Hoverfly communities (Diptera, Syrphidae) in vegetation complexes of river valleys near Bonn (Germany) [1)]

Axel Ssymank

Ssymank, A. (2004): Hoverfly communities (Diptera, Syrphidae) in vegetation complexes of river valleys near Bonn (Germany). – Volucella 7, 157-183. Stuttgart.

In the Drachenfelser Ländchen near Bonn (Germany) both the regional hoverfly fauna and the vegetation are well-known, especially in the river valleys, where a long-term research project has been conducted. This project enabled the study of hoverfly communities to be carried out for the first time on the basis of defined vegetation complexes (sigma-associations). Along selected river sections the syrphid fauna of linear alluvial forest complexes of black alder and willow was studied using an adapted transect sampling regime. From 4187 observations of 71 hoverfly species it could be demonstrated that the different alluvial complexes have their own distinct syrphid communities, with differential species groups (e.g. as shown by representativity analysis). Furthermore, 2534 flower visits were observed to 73 plant species and 4 syrphid species were added to the regional checklist. In the present text the quality of data engendered using this new method of stratified hoverfly sampling in vegetation complexes is assessed, and the method is discussed in comparison with other methods for landscape scale investigation of hoverflies.

Key words: hoverfly communities, river valleys, vegetation complexes, species diversity, site evaluation, flower visiting, Syrphidae.

Zusammenfassung

Auf der Grundlage umfangreicher Daten eines langjährigen Forschungsprojekts zur Regionalfauna der Schwebfliegen (Diptera, Syrphidae) des Drachenfelser Ländchens bei Bonn (Deutschland) und genauer Kenntnis der Vegetation der Bachtäler, war es erstmals möglich, die Beziehungen zwischen Schwebfliegen-Gemeinschaften und Vegetationskomplexen (Sigmeten) zu untersuchen. Entlang ausgewählter Fließgewässerabschnitte wurde die Schwebfliegenfauna der linearen Auenwaldkomplexe (i.w. Schwarzerlen- und Bruchweiden-Galerien) erfasst. Mit 4187 Beobachtungen von 71 Schwebfliegenarten konnte gezeigt werden, dass die verschiedenen Vegetationskomplexe jeweils eigenständige Schwebfliegen-Gemeinschaften mit Differentialgruppen haben (u.a. Repräsentanzanalyse). Darüber hinaus wurden 2534 Blütenbesuche an 73 Pflanzenarten beobachtet und vier neue Arten für die Regionalfauna gefunden. Die neue

[1)] Presentation made at the 2nd international symposium on the Syrphidae, Alicante (Spain) 2003

Methode der stratifizierten Erfassung von Schwebfliegen-Gemeinschaften in Vegetationskomplexen wird im Hinblick auf die Vollständigkeit der Erhebung geprüft und im Vergleich zu anderen Methoden der Schwebfliegenerfassung diskutiert.

1 Introduction

The relationship between animal communities and vegetation is one of most fascinating topics in biocoenology. As early as 1960 Tüxen organized a symposium of the IVV (IAVS, International Association of Vegetation Science) entitled "Biosoziologie", followed by another in 1976 on "Vegetation and Fauna" (Tüxen 1977). A working group on biocoenology was subsequently founded by Kratochwil, in 1988, and a number of projects were initiated and coordinated by Prof. Wilmanns in the Geobotany Department of the University of Freiburg (theoretical approach: Wilmanns 1987, 1988). As flower-visitors and an important pollinator group syrphids have been the subject of a number of studies of their relations to plant communities or plant associations, especially at the University of Freiburg (e.g. Schanowski 1985, Buchholz 1989, Ssymank 1991). Recent advances and methods in biocoenology have been summarised by Kratochwil & Schwabe (2001) and in 2003 a good overview of the subject was presented in the Rintelner Symposium-series, in honour of Prof. Wilmanns, entitled "Pflanzengesellschaften als Lebensraum für Tiere – Interaktionen von Flora und Fauna" (Plant communities as habitat for animals – interactions between fauna and flora, Pott 2003).

For adult hoverflies the plant syntaxa or plant communities give a precise picture of available food resources: Each syntaxon has its characteristic flowering phenology both in space and time of the year. But hoverflies are mobile, so even during the course of one day they often use more than one plant community, depending on needs for food (nectar and pollen), egg-laying and mating places and location of larval food resources. Attention was drawn to these diurnal activity patterns, or movements between different habitats, by Schneider (1958) and in more detail by several more recent workers. It was a logical extension of that work to investigate integration of syrphids at a larger spatial scale, such as that provided by vegetation complexes, to provide a framework for analysis of syrphid communities. Application of vegetation complexes in biocoenology studies has already produced useful results with various other animal groups, especially for birds (for example Seitz 1982, 1988, Schwabe & Mann 1990), but also with a few invertebrate groups (Lepidoptera: Schwabe et al. 1992).

For a number of methodical and practical reasons it is very difficult to assess the hoverfly communities of a landscape. While knowledge of the macro- and microsite features with which the species are associated is constantly growing (for example Syrph-The-Net-Database, Speight et al. 2000), the distribution and behaviour of hoverfly communities in landscapes remains largely unknown.

Hoverflies are mobile and thus they often use more than one plant community during the course of a day, for different purposes, for instance food (nectar and pollen), egg-laying, mating places and larval food resources. One question immediatly arising from this observation is whether vegetation-complexes, as a consistently-defined pattern of plant communities, occur at a scale appropriate for analysing and understanding hoverfly communities and distribution in a landscape. The present text examines this issue, also contributing new data on flower-visiting and additions to the regional check-list for Syrphidae.

The Drachenfelser Ländchen is a cultivated landscape near Bonn (Germany) with semi-natural small river systems, where the data from a long term research project (Ssymank 2001) provide the necessary background for detailed data analysis and testing of new methods of investigating hoverfly communities:

– the regional fauna is well-known with 174 species recorded, based on over 70,000 observations in a 10 year project

– the vegetation, especially the vegetation complexes (Sigma-Associations) of the river valleys, are known and mapped.

This is the first time a landscape-scale study of syrphid communities has been carried out on the basis of vegetation complexes. For sampling the syrphids a specific transect procedure, for sampling linear vegetation complexes of the river valleys, was adapted for use.

2 The study area and its vegetation complexes

The 'Drachenfelser Ländchen' is just south of Bonn (Northrhine-Westfalia, W-Germany) between the Rhine valley and the Eifel-mountains. It is a rather intensively used agricultural landscape, where the most diverse ecosystems are semi-natural linear alluvial forests along small streams and rivers. The climate is subatlantic and warm, with 9-9.5 °C mean annual temperature and annual precipitations of about 710 mm. Elevations range from about 60m in the Rhine valley to 263m. About a quarter of the surface is covered by acidic deciduous forests (Luzulo-Fagion vegetation) and there are various plantations of fir and pine on the hill-tops of volcanic outcrops, or on the gravel deposits of high terraces of the Rhine. The upper slopes of small river valleys and the plateau, with fertile silty to loamy soils, are usually intensively farmed cropland, mainly of cereals and sugar beet. The lower slopes are intensive pasturage for cows and horses (Cynosurion-vegetation). Valley bottoms are usually characterised by linear alluvial forests of black alder and ash (Stellario-Alnetum glutinosae), partly replaced by secondary alluvial willow-woods of *Salix fragilis* or degraded remnants of hygrophilous vegetation. A more detailed description of the study area is given in Ssymank (2001), including a documentation of vegetation relevées and a full description of vegetation complexes. For the purpose of the present text a brief description of the different vegetation complexes of the river valleys should suffice.

Vegetation complex	**I Fraxinus-Fagion-complex**	**II Stellario-Alnetum-complex**		
subtype	3 subtypes	a) Caltha subtype	b) typical subtype	c) Filipenduli-on-subtype
number of plant communities	10-16	10-11	10-11	10-19
dominant canopy species	ash (*Fraxinus excelsior*)	black alder (*Alnus glutinosa*)		
main ecological characters	wet closed forest: a) with ravine forest, b) with oak hornbeam-terrasses, c) with standing water bodies	wet closed *Alnus* gallery with helocrenes on slopes, river undulating	closed *Alnus* gallery: usually > 2 rows of trees, river undulating	gaps in *Alnus* gallery, intermittant tree groups, humid tall herb communities present on banks, river often partly regulated
adjacent plant communities	humid to mesic *Fagus* forests, spruce plantations	mainly forests and pastures, partly crops		
distribution	very rare	rare	widespread	widespread

Tab. 1: Ecological traits of the vegetation complexes of river valleys in the Drachenfelser Ländchen.

Linear vegetation complexes of river valleys

Vegetation complexes represent a higher level of integration of vegetation data, describing components of a landscape by phytosociological means. The first step is analysis of plant communities or plant associations, characterised by a specific combination of plants growing together under defined environmental conditions. Relative plant cover (abundance) and constancy are used to define these units. The second step is to consider the spatial distribution pattern of plant communities in the landscape. Using

Vegetation complex	**III Salicetum fragilis-complex**		**IV Poplar-plantations-complex**	**V Phalaris-Filipendulion-complex**
subtype	a) typical subtype	b) Filipendulion-subtype		
number of plant communities	9-14	11-15	10-16	4-10
dominant canopy species	*Salix fragilis*		*Populus* hybrids	no canopy
main ecological characters	closed *Salix* gallery: usually > 2 rows of trees, river often partly regulated	gaps in *Salix*-gallery, intermittant tree groups, humid tall herb communities present on banks, river often partly regulated	closed Poplar plantations along the river, river usually regulated	no trees, only scattered bushes and occasional *Salix* trees, abundant humid tall herb communities
adjacent plant communities	mainly crops, partly intensive Cynosurion-pastures		mainly crops	mainly intensive Cynosurion-pastures
distribution	widespread	widespread	only locally	widespread in higher elevations (plateau)

landscape cells [2)] with quasi-homogenous sample plots, the relative cover of plant communities is assessed and analysed in vegetation complex tables (e.g. Wilmanns 1988). The results are vegetation complexes (Sigma-associations) with a characteristic set of plant communities. For the linear vegetation complexes of river valleys the sample plots represent a quasi-homogenous section of the valley bottom. Vegetation complexes, once defined, allow detailed and rapid mapping of large areas or entire landscapes. In nature conservation they can give multiple information for example on hemerobiotic [3)] level, on restoration of modified or degraded river systems, on distribution of rare plants, rare plant communities etc.

Vegetation analysis and mapping of the linear vegetation complexes of river valleys in the Drachenfelser Ländchen of Ssymank (2001, based on 22 sigma-relevées), revealed the occurrence of 5 types (8 subtypes) of vegetation complex exhibiting a distinct pattern of plant communities. They represent basically different hemerobiotic levels of the river valley vegetation and are differentiated [4)] mainly by their dominant tree species, canopy cover and different levels of humidity (Table 1).

