this vulnerability. However, rarity in our catch might not necessarily mean that species are rare more generally: they might not be effectively sampled by Malaise traps, or might have peak flight seasons outside our sample period.

Of the 22 (32%) species only caught once or twice, three are Diplazontinae and 19 are Pimplinae, suggesting that Diplazontinae species may be less vulnerable to extinction. This suggestion is supported by Thirion's (1979) conclusion that this taxon has declined somewhat less than some other ichneumonid taxa in Belgium. Presumably this is at least partly an effect of their parasitizing aphidophagous syrphid larvae which often thrive in early successional and agricultural landscapes, rather than other hosts, such as the Lepidoptera parasitized by Ichneumoninae, which have declined more in Belgium (Thirion, 1981). Other features of our data that may support this suggestion include the fact that only four woods are required to include all Diplazontinae species found here, that the species accumulation curves are sometimes much closer to an asymptote than for the Pimplinae (Fraser *et al*, 2007, 2008a), the absence of sites as a factor explaining Diplazontinae abundance and richness (Fraser *et al*., 2007), and the general absence of any associations with vegetation features (Fraser *et al*., 2007, 2008a), perhaps suggesting that their habitat requirements are fairly general in comparison. The latter is also reflected in the generally large number of habitats described for each species by Thirion (1994).

Fourth, there was considerable variation in the number of individuals (but to lesser extent species) captured in different woods (Table 1). Our previous analyses of the

collections have identified woodland tree/shrub richness as a variable that is associated with high wasp abundance and richness, particularly for the Pimplinae (Fraser *et al*., 2007). This may be a useful surrogate to use when assessing the value of a site, or potentially when managing a site to improve its conservation value. Tree/shrub richness also works well as a surrogate to maximize when selecting a portfolio of reserves (Fraser *et al*., 2009), suggesting that some woodland sites may have value by adding species to the landscape even though they are not themselves particularly species-rich. Several other studies have suggested links between parasitoid diversity and measures of vegetation diversity (e.g. Sperber *et al*., 2004; Saaksjarvi *et al*. 2006; Lassau & Hochuli, 2005), suggesting that such surrogates might be more generally applicable. Tree/shrub richness is presumably important because it governs the diversity of hosts and other resources that the parasitoids require.

Finally, there was some variation in the catch between core and edge traps in the two woods sampled in 2004. The Poemeniinae for example were more abundant and rich at edge compared to core traps (see Results above; Fraser *et al.* 2008a). Our previous analyses of these data have suggested that the composition of the parasitoid communities generally differs from core to edge, and thus that this taxon could be affected by habitat fragmentation which increases the proportion of edge habitat (Fraser *et al.* 2008a). There is, however, no indication that species richness or abundance is generally lower towards woodland edges. Thus, the practice of breaking up blocks of forestry with rides and clearings might be beneficial for some but not all taxa. In contrast, Noyes (1989b) found that parasitic wasp diversity was higher in the interior than edge of a Sulawezi forest.

In conclusion our collection demonstrates that Yorkshire's ichneumonid fauna is under-recorded and therefore that its richness is higher than records to date have suggested; that the status of many species nationally may need to be re-assessed after further collecting; that local and individual woodland richness is very high making small woodlands a valuable local biodiversity resource; that rare parasitic wasps may suffer double-jeopardy from extinction risks; that a higher proportion of Pimplinae species may be at risk than Diplazontinae species; and that tree/shrub species richness could be used as a surrogacy tool to identify or appropriately manage individual sites or a portfolio of sites for Pimplinae in the absence of direct sampling of the wasps themselves. Given their

diverse life histories and the diversity of host taxa they utilize, it is possible that Pimplinae may be an appropriate surrogate taxon for parasitic wasps in general. At present the conservation of parasitic wasps relies to a large extent on the hope that the conservation of other species and habitats will be generally sufficient. Determining whether or not it is will depend on further field collections to establish and monitor the status of species over time.

