Predicting the changes in farm syrphid faunas that could be caused by changes in farm management regimes (Diptera, Syrphidae)

M.C.D. Speight, J.A. Good and E. Castella

Speight, M.C.D.; Good, J.A.; Castella, E. (2002): Predicting the changes in farm syrphid faunas that could be caused by changes in farm management regimes (Diptera, Syrphidae). – Volucella 6, 125-137. Stuttgart.

Data on habitat associations coded into a computerised database of information about European Syrphidae are used, together with information on the habitats present on a farm, to predict the likely future of the observed syrphid fauna of the farm under various management regimes. Most of the observed species appear to be dependent on habitats occurring in non-productive parts of the farm and it is predicted that loss of these habitats through intensification of use of the farm could reduce the existing syrphid fauna by more than 80 %. It is also apparent that financially viable management options are not available, to ensure the survival of the existing farm fauna, which would be expected to diminish by at least 20 % in consequence.

Zusammenfassung

Die Schwebfliegenfauna und die Habitate einer Farm wurden erfasst. Mit Hilfe von in einer Datenbank über europäische Syrphiden verfügbaren Daten über die Habitatbindung einzelner Arten werden Schlüsse auf die wahrscheinlichen Veränderungen der bestehenden Syrphidenfauna der Farm unter verschiedenen Bewirtschaftungsformen gezogen. Die meisten der dort vorkommenden Arten sind an Habitate auf Flächen gebunden, die derzeit nicht in die Produktionsvorgänge einbezogen sind. Bei Verlust dieser Habitate durch Nutzungs-Intensivierung wird ein Verlust von über 80 % der bestehenden Syrphidenfauna erwartet. Weiter ist offensichtlich, dass keine finanziell machbaren Managmentoptionen bestehen, die das Überleben der bestehenden Fauna der Farm sichern, so dass mindestens Verluste von 20 % zu erwarten sind.

Introduction

During the last 50 years, management of land used for farming has become increasing intensive in many parts of Europe, and it is well-recognised that, for groups of organisms like flowering plants and birds, this has resulted in loss of species (Stanners & Bordeau 1995). But the effects of intensification have not been systematically studied for many taxonomic groups. In the case of Syrphidae, there is a body of knowledge concerning which species maintain populations in farm crops, focussed particularly on those with aphidophagous larvae and their potential role in control of plant-bug crop pests. Much of that information has been brought together in Barkemeyer (1994) and particular aspects of these aphid-feeding farmland syrphid faunas are reviewed by various authors, for example Rojo and Marcos-García (1998) and Krause (1997). Other texts review the role of particular habitats found within farmland, and may make passing reference to syrphids, as in the case of the volume on hedgerows by Pollard et al. (1974). But, when put together, these various sources do not add up to comprehensive understanding of the way farming affects syrphid faunas and the large-scale, longitudinal studies necessary to produce definitive information seem unlikely to be conducted. Further, even if embarked upon today, the results from such studies would be a long time appearing. And there is need for understanding of how farming impacts on biodiversity *now*, so if syrphids are to play a part in developing this understanding, some other approach has to be found to bring them into play. The present text suggests that an alternative approach is, indeed, possible and provides an example of its use.

A considerable body of autecological data has been gathered about European species during the 20th century by naturalists, both professional and amateur. That body of data is not generally available to the ecologists of today, in a form in which it can be easily accessed. The Syrphidae represent almost the only predominantly terrestrial/subaquatic group of invertebrates for which such information has been compiled into a computerised system and made freely available to those who might wish to use it, in the form of the Syrph the Net (StN) database. Moog (1995) and Statzner et al. (1994) provide examples of similar systems developed for aquatic organisms. The version of the StN database published in 2000 (Speight et al. 2000), includes codified information on the habitats, microhabitats, traits, range and status of 550 of Europe's syrphid species. Application of the StN database in various biodiversity-related contexts is reviewed in Speight & Castella (2001). Here, it is used in predicting changes to the syrphid fauna of a farm, that would be caused by implementation of various different farm management options. This text is one of a number reporting on the results of a study of that farm, some of which have already been published elsewhere (Good 2001; Speight 2001; Speight & Good 2001), and provides a written version of an oral presentation made at the First International Workshop on Syrphidae, Stuttgart, July 2001.

