More than one third of the Belgian spider fauna (Araneae) found within the city of Antwerp: faunistics and some reflections on urban ecology

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Summary

For four years, the city of Antwerp (without the bordering woods, harbour and rural areas) was searched for spiders as part of the Antwerp Spider Research Project. 249 species were found, including four species new to the Belgian fauna: Clubiona leucaspis Simon 1932, Tapinesthis inermis (Simon, 1882), Heliophanus kochii Simon, 1868 and Cheiracanthium mildei L. Koch, 1864. The presence of 41 species which occur on the 'Red List' of rare and endangered spider species in Flanders, was established. The article at hand is one of the first to investigate the arachnological faunistic characteristics of an "all urban" western European city area and raises several interesting ecological questions.
Some notable captures are discussed.

Samenvatting

Gedurende vier jaar werd de spinnenfauna van Antwerpen (zonder de aangrenzende bossen, landelijke zones en het havengebied) onderzocht in het kader van het Antwerps Spinnenonderzoeksproject (ASOP). 249 soorten werden aangetroffen, waaronder vier nieuwe soorten voor België: Clubiona leucaspis Simon 1932, Tapinesthis inermis (Simon, 1882), Heliophanus kochii Simon, 1868 en Cheiracanthium mildei L. Koch, 1864. Er werden 41 Rode Lijstsoorten gevonden. Voorliggend artikel is één van de eerste die de spinnenfauna van een volledig verstedelijkt West-Europees stadsgebied onderzoekt. De resultaten roepen verschillende interessante ecologische vragen op.
Enkele opmerkelijke vangsten worden besproken.

Résumé

Pendant quatre ans, la faune arachnologique de la ville d'Anvers (les bois, zones rurales et le port exceptés) a été examinée dans le cadre du Projet de Recherche Arachnologique Anversois. 249 espèces ont été trouvées, parmi lesquelles quatre espèces nouvelles pour la faune de Belgique: Clubiona leucaspis *Simon 1932,* Tapinesthis inermis *(Simon, 1882),* Heliophanus kochii *Simon, 1868 et* Cheiracanthium mildei *L. Koch, 1864. 41 espèces qui figurent sur la "Liste Rouge" des espèces rares et menacées en Flandre ont également été capturées.*
L'article présenté est un des premier à rechercher la faune arachnologique d'une surface entièrement urbaine de l'Europe Occidentale. Les résultats donnent lieu à des questions écologiques intéressantes.
Quelques captures frappantes sont discutées.

Introduction

Research on the spider fauna of inner cities is rarely undertaken for several reasons. One of them being that the results of such an investigation are mostly considered irrelevant to the management of urban environments. Inner cities are by definition biotopes which are completely dominated and functionally shaped by humans. Consequently, there seems to be little scope for an environmental management policy which sets goals concerning biodiversity in a city center. One can imagine that e.g. a policy which encouraged the retention of a percentage of wasteland in an inner city in order to increase biodiversity, would generate little sympathy or would be poorly acknowledged by both policymakers and inhabitants. It is however often overlooked that townsmen actually benefit from a "healthy" spider population. The *Antwerp Spider Research Project* shows that inner city areas can be ecologically interesting and not necessarily have to be biodiversity "black spots".

Comparison with other studies of the urban ecology of spiders is difficult. On one hand, there are the investigations of well-defined sites or biotopes within cities (e.g. BROEN, 1977, 1985; GASTON et al., 2005; HANSEN, 1992; HEINZ et al., 2002; HERVÉ & ROLLARD, 2006; KADAS, 2006; REUMER, 1996; SMITH et al., 2005; 2006a; 2006b; VANUYTVEN, 1986; 1997) and on the other hand, there are the studies on entire metropolitan areas, which include the forests and larger greenbelts at the edges of the cities (e.g. SALZ, 1992 ; THALER & STEINER, 1993). The study at hand has the important characteristics that the area investigated is 1. clearly defined and consists only of undisputed "urban biotope" and 2. has been thoroughly searched, using different sampling methods (see under "Method").

Area and biotope

The investigated area counts more than 200.000 inhabitants and has relatively little green surfaces because of its historical concentric growth (successive city walls whithin which almost all the space was used to built houses). It is situated within the Antwerp "Singel" (road around the city, see fig. 1) and this "Singel" is situated against the very densely built city center in which there are e.g. no fields, but also no woodlands or any other type of "natural" habitat area. The only green areas consist of parks, public and private gardens, wasteland and roadsides.

The western border of the investigated area is formed by the right bank of the river Scheldt. The total surface of the investigated area -furtheron called "city center"- measures 14 km^2.

The Antwerp city center makes an excellent case study as a referential research site for a strongly urbanized biotope in western Europe. Outside the Singel, the landscape turns gradually more rural. Moreover, there is the river Scheldt, which forms a relatively broad (± 370m on smallest width and ± 480m on largest width) natural boundary, following the entire length of the inner city.

293 locations within the city were sampled. We distinguished 12 different subhabitats, the criteria being structural as well as useful for policy purposes:

- Wasteland (Wa)
- Roadsides (RS)
- Railroadsides (RRS)
- Parks (Pa)
- Public greenspots (public garden, Ivy -*Hedera helix* L.- against buildings,...) (PG)
- Large gardens (mainly with monasteries) (LG)
- Private city gardens (PCG)
- Railway yards (RY)
- Against constructions (AC)
- Inside buildings (IB)
- Sewers (Se)
- Greenhouses (Gr)

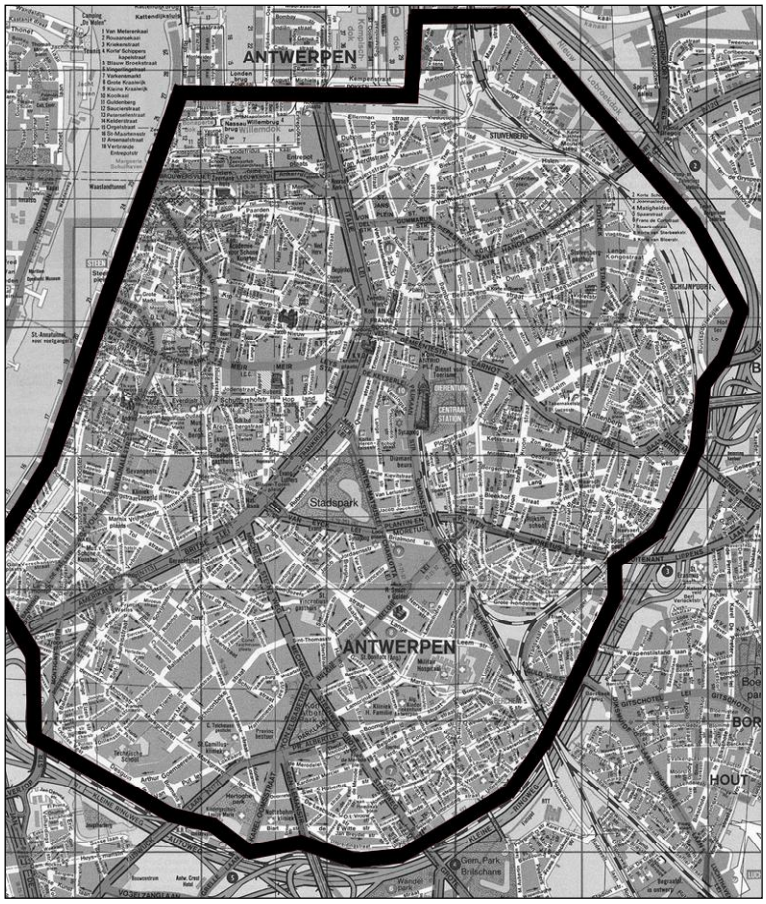

Fig. 1: The Belgian city of Antwerp. Marked in black, the investigated city area within the "Singel"

Method

The main collecting period is situated between September 2004 and June 2008. Over this period about 250 excursions were undertaken. Samplings were carried out using different methods, the most important being beating of shrubs, sifting out litter, sweaping, collecting by handcatching and pitfall sampling.

Pitfall cycles were implemented on 9 locations (3 parks, 3 large gardens, 1 private garden and 2 railway yards). The Antwerp city center has limited possibilities for the use of pitfalls due to an ever-present human disturbance and restrictions by the authorities because of the concern for poisoning of pets by the formaldehyde solution in the pitfalls.

According to LE PERU (2004), the percentage of the spider species found with only one specimen is often situated around 20% of the fauna found during inventorisations. In Antwerp, this percentage is 9.6. This indicates that the sampling efforts have been carried out thoroughly and it might also be an indication that the percentage of coincidental species observations, is low. In other words, we can assume that most of the species found in this research project, were present in numbers/colonies at the time of collecting.

Material

GENERAL RESULTS:

- General species diversity

We found 249 spider species within the study area. This is more than 1/3 of the total Belgian spider fauna and even more than 40% of the one in Flanders (the northern part of Belgium where Antwerp is situated and which can geographically be described as a lowland plain). An important explanation for this surprisingly high number, lies within the diversity in substrate structure, humidity, temperature and vegetation of the city subhabitats.

- General species composition

It is not really possible to describe a general species composition for the Antwerp city center. Traditionally thinking about a urban area, one would be tempted to think that the species composition is a synantropic one. Of course synantropic species are present, but make out only about 10-15% (depending on how "synantropic" is interpreted) of the Antwerp spider fauna. Looking at the habitat description of e.g. the red list species, one could also perceive a considerable representation of xerophile and thermophile species (see "Thermophile spiders"), which corresponds to the general fact that urban habitats in western Europe are overall warmer and dryer than the surrounding environments (KUTTLER, 1993; VON STÜLPNAGEL et al. 1990).

*** Most collected species**

The fifteen most collected species are: *Araneus diadematus* (775 ind.), *Diplostyla concolor* (757), *Tenuiphantes tenuis* (718), *Microneta viaria* (546), *Erigone dentipalpis* (501), *Platnickina tincta* (476), *Erigone atra* (455), *Philodromus aureolus* (365), *Diplocephalus cristatus* (341), *Zygiella x-notata* (328), *Phrurolithus festivus* (323), *Lepthyphantes leprosus* (311), *Enoplognatha ovata* (307), *Pholcus phalangioides* (266) and *Clubiona terrestris* (263).

Important to note is that, contrary to most spider inventorisation projects, pitfall samplings were not dominant in this project. This is reflected by the fact that 11 out of the 15 most found species were not collected mainly via pitfalls.

