Patterns of habitat use by Syrphidae (Diptera) in the valley of the river Strom in north-east Brandenburg

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The Stromtal, in north-east Brandenburg, is a typical small river valley of the northern Baltic lowlands in Germany. The presence of a very compact habitat mosaic, with dry to wet pastures, bogs, reed beds and alluvial alder forest makes this valley an ideal place for studying the habitat-use patterns of hoverflies (Diptera, Syrphidae). From two grid-mapped landscape-transects across the valley 7997 individuals belonging to 108 species were recorded, from the years 1999 and 2000. During the same period, 3976 flower visits to 124 different plant species were observed. A detailed analysis of these data is presented, with special reference to spatial use of habitats and flower visiting preferences.

Syrphid genera of wet, open areas, like *Helophilus*, *Neoascia* and *Platycheirus*, were found to be abundant and species-rich, but xerophilous species also existed on the slopes. Remarkable species found were *Temnostoma meridionale* (Krivosheina & Mamaev), with other *Temnostoma* species and *Chalcosyrphus nemorum* (Fabricius) in the black alder forests, and *Arctophila superbiens* (Müller), a typical autumn species of the Molinion wet grassland,which regularly visited the flowers of *Succisa pratensis*. Syrphid faunistics in Brandenburg and nature conservation are briefly discussed.

It is concluded that the observed distribution of adult syrphids in the Stromtal is dictated as much by the location of flowers at which they prefer to feed, as by the location of the habitats in which their larvae develop. It is also concluded that, through exercise of well-defined flower preferences, and the limited availability of preferred flowers locally, during the flight period of each species, adult syrphids are much more important flower-pollination agents than has been hitherto suggested.

Zusammenfassung

Das Stromtal in Nordost-Brandenburg (Uckermark) ist ein typisches Flusstal des nordostdeutschen Tieflands. Durch sein sehr kompaktes Biotopmosaik mit trockenem bis feuchtem Grünland, Sümpfen, Röhrichten und Schwarzerlen-Auwäldern ist es ideal für das Studium der Habitatnutzungsmuster von Schwebfliegen (Diptera,

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Syrphidae). In zwei Landschaftstransekten durch das Tal wurden mit einer Rasterkartierungsmethode 7997 Beobachtungen von 108 Arten in den Jahren 1999 und 2000 gemacht. Gleichzeitig liegen Daten von 3976 Blütenbesuchen an 124 verschiedenen Pflanzenarten vor. Es wird eine detaillierte Analyse der räumlichen Habitatnutzungsmuster und der Blütenbesuchspräferenzen durchgeführt.

Schwebfliegengattungen offener Feuchtbiotope wie *Helophilus*, *Neoascia* und *Platycheirus* sind häufig und artenreich vertreten, an den Talhängen leben jedoch auch xerophile Arten. Bemerkenswert sind u.a. *Temnostoma meridionale* (Krivosheina & Mamaev), die zusammen mit anderen *Temnostoma*-Arten und *Chalcosyrphus nemorum* (Fabricius) in den Schwarzerlenwäldern lebt, sowie *Arctophila superbiens* (Müller) die im Spätherbst regelmäßig die Blüten von *Succisa pratensis* in Pfeifengraswiesen besucht. Die Ergebnisse werden mit Bezug zum Stand der Schwebfliegenfaunistik in Brandenburg und zum Naturschutz kurz diskutiert.

Aus den Ergebnissen wird abgeleitet, dass die Verteilung der Schwebfliegen im Stromtal sowohl von der räumlichen Verteilung der präferierten Blumen, als auch dem Biotopmosaik mit Bezug zu den Larvalhabitaten abhängig ist. Die Bedeutung der Schwebfliegen als Blütenbestäuber ist viel größer als bislang angenommen, da genau definierte Blumenbesuchstypen vorhanden sind, die u.a. durch die begrenzte lokale Verfügbarkeit der Blütenressourcen und die spezifische Flugzeit jeder Schwebfliegenart zustandekommen.

Introduction

The Stromtal, in north-east Brandenburg (Germany), is a typical, small river valley of the northern Baltic lowlands, about 20 metres deep, carved into the ground moraine close to the watershed between the North Sea and the Baltic Sea. The valley is only 200-300 m wide, with a slightly meandering river, relatively steep slopes and many springs originating from groundwater aquifers. The valley has been extensively farmed for a long time, with pasturing in the valley bottom and some arable areas on the upper slopes. The valley is now a Nature Conservation Area and a National Nature conservation project, "Uckermärkische Seen", is being conducted there, with co-financing by the Federal Agency of Nature Conservation in Bonn. The area has a particularly rich flora, and is partly managed by extensive sheep grazing. The black alder forests are at relatively young successional stages on former wet grassland, and date from around 1950.

The valley was chosen for the study of habitat use of hoverflies for three major reasons:

1. general knowledge on syrphids in Brandenburg is poor
2. a very compact habitat mosaic with dry to wet pastures, bogs, reed beds and alluvial alder forest is present in the valley
3. comparable data on other river systems exist from western parts of Germany.

Together, these considerations make this valley an ideal place for studying syrphid habitat-use patterns, while at the same time providing an opportunity to obtain the first faunistic data for syrphids, from a poorly known landscape in Germany.

The study area

The study area forms part of the landscape "Uckermark" in north-east-Brandenburg, not very far from the city of Prenzlau (fig. 1), in an area with a subcontinental climate (approximately 650 mm annual rainfall, 8.4 °C mean annual temperature). The valley of the river Strom, between Boitzenburg and Kröchlendorff, is about 20 m deep, carved into the ground moraine. The river channel has an inclination gradiant of about 2 ‰, which results in a slightly meandering river with a water flow still sufficiently rapid for salmonid fish. The area is under a strict nature protection regime (Naturschutzgebiet) and forms part of the Nature Park "Uckermärkische Seen". It has recently been proposed by Germany as a Site of Community Importance, in the Natura 2000 Network of protected sites, established under the Habitats Directive (regulation 43/92/EEC).

The vegetation of the Stromtal was first described by Voigtländer (1991). It was later described in more detail, to provide a basis for management planning, in a large nature conservation project with a core zone of 24,500 ha. This project was funded by

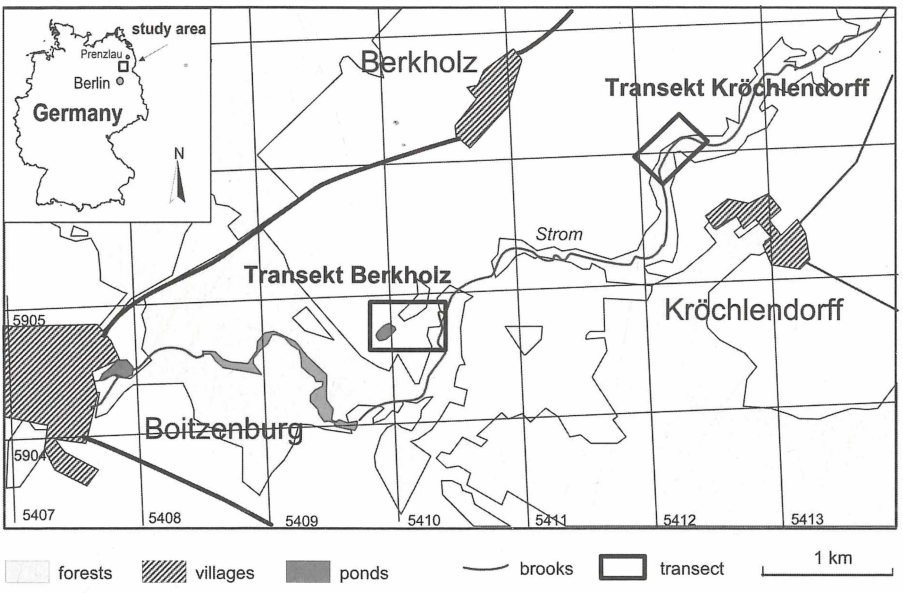


Fig. 1: Study area with transects used for grid mapping.

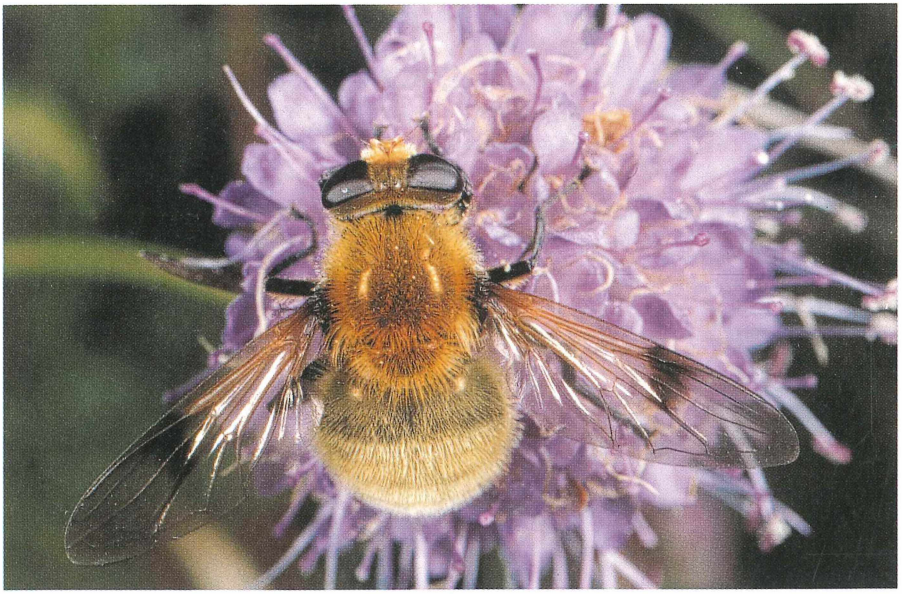


Photo 1: ***Arctophila superbiens*** visiting the flowers of *Succisa pratensis* in a wet grassland of the Molinion in September. Photo taken in the Berkholz transect (grid square E3) on 20.09.2000, A. Ssymank.

Photo 2: ***Temnostoma meridionale***, a wasp mimic, with larvae developing in wet logs of *Alnus glutinosa* in the alluvial forest on the Berkholz transect (grid square F1). Photo taken on 30.05.2001, A. Ssymank.

Photo 3: Eutrophic shallow pond with vegetation zonation of *Equisetum fluviatile* (dark green), eutrophic reeds of *Phragmites australis* and *Typha latifolia* on the Berkholz transect (grid squares Be-A3, A4), in the background arable fields and hedgerows, Photo no. 12350, taken on 09.05.1999, A. Ssymank.

Photo 4: Overview of the relatively open wet fallows and reeds of the valley bottom on the Berkholz transect with *Salix cinerea* scrub and black alder forest in the background (grid square E2, Photo No. 12355, 9.05.1999, A. Ssymank).

the Federal Agency of Nature Conservation (Naturschutzgroßprojekt, unpublished data). Both vegetation relevees and phenological data have also been collected by the author, but a short description of dominant vegetation types will be sufficient as background here. The bottom of the valley and the lower parts of the slopes are dominated by reed (Scirpo-Phragmitetum) and sedge-beds (Caricetum paniculatae, *Carex acutiformis*-dominated Magnocaricion). In some parts of the valley the Salicion cinereae (wet shrub vegetation) formation is abundant, and present in various successional stages, together with young *Alnus glutinosa*-coppice or woodland. The *Alnus glutinosa* stands form a mosaic of swamp woods (Carici elongatae-Alnetum glutinosae) with much *Iris pseudacorus* and alluvial or spring-water influenced forests, close to Stellario-Alnetum glutinosae and Carici remotae-Fraxinetum. *Fraxinus excelsior* itself is very infrequent, but *Cardamine amara*, *Carex remota*, *Myosotis scorpioides* agg. and *Veronica beccabunga* are locally very abundant in the herb layer. There are only a few poplar plantations, the drier upper slopes carry rich *Quercus robur* and *Fagus sylvatica* forests, or sometimes oak-hornbeam forests (Stellario-Carpinetum).Wet, intensively used Calthion grassland is rare. Molinion vegetation with *Succisa pratensis*, *Valeriana dioica* and a whole series of rare plant species is present, but only very locally. In places where the slopes are still regularly grazed by cows, a catena from mesic grasslands (Arrhenatherion) to dry grasslands (Mesobromion) is developed, the latter on the upper south facing slopes. A detailed map of the biotope types in the study area will be given later.

