INVERTEBRATE COMMUNITIES OF OLD TRADITIONAL ORCHARDS IN SOUTH SHROPSHIRE (VC40)

IAN THOMPSON and GODFREY BLUNT
iansthompson@f2s.com; arthur.blunt195@btinternet.com

A study was carried out in 2015-2017 in 22 orchards in south Shropshire. The state and management of the orchards and their characteristic vegetation were noted. Targeted searches were made for eight nationally local or uncommon invertebrate species associated with mistletoe and fruit-trees. Six target species were found, along with 306 other invertebrate taxa. These are presented in four invertebrate communities and 11 faunal groups. Their functions in the orchards and relationships to each other, to vegetation communities and management are identified and discussed. The study found a few species of national or regional importance and many common species. Together these form complex invertebrate communities that are highly integrated into habitats of the region and potentially make a valuable contribution to regional biodiversity.

INTRODUCTION

In the extreme south of Shropshire is an area extending from just north of Richards Castle in the west to Neen Sollars in the east; generally bounded to the north by the rising mass of the Clee Hills and the town of Ludlow and to the south by the River Teme. This area has geographic and climatic conditions similar to adjacent areas of north Herefordshire and north Worcestershire. The traditional agricultural practices are also similar.

In 2003 the Shropshire Hills Area of Outstanding Natural Beauty (AONB) office started work on an inventory of all known orchards in the area with the intention of creating a list and map. Its further aims were to form an action plan for studying improvement, management and fruit varieties; but after two years it was realised that the extent of the task, which was carried out by volunteers, was unachievable and the work was stopped. The Marcher Apple Network (MAN) took possession of the orchard inventory data from the Shropshire Hills AONB.

In 2011 papers published in *British Wildlife* showed that Herefordshire, west Gloucestershire and Worcestershire are a core area for traditional orchards and mistletoe in Britain; they also hold the largest concentration of noble chafer (*Gnorimus nobilis*), and other rare invertebrates, lichens and fungi (Alexander & Bower, 2011; Barker *et al*., 2011; Briggs, 2011). At that time no detailed work on the invertebrates of Shropshire's orchards had been carried out. The People's Trust for Endangered Species (PTES), who had an inventory of traditional orchards and are the lead partner for the noble chafer, a Priority Species in the UK Biodiversity Action Plan, had no relevant invertebrate records for Shropshire but were able to supply details of the recorded distribution of *G. nobilis* in Herefordshire and Worcestershire within 8 km of their borders with Shropshire.

In July 2011 the Shropshire Invertebrates Group (SIG) organised a field trip to Mahorall Farm, a traditional cider apple orchard in Nash, to look for three orchard specialist invertebrates: the micro-moth *Celypha woodiana*, noble chafer (*G. nobilis)* and red-belted clearwing (*Synanthedon myopaeformis*). We had no success in finding any of these species so in May 2013 a second visit was arranged. This time larval frass of noble chafer was found, although the other targets remained elusive. A visit was also made in July 2013 to an old orchard and adjacent churchyard at Morville Hall near Bridgnorth. One mistletoe specialist species, *Pinalitus viscicola*, was found there.

With the end of the Invertebrate Challenge programme at FSC Preston Montford a study of Shropshire's orchards was seen as a useful follow-up to apply invertebrate recording skills. Therefore in spring 2015 a programme of surveys of old traditional orchards was started to look at a representative sample of sites over the area of south Shropshire described above. We hoped to establish how far the ranges of specialist orchard species extend into south Shropshire and show that it is properly part of the core area of mistletoe, its invertebrate fauna, and the noble chafer.

AIMS OF THE SURVEY

Eight target species of orchard specialist invertebrates for this study are detailed below together with their previously known VC40 statuses.

1. *Celypha woodiana* – a mistletoe leaf-mining micro-moth, a UK species of Principal Importance (formerly BAP species). No VC40 records; its nearest known populations in Herefordshire and Worcestershire are some distance south of their borders with Shropshire.
2. *Synanthedon myopaeformis* – red-belted clearwing, a moth of apple trees for which there are two previous VC40 records, in the Wyre Forest in 1991 and 1992.

3. *Gnorimus nobilis* – noble chafer, recorded by SIG in 2013 (see above). In 2014 three further VC40 records from 2005, 2010 and 2012, mistakenly believed to be from Worcestershire, were forwarded by the Worcestershire Biological Records Centre. All four records were made from the discovery of larval frass in rot-holes – three in cherry trees, one in apple.
4. *Cacopsylla visci* – a psyllid bug. The only record for VC40 was in 2013 at Mahorall Farm.
5. *Pinalitus viscicola* – a mirid bug for which there were two VC40 records; in an orchard near The Sturt in the Wyre Forest in 1997, and in 2013 at Morville churchyard.
6. *Hypseloecus visci* – a mirid bug first recorded in Britain in 2003 but not yet found in VC40.
7. *Anthocoris visci* – a bug predator of psyllids. One VC40 record from the orchard near The Sturt in 1997.
8. *Ixapion variegatum* – mistletoe weevil, first recorded in Britain in 2000 near Bromyard, Herefordshire. No VC40 records.

A further aim was, within the time available for each visit, to record other invertebrates within this specialised habitat in order that a characteristic orchard fauna could be established.

SITE SELECTION

The criteria for selection of sites were as follows:

1. Presence of mistletoe, preferably in quantity and on trees that are under stress.
2. Presence of dead/fallen trees and/or fallen branches together with the existence of rot-holes or other cavities.
3. Where possible, the orchard to contain a mixture of fruit-tree species.
4. A geographic spread across the area chosen.

Initially one property (Froggatt's Farm) and its owner were known to one of us (IT) from previous survey work of a different nature, and permission for access was readily obtained. Other locations were established, and an initial short-list made, by reference to the latest 1:25000 scale OS maps. Visits were then made to establish whether the site was suitable and if access could be arranged. We found, with only one exception, a willingness among owners to agree to surveys, and in some cases a surprising degree of interest in the outcomes we sought. Owners also suggested other sites, sometimes providing contact details for them. In 2016 an entomologist in Boraston provided much information on orchards in that area, including contact details. The MAN inventory data were made available to us to help identify sites. This inventory is based upon surveys carried out from 2003 to 2005 so is out of date, but five sites ultimately selected for our study were identified from these records.

Surveys were carried out in seven orchards on five properties in 2015, eight orchards on seven properties in 2016 and seven orchards on five properties in 2017. Site locations are on Figure 1, site descriptions in Appendix 1.

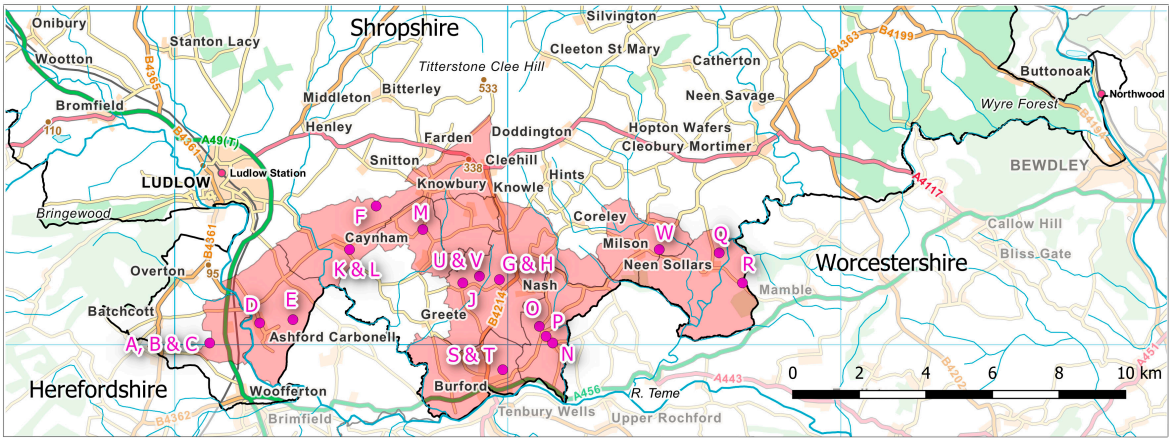


FIGURE 1. Map showing (in pink) the parishes and location of 22 orchards selected for this study. Map: Rich Burkmar.

Froggatt's Farm, Ashford Bowdler:
3 sites – old (A), young (B) and pear (C) orchards
Ashford Farm, Ashford Carbonel (D)
Little Huntington, Ashford Carbonel (E)
Stonehouse Farm near Caynham (F)
Weston Court Farm, Nash:
2 sites – upper (G) and lower (H) orchards
Badgers Amble, Nash (J)
Pervin Farm, Caynham:
2 sites – old (K) and young (L) orchards
Park Gate, Whitton, Nash (M)
Boraston Court, church orchard, Boraston (N)
Whistlewood, Boraston (O)
Bowerswood, Boraston (P)
Reaside Farm, Neen Sollars (Q)
Neenshilltop, long orchard, Neen Sollars (R)
Dean Park, Burford:
2 sites – west (S) and north (T) orchards
Mahorall Farm, Nash:
2 sites – Grove (U) and dingle (V) orchards
Lea Fields, Milson (W)

FIELDWORK METHODS

Timing of visits

The first two survey days in May 2015 were to enable us to find mistletoe leaves mined by *Celypha woodiana* before they fell in June/July. The third and fourth survey days in June aimed to coincide with the flight period of red-belted clearwing and noble chafer, although the latter is more likely to be recorded by discovery of larval frass which can be carried out at any time. These timings were repeated in 2016, but in 2017, to enlarge the scope of fieldwork, the programme was carried out in June and July. Dates for visits were fixed in discussion with owners. Most sites are working farms, and factors to be considered were the avoidance of weekends and the presence of farm stock in orchards, which might prove a problem. The dates of site visits are given in Appendix 1. Those undertaking site visits had to be available for as many survey days as possible, these being weekdays. Because of the nature of the sites, particularly those which were non-farming properties, it was felt desirable to restrict numbers to around six.

Operations and methods conducted during each visit

The general character of each orchard was assessed and noted, as detailed in site descriptions in Appendix 1. Mistletoe was scanned with binoculars and any potentially mined leaves removed with a long-handled pruner for examination (Figure 2). This method became central in finding the characteristic leaf dieback and exit-holes associated with mistletoe weevil and was continued throughout the study. Reachable mistletoe clumps were beaten on all survey days and specimens of the target psyllid, mirid and anthocorid bugs were thus obtained together with other species. Vegetation of surrounding trees, hedges and the field layer was beaten, sweep-netted and visually examined to establish a list of invertebrates of these habitats. All accessible rot-holes and cavities were examined for frass which would indicate the presence of noble chafer larvae, the only exceptions being two holes occupied by nests of great tit (*Parus major*) and hornet (*Vespa crabro*). Pheromone lures for red-belted clearwing (ALS code myo) were carried in its flight period in June and July. Invertebrate fauna not recorded by these methods, e.g. butterflies and bumblebees and some casual visitors, were also noted. The survey did not use traps which needed to be left unattended, because of considerations involving farm stock; nor light-traps which would require constant attendance or return visits, and which might have caused inconvenience to site owners or neighbours.

FIGURE 2. Apple tree stressed by heavy mistletoe load at Weston Court Farm lower orchard (left) and method used for sampling mistletoe leaves (right). Photos: Ian Thompson.

Identification and recording of species

A list of invertebrate species recorded is in Appendix 2. The sequencing of Orders and Families in Appendix 2 follows Chinery (1993). Invertebrate nomenclature follows Agassiz *et al*. (2013, 2016a, b) for Lepidoptera, Bantock & Botting (2013) for Hemiptera, Biological Records Centre [2018] for Psocoptera, Boyko *et al*. (2008 onwards) for Isopoda, Duff (2012) for Coleoptera, Chandler (1998) for Diptera, and Else *et al*. (2004, 2016) for aculeate Hymenoptera. Plant nomenclature follows Stace (2010). The species concepts, identification and nomenclature of all species of gall-causing invertebrates follow Redfern & Shirley (2011).

As a rule only invertebrates and vascular plants were recorded. However, it was noted that in orchards that contained trees heavily infested with mistletoe, or where larger mistletoe clumps showed signs of stress, the plants were affected by a fungus appearing as small black spots on leaves and twigs; it was seldom found on young plants. This fungus proved difficult to identify from literature sources, but contact was made with the Herefordshire Fungus Survey Group, who identified our specimen as a mistletoe-specific species of coelomycete microfungus, *Sphaeropsis visci* (Alb. & Schwein.) Sacc. 1880 (E. Blackwell pers. comm.). It is probably common, but is not often recorded as it is usually out of reach on fungus surveys and would not be found on Christmas mistletoe as diseased sprigs would not be on sale. This is a new species for VC40. It proved to be quite widespread, found in 13 of the 22 orchards visited.

DISCUSSION: STATE OF THE ORCHARDS TODAY

The orchards in this study, whilst primarily selected using criteria described above, comprise a variety of sites of differing sizes, usages and levels of management (Table 1). The current state of the orchards, their place in the commercial operations of the properties and their likely future are discussed below. For five of the orchards identified from MAN data comparisons of their current state with the situation pertaining at the time of their original survey by the Shropshire Hills AONB team are made later in this section.

The basic classification used here is whether the orchard is part of a domestic or farming property (Table 1). Three sites are domestic: Badgers Amble, where the orchard is adjacent to but separated from the garden; Park Gate, where the orchard is effectively an extension to the garden but separated from it by a public road; and Whistlewood, whose garden merges with the remains of two orchards. The remaining 19 sites are all within a farming environment.

TABLE 1. Classification of orchards in this study according to types resulting from current management, and showing grazing regimes for the 16 grazed orchards. (†Cattle primarily and sheep †† Cattle as aftermath grazing following hay cut).