[2)] Landscape cells (Physiotop): smallest homogenous landscape unit with the same abiotical conditions (for example geology, soils, climate) and landuse.
[3)] Hemerobiotic level: level of intensity of direct and indirect human influences on ecosystems or biocoenoses.
[4)] This is a rather simplified interpretation of the vegetation complexes in order to make the paper easier to understand for zoologists not used to phytosociological methods.

These main types are:

I. Fraxinus-Fagion-complex (closed ash- and beech-forest)
II. Stellario-Alnetum complex (black alder galleries)
III. Salicetum fragilis complex (willow galleries)
IV. Poplar plantations-complex
V. Phalaris-Filipendulion-complex (brooks and streams without tree canopy)

The main differentiating plant communities were for gallery forests (complexes I-III) those of at least partly shaded conditions: Rhamno-Cornetum sanguinei, Urtico-Aegopodietum and Epilobio-Geranietum. The Fraxinus-Fagion-complex (I) was characterised by Fraxinus-Fagion-community, Sambucus nigra-scrub and the Aceri-Fraxinetum.

The Black alder galleries (II) were characterised by the Stellario-Alnetum, the wettest subtype by the *Caltha palustris*-variant with the Glycerietum nemoralis indicating helocrenes (flushes). The Filipendulion subtype corresponds to a partly open canopy, which allows wet, tall herb communities to grow partially on river banks as Filipendulion, Phalaridetum arundinaceae and Petasitetum hybridi.

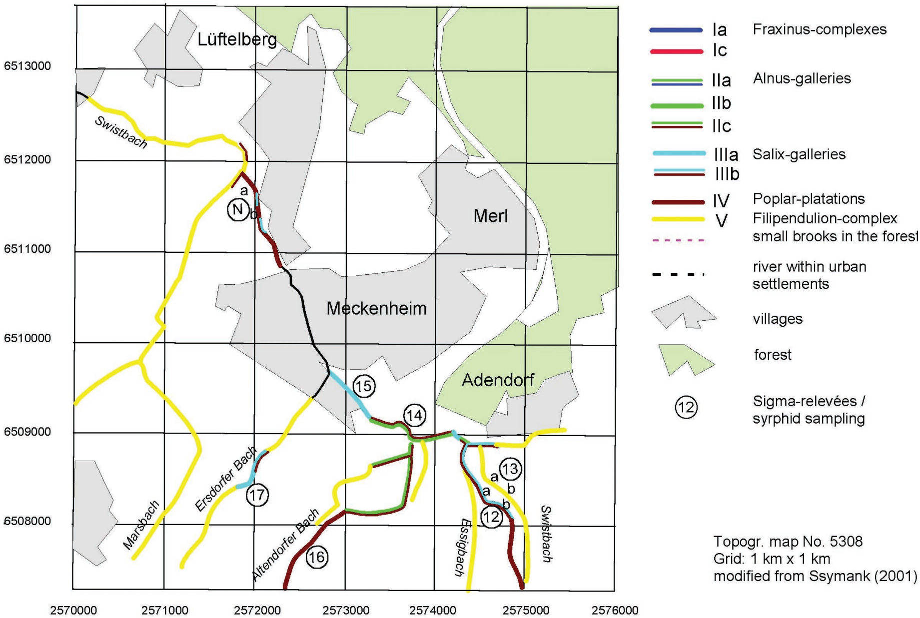
The Willow galleries (III) were characterised by Salicetum fragilis, differentiated into two subtypes. Here there is also a Filipendulion-subtype where there are gaps in the canopy and the same differentiating plant communities exist as for the equivalent subtype of the black alder galleries.

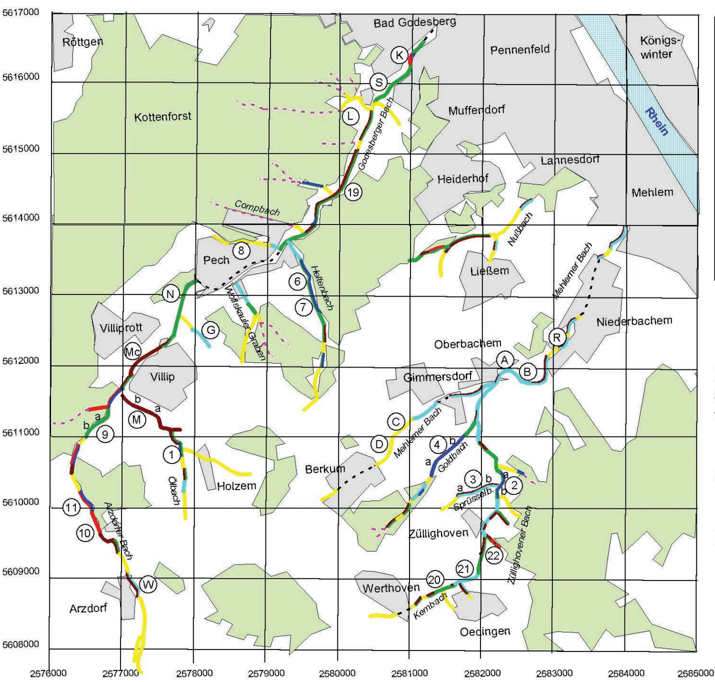
Poplar plantations are relatively rare, sometimes mixed with cherry-plantations and also have a number of wet, tall herb communities, because the canopy cover is generally lower for poplars. The Phalaris-Filipendulion complex is a highly degenerate remnant of alluvial vegetation with either scattered single willows, black alders or *Salix caprea* bushes, characterised by wet, tall herb communities and specifically plant communities which do not support much shading, like curtains of *Solanum dulcamara* and small reeds of the Typhetum latifoliae.

The river valley transects sampled are indicated and numbered in the map of vegetation complexes (Fig. 1a/b). All localities were in the collinar zone, at 60 - 200m altitude, as shown on topographical maps scale 1:25.000, Nos. 5308 and 5309, in the Mehlemer Bach/ Godesberger Bach and Swistbach river systems, only a few kilometres apart. The detailed list of sampling localities and times is given in table 2.

Fig. 1a/b: Study area, sampling transects and vegetation complexes. Numbers of localities are indicated with original number of vegetation relevées, given in table 2 in brackets behind faunistical sampling localities. Part a) shows the surroundings of Meckenheim with the Swistbach-river system with largely degraded alluvial systems, dominated by the Phalaris-Filipendulion complex. Part b) shows the Godesberger and Mehlemer Bach-system with mostly semi-natural conditions and dominating black alder and willow gallery forests.

Fig. 1 a: Study area, sampling transects and vegetation complexes Swistbach





Study area

Fig. 1 b: Study area, sampling transects and vegetation complexes:

Godesberger Bach & Mehlemer Bach

Legend see Fig. 1 a

Table 2: Sampling Localities. Numbers in brackets indicate the number of the vegetation complex relevée, and are also used on the map showing the vegetation complexes in the study area (Fig. 1a/b).

No. 803 [4a]: Goldbach, Berkum; Fraxinus-Fagion-complex, Aceri-Fraxinetum-subtype (Ia); topographical map (1:25.000) No. 5308 SE, 50 37’33”N, 07 08’58”E, 160 m; date & time: 06.08.1999, 13.30 - 13.50 and 22.08.1999, 11.50 - 12.20.

No. 804 [4b]: Goldbach, Berkum; Fraxinus-Fagion-complex, Aceri-Fraxinetum-subtype (Ia); topographical map (1:25.000) No. 5308 SE, 50 37’40”N, 07 09’10”E, 150 m; date & time: 06.08.1999, 13.55 - 14.15 and 22.08.1999, 11.10 - 11.40.

No. 805 [10]: Arzdorfer Bach, Klein Villip; Fraxinus-Fagion-complex, typical subtype (Ib); topographical map (1:25.000) No. 5308 SW, 50 37’07”N, 07 04’55”E, 190 m; date & time: 06.08.1999, 11.20 - 11.40 and 22.08.1999, 14.00 - 14.20.

No. 806 [K]: Godesberger Bach; Fraxinus-Fagion-complex, typical-subtype (Ib); topographical map (1:25.000) No. 5308 NE, 50 40’16”N, 07 07’28”E, 60 m; date & time: 12.08.1999, 13.15 - 13.35 and 22.08.1999, 12.10 - 12.30.

No. 807 [11]: Arzdorfer Bach, Klein Villip; Fraxinus-Fagion-complex, Carici remotae-Fraxinetum-subtype (Ic); topographical map (1:25.000) No. 5308 SW, 50 37’19”N, 07 04’44”E, 180 m; date & time: 06.08.1999, 11.45 - 12.05 and 22.08.1999, 14.25 - 14.45.

No. 808 [6]: Heltenbach; Stellario Alnetum-complex, Caltha palustris-subtype (IIa); topographical map (1:25.000) No. 5308 NE, 50 39’01”N, 07 07’25”E, 120 m; date & time: 04.08.1999, 14.50 - 15.10 and 25.08.1999, 14.50 - 15.10.

No. 809 [7]: Heltenbach; Stellario Alnetum-complex, Caltha palustris-subtype (IIa); topographical map (1:25.000) No. 5308 NE, 50 38’45”N, 07 07’32”E, 130 m; date & time: 04.08.1999, 15.20 - 15.40 and 25.08.1999, 15.10 - 15.30.

No. 810 [2a]: Züllighovener Bach; Stellario Alnetum-complex, Caltha palustris-subtype (IIa); topographical map (1:25.000) No. 5308 SE, 50 37’28”N, 07 09’42”E, 150 m; date & time: 01.08.1999, 12.10 - 12.30 and 25.08.1999, 10.45 - 11.05.

No. 811 [2b]: Züllighovener Bach; Stellario Alnetum-complex, Caltha palustris subtype (IIa); topographical map (1:25.000) No. 5308 SE, 50 37’18”N, 07 09’14”E, 160 m; date & time: 01.08.1999, 13.00 - 13.20 and 25.08.1999, 11.05 - 11.25.

No. 812 [9a]: Arzdorfer Bach, Burg Gudenau; Stellario Alnetum-complex, typical subtype (IIb); topographical map (1:25.000) No. 5308 SW, 50 37’53”N, 07 04’59”E, 160 m; date & time: 12.08.1999, 14.50 - 15.10 and 29.08.1999, 10.05 - 10.25.

No. 813 [9b]: Arzdorfer Bach, Burg Gudenau; Stellario Alnetum-complex, typical subtype (IIb); topographical map (1:25.000) No. 5308 SW, 50 37’47”N, 07 04’51”E, 160 m; date & time: 12.08.1999, 15.15 - 15.35 and 29.08.1999, 09.40 - 10.00.

No. 814 [N]: Goderberger Bach, Villiper Ölmühle; Stellario Alnetum-complex, typical Subtype (IIb); topographical map (1:25.000) No. 5308 NE, 50 38’50”N, 07 05’59”E, 130 m; date & time: 13.08.1999, 13.30 - 13.50 and 29.08.1999, 11.05 - 11.25.