Methods

Two landscape transects, with a grid of 100 x 100 m² units, were established in the valley of the Strom, using infrared aerial photography (fig. 1), to ensure coverage of most of the habitat types present. The transects were perpendicular to the long axis of the river valley, comprising 20 grid units in the "Berkholz" transect and 23 grid units in the "Kröchlendorff" transect. The transects were 500-600 m long and 400 m wide, representing in total 43 ha. Being 4-5 grid units wide, each habitat type was usually present in at least four grid units, if occurring in both transects in 8 or more grid units. The "Berkholz" transect (20 grid units) is characterised by a valley bottom dominated by seasonally-flooded, more-or-less abandoned grassland and reedbeds, with coppice and small forests, one eutrophic pond on a valley shoulder, mesic to dry, unfenced grassland on the slopes, either used for light sheep grazing in autumn, or abandoned. The "Kröchlendorff " transect (23 grid units) is dominated by dry and mesic pastures, on the relatively steep slopes grazed by cows, and a valley bottom almost completely covered by alluvial alder forest, with only small areas of seasonally-flooded grassland or reedbeds. Both transects are ecologically equivalent, but differ substantially in the degree of anthropozoogenic influence and actual use.

Observation of hoverflies was carried out regularly, for 15 minutes, on the area of each grid unit, once in the morning (9.00-12.00 MEST, middle european summer time) and at noon (12.30-15.30 MEST). Observations in the late afternoon period were omitted, because both species numbers and abundance are low at this time of the day. The details of the method are described in Ssymank (1996, 2001). Each transect was visited in May, July and September, during 1999 and 2000.

During the observation period flower-visiting was noted, as well as any other activities (e.g. sun-bathing on leaves, sitting in the shade or, in rare cases, egg-laying or mating behaviour). At the same time the number of flowering plants was estimated or counted (number of flower heads per 100 m^2) in order to have a semiquantitative dataset on the flower resources available to adult syrphids.

The nomenclature used here follows that of the first German checklist of Syrphidae (Ssymank et al. 1999). Similarly, plant names follow the plant checklist by Wisskirchen & Haeupler (1998). Red Databook references are taken from the national list (Ssymank & Doczkal 1998), because the current Brandenburg Red Databooks do not yet cover the family Syrphidae.

Results

General notes

The grid-map sampling method employed in the two landscape transects resulted in 310 separate samples, from 43 grid units. A combined total of 7997 adult syrphids, belonging to 108 species, were recorded during the three observation periods in 1999 and 2000. The species observed include two morphologically different species of the *Melanostoma mellinum* aggregate (one unnamed species with black hairs on the thorax and reduced yellow spots on tergite 2) and *Xanthogramma stackelbergi* Violovitsh, 1975, which is not yet listed in the German check list. Both *Melanostoma* and *Xanthogramma* are currently under revision.

The sampling programme also resulted in observations of 3976 flower visits, to 124 different plant species. Observations were planned to coincide with periods of good weather, but interactions between phenology, unreliable weather forecasting and the long distance between Bonn and the study area made it impossible to obtain a complete data set from every observation period. An overview of the data obtained is given in tab. 1.

Spatial distribution of hoverflies

The relative importance of the landscape mosaic to hoverflies may easily be seen by comparing the results obtained from the two transects. A large number of syrphid species were present exclusively in one of the two transects (7 species for Berkholz

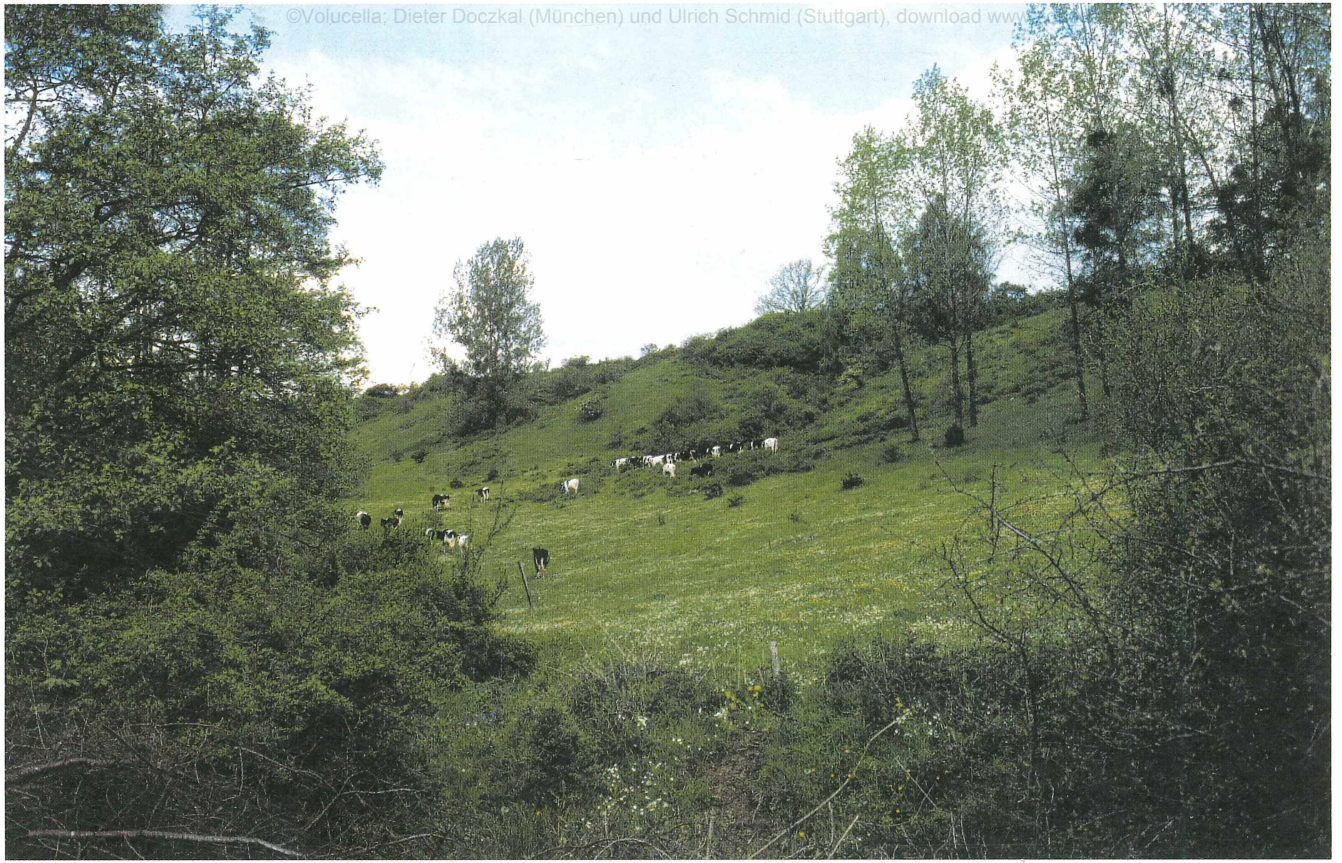


Foto 5: Dry steep slopes grazed by cows on the Kröchlendorff transect with dry scrub of *Prunus spinosa* and a few poplars (Photo No. 12415, 12.05.1999, A. Ssymank).

Photo 6: The river Strom and its surrounding black alder alluvial forest with *Cardamine amara* in full flower, typical habitat of *Cheilosia pubera*, Kröchlendorff transect (grid squares D2, Photo No. 12422, 12.05.1999, A. Ssymank).

Observation cycle	1	2	3	4	5	6
	May 1999	July 1999	Sept. 1999	May 2000	July 2000	Sept. 2000
regular syrphid observation	(1) cold, windy	+ (2)	- rainy	+ (2)	(1) pp. rainy	+ (2)
individuals	1008	4787	16	1599	278	303
species-number	48	57	5	78	29	29
flower ressources	34	ca. 90	no data	ca. 30	ca. 80	89
flower visits	448	2556	14	606	124	228
number of plant species used	16	73	4	24	27	38
Total number of syrphid observations: **7997** (flower visits: 3976 on 124 plant species) Species-number: **108**						

Tab. 1: Overview of observation cycles. – Explanations: Regular syrphid observation: (1) only one 15 minute-observation per grid square was possible, usually late morning to noon, (2) + good wheather conditions with two regular obervations per grid square, - almost no observations possible due to longer rainy wheather periods. Number of indiviuals and species number of Syrphidae are given, together with the number of flowering plant species (Flower ressources) and the number of flower species visited by Syrphidae.

and 3 species for Kröchlendorff) or had more than 75% of their individuals recorded from one transect only (rare species with less than 6 indiviuals not considered, see tab. 2). This is quite an astonishing fact, considering that the transects are only two kilometres apart and the hoverflies should be able to fly from one to the other frequently. Species recorded entirely, or predominantly (i.e 75% or more of the recorded individuals), from the Berkholz transect mainly comprised species of open wetlands and fens gone out of use, like *Sericomyia silentis*, *Pyrophaena rosarum*, *Anasimyia lineata*, *Eristalinus sepulchralis*, *Anasymia interpuncta* and *Neoascia tenur.* Species similarly characteristic of the Kröchlendorff transect included three different ecological groups:

1. species preferring dry or mesic grasslands (as adults), e.g. *Pipizella* sp. and *Xanthogramma pedissequum*,
2. species with coprophagous larvae (e.g. *Rhingia campestris*) or closely linked to pasture through their flower preferences, like species preferring yellow *Ranunculus*-flowers (indirect effect of cattle grazing), e.g. *Cheilosia albitarsis* (see fig. 2) and *Melanogaster nuda*,
3. species of closed forests, such as *Baccha elongata*, *Sphegina elegans* and *Melanostoma scalare*.

This is perfectly in accord with the dominant vegetation types and prevailing land use of the two transects, and shows that the hoverflies are good indicators of the local status of the landscape.

Transect Berkholz	% Berkholz	n
Eristalinus sepulchralis	100	21
Sericomyia silentis	100	13
Eristalis intricaria	100	12
Helophilus trivittatus	100	11
Pyrophaena rosarum	100	9
Chrysotoxum bicinctum	100	8
Anasimyia lineata	100	6
Cheilosia chlorus	90	51
Eristalis tenax	87	67
Anasimyia interpuncta	82	22
Temnostoma meridionale	82	11
Dasysyrphus venustus	82	11
Neoascia tenur	79	1082
Helophilus hybridus	75	8

Transect Kröchlendorff	% Kröchlendorff	n
Xanthogramma pedissequum	100	14
Pipizella spec. (♀)	100	19
Cheilosia vulpina	100	13
Rhingia campestris	94	16
Cheilosia albitarsis	92	189
Melanogaster nuda	91	146
Melanostoma scalare	90	202
Baccha elongata	89	56
Platycheirus peltatus	88	17
Neoascia meticulosa	81	248
Sphegina elegans	79	19
Melanostoma mellinum	79	573
Chrysogaster solstitialis	78	149
Platycheirus albimanus	77	30
Chrysogaster cemiteriorum	77	141

Tab 2: Hoverflies restricted to or clearly dominant in one transect. – n total number of observations, % percent of observations with reference to the Berkholz transect resp. the Kröchlendorff transect.

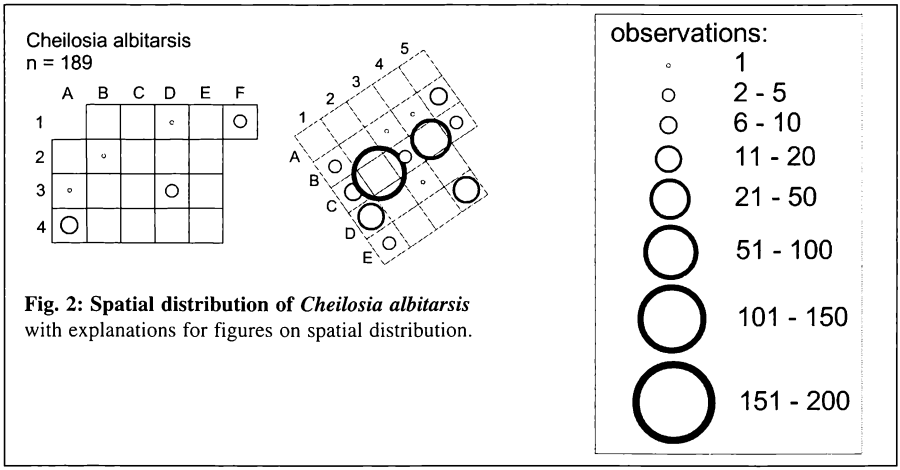


Fig. 2: Spatial distribution of *Cheilosia albitarsis* with explanations for figures on spatial distribution.