Orchard	Code on Fig. 1	Domestic / Farm	Abandoned	Current management	Stocking regime (where grazed)
Ashford Farm	D	F		Wood pasture	Sheep
Badgers Amble	J	D	A	Wood pasture	n/a
Boraston Court church orchard	N	F		Wood pasture	Sheep
Bowerswood	P	F		Wood pasture	Cattle/sheep†
Dean Park north orchard	T	F		Wood pasture	Cattle
Dean Park west orchard	S	F		Wood pasture	Cattle
Froggatt's Farm old orchard	A	F	A	Wood pasture	n/a
Froggatt's Farm pear orchard	C	F		Wood pasture	Cattle
Froggatt's Farm young orchard	B	F		Wood pasture	Cattle / Domestic Poultry
Lea Fields	W	F		Wood pasture	Sheep
Little Huntington	E	F		Wood pasture	Sheep
Mahorall Farm dingle orchard	V	F	A	Wood pasture	n/a
Mahorall Farm Grove orchard	U	F		Wood meadow	n/a
Neenshilltop long orchard	R	F		Wood pasture	Cattle
Park Gate	M	D		Garden/recreational	n/a
Pervin Farm old orchard	K	F		Wood pasture	Sheep
Pervin Farm young orchard	L	F		Wood pasture	Sheep
Reaside Farm	Q	F		Wood meadow	Cattle / Hay ††
Stonehouse Farm	F	F		Wood pasture	Cattle
Weston Court Farm lower orchard	H	F		Wood pasture	Cattle/sheep†
Weston Court Farm upper orchard	G	F		Wood pasture	Cattle/sheep†
Whistlewood	O	D		Wood meadow	n/a

Until 1976 fruit merchants operated in Boraston and Eastham on the River Teme. These businesses no longer exist because there is now little value in the fruit from farm orchards in this area. An exception is Mahorall Farm which currently produces cider commercially. Two other properties formerly produced cider to an extent beyond domestic consumption: Stonehouse Farm, where the processing building has been incorporated into the farmhouse, and Weston Court Farm, where a mill building has recently been restored although no processing equipment remains. The production of fruit for cider-making and perhaps other products still forms a probably minor part of the usage at Ashford Farm, Little Huntington and Pervin Farm young orchard. We understand that there is still a market for damsons – principally for making dyes – but the high cost of labour to pick and gather the fruit makes this uneconomic in most cases. Accordingly most orchards we surveyed are used for grazing stock (Table 1). Park Gate is mown and has no grazing at all; part of this site is used as a workshop and the parking of unused chicken houses and a tractor. At Whistlewood at the time of our visit the meadow had mown paths for access, but we understand it is the owner's intention to cut this for hay in future and introduce aftermath grazing.

Comparisons between 2003 and today

The following five orchards were visited in 2003 as part of the Shropshire Hills AONB survey. Comparisons between the original surveyors' notes and our findings are as follows:

Badgers Amble. Originally visited on 15th August 2003 when it contained 10 apple, eight plum and 12 damson trees. Twelve trees were new plantings. The site was wet, with a brook running through one part and along the edge of a lower area. The ground flora was described as "rough vegetation with patches of apple mint and *Iris pseudacorus*". Grazing was by one horse (regularly) and sheep (occasionally). Most trees did not fruit and the owner said the site was a frost-pocket. There was some mistletoe and both standing and fallen dead wood.

When surveyed on 16th May 2016 the site had seriously deteriorated; there were no damsons, only one plum and three living apple trees, plus two dead apples, one upright and one fallen. No trees appeared to be fruiting. The site was uneven, damp and ungrazed, with extensive meadow buttercup (*Ranunculus acris*), creeping buttercup (*R. repens*) and cuckooflower (*Cardamine pratensis*) in the sward. Mistletoe was confined to the plum tree and a hazel (*Corylus avellana*); it hosted no mistletoe specialist species.

The site is not managed and will soon cease to justify being described as an orchard. It is doubtful that restoration is a viable proposition, and one can envisage a change of use when owners with the time and resources take this property on.

Weston Court Farm lower orchard. Originally visited on 28th October 2003 when it reportedly contained 13 apple and 17 pear trees of similar age. There was some mistletoe and both standing and fallen dead wood. The orchard was grazed by cattle. This site has been known as an orchard since at least 1887.

The resurvey was carried out on 16th May 2016, when trees present were apples, some well-established plums and one large pear. We feel that the AONB survey, carried out in late autumn, may have incorrectly identified the tree species present. At our visit all dead wood except for one standing tree had been cleared and new plantings with protective guards replaced them. Three large older apple trees were heavily infested with mistletoe, and although not yet dead appeared in poor condition (Figure 2). There were rot-holes in a few trunks. The site had a good grass sward and was grazed, currently by beef cattle. At the base of boundary hedges there was evidence of a moist soil flora including cuckooflower (*C. pratensis*).

This orchard appears to continue to be an integral part of this farm. The owners plan to remove dead wood/trees and carry out new planting, although its produce is used only for domestic consumption.

Park Gate. This was originally visited on 15th August 2003. The survey papers refer to the main orchard which is to the west of the house on the other side of the public road; this was described as half an acre in extent containing eight apple, four pear, four plum and four cherry trees. There was "lots" of mistletoe and both standing and fallen dead wood. The grass beneath the trees was mown and there was a children's play area with tree-house.

When surveyed on 24th May 2016 the site was very different. Only apple and plum trees survived. Standing and fallen dead wood had been removed and several trees had been severely pruned to reduce their size. Much of the mistletoe had been removed, and only one apple tree contained more than the smallest of plants; the mistletoe here hosted no specialist species. The grass beneath the trees continued to be mown; the tree-house had gone but there was a trampoline. In one corner was an area where bonfires were regularly made. To one side of the house was a small narrow paddock not included in the 2003 survey; in 2016 this contained two old large apple trees, one now dead, the other in poor condition. This paddock was neither grazed nor mown.

This site being a domestic one, the orchard has little commercial value and it is envisaged that it will remain part of the garden. The narrow paddock will either be effectively abandoned or may be cleared for other uses. It is difficult to imagine any scheme of restoration for this area.

Boraston Court church orchard. The original visit was on 28th October 2003. It contained 38 apples and eight pears described as of similar age. Standing and fallen dead wood was present as was mistletoe. The orchard's condition was described as poor, but some trees were still fruiting; it was commented that the farmer was not interested in the orchard. This is another site known since 1887.

At the resurvey on 14th June 2016 the main trees remaining were plums, with a few apples and one pear. The trees were now variably-sized and the pear was large; they were irregularly spaced but there was no evidence of infilling. A few dead trees existed and one that was fallen but still alive. There appears to have been no maintenance and many trees were in poor condition, but some were still fruiting. There were very few rot-holes in trunks or branches. At our visit the grass was very long and there were extensive areas of nettles (*Urtica dioica*), much broad-leaved dock (*Rumex obtusifolius*) and some creeping thistle (*Cirsium arvense*).

Given the owner's attitude it would appear that as trees are lost this site will become an extension to the adjoining pasture, which is contiguous with the site along its western boundary (Appendix 1).

Bowerswood. This small orchard was originally visited on 28th October 2003 when it contained 30 apples and three damsons. Standing and fallen dead wood and mistletoe were present. There were no comments on the field layer flora but grazing by cattle and sheep was noted. This orchard has also been known since 1887.

The resurvey was carried out on 27th June 2016. Some trees were quite old, with gaps between them; some of these contained recently planted trees with protective guards. One or two old trees were dead but still standing and had extensive rot-holes. One large plum tree (identified as such by the owner) had been felled and the large logs piled on site: this tree had not been recorded in the original survey. The sward contained some coarse grasses, nettles (*U. dioica*) and creeping thistles (*C. arvense*).

This site appears to have a future within the operations of this farm, albeit not in a commercial context. It will continue to be managed by the current owner who also owns other orchards in the area including a relatively new one planted with plums and damsons.

Summary for state of the orchards

Of 10 orchards initially identified from AONB survey data as potentially meeting the criteria for this study on investigation five were found currently suitable, though Badgers Amble only marginally met the criteria. Of the five not selected, one had been largely destroyed by development, one had only two surviving trees, and one had lost most of its trees and all its mistletoe. The current state of two orchards was not followed up as their owners could not easily be contacted. With the exception of only Weston Court Farm lower orchard all orchards whose present condition could be compared with the AONB survey had lost trees in the last 12-14 years, and three had lost their integrity as orchards almost completely.

This attrition has been continuing since at least 1949, when orchards accounted for almost 2,800 acres in Shropshire; by 1963 this had reduced to 1,900 acres (Stamp, 1969 p. 165). When we investigated several orchard sites shown on post-war OS maps we found they no longer existed. Some orchards that form part of this study were indeed located by checking sites on OS maps, but most were brought to our attention by local farmers and residents. This at least shows that, despite heavy losses, orchards still exist in reasonable numbers in south Shropshire, and our study had to proceed on a sampling basis: a comprehensive survey was not feasible.

DISCUSSION: INVERTEBRATE COMMUNITIES OF THE ORCHARDS

Species recorded in our orchards are presented and discussed here in four Communities within which are defined 11 Faunal Groups. These are broadly conceived guilds of invertebrates that inhabit and exploit similar ecological niches; their component species are identified from direct observations made in this study or inferred from the literature. Species with multiple relationships within the orchards are assigned to more than one faunal group as appropriate. Some species whose life histories are less well understood are tentatively assigned to faunal groups but excluded from calculations relating to those groups.

The invertebrate communities of south Shropshire's orchards are as follows:

- *Mistletoe Community* (Faunal Groups M1, M2)
- *Canopy Layer Community* (Faunal Groups CL1, CL2, CL3, CL4)
- *Field Layer Community* (Faunal Groups FL1, FL2, FL3)
- *Ground Layer Community* (Faunal Groups GL1, GL2)

Mistletoe Community

This Community comprises Faunal Groups:

M1 (6 species)
M2 (26 species)

Links to other Faunal Groups:

CL1 (3 species)
CL2 (5 species)
CL3 (6 species)
CL4 (8 species)
FL1 (1 species)
FL2 (2 species)
FL3 (2 species)
GL1 (1 species)

FIGURE 3. Mistletoe showing fungal infestation. Illustration: Bea Pope.

Faunal Group M1 comprises species that are confined to mistletoe and described here as mistletoe specialist species. Table 2 shows the distribution of this faunal group. The survey set out to record six species of mistletoe specialist fauna: the micro-moth *Celypha woodiana*, the psyllid *Cacopsylla visci*, two mirid bugs *Pinalitus viscicola* and *Hypseloecus visci*, a bug predator of psyllids *Anthocoris visci*, and the mistletoe weevil (*Ixapion variegatum).* In south

Shropshire orchards apple is the predominant host of mistletoe, *Prunus* species (cherry, plum and damson) less so, and pear is rarely a host. Most of our sites had moderate to large quantities of this parasitic plant but orchards at Badgers Amble and Park Gate held only small amounts, a factor affecting results for those orchards.

The mistletoe weevil (*I. variegatum*) was recorded from most sites but never in large numbers. Its larvae feed in mistletoe twigs and not on the leaves, leaving an exit-hole on emergence (P. Whitehead pers. comm.). In at least three sites only one twig with a weevil exit-hole was noted, whereas at two sites at Neen Sollars evidence was found of weevils occurring at a density of between 1:2 and 1:3 of trees examined. Adult weevils were beaten from mistletoe at only two sites, with one and two individuals respectively, one teneral, which suggests that our surveys were conducted prior to the main emergence period (confirmed by P. Whitehead pers. comm.); the exit-holes we were finding would therefore have related to the previous year (Figure 4). New-growth mistletoe (as new plants or on established plants) was found to host no invertebrates, while well-established plants in heavy infestations produced most records. Mistletoe under stress was the best substrate in which to find *I. variegatum*, a situation noted also in Worcestershire (Green & Meiklejohn, 2004).

TABLE 2. Faunal Group M1 showing sites visited, species recorded, and number of sites for each species by year.

Year	2015	2016	2017	
Visit dates	early May-end June	mid-May-end June	mid-June-end July	
Sites visited	A-G	H-P	Q-W	Total sites
No. sites in year	7	8	7	22
Species and no. of sites where found				
Cacopsylla visci	7	5	7	19
Pinalitus viscicola	5	3	6	14
Hypseloecus visci	0	0	3	3
Anthocoris visci	0	1	4	5
Ixapion variegatum	7	5	6	18
Triaspis sp.	0	3	4	7

FIGURE 4. Mistletoe showing exit-holes of parasitic wasp *Triaspis* (left) and weevil *Ixapion variegatum* (right). Photos: Ian Thompson.

The distribution of mistletoe in the trees was variable. There was evidence of some browsing on trees where cattle are grazed, and the better clumps of mistletoe were then not always easily reached. In heavily-infested trees much of the growth is high in the crown where the light is better. Fortunately evidence of the weevil was very often on the outside of the clumps; diagnostic signs were then more easily seen and affected twigs easier to access.

On 16th May 2016 at Weston Court Farm lower orchard a piece of mistletoe showing dieback of terminal leaves but no weevil exit-hole was taken from a large old clump on an apple tree. It was envisaged that in due course an adult weevil would emerge, but after four days a small braconid wasp was found in the rearing box and a small exit-hole was noted below the terminal bud where the typical weevil exit-hole would be expected. This wasp, a male, was sent to the Natural History Museum where it was provisionally identified as *Triaspis podlussanyi* Papp, a species recently described as new to Britain (Shaw *et al.*, 2016). As the wasp had been bred out so quickly we had the opportunity to look for its distinctive small, round exit-hole (c. 0.7mm diameter) in future searches of mistletoe. In the rest of 2016 we noted these smaller holes at Boraston Court church orchard and Whistlewood. Subsequently all previous samples of mistletoe with weevil exit-holes taken from sites visited in 2015 were examined for signs of the

parasite, but we determined that earlier identifications of weevil presence based on exit-holes was sound: in contrast to *Triaspis* exit-holes, those of *I. variegatum* are distinctively larger and more irregular in shape (Figure 4).