Two levels of impact of farm management practices upon ecosystems can be distinguished. The present text is focussed on changes in farm management practice that result in replacement of one habitat occurring on a farm by another, i.e. the impact of farm management occurs at the habitat level. Secondary impacts occur at microhabitat level, i.e. the habitat remains in place but its structure is modified. Identification of effects of such secondary impacts upon the syrphid fauna requires knowledge of the particular farm management operations involved, the microhabitats upon which they impact and the syrphids which depend upon those microhabitats (see Speight et al. 2000). Secondary impacts are not considered here.

Here it is assumed that the impact of loss of a habitat on a farm is transmitted to the species of Syrphidae living in that habitat in the form of eradication of their populations along with their habitat. No attempt is made to consider subliminal effects, expressed as reduction in vitality of populations surviving in sub-optimal habitats in farmland, as detailed for carabids by Östman et al. (2001). This could well be manifest in syrphids, in circumstances where certain species occupy more than one habitat on a farm, and the habitat most favourable to them there is lost by changes in farm management.

The potential for species gains consequent upon changes in farm management is considered here only within the restricted context of the species observed to reach the farm during course of the year 2000, and thus definitely available to colonise the farm then, should habitats appropriate for them be introduced to the farm at that point in time. The broader question of which species might be available for colonisation of the farm from the region in which the farm is located, although not collected on the farm during 2000, is considered by Speight & Good (2001).

Fig 1: Outline map of Ireland, showing the location of the farm studied. – The farm, known as Glinny House Farm, is located in Co.Cork. There are 175 species of Syrphidae recorded from Ireland, 116 of which are known from Co.Cork (see Speight et al. 2000). On the farm, 73 species have been found.

Methods

An inventory of the syrphid fauna of a 41 ha farm in south-west Ireland (see Fig.1) was compiled by saturation trapping, using Malaise traps (installed at an average density of one trap per 1.5 ha throughout the farm) and hand-net, augmented by emergence traps. The disposition of the Malaise traps on the farm is shown in Speight (2001). The Malaise trapping was carried out from April to September in 2000 and a comprehensive habitat survey of the farm was conducted in the spring of the same year. The emergence traps were used over the same time period as the Malaise traps, but on a much smaller scale, there being only 20 emergence traps in operation at any one time. Collection by hand net was not systematic, but all parts of the farm were visited at different times.

The array of habitat categories used in recording the results of the farm habitat survey was the same as is used in coding syrphid habitat associations in vol. 22 of the StN database (Speight et al. 2000), which employs, where possible, CORINE habitat categories (see Devillers et al. 1991). The habitats recorded were put into three groups according to their role in the farm economy: productive sector habitats, infrastructural habitats and disused sector habitats. These three groups are discussed more fully elsewhere (Good 2001; Speight 2001). Essentially, productive sector habitats comprise the field surfaces used to produce the products on which the farm economy depends, while infrastructural habitats are man-made features introduced to the landscape as adjuncts to farming, but not used directly in production of goods for sale. Disused sector habitats occur on the land which is not in productive use, because the economic return on expenditure necessary to bring that land into productive use has been deemed insufficient. Setaside is a form of fallowing institutionalised by EU agricultural sector support schemes and, as such, does not fall easily (see Speight, in press) into any one of these three groups. For convenience, it has been included here as part of the productive land area.