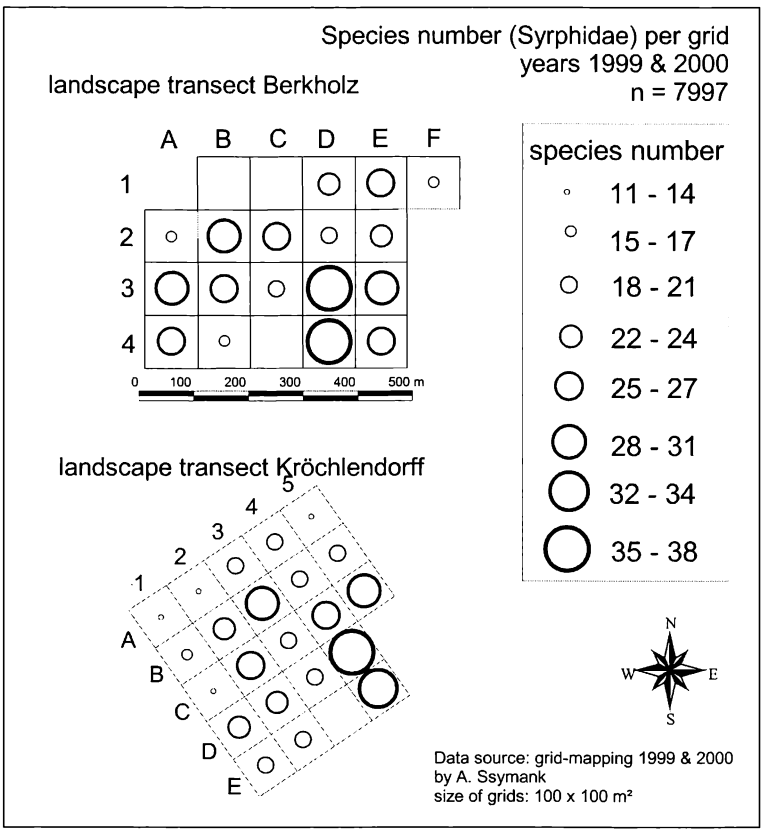


Fig. 4: Species number and observations of Syrphidae per grid square.

Furthermore, detailed analysis with regard to biotope types shows that, within each transect, the species exhibit clear preferences for certain biotopes or biotope complexes. Biotope mapping results from the two transects are given in the map (fig. 3). All species for which there are more than 10 observations (52 species) have been plotted, with their relative abundance, in the 43 grid squares of the two transects. The complete data set, for all 4705 observations from the Kröchlendorff transect, is shown in tab. 3, and its equivalent for the 3490 observations from the Berkholz transect is shown in tab. 4 .

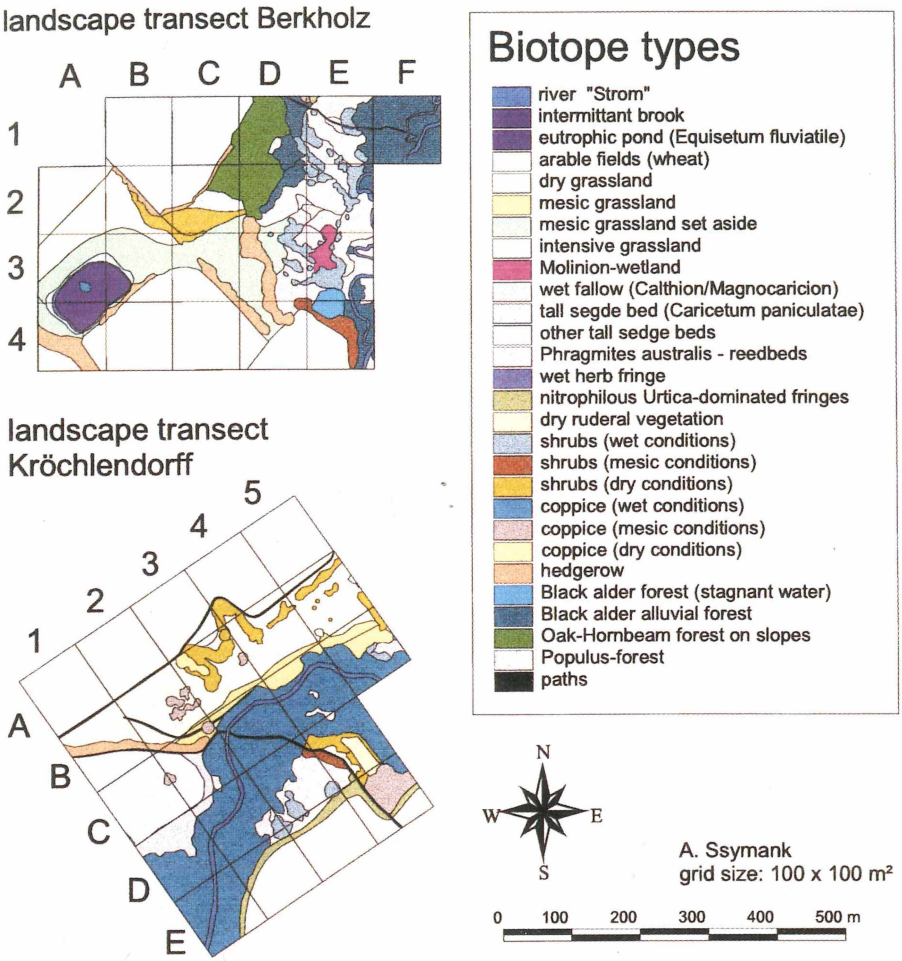


Fig. 3: Biotope (habitat) types of the two landscape transects.

Grid	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**C1**	**C2**
number of observations	91	140	207	180	190	98	122	93	103	115	45	403
species number	14	12	20	21	11	16	24	28	19	19	14	25
Anasimyia interpuncta												
Arctophila superbiens												4
Baccha elongata												
Chrysogaster cemiteriorum	1		6			20	25	10	26	17		2
Chrysogaster solstitialis	1	3	4	6		5	23	9	21	39		2
Cheilosia albitarsis						2		1	1	6	8	66
Cheilosia bergenstammi												
Cheilosia carbonaria								1				
Cheilosia chlorus			1									
Cheilosia impressa												
Cheilosia pagana							1					
Cheilosia proxima												
Cheilosia pubera							2		4	1	8	11
Cheilosia rufimana												
Cheilosia variabilis												
Cheilosia vernalis												
Cheilosia vicina												
Cheilosia vulpina				1			1					
Chalcosyrphus nemorum												
Chrysotoxum cautum								1				2
Chrysotoxum verralli							1					
Chrysotoxum vernale							2	1		3		
Dasysyrphus venustus								1				1
Meliscaeva auricollis var. *maculicornis*												
Epistrophe eligans			1					1	1			
Eristalis arbustorum	2		1	6	13		2				4	2
Eristalis horticola												
Eristalis interrupta	1			2		2	1	1		2		1
Eristalis pertinax			2	2	2	2		1			1	2
Eristalis tenax	1				3	1				1		
Episyrphus balteatus	57	90	148	113	108	37	22	20	12	14	6	81
Meliscaeva cinctella												
Eumerus strigatus											1	
Helophilus hybridus			1									
Helophilus pendulus				1				1	1			13
Leucozona lucorum (s.str.)												
Lejogaster metallina									1	1		
Melanogaster nuda								2			5	87
Melanogaster cf. *parumplicata*								1				
Melanostoma mellinum s.str.	10	25	4	1	2	9	24	2	10	8	3	95
Melanostoma mellinum agg.			2					1				
Melanostoma scalare			1									
Meligramma triangulifera							1					
Eupeodes corollae	3	5	2	3	17	1	1	1	3		1	1
Eupeodes latifasciatus				2							1	

C3	C4	C5	D1	D2	D3	D4	E1	E2	E3	E4	sum
238	184	162	141	471	184	340	439	218	99	244	4507
21	26	31	22	22	20	38	19	19	9	34	
	1			1		1	1				4
	1	1		3	1	4					14
37	3	2	1	5			1	1			50
		1									108
			1			2					116
2	43	3	20		1		2			18	173
						2				2	
	1										2
1	1	1	1								5
						1			1	2	
									1	2	
					1					1	
12	11	20	48	4			3	1			125
					8					8	
2	1			2							5
						1					1
										1	1
					1				10	13	
	3	1					3				7
2						1					4
				1		1					3
											6
1											2
				1							1
1											4
	1	6				1		1		9	48
		2			1	2				2	7
		3			1	3			2	12	31
	2	6	1	1	1	2		1		10	36
						1				2	9
34	24	56	26	199	107	93	312	120	39	31	1749
				1							1
											1
					1						2
3		3	2	3	4	8	1	1	4	2	47
2	1		1			1					5
		1									3
1	1	3				8				26	133
										1	
1	13	7	9	21	11	89	55	12	19	21	451
											3
6	7	16	5	29	2	4	36	30		45	181
											1
				1		1		1	1	2	45
								1			4

Tab. 3 (part 1) : Grid mapping observations of the years 1999 and 2000, Kröchlendorff transect.

Grid	**A1**	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**	**C1**	**C2**
number of observations	91	140	207	180	190	98	122	93	103	115	45	403
species number	14	12	20	21	11	16	24	28	19	19	14	25
Eupeodes luniger	1											
Myathropa florea	1			2				1				
Neoascia meticulosa				1			1		2	1	3	11
Neoascia podagrica								1		1		1
Neoascia tenur							1					
Orthonevra brevicornis								1	1	1		
Paragus haemorrhous								1				
Paragus majoranae												
Parhelophilus frutetorum				1								
Platycheirus albimanus		1		1								1
Platycheirus angustatus												
Platycheirus clypeatus		2									1	
Platycheirus europaeus												
Platycheirus fulviventris							1					1
Platycheirus occultus												
Platycheirus peltatus												3
Platycheirus scutatus							1					
Pipizella sp. (w)						2	1	7	5			2
Pipizella viduata						2	2		4	3		1
Pipizella divicoi									1			
Rhingia campestris			1	1						1		2
Riponnensia splendens		1										
Scaeva pyrastri			4		2							
Scaeva selenitica		2				1	1			1		
Sphegina clunipes												
Sphegina elegans			1									
Sphaerophoria interrupta agg. (♀)												
Sphaerophoria scripta	9	7	18	9	8	10	4	3	4	10	2	10
Sphaerophoria taeniata			3	3								
Syritta pipiens	1	1	1	12	31	2	1	13	4			
Syrphus ribesii	2	1	1	2	1	1	2	1				1
Syrphus torvus				1			1					
Syrphus vitripennis	1	2	5	10	3	1		2	1	1		
Temnostoma apiforme												
Temnostoma bombylans												
Temnostoma meridionale												
Tropidia scita												
Xanthogramma festivum								4	1	4	1	
Xanthogramma pedissequum								4				

C3	C4	C5	D1	D2	D3	D4	E1	E2	E3	E4	sum
238	184	162	141	471	184	340	439	218	99	244	4507
21	26	31	22	22	20	38	19	19	9	34	
											1
						1				1	6
81	55	5	4		29	2				6	201
14			2		3		2			2	26
21		8		184	1	2	7	1		2	227
											3
											1
						1					1
										1	
1	2	1	4		1	2	4	2		3	23
								1	2	1	4
	2	2	2	6	2	13	2	35	28	10	105
				1		1					2
		1		1		4		3		1	12
	1										1
			1		5	1	2	2		1	15
											1
	1				1						19
						1					13
											1
	2		5	1			2				15
											1
						1					7
										1	6
4			2								6
11		1	2								15
										1	1
1	1	2	1	3	2	12		1	3	6	126
		1									7
						1				5	72
2	4		2		3	2	1	2	1		29
											2
1		1		2			2	2		1	35
	1										1
		2									2
		1								1	2
					7	58				3	68
	1	3	1			1				2	18
		1		1		4				4	14

Tab. 3 (part 2) : Grid mapping observations of the years 1999 and 2000, Kröchlendorff transect.

