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Research Paper

Artificial lighting triggers the presence of urban spiders and their webs on historical buildings

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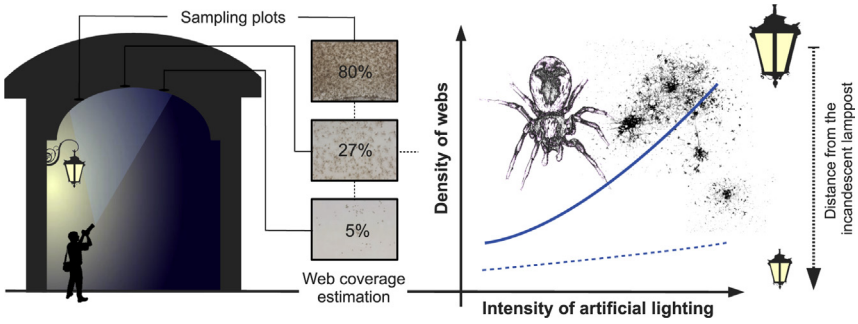
GRAPHICAL ABSTRACT



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ABSTRACT

Different spider species living in the urban environment spin their webs on building facades. Due to air pollution, web aggregations entrap dirt particles over time, assuming a brownish-greyish colouration and thus determining an aesthetic impact on buildings and street furniture. In Europe, the most common species causing such an aesthetic nuisance is *Brigittea civica* (Lucas) (Dictynidae). In spite of the socio-economical relevance of the problem, the ecological factors driving the proliferation of this species in the urban environment are poorly described and the effectiveness of potential cleaning activities has never been discussed in scientific literature. Over one year, we studied the environmental drivers of *B. civica* webs in the arcades of the historical down-town district of Turin (NW-Italy). We selected a number of sampling plots on arcade ceilings and we estimated the density of *B. civica* webs by means of digital image analysis. In parallel, we collected information on a number of potential explanatory variables driving the arcade colonization, namely artificial lighting at night, substrate temperature, distance from the main artificial light sources and distance from the river. Regression analysis showed that the coverage of spider webs increased significantly at plots with higher light intensity, with a major effect related to the presence of historical lampposts with incandescent lamps rather than halogen lamps. We also detected a seasonal variation in the web coverage, with significant higher values in summer. Stemming from our results, we are able to suggest good practices for the containment of this phenomenon.

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1. Introduction

Environmental modifications driven by urbanization have a significant effect on biodiversity (Güneralp & Seto, 2013; Seto, Guneralp, & Hutyra, 2012; Vitousek, 1997), driving large changes in species abundances and distributions within the original biological communities (McKinney, 2008). Whilst urbanization is considered to be a major determinant of biodiversity loss (Grimm et al., 2008; Newbold, 2015), a number of organisms are able to coexist alongside us in urban environments (e.g., Aronson et al., 2014; Bertone et al., 2016; McKinney, 2002). Owing to their high ecological plasticity (Turnbull, 1973), several species of spiders are able to dwell in cities, representing an important component of the urban wildlife (McIntyre, 2000; Shochat, Stefanov, Whitehouse, & Faeth, 2004; Taucare-Ríos, Brescovit, & Canals, 2013). With the exception of some species of medical importance (e.g. Isbister et al., 2005; Sams et al., 2001; Vetter & Isbister, 2008), urban spiders usually have little socio-economic impacts and often remain unnoticed. A remarkable exception is found in those spider that due to their webs may cause aesthetic alterations to buildings facades—see discussion in Nentwig (2015).

In Europe, one of the most noticeable species causing aesthetic nuisance to buildings is *Brigittea civica* (Lucas) (Araneae: Dictynidae) (Fig. 1A) (Samu, Jozsa, & Csànyi, 2004). This is a small cribellate spider (body length 2.3–3.5 mm; Nentwig, Blick, Gloor, Hänggi, & Kropf, 2018) of South European origin (Hertel, 1968), which spins a circular, tangled cribellate cobweb on flat surfaces (Billaudelle, 1957; Krumpálová, 2001). Although being relatively small in size (ca. 5 cm in diameter), cobwebs of *B. civica* may occur at very high density on wall facades and can persist for long periods of time (Fig. 1B–D). The fact that multiple individuals are able to coexist and spin their cobwebs at a very close distance to one another can be explained in light of the peculiar behaviour of *B. civica*, with different individuals being able to share prey without fighting each other (Billaudelle, 1957). Due to air pollution, these large web aggregations entrap dust and dirt particles over time, assuming a brownish-greyish coloration and thus significantly reducing the aesthetic value of buildings (Havlová & Hula, 2010; Kostanjšek & Celestina, 2008; Nedvěd et al., 2011; Novotný, Hula, & Niedobová, 2017; Samu et al., 2004; Fig. 1D, E).