No. 815 [S]: Godesberger Bach; Stellario Alnetum-complex, typical subtype (IIb); topographical map (1:25.000) No. 5308 NE, 50 40’25”N, 07 08’26”E, 70 m; date & time: 17.08.1999, 13.00 - 13.20 and 23.08.1999, 10.25 - 10.40.

No. 816 [20]: Kernbach, Oedingen; Stellario Alnetum-complex, typical subtype (IIb); topographical map (1:25.000) No. 5308 SE, 50 36’34”N, 07 08’56”E, 200 m; date & time: 17.08.1999, 09.30 - 09.50 and 25.08.1999, 12.35 - 12.55.

No. 817 [1]: Oelbach, Holzem; Stellario Alnetum-complex, typical subtype (IIb); topographical map (1:25.000) No. 5308 SE, 50 37’42”N, 07 05’56”E, 180 m; date & time: 13.08.1999, 10.35 - 10.50 and 29.08.1999, 14.20 - 14.40.

No. 818 [14a]: Swistbach, Meckenheim; Stellario Alnetum-complex, Filipendulion subtype (IIc); topographical map (1:25.000) No. 5308 SW, 50 36’49”N, 07 02’05”E, 175 m; date & time: 04.08.1999, 10.00 - 10.20 and 22.08.1999, 15.10 - 15.30.

No. 819 [19a]: Godesberger Bach, Wattendorfer Mühle; Stellario Alnetum-complex, Filipendulion subtype (IIc); topographical map (1:25.000) No. 5308 NE, 50 39’36”N, 07 07’46”E, 100 m; date & time: 04.08.1999, 13.45 - 14.05 and 29.08.1999, 11.30 - 11.50.

No. 820 [19b]: Godesberger Bach, Wattendorfer Mühle; Stellario Alnetum-complex, Filipendulion subtype (IIc); topographical map (1:25.000) No. 5308 NE, 50 39’43”N, 07 07’56”E, 95 m; date & time: 04.08.1999, 14.15 - 14.35 and 29.08.1999, 11.50 - 12.10.

No. 821 [14b]: Swistbach, Meckenheim; Stellario Alnetum-complex, Filipendulion subtype (IIc); topographical

map (1:25.000) No. 5308 SW, 50 36’46”N, 07 02’21”E, 175 m; date & time: 04.08.1999, 10.30 - 10.50 and 22.08.1999, 15.30 - 15.50.
No. 822 [P”]: Altendorfer Bach, Meckenheim; Stellario Alnetum-complex, Filipendulion subtype (IIc); topographical map (1:25.000) No. 5308 SW, 50 36’15”N, 07 02’01”E, 190 m; date & time: 21.08.1999, 13.50 - 14.10 and 29.08.1999, 09.05 - 09.25.
No. 823 [22]: Kernbach, Züllighoven; Stellario Alnetum-complex, Filipendulion subtype (IIc); topographical map (1:25.000) No. 5308 SE, 50 36’56”N, 07 09’30”E, 170 m; date & time: 05.08.1999, 10.40 - 11.00 and 25.08.1999, 13.35 - 13.55.
No. 824 [G]: Villip Seitenbach des Godesberger Bachs; Salicetum fragilis-complex, typical subtype (IIIa); topographical map (1:25.000) No. 5308 SE, 50 38’32”N, 07 06’08”E, 160 m; date & time: 15.08.1999, 12.30 - 12.50 and 29.08.1999, 10.35 - 10.55.
No. 825 [A]: Mehlemer Bach, Oberbachem; Salicetum fragilis-complex, typical subtype (IIIa); topographical map (1:25.000) No. 5308 SE, 50 38’12”N, 07 09’55”E, 120 m; date & time: 01.08.1999, 09.45 - 10.05 and 29.08.1999, 15.10 - 15.30.
No. 826 [B]: Mehlemer Bach, Oberbachem; Salicetum fragilis-complex, typical subtype (IIIa); topographical map (1:25.000) No. 5308 SE, 50 38’15”N, 07 09’48”E, 130 m; date & time: 01.08.1999, 10.05 - 10.25 and 29.08.1999, 14.50 - 15.10.
No. 827 [15]: Swistbach, Meckenheim; Salicetum fragilis-complex, typical subtype (IIIa); topographical map (1:25.000) No. 5308 SW, 50 36’59”N, 07 01’52”E, 175 m; date & time: 22.08.1999, 14.50 - 15.10 and 04.08.1999, 09.30 - 09.50.
No. 828 [17]: Ersdorfer Bach, Meckenheim; Salicetum fragilis-complex, typical subtype (IIIa); topographical map (1:25.000) No. 5308 SW, 50 36’28”N, 07 00’56”E, 190 m; date & time: 04.08.1999, 11.45 - 12.05 and 23.08.1999, 13.15 - 13.35.
No. 829 [21]: Kernbach, Oedingen; Salicetum fragilis-complex, typical subtype (IIIa); topographical map (1:25.000) No. 5308 SE, 50 36’38”N, 07 09’14”E, 190 m; date & time: 17.08.1999, 09.50 - 10.10 and 25.08.1999, 12.55 - 13.15.
No. 830 [W]: Arzforfer Bach, Arzdorf; Salicetum fragilis-complex, Filipendulion-subtype (IIIb); topographical map (1:25.000) No. 5308 SE, 50 36’36”N, 07 08’24”E, 200 m; date & time: 22.08.1999, 13.20 - 13.40 and 25.08.1999, 12.05 - 12.25.
No. 831 [R]: Mehlemer Bach, Niederbachem; Salicetum fragilis-complex, Filipendulion-subtype (IIIb); topographical map (1:25.000) No. 5309 SW, 50 38’25”N, 07 10’26”E, 130 m; date & time: 21.08.1999, 13.05 - 13.25 and 29.08.1999, 15.30 - 15.50.
No. 832 [3a]: Sprüsselbach, Züllighoven; Salicetum fragilis-complex, Filipendulion-subtype (IIIb); topographical map (1:25.000) No. 5308 SE, 50 37’21”N, 07 09’33”E, 165 m; date & time: 01.08.1999, 13.35 - 13.55 and 25.08.1999, 11.25 - 11.40.
No. 833 [3b]: Sprüsselbach, Züllighoven; Salicetum fragilis-complex, Filipendulion-subtype (IIIb); topographical map (1:25.000) No. 5308 SE, 50 37’17”N, 07 09’16”E, 170 m; date & time: 01.08.1999, 13.55 - 14.15 and 25.08.1999, 11.40 - 12.00.
No. 834 [12a]: Swistbach, Kempermühle bei Adendorf; Salicetum fragilis-complex, Filipendulion-subtype (IIIb); topographical map (1:25.000) No. 5308 SW, 50 36’21”N, 07 03’08”E, 180 m; date & time: 06.08.1999, 09.55 - 10.15 and 23.08.1999, 14.25 - 14.45.
No. 835 [12b]: Swistbach, Kempermühle bei Adendorf; Salicetum fragilis-complex, Filipendulion-subtype (IIIb); topographical map (1:25.000) No. 5308 SW, 50 36’14”N, 07 03’23”E, 185 m; date & time: 06.08.1999, 10.20 - 10.40 and 23.08.1999, 14.45 - 15.05.
No. 836 [Na]: Swistbach, Meckenheim; Pappelforsten-complex (IV); topographical map (1:25.000) No. 5308 NE, 50 38’11”N, 07 01’01”E, 160 m; date & time: 13.08.1999, 15.00 - 15.20 and 23.08.1999, 11.45 - 12.05.
No. 837 [Nb]: Swistbach, Meckenheim; Pappelforsten-complex (IV); topographical map (1:25.000) No. 5308 NE, 50 37’55”N, 07 01’07”E, 160 m; date & time: 13.08.1999, 15.20 - 15.40 and 23.08.1999, 12.05 - 12.25.
No. 838 [16]: Altendorfer Bach, Meckenheim; Pappelforsten-complex (IV); topographical map (1:25.000) No. 5308 SW, 50 36’04”N, 07 01’30”E, 190 m; date & time: 04.08.1999, 11.10 - 11.30 and 23.08.1999, 12.50 - 13.10.
No. 839 [Ma]: Ölbach, Villip; Pappelforsten-complex (IV); topographical map (1:25.000) No. 5308 SE, 50 37’58”N, 07 05’31”E, 160 m; date & time: 13.08.1999, 10.55 - 11.15 and 29.08.1999, 13.30 - 13.50.
No. 840 [Mb]: Ölbach, Villip; Pappelforsten-complex (IV); topographical map (1:25.000) No. 5308 SE, 50 38’01”N, 07 05’20”E, 160 m; date & time: 13.08.1999, 11.15 - 11.35 and 29.08.1999, 13.10 - 13.30.

No. 841 [Mc]: Godesberger Bach, Villip; Pappelforsten-complex (IV); topographical map (1:25.000) No. 5308 SE, 50 38'21"N, 07 05'27"E, 150 m; date & time: 13.08.1999, 11.40 - 11.55 and 29.08.1999, 13.55 - 14.15.
No. 842 [L]: Seitenbach Godesberger Bach, Gut Marienforst; Phalaris-Filipendulion-complex (V); topographical map (1:25.000) No. 5308 NE, 50 40'18"N, 07 08'00"E, 100 m; date & time: 12.08.1999, 13.50 - 14.10 and 23.08.1999, 10.00 - 10.20.
No. 843 [8]: Seitenbach Godesberger Bach, in Pech; Phalaris-Filipendulion-complex (V); topographical map (1:25.000) No. 5308 NE, 50 39'15"N, 07 06'43"E, 130 m; date & time: 12.08.1999, 14.20 - 14.40 and 23.08.1999, 10.55 - 11.15.
No. 844 [13a]: Bach in Adendorf, Seitenbach des Swistbachs; Phalaris-Filipendulion-complex (V); topographical map (1:25.000) No. 5308 SW, 50 36'25"N, 07 03'13"E, 180 m; date & time: 06.08.1999, 09.00 - 09.20 and 23.08.1999, 13.40 - 14.00.
No. 845 [13b]: Bach in Adendorf, Seitenbach des Swistbachs; Phalaris-Filipendulion-complex (V); topographical map (1:25.000) No. 5308 SW, 50 36'16"N, 07 03'27"E, 180 m; date & time: 06.08.1999, 09.25 - 09.45 and 23.08.1999, 14.05 - 14.25.
No. 846 [C]: Mehlemer Bach, Berkum; Phalaris-Filipendulion-complex (V); topographical map (1:25.000) No. 5308 SE, 50 37'53"N, 07 08'45"E, 160 m; date & time: 01.08.1999, 11.00 - 11.20 and 25.08.1999, 14.05 - 14.25.
No. 847 [D]: Mehlemer Bach, Berkum; Phalaris-Filipendulion-complex (V); topographical map (1:25.000) No. 5308 SE, 50 37'45"N, 07 08'29"E, 170 m; date & time: 01.08.1999, 11.20 - 11.40 and 25.08.1999, 14.25 - 14.45.

