Hypoponera eduardi (Forel, 1894) (Hymenoptera: Formicidae) on extensive green roofs in the Province of Antwerp: a new species for the Belgian ant fauna.

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Abstract

From 2019 until 2021, we investigated extensive green roofs in Flanders (Belgium) for their arthropod communities. On two different roofs we found, amongst the collected specimens, a species new for the Belgian ant fauna: *Hypoponera eduardi* (Forel, 1894). The presence of multiple worker ants belonging to this species indicates that it has formed a colony on at least one roof. Apparently, the warm and dry conditions that arise on extensive green roofs as a consequence of the shallow substrate layers lead to suitable habitat conditions for this species.

Keywords: Hypoponera, green roofs, ants

Samenvatting

Van 2019 tot en met 2021 hebben we onderzoek uitgevoerd naar geleedpotigen op extensieve groendaken in Vlaanderen (België). Op twee verschillende daken troffen we, tussen de geïdentificeerde soorten, een nieuwe soort voor België aan: *Hypoponera eduardi* (Forel, 1894). De aanwezigheid van meerdere werksters duidt erop dat er zich een kolonie ontwikkeld heeft op minstens één groendak. Het lijkt erop dat de warme en droge omstandigheden die kunnen optreden op deze groendaken als gevolge van de dunne substraatlagen gunstig zijn voor deze soort.

Résumé

Nous avons inventorié les communautés d'arthropodes des toits végétalisés en Flandres (Belgique) de 2019 à 2021. Parmi les spécimens récoltés, *Hypoponera eduardi* (Forel, 1894), une espèce de Formicidae encore jamais répertoriée en Belgique, a été trouvée sur deux toits différents. La présence de nombreuses ouvrières de cette espèce indique la présence d'une colonie sur au moins un toit. Il semble que la combinaison de températures élevées et de faible humidité de l'écosystème du toit végétalisé engendrent un habitat propice au développement de cette espèce.

Introduction

Green roofs, or vegetated roofs, are becoming more popular in Belgium (Van Driessche, 2021). They contribute to the mitigation of some of the problems associated with urbanization, such as reducing heat islands effects, retaining storm water, or increasing local biodiversity (Oberndorfer *et al*., 2007; Williams *et al.,* 2014; Francis, 2017; Nguyen *et al*., 2022).

Most of the installed green roofs are so-called extensive green roofs. This type of green roof is characterized by drought-tolerant plant species, mainly species of *Sedum*, planted in a thin layer of porous, mineral substrate (± 5cm). Its popularity arises from the fact that they require