The factors determining this phenomenon are as yet poorly described, and thus no good practices have been put forward to address this problem and to maximize the effectiveness of potential cleaning activities. To the best of our knowledge, the only study referring to habitat selection by *B. civica* was conducted by Samu et al. (2004) in urban environments in Hungary. The authors demonstrated quantitatively how web density is significantly higher in facades with a southern exposure and sheltered to external weathering (especially rain), whereas they found no clear pattern in the selection of different surface-types.

Because of its artistic heritage from one side and of its predominantly Mediterranean climate suitable for *B. civica* on the other, Italy is potentially among the most affected countries by this issue. In several Italian heritage cities, webs of this spider are found on churches, arcades, palaces and other historical buildings exploited for touristic purposes, resulting in possible economic impacts connected to the cleaning activities aimed at removing the webs.

We conducted a one-year field study to identify the environmental factors driving the proliferation of *B. civica* webs in the arcades of the historical down-town district of Turin (NW-Italy) (Fig. 1E). Observations made by the authors during a preliminary site inspection, and similar recorded observations published by Samu et al. (2004), lead to an initial prediction that i) the density of webs is significantly higher in the vicinity of artificial lighting systems and in other areas with high illuminance. Moreover, given that webs of *B. civica* may last for long time on the surfaces, we further hypothesize that ii) webs are present through the year, but there should be variation in their density connected with the phenology of the species. In particular, increases in the density of webs may be expected right after the breeding period for this species, approximately from April to June (Kostanjšek & Celestina, 2008; Nentwig et al., 2018; Wiehle, 1953).

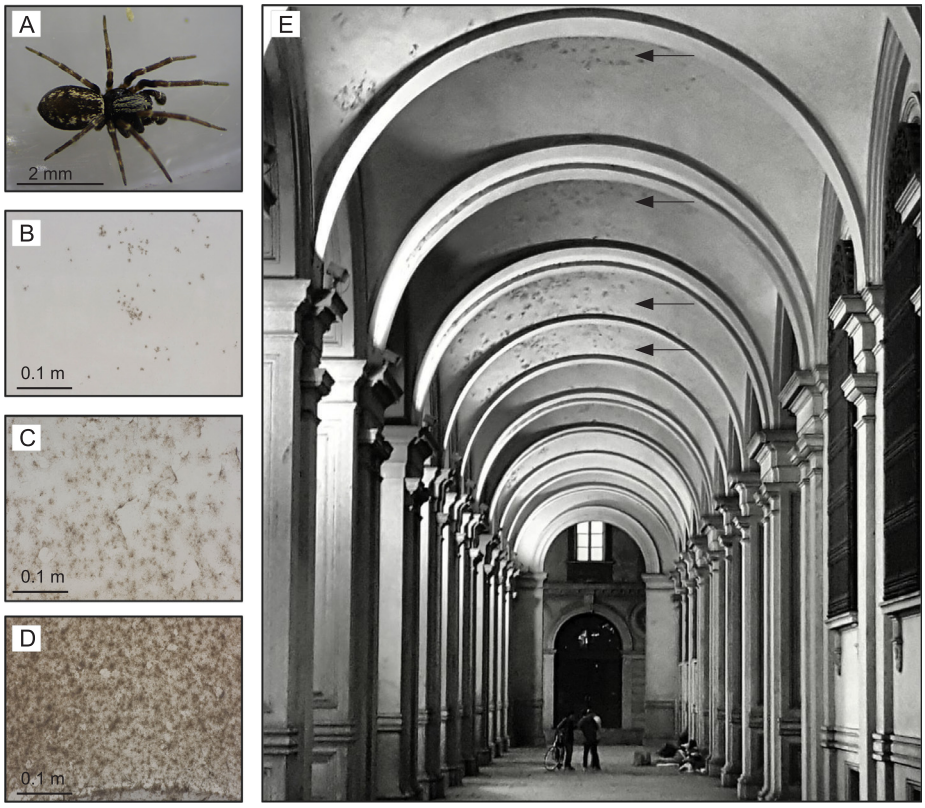

Fig. 1. A) *Brigittea civica* (Lucas) (Araneae: Dictynidae) (photo credits: Dr. Hans-Juergen Thorns). B) Sampling plot on an arcade ceiling with a reduced density of cobwebs of *B. civica*. C) Sampling plot on an arcade ceiling with a significant contamination of cobwebs of *B. civica*. D) Sampling plot on an arcade ceiling entirely covered by cobwebs of *B. civica*. E) The historical arcades of Turin in the area close to Palazzo Carignano. Arrows point at area covered by webs of *B. civica* (Photo credits: Nicola Paccagnella—www.nicola.photos).