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Spider web contamination of house facades: habitat selection of spiders on urban wall surfaces

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Abstract
Spider web contamination of house wall surfaces is a serious problem in Hungary. Suction samples from walls in eight settlements revealed that the degree of contamination changes both regionally and locally. Although the present study demonstrated the presence of 9 spider species on walls, over 90% of spiders collected belonged to a single cribellate web building species, *Dictyna civica*. Habitat selection of *D. civica* in terms of the physical or chemical properties of the surface material of walls was very wide-ranging and variable. So far, we could not uncover any consistent pattern in the selection of certain surfaces, which could be utilised for the prevention of web contamination. On the other hand, spiders showed very clear preferences for particular external environmental conditions, such as the orientation of walls, their degree of exposure and the presence of artificial light source. Indirect evidence suggests that pollution caused by heavy traffic increases the number of abandoned webs, thus worsening the problem. Although spider webs absorbing pollutants can potentially deteriorate wall materials, preliminary visual comparison of surfaces beneath webs and of nearby areas provided no concrete evidence for this.

Key words: urban ecology, building materials, spider web, air pollution, urban planning

INTRODUCTION

Small dirt-patches show up on some house walls which spoil the appearance of buildings and are regarded as a nuisance by house owners. The origin of these patches is well known to arachnologists: small webs of *Dictyna civica* (Lucas, 1850) 'decorate' these walls which, due to air pollution, not only catch insects, but also dirt from the air.

The species was described by Lucas from house walls in Paris (Lucas 1850). Since then it has been reported mostly from urban habitats (Bonnet 1931; Billandelle 1957; Keer & Keer 1987). Although known from many urban places in Western Europe, the species appears to be of South European origin (Hertel 1968). In the Hungarian arachnological literature initial reports of the occurrence of *D. civica* are from areas close to the Adriatic Sea (Chyzer & Kulczynski 1891). The next mention was from József Jablonowski (1925), who reported an invasion of these spiders on Budapest house walls in the years 1923-24. All subsequent data from the present territory of Hungary are from urban habitats (Kolosváry 1928; Loksa 1958; Szinetár 1992a; Szinetár et. al. 1999). Szinetár (1992b) collected the species not only from walls, but from urban spruce foliage, too.

D. civica builds a circular, tangled cribellate web on flat surfaces. The location of the web is chosen, such that under its central part there is usually a small depression of the surface. The web is also more densely woven in this region, forming a retreat, beneath which the spider sits. The breeding season is autumn and spring (Wiehle 1953; Loksa 1969), when males search for females and, after mate location, the male cohabits within the female's web for few weeks. After this the female lays her cocoon, which she guards in the retreat until her death.

Although much is already known about the biology of *D. civica*, we still lack data on the most practical aspects of its ecology: what are the main parameters of its habitat choice (large and small scale); exactly which wall surfaces does it prefer? These were the main questions, which our small team (an arachnologist, an architect and a chemical engineer, the latter two building material experts) set out to study in several settlements in Hungary.

MATERIAL AND METHODS

Sampling the spiders

We used a hand-held suction sampler (Samu & Sárospataki 1995), which, after the idea of Csaba Szinetár (unpublished), was modified with a circular brush end, that made sampling from wall surfaces very effective: after hoovering the 1 m² sample, a clean rectangle remained on the wall. Wall surfaces to be sampled, and the choice of settlements in Hungary was haphazard. We choose web contaminated surfaces, and within them those sampling areas where we thought the contamination was typical. The 1 m² samples taken from these surfaces were stored in a plastic bag, from which spiders were live-sorted and identified in the laboratory. Web material was handed over for chemical analysis. We took notes of several parameters about the wall sampled:

- relative mean cover by webs (assessed on a scale 1-5);
- rendering type of external wall surfaces (qualitative classification: rough-cast rendering, coarse plaster, scratch coat, silicate rendering, lime painted, polymer dispersion painted, stone, article stone, brick, metal, glass);
- amount of organic components as a percentage from the laboratory analysis;
- physical properties of the surface (colour, roughness);
- position of the surface (orientation; degree of exposure: freely exposed or shaded/covered by other parts of the building, internal/external wall);
- vicinity of vegetation (trees);
- heaviness of nearby traffic.