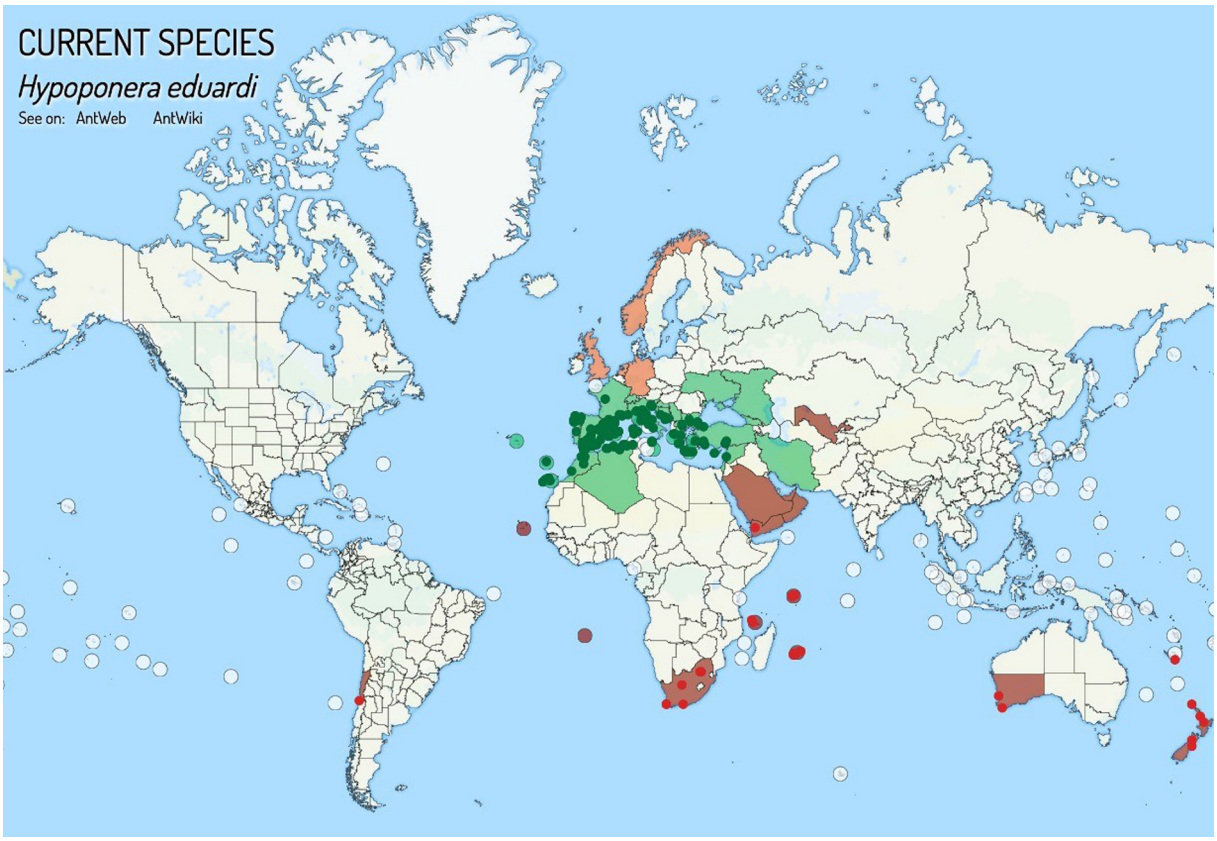

Fig. 1. Geographical distribution of *Hypoponera eduardi* (Forel, 1894; green: native; brown; exotic; orange: introduced indoors). Picture obtained from antmaps.org (Guénard *et al*., 2017; Janicki *et al*., 2016).

low maintenance and that no costly structural reinforcements are needed to the buildings they are installed upon.

During a study that investigated arthropod communities on extensive green roofs in Flanders, we found a new ant species for Belgium: *Hypoponera eduardi*. Of the more than 170 species worldwide attributed to the genus *Hypoponera* (Santschi, 1938), only two were previously known to occur in Belgium: *H. punctatissima* (Roger, 1859) and *H. ergatandria* (Forel, 1893) [*H. bondroiti* (Forel, 1911) and *H. schauinslandi* (Emery, 1899) being junior synonyms thereof (Seifert, 2013)].

Hypoponera eduardi, a thermophilic ant species, natively has a holomediterranean distribution (Fig. 1). However, it has also been recorded in areas of the Southern Hemisphere, including reports from South Africa and New Zealand. In Northern Europe, this species has been found in botanical gardens in Germany and the United Kingdom (Seifert, 2018), the Netherlands (Boer & Vierbergen, 2008; Noordijk, 2021), and Norway (Odegaard *et al*., 2020), where it has been introduced via the import of potted plants. As has been shown for the congeneric species *H. punctatissima* (Dekoninck *et al*., 2012; Boer *et al*., 2014), and as already stated by Seifert (2018), in the face of climate change it is possible that this species establishes itself outdoors in our region.

Material and Methods

Collecting ants

Ants were collected during two separate studies investigating arthropods on extensive green roofs in Flanders (Belgium): the first one from December 2018 until December 2019 on twelve extensive green roofs in Ghent, Antwerp and Hasselt (four roofs/city; Van Dijck *et al*., TBP);

Fig. 2. A photograph of the extensive green roof on the district house in Wilrijk (5.VI.2019). Notice the dominance of *Sedum album*, which turned red because of the dry weather conditions © Thomas Van Dijck.

