

RELATÓRIO PROJECTO

COMBATE E GESTÃO DAS TÉRMITAS (ISOPTERA) EM HABITAÇÕES DOS AÇORES COM ENFASE NA ILHA TERCEIRA

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Management strategies for Termites in the Azores

Estratégias para combate e gestão das térmitas nos Açores

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Abstract: Termites are well-established and are serious pest of structural wood in the Azores. Eradication of termites cannot currently be achieved. Three species of termites are currently known from the archipelago (dry-wood termite *Cryptotermes brevis*, living trees *Kaloterme flavicollis* and subterranean termite *Reticulitermes grassei*). Whatever the infestation strategy, all these three species will cause enormous economic impact in the next decades in the Azores, and the types of control that are needed are entirely different for the three. As a result of the scientific research performed with the dry-wood termite *Cryptotermes brevis* in the last year it is now clear that the main management strategies are: 1) avoid further dispersal between islands; 2) improve quarantine measures to avoid the entrance in the archipelago of new termite species; 3) improve inspection techniques and train new inspectors; 4) educate home-owners to manage alates spread; 5) treat furniture with newly available techniques (e.g. Gas Bubble with non-toxic physical controls such as CO₂, or N₂ gas) or simple use of "sun heat" or extreme cold; 6) remove all highly infested wood and replace it with new materials such as metal parts or pressure-treated wood when (re)building; 7) use chemicals in spot-treatments only when the infestation is moderate to small and select the most adequate chemical based on experimental grounds; 8) test the possibility of using in the Azores whole-block control usually by gas or heat fumigation; 9) create new legislation.

Resumo: As térmitas estão bem estabelecidas nos Açores e constituem já uma praga de dimensões apreciadas nas zonas urbanas. Com base no conhecimento actual é impossível erradicar as térmitas dos Açores. São conhecidas actualmente três espécies de térmitas nos Açores: uma térmita de madeira seca *Cryptotermes brevis*, uma térmita de madeira viva *Kaloterme flavicollis*, e uma térmita subterrânea *Reticulitermes grassei*. Qualquer que seja a estratégia de infestação todas estas espécies irão causar grandes prejuízos económicos aos açorianos, sendo as formas de combate e gestão diferentes para as três espécies. Com base na investigação científica realizada no último ano em relação à espécie térmita de madeira seca *Cryptotermes brevis*, torna-se claro que as principais estratégias de gestão passam por: 1) evitar a dispersão das espécies entre ilhas; 2) melhorar as medidas de quarentena para assim evitar a entrada de novas espécies no arquipélago; 3) melhorar as técnicas de inspecção e treinar novos inspectores; 4) educar as pessoas para lidarem com a gestão dos insectos alados; 5) tratar o mobiliário com uma série de técnicas recentemente disponibilizadas ("Bolhas de gás" com CO₂, ou N₂) ou o uso simples do frio ou do calor do sol; 6) remoção das peças de madeira muito infestadas e substituição destas por peças de

metal ou madeira pré tratada com químicos em auto-clave; 7) usar químicos em tratamentos localizados apenas quando a infestação tiver um carácter de fraca ou média infestação e ter sempre o cuidados de seleccionar o químico considerado mais adequado com base nos dados experimentais; 8) testar a possibilidade de utilizar medidas de controle em grande escala com base no uso de fumigação por gases ou pelo calor; 9) criar nova legislação.

1. Introduction

Based on current knowledge on termite distribution in the Azorean islands (Borges et al, 2005), it is our belief that the situation is too far gone to realistically expect that eradication is now achievable (see also Borges et al, 2004; Myles, 2004; Scheffrahn et al., 2006). Consequently, any attempt to achieve eradication through a massive publicly funded program would probably be unsuccessful in the long run. Assuming a continuous spread of all the known species both within islands and between islands, management measures should be implemented rigorously.