Laboratory examinations

We took small samples of the plaster material from walls where spiders were collected. This, and its organic contents, was identified using thermo-analytical tests, infrared spectrophotometry and X-ray diffractometry. Surface roughness was examined by taking prints of the surface using a quickly-setting silicon compound and by the visual comparison of these samples. The presence of polluting components from the air incorporated into the spider webs were tested through the measurement of pH, nitrate-, chloride-, and sulphate-ion contents of web samples.

RESULTS

The fauna of the external surface of the wall

We took 51 samples from 8 settlements in Hungary. Over 90% of the 285 animals caught belonged to the species *Dictyna civica*; the rest represented at least 8 species (Table 1), out of which Theridiidae was represented by the most individuals. Spider families had a characteristic distribution on the walls: web-building spiders other than *D. civica*, occupied the more protected areas: corners, nook, underside of borders, behind the gutters, etc. On open, exposed surfaces *D. civica* was virtually the only web-building spider, while for hunting spiders (Philodromidae, Thomisidae, Salticidae), such selectivity was not observed. The remaining results concern only the dominant species, *D. civica*.

Patterns of distribution of *D. civica*

On the contaminated surfaces we sampled, the average spider density was mean±SD=9.6± 18.05 (N=50). The maximum value was 82 spiders/m^2, which resulted in a virtually continuous contamination of the wall by webs. Spider density and web cover showed strong positive correlation (R=0.4, P<0.005, N=50).

Spider density was not uniform across the different regions in Hungary where the samples were taken (one-way ANOVA: $F_{4,45}$=3.15, P=0.02). In two areas (around Tokaj and in Budapest) the mean density was around 20 spiders/m^2, while in the remaining places the mean was less than 5 spiders/m^2. This observed distribution did not coincide with the pattern of any environmental variable (e.g. settlement size, local climate, vicinity of a river, general pollution level, mountainous vs. plain area), which we could determine.

Table 1. List of spider species collected during the study from house walls.

Taxon	No. of individuals	%
Araneus diadematus	1	0.4
Dictyna civica	262	91.9
Pholcus phalangioides	1	0.4
Salticidae sp.	1	0.4
Scytodes thoracica	1	0.4
Sitticus distinguendus	2	0.7
Steatoda bipunctata	1	0.4
Steatoda sp.	5	1.8
Tegenaria nemorosa	2	0.7
Thanatus sp.	1	0.4
Theridiidae sp.	2	0.7
Xysticus sp.	6	2.1

Material and quality of the surface

The material type of the surface did not consistently affect either spider density or web cover (one-way ANOVAs, density: $F_{8,41}$=1.04, NS; web cover: $F_{9,139}$=1.64, NS). Qualitatively, stone and article stone surfaces, and those painted with dispersion paints were more contaminated. Interestingly, the two observed metal surfaces showed extremely high contamination levels (mean density=38.6 spiders/ m^2).

Web cover showed a negative, although not significant relationship to the organic content of the surface material (R=0.13, N=24, NS). Spiders built fewer webs on surfaces of very high (20-30%) organic content (Fig. 1).