Grid	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1
number of observations	185	337	194	18	97	331	161	23	71	113	26	184
species number	16	31	26	8	28	25	17	9	25	21	9	22
Anasimyia interpuncta		2	3			4	1					
Anasimyia lineata		1	3									
Arctophila superbiens										1		
Baccha elongata									1			5
Brachymyia berberina												2
Brachyopa pilosa												
Chrysogaster cemiteriorum	24	3	1		3		1			1		
Chrysogaster solstitialis	10	4		1	4		1	3	8			
Cheilosia albitarsis		1	6		1							1
Cheilosia bergenstammi									1			
Cheilosia carbonaria												1
Cheilosia chlorus					1			1	1			3
Cheilosia fraterna												
Cheilosia pagana												2
Cheilosia pubera			1									14
Cheilosia rufimana												6
Cheilosia variabilis												
Chalcosyrphus nemorum												
Chrysotoxum bicinctum	1	4	2		1							
Chrysotoxum cautum					1				1			
Chrysotoxum verralli							1					
Dasysyrphus hilaris												
Dasysyrphus venustus					4							1
Didea fasciata		1										
Eristalinus sepulchralis		9	2	2		4		2				
Meliscaeva auricollis var. *maculicornis*									1			
Epistrophe eligans					1	1	1		2			
Epistrophe nitidicollis												
Eristalis abusiva			2			1						
Eristalis arbustorum		12	1		3	4			1	3		
Eristalis horticola						2				1		
Eristalis intricaria		1				6						
Eristalis interrupta	1	3	1			1			3	2		
Eristalis pertinax		4	1		2	10		1		2		
Eristalis tenax	4	3			4	34	1			1	1	
Episyrphus balteatus	85	57	19	5	32	122	42	4	16	43	5	60
Meliscaeva cinctella												
Ferdinandea cuprea									2			
Helophilus affinis												
Helophilus hybridus		1			1	2				1		
Helophilus pendulus		1	1		2	12				1		
Helophilus trivittatus			1			2	3				3	
Heringia heringi					1				1			
Leucozona lucorum (s.str.)										1		1
Melanogaster nuda		1	2									

D2	D3	D4	E1	E2	E3	E4	F1	sum
130	235	163	451	231	325	168	47	3490
19	37	35	25	22	29	25	15	
	2	4	1	1				18
		1		1				6
2	6	1		2	15			27
								6
								2
							1	1
								33
	1					1		33
	5						2	16
								1
1						1		3
2	19	1		6	6	5	1	46
						5		5
				1			2	5
7	29	1	3	4	12	36		107
			1	2	1			10
		1						1
							7	7
								8
	1		1					4
								1
	1							1
	1	1	1		1			9
								1
		1				1		21
								1
	1							6
	1							1
								3
	2		1			1		28
		1			1		1	6
	1	2	1		1			12
	15	6	1	1	3			37
7	5	47			2			81
3	3	2			2			58
82	29	28	62	68	85	71	12	927
		1					1	2
								2
							1	1
						1		6
3	4	1		4	23	1	2	55
					2			11
								2
								2
1	1	3	1	1	2	1		13

Tab. 4 (part 1): Grid mapping observations of the years 1999 and 2000, Berkholz transect.

Grid	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1
number of observations	185	337	194	18	97	331	161	23	71	113	26	184
species number	16	31	26	8	28	25	17	9	25	21	9	22
Melanostoma mellinum Intersex			1									
Melanostoma mellinum s.str.	4	14	5	1	6	2	2	3	3	7	1	
Melanostoma scalare			2		1	1						3
Eupeodes corollae	2	2	2			7			1	1	2	
Eupeodes latifasciatus					1							
Eupeodes luniger		1			1							
Eupeodes nitens					1							
Myathropa florea						1			1			
Neoascia interrupta		2					2					
Neoascia meticulosa									1	1		10
Neoascia podagrica								1		1		1
Neoascia tenur		122	71			45	5					63
Orthonevra brevicornis												
Orthonevra nobilis	2											
Paragus majoranae												
Pipiza noctiluca												
Platycheirus albimanus								1			2	2
Platycheirus angustatus												
Platycheirus clypeatus		9	4	1		11	2		2			
Platycheirus europaeus												
Platycheirus fulviventris		1	3			4				1		
Platycheirus occultus												
Platycheirus peltatus												
Pyrophaena rosarum												
Pipizella viduata	1								4	1		
Rhingia campestris												
Scaeva pyrastri		5			1				1			
Scaeva selenitica					2							
Sericomyia silentis												
Sphegina clunipes												3
Sphegina elegans												2
Sphaerophoria interrupta agg. (♀)	1											
Sphaerophoria scripta	38	29	20	5	18	36	85	7	1	31	10	1
Sphaerophoria taeniata	7				1					1	1	
Syritta pipiens	2	8		2			11		3		1	
Syrphus ribesii	1	2		1	1		1		1			1
Syrphus torvus			1									
Syrphus vitripennis	2	3	2		1	8	1		3	2		
Temnostoma apiforme					1							
Temnostoma meridionale												
Tropidia scita		28	37			10						1
Volucella bombylans												
Volucella pellucens							1					
Xanthogramma cf. *dives*									5			
Xanthogramma festivum		3			1	1			7	10		
Xylota segnis												

D2	D3	D4	E1	E2	E3	E4	F1	sum
130	235	163	451	231	325	168	47	3490
19	37	35	25	22	29	25	15	
								1
3	8	2	3	45	7	3	3	122
	5			4	2	3		21
		1			1	1		20
						2		3
								2
								1
			3					5
								4
	1	1	30			3		47
2			15	1	4			25
10	57	10	294	63	113		2	855
		1				2		3
								2
		1						1
			1					1
		2						7
		1			2			3
	2	3		4	1	5		44
					1			1
		6	11		1	1		28
					1			1
	1		1					2
	1		6	1	1			9
		3						9
1								1
	1	2						10
			1					3
				2	11			13
1							2	6
1						1		4
	1							2
1	9	11		7	13	17		339
	2	2	1					15
		8	1	1		1		38
	2	3	1	1		2		17
	1							2
	4	1		1		1	1	30
								1
							9	9
1	7	5	9	11	10	2		121
1					1			2
	2		1					4
	1							6
	1							23
1								1

Tab. 4 (part 2): Grid mapping observations of the years 1999 and 2000, Berkholz transect.

Species numbers per grid square varied from 8 to 38 species and number of observations varied between 18 and 471. Highest species numbers were found in grid squares on the valley bottom, or in grid squares with very complex structure, including ecotones involving several biotope types (fig. 4). Grid squares typical of ecotones, or a zonation from wet to dry biotopes, can be seen on the Berkholz transect at A3, B3 and A4, where a pond was present, and at D3 and D4, which included part of the wet valley bottom and the mesic biotopes of the slope. Grid squares from the valley bottom in Berkholz, with fen or reedbeds, and in Kröchlendorff with predominant black alder-forest, had relatively high species numbers of 25-30 species. Species poor grid squares were monotonous biotopes under intensive agricultural use, either crops or mesic grassland with cows grazing, with insignificant field margins.

About a quarter of the species show no clear biotope preference and are more or less evenly distributed in all grid squares, including the arable fields. Examples are *Episyrphus balteatus* (fig. 5), *Melanostoma mellinum* and *Sphaerophoria scripta*. However, the majority of species show a very distinctive spatial pattern of habitat use within the transects. Each of these patterns will be described briefly and selected examples will be illustrated.

- A relatively large group of syrphid species can be characterised as using all open habitats, being absent in the wet, black alder-forest. Species with this habitat use pattern were, for example, *Eristalis tenax* (fig. 6), *Sphaerophoria taeniata* (fig. 7) (both occasionally found in grid squares with arable fields as well), *Eristalis horticola* and *Epistrophe eligans*.
- Species restricted to the dry and mesic grasslands of the valley slopes were *Chrysogaster solstitialis*, *C. cemiteriorum* (fig. 8), *Xanthogramma festivum* and *Pipizella* species. This group would include also some rarer species, for which the number of observations was too low for an analysis.
- Wetland species preferring the standing, eutrophic water body of the pond, with its zonation of *Equisetum fluviatile*, *Phragmites australis* reed beds and Magnocaricion vegetation, were *Eristalinus sepulchralis* and *Eristalis intricaria*. Several other species used predominantly the fen, seasonally-flooded grassland and reedbeds of the valley bottom (partly alluvial biotopes) but did not occur in closed, black alder forests: *Arctophila superbiens* (fig. 9, photo 1), *Pyrophaena rosarum*, *Sericomyia silentis*, *Anasimyia interpuncta*, *Tropidia scita* (fig. 10) and *Neoascia tenur*. *Sericomyia silentis* was found exclusively in Molinion-vegetation with *Succisa pratensis* (grids E2, E3 of transect Berkholz), where *Arctophila superbiens* also reached its greatest abundance.
- Wetland species occurring both in open wetlands and in the black alder forests were *Cheilosia pubera* (fig. 11), *Cheilosia chlorus*, *Cheilosia albitarsis*, *Neoascia podagrica*, *N. meticulosa*, *Melanostoma scalare*, *Melanogaster nuda* and *Platycheirus fulviventris*. Where these species occurred within grid squares dominated by black alder forest most of them showed a preference for the forest margins or small sunlit places. Only *Cheilosia pubera* could also be found in numbers under closed canopy,

in the alluvial alder forest, and showed an affinity for margins of the Salicion cinereae-bushes, in the more open parts of the valley bottom.

- Species preferring the black alder forest of the valley bottom (and thus often species which were present mainly in the Kröchlendorff transect) were *Baccha elongata* (fig. 12), *Chalcosyrphus nemorum*, *Sphegina clunipes*, *S. elegans* and *Temnostoma meridionale* (fig. 13, photo 2). The latter was observed only on black alder logs, partly submerged in brooks in the alluvial black alder forest. Males of *Temnostoma meridionale* were sometimes observed perching on leaves close to logs. These males chased all larger insects that flew close. The females were seen searching for oviposition sites under partly loose bark, close to the water surface, on the side or under these logs. *Rhingia campestris* also showed a preference for the grid squares with black alder forest, but a few observations of this species were also made outside the forests.

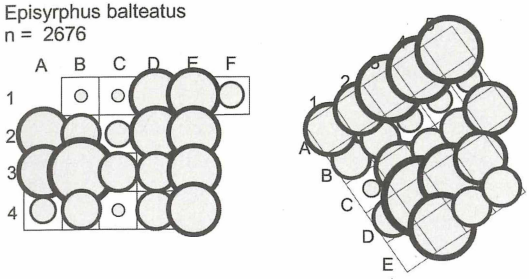


Fig. 5: Spatial distribution of *Episyrphus balteatus*. For explanations on number of observations see fig. 2.

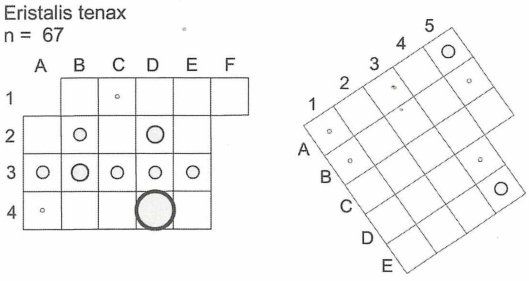


Fig. 6: Spatial distribution of *Eristalis tenax*. For explanations on number of observations see fig. 2.

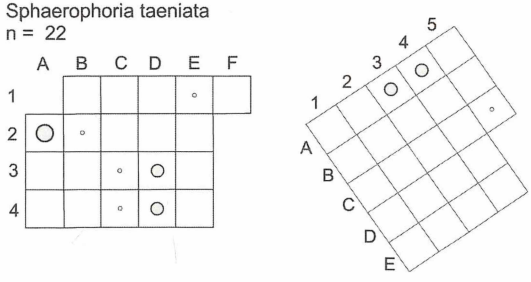


Fig. 7: Spatial distribution of *Sphaerophoria taeniata*. For explanations on number of observations see fig. 2.

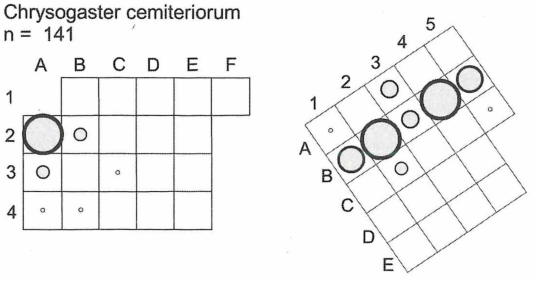


Fig. 8: Spatial distribution of *Chrysogaster cemiteriorum*. For explanations on number of observations see fig. 2.