Methods

In 1999 there were 45 transects established for sampling hoverflies within the vegetation complexes of the river valleys. For each of the 8 vegetation-complexes, including its subunits, 5-6 homogenous sections of river valley, each of 100m, were selected as parallel samples (with the exception of complex I, where not enough sampling sites were available). Sampling of these transects was carried out over 20 minute periods, once in the morning (9.00-12.00 central European summer time, MEST) and once at noon (12.30-15.30 MEST), each time following the same route, walking along the gallery forest margin on both sides of the river and crossing the river or brook with its vegetation zonation at least twice. This configuration was used to ensure that all existing plant communities within the vegetation complex were crossed or visited. All the samples were taken in August (1.8.-29.8.1999) in the same phenological period, which can be described as beginning flowering to end of flowering of *Heracleum sphondylium*, full flowering to end of flowering of *Cirsium arvense*, beginning of flowering of *Filipendula ulmaria* (and other species of wet fallows) and in the adjacent crops flowering of *Matricaria chamomilla* and *Chenopodium album.* This sampling regime delivered 90 sets of samples. For analysis the morning sample from a transect was combined with the noon sample from the same transect.

For syrphid determinations a number of existing keys from adjacent countries were used because no complete set of German keys exists. The keys used were mainly from the Netherlands (Goot 1981), Belgium (Verlinden 1991), Denmark (Torp 1994), United Kingdom (Stubbs & Falk 1983, Stubbs 1996) together with a number of separate papers for difficult genera, only the more important of which can be cited: *Cheilosia* (Barkalov & Ståhls 1997 u.a.), *Eupeodes* (Dušek & Laska 1976), *Neoascia* (Barkemeyer & Claussen 1986), *Sphegina* (Thompson & Torp 1986, Doczkal 1995), *Platycheirus* (z.B. Goeldlin et al. 1990), *Paragus* (Goeldlin 1976). All species have also been checked against material from the reference collection of the author. In additional, certain critical specimens were checked by Dieter Doczkal, Malsch and Claus Claußen, Flensburg.

Syrphid nomenclature follows the German checklist (Ssymank et al. 1999) with its recent additions and corrections (Doczkal et al. 2002). Plant names are used according to the German checklist of the floristic mapping scheme (Wisskirchen & Haeupler 1998).

4 Results

4.1 Syrphid mapping in the vegetation complexes

71 species represented by a total of 4187 individuals were recorded on the transects. The main types of vegetation complex clearly had different assemblages of adult syrphids. The full observations within the different vegetation complexes are given in Table 3.

Species numbers were generally high in samples from the more natural vegetation complexes of the Fraxinus-Fagion-complex (I) and the black alder galleries (Stellario-Alnetum complex, subtype IIa, IIb), with 36-39 species observed. However, even higher species numbers, of 42-43 species observed, were recorded from a moderately disturbed situation in alder gallery-complexes with partly reduced canopy (subcomplex II.c) and in the closed willow galleries (Salicetum fragilis complex, typical subtype III a). Further degradation resulted in a loss of species with 28 species being present in the Phalaris-Filipendulion-complex (V). Average species numbers per sampling transect ranged from 22 species in complexes I and IIa, to 14 species in complex V, with the greatest variation observed in the willow gallery-complexes (III1, IIIb). This may indicate occurrence of greater species fluctuation in the willow galleries and thus the necessity to prolong sampling time there or to enlarge the number of samples collected in these complexes.

For analysis of the differences between the vegetation complexes of the river valleys two main synthetic characteristics of biocoenoses will be presented: constancy as a measure indicating in what percentage of individual samples a particular species is present, or can be expected, and representativity, which compares the relative abundances of the species over the different vegetation complexes. Table 4 shows the results for constancy in all species for which there are more than eight observations. To provide a better overview the percentages were converted into four classes and the table sorted to species that have the same pattern over the vegetation complexes. The head of the table shows vegetation complex number and for easier reading the dominant

Table 3: Syrphidae observed in the different vegetation complexes									
Vegetation Complex No.:	**I**	**IIa**	**IIb**	**IIc**	**IIIa**	**IIIb**	**IV**	**V**	**sum**
Baccha elongata	9	3	4	.	4	.	1	.	21
Chalcosyrphus nemorum	.	1	.	.	.	.	.	.	1
Cheilosia barbata	.	1	.	.	.	.	.	.	1
Cheilosia illustrata	1	2	.	18	3	15	4	1	44
Cheilosia impressa	5	3	4	11	2	1	2	5	33
Cheilosia pagana	3	2	3	9	2	11	.	1	31
Cheilosia proxima	.	.	1	1	.	.	.	.	2
Cheilosia soror	.	.	.	.	1	.	1	.	2
Cheilosia spec.	.	.	1	1	.	.	1	.	3
Cheilosia vernalis	.	.	1	3	.	1	.	1	6
Cheilosia vulpina	1	.	.	.	.	.	.	.	1
Chrysogaster solstitialis	.	.	.	3	3	2	3	.	11
Chrysotoxum bicinctum	.	.	1	1	2	.	.	.	4
Chrysotoxum verralli	.	.	.	.	1	.	.	.	1
Dasysyrphus albostriatus	.	.	.	.	1	1	.	.	2
Episyrphus balteatus	81	128	17	285	258	77	46	39	931
Eristalinus sepulchralis	.	.	.	2	.	.	.	1	3
Eristalis arbustorum	7	5	2	6	2	3	4	7	36
Eristalis interrupta	7	10	2	6	2	15	2	35	79
Eristalis intricaria	.	.	.	.	.	1	.	.	1
Eristalis pertinax	66	26	39	147	78	52	53	10	471
Eristalis tenax	19	23	6	7	9	15	23	40	142
Eristalis lineata	1	.	2	.	.	1	4	3	11
Eumerus strigatus	1	.	4	1	.	1	.	1	8
Eumerus tuberculatus	1	.	.	.	.	.	.	.	1
Eupeodes corollae	.	8	1	1	6	6	1	13	36
Eupeodes latifasciatus	1	.	.	4	1	8	.	.	14
Eupeodes luniger	.	.	.	2	.	.	.	.	2
Helophilus hybridus	6	7	.	1	1	6	3	18	42
Helophilus pendulus	12	21	3	9	3	1	1	14	64
Helophilus trivittatus	6	3	.	3	3	2	3	22	42
Heringia (*Neocnemodon*) spec.(ff)	.	.	1	.	.	.	1	.	2
Heringia vitripennis	1	.	.	.	.	.	.	.	1
Melanostoma mellinum	25	31	69	21	163	53	18	20	400
Melanostoma scalare	24	15	7	.	8	4	5	.	63
Meliscaeva cinctella	3	.	.	.	.	.	1	.	4
Myathropa florea	15	8	7	11	5	.	4	.	50
Neoascia podagrica	3	95	4	34	2	11	.	80	229
Orthonevra nobilis	.	1	.	1	1	1	.	.	4
Paragus quadrifasciatus	.	.	.	.	.	.	.	1	1
Parasyrphus annulatus	1	.	.	.	.	.	1	.	2
Pipiza austriaca	.	.	.	.	1	.	.	.	1
Pipiza lugubris	.	.	.	.	2	1	.	.	3

Vegetation Complex No.:	I	IIa	IIb	IIc	IIIa	IIIb	IV	V	sum
Pipiza noctiluca	.	1	1	1	.	1	.	.	4
Pipizella spec. (ff)	1	.	1	1	.	5	2	1	11
Pipizella annulata	.	.	.	1	.	.	.	.	1
Pipizella viduata	4	2	1	21	21	.	7	.	56
Platycheirus albimanus	4	5	2	4	.	.	.	.	15
Platycheirus angustatus	.	1	.	.	.	.	.	.	1
Platycheirus clypeatus	15	8	18	30	24	28	10	7	140
Platycheirus fulviventris	.	.	.	1	.	.	.	.	1
Platycheirus peltatus	3	2	1	6	4	2	.	25	43
Platycheirus scutatus	2	2	.	1	3	.	.	.	8
Pyrophaena granditarsa	.	3	.	.	.	.	.	.	3
Pyrophaena rosarum	.	7	2	.	.	.	.	.	9
Rhingia campestris	7	11	37	17	13	34	9	106	234
Scaeva pyrastri	.	1	1	1	.	5	.	1	9
Sericomyia silentis	.	1	.	1	1	.	.	.	3
Sphaerophoria interrupta	.	.	.	.	1	.	.	.	1
Sphaerophoria interrupta agg. (ff)	.	.	.	2	1	.	.	.	3
Sphaerophoria rueppellii	.	.	.	.	7	.	.	.	7
Sphaerophoria scripta	9	7	40	101	70	13	17	14	271
Sphaerophoria taeniata	.	2	5	14	2	2	1	4	30
Sphegina clunipes	10	1	2	.	.	.	12	.	25
Sphegina elegans	1	1	.	.	.	.	.	.	2
Sphegina verecunda	5	.	.	.	.	.	1	.	6
Syritta pipiens	41	14	56	153	21	29	54	20	388
Syrphus ribesii	13	4	6	16	5	2	2	.	48
Syrphus spec.	.	2	.	.	.	.	.	.	2
Syrphus torvus	.	.	.	.	.	.	1	.	1
Syrphus vitripennis	3	.	1	14	9	1	6	.	34
Volucella pellucens	3	3	.	1	2	1	1	.	11
Volucella zonaria	1	.	.	.	.	.	.	.	1
Xylota segnis	4	.	4	1	2	.	.	.	11
Xylota sylvarum	.	.	1	.	.	.	.	1	2
Number of species	40	39	36	43	42	36	33	28	71
Number of individuals	425	471	358	975	750	412	305	491	4187

Tab. 3: Syrphidae observed in the different vegetation complexes. The complexes (columns) include the following sampling localities: I (803 - 807), IIa (808 - 811), IIb (812 - 817), IIIa (824 - 829), IIIb (830 - 835), IV (836 - 841) and V (842 - 847). ff: females.

tree species of the canopy and the subtype of the vegetation complex, coded to indicate typical (t, closed gallery), open canopy (o) and the wet subtypes (w) with helocrenes. The results show clearly that between vegetation complexes the species assemblages differ in a number of species groups. However, five species representing 60% of the total catch are constant over all vegetation complexes (*Episyrphus balteatus*, *Eristalis*