In 2017 further exit-holes of the parasite were found at Reaside Farm, Dean Park west orchard, Mahorall Farm Grove orchard and Lea Fields. A further wasp was bred from material collected at Mahorall Farm and reared in similar circumstances to the 2016 specimen.This second wasp, also a male, was sent to Dr Mark Shaw for identification, who responded that it was not *T. podlussanyi* as this species is thelytokous (i.e. without males); it was of the same genus *Triaspis* but could not be determined to species from a male specimen. Braconid wasps of this genus are endoparasitoids of Coleoptera larvae, so our presumption that we have found an association with *I. variegatum* seems reasonable. To determine the precise species of wasp involved a future breeding programme is being put in place in order to build on the research presented in this study.

Faunal Group M2 comprises species that were found on mistletoe in this study but which also occupy other niches in the orchards. Besides the mistletoe specialist fauna we obtained 26 other species from this plant. These are listed in Table 3, together with the number of orchard sites where each species occurred on mistletoe.

TABLE 3. Faunal Group M2 comprising non-specialist invertebrate species obtained from mistletoe.

Order and Species	No. sites on mistletoe	Order and Species	No .sites on mistletoe
HEMIPTERA		COLEOPTERA	
Anthocoris nemoralis	5	*Malthodes marginatus*	1
Anthocoris simulans	2		
Aphrophora alni	1	DERMAPTERA	
Atractotomus mali	2	*Forficula auricularia*	3
Blepharidopterus angulatus	1		
Cacopsylla melaneura	2	DIPTERA	
Campyloneura virgula	1	*Anomoia purmunda*	1
Deraeocoris flavilinea	4	*Beris vallata*	1
Grypocoris stysi	1		
Himacerus apterus	2	PSOCOPTERA	
Javesella pellucida	1	*Ectopsocus briggsi*	3
Neolygus contaminatus	1	*Ectopsocus petersi*	1
Orius vicinus	1	*Elipsocus hyalinus*	1
Pentatoma rufipes	1	*Graphopsocus cruciatus*	3
Scolopostethus affinis	1	*Valenzuela burmeisteri*	1
		Valenzuela flavidus	1
LEPIDOPTERA			
Euproctis similis	1		

Some species listed in Table 3 probably occurred on mistletoe only casually and have no particular association with that plant; for example, a larva of yellow-tail moth (*Euproctis similis*) found on mistletoe growing on hazel (*Corylus avellana*) at Badgers Amble refused mistletoe in captivity but fed up on hazel. Species also found more generally in the canopies of trees and shrubs are discussed under invertebrate communities of the canopy layer. Four species (*Grypocoris stysi*, *Javesella pellucida*, *Scolopostethus affinis*, *Beris vallata*) are also associated with field and ground layer communities and are dealt with in those communities.

Of the 26 species in this group 54% are chewing herbivores, sap-suckers or grazers, 31% are predators, 12% are both herbivorous and predatory at different stages in their life cycles, and 3% are omnivores. This wide distribution with a high percentage of predators suggests that the majority of species were opportunistic in their occurrence on mistletoe. One potential guild within this non-specialist faunal group comprises the six species of Psocoptera; these are grazers on microflora including fungal spores, and their presence on mistletoe in our orchards may be linked to infestations of the micro-fungus *Sphaeropsis visci*. It is thought that these psocids attracted the predators in Table 3, thereby forming a small but interesting food web.

Canopy Layer Community

This Community comprises Faunal Groups:

- **CL1** (26 species)
- **CL2** (71 species)
- **CL3** (23 species)
- **CL4** (40 species)

Links to other Faunal Groups:

- M2 (19 species)
- FL1 (2 species)
- FL2 (5 species)
- FL3 (15 species)
- GL1 (3 species)
- GL2 (4 species)

Faunal Group CL1 comprises phytophagous species associated with fruit and nut trees in the orchards. CL1 is represented by 26 species shown in Table 4 whose main hostplants include cultivated apple (*Malus pumila*), plum and damson (*Prunus domestica*), cherry (*P. avium*), pear (*Pyrus communis*) and walnut (*Juglans regia*). Two taxa in this group could not be identified to species level and are shown as species pairs.

Most CL1 species feed on apple and plum, which were the most widespread fruit-trees in our orchards. Pears were grown on a small scale in a few orchards, two or three walnuts grew at Froggatt's Farm young orchard and Neenshilltop, while cherries grew only at Whistlewood.

Faunal Group CL1 is represented by 27% leaf-miners, 23% gall-causers, 19% internal feeders in shoots and fruits, 19% suckers and 12% chewers on flowers and foliage. The presence of many leaf-miners and gall-causers indicates well-established invertebrate communities, since colonisation rates by these guilds are generally lower than those of chewing and sucking invertebrates (Strong, Lawton & Southwood, 1984).

TABLE 4. Faunal Group CL1 comprising phytophagous species of fruit and nut trees in the orchards. Species in bold type are also predators represented in Faunal Group CL4. (+ also associated with *Crataegus*; ++ also associated with *Corylus;* † also associated with *Tilia;* †† also associated with *Quercus* and *Corylus).*

Order and Species	Host Plants			
	Malus	*Prunus*	*Pyrus*	*Juglans*
ACARI				
Aceria erinea				X
Eriophyes mali	X			
Eriophyes pyri			X	
Eriophyes similis		X		
Phyllocoptes malinus	X			
HEMIPTERA				
Atractotomus mali +	X			
Blepharidopterus angulatus †	X			
Cercopis vulnerata	X	X	X	
Eriosoma lanigerum +	X			
Pentatoma rufipes ††	X	X	X	
Psallus ambiguus +	X			
LEPIDOPTERA				
Argyresthia conjugella	X			
Argyresthia curvella	X			
Argyresthia ivella ++	X			
Argyresthia pruniella		X		
Bohemannia pulverosella	X			
Callisto denticulella	X			
Cydia pomonella	X			
Hedya pruniana +		X		
Lyonetia clerkella +	X	X	X	
Parornix finitimella/torquillella		X		
Parornix scoticella	X			
Pasiphila rectangulata	X	X	X	
Phyllonorycter blancardella/hostis	X			
Phyllonorycter leucographella +	?	X		
Yponomeuta malinellus	X			

Two CL1 species are nationally local: the apple ermine (*Yponomeuta malinellus*), found in 13 orchards and infesting many trees in Froggatt's Farm young orchard and Weston Court Farm upper orchard, and *Argyresthia curvella*, from Boraston Court church orchard. *Argyresthia ivella*, found at Stonehouse Farm, is Nationally Notable B (known from 31-100 hectads nationally). These observations add significantly to our knowledge of these species in Shropshire, where previously *Y. malinellus* was confirmed at only one site, *A. ivella* at two and *A. curvella* at five (Blunt, 2014); the first two species remain largely confined to orchards here.

Five mite species and one hemipteran *Eriosoma lanigerum* galled orchard trees. All walnuts were infested with *Aceria erinea*, and several other gall-causers were abundant where they occurred. *Eriophyes similis* was particularly common on plums, with a heavy infestation at Lea Fields. By contrast, *Eriophyes mali* had very small populations in the three orchards where it occurred, galling only a small percentage of apple trees and few leaves on those trees. *Eriophyes pyri* too was found at very low density on just one pear in one orchard, Whistlewood.

Many species in this faunal group are potential pests in commercial fruit orchards (Alford, 2014), but we saw no evidence of any reaching pest proportions in our study. The wide variety of parasitoid and predator species in the orchards must play a part in controlling pest outbreaks there.

All taxa listed for *Prunus* in Table 4 may also feed on blackthorn (*Prunus spinosa)* in local hedgerows. Seven species in this Table also feed on hawthorn (*Crataegus monogyna)* or hazel (*Corylus avellana)*; one other has an association with lime (*Tilia)*, and one more with oak (*Quercus)* as well as hazel. These trees and shrubs grow in orchard boundaries and roadside habitats throughout the region, and their fauna is dealt with more fully below. It is enough here to note that over half the invertebrates of orchard fruit-trees in Table 4 are also linked to other local habitats, showing a good association between the fauna of orchard trees and that of the wider countryside.

Faunal Group CL2 comprises phytophagous species associated with trees other than fruit-trees, together with shrubs and other woody plants in the orchards and their boundary habitats (see Table 5). This is the largest faunal group identified in our study with 71 species.

TABLE 5. Faunal Group CL2 comprising the phytophagous fauna of other trees and shrubs in the orchards and their boundary habitats. Species in bold type are also predators represented in Faunal Group CL4. Colour coding distinguishes columns. († – Polyphagous on deciduous trees and shrubs).

Order and Species	Main Foodplant(s)												
	Acer	*Betula*	*Corylus*	*Crataegus*	*Euonymus*	*Fraxinus*	*Quercus*	*Rubus*	*Rosaceae*	*Salix*	*Tilia*	*Hedera/Ilex*	Polyphagous †
ACARI													
Aceria pseudoplatani	X												
Aculus fraxini						X							
Eriophyes lateannulatus											X		
Eriophyes leiosoma											X		
Phyllocoptes goniothorax				X									
Phytoptus avellanae			X										
Stenacis convolvens					X								
COLLEMBOLA													
Entomobrya nivalis													X
DIPTERA													
Anomoia purmunda				X									
Dasineura fraxini						X							
HEMIPTERA													
Acanthosoma haemorrhoidale				X									
Alebra albostriella							X						
Aphrophora alni													X
Cacopsylla melanoneura				X									
Chamaepsylla hartigi		X											
Cixius nervosus													X
Cyllecoris histrionius							X						
Deraeocoris flavilinea	X												
Dryophilocoris flavoquadrimaculatus							X						
Elasmostethus interstinctus		X	X										
Empoasca vitis													X
Eurhadina pulchella							X						
Fagocyba cruenta													X
Heterotoma planicornis													X
Lindbergina aurovittata							X						
Lygocoris pabulinus													X
Neolygus contaminatus		X											
Neolygus viridis							X				X		
Oncopsis subangulata		X											
Oncopsis tristis		X											
Palomena prasina													X
Philaenus spumarius													X
Phylus coryli			X										
Phylus melanocephalus							X						
Pinalitus cervinus			X			X					X		

TABLE 5 continued.

Order and Species	Main Foodplant(s)												
	Acer	*Betula*	*Corylus*	*Crataegus*	*Euonymus*	*Fraxinus*	*Quercus*	*Rubus*	*Rosaceae*	*Salix*	*Tilia*	*Hedera/Ilex*	Polyphagous †
HEMIPTERA continued													
Psallus flavellus						X							
Psallus lepidus						X							
Psallus varians							X						
Psyllopsis fraxini						X							
Typhlocyba quercus													X
HYMENOPTERA													
Andricus foecundatrix							X						
Heterarthrus wuestneii	X												
Neuroterus numismalis							X						
Pontania proxima										X			
LEPIDOPTERA													
Aleimma loeflingiana							X						
Allophyes oxyacanthae				X									
Cabera pusaria													X
Celastrina argiolus												X	
Ditula angustiorana													X
Erannis defoliaria													X
Euproctis similis													X
Hedya nubiferana													X
Lomaspilis marginata			?							X			
Operophtera brumata													X
Opisthograptis luteolata									X				
Orthosia cerasi													X
Orthosia gothica													X
Parornix anglicella				X									
Parornix devoniella			X										
Phyllonorycter coryli			X										
Phyllonorycter corylifoliella				X									
Phyllonorycter harrisella							X						
Phyllonorycter nicellii			X										
Phyllonorycter aff. *quercifoliella*							X						
Prays fraxinella						X							
Pseudargyrotoza conwagana						X							
Stigmella atricapitella							X						
Stigmella aurella								X					
Stigmella floslactella			X										
Stigmella microtheriella			X										
ORTHOPTERA													
Leptophyes punctatissima								X					

Boundaries of all orchards supported a range of trees and shrubs, some of which also grew sparingly in the orchards themselves. Hedges at Ashford Farm and Weston Court Farm upper orchard consisted of planted hawthorn (*C. monogyna*), but elsewhere they were a natural extension of the vegetation of local woods and copses. The climax vegetation of base-rich soils in the area is the National Vegetation Classification (NVC) W8 *Fraxinus excelsior-Acer campestre-Mercurialis perennis* community in which ash (*F. excelsior*), field maple (*A. campestre*), bramble (*Rubus fruticosus* agg.) and hazel (*C. avellana*) are constant species, and hawthorn (*C. monogyna*), blackthorn (*P. spinosa*), pedunculate oak (*Quercus robur*), holly (*Ilex aquifolium*) and ivy (*Hedera helix*) are frequent (Rodwell, 1991; Lockton & Whild, 2015). Occasional members of this community are silver birch (*Betula pendula*), spindle (*Euonymus europaeus*), sallows (*Salix cinerea* and *S. caprea*) and small-leaved lime (*Tilia cordata*). Sycamore (*Acer pseudoplatanus*) and lime (*Tilia x europaea*) may be naturalised or planted within it (Rodwell, 1991).

It is apparent that nearly all woody plants of our orchard boundaries, with their associated fauna (Table 5), are members of this W8 community. The exception is crack-willow (*Salix x fragilis*) which grew as presumably planted specimens in damper places at Reaside Farm and Neenshilltop. The potential for good interchange between

the canopy fauna of fruit-trees and boundary habitats has been suggested above; the relationship of hostplants in Table 5 to the region's climax vegetation further emphasizes that the arboreal fauna of our orchards is well integrated into the native vegetation matrix of these south Shropshire parishes.

