Gardens: An important refuge for insects, or a green desert ?

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Abstract

In recent years, the conservation of insects has received increasing attention. It has been stated several times in the past that gardens are becoming increasingly important as a refuge for wildlife, particularly for smaller organisms like insects and other small Arthropods.
To test this hypothesis, a sampling campaign was started in three gardens with a different environmental background, but each typical for the local situation. The order of Diptera was chosen as a target group because it is a large insect group which encompasses a wide range of feeding styles (e.g. herbivores, predators, parasitoids, detrivores, coprophages, ...). In addition, flies were collected in a number of natural habitats (including several nature reserves). To capture the flies a Malaise trap was used at each sample site.
A preliminary analysis of the data revealed that in general the Diptera fauna of the gardens studied is poor compared to the Diptera fauna of natural habitats.
Key-words: insect conservation, gardens, Diptera.

Samenvatting

De laatste jaren wordt meer en meer aandacht geschonken aan de bescherming van insekten. In het verleden werd verscheidene malen geopperd dat tuinen een steeds belangrijkere rol spelen als een refugium voor bedreigde dieren en meer bepaald voor kleinere organismen zoals insekten en andere Arthropoda. Om deze hypothese te testen werd gestart met de inventarisatie van drie tuinen, elk gelegen in een andere ecologische omgeving. Als doelgroep werd de orde Diptera uitgekozen daar dit een grote insektengroep is waarvan de vertegenwoordigers een groot aantal verschillende voedingswijzen vertonen (o.a. herbivoren, predatoren, parasitoïden, detritivoren, coprofagen, ...). Naast de tuinen werden tevens Diptera verzameld in een aantal natuurlijke habitaten (inclusief een aantal natuurreservaten). Om de vliegen te vangen werden Malaise vallen gebruikt.
De analyse van de gegevens toonde aan dat, algemeen genomen, de Diptera fauna van de tuinen veel armer was dan deze van de natuurlijke habitaten.
Trefwoorden: bescherming van insekten, tuinen, Diptera.

Introduction

One of the most important aspects of human impact on nature is fragmentation of natural habitats. The resulting distribution and subdivision of the total habitat not only holds important demographical and evolutionary implications, but also largely affects the extinction probability of a resident animal or plant population (SOULÉ, 1986; SAUNDERS *et al.*, 1991). Therefore the preservation of suitable habitats is of vital importance in nature conservation (PYLE *et al.*, 1981; NOSS, 1987; SAMWAYS, 1989a).

In the past, biological conservation efforts were mainly focused on plants, birds and/or mammals (USHER, 1986). The last decade, however, the conservation of insects has received increasing attention. (PYLE *et al.*, 1981; SAMWAYS, 1989b; COLLIN *et al.*, 1991), This is not only because many of them are endangered, but also because insects are particularly good ecological indicators which makes them suitable for site assessment for nature conservation (DISNEY, 1986; SIEPEL, 1989; USHER, 1990).

It has been stated repeatedly that gardens are becoming increasingly important as a refuge for wildlife, particularly for smaller organisms like insects (OWEN, 1980, 1991). OWEN & OWEN (1975) and OWEN (1991) even stated that suburban gardens could constitute the most important nature reserve for small Arthropods. However, a faunal survey of a garden in Schoten in 1983 revealed that the entomofauna, and more particular the Diptera fauna, was quite poor (POLLET & DE BRUYN, 1987). Other studies carried out in agricultural and residential areas gave analogous results (BANKS, 1959; BANKOWSKA, 1980). To test whether or not the assumption of OWEN & OWEN (1975) and OWEN (1991) can be applied to insects, and more in particular to Diptera, we started a sampling campaign in two additional gardens in the vicinity of Antwerp (Belgium). The results were compared with the faunal composition of some natural habitats in the same geographical area.