No strongly significant relationship was discovered in the preference for surface roughness (one-way ANOVA: $F_{4,45}$=2.39,

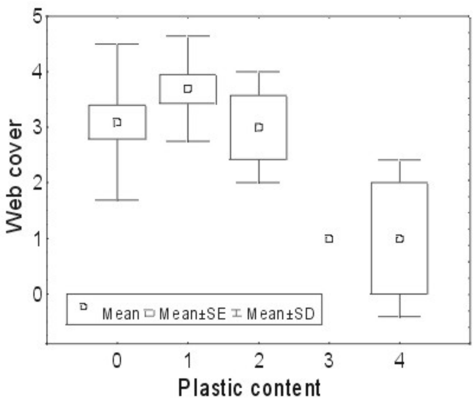

Fig. 1. Relationship between organic content of rendering material (0: 0%, 1: 2-5%, 2: 5-10%, 3:10-20%, 4: 20-30%) and web cover (0: no webs, 5: web cover > 50% of surface area).

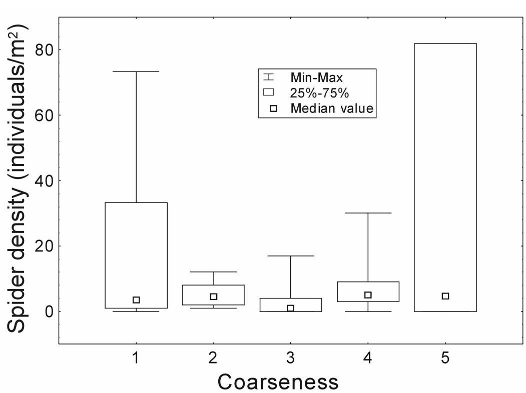

Fig. 2. The effect of roughness (1: smooth, 5: rough) on the density of *D. civica* on contaminated wall surfaces.

P=0.06). Dense spider populations were found on the roughest surfaces, as well as on relatively smooth surfaces (Fig. 2). However, casual observations showed that on smooth surfaces spiders preferred small irregularities, such as holes remaining from removed nails.

The colour of the wall did not affect spider density, but considering web cover, there were significant differences (ANOVA: $F_{9,139}$=3.43, P<0.001). Spiders preferred light grey and light green surfaces, while more saturated colours, such as green, pink and red were preferred less.

Environmental influences on web contamination

The orientation of the wall had a strong influence on spider distribution. Most spiders were collected, and the highest web cover was observed, on walls facing south-east. Departing from this orientation, spider web contamination decreased gradually, and the smallest number of spiders was recovered from the opposite, west-facing walls (Fig. 3).

Another environmental variable, exposition, also had strong, significant influence on both web cover and spider density, both of which decreased with higher exposition (open, freely standing walls) (r=-0.2, t=-2.48, P=0.01; Fig. 4). On the other hand, a separate aspect of exposure, the distance to nearby vegetation (trees) which could shade and protect walls, had no effect on either web cover (ANOVA: $F_{3,145}$=0.11, NS) or on spider density ($F_{3,46}$=0.65, NS).

We assessed the heaviness of nearby traffic on a scale of 1-4, which we suggest characterises the amount of airborne pollution reaching wall surfaces. Interestingly there was no significant relationship between traffic and spider density (ANOVA: $F_{3,46}$=0.16, NS), but there was a strong positive relationship between the intensity of traffic and web cover ($F_{3,145}$=6.03, P<0.001).

DISCUSSION

There seems to be no easy „ecological solution" to spider web contamination of external wall surfaces. *D. civica* showed no consistent preference or dislike towards any particular rendering or paint material. It occurred on both rough and smooth surfaces, including uncleaned glass. Paint types that have high organic content, and some colours seem to deter spiders, but overall these effects do not seem to be robust enough to base a prevention strategy on them. The occurrence of spider

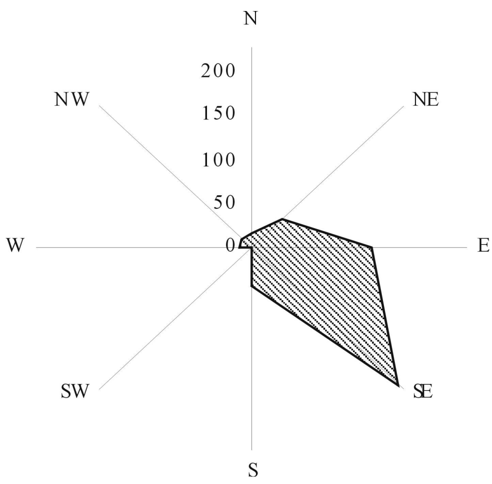

Fig. 3. Preference of spiders for wall orientation.