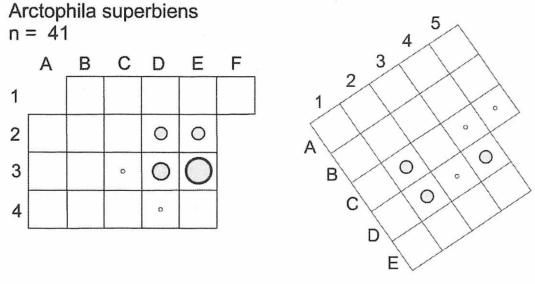


Fig. 9: Spatial distribution of *Arctophila superbiens*. For explanations on number of observations see fig. 2.

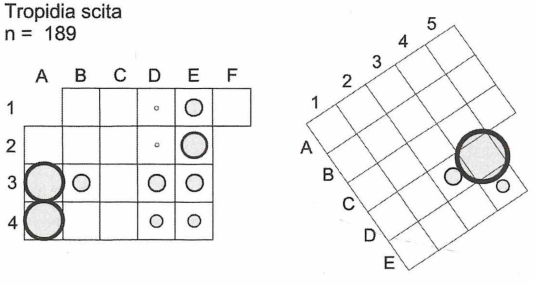


Fig. 10: Spatial distribution of *Tropidia scita*. For explanations on number of observations see fig. 2.

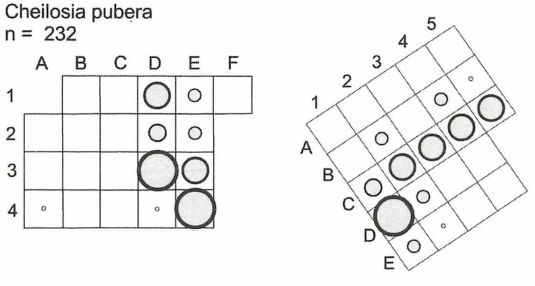


Fig. 11: Spatial distribution of *Cheilosia pubera*. For explanations on number of observations see fig. 2.

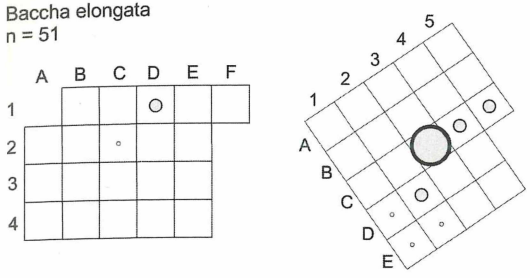


Fig. 12: Spatial distribution of *Baccha elongata*. For explanations on number of observations see fig. 2.

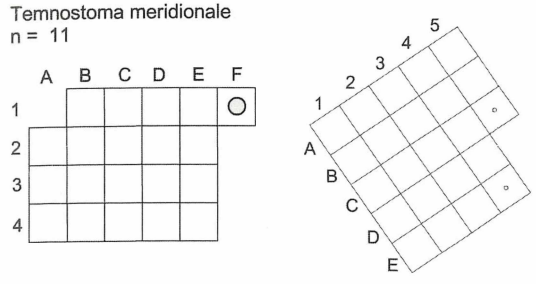


Fig. 13: Spatial distribution of *Temnostoma meridionale*. For explanations on number of observations see fig. 2.

Flower visiting patterns

During grid mapping of syrphid distribution, observation was made of 3976 flower visits by Syrphidae, to 124 different plant species. The full data set for each phenological period is shown for the Kröchlendorff transect in tab. 5-9 and for the Berkholz transect in tab. 10-15.

Data analysis was carried out using the following characteristics of plant species visited:

- flower colour (white, yellow, red/blue, green or without petals)
- plant height (in 3 classes low: < 0.3 m, medium: 0.3-0.7 m, high: > 0.7 m)
- flower type (A- radial solitary flowers, B- bilateral solitary flowers, C - composite flowers with subtypes C1 - basket type, as in Asteraceae-flowers, C2 - umbel-type and C3 - agglomerate type, and finally D - anemophilous flowers, for example grasses and sedges)
- plant families

Data analysis only included complete data sets from one phenological period (with 2 observation times per grid square, see. tab. 1), ignoring incomplete data sets due to bad wheather conditions. The observations from each year and from each phenological period were considered separately. Due to the large amount of data it is not possible to present the analysis in every detail within this article. Thus a general overview will be given, with examples of detailed data.

Flower visiting patterns and preferences are to a high degree dependent on:
- spatial scale considered
- phenological time or duration of observation period
- behaviour patterns of individual syrphid species

Nevertheless, most species showed distinct, and constant, flower preferences (colour, type of flower or plant families) within one region or investigation area. Only a minority of species changes preferences during the year (evidence for learning behaviour).

Hoverflies are often believed to visit the flowers of a wide spectrum of plant species and thus to be of minor importance in flower pollination. While the first statement is basically true for a certain number of syrphid species, the conclusion drawn from it may be entirely incorrect: Although in data collected from all times of the year, in a large geographic area like Germany or Belgium, the list of flowers visited by a given syrphid species can be relatively long, over a more restricted geographic area and within a particular phenological period, the number of flowers visited by that same species reduces dramatically (see tab. 16).

Even ubiquitous species, with virtually no flower preference as compared to other syrphid species, like *Episyrphus balteatus,* used in the Stromtal (both transects) only a third of the available flowers throughout the year. Separating phenological periods, a maximum of 29 different plant species were visited simultaneously. More specialised species, like *Myathropa florea*, which has a preference for white umbels, or *Cheilosia albitarsis*, which has a preference for the solitary, yellow flowers of Ranunculaceae, usually visited the flowers of only 2-6 different plant species, with the majority of visits often concentrated on the flowers of one plant species. Thus, the availability of flowers at a given time of the year, and in a certain area, together with a relatively moderate preference for particular flower types, flower colour, or plant families, is sufficent to ensure a high flower constancy in flower visits, in most cases, and thus to make syrphid species effective pollinators.

As a group, flower flies usually exploit the flowers of 50-80 % of the plant resources available in a local area. A general phenological pattern was observed for flower visiting preferences in both transects. This will be described here using data from the Kröchlendorff transect (fig. 14).

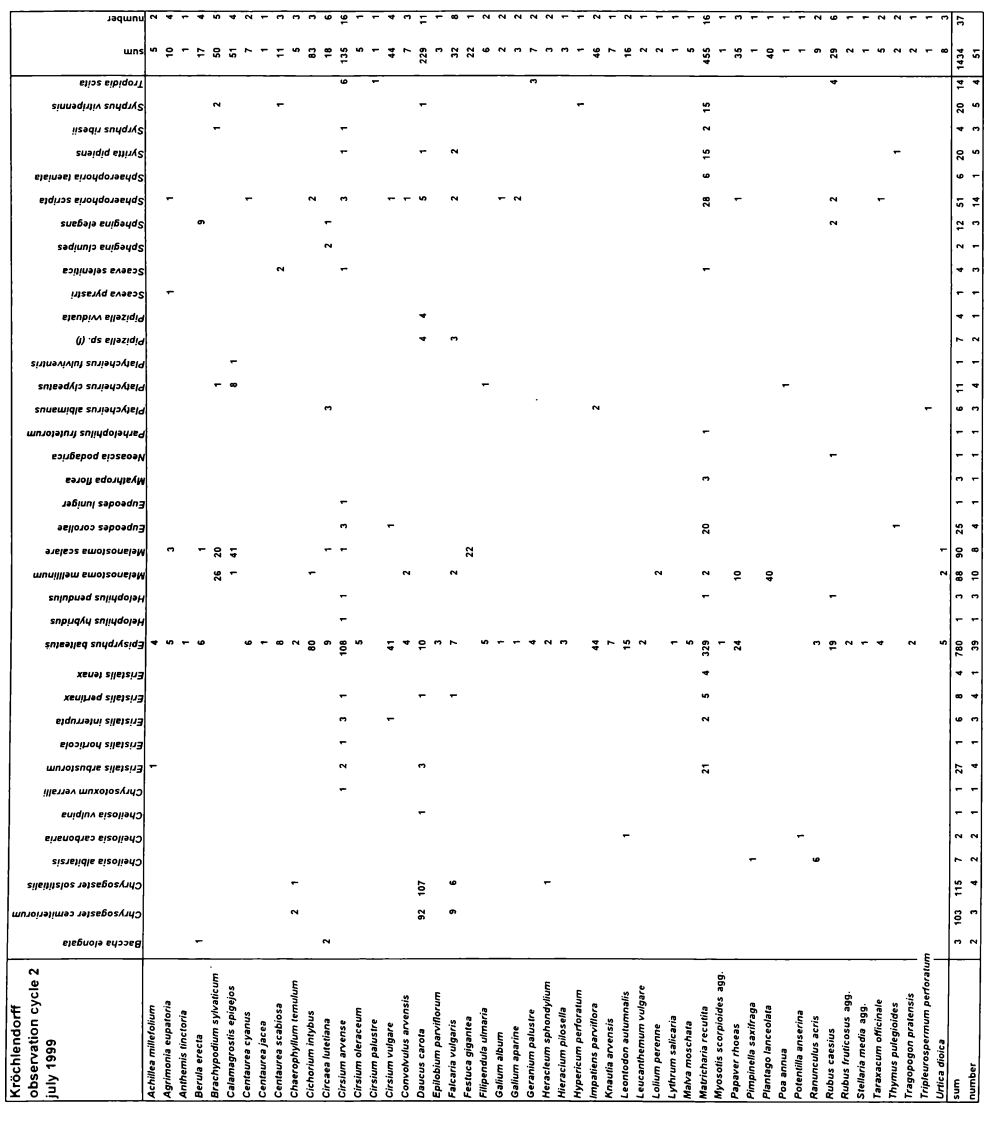
Flower preferences shown in
- spring: a high proportion of yellow flowers (often between 50-60%, in Kröchlendorff 53%); a high proportion of radial, single flower types (with nectar and pollen, here 52 %); plant families mainly visited were Ranunculaceae (47%), Poaceae (22%) or Cyperaceae, Brassicaceae (23%).
- summer: white and/or red flowers visited predominantly; high proportion of composite flower types of >70% visited; plant families mainly visited were Asteraceae, Apiaceae.

• autumn: all flower colours visited, strongly dependent on resources available (no marked preferences); almost exclusively composite flower types visited, of basket subtype; plant families mainly visited were Asteraceae, Dipsacaceae.

Combining data from the whole year, the results are almost identical with the July-results, because in July/August the highest abundances of hoverflies are to be found. Differing preferences in spring and autumn are thus masked.

Kröchlendorff observation cycle 1 may 1999	*Alopecurus pratensis*	*Anthriscus sylvestris*	*Cardamine amara*	*Carex acutiformis*	*Carex paniculata*	*Crataegus monogyna*	*Ranunculus bulbosus*	*Ranunculus repens*	*Taraxacum officinale*	*Veronica chamaedrys*	sum	number
Anasimyia interpuncta					1						1	1
Baccha elongata			14								14	1
Cheilosia albitarsis							5	33			38	2
Cheilosia impressa								1			1	1
Cheilosia proxima		1									1	1
Cheilosia pubera								2			2	1
Cheilosia rufimana		8									8	1
Cheilosia vicina		1									1	1
Cheilosia vulpina		1						9			10	2
Chrysotoxum cautum										2	2	1
Dasysyrphus venustus								1			1	1
Epistrophe eligans						1					1	1
Eristalis interrupta						1			2		3	2
Eristalis pertinax						1					1	1
Helophilus pendulus						1					1	1
Leucozona lucorum s.str.		1									1	1
Melanogaster nuda						1		104			105	2
Melanogaster cf. *parumplicata*						1					1	1
Melanostoma mellinum	34			2							36	2
Melanostoma scalare					5						5	1
Myathropa florea		2				1					3	2
Neoascia meticulosa		2	2			2					6	3
Neoascia tenur					12						12	1
Orthonevra brevicornis						1					1	1
Platycheirus clypeatus					4						4	1
Platycheirus europaeus					1						1	1
Platycheirus fulviventris					1						1	1
Platycheirus peltatus				4							4	1
Pipizella viduata							2				2	1
Sphegina clunipes			3								3	1
Sphaerophoria interrupta agg. (f)								1			1	1
Syritta pipiens		1									1	1
Syrphus ribesii		1				1		1			3	3
Xanthogramma pedissequum			1								1	1
sum	34	18	20	6	24	11	7	152	2	2	276	10
number	1	9	4	2	6	10	2	8	1	1	34	

Tab. 5: Flower visits of Syrphidae in May 1999, Kröchlendorff transect.



Tab. 6: Flower visits of Syrphidae in July 1999, Kröchlendorff transect.