Material and Methods

Sample localities

During the present study the entomofauna of three garden habitats (Schoten - FS.08; Wijnegem - FS.07 and Oelegem - FS.17) and six natural habitats (the nature reserve "De Kuifeend": Antwerpen - ES.98, two sites; the nature reserve "De Oude Landen": Ekeren - ES.98, two sites; and the nature reserve "Het Groot Schietveld": Wuustwezel - FS.09 and Brasschaat - FS.08) were compared.

The garden in Schoten, which covers a total surface of approximately 500 m², consists mainly of two habitat types; a more or less conventional garden and an unkempt woodland. The first consists of a central lawn (mown weekly) bordered by flowerbeds and shrubberies. Many plants are introduced aliens, other are natives which could penetrate the garden, or were introduced intentionally, and established afterwards. A small pond (± 20 m²) bordered by a swampy vegetation is situated in one of the corners of the garden. The other side of the garden serves as a small orchard of *Malus* sp., *Prunus persica* and *Pyrus* sp. The woodland consists mainly of native trees like *Alnus glutinosa*, *Quercus rubra*, *Q. robur*, *Betula pendula* and *Sorbus aucuparia*. Furthermore, we have to mention the sampling plot was situated in a humid environment due to the presence of a (strongly polluted) brooklet which has its course through the garden, and the canal Schoten-Turnhout at the back of the garden. The adjacent gardens are similar in general appearance although the vegetational diversity is usually lower due to a strong dominance of shortly cut lawns.

The main part of the garden in Wijnegem (± 250 m²) is also occupied by a central lawn (mown twice a week), surrounded by coniferous and ornamental shrubs (*Viburnum* sp., *Forsytia* sp., *Syringa* sp.). A number of fruit trees (*Malus* sp., *Pyrus* sp., *Prunus* sp.) are scattered in the garden. The garden is situated in a residential area with approximately the same type of gardens in the neighbourhood. At the other side of the house there is an agricultural pasture of ± 3 ha.

The third garden, "Vrieselhof" at Oelegem (± 900 m²) is situated at the edge of a deciduous forest (mainly *Fagus*). Here again, there is a large central lawn (mown at longer, irregular intervals) with a *Crataegus* hedge. A few coniferous shrubs and trees are scattered in the garden. At one side, the garden is bordered by a house, on the other side by the stables of a riding school.

In the nature reserve "De Kuifeend" two different habitat types were selected. The first (Kuifeend 1), was a narrow strip (± 20 m) of moist reedland, bordered by a lake at the one side and a moist *Salix* forest at the other side. The vegetation consisted mainly of *Phragmites australis* with patches of *Carex* sp. and *Typha latifolia*. The second habitat (Kuifeend 2) was a ruderal area on a sandy soil. Dominant plants were Poaceae, *Oenothera parviflora, Reseda lutea, Urtica dioica* and *Symphytum officinale*.

The first sample plot in the nature reserve "De Oude landen" (Oude Landen 1) was situated in a large marshy reedland, dominated by *Phragmites australis*. Other abundant species were *Carex* spp. Some 20 m to the North was a deciduous forest edge. The second plot (Oude Landen 2) consisted of an overgrown, moist grassland, surrounded by an *Alnus-Salix* brushwood. Abundant plant species in the grassland were *Symphytum officinale, Mentha aquatica* and some *Carex* spp.

Both sample plots in the nature reserve "Groot Schietveld" were heathland habitats, dominated by *Molinia caerulea*. In the first (Groot Schietveld 1), which was very humid, also *Phragmites australis, Narthecium ossifragum* and *Juncus* spp. were abundant. Some *Betula pendula* trees were scattered in the vegetation. In the second, dry heathland (Groot Schietveld 2), *Molinia caerulea* was less abundant and replaced by *Calluna vulgaris* and *Erica tetralix*. Several forest patches of *Betula pendula* and *Myrica gale* were scattered in the sample station.