*** Thermophile spiders**

The relatively higher temperature (in comparison to the rural surroundings), of the city seems to provide suitable conditions for quite some thermophile (and xerotherm) species. In this category, we could recognize a few subcategories (with clear intercategorial overlap!) like:

- Species introduced from southern areas (treated here under the separate title 'Introduced spiders')
- "Eusynantropic" species (spider, only found in the direct neighbourhood of humans, mostly in buildings and this in the investigated climatic zone) (VANUYTVEN, 1987; 1991), e.g. *Scytodes thoracica, Pholcus phalangioides, Psilochorus simoni, Parasteatoda tepidariorum, Tegenaria parietina, Steatoda grossa* and *Steatoda triangulosa.*
- Spiders, preferring warmer (and often dryer) biotopes, e.g. *Xerolycosa miniata, Xerolycosa nemoralis, Phlegra fasciata, Sitticus distinguendus, Talavera aequipes, Talavera petrensis, Zodarion italicum,...*
- "Southern" spider species believed to have their northern limit of geographical range near the 51st degree of latitude (MAELFAIT et al. 1998), e.g. *Dictyna civica, Zodarion rubidum, Zelotes aeneus, Philodromus buxi, Philodromus rufus* and *Xysticus ferrugineus.*
- "Southern" spiders expanding their range northward, e.g. *Argiope bruennichi* and *Ero aphana* (VAN KEER & VANUYTVEN, 2009).

*** Introduced spiders**

The study of the introduction of spiders has only quite recently evolved towards a scientific level, certainly in Belgium (VAN KEER, 2007). Consequently, a certain number of introduced species (e.g. *Pholcus phalangioides*, but probably even some of our *Tegenaria* spp. (KOBELT & NENTWIG, 2008) have never been catalogued as "introduced" in Belgian faunistic publications. We are not going to start doing this in the

study at hand. Consequently, the list of Belgian introduced species found in the city of Antwerp, is limited to the more "recent" exotic spiders, the oldest one being *Steatoda grossa*, which was recorded for the first time from Belgium in 1978 (KEKENBOSCH & BAERT, 1978).
Obvious or highly likely introduced species are:

- *Cryptachaea acoreensis*: we propose as vernacular dutch name "Kleine broeikasspin"
- *Cheiracanthium mildei*: the dutch name "Gele spoorspin" has been suggested in VAN KEER et al. 2007
- *Hasarius adansoni*: the dutch name "Kasspringspin" was suggested by JOCQUÉ, 1992
- *Heliophanus kochii*: "Kochs blinker" in ROBERTS, 1998
- *Holocnemus pluchei*: "Marmertrilspin" in VAN KEER & VAN KEER, 2006
- *Macaroeris nidicolens*: "Ovale dennenspringer" in JOCQUÉ, 1992
- *Mermessus trilobatus*: "Drielobbige Amerikaanse dwergspin". The first record we found of this vernacular name, appears in LAMBRECHTS et al., 2002
- *Pholcus opilionoides*: "Nistrilspin" in ROBERTS, 1998
- *Steatoda grossa*: "Grote steatoda" in JOCQUÉ, 1992
- *Uloborus plumipes*: "Kaskaardespin" in JOCQUÉ, 1992

Most likely, the high intensity of international transport is responsible for the majority of the introductions (KOBELT & NENTWIG, 2008). However, the distribution evolution of some of these species, suggests that not only increased global transport is responsible for the settling of exotic spiders. This is the case in e.g. *Holocnemus pluchei*. A species which must have been introduced for at least many decades and maybe even centuries, taken into account the intensive trade between its native region (the mediterranean) and a harbour city like Antwerp (harbour dock constructed by Napoleon Bonaparte in 1811). Despite this fact, the species seems to be settling in our region, only for the past 10-15 years. This evolution could be the result of increased temperatures during that period. For the moment, the species has been found in about 15 locations in Belgium, harbouring a few to several hundreds of specimens each (VAN KEER, 2007; VAN KEER, *in prep.*).

*** Species new to Belgium**

- *Cheiracanthium mildei*: one female individual was collected on the 28th of April 2007 in a former monastery garden and another one on the 24th of May of the same year in a private city garden. The records were reported in VAN KEER et al. 2007.
- *Clubiona leucaspis*: on the 31th of May 2005, one male was found under bark of a lime tree on a parking space next to river Scheldt. In VAN KEER & VAN KEER 2005, we suggested that this is probably a species which is expanding its range northward by non-human means. A record of the species in a non-synantropic environment by the Belgian coast (LAMBRECHTS et al., 2007) and a second one of *C. leucaspis* in Antwerp (city park, 1 female on the 18th of May 2007, again under bark), seem to confirm this assumption. The dutch vernacular name "Witrugzakspin" was suggested in VAN KEER & VAN KEER, 2006.
- *Heliophanus kochii*: between the 4th of May and the 15th of July 2006, 29 specimens (10mm/16ff/3jj) of this species were found, of which 20 were collected. *Heliophanus kochii* was found on an abandoned shunting-yard along a concrete south oriented slip roadside. At the time of collecting, the species was common and clearly established in this location (e.g. many females with egg sacs were found). The land use of the area has been altered drastically (a park was implanted) and it is unclear whether the species is still present in this location. For more information on its distribution, see VAN KEER et al. 2006.
- *Tapinesthis inermis*: between the 21st of May 2006 and the 12th of January 2008, 124 specimens (27mm/36ff/61jj) of the species were collected in the Antwerp city center. Specimens were found during samplings elsewhere in Belgium (e.g. Turnhout, Beerse, Vosselaar, Oud-Turnhout, Kasterlee, Arendonk, Geel) as well (DE KONINCK, pers. comm.). On almost all occasions, they were found in the direct vicinity of Ivy. For more detail on the records, see VAN KEER et al. 2006. The dutch vernacular name "Klimopdwergzesoog" was first published in BOSMANS, 2009.
- *Macaroeris nidicolens*: technically spoken, the Antwerp records are not the first for Belgium, but they are the first verifiable records for our country. BECKER reported one juvenile female at the end of the 19th century (BECKER, 1882), but the specimen was lost (BOSMANS & VANUYTVEN, 2001). Therefore no more

evidence of the presence of this species in Belgium was available. We found 1 female on the 17th of June 2006 and 1 male on the 6th of June 2007, both in private gardens in the same city district. For more details, see VAN KEER et al. 2006 and VAN KEER & LOUVIGNY 2010.

*** Red List species**

The percentage of Red List species found in Antwerp, is 16.5. Many nature conservationists were relieved to find that this percentage lies considerably lower than in other faunistic spider studies with a comparable amount of species found in e.g. nature reserves. Belgian studies with more than 200 species found in "more natural" environments have percentages between 27.4 up to 40.1 (e.g. DE KONINCK, 2009; pers. comm.; JANSSEN & POOT, 2000).

The study at hand can be used to refine the current Red List for the spiders of Flanders (MAELFAIT et al., 1998) and consequently to deliver useful data for (re-)determining the red list status of some species.

Since habitat scarcity is an important factor in determining the red list status of the species linked to it, the main conclusion of the study in this regard may be that the habitat preference of some species is not restricted to the endangered habitat on which their red list status is based, since they were obviously found abundantly in urban (sub)habitats. This abundant occurrence seems to reduce their value as indicators for the listed endangered habitat to which their preference was attributed. This can be a reason to revise their Red List-category since habitat-scarcity can hardly be attributed to "city-dwellers". Naturally, the population stability of the evaluated species in the city should be established without doubt. Thus should be looked at the occurrence in consecutive years over a longer period, numbers of specimens, occurrence in other cities, microhabitat preference,... Also the geographical distribution of the species in Flanders should be looked at when re-evaluating the red list status is considered: it could well be that the geographical range of certain species in Flanders is restricted to the area around Antwerp, which would make it unwise to remove it from the Red List of Flanders only on the bases of its occurrence in the Antwerp inner city. Flanders is not Antwerp and vice versa.

Candidates for revision, based on numbers of individuals collected (in a high number of different subhabitats, indicating low preference), occurrence in the city of Ghent (BOSMANS, pers. comm.) and abundance of the city microhabitats in which they were found, could be:

- *Philodromus albidus*: RL-status: endangered. Habitat preference according to RL: "Verges of dry deciduous forest". Was found in Antwerp with 150 individuals in 6 different subhabitats, but mostly in private city gardens and parks.
- *Philodromus buxi*: RL-status: rare. 52 individuals found in 6 different subhabitats.
- *Philodromus rufus*: RL-status: rare. 75 ind. in 6 different subhabitats.
- *Ero aphana*: RL-status: rare. 160 ind. in 8 different subhabitats, among which 41 private city gardens, but also in parks, public greenspots and wasteland.
- *Hahnia nava*: RL-status: endangered. Habitat preference according to RL: "Dry oligotrophic grassland with rough vegetation". 86 ind. were found in 5 different subhabitats, mostly in parks, large gardens and wasteland.
- *Heliophanus auratus*: RL-status: endangered. Habitat preference according to RL: "Marshland with rough reed vegetation". The 48 individuals found in Antwerp, were located in 5 subhabitats, mostly in public greenspots and wasteland.
- *Argiope bruennichi*: 23 individuals were found in 4 different subhabitats.

A separate category of Red List species (not directly in need of re-evaluation because they do not meet all the criteria mentioned above), are the species with a habitat preference for dry and warm biotopes and which were found in Antwerp, mainly at or in the direct vicinity of railway terrains.

- *Phlegra fasciata:* RL status: vulnerable (5 ind.)
- *Sitticus distinguendus:* RL status: vulnerable (2 ind.)
- *Steatoda phalerata:* RL status: vulnerable (1 ind.)
- *Talavera aequipes:* RL status: vulnerable (1 ind.)
- *Talavera petrensis:* RL status: endangered (4 ind.)

- *Thanatus striatus*: RL status: vulnerable (2 ind.)
- *Trachyzelotes pedestris*: RL status: endangered (4 ind.)
- *Xerolycosa miniata:* RL status: endangered (17 ind.)
- *Xerolycosa nemoralis:* RL status: vulnerable (154 ind.)
- *Xysticus erraticus:* RL status: endangered (1ind.)
- *Xysticus ferrugineus:* RL status: rare (1 ind.)
- *Zelotes aeneus:* RL status: rare (27 ind.)
- *Zodarion rubidum:* RL status: rare (102 ind.)

The remaining Red List species are: *Alopecosa cuneata*, *Arctosa leopardus*, *Argenna subnigra*, *Clubiona frisia*, *Crustulina guttata*, *Dictyna civica*, *Dictyna latens*, *Dictyna pusilla*, *Dipoena melanogaster*, *Dysdera erythrina*, *Entelecara congenera*, *Erigonella hiemalis*, *Harpactea hombergi*, *Leptorhoptrum robustum*, *Meioneta fuscipalpa*, *Misumena vatia*, *Pardosa prativaga*, *Philodromus praedatus*, *Pholcomma gibbum*, *Robertus arundineti* and *Tibellus oblongus*.