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REFERENCES

Bartlett, R., Pickering, J., Gauld, I. and Windsor, D. (1999) Estimating global biodiversity: Tropical beetles and wasps send different signals. *Ecol. Entomol.* **24**: 118-121.

Beirne, B.P. (1941) British species of Diplazonini (Bassini Auctt.) with a study of the genital and postgenital abdominal sclerites in the male (Hym. Ichneum.). *Trans. R. Entomol. Soc., London* **91**: 661-712.

Broad, G. R. (2008) *Checklist of British and Irish Ichneumonidae (Hymenoptera).* Biological Records Centre, Monks Wood. Available from http://www.brc.ac.uk/downloads/Ichneumonidae_checklist.pdf (accessed 3 September 2008).

Brock, J.P. and Shaw, M.R. (1997) *Perithous albicinctus* (Gravenhorst), a large pimpline ichneumon-wasp new to Britain (Hymenoptera Ichneumonidae). *Ent. Gazette* **48**: 49-50.

Fitton, M.G. and Rotheray, G.E. (1982) A key to the European genera of diplazontine ichneumon-flies with notes on the British fauna. *Syst. Entomol.* **7**: 311-320.

Fitton, M.G., Shaw, M.R. and Gauld, I.D. (1988) *Pimpline Ichneumon-flies, Hymenoptera Ichneumonidae, Pimplinae.* Handbooks for the Identification of British Insects Vol. 7, Part 1. Royal Entomological Society, London.

Forestry Commission. (2002) *UK indicators of Sustainable Forestry*. Forestry Commission, Edinburgh.

Forestry Commission. (2004) *The UK Forestry Standard*. Forestry Commission, Edinburgh.

Fraser S.E.M., Beresford A.E., Peters J., Redhead J.W., Welch A.J., Mayhew P.J. and Dytham C. (2009) Effectiveness of vegetation surrogates for parasitoid wasps in reserve selection. *Cons. Biol.* (in press).

Fraser, S.E.M., Dytham, C. and Mayhew, P.J. (2007) Determinants of parasitoid abundance and diversity in woodland habitats. *J. Appl. Ecol.* **44**: 352-361.

Fraser, S.E.M., Dytham, C. and Mayhew, P.J. (2008a) The effectiveness and optimal use of Malaise traps for monitoring parasitoid wasps. *Insect Conservation & Diversity* **1**: 22-31.

Fraser, S.E.M., Dytham, C. and Mayhew, P.J. (2008b) Patterns in the abundance and distribution of ichneumonid parasitoids within and across habitat patches. *Ecol. Entomol.* **33**: 473-483.

Gaston, K.J. (1999) Implications of interspecific and intraspecific abundance-occupancy relationships. *Oikos* **86**: 195-207.

Gaston K.J. and Gauld, I.D. (1993) How many species of Pimplines (Hymenoptera: Ichneumonidae) are there in Costa Rica? *J. Trop. Ecol.* **9**: 491-499.

Gauld, I.D. and Dubois, J. (2006) Phylogeny of the *Polysphincta* group of genera (Hymenoptera: Pimplinae): a taxonomic revision of spider ectoparasitoids. *Syst. Entomol.* **31**: 529-564.

Gauld, I.D., Wahl, D.B. and Broad, G. (2002) The suprageneric groups of the Pimplinae (Hymenoptera: Ichneumonidae): a cladistic re-evaluation and evolutionary biological study. *Zool. J. Linn. Soc.* **136**: 412-485.

Hawkins, B.A. (1994) *Pattern and Process in Host-Parasitoid Interactions.* Cambridge University Press, Cambridge.

Horstmann, K. (2005) Über einiger mit *Scambus inanis* (Schrank, 1802) nah verwandte

Arten (Hymenoptera, Ichneumonidae, Pimplinae). *Entomofauna* **26**: 101-115.

I.U.C.N. (2007) *2007 IUCN Red List of Threatened Species*. http://www.iucnredlist.org/, accessed 22/9/08.