Collection techniques

To collect the flies, one Malaise trap (TOWNES, 1972; MUIRHEAD-THOMSON, 1991) was used at each sample station. The trap has a black, vertical panel which forms a barrier across the flight paths of flying insects. The insects striking this barrier crawl upwards into a peaked roof where they enter a collecting jar attached at the highest point of the trap. The collecting jar was filled with a 70% alcohol solution. The traps in the three gardens were operative from 28.04.1991 to 25.08.1991 and emptied at weekly intervals. The other trap were active during complete year cycles, but only the same time period was used in the faunal analyses. For each locality we determined the species number and abundance, and calculated the diversity index (Shannon-Wiener index and Simpson index) and evenness index (Hurlbert index) (PIELOU, 1966; KREBS, 1989).

Results

Identification of the captured flies revealed that representatives of several Diptera families were present (e.g. POLLET & DE BRUYN, 1987). In the present work, we confined our analyses to the family Syrphidae. This family was selected because it is a well studied and well known, rather large group of insects that encompass a wide range of feeding styles like herbivores, predators, coprophages, ... (e.g. OWEN, 1981; VERLINDEN & DECLEER, 1987; RÖDER, 1990). Besides this, an extensive survey of the Belgian Diptera fauna has been carried out during the last decade (GROOTAERT, 1989) which gives us a fair idea of the actual distribution and abundance of the different Syrphidae species (VERLINDEN & DECLEER, 1987).

All three gardens harbour conspicuously less Syrphidae species than the natural habitats (Tab. 1). In addition, these species are all caught in very low numbers; most species are only represented by a single individual. This is also reflected in the diversity indices which are lowest for the gardens. Furthermore, the Hurlbert evenness index shows the hoverfly communities in Wijnegem and Oelegem are not homogeneously spread. Two species, *Episyrphus balteatus* (DE GEER) (Wijnegem: 190; Oelegem: 95) and *Metasyrphus corollae* (FABRICIUS) (Wijnegem: 89; Oelegem: 15), together account for 79% and 63.6% of the total number hoverflies collected in the respective localities. Both species are known to migrate in large numbers over long distances (AUBERT *et al.*, 1976; GATTER & SCHMID, 1990). Almost all specimens of both fly species were caught during one single week between 2.08.1991 and 9.08.1991. During this period the flies were also recorded in high numbers throughout the country. This indicates that the high numbers caught at both localities were presumably produced by migrating flies, and not by local breeding flies.

Table 1. Species composition, diversity (Shannon-Wiener & Simpson) index and evenness index of the different sample sites.

Locality	# species	# specimens	Shannon-Wiener	Simpson	Hurlbert	N_1
Schoten	14	36	2.062	0.853	0.781	0.724
Wijnegem	19	376	1.588	0.678	0.539	0.462
Oelegem	29	176	1.914	0.682	0.568	0.649
Oude Landen 1	37	1025	2.814	0.917	0.779	1.035
Oude Landen 2	55	1148	2.427	0.826	0.606	0.887
Groot Schietveld 1	48	519	2.678	0.886	0.692	0.985
Groot Schietveld 2	55	693	3.095	0.928	0.772	1.130
Kuifeend 1	47	2023	2.769	0.946	0.719	1.018
Kuifeend 2	64	2238	2.789	0.926	0.671	1.026

When comparing sites for conservation purposes, the classical way of measuring species richness or species diversity indices, where all species (of the same taxonomic group) carry the same weight, are considered inadequate (VANE-WRIGHT *et al.*, 1991; COUSINS, 1991). In addition, other properties of the species in question have to be taken into account. Therefore we analysed the Syrphidae communities according to the adult habitat preference and migrating abilities, and the larval feeding type (Tab. 2).