Kröchlendorff observation cycle 4 may 2000	*Alopecurus pratensis*	*Anthriscus sylvestris*	*Bellis perennis*	*Brassica napus*	*Caltha palustris*	*Capsella bursa-pastoris*	*Cardamine amara*	*Cardamine pratensis*	*Carex paniculata*	*Cerastium fontanum agg.*	*Crataegus monogyna*	*Geum rivale*	*Ranunculus acris*	*Ranunculus bulbosus*	*Ranunculus repens*	*Taraxacum officinale*	*Veronica chamaedrys*	sum	number
Anasimyia interpuncta																1		1	1
Cheilosia albitarsis					21		1						50	32	8	2		114	6
Cheilosia chlorus					1		3								1			5	3
Cheilosia pagana															1			1	1
Cheilosia pubera					17		1				1		13	4	8	3		47	7
Cheilosia variabilis							2						1					3	2
Cheilosia vernalis																1		1	1
Epistrophe eligans				1														1	1
Eristalis arbustorum							1				1							2	2
Eristalis interrupta							1				3							4	2
Eristalis pertinax											1					1		2	2
Eumerus strigatus															1			1	1
Helophilus pendulus							3											3	1
Leucozona lucorum s.str.							2											2	1
Lejogaster metallina													1	1	1			3	3
Melanogaster nuda													5		16			21	2
Melanostoma mellinum	25			1		1					1							28	4
Melanostoma scalare	12			1			3											16	3
Eupeodes latifasciatus				1												1		2	2
Neoascia meticulosa		1		1			23				1						3	29	5
Neoascia podagrica							4											4	1
Neoascia tenur							21	4			1							26	3
Orthonevra brevicornis											1							1	1
Platycheirus albimanus													1					1	1
Platycheirus angustatus	4																	4	1
Platycherius clypeatus	39								2									41	2
Platycheirus europaeus																		0	0
Platycheirus fulviventris	2																	2	1
Platycheirus peltatus							1											1	1
Pipizella sp. (f)							1											1	1
Rhingia campestris				1			2					5						8	3
Sphegina clunipes							1											1	1
Sphaerophoria scripta			1				1			1	1						1	5	5
Syrphus ribesii				2			2				1							5	3
Syrphus vitripennis				1			1											2	2
Temnostoma meridionale											1							1	1
Tropidia scita																	1	1	1
Xanthogramma festivum																	1	1	1
sum	82	1	1	9	39	1	74	4	2	1	13	5	71	37	36	9	6	391	17
number	5	1	1	8	3	1	19	1	1	1	11	1	6	3	7	6	4	38	

Tab. 7: Flower visits of Syrphidae in May 2000, Kröchlendorff transect.

Kröchlendorff observation cycle 5 july 2000	*Aegopodium podagraria*	*Capsella bursa-pastoris*	*Cichorium intybus*	*Daucus carota*	*Elymus repens*	*Matricharia recutita*	*Papaver rhoeas*	*Phleum pratense*	*Rubus fruticosus* agg.	*Urtica dioica*	sum	number
Chrysogaster cemiteriorum				4							4	1
Chrysogaster solstitialis				1							1	1
Episyrphus balteatus	1	1	4			2	2		1		11	6
Melanostoma mellinum	2				1		3	10		1	17	5
Melanostoma scalare					1						1	1
Platycheirus albimanus								1			1	1
Platycheirus clypeatus	7							6			13	2
Platycheirus europaeus								1			1	1
Platycheirus fulviventris					1			4			5	2
Scaeva pyrastri			3								3	1
Sphaerophoria scripta	1					3					4	2
sum	11	1	7	5	3	5	5	22	1	1	61	10
number	4	1	2	2	3	2	2	5	1	1	11	

Kröchlendorff observation cycle 6 september 2000	*Arctophila superbiens*	*Eristalis arbustorum*	*Eristalis horticola*	*Eristalis interrupta*	*Eristalis pertinax*	*Eristalis tenax*	*Episyrphus balteatus*	*Helophilus pendulus*	*Melanostoma mellinum*	*Melanostoma mellinum* agg.	*Melanostoma scalare*	*Neoascia podagrica*	*Platycheirus albimanus*	*Platycheirus clypeatus*	*Platycheirus peltatus*	*Platycheirus scutatus*	*Sphaerophoria scripta*	*Syritta pipiens*	*Syrphus ribesii*	*Syrphus vitripennis*	sum	number
Achillea millefolium		8	2	9	7	1		3					1				1	2			34	9
Arctium tomentosum							1														1	1
Centaurea scabiosa	1							2											1		4	3
Centaurea stoebe																	1				1	1
Cichorium intybus																1					1	1
Cirisum arvense				1	1			4													6	3
Cirsium oleraceum	4																				4	1
Cirsium vulgare	2				2			1													5	3
Daucus carota								1	1			1									3	3
Echinops sphaerocephalus										2							1			3	6	3
Erigeron acris									1												1	1
Festuca arundinacea											1										1	1
Fragaria viridis												1									1	1
Geranium palustre								8							1		1				10	3
Geranium robertianum								1													1	1
Hypericum perforatum																			1		1	1
Impatiens parviflora							1	1							2						4	3
Leontodon hispidus						1															1	1
Phleum pratense														1							1	1
Plantago lanceolata									11	1											12	2
Ranunculus acris									1												1	1
Ranunculus repens									6								1				7	2
Scrophularia umbrosa									2		1										3	2
Senecio jacobaea				1		1		1									2				5	4
Sonchus arvensis ssp. *uliginosus*				1																	1	1
Sonchus oleraceus				1																	1	1
Taraxacum officinale				2	1			2	1						1						7	5
Tripleurospermum perforatum																	1				1	1
sum	7	8	2	15	11	3	2	24	23	3	2	2	1	1	4	1	8	2	2	3	124	20
number	3	1	1	6	4	3	2	10	7	2	2	2	1	1	3	1	7	1	2	1	28	

Berkholz observation cycle 1 may 1999	*Alopecurus pratensis*	*Caltha palustris*	*Cardamine amara*	*Cardamine pratensis*	*Carex paniculata*	*Lonicera xylosteum*	*Moehringia trinervia*	*Ranunculus acris*	*Ranunculus repens*	*Taraxacum officinale*	*Valeriana dioica*	sum	number
Anasimyia interpuncta			4									4	1
Anasimyia lineata			1						3			4	2
Cheilosia albitarsis		1						2				3	2
Cheilosia chlorus		2										2	1
Cheilosia pagana		2										2	1
Cheilosia pubera		4	1									5	2
Cheilosia rufimana		1	6	2								9	3
Brachymyia berberina			1									1	1
Dasysyrphus venustus		1	1			3				1		6	4
Epistrophe eligans						1						1	1
Eristalis horticola			1									1	1
Eristalis interrupta			2									2	1
Eristalis pertinax		1				1						2	2
Helophilus pendulus						2					1	3	2
Leucozona lucorum s.str.			2									2	1
Melanogaster nuda		2	1									3	2
Melanostoma mellinum	1				2							3	2
Neoascia meticulosa			5									5	1
Neoascia podagrica			1									1	1
Neoascia tenur			1	90	14				4			109	4
Orthonevra brevicornis		1										1	1
Platycheirus albimanus			1									1	1
Pyrophaena rosarum							1					1	1
Tropidia scita				1								1	1
sum	1	15	28	93	16	7	1	2	7	1	1	172	11
number	1	9	14	3	2	4	1	1	2	1	1	24	

Tab. 10: Flower visits of Syrphidae in May 1999, Berkholz transect.

← **Tab. 8: Flower visits** of Syrphidae in July 2000, Kröchlendorff transect.

← **Tab. 9: Flower visits** of Syrphidae in September 2000, Kröchlendorff transect.

Berkholz observation cycle 2 july 1999	*Achillea millefolium*	*Agrimonia eupatoria*	*Alisma plantago-aquatica*	*Arctium tomentosum*	*Capsella bursa-pastoris*	*Centaurea cyanus*	*Centaurea jacea*	*Centaurea scabiosa*	*Chaerophyllum temulum*	*Circaea lutetiana*	*Cirsium arvense*	*Cirsium palustre*	*Convolvulus arvensis*	*Daucus carota*	*Epilobium tetragonum*	*Eupatorium cannabinum*	*Falcaria vulgaris*	*Filipendula ulmaria*	*Galium album*
Anasimyia lineata																			
Chrysogaster cemiteriorum									4				3	5			15		
Chrysogaster solstitialis	2								16				3	4			5		
Cheilosia pagana																			
Chrysotoxum bicinctum						1		1	1				2						
Chrysotoxum verralli											1								
Eristalinus sepulchralis											1								
Eristalis arbustorum								1	11		6	1		1					
Eristalis horticola											2								
Eristalis intricaria											10	2							
Eristalis interrupta	1								4		10			1				1	
Eristalis pertinax									3		56					5	1		
Eristalis tenax								1	2		38								
Episyrphus balteatus	1	2		7	3	9		31	43	7	146	72	38	5		3	4	51	3
Meliscaeva cinctella																		1	
Helophilus hybridus											5								
Helophilus pendulus			1								10								
Helophilus trivittatus											6								
Melanostoma mellinum									2										
Melanostoma scalare																			
Eupeodes corollae									1		5		1						
Eupeodes luniger													1						
Myathropa florea	1								1										
Neoascia tenur																			
Orthonevra nobilis														1					
Pipiza noctiluca																		1	
Platycheirus albimanus										1									
Platycheirus clypeatus																			
Platycheirus fulviventris																			
Pipizella viduata									1										
Scaeva pyrastri									2		3		3						
Scaeva selenitica								2				1							
Sphegina clunipes										2									
Sphegina elegans										2					1				
Sphaerophoria scripta			4			3			7		22	1	11	1			4		1
Sphaerophoria taeniata	1								1		1								
Syritta pipiens									2		1								1
Syrphus ribesii							1				5								
Syrphus vitripennis							1	1	6		9	1		1					
Tropidia scita																			
Volucella bombylans												1							
Volucella pellucens											3	1							
sum	6	2	5	7	3	13	2	37	107	12	340	80	62	19	1	8	29	54	5
number	5	1	2	1	1	3	2	6	17	4	20	8	8	8	1	2	5	4	3

Tab. 11: Flower visits of Syrphidae in July 1999, Berkholz transect.

																								1	1
											1													6	2
									3		2													16	4
																								6	1
	1							1					39			1								44	5
													3			2								5	2
									1		3													11	5
																								1	1
															3									5	3
	9								3	3			9					9						33	5
																								1	1
																								1	1
											2													3	2
													1						1					2	2
																			3					3	1
																								1	1
																								8	3
																								3	2
																								2	1
																								3	2
	9					1		2	3		64									1		1		135	16
											1			1										5	5
											5	1												10	5
											1													7	3
		1																						20	7
	5	1							10		1			4	4							2	1	28	8
																								1	1
																								4	2
1	31	9	14	2	25	1	1	3	23	5	119	2	52	5	7	3	5	10	4	2	1	4	1	1122	43
1	7	3	1	1	1	1	1	2	7	2	12	2	4	2	2	2	4	2	2	2	1	3	1	42	

Galium palustre	Galium uliginosum	Hypericum perforatum	Hypericum tetrapterum	Impatiens noli-tangere	Impatiens parviflora	Juncus effusus	Knautia arvensis	Lolium perenne	Lycopus europaeus	Lysimachia vulgaris	Matricharia recutita	Mentha aquatica	Molinia caerulea	Myosotis scorpioides agg.	Peucedanum palustre	Phalaris arundinacea	Pimpinella saxifraga	Potentilla erecta	Scirpus sylvaticus	Senecio sylvaticus	Silene flos-cuculi	Stellaria graminea	Valeriana officinalis agg.	sum	number
1																								1	1
																								27	4
																	1							31	6
	1																							1	1
	1																					1		7	6
																								1	1
											1													2	2
									1		1						1							23	8
																								2	1
																								12	2
																	2							19	6
																								65	4
																				1				42	4
	5	7	14	2	25		1		2	2	37	1					1	1			1			524	29
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1	1

Berkholz observation cylce 3 september 1999	*Angelica sylvestris*	*Cirsium palustre*	*Bistorta officinalis*	*Succisa pratensis*	sum	number
Arctophila superbiens		2		7	9	2
Eristalis tenax	2				2	1
Episyrphus balteatus	1				1	1
Helophilus pendulus			1		1	1
Platycheirus peltatus	1				1	1
sum	4	2	1	7	14	4
number	3	1	1	1	5	

Tab. 12: Flower visits of Syrphidae in September 1999, Berkholz transect.