Kerrich G.J. (1949) Taxonomic and distributional notes on British Diplazontinae (Hym. Ichneumonidae). *J. Soc. Br. Entomol.* **3**: 67-83.

Kruess, A. and Tscharntke, T. (1994) Habitat fragmentation, species loss, and biological control. *Science* **264**: 1581-1584.

Lassau, S.A and Hochuli, D.F. (2005) Wasp community responses to habitat complexity in Sydney sandstone forests. *Austral Ecol.* **30**: 179-187.

Levenson, J.B. (1981). Woodlots as biogeographic islands in southeastern Wisconsin. In *Forest island dynamics in man-dominated landscapes* (Burgess, R.L. and Sharpe, D.M. eds), pp. 13-39, Springer-Verlag, New York.

Noyes, J.S. (1989a) A study of five methods of sampling Hymenoptera (Insecta) in a tropical rainforest, with special reference to the Parasitica. *J. Nat. Hist.* **23**: 285-298.

Noyes, J.S. (1989b) The diversity of Hymenoptera in the tropics with special reference to Parasitica in Sulewesi. *Ecol. Entomol.* **14**: 197-207.

Owen, D.F. and Owen, J. (1974) Species diversity in temperate and tropical Ichneumonidae. *Nature* **249**: 583-584.

Owen, J. (1991) *The Ecology of a Garden*. Cambridge University Press, Cambridge.

Petit, S. and Usher, M.B. (1998) Biodiversity in agricultural landscapes: the ground beetle communities of woody uncultivated habitats. *Biodiv. Cons.* **7**: 1549–1561.

Purvis, A., Jones, K.E. and Mace, G.M. (2000) Extinction. *Bioessays* **22**: 1123-1133.

Rackham, O. (2006) *Woodlands.* Harper Collins, London.

Sääksjärvi, I.E., Haataja, S., Neuvonen, S., Gauld, I.D., Jussila, R., Salo, J. and Marmol Burgos, A. (2004) High local species richness of parasitic wasps (Hymenoptera: Icheneumonidae; Pimplinae and Rhyssinae) from the lowland rainforests of Peruvian Amazonia. *Ecol. Entomol.* **29**: 735–743.

Sääksjärvi, I.E., Ruokaolainen, K., Tuomisto, H., Haataja, S., Fine, P.V.A., Cárenas, G., Mesones, I. and Vargas, V. (2006) Comparing composition and diversity of

parasitoid wasps and plants in an Amazonian rain-forest mosaic. *J. Trop. Ecol.* **22**: 167-176.

Samways, M.J. (2005) *Insect diversity conservation*. Cambridge University. Press, Cambridge.

Shaw, M.R. (2006) Notes on British Pimplinae and Poemeniinae (Hymenoptera: Ichneumonidae), with additions to the British list. *Br. J. Ent. Nat. Hist.* **19**: 217-238.

Shaw, M.R. and Hochberg, M.E. (2001) The neglect of parasitic Hymenoptera in insect conservation strategies: The British fauna as a prime example. *J. Insect Cons.* **5**: 253-263.

Southwood, T.R.E., Brown, V.K. and Reader, P.M. (1979) The relationships of plant and insect diversities in succession. *Biol. J. Linn. Soc.* **12**: 327–348.

Sperber, C.F., Nakayama, K., Valverde, M.J. and Neves, F.D. (2004) Tree species richness and density affect parasitoid diversity in cacao agroforestry. *Basic & Appl. Ecol.* **5**: 241-251.

Stireman, J. O. III *et al.* (2005) Climatic unpredictability and parasitism of caterpillars: Implications of global warming. *Proc. Nat. Acad. Sci., USA* **102**: 17384-17387.

Thirion, C. (1979) Les Diplazontinae (Hymenoptera I chenumonidae) en Belgique. *Bull. Ann. Soc. Roy. belge d'Entomol.* **115**: 57-76.

Thirion, C. (1981) Les Ichenumoninae (Hymenoptera Ichneumonidae) en Belgique (2ème partie). *Bull. Ann. Soc. Roy. belge d'Entomol.* **117**: 229-254.