Present management of the farm and potential changes to the management regimes operated there, together with the socio-cultural and socio-economic forces likely to lead to their implementation, are discussed by Good (2001). Using these data, a list of the alternative management regimes most likely to affect the farm was compiled, and the gross changes in habitat representation on the farm that would accompany each management regime were identified. From a knowledge of these habitat changes, the habitat associations of the syrphid species observed on the farm (as coded into vol. 22 of the StN database), and the habitats observed on the farm, two sets of predictions were made:

- the distribution of the syrphid species known to occur on the farm, among the habitats represented on the farm;
- changes in the observed syrphid fauna of the farm resulting from changes in the habitats represented on the farm.

The procedure used in deriving the predictions relating to occupancy of the habitats observed on the farm, by the syrphid species observed on the farm, is shown diagrammatically in Fig. 2.

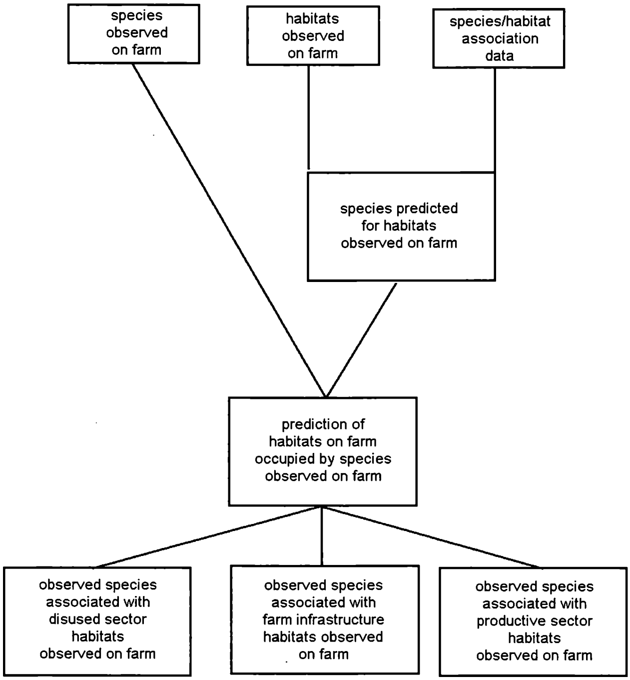

Fig 2: Procedure used for predicting which of the syrphid species observed on the farm occur in each of the three land sectors on the farm. The species and habitats observed are derived from field survey, the species/habitat association data are derived from the StN database (see text). The observed habitats are assigned to land sectors as shown in Table 1.

Results

The 73 species of Syrphidae recorded from the farm are listed in Appendix 1. The habitats observed on the farm are indicated in Table 1. The predicted distribution of the observed syrphid species, between habitats belonging to the three farm sectors, is also shown in Appendix 1. An overview of the expected changes in the farm syrphid fauna consequential upon loss of either, or both, the infrastructural and disused sector habitats from the farm, is shown in Fig. 3.

LAND SECTOR	CONSTITUENT HABITATS
Disused sector (c 5 ha extent)	• Atlantic thickets with flushes • *Alnus* forest with flushes and brook • unimproved, oligotrophic *Molinia* grassland with flushes and temporary pools/acid fen
Infrastructure (c 5 ha extent)	• scattered trees in open ground (tree lines of *Fagus* and *Acer pseudoplatanus*) • hedges, with and without associated drainage ditches and/or canalised, seasonal brooks • old walls • field margins • orchard • farmyard organic waste • pond • farm buildings
Productive sector (c 30 ha extent)	• improved grassland • intensive grassland • crops • cow dung • setaside

Tab. 1: Habitats observed on the farm and the land sectors to which they are consigned (see text). Definitions of the habitat categories employed are given in Speight (in press).