- *Zodarion italicum:* the RL mentions for this species (there incorrectly placed under *Zodarion gallicum*): "Insufficiently known. Species that are suspected but not definitely known to belong to any of the above categories, because of lack of information". Five individuals of this species were found in the Antwerp city center.

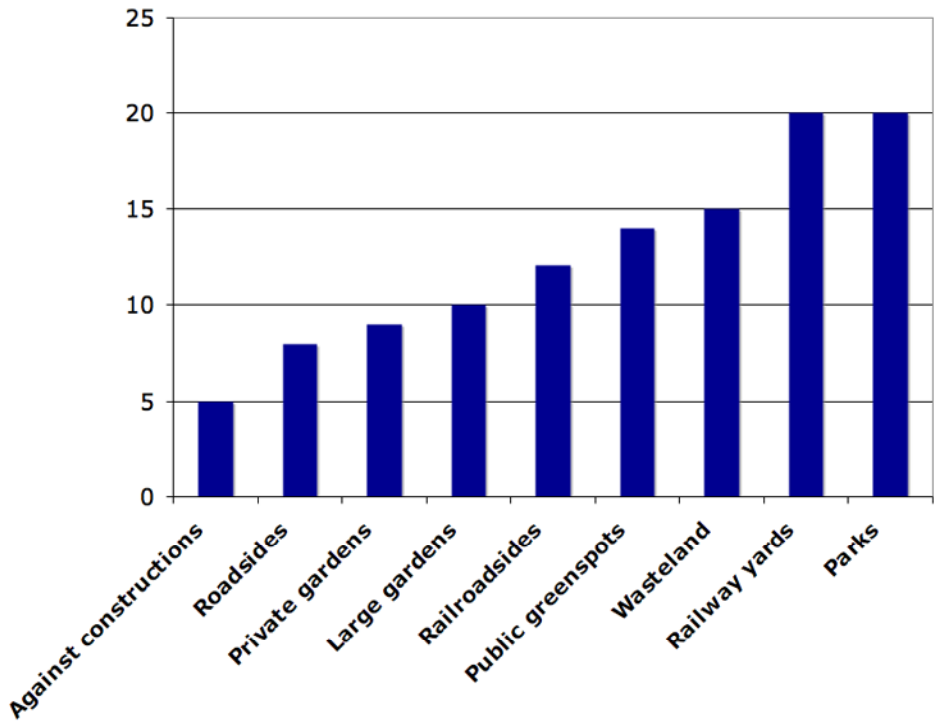

Fig. 2: Number of Red List species per subhabitat. No red list species were recorded from "Inside buildings", "Sewers" and "Heated greenhouses"

- General population density

It was impossible for us to sample the entire study area in a standardized way. For several of the subhabitats, a standardized method of collecting is still to be invented (e.g. within buildings,...). The heterogeneous way of collecting therefore does not enable us to do scientific statements concerning the general spider population density within the city center. The amount of (adult) individuals caught in the placed pitfalls however (an average of 7.85 individuals per trap, per month), seems to be considerably lower than the amounts caught with the same type of trap, used in nature reserves. This impression is

supported by the observations of other authors claiming that spider population density is lower in urban areas than in "natural biotopes" (e.g. NYFFELER 2000).

SPECIFIC RESULTS

Table 1: Complete species list, with percentage of individuals found per city subhabitat (Wa=Wasteland, RY=Railway yards, IB=Inside buildings, LG=Large gardens, Pa=Parks, PCG=Private city gardens, Se=Sewers, RRS=Railroadsides, Gr=Greenhouses, AC=Against constructions, PG=Public greenspots, RS=Roadsides)
- Lower totals reduce of course the significance of the subhabitat percentages.
- A number of figures ask for interpretation: results of different collecting methods e.g. can not be compared in a linear way.
- Nevertheless, tendencies can be discovered in several cases.
- The nomenclature of PLATNICK (2010) was used.

SPECIES	Tot	Wa	RY	IB	LG	Pa	PCG	Se	RRS	Gr	AC	PG	RS
Scytodidae													
Scytodes thoracica (Latreille, 1802)	**21**		5	19	5		33					38	
Pholcidae													
Holocnemus pluchei Scopoli, 1763	**12**			84			8				8		
Pholcus opilionoides (Schrank, 1781)	**54**		48						4			48	
Pholcus phalangioides (Fuesslin, 1775)	**266**	0,5	2	15,5	5	2	61	1		2	5	6	
Psilochorus simoni (Berland, 1911)	**19**	5		79			16						
Segestriidae													
Segestria bavarica C.L. Koch, 1843	**159**	1	1	0,5	13	7	35		3,5		31	8	
Segestria senoculata (Linnaeus, 1758)	**24**				8	47	33				4	8	
Dysderidae													
Dysdera crocata C.L. Koch, 1838	**111**	3	5	3	66	8	8		1			6	
Dysdera erythrina (Walckenaer, 1802)	**2**					50			50				
Harpactea hombergi (Scopoli, 1763)	**31**					100							
Harpactea rubicunda (C.L. Koch, 1838)	**9**											44	56
Oonopidae													
Oonops domesticus Dalmas, 1916	**17**			64		12						24	
Oonops pulcher Templeton, 1835	**33**			9	6		33					52	
Tapinesthis inermis (Simon, 1882)	**124**			1	8	17	6					68	
Mimetidae													
Ero aphana (Walckenaer, 1802)	**160**	8	1		6	21	49				0,5	14	0,5
Ero cambridgei Kulczyn'ski, 1911	**8**	87							13				
Ero furcata (Villers, 1789)	**37**	22			16	46	11					5	
Uloboridae													
Uloborus plumipes Lucas, 1846	**9**									100			
Nesticidae													
Nesticus cellulanus (Clerck, 1757)	**23**			26		17	9	48					
Theridiidae													
Anelosimus vittatus (C.L. Koch, 1836)	**70**	1	1		3	30	1					23	41
Asagena phalerata (Panzer, 1801)	**1**		100										
Crustulina guttata (Wider, 1834)	**12**					100							
Cryptachaea blattea (Urquhart, 1886)	**5**									100			
Dipoena melanogaster (C.L. Koch, 1837)	**16**					100							
Enoplognatha latimana Hippa & Oksala, 1982	**45**	38			11		2		18		2	29	
Enoplognatha ovata (Clerck, 1757)	**307**	2			7	19	51		1		0,5	18	1,5
Enoplognatha thoracica (Hahn, 1833)	**5**		20			40						40	
Episinus angulatus (Blackwall, 1836)	**3**	67					33						
Neottiura bimaculata (Linnaeus, 1767)	**62**	26	2		35	13	11		2			6	5
Paidiscura pallens (Blackwall, 1834)	**89**	2			19	61	6					6	6
Parasteatoda lunata (Clerck, 1757)	**22**					64	9				27		
Parasteatoda simulans (Thorell, 1875)	**18**					83	17						
Parasteatoda tepidariorum (C.L. Koch, 1841)	**62**	3	3		5	5	36		6		34	5	3

Pholcomma gibbum (Westring, 1851)	**47**					98						2	
Phylloneta impressa (L. Koch, 1881)	**8**	12,5	50			12,5						25	
Platnickina tincta (Walckenaer, 1802)	**476**				16	21	52		0,5		1	8	1,5
Robertus arundineti (O.P.-Cambridge, 1871)	**31**	97				3							
Robertus lividus (Blackwall, 1836)	**1**	100											
Sardinidion blackwalli (O.P.-Cambridge, 1871)	**9**					33					67		
Steatoda bipunctata (Linnaeus, 1758)	**34**	3			9	15	61				3	9	
Steatoda grossa (C.L. Koch, 1838)	**181**	8	1	28	5	4,5	32	0,5	1	0,5	16	3,5	
Steatoda triangulosa (Walckenaer, 1802)	**22**		18	40		5	23				9	5	
Theridion hannoniae Denis, 1944	**11**		91								9		
Theridion melanurum Hahn, 1831	**250**	1	12	4	3	1	5		9		64	0,5	0,5
Theridion mystaceum L. Koch, 1870	**96**	2			9	52	22					15	
Theridion n.sp. cfr. *mystaceum*	**19**	5	5								85	5	
Theridion pictum (Walckenaer, 1802)	**3**				33	33					33		
Theridion pinastri L. Koch, 1872	**16**				12	38	6					6	38
Theridion varians Hahn, 1833	**138**	1			8	78	10					2	1
Linyphiidae													
Agyneta conigera (O.P.-Cambridge, 1863)	**2**					100							
Araeoncus humilis (Blackwall, 1841)	**3**	67				33							
Bathyphantes gracilis (Blackwall, 1841)	**180**	4	10	2		55	6				12	11	
Bathyphantes parvulus (Westring, 1851)	**36**					100							
Centromerita bicolor (Blackwall, 1833)	**81**	2	4		78	12						4	
Centromerita concinna (Thorell, 1875)	**17**	35	30		35								
Centromerus dilutus (O.P.-Cambridge, 1875)	**1**				100								
Centromerus sylvaticus (Blackwall, 1841)	**36**	8	3		8	67						14	
Ceratinella brevipes (Westring, 1851)	**1**				100								
Ceratinella brevis (Wider, 1834)	**17**				53	41						6	
Ceratinella scabrosa (O.P.-Cambridge, 1871)	**1**					100							
Collinsia inerrans (O.P.-Cambridge, 1885)	**72**	18	7		4	43	1		1			25	
Dicymbium nigrum (Blackwall, 1834)	**31**	16			3	81							
Diplocephalus cristatus (Blackwall, 1833)	**341**	3	0,5	1	22	33	6	3	0,5		0,5	30	0,5
Diplocephalus picinus (Blackwall, 1841)	**231**	1,5			11	87						0,5	
Diplostyla concolor (Wider, 1834)	**757**	3	1,5		27	39	1		0,5			26	2
Dismodicus bifrons (Blackwall, 1841)	**13**	54			46								
Entelecara acuminata (Wider, 1834)	**62**					94	2				2		2
Entelecara congenera (O.P.-Cambridge, 1879)	**59**				3	72	22					3	
Entelecara erythropus (Westring, 1851)	**3**					33					67		
Erigone arctica (White, 1852)	**1**											100	
Erigone atra Blackwall, 1833	**455**	5	4	0,5	2,5	71	4,5		0,5	1,5	2	7,5	1
Erigone dentipalpis (Wider, 1834)	**501**	4,5	3,5		1	75	5		0,5		1,5	9	
Erigonella hiemalis (Blackwall, 1841)	**14**				79	21							
Floronia bucculenta (Clerck, 1757)	**1**	100											
Gnathonarium dentatum (Wider, 1834)	**11**											100	
Gonathium rubens (Blackwall, 1833)	**1**					100							
Gongylidiellum vivum (O.P.-Cambridge, 1875)	**3**	67				33							
Gongylidium rufipes (Linnaeus, 1758)	**11**				36	64							
Lepthyphantes leprosus (Ohlert, 1865)	**311**	7,5	0,5	9	8	7	50				6	12	
Lepthyphantes minutus (Blackwall, 1833)	**26**			12	23	57						8	
Leptorhoptrum robustum (Westring, 1851)	**2**					100							
Lessertia dentichelis (Simon, 1884)	**3**							100					
Linyphia hortensis Sundevall, 1830	**5**				40	60							
Linyphia triangularis (Clerck, 1757)	**58**	7			21	17	36					14	5
Maso sundevalli (Westring, 1851)	**134**	17	1		20	53			1			7	1
Meioneta fuscipalpa (C.L. Koch, 1836)	**5**		100										
Meioneta rurestris (C.L. Koch, 1836)	**147**	5	12	1	9	31			3		14	20	5
Mermessus trilobatus (Emerton, 1892)	**12**	25	8			50						17	
Micrargus herbigradus (Blackwall, 1854)	**33**				73	27							
Micrargus subaequalis (Westring, 1851)	**96**	5	4		24	63	1		1			1	1
Microctenonyx subitaneus (O.P.-Cambridge, 1875)	**24**											100	
Microneta viaria (Blackwall, 1841)	**546**	16			1,5	61			0,5			14	7