The high proportion of stenophagous species (53 species, 75%) in Faunal Group CL2 compared with polyphagous species (18 species, 25%) implies an established and relatively stable canopy fauna, as polyphagous species are thought to favour changing conditions (Young, 1997; Blunt, 2014). The polyphagous fauna of this group consists largely of Hemiptera and non-mining Lepidoptera, whose presence adjusts the proportions of the herbivore guilds of the total canopy fauna (groups CL1 and CL2 combined) in favour of surface feeders (sucking, chewing and grazing invertebrates) with 53% of species over internal feeders (leaf-miners, gall-causers, feeders within buds and fruits) with 47%. The figures for each guild are: 35% suckers, 21% leaf-miners, 19% gall-causers, 17% chewers, 7% internal feeders in buds and fruits, and 1% grazers on microflora.

Some Lepidoptera in this faunal group are potential orchard pests: the winter moth (*Operophtera brumata*), mottled umber (*Erannis defoliaria*) and Hebrew character (*Orthosia gothica*). Larvae of these moths were encountered in only two orchards, Park Gate and Boraston Court church orchard, and there only in small numbers.

Faunal Group CL3 consists of non-predatory species that live on or in the bark and wood of trunks and branches, including rot-holes; these are shown in Table 6, where the main substrate of each species is indicated. One species is placed here with less confidence. This group includes one of the main targets for this study: the noble chafer (*Gnorimus nobilis*). This beetle is most easily located by searching for the characteristic frass of larvae in moist wood-mould in tree cavities (Alexander, 2008). Nearly all orchards contained trees with accessible rot-holes, but we generally found only a handful of such holes in any orchard, and a high proportion had wood-mould that seemed too dry for larvae of this beetle. We located frass in two new orchards in our study: at Bowerswood, in a dead plum cut down and stacked in the centre of the orchard; and in a living plum at Lea Fields. The apple tree at Mahorall Farm Grove orchard which contained noble chafer frass in 2013 (Figure 5) blew down in gales in winter 2016-17, and while the farmer retained the fallen trunk to conserve this insect we were unable to access it to check for continuing signs of the beetle's presence.

FIGURE 5. *Left*: noble chafer *Gnorimus nobilis* (photo: Rosemary Winnall). *Right*: larval frass from Mahorall Farm Grove orchard in 2013 (photo: Ian Thompson).

There are now four orchards in our study area where noble chafer has been found: May Hill and Mahorall Farm Grove orchard prior to this study, Bowerswood in 2016, and Lea Fields in 2017. This cluster of orchards forms a natural extension of an arc of distribution in Worcestershire between the Wyre Forest and River Teme (Worcestershire Biological Records Centre data). A feature of Worcestershire records not repeated in our study is a tendency for noble chafer to occupy several trees in orchards where it occurs (H. Green, pers. comm.); we found it in only one tree in each of our orchards. This implies that south Shropshire populations are small and probably at the edge of the beetle's potential range in western England. This insect requires relatively warm, dry summers to complete its life cycle here (Alexander & Bower, 2011), and only the narrow belt of warm climate along the Severn valley seems to offer a possibility of range extension by this species in the vice-county. The extensive high ground that dominates much of south Shropshire may present a barrier against its further northward expansion; though we may note that in Hungary noble chafer favours closed forests on mountains and prefers cold, humid valleys and gorges (Csóka & Kovács, 1999).

TABLE 6. Faunal Group CL3 comprising non-predatory species living under bark, in wood, rot-holes and epiphytic habitats. (* this predatory species had a nest in a tree-hole in this study).

Order and Species	Substrate	
	Under bark, in wood or rot-holes	On bark epiphytes
COLEOPTERA		
Clytus arietis	X	
Gnorimus nobilis	X	
Grammoptera ruficornis	X	
(*Hemicrepidius hirtus*)	?	
Rhagium bifasciatum	X	
Tetrops praeustus	X	
HYMENOPTERA		
Apis mellifera	X	
Bombus hypnorum	X	
[*Vespa crabro*]	X*	
ISOPODA		
Phylloscia muscorum	X	X
Porcellio scaber	X	X
LEPIDOPTERA		
Batia lunaris		X
Endrosis sarcitrella	X	
Hofmannophila pseudospretella	X	
Esperia sulphurella	X	
PSOCOPTERA		
Ectopsocus briggsi		X
Ectopsocus petersi		X
Elipsocus hyalinus		X
Graphopsocus cruciatus		X
Mesopsocus immunis		X
Stenopsocus immaculatus		X
Stenopsocus stigmaticus		X
Trichopsocus brincki		X
Valenzuela burmeisteri		X
Valenzuela flavidus		X

Of other species in Faunal Group CL3 four are longhorn beetles (Cerambycidae) whose saproxylic larvae feed in twigs, branches or tree-trunks. Three are fairly widespread in England and Wales, occurring in a variety of habitats in association with several trees and shrubs. *Tetrops praeustus*, however, is classed as nationally local and shows an affinity with old orchards, though it is not confined to them (Lush *et al*., 2009); in our survey it occurred at Ashford Farm and Weston Court Farm lower orchard, in the latter case beaten from apple.

Also in this faunal group are Hymenoptera that nest in tree cavities. Two were confirmed breeding in our study: the honeybee (*Apis mellifera*), which had a wild nest in a moribund ash at Whistlewood, and the hornet (*Vespa crabro*), which nested in an apple at Froggatt's Farm pear orchard; hornets were also observed flying in three other orchards. *V. crabro* is a predator and as such is not strictly part of Faunal Group CL3. The Lepidoptera in this group are *Endrosis sarcitrella* and *Hofmannophila pseudospretella*, which were reared from larvae found in rot-holes, and *Esperia sulphurella*, a micro-moth whose larvae feed on drier dead wood; two adults *in cop*. in Pervin Farm old orchard were evidence that this species was most probably breeding there.

Several species are associated with lichens, algae and bryophytes growing on tree bark. Though recording these epiphytes was beyond the study's remit we observed that different orchard trees and shrubs supported different quantities of them. Crustose and foliose lichens were particularly abundant on apples and hawthorns, but only one fruticose lichen was observed, on apple at Dean Park north orchard. Plum trees were generally intermediate in their amounts of epiphytic lichens, with ash and pedunculate oak supporting less. Mosses were more abundant on apple and ash than on other woody plants. Pear consistently had very few epiphytes of any kind. Though these relative amounts remained fairly constant across our orchards some local variations occurred; for example, epiphytes were less abundant on apple in Dean Park west orchard than the nearby north orchard, while at Lea Fields epiphytic lichens were as abundant on plum as on apple.

Most invertebrates associated with epiphytes in Table 6 are barkflies Psocoptera. These are generalist feeders on the microflora of tree bark, including algae, lichens, fungal spores and organic debris. As such they may be found on the bark of a wide variety of tree and shrub species. As indicated in Table 3 several of these species were also found on mistletoe. Most Psocoptera recorded are common in Britain and Ireland, but *Stenopsocus stigmaticus* is

nationally uncommon and *Trichopsocus brincki* nationally scarce (Biological Records Centre, [2018]); *T. brincki* is strongly associated with conifers and evergreens, as is the common *Valenzuela burmeisteri*; both were located at Lea Fields, where a cypress grew immediately beyond the orchard boundary.

Other fauna of tree and shrub epiphytes include the micro-moth *Batia lunaris* and two woodlice. Larvae of *B. lunaris* feed on crustose lichens and midge-galls (Emmet & Langmaid, 2002); in Shropshire this moth is found mainly in the Wyre Forest (Blunt, 2014). The two woodlice, *Phylloscia muscorum* and *Porcellio scaber,* were found on dead wood. *Porcellio scaber* is often noted on tree trunks in Britain where it feeds on green algae, while *Phylloscia muscorum* is associated with moss and rotting wood up to 3 m above ground (Harding & Sutton, 1985). Woodlice are generalist feeders mainly on decaying plant material, and may occur also as detritivores in the ground layer.

Faunal Group CL4 comprises parasitoids and predators of all canopy layer habitats. Table 7 details the species in this group, consisting of four parasitoids and 36 predators; four other potential predators are placed here with less certainty. One parasitoid, the *Triaspis* species associated with the mistletoe weevil *Ixapion variegatum*, is omitted from this Table; it is discussed above under Faunal Group M1.

TABLE 7. Faunal Group CL4 comprising the predator and parasitoid fauna associated with canopy layer habitats. ([P] = parasitoid; [H] = hyperparasitoid).

Order and Species	Order and Species	Order and Species
ARANEAE	HEMIPTERA	HEMIPTERA continued
Paidiscura pallens	*Anthocoris confusus*	*Phylus coryli*
	Anthocoris nemoralis	*Phylus melanocephalus*
COLEOPTERA	*Anthocoris nemorum*	*Psallus ambiguus*
Adalia bipunctata	(*Anthocoris simulans*?)	(*Psallus flavellus*?)
Adalia decempunctata	*Atractotomus mali*	*Psallus lepidus*
Calvia quattuordecimguttata	*Blepharidopterus angulatus*	*Psallus varians*
Coccinella septempunctata	*Campyloneura virgula*	
Harmonia axyridis	(*Cardiastethus fasciventris*?)	HYMENOPTERA
Malachius bipustulatus	*Cyllecoris histrionius*	*Agrypon canaliculatum* [P]
Malthodes marginatus	*Dryophilocoris flavoquadrimaculatus*	*Diadegma armillatum* [P]
Propylea quattuordecimpunctata	*Heterotoma planicornis*	*Sympiesis sericeicornis* [P]
Pyrochroa serraticornis	*Himacerus apterus*	*Mesochorus pallipes* [H]
	(*Loricula pselaphiformis*?)	*Vespa crabro*
DIPTERA	*Neolygus viridis*	
Epistrophe eligans	*Orius vicinus*	ORTHOPTERA
Episyrphus balteatus	*Orthotylus ochrotrichus*	*Meconema thalassinum*
Rhagio scolopaceus	*Pentatoma rufipes*	
Syrphus ribesii	*Phytocoris longipennis*	

In this survey some larvae and pupae of Lepidoptera were reared, during which process a few parasitoids also emerged. These were identified by Dr Mark Shaw, and the following notes are based on Dr Shaw's comments.

Small larvae of *Yponomeuta malinellus* collected at Whistlewood produced an ichneumon *Diadegma armillatum*, a parasitoid of several arboreal species of microlepidoptera. A further web of *Y. malinellus* containing pupae and one larva was collected at Dean Park north orchard; adults of *Y. malinellus* subsequently emerged but the larva proved to be parasitized by an ichneumon *Agrypon canaliculatum*, a species currently being described as new to Britain. Also emerging from the same larval nest was *Mesochorus pallipes*; this is a koinobiont true hyperparasitoid important in the parasitoid complexes of web-feeding Lepidoptera such as *Yponomeuta* spp. and *Anthophila fabriciana* (Shaw, 2017) through specialised orientation to the still-feeding caterpillar, within which it uses whatever ichneumonoid primary parasitoids are available (Shaw, 1993, 2017). Dr Shaw (*in litt.*) suggests that the primary parasitoid at Dean Park north orchard may have been *D. armillatum*. At Lea Fields in 2017 mines of *Phyllonorycter blancardella/hostis* were retained for breeding out; from one emerged a parasitoid identified as *Sympiesis sericeicornis*, a chalcid wasp known to be a common parasitoid of arboreal *Phyllonorycter* species.

Among the predators in Faunal Group CL4 are three beetles that feed as larvae on the saproxylic fauna of decaying wood (*Malachius bipustulatus*, *Malthodes marginatus*, *Pyrochroa serraticornis*). In common with the non-predatory saproxylic fauna described earlier these predators were thinly distributed across our orchards; and taking both predators and non-predators together, only Weston Court Farm lower orchard showed even a small concentration of saproxylic species in our study, with four. The range of dead-wood insects in our orchards has been only superficially examined, and our study is not comparable with others that have specifically targeted this fauna. It remains a major area for further investigation in Shropshire's orchards.

Most predators in this faunal group feed on invertebrates of tree and shrub foliage. Aphids are the pabulum of adults and larvae of six species of ladybird and larvae of three hoverflies (*Epistrophe eligans*, *Syrphus ribesii*,

Episyrphus balteatus). A range of small invertebrates including aphids, psyllids, mites, insect eggs and small larvae form the diet of most of the Hemiptera in Table 7. Some, e.g. *Atractotomus mali*, *Blepharidopterus angulatus*, *Cyllecoris histrionius*, *Dryophilocoris flavoquadrimaculatus*, *Pentatoma rufipes*, *Phylus* spp., *Psallus* spp., are both predators and herbivores in the canopy layer. *B. angulatus* is an important predator of fruit-tree red spider mite (Southwood & Leston, 1959). *Anthocoris nemoralis*, *A. nemorum* and *Orius vicinus* have been investigated as potential biological pest control agents in orchards (Heitmans *et al*., 1986; Shaltiel & Coll, 2004; Sigsgaard *et al*. 2006). All Hemiptera species are common in Britain except *Cardiastethus fasciiventris* which is nationally local (Bantock & Botting, 2013). This faunal group is completed by the small spider *Paidiscura pallens*, a predator at many levels, the arboreal oak bush-cricket (*Meconema thalassinum*), and the hornet (*Vespa crabro*), which typically catches larger insects in flight.

Field Layer Community

This Community comprises Faunal Groups:

FL1 (31 species)
FL2 (61 species)
FL3 (34 species)

Links to other Faunal Groups:

M2 (3 species)
CL1 (1 species)
CL2 (5 species)
CL4 (15 species)
GL1 (3 species)
GL2 (6 species)

FIGURE 6: Representation of typical field layer vegetation. Illustration: Bea Pope.