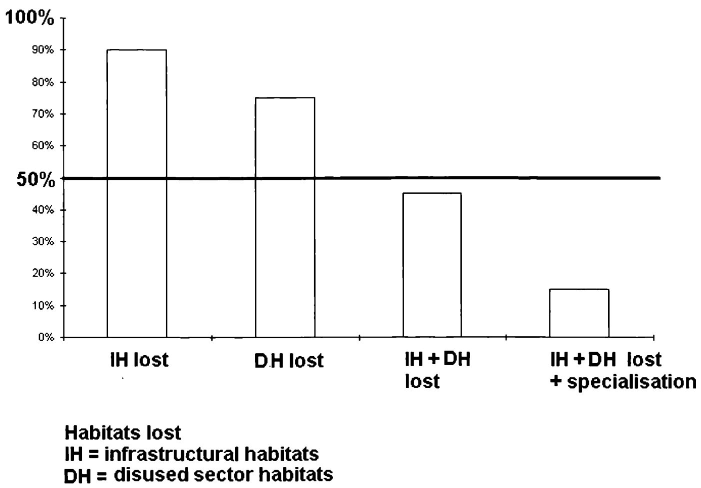

Fig. 3: The proportion of the existing syrphid fauna of the farm predicted to survive the loss of the infrastructural (IH) habitats and/or disused (DH) sector habitats from the farm, plus specialisation in use of the farm. Specialisation is the process of conversion of the farm from use for various purposes i.e. hay production, livestock grazing, silage production and crop production, to use for only one purpose i.e. crop production (see text).

At first glance, loss of the infrastructural and disused sector habitats, en bloc, may seem unlikely. However, the entire farm only occupies 41 ha and areas of this size, converted to two adjacent field units demarkated only by the crops growing on them, are less the exception than the norm over much of Europe's farmland landscape. Indeed, within 500m of the outer edge of the case study farm just such a conversion has been carried out recently, a series of small fields and their infrastructure having been transformed into one, homogenous, 25 ha field unit. Fig. 3 shows that, in the event that such a conversion were carried out on the case-study farm, more than 50 % of its existing syrphid fauna would be expected to be lost, on a basis of the habitat requirements of the species. Fig. 3 also shows that, were the farm to specialise in production of only one product (crops) following its conversion, rather than being used for a combination of crop production, livestock grazing, silage production and hay making, as at present (Good, in press), the syrphid fauna would be expected to diminish further, to comprise less than 20 % of its present species. It should be recognised that this 20 % remnant of the present fauna would also become non-resident on the farm under these conditions, since annual ploughing, as part of a crop production regime, effectively renders the land uninhabitable to even those syrphid species, for part of each year. During that time, the species that might occupy the farm, when it was once more vegetated, would have to survive somewhere in its vicinity, but not on it. And there is, of course, no guarantee that appropriate habitat would be available for these species in the vicinity of the farm during those periods – especially if the surrounding land were ploughed at the same time.

Loss of the farm's disused sector habitats alone would be predicted to cause a 25 % reduction in the present syrphid fauna, while loss of infrastructure alone would be expected to cause a smaller reduction. Loss of the habitats in either of these sectors would be likely to have substantially less effect than loss of both together, because of the number of species shared by habitats in these two sectors. For instance, hedges (infrastructure) support some of the same species as Atlantic scrub (disused sector), so those shared species would be expected to survive the loss of hedges on the farm if the disused sector habitats remained in place.