Moebelia penicillata (Westring, 1851)	**19**				5	21						74	
Monocephalus fuscipes (Blackwall, 1836)	**84**				84	14						1	1
Neriene clathrata (Sundevall, 1830)	**212**	58			15	5	12					9	1
Neriene peltata (Wider, 1834)	**28**					100							
Obscuriphantes obscurus (Blackwall, 1841)	**3**					100							
Oedothorax apicatus (Blackwall, 1850)	**1**	100											
Oedothorax fuscus (Blackwall, 1834)	**25**				8	64	12					16	
Oedothorax retusus (Westring, 1851)	**163**	1				98						1	
Ostearius melanopygius (O.P.-Cambridge, 1879)	**29**	56	3			31					3	7	
Palliduphantes ericaeus (Blackwall, 1853)	**6**	17				66						17	
Palliduphantes insignis (O.P.-Cambridge, 1913)	**2**					100							
Palliduphantes pallidus (O.P.-Cambridge, 1871)	**27**	7			4	85						4	
Pelecopsis parallela (Wider, 1834)	**17**	24			6	52	6					12	
Pocadicnemis juncea Locket & Millidge, 1953	**2**	50	50										
Porrhomma convexum (Westring, 1851)	**75**							100					
Porrhomma egeria Simon, 1884	**1**					100							
Porrhomma microphthalmum (O.P.-Cambridge, 1871)	**1**				100								
Prinerigone vagans (Audouin, 1826)	**18**					94	6						
Saaristoa abnormis (Blackwall, 1841)	**1**					100							
Stemonyphantes lineatus (Linnaeus, 1758)	**7**				100								
Tapinopa longidens (Wider, 1834)	**1**					100							
Tenuiphantes flavipes (Blackwall, 1854)	**250**				11	68	1		1		1	13	5
Tenuiphantes mengei (Kulczyn'ski, 1887)	**9**				22	56	22						
Tenuiphantes tenuis (Blackwall, 1852)	**718**	13	4	1	8	31	5		2		11	18	7
Tenuiphantes zimmermanni (Bertkau, 1890)	**69**	1	3			84	7		1			3	
Thyreosthenius parasiticus (Westring, 1851)	**121**			1	12		2					85	
Tiso vagans (Blackwall, 1834)	**31**	19				71						10	
Troxochrus cirrifrons (O.P.-Cambridge, 1871)	**18**				39	44						17	
Troxochrus scabriculus (Westring, 1851)	**226**	11			27	49			1			11	1
Walckenaeria acuminata Blackwall, 1833	**33**				79	21							
Walckenaeria antica (Wider, 1834)	**45**	52	7		33				2			2	4
Walckenaeria cucullata (C.L. Koch, 1836)	**3**					100							
Tetragnathidae													
Metellina mengei (Blackwall, 1870)	**13**				8	69	15					8	
Metellina merianae (Scopoli, 1763)	**1**						100						
Metellina segmentata (Clerck, 1757)	**39**	5			21		62					13	
Pachygnatha clercki Sundevall, 1823	**8**	12,5			50	25						12,5	
Pachygnatha degeeri Sundevall, 1830	**169**	2	1		69	24			1			3	
Tetragnatha extensa (Linnaeus, 1758)	**2**	50										50	
Tetragnatha montana Simon, 1874	**20**	10			35	20	35						
Tetragnatha obtusa C.L. Koch, 1837	**22**				18	68	14						
Tetragnatha pinicola L. Koch, 1870	**1**				100								
Araneidae													
Araneus diadematus Clerck, 1757	**775**	5	2		5	3	61				2	21	1
Araneus quadratus Clerck, 1757	**4**				75							25	
Araneus sturmi (Hahn, 1831)	**4**					100							
Araniella cucurbitina (Clerck, 1757)	**55**		2		4	40	41					13	
Araniella opisthographa (Kulczyn'ski, 1905)	**26**	4			4	35						22	35
Argiope bruennichi (Scopoli, 1772)	**23**	52			22		13					13	
Cercidia prominens (Westring, 1851)	**10**	100											
Cyclosa conica (Pallas, 1772)	**3**				33	67							
Gibbaranea gibbosa (Walckenaer, 1802)	**12**	16										42	42
Larinioides cornutus (Clerck, 1757)	**2**	50										50	
Larinioides sclopetarius (Clerck, 1757)	**4**		25								75		
Mangora acalypha (Walckenaer, 1802)	**21**	29	37		5	10	14					5	
Nuctenea umbratica (Clerck, 1757)	**18**				50	39	6					6	
Zilla diodia (Walckenaer, 1802)	**75**				27	23	36					13	1
Zygiella x-notata (Clerck, 1757)	**328**	2			5	1,5	71		0,5		11	9	
Lycosidae													
Alopecosa cuneata (Clerck, 1757)	**32**				100								

Alopecosa pulverulenta (Clerck, 1757)	**2**	50				50							
Arctosa leopardus (Sundevall, 1833)	**8**		13			87							
Pardosa nigriceps (Thorell, 1856)	**6**	17	49		17				17				
Pardosa palustris (Linnaeus, 1758)	**3**	67				33							
Pardosa prativaga (L. Koch, 1870)	**149**	20	3		59	9	1,5		0,5			7	
Pardosa pullata (Clerck, 1757)	**71**				100								
Pirata hygrophilus Thorell, 1872	**15**				53	40	7						
Pirata latitans (Blackwall, 1841)	**15**				33	67							
Pirata piraticus (Clerck, 1757)	**5**					80						20	
Trochosa ruricola (De Geer, 1778)	**3**		67						33				
Trochosa terricola Thorell, 1856	**2**		50			50							
Xerolycosa miniata (C.L. Koch, 1834)	**17**		94									6	
Xerolycosa nemoralis (Westring, 1861)	**154**		99						1				
Pisauridae													
Pisaura mirabilis (Clerck, 1757)	**66**	44	1,5		1,5	3	5		15			27	3
Zoridae													
Zora spinimana (Dufour, 1820)	**4**	100											
Agelenidae													
Agelena labyrinthica (Clerck, 1757)	**9**	33			45							22	
Tegenaria agrestis (Walckenaer, 1802)	**14**	14	65									21	
Tegenaria atrica C.L. Koch, 1843	**172**	9	0,5	6	16	3,5	63		0,5		0,5	1	
Tegenaria domestica (Clerck, 1757)	**43**		2	2	14	21	54				7		
Tegenaria parietina (Fourcroy, 1785)	**204**		0,5	8,5	15	6	49				21		
Textrix denticulata (Olivier, 1789)	**6**					17					66	17	
Hahniidae													
Hahnia montana (Blackwall, 1841)	**4**											50	50
Hahnia nava (Blackwall, 1841)	**86**	21	6		23	48			2				
Dictynidae													
Argenna subnigra (O.P.-Cambridge, 1861)	**1**	100											
Dictyna civica (Lucas, 1850)	**29**		7		3	14	17		10		49		
Dictyna latens (Fabricius, 1775)	**23**	30										57	13
Dictyna pusilla Thorell, 1856	**5**					100							
Dictyna uncinata Thorell, 1856	**243**	1	0,5		7	51	8		0,5			21	11
Lathys humilis (Blackwall, 1855)	**113**				9	50	3					37	1
Nigma flavescens (Walckenaer, 1830)	**87**	1			5	59						18	17
Nigma walckenaeri (Roewer, 1951)	**92**		2	1	16	16	30				1	33	
Amaurobiidae													
Amaurobius ferox (Walckenaer, 1830)	**110**		1		25		67	2	1		4		
Amaurobius similis (Blackwall, 1861)	**123**				14	8	71					7	
Miturgidae													
Cheiracanthium erraticum (Walckenaer, 1802)	**6**	67	33										
Cheiracanthium mildei L. Koch, 1864	**2**				50		50						
Anyphaenidae													
Anyphaena accentuata (Walckenaer, 1802)	**44**	2				80	11					7	
Liocranidae													
Agroeca brunnea (Blackwall, 1833)	**1**					100							
Clubionidae													
Clubiona brevipes Blackwall, 1841	**111**		1		16	28	14		1			29	11
Clubiona comta C.L. Koch, 1839	**96**	11			5	72	4		1			6	1
Clubiona corticalis (Walckenaer, 1802)	**82**				30	6	48		2			9	5
Clubiona diversa O.P.-Cambridge, 1862	**1**	100											
Clubiona frisia Wunderlich & Schuett, 1995	**1**										100		
Clubiona leucaspis Simon, 1932	**2**					50						50	
Clubiona lutescens Westring, 1851	**4**				75							25	
Clubiona neglecta O.P.-Cambridge, 1862	**4**	25	50						25				
Clubiona pallidula (Clerck, 1757)	**16**					75	6					19	
Clubiona phragmitis C.L. Koch, 1843	**2**											100	
Clubiona reclusa O.P.-Cambridge, 1863	**19**	63			32								5
Clubiona subtilis L. Koch, 1867	**8**	63											37
Clubiona terrestris Westring, 1851	**263**	9			21	10	34		1,5		0,5	24	