With little current commercial value in their fruit yield, south Shropshire's orchards are now used chiefly for grazing cattle or sheep (Table 1). This has led in most orchards to a characteristic, species-poor field layer vegetation dominated by coarse grasses, especially *Holcus lanatus*, *Dactylis glomerata*, *Lolium perenne* and *Poa pratensis*, and a tall-herb vegetation typical of nutrient-enriched soils: *Urtica dioica*, *Cirsium arvense*, *Rumex obtusifolius* and *Galium aparine*, with *Cirsium vulgare*, *Heracleum sphondylium*, *Arctium minus* and a few others occasional. This vegetation relates to the NVC OV25 *Urtica dioica–Cirsium arvense* community (Rodwell, 2000). In Shropshire it is typical of arable field margins and neglected corners of grassland (Lockton & Whild, 2015); it has some affinities with the vegetation of managed roadside verges, though *Arrhenatherum elatius* and *Anthriscus sylvestris*, so typical of the latter habitat, are infrequent in grazed orchards.

Regular grazing reduces field layer vegetation to a low grass sward in which only scattered plants of grazing-resistant nettles and thistles form an architectural element. Some protection for seedlings of these and other plants is offered by fallen trunks or boughs. Livestock often gather in such places and around tree boles, where high nutrient inputs from dung and urine produce a local abundance of *U. dioica*, *C. arvense* and sometimes other plants. At lower stocking levels on deeper or moister soils in shade this vegetation may become lush.

Lightly-grazed orchards on well-drained open slopes may support fine-leaved grassland with a greater diversity of herbaceous plants. *Cynosurus cristatus* is the characteristic grass of this habitat, with locally frequent *Elymus repens*, *Lolium perenne*, *Agrostis capillaris*, *Alopecurus pratensis*, *Anthoxanthum odoratum*, *Holcus lanatus*; typical forbs (herbaceous plants other than grasses) include *Ranunculus acris*, *Trifolium repens*, *T. pratense* and *Lotus corniculatus*. This vegetation is probably referable to the NVC MG6 *Lolium perenne–Cynosurus cristatus* community (Rodwell, 1992). We found the best examples at Reaside Farm and both Dean Park orchards; Dean Park west showed a striking contrast between a vigorous growth of nettles and other OV25 vegetation under shade in the dingle bottom and fine-leaved grassland on open upper slopes. Few orchards had much drainage, and Weston Court Farm lower orchard, Badgers Amble, Mahorall Farm Grove orchard and Dean Park west orchard supported plants of damper soils such as *Cardamine pratensis*, *Filipendula ulmaria* and *Juncus* spp.

Faunal Group FL1 is detailed in Table 8. It comprises 31 species that feed on grasses as larvae or adults or both, plus two that are placed here with less certainty. This faunal group is dominated by Hemiptera and Lepidoptera, the one exception being the meadow grasshopper *Chorthippus parallelus*; this insect is typical of coarse grassland on regularly mown or grazed sites (Marshall & Haes, 1988). We found that invertebrates feeding on grasses were concentrated in orchards that were only lightly grazed, mown, or unmanaged. Heavier stocking levels produced a low sward in which these species barely survived; seven well-grazed orchards had no grass herbivores at all, and the most species of this faunal group found in a well-grazed orchard were four at Bowerswood, where a log pile gave protection from grazing.

TABLE 8. Faunal Group FL1 comprising species that feed on grasses within the orchards.

Order and Species	Order and Species	Order and Species
HEMIPTERA	HEMIPTERA continued	LEPIDOPTERA
Acetropis gimmerthali	*Neophilaenus lineatus*	*Agriphila straminella*
(*Anoscopus albifrons*?)	*Philaenus spumarius*	*Agriphila tristella*
Aphrodes makarovi	*Pithanus maerkelii*	*Aphantopus hyperantus*
Arthaldeus pascuellus	*Stenodema calcarata*	*Chrysoteuchia culmella*
Capsus ater	*Stenodema laevigata*	*Coenonympha pamphilus*
Cercopis vulnerata	*Stenotus binotatus*	*Glyphipterix simpliciella*
Deltocephalus pulicaris	*Streptanus sordidus*	*Maniola jurtina*
Euscelis incisus	*Tachycixius pilosus*	*Ochlodes sylvanus*
Javesella pellucida		*Pararge aegeria*
Leptopterna dolabrata	ORTHOPTERA	*Pyronia tithonus*
Leptopterna ferrugata	*Chorthippus parallelus*	*Rivula sericealis*
(*Megalocera recticornis*?)		*Thymelicus sylvestris*

Sites with MG6 vegetation had a greater species richness than those with OV25. Most species in Table 8 are associated with fine-leaved grasses, and the largest counts of these were from orchards with MG6 vegetation: 11 at Mahorall Farm Grove orchard, 10 at Reaside Farm, nine at Dean Park north orchard and eight at Dean Park west orchard. Mahorall Farm is managed by topping the sward, producing vegetation transitional between fine-leaved and coarse grassland, with plants of both MG6 and OV25 communities present.

No species whose larval foodplants are dominant grasses of OV25 vegetation (e.g. large skipper (*Ochlodes sylvanus*), speckled wood (*Pararge aegeria*), cocksfoot moth (*Glyphipterix simpliciella*)) showed very much association with this vegetation. At Dean Park west orchard adults of the garden grass veneer (*Chrysoteuchia culmella)*, that feeds on the OV25 grass *Dactylis glomerata* among others, were found only in MG6 vegetation and shunned OV25 just a few metres away.

Faunal Group FL1 is a much simplified fauna comprising 58% suckers and 42% chewers.

Faunal Group FL2 comprises species that feed on forbs as detailed in Table 9. The froghoppers *Cercopis vulnerata* and *Philaenus spumarius* feed on both forbs and grasses. Sixty-one species are represented in this faunal group. Some Heteroptera, such as *Heterotoma planicornis*, *Dicyphus errans* and *Orthotylus ochrotrichus*, are partly predacious and appear also in Faunal Group FL3.

As with the grass-feeding community Hemiptera and Lepidoptera predominate, but Faunal Group FL2 has a wider taxonomic base, including some Diptera and Coleoptera and one species of Orthoptera, the speckled bush-cricket (*Leptophyes punctatissima*). In marked contrast to the grass-feeding fauna, species feeding on forbs are predominantly associated with OV25 vegetation. Common nettle (*Urtica dioica*) is particularly well represented in our study; of species mainly restricted to *Urtica* and its close relatives nationally (Davies, 1983) we recorded 5 of 7 Hemiptera (excluding aphids), 4 of 8 Lepidoptera and 2 of 5 Coleoptera. Common nettle is also the foodplant of both gall-causers in this group, *Dasineura urticae* and *Trioza urticae*. The fauna of thistles is less well represented in our orchards, though it includes both lacebugs that are fairly specific to the two thistles in OV25 vegetation: *Tingis ampliata* on *Cirsium arvense* and *T. cardui* on *C. vulgare* (Redfern, 1983).

Most other species in this group feed on typical forbs of OV25 vegetation. Host plants include *Arctium minus* for *Phytomyza lappae* and *Terellia tussilaginis*; *Heracleum sphondylium* and *Anthriscus sylvestris* for three species; and *Rumex obtusifolius,* which hosted the leaf beetle *Gastrophysa viridula* in six orchards and leaf-miner *Pegomya solennis* in two, the former notably abundant in Boraston Court church orchard. The blood-vein moth (*Timandra comae*) was also probably associated with *R. obtusifolius* in this study. Silver-ground carpet (*Xanthorhoe montanata*) occurred among *Galium aparine* in three orchards; while *Ranunculus repens* was the observed or likely foodplant of *Phytomyza ranunculi* and *Olindia schumacherana.*

The low utilization of MG6 vegetation by forb-feeders in our orchards is evidenced by just three species in Table 9 that feed on plants typical of MG6 grassland: common blue *(Polyommatus icarus*) and six-spot burnet (*Zygaena filipendulae)* on *Lotus corniculatus* and small copper (*Lycaena phlaeas)* on *Rumex acetosa*.

Also noteworthy is that, in contrast to woody plants, characteristic field layer plants of W8 woodland showed very little penetration into the orchards. Hedge woundwort (*Stachys sylvatica*) occasionally invaded OV25 vegetation, though two specialist bugs on this plant, *Dicyphus stachydis* and *Eysarcoris venustissimus*, turned up only at Whistlewood, which lacked OV25. The same orchard held a population of the micro-moth *Acrolepia autumnitella* in a damp marginal area. Moist soils with cuckooflower (*Cardamine pratensis*) at Weston Court Farm lower orchard and Badgers Amble produced records of orange-tip (*Anthocharis cardamines*), green-veined white (*Pieris napi*) and the micro-moth *Cauchas rufimitrella,* which all utilize this foodplant.

TABLE 9. Faunal Group FL2 comprising species that feed on forbs in the orchards. Colour coding distinguishes columns.

Order and Species	Main Foodplant(s)										
	Apiaceae (*Anthriscus, Heracleum*)	Asteraceae (*Arctium, Cirsium*)	Brassicaceae (*Alliaria, Cardamine, Sisymbrium*)	Fabaceae (*Lotus corniculatus*)	Lamiaceae (*Stachys sylvatica*)	Polygonaceae (*Rumex*)	Ranunculaceae (*Ranunculus*)	Rubiaceae (*Galium aparine*)	Solanaceae (*Solanum dulcamara*)	Urticaceae (*Urtica dioica*)	*Polyphagous*
COLEOPTERA											
Apteropeda orbiculata											X
Gastrophysa viridula						X					
Nedyus quadrimaculatus										X	
Oedemera nobilis		X									
Phyllobius pomaceus										X	
DIPTERA											
Dasineura urticae										X	
Pegomya solennis						X					
Phytomyza lappae		X									
Phytomyza ranunculi							X				
Phytomyza ranunculivora							X				
Phytomyza spondylii/pastinacae	X										
Terellia tussilaginis		X									
HEMIPTERA											
Apolygus spinolae		X								X	
Cercopis vulnerata											X
Closterostomus norwegicus											X
Dicyphus errans											X
Dicyphus stachydis					X						
Eupteryx aurata										X	
Eupteryx urticae										X	
Eysarcoris venustissimus					X						
Grypocoris stysi	?									X	
Heterogaster urticae										X	
Heterotoma planicornis											X
Liocoris tripustulatus										X	
Lygocoris pabulinus											X
Orthonotus rufifrons										X	
Orthops basalis	X										
Orthotylus ochrotrichus										X	
Philaenus spumarius											X
Plagiognathus arbustorum										X	
Scolopostethus affinis										X	
Scolopostethus thomsoni										X	
Tingis ampliata		X									
Tingis cardui		X									
Trioza urticae										X	
LEPIDOPTERA											
Acrolepia autumnitella									X		
Aglais urticae										X	
Agonopterix arenella		X									
Agonopterix heracliana	X										
Anania hortulata										X	
Anthocharis cardamines			X								

TABLE 9 continued.

Order and Species	Main Foodplant(s)										
	Apiaceae (*Anthriscus, Heracleum*)	Asteraceae (*Arctium, Cirsium*)	Brassicaceae (*Alliaria, Cardamine, Sisymbrium*)	Fabaceae (*Lotus corniculatus*)	Lamiaceae (*Stachys sylvatica*)	Polygonaceae (*Rumex*)	Ranunculaceae (*Ranunculus*)	Rubiaceae (*Galium aparine*)	Solanaceae (*Solanum dulcamara*)	Urticaceae (*Urtica dioica*)	*Polyphagous*
LEPIDOPTERA continued											
Anthophila fabriciana										X	
Autographa gamma											X
Camptogramma bilineata											X
Cauchas rufimitrella			X								
Celypha lacunana											X
Lycaena phlaeas						X					
Olindia schumacherana							X				
Pieris brassicae			X								
Pieris napi			X								
Pieris rapae			X								
Pleuroptya ruralis										X	
Plutella xylostella			X								
Polyommatus icarus				X							
Timandra comae						X					
Udea lutealis											X
Vanessa atalanta										X	
Vanessa cardui		X									
Xanthorhoe montanata								X			
Zygaena filipendulae				X							
ORTHOPTERA											
Leptophyes punctatissima											X

Transience may account for records of some very mobile species that could potentially feed on the forbs in our orchards but which we did not find breeding there: painted lady (*Vanessa cardui*), red admiral (*V. atalanta*), small tortoiseshell (*Aglais urticae*), large white (*Pieris brassicae*), small white (*P. rapae*) and diamond-backed moth (*Plutella xylostella*); the last three of these feed on Brassicaceae, a plant family patchily represented in our orchards by *Sisymbrium officinale*, *Alliaria petiolata* and *Cardamine pratensis*.

In summary Faunal Group FL2 is represented by 43% chewers, 36% suckers, 13% leaf-miners, 3% gall-causers and 5% internal feeders in stems, fruits or capitula of their host plants. Stenophagous species comprise 80% of the fauna and polyphagous species 20%.

Faunal Group FL3 comprises predators of the field layer, detailed in Table 10. Thirty-four species are placed here. Several species are also predators of canopy or ground layer habitats, often in their larval stage; they are also included and discussed in those communities. A high level of interchange between the predator faunas of all orchard communities is a particular finding of this study.

Six species in this faunal group largely predate aphids. These are three hoverflies (*Baccha elongata*, *Eupeodes corolla*, *Leucozona lucorum*), two ladybirds (*Adalia bipunctata*, *Coccinella septempunctata*) and adults of the lacewing *Micromus variegatus*. Another ladybird, *Harmonia axyridis*, predates aphids along with other invertebrates. In the field layer these species largely attack aphid colonies on forbs, since grasses harbour few aphids (Van Emden, 1990).