Fig. 3. A photograph of the extensive green roof on top of a pavilion in the Boekenbergpark in Deurne (16.IX.2021). This green roof also had numerous forbs and grasses growing on it in comparison with Roof 1 (photograph: Jeffrey Jacobs).

the second one from March until September 2020, 2021 on twenty green roofs in Antwerp (the four roofs that were investigated in the first study included; Jacobs *et al*., TBP). Ants were caught with pitfall traps (n = 4/roof). Every four weeks, the traps were emptied and replaced randomly. The traps were transparent, and they measured 9.5 cm in diameter. They had a height of 4.5 cm to account for the shallow substrate layers. Transparent rain guards of 15 cm diameter were fixed at 5 cm above the traps. The traps were filled with 70% propylene glycol, a nontoxic killing preservative. The captured invertebrates were collected by running the capture fluid through a 1mm-sieve. The retained organisms were transferred to vials containing 70% denatured ethanol and stored at room temperature until taxonomic identification.

Green roof characteristics

Hypoponera eduardi was found on two extensive green roofs. The first green roof (Roof 1) is installed on top of the district house of Wilrijk (51.1693°N, 4.3941°E; Fig. 2). This roof is located 9 m above ground level, and it was installed in 2008. It measures 280 m^2, is characterized by a thin layer (4.8 ± 0.8 cm) of mineral substrate (lava stone and pumice), and the vegetation consisted mainly of species of *Sedum*. The second green roof (Roof 2) on which we found *H. eduardi* is installed on top of a pavilion in the Boekenbergpark in Deurne (N51.197°, E4.462°; Fig. 3). The pavilion is 4 m high, and it was installed in 2006. Its green roof measures 85 m² and it is also characterized by a thin layer of mineral substrate (9.8 0.7 cm). Besides species of *Sedum*, this green roof also had forbs and grasses growing on top of it. Both roofs are fully exposed to the sun for most of the day.

Results

During the sampling period, on two extensive green roofs we caught *Hypoponera eduardi* together with nine more ant species (Table 1). Seven of them were only represented as sexuals, *i.e.* males, winged and wingless females. On both green roofs, we found worker ants belonging to *Lasius niger*, *L. platythorax* and *Hypoponera eduardi*.

Involving *H. eduardi* (Fig. 4), we caught three workers on Roof 1 and one worker on Roof 2. Amongst the workers on Roof 1, two specimens were collected in July 2019 and another one in

Table 1. Overview of the collected ant species on the two extensive green roofs. AG = alate gyne, DG = dealate gyne, W = worker ant, M = mal

	Roof 1			Roof 2			
Species	**AG**	**DG**	**W**	**AG**	**DG**	**W**	**M**
Hypoponera eduardi (Forel, 1894)			3			1	
Lasius brunneus (Latreille, 1798)							1
Lasius flavus (Fabricius, 1782)							1
Lasius niger (Linnaeus, 1758)		1	>10	2	2	>10	
Lasius platythorax (Seifert, 1991)			>10			1	
Lasius umbratus (Nylander, 1846)	1	2					
Myrmecina graminicola (Latreille, 1802)		1					
Myrmica rugulosa (Nylander, 1849)		6					
Myrmica scabrinodis (Nylander, 1846)		4					
Stenamma debile (Foerster, 1850)		1					

Fig. 4. Lateral view of a worker ant of *Hypoponera eduardi*. © 2021 California Academy of Sciences.

August 2019. On both occasions, pitfall traps were situated 0.50 m from the overhanging eaves. The distance between both pitfall traps was 16 m. Specimens of *H. eduardi* can be confused with *H. punctatissima*, but the latter species is characterised by a shorter scapus and a frontal groove extending to the hind margin of the head (Fig. 5; Seifert, 2018). One specimen is stored in the collection of Dr. Bernard Seifert (Senckenberg Museum für Naturkunde; Goerlitz, Germany) who confirmed the identification of this specific individual. One of the two other specimens (both added to the collection of the last author) lacked an antenna, but we could identify it as being *H. eduardi*. After measuring the dimensions of the width of the head (HW = 558 µ) and the length of the scapus (SL = 493 µ), we concluded that with an index of SL/CW = 0.883 this specimen also is *H. eduardi* (Seifert, 2018). The third specimen was damaged, and it lacked its legs, flagellum, and scapes. Based on the identification of the previous specimens, however, we concluded that this individual also belongs to the same species.

On Roof 2, one intact specimen was caught in June 2021 at 1.4 m away from the closest eave.

