REDIA, XCVII, 2014: 177-182

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ABOUT THE PRESENCE OF TERMITES IN FLORENCE ([1])

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Di Domenico D., Maistrello L. - About the presence of termites in Florence.

This work highlights the problem of the presence of the termites *Reticulitermes lucifugus* and *Kalotermes flavicollis,* detected in an area of the historic center of Florence (Italy). Pest management was immediately undertaken by a specific monitoring program to determine the status of the infestation, identifying the critical elements and their potential impact on the structures involved, as well as outlining the necessary control measures. Analyzing the area, several colonies of both termite species were detected, some located within the wooden flooring of a gym and some others outdoor, in tree stumps and in necrosated roots at the base of some trees. Two episodes of collapsed tall trees were also reported. Termites were detected also in other areas of the city of Florence, such as the Cascine park and the Boboli garden, where many trees were clearly infested by *K. flavicollis*. This work allowed to realize that problems with termite infestations could be higher than expected, by seriously threatening the historical and artistic heritage of the city and by causing trees weakening in public areas, thus also threatening the people safety. Taking into account these findings, we suggest to extend the termite survey to the entire city and to establish a working group, with multidisciplinary competences, able to develop a proper prevention and control program aimed at the protection of cultural heritage and management of tree health in public parks.

KEY WORDS: Rhinotermitidae, Kalotermitidae, termite monitoring, cultural heritage.

INTRODUCTION

The high historical and artistic value of the city of Florence is unquestionable. After the discovery in September 2013 of an active presence of termites in an area of the city center, a monitoring program was developed to determine the extent of the infestation both inside building structures and in the surrounding green area, a public park with tall, old trees. The aim was to evaluate if and how the termite attacks could affect the structural elements of the buildings and the health status of the trees. Furthermore, we raise the question about the presence of termites in other parts of the city and about the potential consequences of their activity on the timber deterioration inside buildings and the weakening of alive trees in public parks. This work highlights the importance of considering the consequences of termite occurrence in sites with inestimable artistic value, a problem that in recent years appears quite neglected in Italy.

MATERIALS AND METHODS

The area of investigation is located within a park of 32 hectares in the city centre of Florence (Italy). This area, which is under landscape constraints, includes a complex of buildings dating back to the nineteenth century, presently serving for both private and public activities.

The first detection of termites occurred inside a gym, located on the ground floor of one of the complex buildings, where, after the summer break (August 2013), users reported the failure of some parquet's strips and the presence of some "strange, white ants" inside the strips. The site's inspection revealed a heavy termite infestation in the wood flooring, where most of the parquet's strips appeared already seriously damaged.

A specific monitoring program was therefore developed, taking into account both the outdoor areas and the buildings.

INSPECTION OF OUTDOOR AREAS

The whole garden area was carefully inspected, searching for clues related to the presence or damage by termites. Inspections were conducted on any type of wooden material, including tree logs, woodpiles, fences, waste cellulosic materials, and on every contact area between wood and soil, particularly along buildings' perimeters and adjacent areas (paths of access, shafts, etc.). Particular attention was paid to trees: the vegetation within the park is wide and diverse, including oak (*Quercus* L.), linden (*Tilia* L.), plane (*Platanus* L.), acacia (*Acacia* Mill.), pine (*Pinus* L.), maple (*Acer* L.) and plum (*Prunus* L.) trees. Some of the trees were hundreds years old and quite tall.

PLACEMENT OF CELLULOSE BAITS

To quantify the spread of subterranean termites in the park, a specific monitoring system based on the use of cellulosic baits was set up. During March 2014 the study area was covered with 70 cellulose baiting stations: baits consisted of perforated plastic jars containing a cylinder of

[1] Original scientific contribution presented and discussed at XV Meeting of A.I.S.A.S.P., Italian Section of I.U.S.S.I. (International Union for the Study of Social Insects); Reggio Emilia - Italy, 18-19 September 2014.

