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Termite infestation risk in Portuguese historic buildings

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Abstract

In mainland Portugal, subterranean termites of the genus *Reticulitermes* are indigenous and a well-established pest of wood in service. This has particular relevance in the maintenance of historic buildings. Dry wood termites of the genus *Cryptotermes* are now also recognized as a major problem in the conservation of old buildings in the islands of Madeira and in several of the Azorean Islands. The present recorded distribution of dry wood and subterranean termites in Portugal is discussed. The very recent discovery of *Cryptotermes brevis* in Lisbon is highlighted and the possible impacts of this finding discussed.

1. INTRODUCTION

Termites are social insects found in a wide range of terrestrial environments and are distributed throughout the warmer regions of the world. They are very important organisms ecologically as they significantly contribute to the organic decomposition process either by direct consumption of decomposing plant materials, by physical and chemical conditioning the soil they inhabit and by nitrogen fixation. They feed on a very wide variety of organic detritus like dry grass, decaying leaves, animal dung, humus and living or dead wood.

As termites forage on cellulosic resources they can cause damage to living trees and many crop plants, but the fact that they can use dead wood makes them a major pest for timber used for construction purposes both outdoors and inside buildings. They are known to cause damage to buildings throughout the tropics, sub-tropics and temperate regions and have an increasing economic impact when present [1].

Several factors are suggested to explain their special distribution but the absence of a sufficiently high temperature for long periods of the year seems to be chiefly responsible for the absence of termites. However, an increase in the demand for wood products for construction linked with the growth of human population and the much discuss "global warming", will most likely favor the spread of the pest species well beyond their natural distributions. Anthropogenic climate changes and the increased use of central-heating systems can already be linked to the establishment of *Reticulitermes sp.* in more northerly cities such as Paris, Hamburg and Toronto, or in Saunton, U.K. [2].

In Portugal, the first known reference to the presence of subterranean termites, *Reticulitermes lucifugus* (Rossi), dates back to the end of the XIX century [3]. They occur naturally over the entire country, and are a well-established pest to wood in service particularly linked to historic buildings [4, 6, 7, 10]. A second termite species can be easily found on the mainland of Portugal though more often in the natural habit than linked to applied wood, the drywood termite *Kalotermes flavicollis* Fabricius.

In the Portuguese islands of Madeira and Porto Santo, Mateus and Goes [8] reported the presence of another drywood termite, in this case also a known building pest, *Cryptotermes brevis* (Walker). Carvalho [9] referred to the existence of two endemic species (not linked to construction) in the Island of Madeira, *Cryptotermes barretoi* (Grassé) and *Neotermes precox* (Hagen). *C. brevis* was also recently identified in the Islands of the Azores [10, 11]. Further details of the distribution of termites in Portugal are given in the following chapter.

2. DISTRIBUTION

2.1. Subterranean termites

In continental Portugal, subterranean termites are a well-establish pest of wood in service and all known infestations involve termites from the species formerly referred to as *Reticulitermes lucifugus* (Rossi) and presently known as *Reticulitermes grassei* Clément [12] which is indigenous. The same species was also identified in the city of Horta in the Azorean Island of Faial [11, 16].

Figure 1 shows the present known distribution of *R. grassei* in continental Portugal, considering all municipalities where at least one record of the presence of termites exists. The map is based on LNEC´s data base of termite occurrence, mostly in buildings but also in the natural environment. At present, the data base has close to 1000 records.

In particular, the region of Lisbon and its surroundings is considered severely infested, showing the highest total number of reported infestations. Figure 2 shows the present known distribution of *R. grassei* in Lisbon, considering all boroughs (48 out of 53) where at least one record of the presence of termites exists.

Taking into account the biology of the species and the present known distribution, *R. grassei* seems to have a wide distribution, apparently without latitudinal, longitudinal or altitudinal patterns [4, 7]. Municipalities or boroughs without records should not be seen as zones without termites just zones where termites have not yet been identified.