Thirion, C. (1987) *Diplazon scutatorius* Teunissen, 1943 (Hymenoptera: Ichneumonidae) new to Britain. *Ent. Gazette* **38**: 55-56.

Thirion, C. (1994) Les Diplazontinae (Hymenoptera Ichneumonidae) en Belgiques et dans les regions limitrophes. Deuxième contribution. *Notes Fauniques de Gembloux* **29**: 3-100.

Townes, H. (1972) A light-weight Malaise trap. *Entomol. News* **83**: 239–247.

Wahl, D.B. and Gauld, I.D. (1998) The cladistics and higher classification of the Pimpliformes (Hymenoptera: Ichneumonidae). *Syst. Entomol.* **23**: 265-298.

Webb, J.R. and Lott, D.A. (2006) The development of ISIS: a habitat-based invertebrate assemblage classification system for assessing conservation interest in England. *J. Insect Cons.* **10**: 179-188.

Zwakhals, K. (2004) Fauna Europaea: Ichneumonidae. In: *Fauna Europaea: Symphyta + Ichneumonoidea* (van Achterberg, K., ed.). *Fauna Europaea version 1.3* http://www.faunaeur.org. Accessed 22/8/08.

1 TABLE 1. Details of study woodlands.

Woodland name	Grid reference	Size (ha)	Habitat†	Ground species richness*	Tree/shrub species richness	Most common Tree/shrub	Plant height diversity α **	Plant architect. diversity α **	Tree/shrub density (m^{-2})	Canopy cover %	Ground cover %	Broadleaf content %	Wasp abundance 2003	Wasp species 2003
Copmanthorpe Wood	SE 562 450	6	Mixed	9	10	Silver birch	2.177	3.770	2.01	96.39	25.20	95.92	135	25
Fox Covert	SE 629 417	3.7	Mixed	14	9	Rhodod-endron	1.958	2.863	1.86	90.83	56.75	61.40	81	23
Greenland Wood	SE 563 449	2	Broadleaved	12	6	Silver birch	1.880	2.088	1.6	86.39	90	100	154	23
Grimstone	SE 660 501	4.9	Coniferous	17	6	Corsican pine	1.108	2.117	2.13	63.61	42.50	12.50	50	21
Hacking Wood	SE 644 408	6.6	Mixed	11	4	Sycamore	1.832	2.663	0.76	72.78	82	32	81	25
Harrop's Plantation	SE 629 413	5	Mixed	15	9	Elder	2.016	2.713	1.73	94.17	65.25	83.33	75	20
Many Gates Plantation	SE 693 537	2	Coniferous	10	4	Scots pine	1.707	3.025	1.71	80.28	76	0	29	12
Melbourne Hall	SE 749 433	3.5	Broadleaved	6	10	Rhodo-dendron	2.017	2.244	2.15	98.19	23	100	151	23
Naburn Wood	SE 609 438	18	Coniferous	16	9	Scots pine	1.893	3.219	0.95	75.14	66.25	22.81	59	23
New Covert	SE 732 442	3.3	Broadleaved	14	12	Silver birch	1.987	3.152	3.55	94.44	68.25	100	96	22
New Drive Plantation	SE 753 427	11.2	Coniferous	14	6	Corsican pine	1.271	2.275	1.91	82.36	51.50	15.89	37	19
Park Wood	SE 733 445	2.8	Broadleaved	10	4	Silver birch	1.992	2.445	2.23	89.03	78.25	100	45	20

Rush Wood	SE 603 443	2.4	Broadleaved	9	8	Sycamore	1.995	2.248	1.6	96.11	17.25	100	232	27
Wigman Wood	SE 644 453	4.5	Coniferous	10	7	Scots pine	1.862	2.712	0.76	73.06	90	4.55	111	25
Wilson's Plantation	SE 696 539	3	Mixed	8	7	Sycamore	1.935	3.298	1.6	77.78	59.50	18.87	207	31