However, first we must understand the fact that there are three types of termites in the Azores with different biology (Myles et al. 2007a) and consequently the types of control that are appropriate are entirely different for the three:

- a) drywood termite *Cryptotermes brevis*
- b) living trees *Kaloterme flavicollis*
- c) subterranean termite *Reticulitermes grassei*

The current limitations on the termite management in the Azores are mainly due to (see also Borges et al., 2004):

- a) Logistical barriers – lack of resources and time to achieve adequate scientific knowledge; lack of a forum for public support and involvement.
- b) Communication barriers – inability to interact across disciplines (e.g. biology, engineering) or between scientists and public and/or pest control companies; Lack of problem understanding of decision-makers; need of stakeholders feel safe to questioning ideas and participate positively in the management process;

c) Attitudinal barriers – misperceptions that people, private sector and scientists have of each other; There is also some fear of the uncertainties related with termite management options.

d) Educational barriers – relate to the level of knowledge that public and key stakeholders have of termite problem. Private pest-control companies will need additional training. Moreover, Azorean entomologists lack training in termite management.

e) Institutional barrier –political boundaries do not fit within termite risk assessment, that is, a general misperceptions that institutions have of the risk related with their current passive attitude concerning termite management. There is a need to a more flexible framework. The past unsuccessful experiences with the management of insect pests (e.g. Japanese Beetle) are not helping.

2. General termite management strategies with emphasis on the dry-wood termite *Cryptotermes brevis*

Attempts to arouse public and governmental support for the prevention or control of insect invasions often fail because of lack of peoples attitudes towards risk assessment. We should think on preventive control and remedial control.

Preventive control can be subdivided into:

- 1) regulatory control;
- 2) inspection measures, and,
- 3) construction practices.

Remedial control can be either

- 1) removal and destruction of infested furniture or isolated structural parts;
- 2) direct treatment of known infested items of furniture or exposed wood work, or,
- 3) compartmentalized treatment of rooms or attic areas that can be more or less closed off and individually treated, or,

- 4) whole-house or whole-structure control, or,
- 5) whole-block control usually by gas fumigation or heat treatment.

2.1 PREVENTIVE CONTROL

- A) **New species introductions and between island dispersal**, Educate people to avoid (re)-infestation due to commerce and movement of furniture between islands (directed mainly to *C. brevis* and *R. grassei*). Moreover, there is the risk of introduction of additional species some of them of great risk since could cause even greater impacts on houses (e.g. *Cryptotermes domenicus*, *Cryptotermes dudleyi*, *Cryptotermes cynocephalus*, *Coptotermes formosanus*, *Coptotermes havilandii*).

We should invest in stirring public and governmental support for the prevention of termite dispersal between islands. The threats to the economy of the other islands are high with implications in losses in public and private sector. Preventing entry of additional termite species should be a key subject and eventually the use of quarantine measures could be the solution. The costs of those quarantine measures will be trivial compared to the costs and effort of later control.

Management solution:

- a) Educational material should be produced (posters, leaflets, etc.) to inform people that no transport of furniture should be performed between islands or imported from other countries without a quarantine period and eventual treatment. Large posters should be located in Airports and Ports;
- b) New regulations should be legislated and would probably fall under existing phyto-sanitation and inspection regulations or procedures;

c) Port inspector officials must be trained in the identification of termites and signs of termite infestation including the appearance of termite damage, drywood termite fecal pellets, and subterranean termite shelter tubes.

B) **Inspection measures** . inspection techniques should be improved and if possible well trained inspectors should be available to perform a correct evaluation of termite infestation to all home-owners.

Management solution:

Private pest control inspectors, public inspectors and scientists may need additional training in new adequate methods to evaluate termite infestation in the several types of Azorean House architecture and wood types.

C) **Individual home-owner management** implies a changing of behaviour of each home-owner towards the application of simple prevention measures.

Management solution:

Educate people to apply simple measures such as screening of windows and sealing all cracks and holes which would provide nesting sites for alates to start colonies, with caulk and paint around door and window frames is advisable.

D) **New construction practices** implies a changing of behaviour of each home-owner towards the use of new materials in building and rebuilding houses in the Azores.

Management solution:

New wood construction in attics should be with pressure treated wood. Wood in attics should be wood preservatives, such as Borate compounds such as disodium

octaborate tetrahydrate formulated for with glycol for drywood application such as Boracare should be used to treat unfinished wood in attics. Attics can also be dusted with boric acid or more adequately a fipronil based insecticide (see Scheffrahn et al, 2006) to deter alates from successfully initiating new colonies (see also Ferreira et al., 2007; Guerreiro et al., 2007; Myles et al., 2007b) Such measures are likely to be only partially effective, but nevertheless should be used.