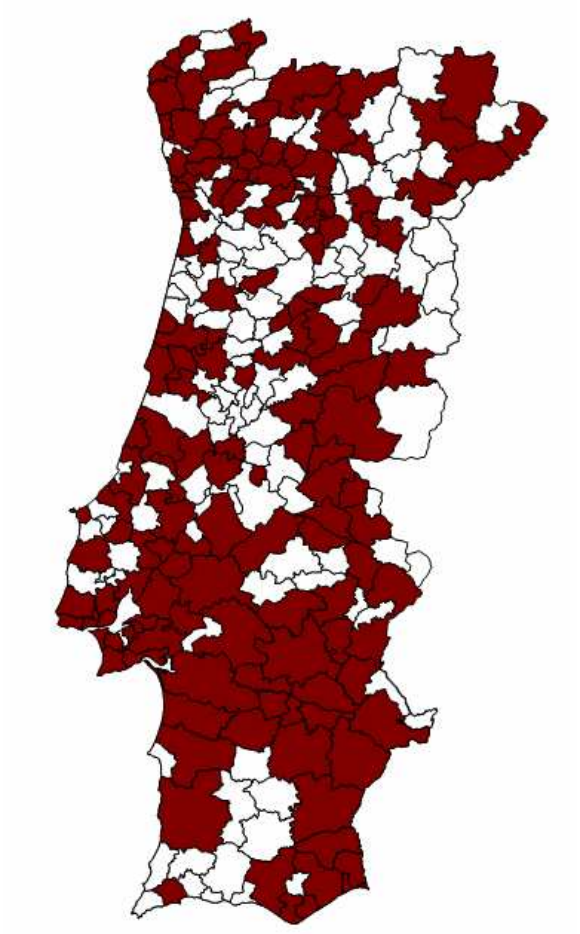

Figure 1: Subterranean termites distribution in Continental Portugal. Municipalities with at least one recorded case of *Reticulitermes grassei* presence.

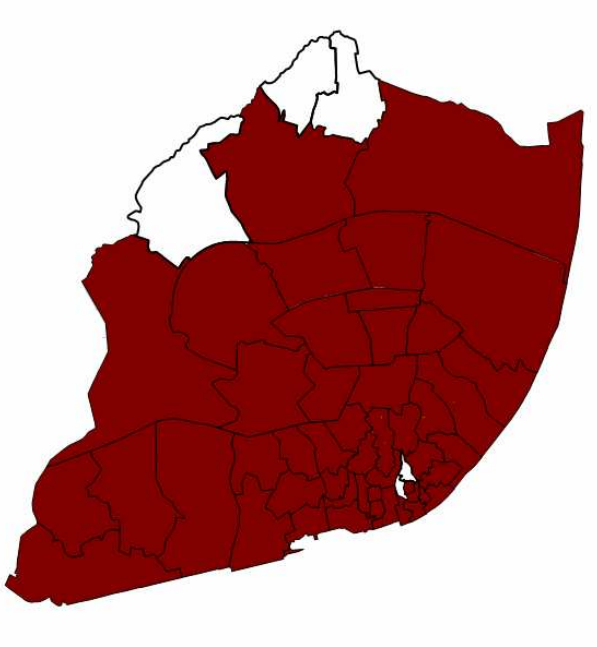

Figure 2: Subterranean termites distribution in the city of Lisbon. Boroughs with at least one recorded case of *Reticulitermes grassei* presence.

The presence of termites in buildings follow a general pattern closely linked with the amount of susceptible timber used in the construction and eventual building deficiencies occurring during the life of the construction and causing increased moisture contents of the applied wood.

In what concerns the presence of subterranean termites in heritage buildings or building sites, no systematic studies have been so far conducted but the presence of termites has been already recorded in several important World Heritage sites like the Monasteries of Jerónimos in Lisbon and Santa Maria of Alcobaça, the Convent of Christ in Tomar and a number of buildings in the city of Évora like the old University and the churches of Santa Clara and Misericórdia.

These buildings have all undergone in recent years large interventions, to correct mainly moisture problems, which were likely to contribute to the control of subterranean termites. The rehabilitation and maintenance works should have had taken into account the presence of the insects and were hopefully adequate to their control.

Nevertheless, in many other rehabilitation works the termite risk is often overlooked and it is not unusual to find situations were infested timber are left as ruble in hidden parts of the repaired constructions and new susceptible timbers are used without any preventive treatments or control measure that would prevent termite re-infestation.

2.2.Drywood termites

Drywood termites are social insects as well, but unlike subterranean termites, they live inside the wood they infest. This characteristic facilitates their dispersion, thus being easily transported with infested materials and, once introduced in suitable environments, colonies can survive and establish. *Cryptotermes brevis* is considered to be the termite species that has suffered more introductions and the most important drywood termite with pest status.

