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THE INVASIVE ANT, *TAPINOMA MAGNUM* IN WESTERN SWITZERLAND

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Abstract *Tapinoma magnum* (Hymenoptera: Formicidae) is an ant of Mediterranean origin that is considered an invasive species in central and northern Europe. It is now present in Switzerland, where it was first observed in the canton of Vaud in 2012. *Tapinoma magnum* colonizes urban and suburban zones, including residential neighborhoods, private gardens, cemeteries, parking lots and fallow land. They may even colonize homes. They build their nests in the ground and form strongly polygynous, unicolonial societies. In Cully, the colonized zone covers more than two hectares. In this zone, the density of workers is so high that human outdoor activities are disturbed. In 2018-21, research pertaining to the colony's eradication was undertaken by several individuals. The results of their concerted efforts are presented and discussed in this article.

Key words *Tapinoma magnum*, invasive ant, species invasion, pest control, passive transport, Switzerland

INTRODUCTION

Over the past several years, a new exotic ant species, *Tapinoma magnum* Mayr, 1861 (Hymenoptera Formicidae), has been observed in Switzerland. Unlike the majority of exotic ant species which infest heated buildings or greenhouses, *T. magnum* lives outdoors in what are sometimes huge, polygenic colonies. Nevertheless, the species is also able to enter and infest buildings if given the opportunity.

Tapinoma magnum belongs to the *Tapinoma nigerrimum* complex (Hymenoptera Formicidae) consisting of four species of actually known Mediterranean distribution (Seifert et al., 2017). These four species are difficult to tell apart (Seifert et al., 2017), but the complex as a whole is distinguished from other European *Tapinoma* by the marked polymorphism of its workers (Figure 1): the largest individuals have heads measuring more than 0.9 mm in width (Seifert, 2012).

Figure 1. *Tapinoma magnum*, strong polymorphism of the workers: size 2 mm to 4 mm (Photo Marion Podolak)

The *Tapinoma magnum* species range covers most of the Mediterranean Rim, including North Africa, Italy, Corsica, Sardinia, and southern France (Seifert et al., 2017). Since the 2000s, *T. magnum* has been observed outside its geographical range, in regions north of the Mediterranean, where it has become invasive in urban and suburban environments (Seifert et al., 2017). In France, the species was observed in the suburbs of Bordeaux by Lenoir and Galkowski (2017) in 2008. In 2017, it was found in two cities in the department of Pyrénées-Atlantiques (cite: Lenoir and Galkowski, 2017?) as well as in areas surrounding the city of Lyon (Jérôme Gippet, pers. com.). Heller (2011) has reported its presence in the German state of Rhineland-Palatinate since 2009. *T. magnum* was discovered in Wageningen, The Netherlands, by Noordijk (2016) in 2013. In 2014, Dekoninck et al. (2015) observed the ants in Ostend, Belgium. A common feature of these sites is the presence of *T. magnum* in highly anthropized environments such as shopping center parking lots, residential neighborhoods, paved walkways, roadsides, and garden centers. The northward expansion of *T. magnum* in Europe is surely the result of passive transport – occurring, for example, when the species travels along with horticultural products, such as potted plants, shrubs, and trees, from Mediterranean points of origin (Heller, 2011; Lenoir and Galkowski, 2017; Seifert et al., 2017).

Tapinoma magnum is highly polygynous and often supercolonial. Of the four *nigerrimum* complex species, *T. magnum* has the highest invasive potential (Seifert et al., 2017). In the Mediterranean region, *T. magnum* is particularly abundant in open and unstable, or degraded environments, marked by significant anthropogenic influence, and a weakly developed tree stratum (Seifert et al., 2017). It constructs subterranean nests which are often sprawling and frequently reach depths of up to 1 m. Nest entrances typically develop into big crater-like domes of ejected soil particles (Seifert et al., 2017). The workers form long, and often very tight foraging columns, which extend along sidewalks, walls, and curbs. The species feeds on sugary liquids, such as honeydew, nectar, or sugar juice on fruits, and hunts small invertebrates as live or dead prey (Cerda et al., 1989; Heller, 2011; Noordijk, 2016).

This article presents the characteristics of a supercolony situated in Cully (municipality of Bourg-en-Lavaux, Canton of Vaud, Switzerland), in addition to the pest control measures taken to contain its spread and eradicate it.