In Fig. 4, the potential fate of the species inhabiting disused sector habitats on the farm is considered in more detail. Firstly, the result of continuation of the present situation is predicted, showing that, without management, the fauna of the disused sector can be expected to decrease. The only assumption made here is that the expansion of scrub (*Alnus/Salix/Betula/Rubus/Ulex/Prunus*) occurring there now will continue, to a point where open habitats are lost in the disused sector land. The second scenario considered is that the abandoned sector land is converted to improved grassland. This is not considered to be a viable option, economically, at the moment (Good, in press), but could become viable if conditions changed in the agricultural sector. The third and fourth options considered are that the disused sector land is converted either to conifer plantation or deciduous (oak) plantation, respectively. There are financially attractive schemes in operation in Ireland at present, aimed at encouraging farmers to plant small areas of trees on farms, so these options are economically viable. Expected losses to the farm syrphid fauna can be seen to be of the same order of magnitude from adoption of these options as from either leaving the disused sector unmanaged or converting it to improved grassland. Finally, the implications to the syrphid fauna of attempting to resuscitate the residual acid fen on the disused sector land, or to actively manage the disused sector such as to maintain the status quo (i.e. essentially to prevent further scrub expansion), are indicated. The acid fen habitat is given specific consideration because it was better represented within the disused sector of this farm in the immediate past (Good, in press). The only alternative future for the disused sector land that would *not* be expected to result in a loss of species from the existing farm fauna is attempting to maintain the status quo there. The problem with this option is that it provides the farmer with no economic return yet involves expenditure on active management (to control scrub). And the same has to be said for management that would be carried out with the objective of resuscitating acid fen. This is so because existing schemes that might be expected to provide financial support for such management action on farms in Ireland are not at present being operated in this way (Hickie et al. 1999).

Turning to the question of potential gains to the farm syrphid fauna, from adoption of these various alternative management options on the disused sector land on the farm, Fig. 4 once again suggests a far-from-optimistic picture. The basis for predicting gains to the fauna is that there are some species recorded from i.e. reaching, the farm that would not be predicted to occur there at present, on the basis of the habitats represented, but which might come to occupy habitats introduced to the farm with these alternative forms of management. Among the 73 species observed on the case

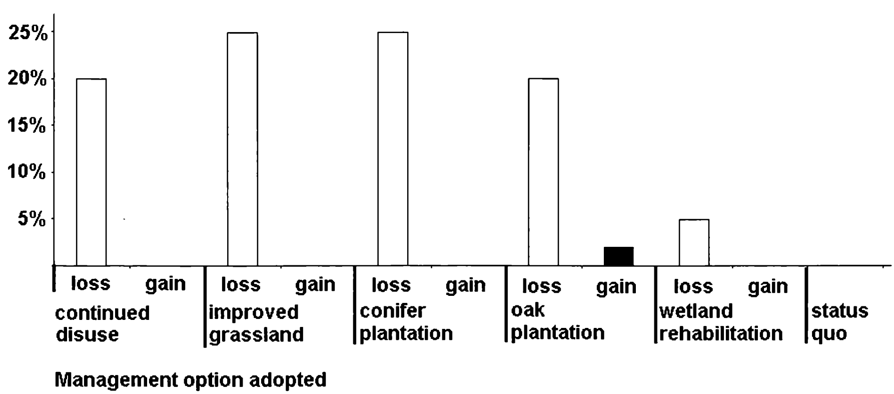

Fig. 4: Net losses and gains predicted to the observed farm syrphid fauna, following from adoption of different management options for the disused sector land on the farm. Losses are represented by hollow (white) columns, gains by solid (black) columns.

study farm only three, *Helophilus trivittatus*, *Sphegina elegans* and *Xylota sylvarum*, would not be predicted to occur in association with any of the habitats present on the farm at the moment. So the question becomes whether any of the alternative scenarios considered for the future of the abandoned sector land would be expected to introduce habitats to the farm with which any of these three species are associated. None of the options would be expected to favour the establishment of *H. trivittatus* on the farm, and only introduction of an oak plantation would be expected to result in establishment of *S. elegans* and *X. sylvarum*. And these two species would not be expected to establish themselves on the farm until the oak plantation reached some semblance of maturity, after the passage of 50 or more years.