The adults flies of most species caught in the gardens are eurytopic, while their larvae are opportunist feeders, mainly predacious on aphids and other Homoptera. Other species have aquatic larvae which are common in waters, strongly polluted with organic matter (e.g. *Eristalis arbustorum* (LINNAEUS), *Helophilus pendulus* (LINNAEUS)) or burrow in decaying organic matter (e.g. *Syritta pipiens* (LINNAEUS)). The phytophagous species *Merodon equestris* (FABRICIUS) and *Eumerus strigatus* (FALLÉN) are commonly encountered in gardens and other cultured areas. The larvae of both species live as internal parasites in bulbs (RÖDER, 1990). At Oelegem, also a considerable number of woodland species were caught as might have been expected with a view to the proximity of the deciduous forest.

It was quite surprising, however, to find that at Wijnegem a couple of the rare *Platycheirus ambiguous* (FALLÉN) was caught, so far the only capture in 50 Malaise trap samplings. Both at

Wijnegem and Oelegem there were single individuals of *Epistrophe melanostoma* (ZETTERSTEDT) and *Metasyrphus latilunulatus* (COLLIN), known from 22 and 28 UTM-squares respectively, but not known from this country until recent times. Especially these last years, *E. melanostoma* has turned up regularly and the species may well be a recent immigrant, expanding its area and now established and prospering. *M. latilunulatus* is probably a very widespread species; it was only defined accurately in 1976 by DUSEK & LASKA and is in the field indistinguishable from more common *Metasyrphus*; it has turned up (1 or 2 specimens) regularly in Malaise traps and may be less rare than we thought so far.

Table 2. Species composition based on adult habitat preference, larval feeding type and adult migrating ability for the different sample localities (species with unknown or doubtful lifestyle are omitted).

		Schoten	Wijnegem	Oelegem	Kuifeend 1	Kuifeend 2	Oude Landen 1	Oude Landen 2	Groot Schietveld 1	Groot Schietveld 2
adult habitat	ubiquist	8	11	15	21	27	19	23	22	25
	woodlands (s.l.)	2	4	10	2	11	6	16	14	11
	wetlands (s.l.)	1			13	13	8	7	5	11
	grasslands (s.l.)	2	3	2	7	6	4	5	3	4
	cultures / gardens	1	1		1	2		1		1
	xerophilous				3	2		1		2
larval type	carnivorous	9	18	21	23	30	21	32	25	26
	aquatic	2		3	17	20	11	9	8	15
	phytophagous	2	1	1	4	6	1	4		4
	nests					3		3	6	5
	rotting wood			3		1	2	3	4	4
	coprophagous	1		1	2	3	2	3	3	3
	sap feeding							1	1	
Migrants/	long distance migrants	6	7	6	11	13	10	10	10	13
	short distance migrants	4	6	12	7	10	8	11	9	9
	local species	6	8	11	31	44	19	19	28	38

In the nature reserves most species turned out to be eurytopic. In addition there were a fair number of flies with more specialised environmental requirements (e.g. xerophilous: *Paragus haemorrhous* MEIGEN, *Sphaerophoria rueppelli* (WIEDEMANN); swamps: *Neoascia* spp.; heathlands: *Chrysotoxum vernale* LOEW, *Didea intermedia* LOEW) or specialised larval feeding type, which were completely absent in the gardens. The latter group comprises species as *Chrysotoxum* spp. and *Microdon egerri* MIK which are scavengers in the nests of wasps and bumblebees, *Ferdinandea cuprea* (SCOPOLI) and *Brachyopa pilosa* COLLIN which feed on sap running from tree wounds and *Xylota* spp. with larvae living in decaying wood.

Interesting to notice is the small proportion of local species in the three garden habitats in comparison to the natural habitats (Tab. 2). Local species are species with low mobility which do not migrate during their life cycle and are assumed to breed in the garden or surrounding area. The other two groups of long distance and short distance migrators pass through a migrating phase to some extent (GATTER & SCHMID, 1990). The species of the last two categories may occasionally visit the garden when dispersing or migrating. However, as many migrants are known to breed in our country, it cannot be excluded that some of them actually are residents.