C. brevis possess a lifecycle with caste division (reproductives, nymphs, pseudergates and soldiers) as all social insects. Every year (usually starting in June), the primary reproductives or alates emerge and are responsible for the colonization of new areas. Due to their feeding habits on drywood, all untreated timbers can become a potential food source and suffer destruction.

Cryptotermes brevis is native of the Caribbean region, being present in all islands of the Greater and Lesser Antilles. It occurs in southern Florida and coastal regions of Mexico, Central America and northern South America. It has been introduced to Pacific islands including the Galapagos, Fiji, Hawaii, Marquesas, New Caledonia and Easter Island. It is known to be also present in the Atlantic Islands of Ascension, Bermuda and St. Helena. It has also been introduced to the coastal areas of continents including several locations in Australia, China, Madagascar, Gambia, Ghana, Nigeria, Senegal, Sierra Leon, South Africa, Uganda and Zaire [13, 14]. In Europe, references exist on the presence and establishment of *C. brevis* in Canary Islands [8], Madeira Island [8], Naples, Liguria and Sicily [15].

C. brevis was identified in the Islands of Azores in 2002 though alates and wings had been noted by a number of people in the previous years without clear recognition of their origin. An assessment of the situation on the several islands of the Azorean archipelago has already begun and so far well established populations of this pest termite were found in the Islands of S. Miguel, Terceira, Faial and Santa Maria [11, 16].

In Angra do Heroísmo, a World Heritage Site, Borges and co-workers [17] refer a progressive degradation, which is often alarming to the architectural heritage, showing the impact of this termite species as a building pest. The data available indicates that 43 % of the buildings in Angra do Heroismo were infested. It is also important to mention that 50% of the infested cases presented severe infestation and destruction.

The most infested parts of the buildings are usually the roof structures. Drywood termites may enter through attic ventilations or other entries that might exist (doors or windows). Once installed inside the wood (possibly using holes already made by wood borers like *Anobium* spp.) the holes to the exterior are sealed and the identification of their presence becomes even more difficult.

The origin of the termites in the Islands of Azores is still undetermined, though their distribution in Angra do Heroísmo (heavy infestation extending from the harbour) suggests an entry in the port area at least several decades ago, possibly at the time of the last major earthquake (in 1980) and associated with the extensive rebuilding that took place at that time [10].

Buildings in the Azorean cities historical centres usually are masonry buildings, most of them three and four stories high, with timber floor and roof structures. Each building may share, with the adjacent buildings, its lateral two walls, and several buildings in these conditions form a city block acting in the urban panorama as an unitary building structure.

This kind of construction is common in buildings constructed after the XIX century and can also be found in several cities in Continental Portugal and particularly in Lisbon (Figure 3). Lisbon shares also with the most termite infested cities of the Azores, the proximity to the sea and the continuous flow of wood, mostly cryptomeria, that arrive at its port from those islands. Infested furniture is traditionally one of the most important means of introducing the pest and should also be considered as a serious risk taking into account the normal circulation of people and products between Portugal and the Azores.

It was therefore not very surprising the recent identification by the author of a well established infestation by *Cryptotermes brevis* (figure 4) in a building located in a Lisbon street (Rua da Junqueira) not far from the river Tagus and the port area but also very close to important sites like the Monastery of Jerónimos in Belém.

Further work is needed to determine whether the presence of *C. brevis* in this building is just the result of a recent hazard introduction or the first symptom of a bigger problem in the city of Lisbon

Figure 3: Typical Portuguese masonry buildings from the late XIXth century or the early XXth century in Rua da Junqueira, Lisbon.

Figure 4: Details of the infestation by *C. brevis* in Rua da Junqueira, Lisbon. Termite fecal pellets on the floor and aspect of an infested timber beam.

3. FINAL CONSIDERATIONS

The growth of urban populations of pest termite species is an increased matter of concern. The importance of termite attack risk assessment in any scheme of monitoring, prevention and control of the condition of timber in buildings cannot be understated. The determination of potential high-risk areas where termites can establish and multiply themselves is a necessary task to be undertaken in order to prevent further spreading of the urban pest species.

Understanding the range of subterranean termite infestation problems in order to predict (to some extent) the occurrence and severity of potential problematic areas in countries like Portugal, where termites have a wide range, not obviously defined by temperature, humidity, vegetation or soil type, the mapping of risk areas needs to consider variables specific to the construction type and its immediate environment.

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