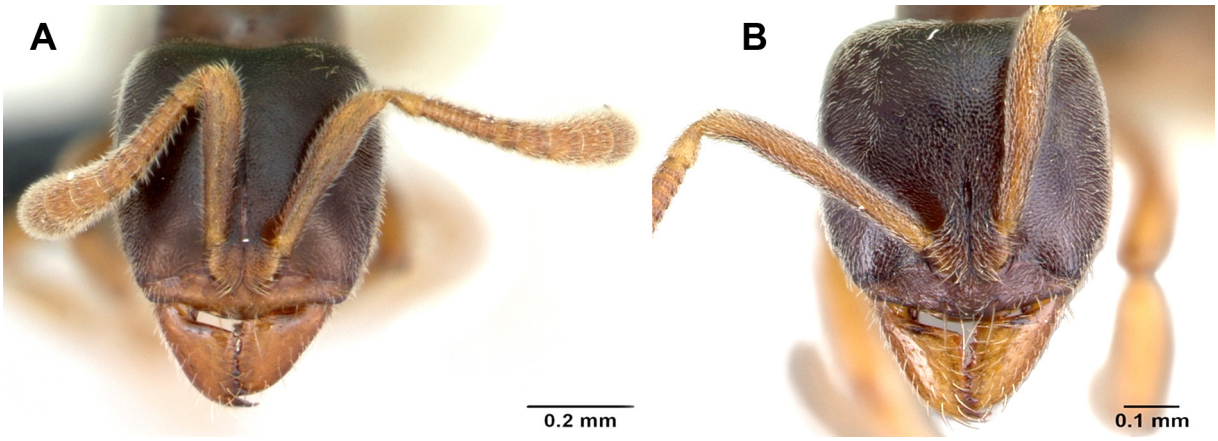

Fig. 5. Comparison of the head of *Hypoponera punctatissima* (left) with that of *Hypoponera eduardi* (right). Notice the larger scapes of *H. eduardi*. © 2021 California Academy of Sciences.

Discussion

Concerning two roofs on which *H. eduardi* was found, most of the other ant species were not represented by worker ants on the investigated green roofs, so we cannot confirm the presence of colonies of these respective species. We assume that the queens ended up on the roofs during their nuptial flights and that the conditions on the roofs are too detrimental for them to establish colonies.

Involving *H. eduardi*, the presence of three worker ants during two consecutive months on the green roof of the district house of Wilrijk led us to believe that this species formed a colony on this roof. On the other green roof only one individual was collected during the sampling period and follow-up studies are needed to confirm the presence of a colony.

As a result of the shallow substrate layers of extensive green roofs, climatic conditions can be very extreme. These xerothermic conditions, however, correspond to the native habitat characteristics of *H. eduardi*, so it is likely that green roofs are a suitable habitat for this species. Furthermore, heat loss of the buildings on which green roofs are installed possibly prohibits the substrate to freeze in winter, allowing the nests of this species to survive this period. This is in analogy with observations of nests of the thermophilic *H. punctatissima* in compost heaps (Dekoninck & Vankerkhoven, 2001).

As to why this species was only found on two green roofs remain unknown for the moment. Most of the investigated green roofs are fully exposed to the sun most part of the day, excluding the potential effect of local climatic conditions. Other parameters such as the planted vegetation, height, or size also did not differ significantly in between the investigated roofs. One possible explanation is that it has been introduced together with plant material, as has also been shown by Seifert (2018) for colonies of this species in Germany and the Isle of Wight. Another explanation is that these roofs were colonized via queens of nests that are located in the vicinity of these green roofs.

Another interesting observation is that we found worker ants belonging to *L. platythorax* on both roofs. Unlike its sibling species, *L. niger*, this species is said to prefer more humid sites (Seifert, 1991) which is in contrast to the xeric conditions that arise on extensive green roofs. Due to our study design, we did not investigate the roofs for the presence of foraging trails or nest domes, but this should be investigated further. However, since we found *L. platythorax* on more green roofs than only these two (Van Dijck *et al*., TBP; Jacobs *et al*., TBP) we presume that it can indeed nest on green roofs.

Green roofs are novel urban habitats, and our initial results show interesting findings regarding the associated ant communities. Future studies are warranted, not only for the search of new ant species, but also to investigate which species use green roofs as a habitat.

Acknowledgements

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