Another way to analyse the data is to look at the frequency of occurrence (Tab. 3). The different frequency classes are based on the number of UTM-squares (maximum = 401 squares; LECLERCQ *et al.*, 1980) in which a species has been recorded (VERLINDEN & DECLEER, 1987). Although this is obviously a rather rough way to catalogise the syrphid fauna, it gives us a fair idea of the relative commonness or rareness of the different species. The four classes used are common and widespread (more than 121 squares), frequent species (49-120 squares), infrequent species (25-48 squares) and rare or local species (fewer than 24 squares). In general, local species are those species which display a narrow ecological tolerance. As a result, these species can only survive in those localities where their specific ecological demands are fulfilled and are therefore usually only found at a limited number of sites. In these localities however, they can reach high population densities.

Table 3. Species composition based on the frequency of occurrence for the different sample localities (species with unknown or doubtful frequency of occurrence are omitted).

		Schoten	Wijnegem	Oelegem	Kuifeend 1	Kuifeend 2	Oude Landen 1	Oude Landen 2	Groot Schietveld 1	Groot Schietveld 2
Frequency	common and widespread	10	12	19	18	23	21	25	22	21
	frequent	4	9	9	16	20	10	15	15	21
	infrequent				6	11	5	7	4	7
	rare or local				6	8	1	8	5	6

In the three gardens, all captured species are common and widespread, or at least frequent (Tab. 3). In the nature reserves the hoverfly fauna is also largely dominated by common and widespread, or frequent species; in addition however, there are also a considerable number of infrequent and rare or local species. Among the locally abundant species we mainly find habitat specialists such as *Neoascia interrupta* (MEIGEN), *N. geniculata* (MEIGEN), *Lejogaster splendida* (MEIGEN), *Parhelophilus versicolor* (FABRICIUS), which are all bound to wetland situations (mainly marshes, vegetation at the margin of ponds and rivers but also humid woodlands), *Didea intermedia* LOEW, a species with affinities to xerotherm woodlands or heathlands and *Xylota meigeniana* STACKELBERG, an inhabitant of humid deciduous forests.

Three species were rarely recorded in the past and can be regarded as rare or threatened (VERLINDEN & DECLEER, 1987). *Cheilosia ruficollis* BECKER was formerly only recorded from 4 (5 specimens) localities. *Pipiza notata* MEIGEN was only reported from 6 localities (9 specimens), mostly in Malaise traps. Practically all records of *Doros conopseus* (FABRICIUS) date from before 1950. Only one additional specimen was found in 1960. Because no other specimen was found during the recent sample campaigns, it was thought that *D. conopseus* had virtually disappeared (VERLINDEN & DECLEER, 1987). The new discovery during the present study shows *D. conopseus* is not extinct, although it probably still is a highly endangered species.

Discussion

The results from our study revealed that, at least for the family Syrphidae, the gardens are a poor habitat for Diptera. The few species inhabiting the gardens are characterised by a high ecological tolerance and mostly possess a high ability to reproduce. These are especially species with aphidophagous larvae (*Episyrphus balteatus* (DE GEER), *Metasyrphus corollae* (FABRICIUS), *Sphaerophoria scripta* (LINNAEUS)) or generalist flies with aquatic larvae which can survive in small, temporary ponds, even when polluted, and/or saprophagous larvae (*Eristalis* spp., *Helophilus pendulus* (LINNAEUS)). More specialised species are completely absent, due to the intense management performed in the gardens. Most suburban gardens are indeed dominated by a large, short cut lawn, surrounded by flowerbeds with usually a strong dominance of introduced plants. The more specialised microhabitats needed for the larval development, such as old and rotting wood, tree wounds or nests of Hymenoptera, are lacking or removed soon after they appear.

Table 4. Species number and abundance for different habitat types.