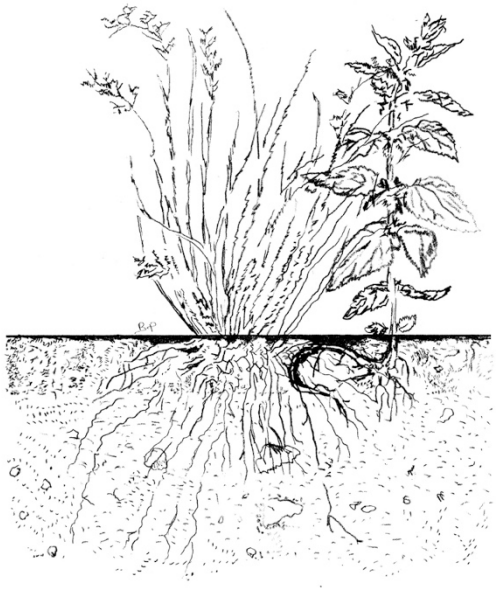
Other Faunal Group FL3 species are more generalist predators of a range of invertebrates. Some bugs such as *Deraeocoris ruber*, *Orthotylus ochrotrichus* and *Plagiognathus arbustorum* are partly herbivorous and serve a dual role in the field layer. These species are generally associated with forbs, and can be especially abundant on nettles (Southwood & Leston, 1959). As nettles and thistles are resistant to grazing, we found that the predator- prey guilds on these plants can survive in regularly grazed orchards, which typically hold from one to three species each; though the well-grazed orchard at Stonehouse Farm had a better representation of these guilds, with seven species, than all the mown and unmanaged orchards and all but two lightly-grazed orchards.

TABLE 10. Faunal Group FL3 comprising predators of field layer habitats.

Order and Species	Order and Species	Order and Species
ARANEAE	DIPTERA	HEMIPTERA continued
Paidiscura pallens	*Baccha elongata*	*Nabis ferus*
	Epistrophe eligans	*Nabis flavomarginatus*
COLEOPTERA	*Episyrphus balteatus*	*Nabis limbatus*
Adalia bipunctata	*Eupeodes corollae*	*Nabis rugosus*
Cantharis cryptica	*Leucozona lucorum*	*Orius vicinus*
Cantharis decipiens	*Rhagio scolopaceus*	*Orthotylus ochrotrichus*
Cantharis nigra	*Syrphus ribesii*	*Phylus coryli*
Cantharis nigricans		*Pithanus maerkelii*
Coccinella septempunctata	HEMIPTERA	*Plagiognathus arbustorum*
Harmonia axyridis	*Anthocoris nemorum*	
Malachius bipustulatus	*Deraeocoris ruber*	HYMENOPTERA
Rhagonycha fulva	*Dicyphus errans*	*Vespa crabro*
Rhagonycha lignosa	*Grypocoris stysi*	
	Heterotoma planicornis	NEUROPTERA
		Micromus variegatus

Four damsel bugs *Nabis* spp. are associated with rough grasses such as *Holcus lanatus*, in the culms of which they lay their eggs; their prey includes grass-bugs *Leptopterna dolabrata*, other mirids and caterpillars (Southwood & Leston, *loc. cit*.). Damsel bugs were only sparingly found in our survey, largely in orchards that are neglected, managed by mowing or lightly grazed. The Coleoptera in Group FL3 include six species in the family Cantharidae; both adults and larvae are mainly carnivorous on small insects, both living and dead; larvae are also predators in the surface layers of soil and in leaf litter, and are further dealt with in the ground layer community below.

Ground Layer Community



This community comprises Faunal Groups:
GL1 (36 species)
GL2 (11 species)

Links to other Faunal Groups:
M2 (1 species)
CL1 (1 species)
CL3 (2 species)
CL4 (4 species)
FL2 (3 species)
FL3 (9 species)

FIGURE 7: Representation of ground layer habitats. Illustration: Bea Pope.

This element of the orchard fauna was not thoroughly studied in our survey. No targeted sampling of ground layer or soil invertebrates was carried out, and species attributed to these habitats are largely inferred from field layer species whose larval stages live on or in the ground. In the absence of specific targeting this community is incompletely evidenced for our orchards, and little can be inferred from its distribution among them.

Faunal Group GL1 comprises 36 non-predatory species detailed in Table 11. One further species is placed here with less certainty.

All Hymenoptera in this Group exploit the ground layer for subterranean nesting sites. A probable nesting site of *Andrena cinerea* was located on a small exposed soil bank at Badgers Amble, and many nests of the ant *Lasius*

flavus were present in Dean Park north and west orchards, where they were confined to MG6 vegetation on more freely-draining upper slopes. The four bumblebees *Bombus* species recorded were represented by adults observed widely in the orchards; these may have been breeding in some though we saw no direct evidence of this; the extent to which they contributed to pollinating orchard trees was also not observed as most visits were made after the flowering period.

TABLE 11. Faunal Group GL1 comprising non-predatory species of ground layer habitats.

Order and Species	Order and Species	Order and Species
COLEOPTERA	DIPTERA continued	HYMENOPTERA
Nedyus quadrimaculatus	*Limonia phragmitidis*	*Andrena cineraria*
Phyllobius pomaceus	*Mesembrina meridiana*	*Andrena fulva*
	Neolimnomyia adjuncta	*Bombus lapidarius*
DIPTERA	*Nephrotoma appendiculata*	*Bombus lucorum*
Beris chalybata	*Nephrotoma quadrifarea*	*Bombus pratorum*
Beris vallata	*Rhingia campestris*	*Bombus pascuorum*
Bibio marci	*Rhipidia maculata*	*Lasius flavus*
Cheilosia albitarsis	*Tipula fascipennis*	
Cheilotrichia cinerascens	*Tipula oleracea*	LEPIDOPTERA
Chloromyia formosa		*Adela reaumurella*
Dicronomyia chorea	HEMIPTERA	*Agapeta hamana*
Dilophus febrilis	*Cercopis vulnerata*	
Erioptera lutea		MECOPTERA
Eristalis pertinax	ISOPODA	*Panorpa cognata*
(*Haematopota pluvialis*?)	*Phylloscia muscorum*	*Panorpa germanica*
Helophilus pendulus	*Porcellio scaber*	

Lasius flavus is entirely subterranean and feeds mainly on the honeydew of specially-raised root aphids (Czechowski *et al*., 2002). Other subterranean species are insects whose larvae feed on plant roots. A few are associated with specific plants: *Agapeta hamana* with *Cirsium* spp., *Nedyus quadrimaculatus* and *Phyllobius pomaceus* with *Urtica dioica*, and *Cheilosia albitarsis* with *Ranunculus*. Nymphs of the froghopper *Cercopis vulnerata* are most associated with grasses but will also feed on the roots of other plants, whereas the nine species of cranefly in this faunal group are probably more generalist root feeders.

The remaining fauna in this group are 15 species that are detritivores of soil surface habitats. Larvae of two scorpion-flies *Panorpa cognata* and *P. germanica* are thought to feed mainly on dead invertebrates of the ground layer. Plant debris is the known pabulum of larvae of *Adela reaumurella*, *Bibio marci*, *Beris chalybata* and *Limonia phragmitidis*, while decaying matter that includes both rotting vegetation and manure support larvae of the hoverflies *Eristalis pertinax* and *Chloromyia formosa*. The widespread use of our orchards for grazing livestock provides a particularly good habitat for dung-feeders, which include *E. pertinax*, *C. formosa*, *Rhingia campestris*, *Dilophus febrilis* and *Mesembrina meridiana*. Partly because of the presence of dung in many orchards, this is the only faunal group to which Diptera contribute most species.

Larvae of several craneflies such as *Neolimnomyia adjuncta* are associated with moist soil, while wet decaying matter is the known larval pabulum of the two *Beris* species and *Helophilus pendulus*. The presence of a range of such species in our orchards probably reflects the siting of a number of these in areas that offer such microhabitats: in humid dingles and on sites with areas of poor drainage.

Faunal Group GL1 is represented in this study by 42% detritivores and carrion-feeders, 39% root-feeders and 19% ground-nesters.

Faunal Group GL2 comprises predators of the ground layer as detailed in Table 12**.** Three species are tentatively placed here as their larval habits need further investigation: the hoverflies *Melanostoma scalare* and *Platycheirus albimanus*, which may feed on aphids in the leaf litter (Rotheray, 1993), and the lacewing *Micromus variegatus*, whose larval pabulum may be root aphids (Plant, 1997).

Most species in this group are beetles whose larvae feed on invertebrates of the leaf litter and soil. Six are members of the Cantharidae whose adults are predators of the field layer and are dealt with in that community. Larvae of *Rhagio scolopaceus* feed typically on soil invertebrates but sometimes occupy wood detritus in tree stumps (Stubbs & Drake, 2001). The remaining species in this faunal group are the spider *Paidiscura pallens*, a predator in leaf litter as well as other vegetation (Lee, [2018]), and the hoverflies *Episyrphus balteatus* and *Syrphus ribesii* whose larvae are associated with a range of ground layer aphids (Rotheray, 1993).

Although our fieldwork was carried out mostly after fruit-trees had flowered, it is interesting to note that the ground layer fauna of our orchards includes a number of potential pollinators, particularly among the Diptera and Hymenoptera; *Dilophilus febrilis*, for example, is said to be of considerable significance in the pollination of fruit-trees (Colyer & Hammond, 1968).

A feature of many species, even common ones, represented in the ground layer community is that their larval habits are poorly studied and imprecisely known. Several may be able to exploit a wider range of plant or animal foodstuffs than suggested, while others are found as adults and sometimes larvae in other habitats. For these reasons our characterization of the ground layer community of our orchards is more tentative than that of other communities within them.

TABLE 12. Faunal Group GL2 comprising predators of ground layer habitats.

Order and Species	Order and Species	Order and Species
ARANEAE	COLEOPTERA continued	DIPTERA
Paidiscura pallens	*Cantharis nigricans*	*Episyrphus balteatus*
	Malachius bipustulatus	(*Melanostoma scalare*?)
COLEOPTERA	*Rhagonycha fulva*	(*Platycheirus albimanus*?)
Aplotarsus incanus	*Rhagonycha lignosa*	*Rhagio scolopaceus*
Cantharis cryptica		
Cantharis decipiens	NEUROPTERA	
Cantharis nigra	(*Micromus variegatus*?)	

Other species

Four species observed in our orchards do not fit neatly into the Faunal Groups as constituted above. Three are omnivores (*Pholidoptera griseoaptera*, *Forficula auricularia*, *Dicranopalpus ramosus*) that may occur in any orchard habitat and most Faunal Groups. A fourth, the dolichopodid fly *Poecilobothrus nobilitatus*, was observed at a rainwater pond in an old bathtub, a unique and entirely artificial situation in this study.

Seven more species in Appendix 2 have no association with the habitats of our orchards or their boundaries. Four have aquatic larvae (the damselflies *Coenagrion puella* and *Ischnura elegans* and mayflies *Cloeon dipterum* and *Electrogena lateralis*) and two are associated with conifers (the ladybird *Exochomus quadripustulatus* and shieldbug *Cyphostethus tristriatus*). The larval foodplants of a further species, the brimstone butterfly (*Gonepteryx rhamni*), are not recorded in the survey area (Lockton & Whild, 2015). These seven species are best interpreted as casual visitors to our orchards; they constitute a mere 2.2% of the 312 taxa recorded in this study.

CONCLUSIONS

This study began with limited aims, to investigate the presence in south Shropshire orchards of six mistletoe specialist species and two species associated with orchard fruit-trees. These aims were soon widened as it became clear that we were gathering information on a wider range of relationships within orchard habitats. Available time and expertise did not allow us to complete a comprehensive faunal inventory, but we have made progress in identifying features of orchard habitats and invertebrate communities associated with them. We have also presented information on the state of orchards and their recent histories.

The parishes that lie south of Titterstone Clee Hill and form our study area share a climate and character more in common with Worcestershire and Herefordshire than with the rest of Shropshire. It is noteworthy how quickly mistletoe disappears from orchards further north. We found only two Shropshire orchards with it north of the Wyre Forest and at one of these, Lowe Farm, Alveley, mistletoe had been introduced as a cash crop for the Christmas market. Further north the distribution of mistletoe becomes patchier and confined largely to the Severn valley, where it grows mainly on hawthorn (*Crataegus monogyna),* poplar (*Populus* spp.) and lime (*Tilia* spp.) (Lockton & Whild, 2015). The little exploratory fieldwork that we have conducted in this area shows that most mistletoe specialists of our southern orchards expand their ranges at least as far as Morville and Underton near Bridgnorth, and occupy mistletoe on hawthorn outside the orchard habitat. Orchards further north along the Severn offer scope for investigation of the relationship of their invertebrate faunas to those of south Shropshire.

In terms of our original aims we have demonstrated the presence in south Shropshire orchards of five of six mistletoe specialists and one of two fruit-tree specialists; we failed to find the micro-moth *Celypha woodiana* and red-belted clearwing (*Synanthedon myopaeformis*). We have also collected data on other species present in our orchards and their relationships to habitats and vegetation. Our study has revealed a complex fauna associated with fruit-trees and other trees and shrubs within the orchards and their boundaries, and a somewhat simpler fauna of field layer

and ground layer habitats, the more limited development of the latter elements arising mainly from the widespread use of orchards for pasturing sheep and cattle.

Traditional orchards are included in the UK Biodiversity Action Plan but have no priority in the Shropshire Biodiversity Action Plan (Shropshire Council, 2002). The orchards of south Shropshire conform to the UKBAP's general characterization of this habitat, though it is hard to make the case that they fulfil its description of "supporting... an array of Nationally Rare and Nationally Scarce species" (DEFRA, 2008). The six target species which we found are nationally local, uncommon or scarce; the noble chafer has RDB2 status and is included in Natural England's Species Recovery Programme, and *Anthocoris visci* is Nationally Notable B. One other species found in this study, the micro-moth *Argyresthia ivella*, has a Nationally Notable B status, and a few more are nationally local. The great majority of species we recorded are widespread and common. This may be partly a result of the sampling methods employed: single visits of around two hours' duration to each orchard, without the use of traps designed for mass collecting over longer periods that might enhance detection of rarer species. Our approach has instead allowed us to observe the relationships of invertebrates to each other, to the vegetation and habitats of our orchards, and to the wider countryside. As a main outcome of the study we have identified and characterized four Invertebrate Communities and 11 Faunal Groups, which by no means exhaust the possible range our orchards may support. Barker *et al*. (2011) expressed a need for investigations into the function of traditional orchards in ecological networks at a landscape scale; we feel we have made progress towards achieving this for south Shropshire.