– Received 6 October 2014 Accepted 3 November 2014 Published 10 December 2014

corrugated cardboard, partially buried in correspondence of the critical areas identified during the previous inspections and in the green areas in proximity of the buildings, to evenly cover the entire area of the park (HAMM *et al.,* 2013; MAISTRELLO *et al.,* 2011; MARINI *et al.,* 1998; SU *et al.,* 1998). All bait positions were geo-referenced and displayed on a map. Inspections of cellulosic baits were performed monthly, checking the status of the lure, annotating the presence of termites (if any) and eventually replacing the baits.

INSPECTION OF BUILDINGS AND UNDERGROUND TUNNELS

A periodic survey of all the buildings in the complex was performed, considering especially the most isolated rooms such as closets, attics, underground warehouses, etc., as well as the extensive network of underground tunnels connecting the buildings. Clues of the presence and/or damage by termites (residues, tracks and tunnels, shelter tubes) were searched surveying moisture-rich areas (which are especially attractive for subterranean termites), shafts, electrical conduits, gutters, water pipes, etc. Visual inspections were performed on all wooden structural elements, especially those in the attics (beams, bearing piles etc.), looking for structural degradation (stains, discoloration and damages) and for the presence of insects (dead or alive or their body parts, such as wings that indicate an active or past presence of swarming winged termites) and fecal pellets. A major problem with attics was that most of the times these areas were totally inaccessible, with precarious/not walkable floors. In these cases a strategy of indirect monitoring was applied, consisting in the use of properly positioned glue panels for capturing swarming insect.

All critical elements detected during monitoring were periodically recorded on a database, together with high-resolution pictures, in order to describe the dynamics of the infestation.

RESULTS AND DISCUSSION

At a first glance, the damaged wood collected from buildings and trees in the study area showed several internal galleries filled with fecal pellets, clear traces of "replacement wood" (Fig. I) and shelter tubes typical of subterranean termites belonging to the family Rhinotermitidae (MAISTRELLO *et al.,* 2011; MAISTRELLO, 2010). However, a more detailed analysis revealed also the presence of areas colonized by drywood termites (Kalotermitidae), easily recognizable by the presence of the characteristic prismatic fecal pellets. The subsequent analysis of the entomological samples collected inside the gym, led to identify the presence of the species *Reticulitermes lucifugus* and *Kalotermes flavicollis* (Fig. II and Fig. III; Tab. 1) (CHIAPPINI *et al.,* 2001; LIOTTA, 1991).

Subterranean termites are characterized by large colonies, made up by several thousand to a few million individuals, and their nests are usually located within or near the ground, in presence of high humidity (LENIAUD *et al.,* 2009). From the ipogeous nest, these termites spread to houses' close proximity and climb on buildings along wooden structures looking for food sources, protected by galleries and shelter tubes (PEDRONI *et al.,* 2007). All the cellulosic materials encountered along this path will be used and, therefore, it is destined to partial or total destruction.

Drywood termites have less numerous colonies that develop within epigeous nests, usually within dry wood, on the necrotic parts of trees or sometimes inside structural timber. The galleries built by these termites appear clean and the fecal pellets are deposited by gravity at the lowest points of the tunnels.

Given their cryptic and elusive nature, termites establish their colonies without being detected, so that when their presence is discovered, the damages are already heavy and

Fig. I – Strips of the parquet of the gym monitored in the study area, showing the typical signs of attack by subterranean termite. The wood appears lined with termite droppings, that being rich in moisture tend to clot and stick to the point where they are released. The droppings, mixed with soil and saliva, are used to construct the cells and galleries occupying the space freed by the wood consumption, forming the so-called "replacement wood".

Fig. II – Sample of *R. lucifugus* collected in the gym. From left: soldier, nymph and worker.

Fig. III – Sample of *K. flavicollis* collected in the gym. From left: soldier, nymph, typical prismatic faeces and royal.

Table 1 – Characteristics of the different monitored sites where termites were detected, and description of the samples collected. The spatial location of the sampling sites is shown in Fig. IV. Swarming termites = individuals collected on the glue panels.