Locality	UTM	year	# species	# specimen	habitat type
St-Martens Latem	ES.45	1985	14	187	Garden
Schoten	FS.07	1983	16	41	Garden
St-Truiden	FS.53	1985	15	76	Orchard
Bleret	FS.51	1984	17	181	Orchard
Woumen	DS.94	1986	18	120	lakeside grassland (*Phragmites*)
Zandvoorde	DS.97	1988	21	268	lakeside grassland (*Phragmites*)
Wemmel	ES.94	1987	23	215	Garden
Oostende	ES.97	1987	27	198	city park
Raverszijde 1	DS.87	1986	27	117	public park in sea dunes
Raverszijde 2	DS.87	1987	27	117	public park in sea dunes
Wanze	FS.50	1982	33	343	Garden
Oude Landen 1	ES.98	1988	37	1110	swamp (*Phragmites*)
Logne	FR.88	1986	38	546	deciduous wood
Erpent	FR.39	1984	39	831	Orchard
Antheit	FS.50	1986	40	314	wood edge
Koksijde	DS.76	1983	41	474	Garden
Torhout	ES.05	1986	42	658	moist *populus* wood
Turnhout 2	FS.38	1985	43	599	overgrown meadow
Virton	FQ.89	1987	45	341	abandoned orchard
Mont-Rigi 2	KA.99	1984	45	594	grassland/wood edge
De Kuifeend 1	ES.98	1988	49	2201	swamp
Gembloux	FS.10	1984	49	3745	woodland relict
Groot Schietveld 1	FS.09	1988	51	692	heathland (*Molinia*)
Oude Landen	ES.98	1989	55	1231	grassland/wood edge
Wingene	ES.25	1986	59	577	unkempt moorland
Groot Schietveld 2	FS.08	1989	60	708	heathland/wood edge
Targnon	FR.88	1986	66	427	deciduous woodland
Logne 2	FR.88	1989	67	1058	deciduous woodland (edge)
De Kuifeend 2	ES.98	1989	67	2266	overgrown meadow
Mont Rigi 1	KA.99	1983	69	1235	grassland/wood edge
Turnhout 1	FS.38	1982	76	1313	overgrown meadow
Treignes	FR.25	1984	79	1947	chalk grassland/wood edge
Werbamont	FR.88	1986	83	1747	wood edge
Virelles	ER.94	1986	103	3857	grassland/border of lake

The large sampling campaign, carried out at several localities spread over the different geographical regions in Belgium during the last decade (GROOTAERT, 1989) gave us the opportunity to extend our study to a much larger scale. As a result we were able to analyse the syrphid communities of 34 localities where a Malaise trap was active during a complete year cycle (Tab. 4). Among those localities were 5 gardens, 4 orchards (one abandoned) and three city parks. The other localities consisted of more natural habitats situated in nature reserves or other areas with less human interference. The results of these analyses confirm the conclusions obtained during the present study. Although the data were collected in geographical areas with different ecological backgrounds (DUFRÊNE & LEGENDRE, 1991), during different years, the man-made habitats on the average harbour fewer species at a lower population level than natural habitats.

The other dipteran groups which are thus far identified produce the same results. Only in some cases, where specific habitat requirements are fulfilled, species of special faunistic interest can occur. The Dolichopodidae community of the garden in Schoten consisted mainly of common, eurytopic species. Besides these, some less common species, characteristic for humid woodlands and fenlands were present (POLLET & DE BRUYN, 1987). Also at Schoten a compost heap, with mainly kitchen refuse, produced more sphaerocerid species, at higher population densities than a nature reserve in the same area (VEN & DE BRUYN, *in litt.*).

As a conclusion we can state that conventional gardens seem to be of low significance for the conservation of Diptera. Although appropriate garden management, creating and maintaining high plant and habitat diversity, can contribute to a high insect diversity, the conservation of rare and specialised species may only be possible by preservation of specific habitats in adequately managed nature reserves.

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