MATERIALS AND METHODS

In the western canton of Vaud, private pest management companies (contacted by residents on account of the bothersome ants) were the first to observe *Tapinoma magnum* in Switzerland. The species and its invasive potential were identified in 2017 in Cully (a small, lakeside village in the municipality of Bourg-en-Lavaux, about 10km east of Lausanne) where the ants had infested a daycare, a church, and a cemetery. This was the first species identification conducted (conducted by B. Seifert, Görlitz, Germany) despite previous infestations beginning in 2012. This article presents the characteristics of this supercolony, situated to the north of Cully's historic center (coordinates: 46.49047, 6.73049 ; altitude: 395 - 412 m), in addition to the pest control measures taken to contain its spread and attempt its eradication. Freitag and Cherix (2019) have identified five other invaded sites in western Switzerland. Very recently, genetic analysis has revealed that another member of the *T. nigerrimum* complex is the invading species of at least one of these sites: *Tapinoma darioi* Seifert et al, 2017 (also present in the area of Lyon). *T. darioi*'s invasive behavior probably matches that of *Tapinoma magnum*.

The colonized site covers about 2.5 ha in Cully. It is situated in a low-density residential zone (detached houses with yards), featuring several public facilities (a church, a cemetery, and a parking lot), and vineyards. *T. magnum* is particularly present in the center of the zone, around the buildings and throughout the cemetery, in all areas with a high mineral component. The species has colonized the area beneath the paving stones in the parking lot on the north-side of the church as well as the grassy area bordering the granite ledges. In the cemetery, signs of activity are omnipresent: large quantities of soil have been excavated around the graves, and soil mounds have been constructed throughout the flowerbeds and shrubbery. Ant holes are visible everywhere in the stony soil. *T. magnum* has also colonized the planters, establishing itself in the potting mixture or underneath the containers. Amidst the vegetation in the vineyards and grassy areas, it has constructed dome-shaped mounds of fine earth. Until 2018, *T. magnum* was also present in one of the houses in the central area of the invaded site. It penetrated the walls by way of existing fissures, and climbed up to the second floor.

The workers are numerous on the ground. They form dense foraging columns along garden walls and sidewalks and explore even the smallest of fissures in the masonry. They are surprisingly active in low temperatures, continuing to forage at temperatures as low as 6 to 7°C even during winter months. *T. magnum* feeds on aphid colonies present on vegetation (ivy) and in trees (cherry, maple, hornbeam), whose trunks they climb in dense columns. They

also hunt live or dead animal prey including earthworms. Their reproductive cycle has not been studied, but brood with eggs, larvae, and pupae of female workers were observed on the 17th of May, 2018 (Freitag and Cherix, 2019). This species is highly polygynous: more than 50 queens were counted in approximately ten liters of potting soil inside a planter. The high number of workers on the ground and inside invaded homes causes serious disturbance to humans. The ants respond aggressively to the slightest perceived attack, climbing and biting their way up feet, legs and hands. When squished, they give off a strong odor reminiscent of rancid butter.

Objectives and methods of the pest control strategy put in place in 2018-19:

1. Prevent the supercolony from expanding beyond the initial infestation site by placing insecticide barriers around all areas where columns of worker ants are visible. Surface treatments using cypermethrin- and chlorfenapyr-based products were applied.
2. Prevent workers from penetrating buildings to keep queens outside (in one case, *T. magnum* had aggressively colonized a dwelling during the entire 2017-18 winter season, attacking residents in their beds, despite heavy applications of poison bait). Once again, cypermethrin- and chlorfenapyr-based barriers were placed around buildings at the base of exterior walls. The interior was treated with gel baits containing indoxacarb, acetamiprid, and fipronil, in addition to physical barriers of diatomaceous earth.
3. Identify a treatment method effective against the numerous queens, in order to totally eradicate the colony. To achieve total eradication, various poison bait products were tested on-site, several of which had been previously tested on artificial laboratory colonies. The active ingredients of the most-consumed baits were then applied to the site: namely, fipronil, borax, and spinosad. Spray treatments using a common permethrin-based formicide were also tested. Diatomaceous earth was applied, dry weather permitting, to areas showing high-levels of worker activity. Finally, hot water vapor was applied on sidewalks, targeting worker activity hotspots.
4. Restriction of food sources or access to such sources – namely, aphid colonies and the honeydew they produce: trees in the cemetery and gardens were banded with barrier glue, while ivy was treated with soft soap or entirely removed.