	R. lucifugus	*K. flavicollis*	Swarming termites	*C. scutellaris*
A) Gym floor	soldiers, nymphs, workers	soldiers, nymphs, royals	*R. lucifugus* (June 2014)	
B) *Acer* stump	workers			
C) necrotic roots of *Acer*		soldiers, nymphs		
D) fallen *Platanus*		soldiers, nymphs		
E) necrotic roots of *Tilia*		soldiers, nymphs		
F) necrotic roots of *Tilia*		soldiers, nymphs		X
G) fallen *Tilia*	Recent news to be checked			
H) *Tilia* stump		soldiers, nymphs, royals	*K. flavicollis* (September 2014)	X
I) *Tilia* stump		soldiers, nymphs, royals	*K. flavicollis* (September 2014)	X

often irreparable: the wood is in fact consumed from the inside, without showing traces of holes or sawdust outside. For this reason, termite control is extremely difficult and, in situations like that discovered in the gym, it was necessary to promptly activate a monitoring program aimed to understand the extent of the problem and to verify possible structural damage.

Analyzing the outdoor area surrounding the gym (Fig. IV, Tab. 1), several colonies of both termite species were detected, some located in tree stumps and other in the necrotic roots of some trees. Two episodes of collapsed tall trees were also reported. In particular: about 20 meters from the gym, a stump of maple was found completely infested by *R. lucifugus* and, after few days since the discovery of termites in the gym, a closely-located large plane tree collapsed, crashing during the night on the top of a bench, only by chance avoiding the occurrence of an accident to people. From the analysis of the trunk, the

Fig. IV – Aerial view of the study area, showing the areas where active termite infestation was recorded during the monitoring program. Yellow circle= gym floor infested by *R. lucifugus* and *K. flavicollis*; Blue dot= tree stump infested by *R. lucifugus*; Yellow dot= tree stumps infested by *K. flavicollis*; Orange dot= necrosated roots of maple tree infested by *K. flavicollis*; Green dots= necrosated roots of linden trees infested by *K. flavicollis*; Red dot= collapsed trees.

plant appeared visibly carious and a conspicuous infestation by both wood boring beetles (Dynastidae) and *K. flavicollis* was detected. Although it is not possible to link the causes of the tree's collapse to termites, their potential role should not be neglected.

A few meters away from the previous findings, in correspondence of necrotic roots of two large linden trees, the co-occurrence of *K. flavicollis* and the ants *Crematogaster scutellaris* was observed, termites occupying the inner parts of the roots and ants on the more superficial layers. Ants and termites are major components of ecosystems but little is known about their interactions. Ants are major, sometimes specialized, termite predators (Leponce *et al.,* 1999) but they may also be commensals or even mutualists (Neves *et al.,* 2014). It would be of great interest to better understand the mechanisms that regulate this type of interaction, also considering the possible role of ants in the biological control of termite colonies.

Considering the results from the baiting stations, in June 2014 termites' feeding activity was found in 2 stations between the gym and the maple tree stump (Fig. V). This finding was useful to plan the application of a low environmental impact control program, based on the foraging of the termite colony by cellulosic baits formulated with a specific IGR (Insect Growth Regulator) (Bagneres *et al.,* 2008; Eger *et al.,* 2012; Gambetta *et al.,* 2000; Sajap *et al.,* 2009).

The presence of termites in Florence was discovered also in other areas of the city, such as in the "Cascine" park and in the "Boboli" garden (Luchetti *et al.,* 2014), where many trees showed clear infestation by *K. flavicollis* (Fig. VI).

In conclusion, based on the findings from this survey, the importance to extend the termite survey to the entire city is highlighted. We also suggest to establish a working group of multidisciplinary competences, able to develop a proper prevention and control program aimed at the protection of cultural heritage and management of tree health and stability in public parks.

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Fig. V – Appearance of a bait station before (left) and after (right) the termite attack. The feeding activity is clearly visible from the total transformation of the bait.