Table 4: Constancy of hoverfly species in the vegetation complexes

Vegetation Complex		I	IIa	IIb	IV	IIIa	IIc	IIIb	V
Forest-Canopy		Frax	Aln	Aln	Pop	Sal	Aln	Sal	Filip
Subtype		t	w	t	t	t	o	o	o
Number of localities	n	5	4	6	6	6	6	6	6
Episyrphus balteatus	931	III	III	III	III	III	III	III	III
Eristalis pertinax	471	III	III	III	III	II	III	III	III
Melanostoma mellinum	400	III	III	III	III	II	III	III	III
Syritta pipiens	388	III	III	III	III	III	III	III	III
Sphaerophoria scripta	271	III	III	III	II	III	III	II	III
Pipizella viduata	56	II	I	+	II	I	II		
Myathropa florea	50	II	III	+	II	I	II		
Sphegina clunipes	26	II	+	I	I				
Baccha elongata	21	III	+	II	+	I			
Platycheirus albimanus	15	II	I	I			I		
Xylota segnis	11	I		I	+	+	+		
Melanostoma scalare	63	III	III	I	I	I		I	
Syrphus ribesii	49	III	III	II	I	I	III	+	
Volucella pellucens	11	I	I		+	I	+	+	
Neoascia podagrica	229	+	III	I		I	II	I	III
Pyrophaena rosarum	9		I	+					
Cheilosia illustrata	44	+	+		I	+	III	I	+
Platycheirus peltatus	43	I	I	+		II	II	I	I
Syrphus vitripennis	33	I		+	I	II	III	+	
Pipizella sp. (ff)	11	+		+	I		+	II	+
Scaeva pyrastri	9		I	+			+	II	+
Rhingia campestris	234	III	III	III	I	I	I	III	III
Eristalis tenax	142	III	III	II	II	III	I	I	III
Eristalis interrupta	79	II	III	+	+	+	I	I	II
Helophilus pendulus	64	III	III	I	+	I	I	+	II
Helophilus trivittatus	42	II	I		+	+	I	+	II
Eristalis arbustorum	36	III	+	+	I	+	II	+	I
Platycheirus clypeatus	140	+	III	II	III	I	I	II	II
Helophilus hybridus	42	I	I		I	+	+	I	I
Eupeodes corollae	36		I	+	+	I	+	I	I
Cheilosia impressa	33	I	I	I	I	+	I	+	+
Cheilosia pagana	31	I	I	I		I	I	I	+
Sphaerophoria taeniata	30		I	I	+	+	II	I	II
Eupeodes latifasciatus	14	+				+	I	I	
Chrysogaster solstitialis	11				I	I	I	+	
Eristalis lineata	11	+		+	I			+	I
Eumerus strigatus	8	+		I			+	+	+
Platycheirus scutatus	8	I	I			I	+		

pertinax, *Melanostoma mellinum*, *Syritta pipiens* and *Sphaerophoria scripta*). A larger number of species is more or less restricted to gallery forest and missing in the Phalaris-Filipendulion complex, examples being *Melanostoma scalare* or *Volucella pellucens*. Some species are already missing in the willow-galleries with open canopy (complex IIIb), which constitute the gallery forest complex with the lowest canopy cover and has almost no completely shady situations. All of these species show quite different classes of constancy. In cases where constancy is relatively low, for example *Sphegina clunipes*, it is not evident whether this species is more or less restricted to the typical, closed gallery forest complexes or would also occur at very low abundances and constancy in the open alder galleries (IIc). The situation is also interesting for species differentiating very wet conditions. Thus *Neoascia podagrica* exhibits greatest constancy in the wet subtype of the alder gallery (IIa) and in the degraded open Phalaris-Filipendulion complex (V). By contrast *Pyrophaena rosarum*, requiring more water-logged conditions, is more or less restricted to the closed alder-gallery complex (IIa and IIb) with a higher constancy in the wet subtype. It should be noted that this species – even if restricted to the Stellario-Alnetum complex – is not recorded in the plant community of the black alder gallery forest (Stellario- Alnetum glutinosae), but is found flying exclusively in the fully open and sunny adjacent vegetation of helocrenes within the pastures or along the sides of the gallery forest. *Platycheirus peltatus*, also a species of wet, open vegetation, obviously has its highest constancy in vegetation complexes with moderately shady conditions, namely the black alder galleries with open canopy (complex IIc) and the willow gallery-complex in its typical subcomplex (IIIa). Without going into the details of the results for all species groups, one species very characteristic of forest margins can be mentioned: *Cheilosia illustrata*. This species exhibits its greatest constancy in the vegetation complex where closed canopy with fully shaded conditions alternates regularly with partly open and fully sunny conditions, which is the Stellario-Alnetum complex in its Filipendulion subtype (IIc).

Constancy of occurrence makes no reference to the relative abundance of the species, and it is well possible that a species with high constancy is very rare but evenly distributed, or conversely more frequent but with very uneven distribution among the vegetation complexes. Thus it is necessary also to compare the relative abundances of species over the vegetation complexes as representativity values (percentage of individuals of a given species in each vegetation complex, 100% being the total catch of this species). Representativity is given in table 5 transformed into percentage classes. Species groups that differentiate the vegetation complexes are more easily identified and become clearer on the basis of representativity (relative abundances). The large block of species needing a more or less closed gallery forest in the vegetation complex

Tab. 4: Constancy of hoverfly species in the vegetation complexes. Scale used for percentage classes of constancy: +: up to 25%, I: 26 – 50 %, II: 51 –75 % and III: 76 – 100 %. Abbreviations forest canopy: Frax: ash (*Fraxinus excelsior*), Aln: black alder (*Alnus glutinosa*), Sal: willows (*Salix fragilis*), Pop: poplar (*Populus*-hybrids). Subtype: subtype of the vegetation complex as a code indicating typical (t, closed gallery), open canopy (o) and the wet subtype (w) with helocrenes; ff: females.

Table 5: Representativity of hoverfly species in the vegetation complexes									
Vegetation Complex	**I**	**IIa**	**IIb**	**IV**	**IIIa**	**IIc**	**IIIb**	**V**	
Forest-Canopy	**Frax**	**Aln**	**Aln**	**Pop**	**Sal**	**Aln**	**Sal**	**Filip**	
Subtype	**t**	**w**	**t**	**t**	**t**	**o**	**o**	**o**	
Number of localities	**5**	**4**	**6**	**6**	**6**	**6**	**6**	**6**	
Melanostoma scalare	III	II	II	I	II	.	I	.	63
Syrphus ribesii	III	I	II	I	II	III	+	.	49
Volucella pellucens	III	III	.	I	II	I	I	.	11
Myathropa florea	III	II	II	I	II	II	.	.	50
Sphegina clunipes	III	+	I	III	.	.	.	.	26
Baccha elongata	III	II	II	+	II	.	.	.	21
Platycheirus albimanus	III	III	II	.	.	III	.	.	15
Xylota segnis	III	.	III	.	II	I	.	.	11
Platycheirus scutatus	III	III	.	.	III	II	.	.	8
Pipizella viduata	I	+	+	II	III	III	.	.	56
Syrphus vitripennis	I	.	+	II	III	III	+	.	33
Chrysogaster solstitialis	.	.	.	III	III	III	II	.	11
Cheilosia illustrata	+	+	.	I	I	III	III	+	44
Cheilosia pagana	II	I	II	.	I	III	III	+	31
Eupeodes latifasciatus	I	.	.	.	I	III	III	.	14
Neoascia podagrica	+	III	+	.	+	II	I	III	229
Pyrophaena rosarum	.	V	III	.	.	.	.	.	9
Eumerus strigatus	II	.	IV	.	.	II	II	II	8
Pipizella sp. (ff)	I	.	I	II	.	I	III	I	11
Scaeva pyrastri	.	II	II	.	.	II	IV	II	9
Rhingia campestris	+	+	II	+	I	I	II	III	234
Eristalis tenax	II	II	+	II	I	+	II	III	142
Eristalis interrupta	I	II	+	+	+	I	II	III	79
Platycheirus peltatus	I	+	+	.	I	II	+	III	43
Helophilus hybridus	II	II	.	I	+	+	II	III	42
Helophilus trivittatus	II	I	.	I	I	I	+	III	42
Eupeodes corollae	.	II	+	+	II	+	II	III	36
Episyrphus balteatus	I	II	+	+	III	III	I	+	931
Eristalis pertinax	II	I	I	II	II	III	II	+	471
Melanostoma mellinum	I	I	II	+	III	I	II	I	400
Syritta pipiens	II	+	II	II	I	III	I	I	388
Sphaerophoria scripta	+	+	II	I	III	III	+	I	271
Cheilosia impressa	II	I	II	I	I	III	+	II	33
Sphaerophoria taeniata	.	I	II	+	I	III	I	II	30
Platycheirus clypeatus	II	I	II	I	II	II	II	I	140
Eristalis arbustorum	II	II	I	II	I	II	I	II	36
Eristalis lineata	I	.	II	III	.	.	I	III	11
Helophilus pendulus	II	III	+	+	+	II	+	II	64

Tab. 5: Representativity of hoverfly species in the vegetation complexes. Scale used for percentage classes of representativity: +: up to 5%, I: 6-10 %, II: 11-25% , III: 26-50%, IV: 51-75%, V: 76-100%. For abbreviations see table 4.

is confirmed by the representativity table, including typical species flying in shaded conditions, like *Baccha elongata* and *Sphegina clunipes*, as well as xylosaprophagous species like *Xylota segnis* or *Myathropa florea*. The three species *Pipizella viduata, Syrphus vitripennis* and *Chrysogaster solstitialis* showed highest representativity within open alder galleries, typical willow galleries and the poplar plantations (complexes IIc, IIIa and IV), representing moderately shaded conditions. *Cheilosia illustrata,* together with *Cheilosia pagana* and *Eupeodes latifasciatus*, exhibit a distinct preference for gallery forests with partly open canopy (Stellario-Alnetum- and Salicetum fragilis -complex, both in their Filipendulion subtypes). *Neoascia podagrica* shows the same pattern as in the constancy table, together with *Pyrophaena rosarum* differentiating the wet *Caltha*-subtype of the Black alder galleries.

Pipizella spec. (probably all *P. viduata* females) and *Scaeva pyrastri* showed highest abundance in the Salicetum fragilis complex with an open canopy (Filipendulion subtype, III b). A number of species exhibited highest abundance in the Phalaris-Filipendulion complex (V), but occurred at lower abundance throughout the river valley complexes. Within this species group there are many Eristaline species with aquatic detritophagous larvae, like *Eristalis interrupta*, *Helophilus hybridus* and *H. trivittatus*. *Helophilus hybridus* was quite abundant in 1999, in the Drachenfelser Ländchen where the observations were made, while being much rarer during the entire 10 year-period prior to 1999 (see Ssymank 2001).

Analysis of ecological species groups revealed some very specific differences between vegetation complexes. Regarding larval feeding types, species with phytophagous larvae generally had low percentages of 1-5%, representativity being only slightly higher within open willow galleries (complex III b) at 7%. Species with zoophagous larvae usually had about 50% (47-51%), the poplar plantations showing a lower level of 39% and the typical subtype (III a) of the Salicetum fragilis-complex showing an exceptionally high value of 79%. Species with aquatic and terrestrial saprophagous larvae made up the rest, while xylophagous species were almost absent with usually less than 5%. The only exception was the Fraxinus-Fagion-complex which reached a level of 8.2% for xylophagous species, which is comparable to normal beech forest ecosystems. Coprophagous species (here only *Rhingia campestris*) showed respresentativity levels of below 10%, only reaching a proportion of 21% in the open Phalaris-Filipendulion-complex (V). Analysis of migration types as defined by Gatter & Schmid (1990) showed no major differences, with about 30-40% migrants and 10-20% dismigrants [5)] with a high migration tendency and about 30% for migrants with low migration tendency. Resident species made up about 20% of the syrphids, with one notable exception: Typical willow galleries (Salicetum fragilis-complex, typical form; III a) and open alder galleries (Stellario-Alnetum-complex, Filipendulion-subtype; II c) had only 10,5% and 13,6%, respectively, of resident species.