Corinnidae													
Phrurolithus festivus (C.L. Koch, 1835)	**323**	33	5		7	15			6			23	11
Zodariidae													
Zodarion italicum (Canestrini, 1868)	**5**		40						20				40
Zodarion rubidum Simon, 1914	**102**	3	66						20				11
Gnaphosidae													
Drassodes lapidosus (Walckenaer, 1802)	**29**	10	69	3	7				10				
Micaria pulicaria (Sundevall, 1831)	**49**	72			2	20						6	
Micaria subopaca (Westring 1861)	**6**				33	50						17	
Scotophaeus scutulatus (L. Koch, 1866)	**4**				25		75						
Trachyzelotes pedestris (C.L. Koch, 1837)	**4**	25							25		25		25
Zelotes aeneus (Simon, 1878)	**27**		100										
Zelotes subterraneus (C.L. Koch, 1833)	**4**												100
Philodromidae													
Philodromus albidus Kulczyn'ski, 1911	**150**	0,5			9	53	34					3	0,5
Philodromus aureolus (Clerck, 1757)	**365**	1	0,5	1	18	14,5	42		1		0,5	20	1,5
Philodromus buxi Simon, 1884	**52**					19	8		2		2	33	36
Philodromus cespitum (Walckenaer, 1802)	**119**	26	3		1	10	2		2			48	8
Philodromus collinus C.L. Koch, 1835	**12**				42	42	8				8		
Philodromus dispar Walckenaer, 1826	**60**	3			25	32	18				2	10	10
Philodromus praedatus O.P.-Cambridge, 1871	**4**					50						50	
Philodromus rufus Walckenaer, 1826	**75**	7			7	14	7					14	51
Thanatus striatus C.L. Koch, 1845	**2**	50							50				
Tibellus oblongus (Walckenaer, 1802)	**22**	9	18						45			5	23
Thomisidae													
Diaea dorsata (Fabricius, 1777)	**39**				5	77	18						
Misumena vatia (Clerck, 1757)	**19**	5	5				85					5	
Ozyptila praticola (C.L. Koch, 1837)	**246**	4			62	17	1		2			13	1
Xysticus cristatus (Clerck, 1757)	**26**	31	8		53		4					4	
Xysticus erraticus (Blackwall, 1834)	**1**		100										
Xysticus ferrugineus Menge, 1876	**1**		100										
Xysticus kochi Thorell, 1872	**23**	9	17		35		4					22	13
Xysticus lanio C.L. Koch, 1835	**1**					100							
Xysticus ulmi (Hahn, 1831)	**8**	13				13						74	
Salticidae													
Ballus chalybeius (Walckenaer, 1802)	**174**	3			10	8	64		1			13	
Dendryphantes rudis (Sundevall, 1833)	**7**					86						14	
Euophrys frontalis (Walckenaer, 1802)	**80**	24	43		4	1			19		3		6
Evarcha arcuata (Clerck, 1757)	**1**											100	
Hasarius adansoni (Audouin, 1826)	**6**									100			
Heliophanus auratus C.L. Koch, 1835	**48**	38	4			6			4			48	
Heliophanus cupreus (Walckenaer, 1802)	**8**	12				38	12		38				
Heliophanus flavipes (Hahn, 1832)	**8**	12	25			12			39			12	
Heliophanus kochii Simon, 1868	**29**								100				
Macaroeris nidicolens (Walckenaer, 1802)	**2**						100						
Marpissa muscosa (Clerck, 1757)	**26**		4			34	23		4			31	4
Neon reticulatus (Blackwall, 1853)	**19**								90			5	5
Phlegra fasciata (Hahn, 1826)	**5**		40						60				
Pseudeuophrys lanigera (Simon, 1871)	**88**	12,5	8	2	15	24	6		1		12,5	19	
Salticus scenicus (Clerck, 1757)	**143**	3	0,5		3	22	59		2		5,5	3,5	1,5
Salticus zebraneus (C.L. Koch, 1837)	**29**	3			17	52						28	
Sitticus distinguendus (Simon, 1868)	**2**		100										
Sitticus pubescens (Fabricius, 1775)	**55**	4	13	5		35	9		9		18	7	
Synageles venator (Lucas, 1836)	**27**	40	11			4			19			19	7
Talavera aequipes (O.P.-Cambridge, 1871)	**1**		100										
Talavera petrensis (C.L. Koch, 1837)	**4**		100										

- Subhabitat species diversity

*** Number of species found per subhabitat**

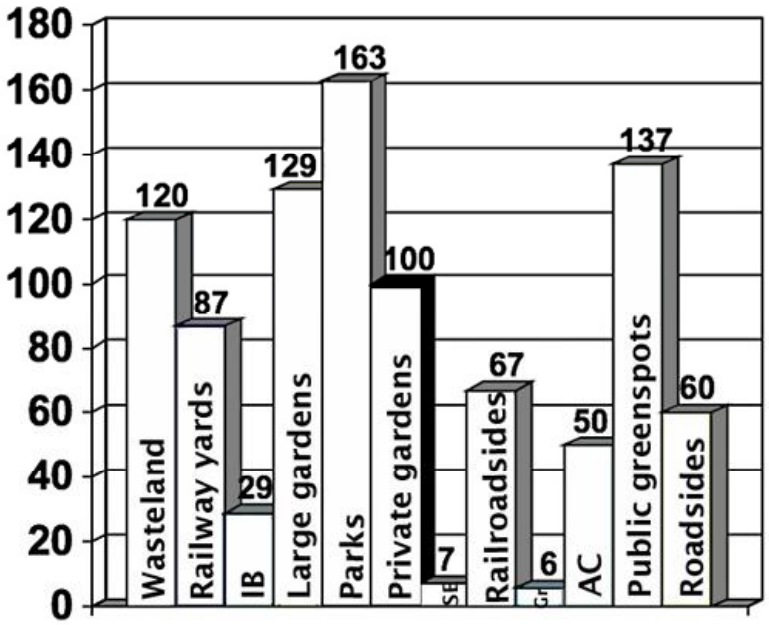

Fig. 3: Species diversity per subhabitat in absolute figures (IB=In Buildings, Se= Sewers, Gr=Greenhouses, AC=Against Constructions)

This order is more or less maintained when we look at the species diversity, corrected for collection efforts.

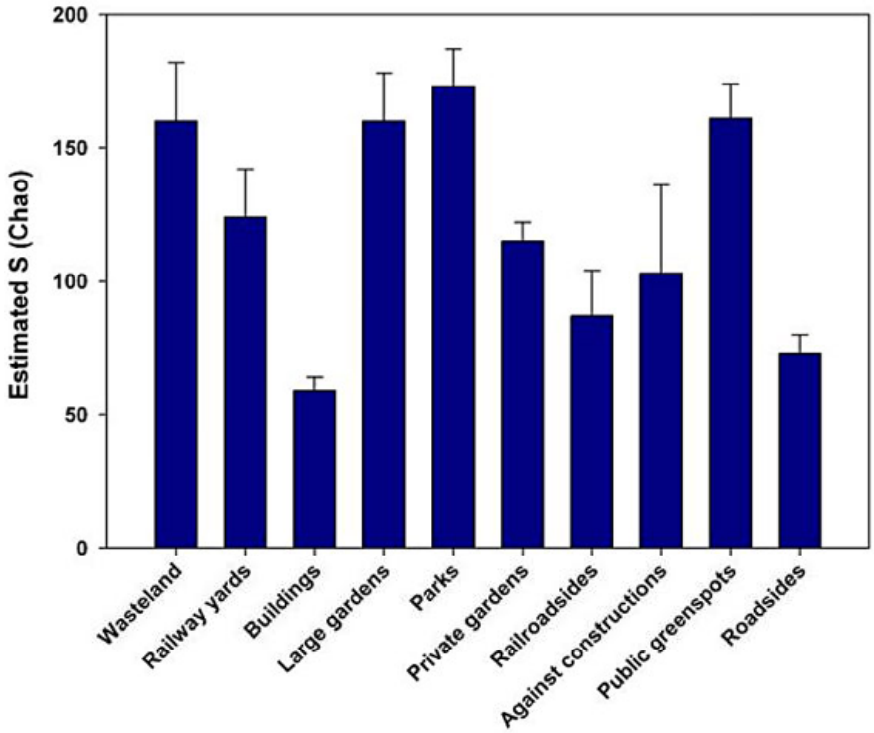

Fig. :. Species diversity per subhabitat, corrected for collection efforts (Subhabitats "In Buildings", "Sewers" and "Greenhouses" are omitted because of insufficient statistical significance)
(Graphics & analyses: Prof. Dr. D. Bonte, Ghent University)

*** Relative species diversity**

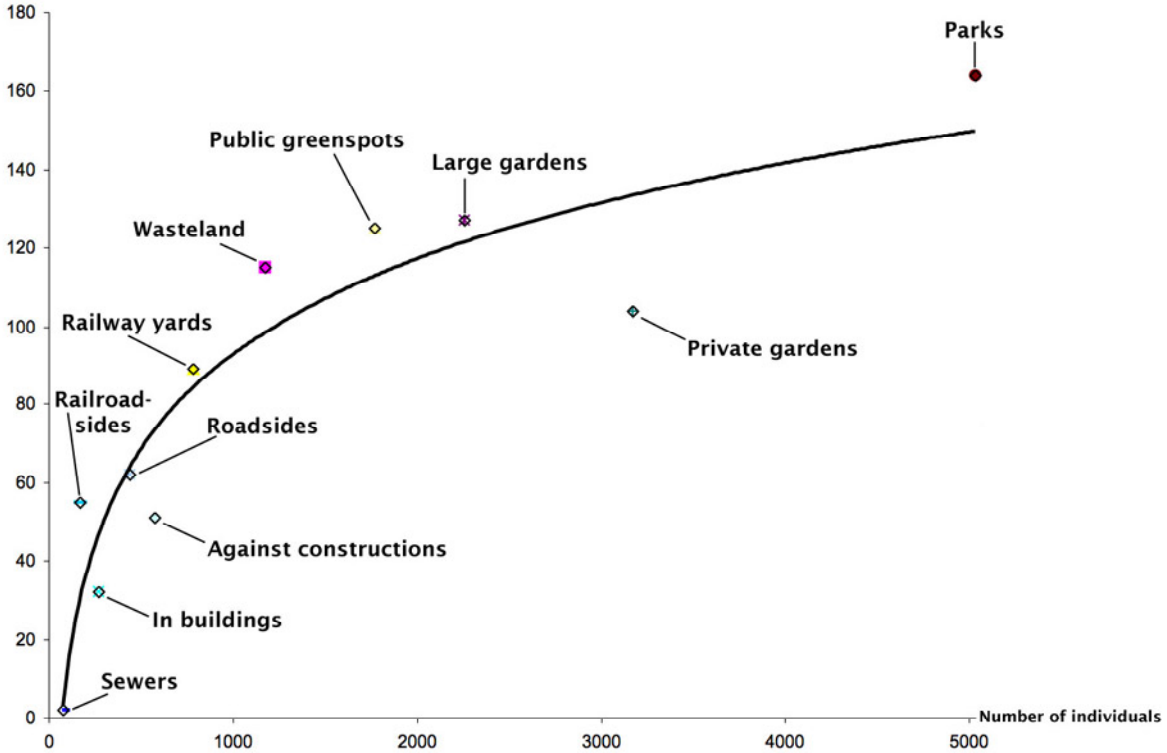

Fig. 5: Expected diversity (curve), relative to all data (specimens/species collected)
(Graphics & analyses: Prof. Dr. J.-P. Maelfait, Ghent University)