- E) **Preventing re-infestation** implies a changing of behaviour of home-owners with infested houses towards the use of traps to avoid that new colonies could start in new places of the house. In fact, the infestation dramatically worsens as the process of re-infestation takes place following flights of alates from the original infesting colony.

Management solution:

When infestations in attics reach the point where this is not possible without complete replacement of all timbers then efforts should be made to trap alates. This can be done with a light trap over a bucket of engine coolant. The light will attract the alates and which will fall into the bucket and drown (see more details in Guerreiro et al., 2007).

- F) **Furniture treatment** implies a changing of behaviour of home-owners towards the monitoring of furniture.

Management solution:

In the initial stages of infestation it is often possible to identify an infested piece of furniture by the fecal droppings from it. Such items should either be removed and destroyed or treated in such a way as to positively kill the termites. Available treatment options are (see also Borges et al. 2007):

- a) a vault with gas fumigant;

- b) a closed plastic container (Gas Bubble) with non-toxic physical controls such as CO₂, or N₂ gas (Fig. 1).
- c) use of a cold storage facility where they could be held at below freezing temperatures for several days or weeks.



Figure 1. Closed plastic container (Gas Bubble) with non-toxic physical controls such as CO₂, or N₂ gas.

- G) **Infested wood removal**, In a situation where we have three types of termites in the Azores, some importance should be given to infested wood waste management.

Management solution:

A designated place at the municipal land fill should be set aside for such wood infested materials to be disposed. Such items should be either buried or incinerated. If a large amount of such material accumulates it should be buried or incinerated before the season of alate flights to prevent flight that could lead to local infestations near the landfill. However, in the case of subterranean termites wood infestation all wood should be incinerated.

2.2 REMEDIAL CONTROL

If eradication is not possible, as in the case of the Azores, the goal becomes “remedial or maintenance control”. The available approaches are mechanical or chemical. Unfortunately biological control is not an option for *Cryptotermes brevis*. Currently, only two processes are being used in the Azores: a) removal of wood parts and replacement by metal parts; b) spot chemical treatment. Chemical treatment unfortunately could create health hazards and should only be applied by trained technicians and following rigid safety measures.

The future available options for the Azores fall within:

a) mechanical removal of wood parts and replacement by metal parts (Figs. 2 and 3);



Figure 2. New construction strategy using metal parts for the ceiling.



Figure 3. Renovation of the Catholic seminary with metal frames, after original building was damaged by *C. brevis*.

b) direct chemical treatment of known infested items of furniture or exposed wood in buildings using spot-treatments (see also Borges et al., 2007; Lopes et al., 2007; Myles et al. 2007b) (Fig. 4);



Figure 4. Injection holes (enhanced by red circles) for chemical spot treatment (adapted from Scheffrahn et al., 2006).

c) whole-block control usually by gas fumigation (see also Scheffrahn et al., 2006) (Figs. 5, 6 and 7).

A project was already submitted to the Azorean government to support a preliminary experiment in two buildings from Angra do Heroísmo. This experiment will include some adaptations to the usual methodology used in the United States (Figs. 5, 6 and 7) (see more details in Scheffrahn et al., 2006).



Figure 5. Condominium in Plantation, Florida showing how tarpaulin is adhered to exterior wall using wooden furring strips (from Scheffrahn et al., 2006).



Figure 6. Close up of Fig. 5 showing wooden furring strips securing tarpaulin (from Scheffrahn et al., 2006).



Figure 7. Blue tape used to seal doors and windows in fumigated structures with impermeable exterior walls in Florida. Walls in the Azores are also of impermeable composite covered with stucco (from Scheffrahn et al., 2006).

4. MANAGEMENT STRATEGY FOR HOME-OWNERS

For a Home-Owner living in the three main infested Azorean Towns, Angra do Heroísmo, Ponta Delgada and Horta, the main problem is to be able to know if there is termites in its home, and if positive, the level of infestation on its property to be able to take an adequate decision on termite control. Therefore, a decision tree could be as follows:

1. Contact a termite inspector or learn yourself to identify termite infestation using information on University Website (available soon)
 - 1.1. In case of no termite presence take the necessary preventive measures (painting over beetle holes; screening windows during the summer) to avoid future termite infestation.
 - 1.2. In case of positive identification, the termite species that colonized the house should be properly identified, as well as the type of infested structures, and how extensive is the infestation (count number of pellet piles)

2. After knowing the termite species and the level of infestation a decision has to be made concerning the remedial treatment to be applied.