[5)] Dismigration is defined here as undirected movements over longer distances (dipersal & migration) as opposed to migration being a movement in one main direction.

Species categorised as threatened in the German red data book (Ssymank & Doczkal 1998) were mainly present in complexes III a (4 species) and II c (3 species) and to a lesser extent also in complexes I and II a (2 species). This was perfectly in line with the results for the numbers of regionally rare species (with < 0.1 % of total catch): Complexes III a and II c each had 11 rare species, complex II had 9 rare species and all other complexes below 6 rare species. The lowest score, of only 3 rare species, occurred in the degraded Phalaris-Filipendulion-complex (V).

4.2 Prognosis of syrphid communities

If syrphid communities are closely linked to vegetation complexes the question arises whether the method using vegetation complexes, for the study of syrphid communities, is more reliable than other methods of investigation, like for example the grid mapping performed by Ssymank (2001) in the same area. To test this the proportion of observed species in relation to the expected species was calculated for both methods. The tool used for calculating the expected hoverfly community was "Syrph-the-Net" (Speight et al. 2000) in its 2001 data version. The basic principle of this tool is to use a number of data filters to maximise the accuracy of prediction, based on:

– the use of a regional check list: Ssymank (2001) with 174 species;

– a definition of a sampling period as a phenological filter of flight times: month of August for flight periods in N-Germany (a flight period table for central Germany, including Nordrhein-Westfalen, is not yet available in the database);

– a list of predefined macro- and microhabitats with their associated hoverfly species.

The main task for data analysis with Syrph-the-Net was therefore to compile a list of all macro- and microhabitats for all vegetation complexes specific to the grid mapping areas. The table of the sigma-relévees of the vegetation complexes (Ssymank 2001) could be transformed relatively easily into the list of macrohabitats and even most of the microhabitats. Only minor additional checking and adding was necessary to complete the lists.

Data set	**Syrphid data of vegetation complexes (this study)**								**Grid mapping (Ssymank 2001)**		
vegetation complex / study area	I	**IIa**	**IIb**	IV	**IIIa**	**IIc**	**IIIb**	V	Z1	Pa	Z2
canopy	Frax	**Aln**	**Aln**	Pop	**Sal**	**Sal**	**Sal**	–	Aln	Aln	Sal
% of expected species	36	**42**	**38**	45	**47**	**47**	**40**	35	36	24	36

Tab. 6: Comparison of Syrphid-sampling in vegetation complexes and grid mapping. Legend: canopy Frax: ash (*Fraxinus excelsior*), Aln: black alder (*Alnus glutinosa*), Sal: willows (*Salix fragilis*), Pop: poplar (*Populus*-hybrids).

From the extensive Grid mapping data of Ssymank (2001) three areas with vegetation of the river valleys were selected for data analysis:

– Z 1: Black alder galleries of the Züllighovener Tälchen (grids D6, C7, C8) corresponding to vegetation complex II (Stellario-Alnetum-complex);

– Z 2: Willow galleries of the Zülighovener Tälchen (grids A8, B7) corresponding to complex III (Salicetum fragilis-complex);

– P 1: Black alder galleries of the Pecher Tälchen (grids G1, G2 and H3) corresponding to complex II (Stellario-Alnetum-complex).

For the results of the data analysis see Table 6.

For the transect mapping of vegetation complexes the percentage of expected species ranged from 35% to 47% and was distinctly higher than for the grid mapping data (24-36%) in the corresponding vegetation complexes (Tab. 6). The corresponding data sets were comparable in number of individuals observed (300< n <900). There are two main reasons for the generally relatively low observation quotas of less than 50%: (1) differences in regional phenology; a cross check against the full data set of Ssymank 2001 (>70.000 observations) showed that only 60% of the species predicted according to Syrph-the Net were ever observed flying in August in the Drachenfelser Ländchen. (2) Extremely rare species, with < 0.1 % of observations, make up 57% of the regional fauna. Therefore the number of observations has to be very high (several 10.000 individuals) to cover also the extremely rare species.

4.3 Flower visiting

There were 2534 flower visits by Syrphidae observed, to 73 different plant species. The full data set of all observations is given in table 6. *Heracleum sphondylium* received 43% (n=1105) of all visits and was used by 51 syrphid species. This is not astonishing, as the sampling period corresponded to the blooming of *Heracleum sphondylium* and it is well-known that this plant is especially attractive to hoverflies. However, the density of *Heracleum sphondylium* in the river transects studied was relatively low. Usually a few plants were blooming along margins, but there were no meadows or set asides present where *Heracleum* was a dominant plant. Other plant species regularly visited by a variety of syrphid species (10 to 17 syrphid species) were *Angelica sylvestris*, *Cirsium arvense*, *Circaea lutetiana*, *Daucus carota, Eupatorium cannabinum, Sanguisorba officinalis, Taraxacum officinale* and *Valeriana officinalis* agg. Most flowers used regularly belong to the wet, tall herb communities or to wet forest vegetation. Ruderal plants like *Heracleum sphondylium, Cirisum arvense* and *Daucus carota* were usually concentrated along forest margins, and along fields margins. Plants regularly visited by hoverflies in adjacent agricultural vegetation were few, mainly *Chenopodium album* and *Chamomilla recutita*, present in both crops and field margins.

Table 7: Flower visits																							
Plant species visited: Syrphidae:	*Achillea millefolium*	*Aethusa cynapium*	*Alopecurus pratensis*	*Angelica sylvestris*	*Artemisia vulgaris*	*Calystegia sepium*	*Carduus crispus*	*Chaerophyllum temulum*	*Chenopodium album*	*Circaea lutetiana*	*Cirsium arvense*	*Cirsium vulgare*	*Crepis capillaris*	*Dactylis glomerata agg.*	*Daucus carota*	*Epilobium hirsutum*	*Epilobium parviflorum*	*Eupatorium cannabinum*	*Filipendula ulmaria*	*Frangula alnus*	*Galeopsis tetrahit*	*Geranium robertianum*	*Glyceria declinata*
Baccha elongata																							
Chrysogaster solstitialis																							
Cheilosia spec.																							
Cheilosia illustrata				2																			
Cheilosia impressa				5				1															
Cheilosia pagana				2				5														1	
Cheilosia vernalis				1																			
Chrysotoxum bicinctum																							
Dasysyrphus albostriatus																							
Eristalinus sepulchralis																							
Eristalis arbustorum	1	1		2							5				1			1	1				
Eristalis lineata											3				1								
Eristalis interrupta	1			3							21							18	1				
Eristalis pertinax				69			1	1			10				7			25					
Eristalis tenax	2					1	2				58	1	1		1		1	20					
Episyrphus balteatus				2		9	9	2	8	16	3		1		4	3	1	1	10	3	10	8	
Meliscaeva cinctella																							
Eumerus strigatus		1																					
Helophilus hybridus											17							7					
Helophilus pendulus									1		12												
Helophilus trivittatus	1			2							14							9					
Melanostoma mellinum			3		2				46	3			3	18							1	2	2
Melanostoma scalare				1						3											1	1	
Eupeodes corollae							1				2		6										
Eupeodes latifasciatus									1														
Eupeodes luniger																							
Myathropa florea		2		4																			
Neoascia podagrica				1						6			1		1								
Orthonevra nobilis															1								
Pipiza lugubris															1								
Pipiza noctiluca																						1	
Platycheirus albimanus										5													
Platycheirus clypeatus			9					1	6					2									1
Platycheirus peltatus											1												
Parasyrphus annulatus										1	1												
Pyrophaena rosarum																							
Pipizella spec. (ff)															1								
Pipizella viduata															3								
Rhingia campestris						5	1					3	1			6		1			25	11	
Scaeva pyrastri																							
Sericomyia silentis				1																			
Sphegina clunipes										12											1		
Sphegina verecunda										5													
Sphaerophoria interrupta agg. (ff)									1														
Sphaerophoria rueppellii									5														
Sphaerophoria scripta	2			1			1	4	27	1	7	1	1		5			3			2		
Sphaerophoria taeniata									2														
Syritta pipiens	2	2		1						1	8	1	2		6			3	1	1	1		
Syrphus spec.										2													
Syrphus ribesii	1			1		3																	
Syrphus vitripennis	1			1											1								
Volucella pellucens											3							2					
Volucella zonaria																							
number of species	8	4	2	17	1	4	6	6	9	11	15	4	9	2	14	2	2	11	4	2	7	6	2
number of flower visits	11	6	12	99	2	18	15	14	97	55	165	6	17	20	34	9	2	90	13	4	41	24	3
Percentage of all visits	0.4	0.2	0.5	3.9	0.1	0.7	0.6	0.6	3.8	2.2	6.5	0.2	0.7	0.8	1.3	0.4	0.1	3.6	0.5	0.2	1.6	0.9	0.1