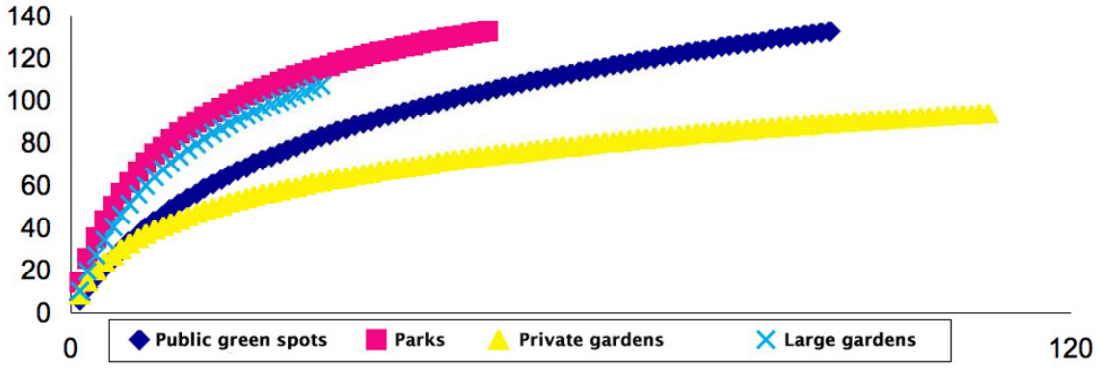

Fig. ∴ Species diversity, relative to number of samplings, in private gardens, public green spots, parks and large gardens. The species diversity in private gardens is significantly lower
(Graphics & analyses: Prof. Dr. J.-P. Maelfait, Ghent University)

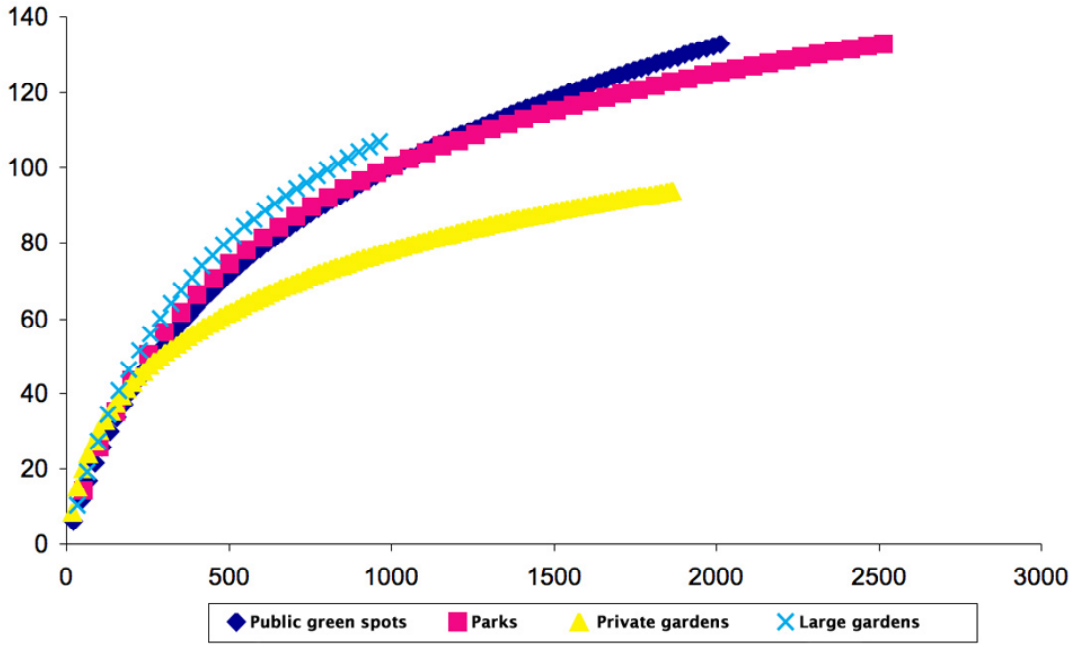

Fig. 7: Species diversity, relative to number of caught individuals, in private gardens, public green spots, parks and large gardens. The species diversity in private gardens is significantly lower (Graphics & analyses: Prof. Dr. J.-P. Maelfait, Ghent University)

These graphics and further analysis could be useful for policy makers in helping them to make choices about how to organize the urban space in order to increase biodiversity. First attempts have already been made (VAN KEER & VAN KEER, 2006; VAN KEER, 2008).

- Subhabitat species composition

*** "Exclusive species"**

Every subhabitat -except for "inside buildings"- has its exclusive species (species that were only caught in that subhabitat). Although numbers are too small to really conclude anything about the way a subhabitat spider fauna distinguishes itself from another, we mention them anyway (fig. 8) because they can be meaningful in an urban green management context:

"Typical" species (= exclusive species, with more than 2 individuals found) for the subhabitats in an Antwerp context, are for:

- Sewers: *Lessertia dentichelis, Porrhomma convexum*
- Greenhouses: *Cryptachaea acoreensis, Hasarius adansoni, Uloborus plumipes*
- Public greenspots: *Microctenonyx subitaneus, Gnathonarium dentatum*
- Wasteland: *Cercidia prominens, Zora spinimana*
- Railway yards: *Meioneta fuscipalpa, Talavera petrensis, Zelotes aeneus*
- Large gardens: *Alopecosa cuneata, Pardosa pullata, Stemonyphantes lineatus*
- Parks: *Crustulina guttata, Dictyna pusilla, Dipoena melanogaster, Harpactea hombergi, Neriene peltata, Obscuriphantes obscurus, Walckenaeria cucullata*
- Railroadsides: *Heliophanus kochii*
- Roadsides: *Zelotes subterraneus*

The subhabitats "Private city gardens" and "Against constructions" don't have exclusive species of which there were found more than two individuals.

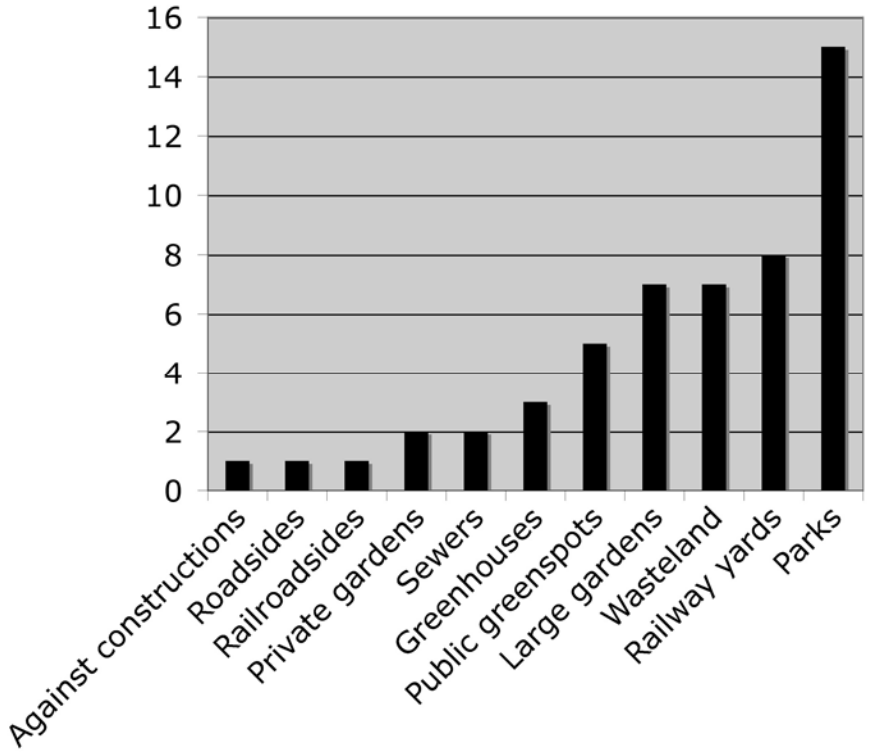

Fig. 8: Number of exclusive species per subhabitat

*** Case: Private gardens**

A quick comparison with SMITH et al. (2006a) of the species occupancy across gardens shows a striking resemblance in number of species that were caught only once in this biotope. In both investigations, this number was 27, although the sampling methods were different and the number of gardens varies a lot between the two studies: 61 in SMITH et al. and 116 in this study.

The average number of species found per garden in Antwerp, was 11.34, with a minimum of 2 and a maximum of 25.

The average number of species caught per garden, similarily sampled (same person, same sampling methods, same period), was 11.0 for the period May-June and 10.2 for the period September.

In Antwerp, the average number of individuals found per garden, was 26.69, with a minimum of 4 and a maximum of 118. SMITH et al. used three main sampling methods: litter samples, pitfalls and malaise traps. Their average number of individuals found per garden was 23.02. The sampled gardens in SMITH et al. (2006a) were situated in a "predominantly urban area", while the gardens of the *Antwerp Spider Research Project* were situated in a city center and were consequently probably subject to a higher degree of urbanisation. The sampling period of SMITH et al. (June-October) is comparable to our garden sampling period (May-September) in terms of general spider phenology around our degree of latitude.

Before sampling each of the 116 private city gardens, a description was made, using a form with different parameters (surface size, vegetation strata, constructions, orientation (according to points of the compass),...). One of the characteristics to determine, was if the garden was 'wild' or 'maintained'. Although there was no possibility to nuance, it generally was not difficult to categorize the gardens in this way. Using the results of the similarily sampled gardens (same person, same sampling methods, same period) to compare the species diversity of these "types" of gardens, we established a clear difference. We found that the wild gardens harboured 20% more species (12.05 average) than the maintained ones (9.65).

In a comparison between two larger gardens of former monasteries (pitfall sampling), we found that the 'wild' one even harboured 31% more species than the 'maintained' one.