A) In case of an infestation by the drywood termite *Cryptotermes brevis* (but also dampwood termite *Kaloterme flavicollis*):

2.1. LOW INFESTATION –

2.1.1. if only furniture is infested than several treatments are already available (sun heating, Gas-Bubbles, cold, solid fumigants);

2.1.2. if structural parts are infested, than the use of spot-chemical treatments (= drill and injection, but not surface spray) could be the most adequate solution. Then, it is important to select:

- a) the most adequate Insecticide (XT-2000 and BORAWOOD are the safest to be applied by the home-owner; the others, TERMIDOR, TERMINATE, XYLOPHENE, WOCOSIN, are eventually more effective in long-term but are more hazardous and should only be applied by training and licensed technicians). **IMPORTANT NOTIFICATION:** only XYLOPHENE and WOCOSIN are currently approved to be used in Portugal for wood insect pests; TERMINATE is an American product only available in American Base at Lajes and it is not approved for use in Portugal; TERMIDOR is approved in Portugal only for soil termites (therefore could not be used for drywood termite *Cryptotermes brevis* and dampwood termite *Kaloterme flavicollis*).
- b) use preventive treatment for future colony multiplication (e.g. painting over beetle holes, caulk over wood cracks, and a surface treatment like silica aerogel – but this needs further research confirmation)
- c) light-trapping and other alternative traps (e.g. colour sticky-traps) to trap wing-forms in the summer months.

2.2. MEDIAN TO HIGH INFESTATION – solutions:

- a) continuing the above mentioned measures and in addition:
- b) the replacement of wood-infested structures by pressure-treated wood (e.g., Chromated Copper or ACZ)

- c) or replace wood boards with metal frames, beams and steel studs, etc.;
- d) the use of whole house gas or heat fumigation (both this techniques are still not available in the Azores).

B) In case of an infestation by the subterranean termite *Reticulitermes grassei* (currently limited to sections of Horta in Faial):

1. Install yard monitors and check regularly and replace as needed (reductive trapping).
2. Rapid measures should be taken to remove and incinerate infested structural wood and yard wood.
3. An adequate treatment of the soil around the foundation of the infested structures with soil termiticides such as DRAGNET (permethrin based), TERMIDOR (fipronil based, already available in Portugal), or others which may become available;
4. Additionally, if available, also use colony suppression methods such as baiting (e.g. EXTERRA or SENTRICON) or TRAP-TREAT-RELEASE (Myles, 1996).

5. MANAGEMENT STRATEGY FOR PEST CONTROL COMPANIES

For a Pest- Control corporation working in the Azores, the traditional main work in these islands was usually related to rats and cockroach infestations. Now a new and complex situation emerges with termites, and eventually, each company will have to create a new strategy based on having operators with specialization only on termite control. A pest control company should be focused on:

- 1) Improving their knowledge on the biology and infestation patterns of the three termite species currently living in the archipelago. This could be achieved through training in cooperation with University of the Azores.

- 2) Adopting new techniques and in a situation of competitiveness try to specialize in a particular technique;
- 3) Create a strong cooperation with University research people in order to monitor the efficacy of new chemical products that will be appearing in the market.
- 4) Be aware of the hazard homeowner safety.
- 5) For subterranean treatment and house fumigation special training and certification is required.

6. MANAGEMENT STRATEGY FOR SCIENTISTS

We need to maintain extensive research on the biology and control of not only *C. brevis* but also on the other two species, *Kaloterms flavicollis* and the subterranean termite *Reticulitermes grassei*. Although much has been learned as could be exemplified by the several interesting results obtained during this last year (see Scheffrahn et al., 2006; Borges et al., 2007; Ferreira et al., 2007, Guerreiro et al., 2007, Lopes et al., 2007; Myles et al., 2007a,b), part of the results lack definitive synthesis and generalization or are not still convincing. Moreover, many more methods need still to be tested: i) heat fumigation; ii) gas fumigation (Scheffrahn et al., 2006).