Table 7: Flower visits (cont.)																						
Plant species visited: Syrphidae:	*Heracleum mantegazzianum*	*Heracleum sphondylium*	*Impatiens glandulifera*	*Impatiens noli-tangere*	*Impatiens parviflora*	*Lamium maculatum*	*Lamium purpureum*	*Lapsana communis*	*Leontodon autumnalis*	*Lolium perenne*	*Lycopus europaeus*	*Lythrum salicaria*	*Matricaria recutita*	*Mentha aquatica*	*Mentha arvensis*	*Myosotis scorpioides agg.*	*Persicaria hydropiper*	*Persicaria maculosa*	*Phleum pratense*	*Plantago lanceolata*	*Poa annua*	*Ranunculus acris*
Baccha elongata		1						1														
Chrysogaster solstitialis		10																				
Cheilosia spec.		1										1										
Cheilosia illustrata		40																				
Cheilosia impressa		23																				
Cheilosia pagana		15																				
Cheilosia vernalis													3									
Chrysotoxum bicinctum		4																				
Dasysyrphus albostriatus		1																				
Eristalinus sepulchralis		2																				
Eristalis arbustorum		14											1									
Eristalis lineata		3												1								
Eristalis interrupta		6											1	7								
Eristalis pertinax	4	325																				
Eristalis tenax		9						1	3					4				1				
Episyrphus balteatus		370	1		5	3		33				5	16									1
Meliscaeva cinctella		3																				
Eumerus strigatus		3																				
Helophilus hybridus		1									1	4		5		1						
Helophilus pendulus		2									2	6		1								
Helophilus trivittatus		1										3		5								
Melanostoma mellinum		8						2	1	14		2	1				1	5	1	20	9	1
Melanostoma scalare		8				5	2			1							2					
Eupeodes corollae		16						1	1													
Eupeodes latifasciatus		4																				
Eupeodes luniger		2																				
Myathropa florea		31																				
Neoascia podagrica		2																1				
Orthonevra nobilis		3																				
Pipiza lugubris	1	1																				
Pipiza noctiluca		1																				
Platycheirus albimanus		1				1																
Platycheirus clypeatus		1								35									8	3	1	
Platycheirus peltatus		4				2																
Parasyrphus annulatus																						
Pyrophaena rosarum																		1				
Pipizella spec. (ff)		5				1																
Pipizella viduata		50																				
Rhingia campestris			1	2		31			1			34						2				
Scaeva pyrastri	1	2										1										
Sericomyia silentis		1																				
Sphegina clunipes		2				2	1															
Sphegina verecunda		1																				
Sphaerophoria interrupta agg. (ff)																						
Sphaerophoria rueppellii																						
Sphaerophoria scripta		26						8	3				29		1	1		2				1
Sphaerophoria taeniata		3											10			1						
Syritta pipiens	1	44						2			3		14		4		1	6				1
Syrphus spec.																						
Syrphus ribesii		27						2														
Syrphus vitripennis		21						4					1									
Volucella pellucens		1																				
Volucella zonaria		1																				
number of species	4	51	2	1	1	7	2	9	5	3	3	8	9	6	2	3	3	7	2	2	2	4
number of flower visits	7	1105	2	2	5	45	3	54	9	50	6	56	76	23	5	3	4	18	9	23	10	4
Percentage of all visits	0.3	43.6	0.1	0.1	0.2	1.8	0.1	2.1	0.4	2.0	0.2	2.2	3.0	0.9	0.2	0.1	0.2	0.7	0.4	0.9	0.4	0.2

Table 7 (cont.): Flower visits																	
Plant species visited: Syrphidae:	*Rubus caesius*	*Rumex obtusifolius*	*Sanguisorba officinalis*	*Scrophularia nodosa*	*Scrophularia umbrosa*	*Senecio jacobaea*	*Solidago canadensis*	*Sonchus oleraceus*	*Stellaria media agg.*	*Stellaria nemorum*	*Tanacetum vulgare*	*Taraxacum officinale agg.*	*Urtica dioica*	*Valeriana officinalis agg.*	*Veronica persica*	number of plant species visited	flower visits observed
Baccha elongata																2	2
Chrysogaster solstitialis																1	10
Cheilosia spec.																2	2
Cheilosia illustrata																2	42
Cheilosia impressa																3	29
Cheilosia pagana	2		4													6	29
Cheilosia vernalis												1				4	6
Chrysotoxum bicinctum																1	4
Dasysyrphus albostriatus												1				2	2
Eristalinus sepulchralis																1	2
Eristalis arbustorum						3								5		11	35
Eristalis lineata														2		5	10
Eristalis interrupta						1	1					2		11		12	73
Eristalis pertinax	1						4					1		6		12	454
Eristalis tenax						17	2	1		1		6		5		20	137
Episyrphus balteatus	1	1	3								3	4	2	5		34	546
Meliscaeva cinctella																1	3
Eumerus strigatus			2													3	6
Helophilus hybridus	1															8	37
Helophilus pendulus	1					2	2					1				10	30
Helophilus trivittatus						1	1							1		10	38
Melanostoma mellinum		9	8									1	2			28	168
Melanostoma scalare	1											1	1			12	27
Eupeodes corollae			1		1				1			1				10	31
Eupeodes latifasciatus												3				3	8
Eupeodes luniger																1	2
Myathropa florea														1		5	39
Neoascia podagrica	1		1	9	25											11	49
Orthonevra nobilis																2	4
Pipiza lugubris																3	3
Pipiza noctiluca																2	2
Platycheirus albimanus										2						4	9
Platycheirus clypeatus		5	3													12	75
Platycheirus peltatus			1	1	21					1		1		1		9	33
Parasyrphus annulatus																2	2
Pyrophaena rosarum									1							2	2
Pipizella spec. (ff)									1							4	8
Pipizella viduata																2	53
Rhingia campestris										1					3	16	128
Scaeva pyrastri												2				4	6
Sericomyia silentis																2	2
Sphegina clunipes																5	18
Sphegina verecunda																2	6
Sphaerophoria interrupta agg. (ff)																1	1
Sphaerophoria rueppellii																1	5
Sphaerophoria scripta		1	1			1			1	3	2	1	1	3		29	140
Sphaerophoria taeniata									3							5	19
Syritta pipiens			2			2					1			2		28	115
Syrphus spec.																1	2
Syrphus ribesii																5	34
Syrphus vitripennis								1								7	30
Volucella pellucens																4	7
Volucella zonaria																1	1
number of species	7	4	10	2	3	7	5	2	5	5	3	14	5	11	1	61	
number of flower visits	8	16	26	10	47	27	10	2	7	8	6	26	7	42	3	2534	
Percentage of all visits	0.3	0.6	1.0	0.4	1.9	1.1	0.4	0.1	0.3	0.3	0.2	1.0	0.3	1.7	0.1	100.0	

4.4 Additions to the regional check list

The river transect sampling programme added two new species to the regional check list for Drachenfelser Ländchen and the surroundings of Bonn, as defined by Ssymank (2001):

– *Paragus quadrifasciatus* Meigen, 1822, 1 female, originating from a clay quarry in Adendorf, transect No. 845, on 6.8.1999 visiting *Crepis capillaris*.

– *Volucella zonaria* (Poda, 17761), as a rare erratic migrant near Bad Godesberg, transect No. 806, on 22.08.1999, visiting the flowers of *Heracleum sphondylium*.

Since the regular programme of research in the Drachenfelser Ländchen (Ssymank 2001) came to an end a small amount of sampling has continued in the same study area, at irregular intervals, following the methodology of Ssymank (1999). The results of this additional sampling will not be presented here, with the exception of the samples that yielded two new species for the regional fauna:

– No. 5001: Topographical map 1:25.000 No. 5308 SW, 50°38'03" N, 07°04'10" E (WGS84), Kottenforst, Meckenheim-Merl, acidic clear-cutting, 2 years after a wind throw, a lot of dead wood of *Picea abies*, bracken-dominated (*Pteridium aquilinum*), small amounts of *Rubus idaeus* and *Calluna vulgaris*, 200 mNN, on 05.06.2001 at 14.00-14.30; low quantities of mostly anemophilous flowers, area 100m². From this individual sampling protocol, at locality No. 5001 in the Kottenforst, near Meckenheim, two further additions to the regional fauna were observed: *Blera fallax* (Linnaeus, 1758) (6 ind., sitting on a stump of *Picea abies* and flying under the bracken-canopy) and *Chalcosyrphus valgus* (Gmelin, 1790) (2 ind.), together with a number of other species like *Caliprobola speciosa*, *Xylota segnis, Xylota sylvarum* and *Microdon analis*.

With these 4 new species, the regional check list of syrphids for the Drachenfelser Ländchen now comprises 178 species and for the surroundings of Bonn 185 species.

Tab. 7 (p. 176-178): Flower visits. The table is containing all flower visits with n >1. – Syrphid species with one flower visit only: *Cheilosia barbata, Cheilosia proxima, Cheilosia vulpina, Chalcosyrphus nemorum, Platycheirus scutatus* and *Volucella zonaria* on *Heracleum sphondylium*; *Cheilosia soror* on *Daucus carota*; *Paragus quadrifasciatus* on *Crepis capillaris*; *Syrphus torvus* on *Urtica dioica*. – Plants species with only one individual recorded: *Arctium minus* with *Volucella pellucens*; *Arrhenatherum elatius* with *Melanostoma mellinum*; *Campanula trachelium* and *Fallopia convolvulus* with *Episyrphus balteatus*; *Leucanthemum vulgare* agg. with *Cheilosia vernalis*; *Cornus sanguinea* with *Myathropa florea*; *Galinsoga ciliata* and *Mercurialis annua* with *Syritta pipiens*; *Plantago major* with *Melanostoma mellinum*; *Raphanus sativus* with *Melanostoma mellinum*; *Berula erecta* with *Neoascia podagrica*; *Stachys palustris* with *Episyrphus balteatus*; *Veronica chamaedrys* with *Syritta pipiens*. – All synthetic columns/rows include the additional single observations.

5 Discussion

Comparison between different sampling methods shows that each has its strengths and weaknesses when used for inventory and study of invertebrate communities:

– Single traps with a maximum efficiency in collecting hoverflies, e.g. Malaise traps or water dish traps, installed at the most "productive" locations – usually on edges of habitats – produce only faunistic lists with almost no information on the relationship between the list and the surrounding vegetation.

– Collecting or trap installation in a distinct habitat or plant association result in data which allow the use of biotope or vegetation maps for data extrapolation. However, very high numbers of collection sites or trap installations are then necessary, due to the high number of biotopes or syntaxa present in almost every landscape and edge effects also tend to be ignored.

– Collecting on broad landscape transects subdivided into units using a grid system, as was done by Ssymank (2001) or using landscape transects for traps (for example Duelli et al. 1999), also needs a high number of sampling stations or sampling plots. Because the total sampling area is relatively small, this method ignores singularities of biotope distribution or vegetation mosaic in the landscape. However, data from grid mapping allow analysis of edge effects and a regional extrapolation of data is to some extent possible.

– Collecting in vegetation complexes, as in the present study, needs a full description of all the landscape units (vegetation complexes) that require sampling. Thus an intensive study of the vegetation is necessary in advance of any syrphid sampling programme, involving allocation of a lot of time in pre-investigation. However, establishment of a wide range of sampling plots within the predefined vegetation complexes allows coverage of large areas by stratified sampling: Specific or even rare situations of the vegetation mosaic in the landscape will not be overlooked, but sampled regularly. The high quality of the collected data can be demonstrated by detection of species additional to those on a check list for a well-known region, as well as in higher percentages of observed species in comparison to grid mapping techniques. Once relationships between vegetation complexes and hoverfly species are established, the vegetation complex mapping allows extrapolation of species densities over a complete river system. For the Drachenfelser Ländchen the map of river valley complexes given in Fig. 1a/b can thus be read as a map of relative abundance of any hoverfly species in August, using the data in the representativity table, e.g. for *Cheilosia illustrata* over an area of approximately 110 km², which can be expected to show moderate abundances in complexes IIc and IIIb, but to be almost absent from most of the river system of the Swistbach.