- Some notable ecological observations

* Our observation (VAN KEER & VAN KEER, 2005) concerning the dominance of *Tegenaria parietina* (204 ind.) over the other two *Tegenaria* spp. (*T. domestica* (43 ind.) & *T. atrica* (172 ind.)) present in the Antwerp city center, remains. Strangely enough, *T. parietina* does not seem to be a common species in the neighbouring Netherlands (TUTELAERS, 2010) and Germany (STAUDT et al., 2010). According to Noordam (ROBERTS, 1998), its geographical range reaches as far north as the Netherlands.
* Another striking "dominance" within synantropic species of the same genus, is the one from *Steatoda grossa* (181 ind.) over *S. bipunctata* (34 ind.) and *S. triangulosa* (22 ind.). SMITHERS (1990), already suggested that *S. grossa* could possibly displace the other *Steatoda* species in a synantropic environment (Plymouth, Engeland).
* Other observations within this study can teach us something about the habitat preference of the species found, e.g.
  - species, often considered as "wood dwellers", rather seem to be "tree dwellers", since they were also found in considerable numbers on trees in parks and even gardens. Examples are *Ballus chalybeius* (174 ind.), *Paidiscura pallens* (89 ind.), *Moebelia penicillata* (19 ind.), *Philodromus albidus* (150 ind.), *Philodromus buxi* (52 ind.), *Segestria senoculata* (24 ind.), *Salticus zebraneus* (29 ind.) and *Theridion mystaceum* (96 ind.).
    In contrast, some "tree loving spiders" which were found in more "woody" habitats outside the city (VAN KEER & VANUYTVEN, 2009), were not found in the Antwerp parks. Consequently, this may be a strong indication for their "wood dweller status". Examples are *Drapetisca socialis, Neriene emphana, Pachygnatha listeri, Malthonica picta, Cicurina cicur* and *Coelotes terrestris*.
  - Examining the sampling results of an Antwerp former monastery garden, we found that there are clear indications for a microhabitat spider fauna specificity. Each of the three pitfall stations within the garden (which is 0,43ha) showed several exclusive species after a year's cycle and this while the maximum distance between two traps was only about 50 meters (VAN KEER et al., 2009)!
  - *Araniella cucurbitina* vs. *A. opisthographa*:
    A. cucurbitina: 55ind., 41% private gardens, 0% roadsides
    A. opisthographa: 26ind., 0% private gardens, 35% roadsides
  - *Lepthyphantes leprosus* vs. *L. minutus:*
    L. leprosus: 311ind., 50% private gardens, 7% parks
    L. minutus: 26ind., 0% private gardens, 57% parks
  - *Clubiona comta vs. C. corticalis:*
    C. comta: 96ind., 11% wasteland, 5% large gardens, 72% parks and 4% private gardens
    C. corticalis: 82ind., 0% wasteland, 30% large gardens, 6% parks and 48% private gardens
  - *Segestria bavarica vs. S. senoculata:*
    S. bavarica: 159ind., parks 7%, against constructions 31%
    S. senoculata: 24ind., parks 47%, against constructions 4%
  - *Philodromus albidus vs. P. rufus:*
    P. albidus: 150ind., parks 53%, private gardens 34%, public greenspots 3%, roadsides 0,5%
    P. rufus: 75ind., parks 14%, private gardens 7%, public greenspots 14%, roadsides 51%
    Strikingly significant differences in representation per subhabitat. 65% of the caught indiviuals of *P. rufus* was collected in green places along roads (=public greenspots + roadsides), whereas only 3,5% of the *P. albidus* individuals were found in these subhabitats. A possible explanation could be found in the fact that the presence of roads results in a more open space along the vegetation. This gives way to more sunlight and wind, which could result in a higher temperature and a lower humidity. To be investigated...
  - *Parasteatoda simulans vs. P. tepidariorum*
    P. simulans: 18 ind., parks, 83%, private gardens 17%, against constructions, 0%
    P. tepidariorum: 62 ind., parks, 5%, private gardens, 36%, against constructions, 34%
  - *Theridion melanurum* vs. *T. mystaceum:*
    T. melanurum: 250ind., railway yards 12%, parks 1%, private gardens 5%, against constructions 64%, public greenspots 0,5%

T. mystaceum: 96ind., railway yards 0%, parks 52%, private gardens 22%, against constructions 0%, public greenspots 15%

Not one individual of *T. melanurum* was found on bark of trees, whereas more than 60% of *T. mystaceum* individuals was collected in this biotope. Contrary to what the figures may suggest, some individuals of *T. mystaceum* were in fact collected against human constructions. These were situated in a park, therefore they are shown under that subhabitat.

- *Enoplognatha latimana* vs. *E. ovata:*

E. latimana: 45ind., wasteland 38%, parks 0%, private gardens 2%, railroadsides 18%, public greenspots, 29%

E. ovata: 307 ind., wasteland 2%, parks 19%, private gardens 51%, railroadsides 1%, public greenspots 18%

Striking differences in representation per subhabitat can be observed. However, the period of collecting could explain part of these differences. We noticed a difference in phenology between the species: *E. latimana* seems to come to adulthood later than *E. ovata* does (Fig. 9). The sampling of the private gardens in the spring period was carried out mostly during the months of May and June. Consequently, sampling of the private gardens stopped before the adult period of *E. latimana*. More intens sampling after June (also in other subhabitats) could have resulted in a higher number of identified (adult) *E. latimana* individuals.

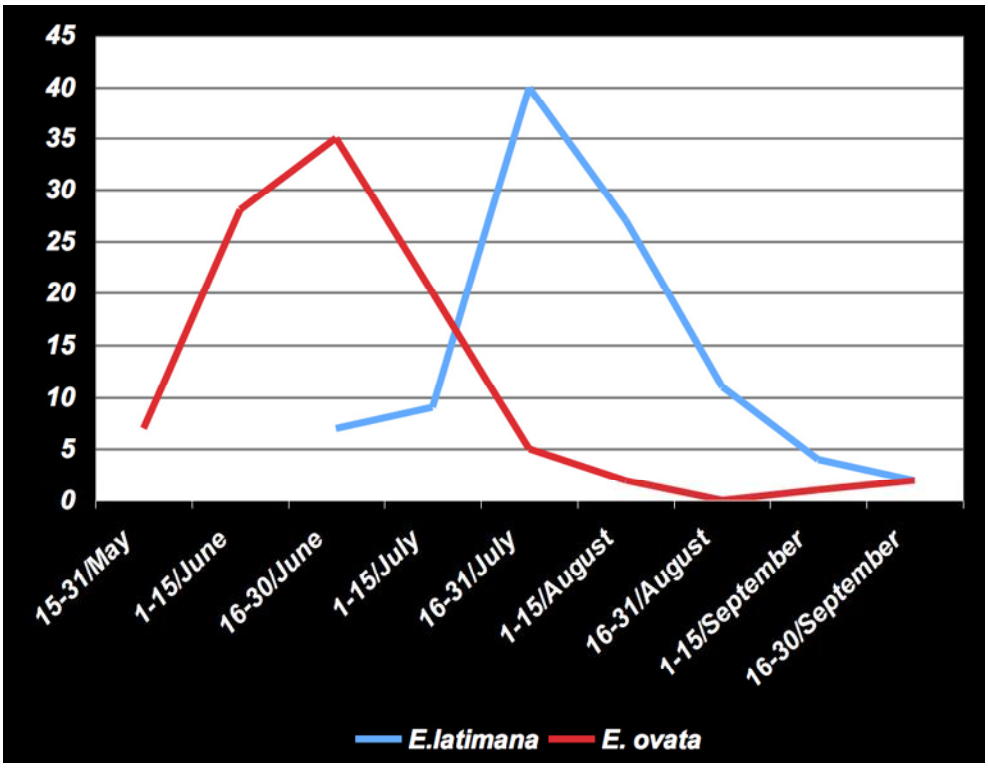

Fig. 9: Percentages of caught adult specimens of Enoplognatha latimana & E. ovata. A clear difference in phenology can be observed.

- *Theridion n. sp. cfr. mystaceum:*

19 indivuals of this undescribed species were found at 7 different locations, all against human constructions in the direct vicinity of a railroad. The habitat type at the other known localities of the species in Belgium (almost all in the south of the country) leads us to believe that its natural habitat are cliff faces. The species was also commonly caught in stone quarries. A plausibel assumption is therefore that the Antwerp population descends from specimens introduced with the ballast (= stones between

railways), which is won in the stone quarries of Spontin and Quenast (both localities from the south of Belgium).
The species is currently being described by Herman Vanuytven.

Discussion

The surprising diversity in spider species found, as well as the number of rare species, are in contradiction with general expectations. These were based mostly on the misguided idea that an urban habitat is little diverse and that the small surfaces of suitable habitat in densely built city centers do not suffice to harbour populations of non-synantropic spider species. An additional indication for the high diversity in habitat can be found in the 14 different habitat categories to which belong the red list species that were captured in Antwerp. We found that the Antwerp city center does in fact contain many subhabitats, varying in several features, like substrate structure, humidity, temperature and vegetation.
The specific urban context, did not allow us to collect, in a standardized way, a lot of hard data to support our supposition that population densities are lower in the sampled area, than in larger and more "natural" habitats. We could however establish that numbers of caught (adult) individuals in pitfall traps, were low (7.85 individuals/trap/month average).
We presume spiders in a higly urbanized habitat suffer higher stress. Supposed elevating stress factors could be:
- Small surface size of suitable habitat (DESENDER et al., 2005; SHAFFER, 1981)
- Relatively low nutrition quantities
- High predation stress
- Constant (and often unnecessary) "management activities" (e.g. too frequent and poorly timed mowing and trimming) in public, as well as in private green zones
- Intensive human use -and consequently disturbance- of the habitat.
- Limited dispersal possibilities following the dense and distinctly vertical structure (buildings) of the urban habitat.

It is clear to us that the collected data provide ample possibilities for additional and further analysis in various fields.

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References

BECKER, L., 1882. Les Arachnides de Belgiques (1ère partie). *Annales du Musée royal d'Histoire Naturelles de Belgique*, Tome **X**.

BOSMANS, R. & VANUYTVEN, H., 2001. Een herziene soortenlijst van de Belgische spinnen (Araneae). *Nieuwsbrief van de Belgiche Arachnologische Vereniging*, **16**(2): 44-80.

BOSMANS, R., 2009. Een herziene soortenlijst van de Belgische spinnen (Araneae). *Nieuwsbrief van de Belgiche Arachnologische Vereniging*, **24**(1-3): 33-58.