So far research has been concentrated on the biology and control of the dry-wood termite *C. brevis*. Many of these laboratory findings have shown the potential for practical applications and now should be taken for the next stage in testing in people's houses.

Clearly we need a much better understanding of some aspects of the ecology of the species knowing better:

- a) the current distribution and spatial invasiveness of the three termite species in the Azores, i.e., we need to invest in a more detailed survey of the current distribution of all the three species followed by an adequate modelling of their potential distribution in the near future in the several islands. Only with this

information it will be possible to establish regional quarantine and management control measures;

- b) in particular, the spread of the subterranean termite *Reticulitermes grassei* in the island of Faial;
- c) the potential impact of *Kaloterme flavicollis* in agriculture and housing;

Other research topics are:

- 1) The laboratory test used a limited range of products mainly for drilling and injection and some wood preservatives. But, a further important area of chemical treatment involves surface treatment of wood to prevent colony multiplication. We intend test Silica Aerogel and other products that might be used for beetle holes.
- 2) We intend also to further test new type of wood that because of their physical and chemical properties could be totally termite proof (e.g. the Brazilian wood Massarundumba).
- 3) In the past and currently the forest and local saw-mills industry produced most of the timber required for local construction needs. Now, because of the treat of termites it is vital important to the survival of this industry to provide pressured treated wood. This requires some scientific evaluation and new equipment.
- 4) Another major area will be the testing of heat and gas whole house fumigation. Although the Tent-Fumigation is an interesting solution it could not be applied to many of the situations in Ponta Delgada and Angra do Heroísmo. The “whole house heat treatment” has also some drawbacks but some effort should be applied to test the feasibility of this technique.
- 5) Test glu-lam (glue lamination) wood products. Some are large beams that have lots glue and resin and could be termite-safe.
- 6) Concerning damp-wood and subterranean termites:
 - a) we need a better understanding of their distribution on the islands;
 - b) a really big problem is that Horta has some heavy infestation of subterranean termites. We need to investigate ways to control this species. The first stage is to have a coordinate project of large-scale baiting in order to known if it is

possible to eradicate the species from the town. There should be a coordination with the building department of Horta.

Other important key areas are:

1) Monitoring and adaptive management: without knowing the success of management measures and remedial treatments it will be impossible to conclude that the control of termites is effective. Therefore, we hope that people could agree to include their houses in a large-scale termite monitoring supporting future remedial actions, needed to meet the future control of the pest. This holds people accountable for evaluating management effectiveness and provides assurance that management efforts are focusing on agreed-upon goals.

the efficacy of chemical spot-treatments (this should be done in cooperation with Pest-control companies);

2) Cooperation: we envision this next stage as involving cooperation between Companies, Home-owners with University oversight.;

3) Information and education: we want to maintain a web-site with all the information available for the general public. Moreover, we want to produce materials for biology teachers.

7. MANAGEMENT STRATEGY FOR THE MAIN STAKEHOLDERS AND POLITICIANS

In near future there is the need to:

1) Inclusive people involvement - include all potential stakeholders, regardless their relative social influence. Because it is often possible to identify all relevant interests in management efforts, this factor will be based on the extent to which termite management achieve broad based support by stakeholders on all sides of the issue.

2) People and stakeholder influence: in increasing people and stakeholders confidence we hope that their input could have real impact on final political decisions, such that all actors in the process are empowered through meaningful participation.

This can take many forms, from simply listening to people's and stakeholders concerns and showing them how their input could be used and eventually some sort of formal power sharing with the managers (e.g. Mayor of the main Towns).

3) Designate infested wood disposal areas: this is of critical importance for the control of all three termite species. All wood should be destroyed by either burning it or digging it.

4) Invest in the spread of information: the regional control of the spreading of the three species will be only possible if the general public understand the risk of moving furniture and wood between islands and within islands. The generation of educational materials should be highly proprietary.

5) Create new legislation: some effort should also be performed in creating adequate public policies and new legislation.

There is also the need to draw attention to the potential costs of termite infestation management, estimating potential damage for home-owners and design cost-benefit analyses.

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