Discussion

Farmland landscapes occupy the greater part of the European lowland in temperate and southern parts of the continent. Outside the pitifully few protected sites the survival of the syrphid fauna of open habitats, in particular, is dependent upon what happens in that farmland landscape. It is demonstrated here that changes in the syrphid fauna, associated with gross changes in habitat representation on a farm caused by changes in management regimes operated there, can be predicted. In this way, an overview has been gained of the probable effects of these management changes on the farmland syrphid fauna. And the exercise has highlighted matters of potentially serious concern. In particular, processes of intensification and specialisation active in the surrounding countryside would, if applied to the farm, potentially cause loss of more than 80 % of the existing farm syrphid fauna. Similarly, the exercise has shown that a significant proportion of the existing farm syrphid fauna is apparently dependent upon part of the farm – the disused sector land – whose future is not assured by any financially viable management option. Effectively, when finance is taken into consideration, the only likely futures for the disused sector land on the farm would be either continued neglect or conversion to some sort of plantation, all of which can be expected to cause loss of 20 % or more of the existing farm fauna. Further, these options seem unlikely to result in gains to the farm fauna which might counterbalance the losses. And should even *Sphegina elegans* and *Xylota sylvarum* be regarded as potential additions to the farm fauna, since they could not be expected to colonise an oak plantation immediately following its establishment? Certainly, there is no clear basis for assuming these two species will still be available locally in 50 years time, to colonise an oak plantation on the farm then, even if they have been found on the farm now.

That all the changes to the farm fauna envisaged in this text are predicted rather than actual could be regarded as either a strength or a weakness, dependent upon one's viewpoint. For those attempting interpretation of man's effects upon the environment such prediction is much needed. For others, such predictions may still seem to be hypotheses demanding further substantiation before they are to be trusted. Introduction of changes to farm management practice will not wait upon us to test to exhaustion the accuracy of our predictive tools. The helplessness of authors attempting interpretation in the absence of such predictive tools can be seen from accounts like that of Frank (1999), where so little autecological information is brought into play that almost nothing can be concluded from the observations made. Others, like Kramer (1996) bring some knowledge of habitat associations into use, in discussing the origins of syrphids collected from setaside, but with no precision and not for all species – without a predictive tool like the StN database it is difficult to consider systematically from where in the surrounding landscape syrphids collected originate, when sampling is based on devices like Malaise traps or water traps.

Use of a predictive tool like the StN database can be expected to proceed at the same time that its predictive accuracy is being tested. In exploring the potential consequences of alternative farm management options, at the level this exercise has been conducted in the present text, accuracy of prediction is largely dependent upon the quality of the data coded into the Macrohabitats file of the database, though the accuracy of predicted habitat change occasioned by farm management regimes is also involved. Ground-truthing of predictions like those made here is at least possible, and the products of such ground-truthing activities can be incorporated into the database as they become available, providing for progressive refinement of its predictive capacity. Thus work on the syrphid fauna of the case-study farm in Ireland continues, with the Malaise traps now largely replaced by sets of emergence traps, to check on the predicted distribution of the observed species among the observed habitats, particularly on productive sector land.

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Addresses of authors:

M.C.D. Speight, Research Branch, National Parks & Wildlife, 7 Ely Place, Dublin 2, Ireland

J.A. Good, Glinny, Riverstick, Co Cork, Ireland

E. Castella, Laboratoire d'Ecologie et de Biologie Aquatique, Université de Genève, 18 chemin des Clochettes, CH - 1206 Genève, Switzerland