The results of the present study show quite well that the hoverfly assemblages vary distinctly between vegetation complexes and that a characteristic species inventory can be expected for each vegetation complex. Among the parameters used to describe animal communities dominance is probably the most inefficient for hoverflies, because dominant species are often the same in different complexes but may change between years (polyvoltine, aphidophagous species !), but dominance structure is relatively constant (Ssymank 2001). A low number of species representing a large percentage (ca. 60%) of the observations showed high constancy, regardless of vegetation complex. This means that presence/absence data are only of limited value for data analysis. Abundance data have to be included in data analysis. While absolute numbers of individuals caught may vary greatly, representativity reveals clear preferences in comparing different vegetation complexes. Characteristic species in a strict sense, or species which are (almost) exclusive to one vegetation type/ vegetation complex, are usually species with relatively low abundance and medium to low constancy. Therefore analysing hoverfly communities will need a high number of observations.

The present study hardly considers the potential for further investigation and data analysis made accessible through the advent of GIS (geographical information systems). For practical reasons it was not possible to conduct a full research programme with the method used here, over a longer time period. To cover the full range of species in this landscape it would be necessary to

– prolong or repeat the investigation over all phenological periods (at least 3 or 4 times a year, especially for spring species missing altogether in this data set)

– repeat the same set of investigations over at least two years, an optimum would be 4-5 years to cover the relatively high fluctuation or species turn-over between years

– finally to enlarge the scope to understand the whole landscape to forest-, pasture- and vegetation complexes of crops.

It is usually beyond the reach of a single person to conduct such detailed studies, even though they might be desirable to distill the "rules" of hoverfly communities or their distribution in a landscape. Hopefully this study may encourage further joint, interdisciplinary research programmes on insect or hoverfly communities at landscape scale. At least this study has shown that vegetation complex sampling may be able to produce the most complete species list and reliable data sets for understanding hoverfly distribution in a landscape.

Acknowledgements

Many thanks go to Claus Claußen, Flensburg for checking difficult specimens of *Cheilosia*, and to Dieter Doczkal, Malsch. Furthermore I wish to thank Martin Speight, Dublin, for language proof reading and critical advice.

References

Barkalov, A.V.; Ståhls, G. (1997): Revision of the Palaearctic bare-eyed and black-legged species of the genus *Cheilosia* Meigen (Diptera, Syrphidae). – Acta Zoologica Fennica 208, 1-74. Helsingfors.

Barkemeyer, W.; Claussen, C. (1986): Zur Identität von *Neoascia unifasciata* (Strobl, 1898) mit einem Schlüssel für die in der Bundesrepublik Deutschland nachgewiesenen Arten der Gattung *Neoascia* Williston 1886 (Dipt., Syrphidae). – Bonner zoologische Beiträge 37(3), 229-239. Bonn.

Buchholz, U. (1989): Blütenbesucher-Gemeinschaften hochstaudenreicher Pflanzengesellschaften der subalpinen Stufe (Syrphidae: Diptera, Apoidea: Hymenoptera, Rhopalocera, Lepidoptera) - Das Beispiel Feldberg im Schwarzwald. – Diplomarbeit Universität Freiburg im Breisgau, 104 p.

Doczkal, D. (1995): Bestimmungsschlüssel für die Weibchen der deutschen *Sphegina*-Arten (Diptera, Syrphidae). – Volucella 1(1), 3-19. Stuttgart.

Doczkal, D.; Claussen, C.; Ssymank, A. (2002): Erster Nachtrag und Korrekturen zur Checkliste der Schwebfliegen Deutschlands (Diptera, Syrphidae). – Volucella 6, 167-173. Stuttgart.

Duelli, P.; Obrist, M.K.; Schmatz, D.R. (1999): Biodiversity evaluation in agricultural landscapes: aboveground insects. – Agriculture Ecosystems and Environment 74, 33-64. Amsterdam.

Dušek, J.; Láska, P. (1976): European species of *Metasyrphus*: key, descriptions and notes (Diptera, Syrphidae). – Acta entomologica bohemslovaca 73, 263-282. Praha.

Gatter, W.; Schmid, U. (1990): Wanderungen der Schwebfliegen (Diptera, Syrphidae) am Randecker Maar. – Spixiana Supplement 15, 1-100. München.

Goeldlin de Tiefenau, P. (1976): Révision du genre *Paragus* (Dipt., Syrphidae) de la région palaearctique occidentale. – Mitteilungen der Schweizer entomologischen Gesesllschaft 49, 79-108. Zürich.

Goeldlin de Tiefenau, P.; Maibach, A.; Speight, M.C.D. (1990): Sur quelques espèces de *Platycheirus* (Diptera, Syrphidae) nouvelles ou méconnues. – Dipterists Digest 5, 19-44. Sheffield.

Goot, V.S. van der (1981): De zweefvliegen van Noordwest-Europa en Europees Rusland, in het bijzonder van de Benelux. Bibliotheek Koninklijke Nederlandse Natuurhist. Vereniging, 275 p. Hoogwoud.

Kratochwil A.; Schwabe, A. (2001): Ökologie der Lebensgemeinschaften: Biozönologie. – 756 p. Stuttgart (Ulmer).

Pott, R. (2003) (ed.): Rintelner Symposium VII (Pflanzengesellschaften als Lebensraum für Tiere – Interaktionen von Flora und Fauna). – Berichte der Reinhold-Tüxen-Gesellschaft 15, 235 p. Hannover.

Schanowski, A. (1985): Zur Syrphiden-Fauna verschiedener Rasengesellschaften des NSG Taubergiessen: Phänologie, Habitatpräferenzen und Blütenbesuchsverhalten. Diplomarbeit Universität Freiburg im Breisgau, 133 p.

Schneider, F. (1958): Künstliche Blumen zum Nachweis von Winterquartieren, Futterpflanzen und Tageswanderungen von *Lasiopticus pyrastri* L. und anderen Schwebfliegen. – Mitteilungen der Schweizer entomologischen Gesesllschaft 31(1), 1-24. Zürich.

Schwabe, A.; Köppler, D.; Kratochwil, A. (1992): Vegetationskomplexe als Elemente einer landschaftsökologisch-biozönologischen Gliederung, gezeigt am Beispiel von Fels- und Moränen-Ökosystemen. – Berichte der Reinhold-Tüxen-Gesellschaft 4, 135-145. Hannover.

Schwabe, A.; Mann, P. (1990): Eine Methode zur Beschreibung und Typisierung von Vogelhabitaten, gezeigt am Beispiel der Zippammer (*Emberiza cia*). – Ökologie der Vögel 12, 127-157. Ludwigsburg.

Seitz, B.-J. (1982): Untersuchungen zur Koinzidenz von Vogelgemeinschaften und Vegetationskomplexen im Kaiserstühler Rebgelände. – Tuexenia 2, 233-255. Göttingen.

Seitz, B.-J. (1988): Zur Koinzidenz von Vegetationskomplexen und Vogelgemeinschaften im Kulturland – Untersuchungen im südwestdeutschen Hügelland. – Phytocoenologia 16, 315-390. Berlin, Stuttgart.

Speight, M.C.D.; Castella, E.; Obrdlik, P. (2000) Use of the Syrph the Net database 2000. – In: Speight, M.C.D.; Castella, E.; Obrdlik, P.; Ball, S. (eds.): Syrph the Net, the database of European Syrphidae, vol.25, 99 p., Syrph the Net publications. Dublin.

Ssymank, A. (1991): Die funktionale Bedeutung des Vegetationsmosaiks eines Waldgebietes der Schwarzwaldvorbergzone für blütenbesuchende Insekten - untersucht am Beispiel der Schwebfliegen (Diptera, Syrphidae). – Phytocoenologia 19(3), 307-390. Berlin, Stuttgart.

Ssymank, A. (1999): Ein bewährter Standard-Erhebungsbogen für Schwebfliegen und erster Beitrag zur Schwebfliegenfauna (Diptera, Syrphidae) der Bonner Umgebung. – Volucella 4(1/2), 127-144. Stuttgart.

Ssymank, A. (2001): Vegetation und blütenbesuchende Insekten in der Kulturlandschaft. - Pflanzengesellschaften, Blühphänologie, Biotopbindung und Raumnutzung von Schwebfliegen (Diptera, Syrphidae) im Drachenfelser Ländchen sowie Methodenoptimierung und Landschaftsbewertung. - Tierwelt in der Zivilisationslandschaft, Teil V. – Schriftenreihe für Landschaftspflege und Naturschutz 64, 513 p. Bonn-Bad Godesberg.

Ssymank, A.; Doczkal, D. (1998): Rote Liste der Schwebfliegen (Diptera, Syrphidae). – In: Bundesamt für Naturschutz (ed.): Rote Liste gefährdeter Tiere Deutschlands. (Bearb.: Binot, M.; Bless, R.; Boye, P.; Gruttke, H.; Pretscher, P.). – Schriftenreihe für Landschaftspflege und Naturschutz (BFANL/BfN) 55, 65-72. Bonn-Bad Godesberg.

Ssymank, A.; Doczkal, D.; Barkemeyer, W.; Claussen, C.; Löhr, P.-W.; Scholz, A. (1999): Syrphidae. – In: Schumann, H.; Bährmann, R.; Stark, A. (eds.): Checkliste der Dipteren Deutschlands. – Studia Dipterologica. Supplement 2, 195-203. Halle (Ampyx-Verlag).

Stubbs, A.E.; Falk, S.J. (1983): British Hoverflies. 254 p. London (British Entomological & Natural History Society).

Stubbs, A.E. (1996): British Hoverflies. Second Supplement. 55 p., London.

Thompson, F.C.; Torp, E. (1986): Synopsis of the European species of *Sphegina* Meigen (Diptera, Syrphidae). – Entomologica scandinavica 17(2), 235-269. Kopenhagen.

Torp, E. (1994): Danmarks svirrefluer (Diptera: Syrphidae). Danmarks Dyreliv 6, 490 p. Kopenhagen.

Tüxen, R. (1977) (ed.): Vegetation und Fauna. – Berichte der Internationalen Symposien der Internationionalen Vereinigung für Vegetationskunde. 566 p. Vaduz (Cramer).

Verlinden, L. (1991): Zweefvliegen (Syrphidae). Fauna van Belgie (Koninklijk Belgisch Instituut voor Natuurwetenschappen). 298 p. Brüssel.

Wilmanns, O. (1987) Zur Verbindung von Pflanzensoziologie und Zoologie in der Biozönologie – Tuexenia 7, 3-12. Göttingen.

Wilmanns, O. (1988a): Zur Nutzung pflanzensoziologischer Daten bei zoozönologischen Untersuchungen. – Mitteilungen des badischen Landesvereins Naturkunde und Naturschutz N.F. 14, 547-556. Freiburg.

Wilmanns, O. (1988b); Ökologische Pflanzensoziologie. 6. ed., 405 p. Wiesbaden (Quelle & Meyer).

Wisskirchen, R.; Haeupler, H. (1998): Standardliste der Farn- und Blütenpflanzen Deutschlands. Bundesamt für Naturschutz. 765 S. Stuttgart (Ulmer).

Author's address:

Dr. Axel Ssymank, c/o Bundesamt für Naturschutz (I.2.2) (Federal Office for Nature Conservation), Konstantinstrasse 110, 53179 Bonn, Germany.
E-mail: Ssymanka@bfn.de