RESULTS AND DISCUSSION

Two objectives were successfully met: the supercolony was prevented from spreading beyond its site of initial infestation, and no buildings were reinvaded. However, success was contingent upon constant effort to maintain insecticide barriers destroyed by rain and chemical breakdown of active ingredients.

T. magnum workers are highly sensitive to the insecticides used; their foraging columns would totally disappear in the day following an application, leaving impressive numbers of dead ants to pile up at bottle-necks in passageways.The on-site use of various bait products did not result in a drastic and lasting reduction of worker activity. This would imply that at least one portion of queens and brood was not affected by insecticides. It is likely the insecticides killed workers too swiftly, and were applied in quantities too small, despite great and repeated effort, to match the astronomical number of workers and queens. In 2019, in the central part of the colony, 35 applications of large quantities of bait were carried out by a team of three people – a notable effort that had a certain degree of success in diminishing the number of visible workers. However, the continued presence of workers in the central zone the following autumn indicates that total eradication did not occur.

Spray treatments of the commonly-used permethrin-based product, meant to penetrate the soil and reach the queens and brood, showed no durable effect (11 kg of the 0,5% permethrin product applied to 100 m^2 of garden had no observable effect two months following the application). The application of both diatomaceous earth (not advised in wet or humid conditions) and hot water vapor immediately reduced appearances of workers but had no lasting effect. The measures taken to restrict access to aphid colonies in trees and ivy do not, in and of themselves, result in eradication, but are fundamentally important in that they reduce access to food sources and push workers to feed on poisoned baits.

After two years of continuous pest control, it was evident that regular control methods would not eradicate the supercolony. The difficulty lies in the population's gigantic size and the high number of queens in fissures and crevices in walls and interstices within soil and rock substrates. A trial was carried out using bait containing methoprene, an active ingredient that sterilizes queens and prevents larvae from moulting. The trial was unsuccessful as the repellent effect exerted by methoprene was too strong for *T. magnum*, even when the substance was coated to form microcapsules.

In 2020 and 2021, treatment using a phytosanitary spray containing spinosad – a natural product-based neurotoxic agent (secreted by the soil bacterium *Saccharopolyspora spinosa*) that does not introduce residues into the environment allowed for large populations of *T. magnum* to be effectively contained outside of buildings, as long as the treatment was performed at least once per month. Repeated spraying did not result in total eradication but allowed or the human inhabitants of infested sites to use the terraced areas outside their homes without being bitten and stopped *T. magnum* from moving inside homes during the winter months. As of late 2021, there are now more than twenty known infested sites in Switzerland (Figure 2), with most of them located near Lake Geneva.

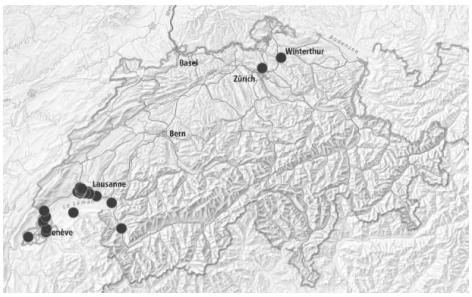

Figure 2. Known distribution 2021

CONCLUSIONS

Given the scale of the *T. magnum* species invasion, the immense size of colonies, and the growing number of invaded sites, it is clear that individual efforts (on the part of homeowners, gardeners, etc.), will not suffice to eradicate existing colonies, however much this may be desired given the real nuisance for humans (frequently attacked and bitten in gardens and outside buildings, and even inside houses) and likelihood of driving long-term biodiversity loss (which has not as of yet been evaluated in Cully).

It is therefore essential that public authorities implement comprehensive action plans (as has been the case in Cully) favouring informed methods specifically tailored to *T. magnum* colonies. It would be judicious to stop the northward spread of *T. magnum* by educating Mediterranean producers of ornamental plants about the risks of exporting this, and other potentially invasive *T. nigerrimum* species, in addition to inspecting destination garden centers and landscaping companies as a means of preventing the diffusion of ants contained in potted plants. A recent survey of 80 garden centers in the area of Lyon showed the presence of *T. magnum* in almost 18 of them (Bernard Kaufmann and Jérôme Gippet, pers. com.)!

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