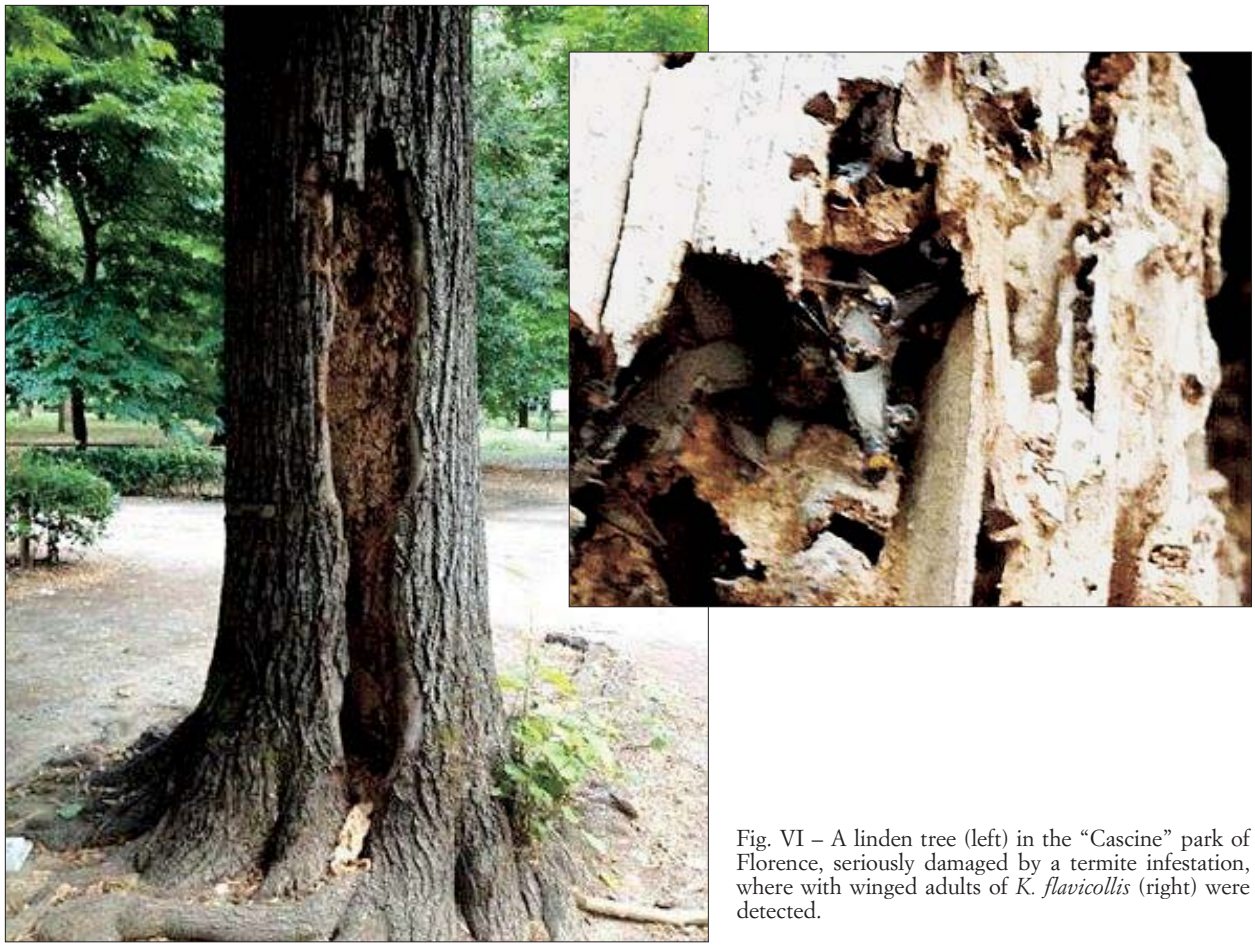

Fig. VI – A linden tree (left) in the "Cascine" park of Florence, seriously damaged by a termite infestation, where with winged adults of *K. flavicollis* (right) were detected.

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