A paucity of rare species should not be allowed to downgrade the conservation value of orchards, but this is a risk where a secondary habitat can be considered as essentially agricultural land. Indices of invertebrates used widely in orchard studies (e.g. Smart & Winnall, 2006, Lush *et al*., 2009, Alexander, 2010) seek to evaluate faunas in relation to species' national statuses and habitat continuity; these are the Saproxylic Quality Index (Fowles *et al*., 1999) and Index of Ecological Continuity (Alexander, 2004). These indices focus on Coleoptera of dead-wood habitats, a fauna represented in some studies by suites of uncommon species but which was explored only superficially in our own study beyond a targeted search for the noble chafer. These indices are heavily weighted towards species that are nationally rare and characteristic of old woodland. They have the merit of being simple to apply and understand; but they are not measures of diversity, and their weighting towards rarity risks undervaluing sites with good suites of commoner species. Diversity indices measure relationships between numbers of species and their abundances, with some diversity measures (e.g. Simpson's index) being weighted towards the abundance of commoner species (Magurran, 1988). Our study suggests that the orchards of south Shropshire, without many rare species, support invertebrate communities that have a reasonably high level of functional diversity, are relatively stable with stenophagous species well represented, and are highly integrated into the invertebrate communities of semi-natural vegetation types in the region. The invertebrates of our orchards show strong links to local hedgerow, woodland edge and grassland habitats, indicating that these orchards offer valuable habitat extensions and refugia for species of the wider countryside. We conclude that south Shropshire's orchards constitute a matrix of small sites that potentially make a much-needed contribution to biodiversity in the local farmed landscape.

In the short term this contribution is likely to remain important; but the current state of south Shropshire's orchards is not encouraging for the longer term. Only at Mahorall Farm and Weston Court Farm are orchards managed as a main economic concern; the produce of some others is used for domestic consumption or occasionally exploited as a secondary cash crop; but most orchards contribute to the farm economy as grazing paddocks in which fruit-trees function merely as shelter for livestock. In consequence orchard trees are now largely unmanaged and neglected. Invertebrates undoubtedly benefit from this neglect. But much of the invertebrate interest of our orchards is associated with mistletoe-bearing fruit-trees, and the continuing loss of these, evident even within the last 12-14 years, does not bode well for the future. Old trees are vulnerable to gales and other natural processes and losses are nowadays seldom replaced. Funding available through the Countryside Stewardship Scheme encourages owners to retain veteran trees, but if our orchards are not ultimately to become open pastures there is a need to encourage new plantings. It is hard to see this happening on a sufficient scale without a turn-round in the economics of fruit production.

This has proved a fascinating study. From a limited set of objectives it has developed into a valuable practical application of the skills and expertise gained through the Field Studies Council's Invertebrate Challenge programme and Biodiversity Project that focused on widening the base of entomological recording in Shropshire. It is not a complete study; many elements of the orchard fauna remain for further investigation. We hope, however, that our study may offer a useful snapshot of what is happening to south Shropshire's orchards at this time and a basis to inform and compare with future investigations.

ACKNOWLEDGEMENTS

The authors wish to thank the owners/tenants named in Appendix 1 who readily granted access for our survey work, and the Marcher Apple Network in making available their very helpful site records. We are grateful to Keith Fowler

for identifying Psocoptera, Hemiptera, some Coleoptera and Diptera; to Dr Mark Shaw for identifying and advising on parasitoids; and to Ted Blackwell for identifying the fungus *Sphaeropsis visci*. Geoff Wookey gave valuable help in identifying sites around Boraston and owners' contact details. The assistance of Rich Burkmar in producing the map, Bea Pope for the line drawings, and Rosemary Winnall for permission to use the photograph of noble chafer, is also much appreciated. In addition to the authors the following volunteers from Invertebrate Challenge and other supporters from SIG participated in the surveys: Jim Cresswell, Keith Fowler, David Poynton, Neville Walters, Graham Wenman and David Williams.

REFERENCES

Agassiz, D.J.L., Beavan, S.D. & Heckford, R.J. (2013). *A checklist of the Lepidoptera of the British Isles*. Royal Entomological Society Handbooks for the Identification of British Insects. Field Studies Council, Telford.

Agassiz, D.J.L., Beavan, S.D. & Heckford, R.J. (2016a). Corrigenda to *A checklist of the Lepidoptera of the British Isles*, 2013. *Entomologist's Record and Journal of Variation* **128**(1), 50-55.

Agassiz, D.J.L., Beavan, S.D. & Heckford, R.J. (2016b). Addenda and amendments to *A checklist of the Lepidoptera of the British Isles* on account of subsequently published data. *Entomologist's Record and Journal of Variation*, **128**(2), 94-98.

Alexander, K.N.A. (2004). *Revision of the Index of Ecological Continuity as used for saproxylic beetles*. Research Report Number 574. English Nature, Peterborough.

Alexander, K.N.A. (2008). The special importance of traditional orchards for invertebrate conservation, with a case study of the BAP Priority Species the Noble Chafer *Gnorimus nobilis*. In Rotherham, I. D. (ed.) Orchards and Groves: their history, ecology, culture and archaeology. *Landscape Archaeology and Ecology*, **7**, 12-18.

Alexander, K.N.A. (2010). A remarkable wood-decay beetle fauna from a group of traditional orchards at Colwall, Herefordshire. *The Coleopterist*, **19**(1), 11-14.

Alexander, K. & Bower, L. (2011). The Noble Chafer and traditional orchards – an old-growth species in the English cultural landscape. *British Wildlife*, **23**(1), 17-22.

Alford, D.V. (2014). *Pests of fruit crops: a colour handbook*. 2nd edition. CRC Press.

Bantock, T. & Botting, J. (2013). *British Bugs: an online identification guide to UK Hemiptera*. http://www.britishbugs.org.uk/systematic_het.html [Accessed 16th January 2018].

Barker, S., Burrough, A., Cordrey, L. Merry, K. & Wedge, C. (2011). Conserving the wildlife of traditional orchards. *British Wildlife,* **23**(1), 8-16.

Biological Records Centre [2018]. National barkfly recording scheme. https://www.brc.ac.uk/schemes/barkfly/homepage.htm [Accessed 15th January 2018].

Blunt, G. (2014). *The smaller moths of Shropshire: their status, distribution and ecology*. FSC Publications, Telford.

Boyko, C.B., Bruce, N.L., Hadfield, K.A., Merrin, K.L., Ota, Y., Poore, G.C.B., Taiti, S., Schotte, M. & Wilson, G.D.F. (eds) (2008 onwards). *World Marine, Freshwater and Terrestrial Isopod Crustaceans database*. http://www.marinespecies.org/isopoda [Accessed 17th January 2018].

Briggs, J. (2011). Mistletoe – a review of its distribution, conservation and insect associates. *British Wildlife*, **23**(1), 23-31.

Chandler, P. (ed.) (1998). *Checklists of insects of the British Isles (New Series) part 1: Diptera*. Royal Entomological Society, London.

Chinery, M. (1993). *Insects of Britain and northern Europe, third edition*. HarperCollins.

Colyer, C.N. & Hammond, C.O. (1968). *Flies of the British Isles*. 2nd edition. Frederick Warne, London.

Csóka, G. & Kovács, T. (1999). *Xylophagous insects*. Budapest, Forest Research Institute.

Czechowski, W., Radchenko, A. & Czechowska, W. (2002). *The ants (Hymenoptera, Formicidae) of Poland*. Warszawa, Museum and Institute of Zoology PAS.

Davis, B.N.K. (1983). *Insects on nettles*. *Naturalists' Handbooks 1*. Cambridge University Press.

DEFRA (2008). *UK Biodiversity Action Plan; Priority Habitat Descriptions: Traditional Orchards*. http://jncc.defra.gov.uk/page-5706 [Accessed 25th November 2017]

Duff, A.G. (ed.) (2012). *Checklist of beetles of the British Isles*. 2nd edition. Pemberley Books, Iver.

Else, G.R., Bolton, B. & Broad, G.R. (2016). Checklist of British and Irish Hymenoptera – aculeates (Apoidea, Chrysidoidea and Vespoidea). *Biodiversity Data Journal*, 4, e8050. doi.org/10.3897/BDJ.4.e8050 [Accessed 18th February 2018].

Else, G.R., Burn, J.T., Olmi, M. & Bolton, B. (2004). Check list of British Hymenoptera Aculeata. In Archer. M.E. (ed.) *BWARS Members' Handbook*. Centre for Ecology and Hydrology, Huntingdon.

Emmet, A.M. & Langmaid, J.R. (eds) (2002). *The moths and butterflies of Great Britain and Ireland: volume 4 part 1 Oecophoridae – Scythrididae (excluding Gelechiidae).* Harley Books, Colchester, Essex.

Foster, A.P., Morris, M.G. & Whitehead, P.F. (2001). *Ixapion variegatum* (Wenker, 1864) (Coleoptera, Apionidae) new to the British Isles, with observations on its European and conservation status. *Entomologist's Monthly Magazine*, **137**, 95-105.

Fowles, A.P., Alexander, K.N.A. & Key, R.S. (1999). The Saproxylic Quality Index: evaluating wooded habitats for the conservation of dead-wood Coleoptera. *The Coleopterist* **8**(3), 121-141.

Gibbs, D. & Nau, B. (2005). *Hypseloecus visci* (Puton) (Hemiptera: Miridae) a Mistletoe bug new to Britain. *British Journal of Entomology and Natural History*, **18**, 159-161.

Green, H. & Meiklejohn, J. (2004). Mistletoe bugs and a weevil: *Ixapion variegatum* in Worcestershire. *Worcestershire Record*, **17**, 24-25 http://www.wbrc.org.uk/WORCRECD/Issue%2017/ mistletoe_bugs_and_a_weevil.htm [Accessed 16th January 2018].

Harding, P.T. & Sutton, S.L. (1985). *Woodlice in Britain and Ireland: distribution and habitat*. National Environment Research Council Institute of Terrestrial Ecology, Huntingdon.

Heitmans, W.R.B., Overmeer, W.P.J. & van der Geest, L.P.S. (1986). The role of *Orius vicinus* Ribaut (Heteroptera: Anthocoridae) as a predator of phytophagous and predacious mites in a Dutch orchard. *Journal of Applied Entomology*, **102**(1-5), 391-402.

Lee, P. [2018]. Summary for *Paidiscura pallens*. *Spider and Harvestman Recording Scheme, British Arachnological Society*. http://srs.britishspiders.org.uk/portal/p/Summary/s/Paidiscura+pallens [Accessed 10th January 2018].

Lockton, A. & Whild, S. (2015). *The flora and vegetation of Shropshire*. Shropshire Botanical Society, Shrewsbury.

Lush, M., Robertson, H.J., Alexander, K.N.A., Giavarini, V., Hewins, E., Mellings, J., Stevenson, C.R., Storey, M. & Whitehead, P.F. (2009). *Biodiversity studies of six traditional orchards in England*. Natural England Research Reports, Number 025.

Magurran, A.E. (1988). *Ecological diversity and its measurement*. Cambridge University Press, Cambridge.

Marshall, J.A. & Haes, E.C.M. (1988). *Grasshoppers and allied insects of Great Britain and Ireland*. Harley Books, Colchester, Essex.

Plant, C.W. (1997). A key to the adults of British lacewings and their allies. *Field Studies*, **9**, 179-269.

Redfern, M. (1983). *Insects and thistles*. *Naturalists' Handbooks 4*. Cambridge University Press.

Redfern, M. & Shirley, P. (2011). *British Plant Galls*. 2nd edition. Field Studies Council.

Rodwell, J.S., (ed.) (1991). *British Plant Communities volume 1: woodlands and scrub*. Cambridge University Press, Cambridge.

Rodwell, J.S. (ed.) (1992). *British plant communities volume 3: grasslands and montane communities.* Cambridge University Press, Cambridge.

Rodwell, J.S. (ed.) (2000). *British plant communities volume 5: maritime communities and vegetation of open habitats*. Cambridge University Press, Cambridge.

Rotheray, G E. (1993). *Colour guide to hoverfly larvae (Diptera, Syrphidae) in Britain and Europe*. Dipterists Digest No. 9. Derek Whiteley, Sheffield.

Shaltiel, L. & Coll, M. (2004). Reduction of pear psylla damage by the predatory bug *Anthocoris nemoralis* (Heteroptera: Anthocoridae): the importance of orchard colonization time and neighboring vegetation. *Biocontrol Science and Technology*, **14**, 811-821.

Shaw, M.R. (1993). Species of *Mesochorus* (Hymenoptera: Ichneumonidae) reared as hyperparasitoids of Lepidoptera via koinobiont ectoparasitoid Tryphoninae (Ichneumonidae). *Entomologists' Gazette*, **44**, 181-182.

Shaw, Mark R. (2017). Anatomy, reach and classification of the parasitoid complex of a common British moth, *Anthophila fabriciana* (L.) (Choreutidae). *Journal of Natural History* doi:10.1080/00222933.2017.1315837 [Accessed 20th January 2018].

Shaw, M.R., van Achterburg, C. & Mendel, H. (2016). A rearing record of *Triaspis podlussanyi* Papp. (Hymenoptera: Brachonidae, Brachistinae), new to Britain. *Entomologist's Monthly Magazine*, **152**, 137-138.