Tab. 13: Flower visits of Syrphidae in May 2000, Berkholz transect.

Berkholz observation cycle 4 may 2000	*Alopecurus aequalis*	*Caltha palustris*	*Capsella bursa-pastoris*	*Cardamine amara*	*Cardamine pratensis*	*Carex paniculata*	*Carex rostrata*	*Cerastium fontanum*	*Geum rivale*	*Lonicera xylosteum*	*Ranunculus lanuginosus*	*Ranunculus repens*	*Taraxacum officinale*	*Trollius europaeus*	*Valeriana dioica*	*Veronica chamaedrys*	sum	number
Anasimyia interpuncta		2			1												3	2
Anasimyia lineata					1												1	1
Cheilosia albitarsis		2										7					9	2
Cheilosia carbonaria				1													1	1
Cheilosia chlorus		25		3	5								3				36	4
Cheilosia pagana				2													2	1
Cheilosia pubera		47		5							1	1					54	4
Cheilosia variabilis				1													1	1
Chrysotoxum cautum													1				1	1
Dasysyrphus hilaris				1													1	1
Dasysyrphus venustus						1											1	1
Eristalinus sepulchralis													3				3	1
Eristalis interrupta				3	1												4	2
Melanogaster nuda		5									1	2					8	3
Melanostoma mellinum		1	1			3											5	3
Melanostoma scalare	1																1	1
Eupeodes luniger										1							1	1
Neoascia meticulosa				2													2	1
Neoascia podagrica		1		2													3	2
Neoascia tenur		5	1	22	2	15								1			46	6
Platycheirus albimanus				1													1	1
Platycheirus clypeatus	4		1				1										6	3
Platycheirus europaeus		1															1	1
Platycheirus fulviventris	3					1											4	2
Platycheirus occultus						1											1	1
Rhingia campestris									1								1	1
Sphaerophoria scripta			6	3				1					1		2	1	14	6
Syritta pipiens				1													1	1
Syrphus ribesii													1				1	1
Temnostoma apiforme													1				1	1
Tropidia scita					1												1	1
sum	8	89	9	47	11	21	1	1	1	1	2	10	10	1	2	1	215	16
number	3	9	4	13	6	5	1	1	1	1	2	3	6	1	1	1	31	

Looking at flower preferences at species level, a small number of distinct preference categories, based on combinations of flower colour, flower type and flower height exist, to which all species can be consigned. In the case of the Kröchlendorff transect the results of this analysis are given in fig. 15, showing only 7 different types of flower preference, plus a "0"-type, meaning no preferences at all. For analysis, only species for which 8 or more observations are available were included and only marked preferences involving over 75% (and in most cases 90-100 %) of visits were considered. An example is given, of Type I, representing a marked preference for solitary, yellow flowers of medium height, essentially visits to plants of the family Ranunuclaceae. For *Cheilosia albitarsis,* in May 1999 a total of 38 flower visits were observed, with 100% falling into this category. Visited plant species were mainly *Ranunculus repens* and to a lesser extent *Ranunculus bulbosus* (see tab. 5). In May 2000 a number of 113 out of 114 observations (>99%) were of visits to yellow flowers, and only two visits

Berkholz observation cycle 5 july 2000	*Chrysogaster cemiteriorum*	*Episyrphus balteatus*	*Melanostoma mellinum* (Intersex)	*Eupeodes corollae*	*Neoascia tenur*	*Scaeva pyrastri*	*Sphegina clunipes*	*Sphegina elegans*	*Sphaerophoria scripta*	*Syritta pipiens*	*Syrphus vitripennis*	*Tropidia scita*	*Volucella bombylans*	sum	number
Achillea millefolium		2												2	1
Aegopodium podagraria							3	1						4	2
Calystegia sepium		2												2	1
Capsella bursa-pastoris		1												1	1
Cardamine amara										1				1	1
Centaurea cyanus		5												5	1
Centaurea scabiosa		2												2	1
Cirsium arvense		1												1	1
Cirsium palustre		1												1	1
Convolvulus arvensis		1		1					3		1			6	4
Daucus carota	1													1	1
Falcaria vulgaris	5													5	1
Galium album		7							2	1	2			12	4
Galium uliginosum			1		5						1	1		8	4
Hypericum perforatum						1					1			2	2
Impatiens parviflora		1												1	1
Lycopus europaeus					2							1		3	2
Matricharia recutita		3												3	1
Myosotis scorpioides agg.		1											1	2	2
Stellaria graminea									1					1	1
sum	6	27	1	1	7	1	3	1	6	2	5	2	1	63	13
number	2	12	1	1	2	1	1	1	3	2	4	2	1	20	

Tab. 14: Flower visits of Syrphidae in July 2000, Berkholz transect.

Berkholz observation cycle 6 september 2000	Arctophila superbiens	Didea fasciata	Eristalis arbustorum	Eristalis horticola	Eristalis interrupta	Eristalis pertinax	Eristalis tenax	Episyrphus balteatus	Helophilus pendulus	Helophilus trivittatus	Melanostoma mellinum	Melanostoma scalare	Eupeodes nitens	Neoascia podagrica	Platycheirus albimanus	Platycheirus peltatus	Sericomyia silentis	Sphaerophoria menthastri agg. (f)	Sphaerophoria scripta	Sphaerophoria taeniata	Syrphus torvus	sum	number
Achillea millefolium			2	1		2	4			2											1	12	6
Angelica sylvestris						1	1															2	2
Arrhenatherum elatius											2											2	1
Centaurea scabiosa	1	1					2						1						1			6	5
Cirsium oleraceum						1					1											2	2
Cirsium palustre	7						3		2													12	3
Crepis capillaris														1					1			1	1
Daucus carota											1				1							2	2
Hypericum perforatum								1														1	1
Knautia arvensis							1															1	1
Leontodon autumnalis																				1		1	1
Matricharia recutita								1											1			2	2
Scrophularia umbrosa														2		1						3	2
Senecio jacobaea	1										1											2	2
Stellaria graminea																			1			1	1
Succisa pratensis	4			1	3	1	2	1	16	2	1	1					11		1			44	12
Taraxacum officinale											2				1				5			8	3
Tripleurospermum perforatum																			1			1	1
Veronica persica																			1			1	1
sum	13	1	2	2	3	5	13	3	18	4	8	1	1	2	1	1	11	1	12	1	1	104	21
number	4	1	1	2	1	4	6	3	2	2	6	1	1	1	1	1	1	1	8	1	1	19	

Tab. 15: Flower visits of Syrphidae in September 2000, Berkholz transect.

	D	Belgium DE BUCK	region: Strom-valley	Be	Kr	Mai 2000	July 1999	Sept. 2000
			1999 & 2000			Berkholz		
Flowering ressources	ca. 3300	ca. 2200	167	113	106	24	45	55
Episyrphus balteatus	>230	239	57	33	42	-	29	3
Syritta pipiens	>160	136	11	6	7	1	5	-
Myathropa florea	>85	75	5	2	2	-	2	-
Arctophila superbiens	8	14	6	4	3	-	-	4
Cheilosia albitarsis	16	24	7	3	7	2	-	-
Chrysogaster solstitialis	21	21	7	6	3	-	6	-

Tab 16: Flower visiting spectra in relation to spatial scale and phenological period. – D Germany with data originating from a database based on published data from Germany and unpublished oberservations from the author; Belgium: data taken from De Buck (1990). B = Berkholz transect, Kr = Kröchlendorff transect.

were not to solitary flowers but to composite flowers of the basket type. But, in May 2000, the visited plant species were more diverse, with six plant species (see tab. 7 for details) involved.

The main types of flower preferences observed on the Kröchlendorff transect were:

I: yellow solitary flowers of medium height (Ranunculaceae)

II: white composite flowers in the highest flower stratum (Apiaceae)

III: Preference for white flowers only in the medium to high strata, but using both solitary and composite flowers

IV: Red or violet composite flowers of the basket type in the highest flower stratum (Asteraceae)

V: Red or violet and blue flowers in medium and lower strata, regardless of flower type

VI: Anemophilous, green or inconspicuous flowers

VII: only a slight preference for flowers in the highest flower stratum, but using all colours and flower types

0: no preferences at all

These basic types also existed among the observations made on the Berkholz transect.

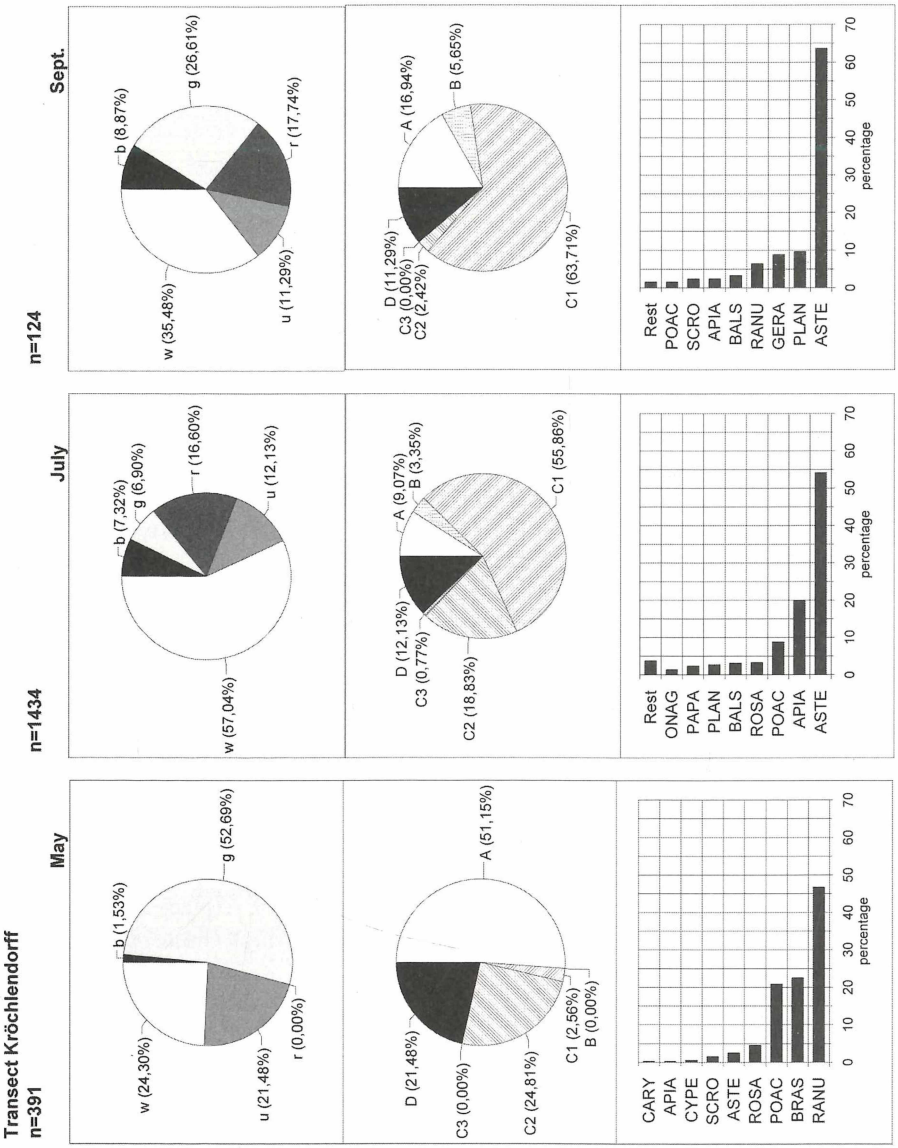


Fig. 14: Flower visiting preferences of Syrphidae in the Kröchlendorff transect throughout the year. – Upper diagrams: colour preferences with w white, b blue, g yellow, r red and u green flowers or without petals. – Middle row of diagrams: flower type preferences, explanations see text. – Lower diagrams: flower visits on different plant families with Apia Apiaceae, Aste Asteraceae, Bals Balsaminaceae, Bras Brassicaceae, Cary Caryophyllaceae, Cype Cyperaceae, Gera Geraniaceae, Onag Onagraceae, Papa Papaveraceae, Plan Plantaginaceae, Poac Poaceae, Ranu Ranunculaceae, Rosa Rosaceae, Scro Scrophulariaceae.