BROEN, B.V., 1977. Zur Kenntnis der Spinnenfauna des Berliner Raums. I. Spinnen eines xerothermen Kulturbiotops (Araneae). *Deutsche Entomologische Zeitung, N. F.* **24**, Heft IV-V: 411-417.

BROEN, B.V., 1985. Zur Kenntnis der Spinnenfauna des Berliner Raums. II. Spinnen eines isolierten Flurgehölzes (Araneae). *Deutsche Entomologische Zeitung, N. F.* **32**, Heft IV-V: 239-250.

DE KONINCK, H., 2009. De arachnofauna van het natuurgebied Buitengoor-Meergoor te Mol. *Nieuwsbrief van de Belgiche Arachnologische Vereniging,* **24**(1-3): 89-98.

DESENDER K., HONNAY O. & MAELFAIT, J.P., 2005. Behoudsmaatregelen voor kleine en geïsoleerde populaties: verbinden of vergroten? *Natuur.focus* **4**(3): 95-100.

GASTON, K.J., SMITH, R.M., THOMPSON, K. & WARREN, P.H., 2005. Urban domestic gardens (II): experimental tests of methods for increasing biodiversity. *Biodiversity & Conservation,* **14**: 395-413.

HANSEN, H., 1992. Über die Arachniden-Fauna von urbanen Lebensraumen in Venedig-II. Die Rinde-bewohnenden Arten des Stammbereiches von *Platanus hybrida* (Arachnida: Scorpiones, Pseudoscorpiones, Araneae). *Boll. Mus. civ. St. nat. Venezia* **41**: 91-108.

HEINZ, M., NÄHRIG, D. & STROCH, V., 2002. Synanthrope Spinnen (Araneae) in Nordbaden. *Carolinea* **60**: 141-150.

HERVE, C. & ROLLARD, C., 2006. Inventaire des araignées des espaces verts de la ville de Paris. Service de l'Ecologie Urbaine Section Etudes et Prospectives Evironnementales (SEPE) Pôle Biodiversité. 31 pp.

JANSSEN, M. & POOT, P., 2000. Bijna de halve Vlaamse spinnenfauna aanwezig in de Ziepbeekvallei (Limburg, België). *Nieuwsbrief van de Belgiche Arachnologische Vereniging,* **15**(2): 37-52.

JOCQUÉ, R., 1992. Nederlandse namen voor inheemse spinnen. *Nieuwsbrief van de Belgiche Arachnologische Vereniging*, **7**(3): 1-20.

KADAS, G., 2006. Rare invertebrates colonizing green roofs in London. *Urban habitats*, 4(1): 66-86.

KEKENBOSCH, J. & BAERT, L. , 1978. Araignées nouvelles pour la faune de Belgique. *Bulletin et Annales de la Société royal Belge d' Entomologie,* **114**: 59-61.

KOBELT, M. & NENTWIG, W., 2008. Alien spider introductions to Europe supported by global trade. *Diversity & Distribution,* **14:** 273-280.

KUTTLER, W., 1993. Stadtklima. In: H. Sukopp & R. Wittig (Eds.), *Stadtökologie*. G. Fisher, Stuttgart. pp 113-153.

LAMBRECHTS, J., JANSSEN, M. & HENDRICKX, A., 2002. 4 nieuwe spinnensoorten voor de Belgische fauna. *Nieuwsbrief van de Belgiche Arachnologische Vereniging,* **17**: 74-79.

LAMBRECHTS, J., JANSSEN, M. & ZWAENEPOEL, A., 2007. De spinnenfauna van het Vlaams natuurreservaat Zwinduinen en -polders (Knokke, West-Vlaanderen). Het is vijf voor twaalf voor de duingraslandsoorten. *Nieuwsbrief van de Belgiche Arachnologische Vereniging,* **22**: 65-82.

LE PERU, B., 2004. Inventaire des araignées d'une vallée du Massif Central, (France) (Arachnida, Araneae). *Revue d'Arachnologie,* **15**(1): 1-14.

MAELFAIT, J.-P., BAERT, L., JANSSEN, M. & ALDERWEIRELDT, M., 1998. A Red list for the spiders of Flanders. *Bulletin van het Koninklijk Belgisch Instituut voor Natuurwetenschappen, Entomologie*, **68** : 131-142.

NYFFELER, M., 2000. Ecological impact of spider predation: a critical assessment of Bristowe's and Turnbull's estimates. *Bulletin of the British arachnological Society,* **11**(9): 367-373.

PLATNICK, N.I., 2010. The World Spider Catalogue, Version 11.0. The American Museum of Natural History. *http://research.amnh.org/entomology/spiders/catalog/*

REUMER, J.W.F., 1996. Flora en fauna van het Rijndam terrein (Rotterdam). Natuurmuseum Rotterdam. *Stadsecologische reeks,* **2**: 15-40.

ROBERTS, M.J. (NOORDAM, A. red.), 1998. Spinnengids. Tirion Natuur. 397pp.

SALZ, R., 1992. Untersuchungen zur Spinnenfauna von Köln (Arachnida: Araneae). Wirbellosen-Fauna der Grosstadt Köln. Naturhistorischen Vereins Bonn. *Decheniana*, Beihefte, **31**: 57-105.

SHAFFER, M.L., 1981. Minimum population sizes for species conservation. *Bio Science,* **30**: 131-134.

SMITH, R.M., GASTON, K.J., WARREN, P.H. & THOMPSON, K., 2005. Urban domestic gardens (V): relationships between landcover composition, housing and landscape. *Landscape ecology* , **20**: 235-253.

SMITH, R.M., GASTON, K.J., WARREN, P.H. & THOMPSON, K., 2006a. Urban domestic gardens (VIII): environmental correlates of invertebrate abundance. *Biodiversity & Conservation,* **15**: 2515-2545.

SMITH, R.M., WARREN, P.H., THOMPSON, K. & GASTON, K.J., 2006b. Urban domestic gardens (VI): environmental correlates of invertebrate species richness. *Biodiversity & Conservation,* **15**: 2415-2438.

SMITHERS P., 1990. A survey of spiders from houses in the Plymouth area. *Newsletter of the British arachnological Society,* **59**: 4-5.

STAUDT, A. et al., 2010. Nachweiskarten der Spinnentiere Deutschlands (Arachnida: Araneae, Opiliones, Pseudoscorpiones) Arachnologische Gesellschaft. *http://spiderling.de.vu/*

THALER, K. & STEINER, M., 1993. Zur epigäischen Spinnenfauna des Stadtgebietes von Wien (Österreich) - nach Aufsammlungen von Prof. Dr. W. Kühnelt. *Ber. Nat.-med. Verein Innsbruck*. Band, **80**: 303-310.

TUTELAERS, P.T.H., 2010. Benelux spider distribution maps. *http://www.tuite.nl/iwg/Araneae/SpiBenelux/*

VAN KEER, K., 2007. Exotic spiders (Araneae): Verified reports from Belgium of imported species (1976-2006) and some notes on apparent neozoan invasive species. *Nieuwsbrief van de Belgiche Arachnologische Vereniging,* **22**(2): 45-54.

VAN KEER, K. , 2008. Ecologisch groenbeleid en -beheer: aanbevelingen aan de stad Antwerpen op basis van de data-analyse binnen het Antwerps Spinnenonderzoeksproject (ASOP, 2004-2008). Belgische Arachnologische Vereniging ARABEL, Antwerps Spinnenonderzoeksproject (ASOP), pp. 1-34.

VAN KEER, K., (*in prep.*). An update on the verified reports of imported spiders (Araneae) from Belgium. *Nieuwsbrief van de Belgiche Arachnologische Vereniging.*

VAN KEER, K., DE KONINCK, H., VANUYTVEN, H. & VAN KEER, J. , 2006. Some -mostly southern European- spider species (Araneae), new or rare to the Belgian fauna, found in the city of Antwerp. *Nieuwsbrief van de Belgiche Arachnologische Vereniging,* **21**(2): 33-40.

VAN KEER, K., DE KONINCK, H., VANUYTVEN, H. & VAN KEER, J. , 2009. Spiders as bio-indicators: Microhabitat spider fauna specificity within an Antwerp former monastery garden. *Nieuwsbrief van de Belgiche Arachnologische Vereniging,* **24**(1-3): 85-88.

VAN KEER, K. & LOUVIGNY, R., 2010. De aanwezigheid van *Macaroeris nidicolens* (Walckenaer, 1802) (Araneae: Salticidae) in België. *Nieuwsbrief van de Belgiche Arachnologische Vereniging,* **25**(1): 41-43.

VAN KEER, K. & VAN KEER, J., 2005. The spiders (Araneae) of Antwerp inner city: faunistics and some reflexions on ecology. *Nieuwsbrief van de Belgiche Arachnologische Vereniging,* **20**(3): 81-90.

VAN KEER, K. & VAN KEER, J., 2006. Verrassende spinnenrijkdom in Antwerpse binnenstad. Kapstok voor ecologisch beheer van stedelijk groen. *Natuur.focus,* **5**(1): 17-21.

VAN KEER, K., VAN KEER, J., DE KONINCK, H. & VANUYTVEN, H., 2007. Another Mediterranean spider, *Cheiracanthium mildei* L. Koch, 1864 (Araneae: Miturgidae), new to Belgium. *Nieuwsbrief van de Belgiche Arachnologische Vereniging* **, 22**(1): 61-64.

VAN KEER, K. & VANUYTVEN, H., 2009. Verschillen in spinnenfauna (Araneae) tussen Antwerpen-stad en haar wijdere omgeving: een poging tot verklaring. *Antenne. Tijdschr. Antw. Koepel Natuurst. (ANKONA),* **3**(4): 17-20.

VANUYTVEN, H., 1986. Spiderfauna of the Antwerp sewers (Araneae). *Phegea*, **14**(4): 127-129.

VANUYTVEN, H., 1987. Een eerste poging tot de indeling van onze "huisspinnen" in Eusynantrope en Hemisynantrope soorten. *Nieuwsbrief van de Belgiche Arachnologische Vereniging* **, 2**(2): 6-7.

VANUYTVEN, H., 1991. Spinnen in gebouwen in België (Araneae). *Nieuwsbrief van de Belgiche Arachnologische Vereniging*, **6**(2): 15-23.

VANUYTVEN, H., 1997. Spinnen van het havengebied op de Antwerpse rechter Scheldeoever. *Nieuwsbrief van de Belgiche Arachnologische Vereniging*, **12**(1): 1-24.

VON STÜLPNAGEL, A., HORBERT, M. & SUKOPP, H., 1990. The importance of vegetation for the urban climate. In: Sukopp H., Hejný S. & Kowarik I., (Eds.). Urban ecology, plant and plant communities in urban environments. SPB Academic Publishing, Den Haag, pp. 175-193.