Shropshire Council (2002). *Biodiversity Action Plan*. https://shropshire.gov.uk/environment/biodiversity-ecology-and-planning/biodiversity-action-plan/ [Accessed 12th January 2018].

Sigsgaard, L., Esbjerg, P. & Philipsen, H. (2006). Experimental releases of *Anthocoris nemoralis* F. and *Anthocoris nemorum* (L.) (Heteroptera: Anthocoridae) against the pear psyllid *Cacopsylla pyri* L. (Homoptera: Psyllidae) in pear. *Biological Control*, **39**(1), 87-95.

Smart, M.J. & Winnall, R.A. (eds) (2006). The biodiversity of three traditional orchards within the Wyre Forest SSSI in Worcestershire: a survey by the Wyre Forest Study Group. *English Nature Research Reports*, No 707.

Southwood, T.R.E. & Leston, D. (1959). *Land and water bugs of the British Isles*. Frederick Warne, London.

Stace, C.A. (2010). *New flora of the British Isles, third edition*. Cambridge University Press, Cambridge.

Stamp, L.D. (1969). *Man and the land*. 3rd edition. Collins, London.

Strong, D.R., Lawton, J.H. & Southwood, Sir R. (1984). *Insects on plants: community patterns and mechanisms*. Harvard University Press.

Stubbs, A.E. & Drake, M. (2001). *British soldierflies and their allies*. British Entomological and Natural History Society.

Van Emden, H.F. (1990). Limitations on insect herbivore abundance in natural vegetation. In Burdon, J.J. & Leather, S.R. (eds.) *Pests, pathogens and plant communities*, pp. 15-30. Blackwell Scientific Publications, Oxford.

Young, M. (1997). *The natural history of moths*. T. & A.D. Poyser, London.

APPENDIX 1: SITE DESCRIPTIONS AND DETAILS

● Three sites at Froggatt's Farm (Featherknowle), Ashford Bowdler, owner Mr Tim Froggatt.

Site A – Froggatt's Farm old orchard. An ancient predominately apple orchard; GR SO511698. Surveyed on 1st May and 29th June 2015. The orchard contains several dead and dying trees and a small amount of infill planting was carried out many years ago. There are some fallen trees and branches and some rot-holes and cavities in the standing trunks. This site is unkempt, with tall ruderal vegetation of grasses, weeds, nettles and large clumps of brambles. The orchard contains several items of abandoned farm machinery and other equipment together with various building materials.

Site B – Froggatt's Farm young orchard. A younger, but still old, predominately apple orchard; GR SO511698 immediately to the west of Site A and separated from it by a metalled driveway leading to the stockyards and farmhouse. Surveyed on 1st May and 29th June 2015. Some planting of gaps was carried out several years ago. At the northern end are a few non-fruit trees and also two walnut trees. There are some fallen branches and a few rot-holes and cavities in standing trunks.

Site C – Froggatt's Farm pear orchard. Another very old originally apple orchard; GR SO511701. Surveyed on 29th June 2015. A few original trees remain around the periphery of the site and there is one large dead pear. Around some trees and on the boundaries are nettles and a few large clumps of bramble. This orchard has in the last few years been replanted with old varieties of pear to the extent that the owner now refers to it as a pear orchard.

● Two sites in Ashford Carbonel, owner Mr Norman Tudge.

Site D – Ashford Farm. An old apple orchard; GR SO529712. Surveyed on 8th May 2015. There are few if any gaps in the lines of trees, infill planting having been carried out on more than one occasion. There are some nettle patches where grazing stock have probably gathered at night. There are no fallen trees or branches but some rot-holes or cavities in the standing trunks. The south-western edge of the orchard is contiguous with a grazed pasture.

Site E – Little Huntington. An old apple orchard next to the Little Huntington property; GR SO536707. Surveyed on 8th May 2015. There are no gaps in the lines of trees, but these are not all even-aged and there must have been some infill planting at some time in the past. There is a similar ground flora to Site D and similar frequency of rot-holes; and as at Site D the south-western edge abuts a pasture.

The above five sites are all fairly level and at an altitude above sea level (a.s.l.) of around 85m.

Site F – Stonehouse Farm. An ancient orchard near Caynham; GR SO561743, owner Mr Rob Genner. Surveyed on 22nd June 2015. An apple orchard on a site of a few acres, now containing around 12 trees, some over 100 years old. There are a few rot-holes in trunks, and clumps of nettles in places. The site is on a west-facing slope at a minimum altitude of 130m a.s.l.

● Two sites at Weston Court Farm, Nash, owners Mr John and Mrs June Davies.

Site G – Weston Court Farm upper orchard. A commercial apple orchard; GR SO586720. Surveyed on 22nd June 2015. An orchard replanted sometime after 1945 on an older orchard site. There are no gaps between the trees and the site is generally well cared for with tree guards for some smaller infill plantings. The apples are used for cider production. Nettle clumps are ubiquitous where grazing animals have gathered. There are no fallen trees or branches but there are some rot-holes in the trunks. The site is sloping with a west-facing aspect at an altitude of around 125m a.s.l.

Site H – Weston Court Farm lower orchard. An old orchard mainly of apple trees but with a large pear and some well-established plums; GR SO587719. Surveyed on 16th May 2016. There are very few gaps between the trees, dead trees having been replaced. The newer plantings have protective guards. Three large older trees are heavily infested with mistletoe and although not yet dead are in poor condition. There are some rot-holes in a few of the trunks. The site is generally level with a southerly aspect; the altitude at the highest part is 113m a.s.l.

Site J – Badgers Amble. An old orchard adjacent to the property Badgers Amble, Nash; GR SO586717, owner Mrs Elizabeth Mace. Surveyed on 16th May 2016. This orchard occupies two small valley fields, one adjacent to and the other bisected by a small stream. There are now only four living and two dead fruit trees, none with any rot-holes in the trunks or branches. Along the western edge there is a steep bank up to a terrace occupied by the house and outbuildings. The altitude is around 95m a.s.l..

● Two sites at Pervin Farm, Caynham, owners Mr David and Mrs Cathy Corfield.

Site K – Pervin Farm old orchard. A mixed-age orchard with some very old apple and eight pear trees; GR SO551727. Surveyed on 24th May 2016. The pears have been planted in a line along the public road side of the site; they are now of some age, one is dead and several others are in a poor state. There has been some former infill planting which has had variable success; trees are irregularly spaced and not all gaps have been filled. There are fallen trees and branches and several older trees have rot-holes in the trunks. The ground flora has nettles. The site is level at an altitude of 100m a.s.l.

Site L – Pervin Farm young orchard. An orchard with a few old trees and consisting mainly of new plantings; GR SO550728. Surveyed on 24th May 2016. The trees are in lines but with some irregularities and a few gaps, and many of the new trees have protective guards. There are two fallen trees. Very few of the older trees have rot-holes in the trunks, and none of the newer plantings do. There are extensive clumps of nettles around many of the trees. The site slopes down from the access drive at 100m a.s.l. to a brook at the boundary of the farm at around 85m a.s.l.

Site M – Park Gate. A mixed orchard of apple and plum at Park Gate, Whitton; GR SO574732, owners Mr and Mrs McGuinness. Surveyed on 24th May 2016. The trees in this orchard are mostly of no great age, although some have been severely pruned to reduce their size; they are irregularly spaced and no recent infilling has occurred. In one corner of the site is an extensive area of rough ground with tall ruderal vegetation including nettles and brambles. At the northern end an area of long grass has been left in which there are two abandoned chicken houses and an old tractor. The site also includes a small narrow paddock on the other side of the public road adjacent to the house. This paddock has a field layer flora of grasses and agricultural weeds and is not managed. The site is level at 155m a.s.l.

Site N – Boraston Court church orchard. A mixed orchard of plum, apple and pear at Boraston Court; GR SO614700, owner Mr Keith Norwood. Surveyed on 24th June 2016 (this visit was disrupted by heavy rain). This orchard is very neglected, but some trees still bear fruit. The western edge is contiguous with a large pasture field although there is evidence that a bank and ditch existed

in times past and there is a line of well-spaced small hawthorns *Crataegus monogyna* which have grown from a former hedge. Some of these trees have died and mistletoe has established itself in at least two of them. The site is gently sloping and has a south-eastern aspect at a maximum altitude of 105m a.s.l.

Site O – Whistlewood. A mixed orchard of plum, pear, cherry and apple adjacent to the property Whistlewood, Boraston; GR SO607705, owners Mr Nick and Mrs Ali Bews. Surveyed on 27th June 2016. This large orchard of c. 4 acres has two distinct areas. That to the north on a moderate slope with a south-facing aspect comprises an area of cherry and pear trees, some of very considerable size. There are dead and fallen trees and branches but no recent replanting. The southern area is partly level and partly on a gentle slope with a north-facing aspect; it comprises apple and plum trees, none large, together with some ash *Fraxinus excelsior*. The field layer flora comprises tall grasses with some introduced wild flowers. At the time of visiting paths had been mown around the site to facilitate access. The maximum altitude of the site is around 120m a.s.l.

Site P – Bowerswood. A mixed orchard of apple, plum and damson at Bowerswood, Boraston; GR SO611702, owner Mr Colin Norwood. Surveyed on 27th June 2016. This small orchard is adjacent to the garden and buildings of this farm. The site is open with scattered old trees and a few recently planted ones. Mistletoe is abundant on apples, and there are extensive rot-holes. The orchard is lightly grazed and has a sward with coarse grasses and ruderal vegetation. The site is level and at an altitude of 110m a.s.l.

Site Q – Reaside Farm. An old apple orchard occupying a part of one pasture and one hayfield at Reaside Farm, Neen Sollars; GR SO663727, owner Mr Gordon Plunket. Surveyed on 19th June 2017. The site slopes down to a seasonal brook separating the two fields. The larger part, on an east-facing slope, has 23 well-spaced apple trees, most of medium age, showing signs of drought stress. There are good quantities of mistletoe and some felled or fallen timber. Three large *Castanea sativa* and two *Quercus robur* grow in the orchard. The ground flora is varied but the greater part consists of fine-leaved grassland. The smaller field has seven apples in better condition on a west-facing slope. Field layer flora is lush. The site has a maximum altitude of 105m a.s.l.

Site R – Neenshilltop long orchard. An old apple orchard adjacent to and partly fenced off from a large pasture field at Neenshilltop, Neen Sollars; GR SO671717, owners Messrs David and Alan Blount. Surveyed on 19th June 2017. This orchard has over 20 apple trees in generally good condition, plus one walnut. There are moderate amounts of mistletoe and a fallen dead tree in the middle of the field. The orchard is heavily grazed with unfenced access to cattle in one part. A thick hedge runs along the western boundary. The site is on a north-west-facing slope with a maximum altitude of 135m a.s.l.

- Two sites at Dean Park, Burford, owner Mr Richard Howard.

Site S – Dean Park west orchard. An old apple orchard; GR SO597692. Surveyed on 22nd June 2017. The site is in a natural hollow between two slopes facing north and south. Around 30 apples, mostly old, grow in the bottom of the hollow. Trees have much mistletoe but a reduced corticolous flora. The lower part of the site is shaded and supports a vegetation of high-nutrient soils. On upper slopes the vegetation consists of fine-leaved grasses, and rabbit burrows are present. There is an area of impeded drainage on one slope, with *Juncus* and *Carex* species. The maximum altitude is 95m a.s.l.

Site T – Dean Park north orchard. An old apple orchard; GR SO597698. Surveyed on 22nd June 2017. This is a very large orchard that spreads over three fields holding over 150 apple trees between them. The part surveyed is an open site with around 100 apples, neglected but mainly in good condition. There is less mistletoe than in the west orchard but more corticolous lichens. Several trees have broken or fallen trunks and branches. The site slopes at its northern end where thinner soils support fine-leaved grassland. The site is otherwise level with a maximum altitude of 95m a.s.l.

- Two sites at Mahorall Farm, Nash, owners Messrs Peter and Chris King-Turner.

Site U – Mahorall Farm Grove orchard. An apple orchard planted around 2000, adjacent to an older orchard; GR SO590729. Surveyed on 24th July 2017. The older area has recently lost its veteran trees to winter gales but fallen dead timber remains, and there are five apples of medium age with a little mistletoe. In the younger part c. 25 trees are evenly spaced with no gaps, fallen branches or dead wood but with moderate amounts of mistletoe. Some plums grow in the boundary hedge. The site has a slight slope and a south-west aspect with a maximum altitude of 175m a.s.l.

Site V – Mahorall Farm dingle orchard. An ancient apple orchard with a few very old trees, mainly not fruiting, and a small number of newer trees planted in the latter part of last century; GR SO594727. Surveyed on 24th July 2017. Mistletoe is present in small amounts, and there is some standing dead timber but few rot-holes. The site is on the side of a dingle with tall enclosing hedges and tall trees beyond the boundary on the east side. These create a humid atmosphere in the orchard and field layer flora is very tall and rank. The site slopes quite steeply to the east with a maximum altitude of 170m a.s.l.

Site W – Lea Fields. A mixed orchard of plum and apple trees at Lea Fields, Milson; GR SO645728, tenant Mr G. Meredith. Surveyed on 24th July 2017. The trees are of varying age and there are gaps with no evidence of any recent infill planting. Some trees are dying and there are fallen trunks and branches. Several of the trees have rot-holes, some of which are small. Mistletoe grows in quantity on the apples but not the plums. There is some fairly recent planting of apple trees along the access track but these have no mistletoe. This site is contiguous on two sides to open pastures; it is almost level with an altitude of 125m a.s.l.

Link to: **APPENDIX 2:** DATA COLLECTED IN THE STUDY: SPECIES AND THEIR DISTRIBUTION BY SITE AND DATE.