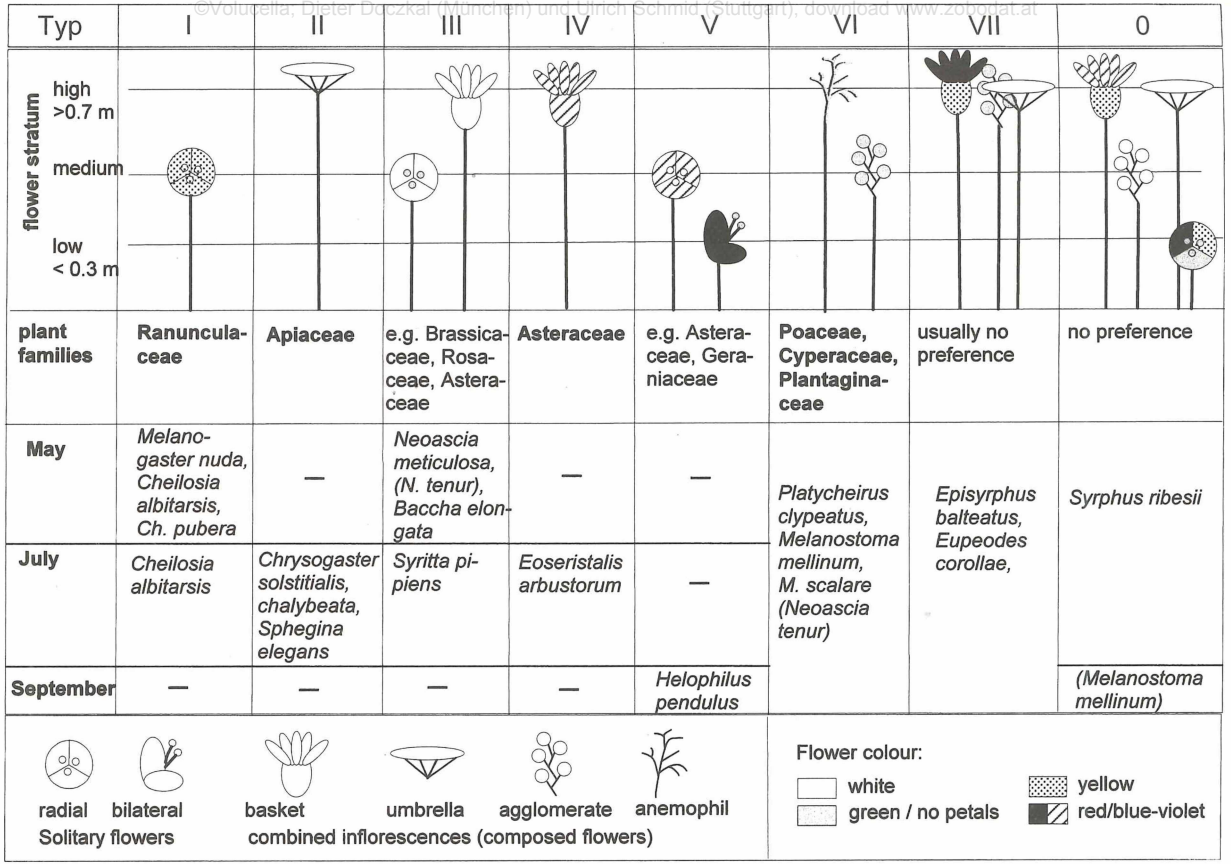


Fig. 15: Preferences for flower types of individual syrphid species; transect Kröchlendorff.

Syrphid species with only a relatively short flying period did not occur in sufficient numbers for detailed analysis in subsequent phenological observation periods. For those species with longer flight periods there was a change of plant species used, observed during the flight period, although the type of flower preference usually stayed the same. This phenological shift in plant species visited can be seen, for example, in *Melanostoma mellinum* (fig. 16): While in May almost all visits were observed to the grass *Alopecurus pratensis*, July-observations showed flower visits to the now flowering grass *Brachypodium sylvaticum* and to *Plantago lanceolata*. All major plant species visited are anemophilous, providing a pollen source only. Thus the flower preference type VI stays the same. In autumn, the availability and densitiy of flowers is much reduced, and while *Melanostoma mellinum* still visited *Plantago lanceolata*, at that time of year it also visited the yellow flowers of *Ranunculus repens*.

On the local scale, comparison between the behaviour of a given species on the two landscape transects, in the same region, showed in some rare cases differences in flower visiting. An interesting example is *Arctophila superbiens* (photo 1), a typical autumn species, easily recognised as a large, brown, bumble bee mimic. This species showed a marked preference for red and blue composite flowers, visiting mainly *Cirsium palustre* and *Succisa pratensis* on the Berkholz transect (fig. 17) and was not observed there on *Cirsium oleraceum,* which was abundant and flowering there at the same time. However, on the Kröchlendorff transect, where *Succisa pratensis* is absent and *Cirsium palustre* is very rare, *Arctophila superbiens* visited mainly *Cirsium oleraceum* and *Cirisum vulgare*. In all cases composite flowers of the basket type were visited. It would seem that flower density may play a decisive role in the choice of flowers visited by *Arctophila superbiens*.

Closely related species may use almost the same plants as nectar and pollen ressource like, for example, *Chrysogaster cemiteriorum* and *Chrysogaster solstitialis* (fig. 18). Both species exhibit the same basic type of flower preference, for white umbels of the Apiaceae, and visited mainly *Daucus carota*. Nevertheless, in spatial distribution they showed differences in habitat use, *Chrysogaster cemiteriorum* preferring the drier grasslands and being more abundant there. This is also reflected in flower visiting, through the larger proportion of *Falcaria vulgaris* visited, while for *Chrysogaster solstitialis, Chaerophyllum temulum*, a plant of more mesic conditions, was more important as plant species visited.

Discussion

The local fauna of the Stromtal can be regarded as very species-rich, with 108 species recorded during this study. The species list certainly includes several species new to the fauna of Brandenburg. However, no check-list exists for Brandenburg and no systematic revision of museum collections has yet been carried out there. The only substantial work on syrphid flies has been published from Berlin, and its adjacent

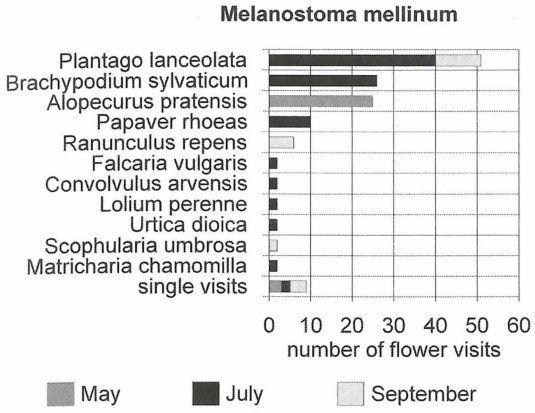


Fig. 16: Phenological shift in flower preferences: *Melanostoma mellinum.*

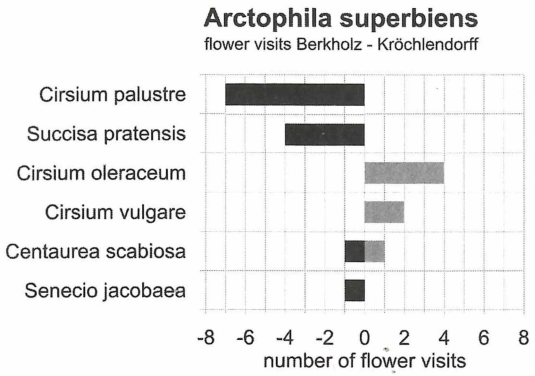


Fig. 17: Different flower visiting preferences in the transects: example *Arctophila superbiens.*

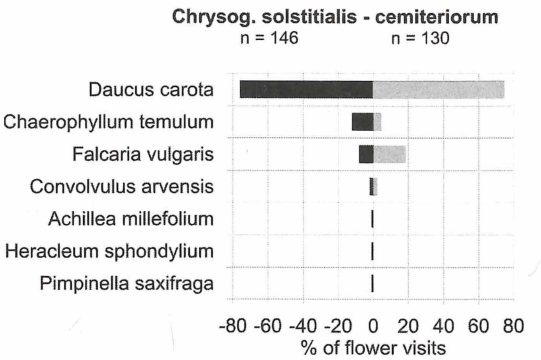


Fig. 18: Related species with the same basic preferences: White Apiaceae flowers *Chrysogaster cemiteriorum* and *C. solstitialis.*

areas in Brandenburg, by Wolff (1998), who lists 253 species. First observations from the Märkische Schweiz (Nüßler 2000) and recent description of a new species (*Brachyopa grunewaldensis)* also from the Berlin area (Kassebeer 2000), show an urgent need to investigate the syrphid fauna of Brandenburg. Further, *Myolepta obscura*, a species believed to be extinct in Germany since about 1895 (Wolff 1996), has been found again near Berlin recently (Kassebeer & Hilger 2000). The species list from the Stromtal does include *Xanthogramma stackelbergi* Violovitsh, 1975 and an unnamed sibling species of *Melanostoma mellinum,* two species not yet listed in the current checklist for Germany (Ssymank et al. 1999).

It can be assumed that the Stromtal species list is not complete yet and that quite a number of additional species await discovery, especially in the forests of the "Tiergarten", near Boitzenburg, which have an outstanding proportion of old oak trees. Thus saproxylic species, which couldn't find suitable habitats in the two valley transects of the present study, can be expected to be present in the vicinity. Additional material from water traps, and other sampling programmes in the region, are not yet fully determined or written up and the research programme with Syrphidae has been continued in the year 2001. The black alder forest in the two transects reported on here is not older than about 50 years, and it is quite remarkable that *Temnostoma meridionale*, together with *T. vespiforme,* were already able to colonise these forests. Larvae of *Chalcosyrphus nemorum* are often found in logs of *Alnus* or *Betula,* of less than 30cm diameter, but *Temnostoma* species were thought to use older dead wood only.

With respect to nature conservation, *Riponnensia splendens* and *Temnostoma meridionale* are highly endangered species (Red Data Book of Germany, Ssymank & Doczkal 1998) and 6 other species recorded from Stromtal are also endangered: *Chrysogaster cemiteriorum*, *Cheilosia pubera*, *Cheilosia rufimana*, *Neoascia interrupta*, *Pipizella divicoi* and *Temnostoma apiforme*. Both *Chrysogaster cemiteriorum* and *Cheilosia pubera* have relatively large populations in the Stromtal and are locally abundant. Furthermore, a number of the species recorded there are believed to be threatened or likely to become threatened in the near future. The full species diversity of the Stromtal could only be maintained if almost all biotopes present there now, both disused, seasonally-flooded grassland and lightly-grazed grassland included, as well as the intensively used pastures of south facing slopes, continue to be present in future. The very distinct patterns of spatial distribution and flower visiting show that most biotope types or complexes present have their own associated species, the only exceptions being crops and intensively pastured, mesic grasslands outside the valley. However, threatened or rare species are concentrated in three major situations: (1) the wet, open, seasonally-flooded grassland and fen, and the reed beds, in the valley bottom, (2) the black alder forest (both alluvial and with stagnant water) and (3) the dry, south facing, upper slopes of the valley.

Using the grid mapping method with units of 100 m², it could be demonstrated that most syrphid species show a very distinct spatial pattern of habitat use, reflecting

the status and use of the landscape and the pattern of biotopes. Although most syrphids are easily capable of flying greater distances and could be expected to occur all over the valley, the results of the two transects, only two kilometres apart, clearly show that the distribution of the adult flies may differ over short distances and that local differences in habitat preference and flower visiting exist. On the other hand, the Syrphidae use flowers in a very precisely defined way, with flower preference types based on flower colour, plant height and flower type (and some preference for the flowers of particular plant families). Furthermore, comparing these data from the Stromtal , in Brandenburg, with data-sets from similar grid-mapped transects across valleys in the area south of Bonn, in North-Rhine Westfalia (Ssymank 2001), in a cultural landscape and in arable landscapes, it may be assumed that, as a general rule, flower preferences of syrphid flies in central Europe can be grouped into a relatively low number of perhaps 10-12 different categories. Though these categories are not necessarily all manifest at each site, this being dependent upon which plant species and syrphid species are present in the regional flora and fauna. Phenology and flower preferences together generally lead to a relatively low number (2-6) of plant species visited simultaneously by any one syrphid species, with the exception of a few unspecialised species. Thus the importance of adult syrphids, for pollination of wild flowers on a given site, can be much higher than might be supposed from use of additive lists of flowers visited, that are based on all seasons or large geographic areas.

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