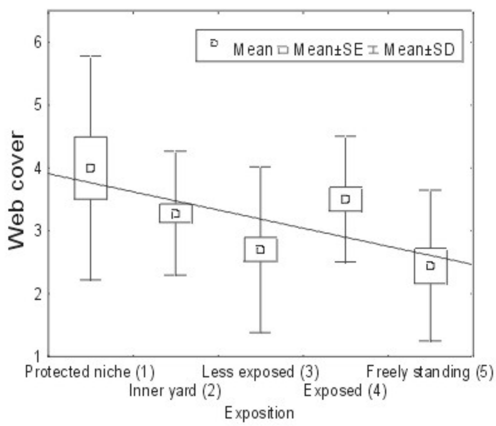

Fig. 4. The effect of wall exposition (classified into 5 ordinal values, see axis legend for explanation) on web cover (0: no webs, 5: web cover > 50% of surface area).

webs and the density of spiders was much more influenced by external environmental variables. There was a very clear preference among spiders for the south-easterly orientation of walls. They also preferred less exposed surfaces, such as inner yards, corners, and other protected niches. The choice of protected micro-habitats could be in connection with the South European origin of the species. Another species of South European origin, *Tegenaria nemorosa* Simon, 1916, was also found in our wall samples (Table 1). It is likely that both species could extend their area to the north by taking advantage of the micro-climate of cities, which is milder than that of the surrounding natural areas (Szinetár & Vajda 1992). We also made some casual observations, which showed that webs were aggregated around artificial lights. The walls of bank buildings also harboured more webs, while churches were virtually free from web contamination. Fig. 5 exemplifies the complex environmental influences (various rendering types, colours, presence of local light source, differently exposed facade areas) on the distribution of spider webs.

The cribellate web of *D. civica* is an excellent trap for air pollutants, including dust. Although spiders themselves might be quite resistant to pollution (no relationship of spider density with traffic was found), the number of webs was higher in streets with heavy traffic. A possible explanation for this is that dust congests the fine threads of the cribellate webs, making them unusable for prey capture. Therefore spiders in heavily polluted areas are forced more frequently out from their webs, and compelled to establish new webs. Thus, pollution by itself indirectly increases the web contamination problem.

The question arises whether spider webs, apart from spoiling the appearance of walls, do any actual harm to these surfaces. Webs might absorb gaseous pollutants, such as SO_2 and NO_2, which might cause the local pH to decrease. The phenomenon of lowered pH was observed in laboratory studies on heavily polluted webs (unpublished data). A further possibility is that microbial or fungal activity starts on abandoned spider webs, which can also produce by-products that can deteriorate the surface material of the walls. Still, in the present study, the visual inspection of surfaces from where webs were cleared off showed no difference from nearby surfaces. Even so, it cannot be ruled out, that the long-term presence of spider webs might be somewhat deleterious to wall surfaces.

Fig. 5. Spider web distribution in a complex architectural environment (Photo by ZsJ).

The present study uncovered the intrinsic and extrinsic factors of habitat choice by the spider *D. civica*, which causes most of the spider web contamination in Hungary. These results, however, could not uncover any clear-cut surface preference that could be utilised in the protection of newly built or renovated houses. Based on the more obvious environmental preferences, it is possible to predict which areas of a building are the most prone to spider webs. Importantly, heavy traffic seems to perpetuate the problem. Preliminary observations on the effect of spiders' webs on the material of walls showed no negative effects, other than aesthetic ones.

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