	Habitat Associations (by sector)		
	Productive	Infrastructure	Disused
SPECIES OBSERVED ON FARM (Syrphidae)			
Anasimyia lineata (Fabricius), 1787			1
Baccha elongata (Fabricius), 1775		1	1
Cheilosia albipila Meigen, 1838			1
Cheilosia albitarsis (Meigen), 1822	1	1	1
Cheilosia antiqua (Meigen), 1822		1	1
Cheilosia bergenstammi Becker, 1894	1	1	
Cheilosia illustrata (Harris), 1780		1	
Cheilosia pagana (Meigen), 1822	1	1	
Cheilosia semifasciata Becker, 1894		1	
Cheilosia vernalis (Fallen), 1817	1	1	
Chrysogaster solstitialis (Fallen), 1817		1	1
Chrysotoxum bicinctum (L.), 1758	1	1	1
Criorhina berberina (Fabricius), 1805			1
Dasysyrphus albostriatus (Fallen), 1817		1	1
Epistrophe eligans (Harris), 1780	1	1	
Episyrphus balteatus (DeGeer), 1776	1	1	1
Eristalinus sepulchralis (L.), 1758	1	1	1
Eristalis abusivus Collin, 1931			1
Eristalis arbustorum (L.), 1758	1	1	1
Eristalis horticola (DeGeer), 1776	1		1
Eristalis interruptus (Poda), 1761	1	1	1
Eristalis intricarius (L.), 1758	1		1
Eristalis pertinax (Scopoli), 1763	1	1	1
Eristalis tenax (L.), 1758	1	1	1
Eumerus strigatus (Fallen), 1817	1	1	
Eupeodes corollae (Fabricius), 1794		1	1
Eupeodes latifasciatus (Macquart), 1829	1		1
Eupeodes luniger (Meigen), 1822	1	1	
Helophilus hybridus Loew, 1846			1
Helophilus pendulus (L.), 1758	1	1	1
Helophilus trivittatus (Fabricius), 1805			
Lejogaster metallina (Fabricius), 1781			1
Leucozona laternaria (Müller), 1776		1	
Leucozona lucorum (L.), 1758		1	
Melangyna lasiophthalma (Zetterstedt), 1843		1	1
Melanogaster hirtella (Loew), 1843		1	1
Melanostoma mellinum (L.), 1758	1	1	1
Melanostoma scalare (Fabricius), 1794	1	1	1
Meligramma cincta (Fallen), 1817		1	
Meliscaeva auricollis (Meigen), 1822	1	1	1
Meliscaeva cinctella (Zetterstedt), 1843		1	1

	Habitat Associations (by sector)		
	Productive	Infrastructure	Disused
SPECIES OBSERVED ON FARM (Syrphidae)			
Myathropa florea (L.), 1758	1		1
Neoascia podagrica (Fabricius), 1775	1	1	1
Neoascia tenur (Harris), 1780			1
Orthonevra geniculata (Meigen), 1830			1
Orthonevra nobilis (Fallen), 1817		1	
Platycheirus albimanus (Fabricius), 1781	1	1	1
Platycheirus ambiguus (Fallen), 1817		1	1
Platycheirus angustatus (Zetterstedt), 1843			1
Platycheirus clypeatus (Meigen), 1822	1		1
Platycheirus granditarsus (Forster), 1771	1		1
Platycheirus manicatus (Meigen), 1822			1
Platycheirus occultus Goeldlin, Maibach & Speight, 1990			1
Platycheirus rosarum (Fabricius), 1787			1
Platycheirus scambus (Staeger), 1843			1
Platycheirus scutatus (Meigen), 1822		1	1
Rhingia campestris Meigen, 1822	1		
Riponnensia splendens (Meigen), 1822		1	1
Scaeva pyrastri (L.), 1758	1	1	1
Sericomyia silentis (Harris), 1776			1
Sphaerophoria interrupta (Fabricius), 1805	1	1	1
Sphaerophoria scripta (L.), 1758	1	1	
Sphegina clunipes (Fallen), 1816			1
Sphegina elegans Schummel, 1843			
Syritta pipiens (L.), 1758	1	1	1
Syrphus ribesii (L.), 1758	1	1	1
Syrphus torvus Osten-Sacken, 1875		1	1
Syrphus vitripennis Meigen, 1822		1	1
Trichopsomyia flavitarsis (Meigen), 1822			1
Volucella bombylans (L.), 1758		1	1
Volucella pellucens (L.), 1758		1	
Xylota segnis (L.), 1758		1	1
Xylota sylvarum (L.), 1758			
number of species:	32	47	55

Appendix 1: Syrphids observed on the farm 1994-2000, plus the sectoral habitat groups with which they are known to be associated. Association between a species and habitat(s) occurring in a particular sector on the farm is indicated by a "1" opposite the name of the species, in the relevant Habitat Associations column.