1 †Habitat as given on 1:25 000 OS map *Includes tree/shrub species < 1m **In the field/shrub layer only (≤ 2m)

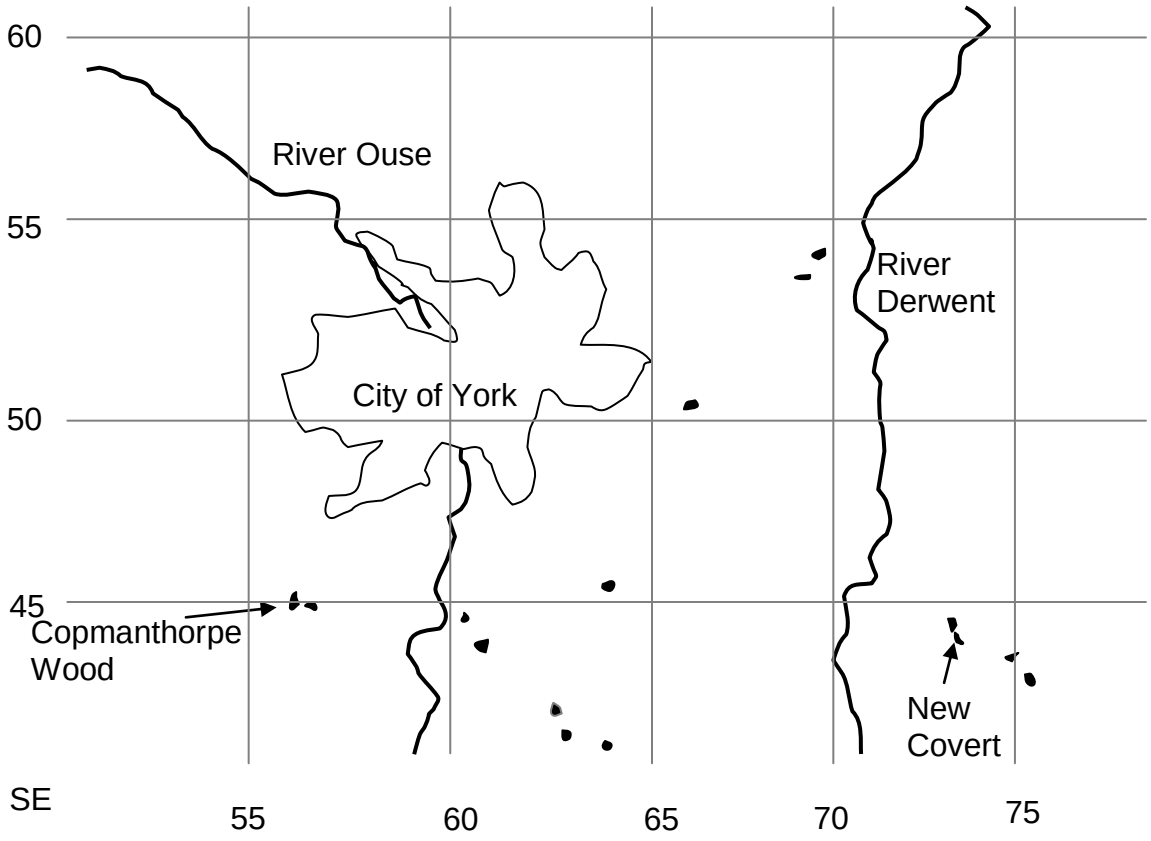

FIGURE 1.

Locations of the two woods both studied in 2003 and 2004 are labelled and grid cells (5 x 5km based on OS co-ordinates) provided.

FIGURE 2.

Malaise trap in Copmanthorpe Wood, 2003.

FIGURE 3.

Malaise trap in New Drive Plantation, 2003.

FIGURE 4.

Diacritus aciculatus ♂, length 6mm

FIGURE 5.

Syrphoctonus longiventris ♂, length 4mm

FIGURE 6.

Zaglyptus multicolor ♀, length 8mm

FIGURE 7.

Poemenia notata ♀, length 7mm