RELATÓRIO PROJECTO

COMBATE E GESTÃO DAS TÉRMITAS (ISOPTERA) EM HABITAÇÕES DOS AÇORES COM ENFASE NA ILHA TERCEIRA
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Abstract: *Cryptotermes brevis* is an extraordinary termite in its unique ability to attack extremely dry wood. It is also unique in its ability to attack a wide variety of wood species. This leads to it being one of the only termites of the world which is commonly found attacking furniture. As such, it is easily moved when people move their furniture from place to place and this is one of the reasons why this termite has become widely dispersed to urban areas around the world. It is very likely it was first introduced into the Azores with furniture and that its continued dispersal from island to island and town to town will be by the further movement of infested furniture. Therefore furniture treatment is an important component of an integrated program for dealing with the control and containment of this pest species. The objective of this presentation is to explain the results of three types of experimental furniture treatment that we conducted. The first of these was a simple method involving the sealing of an infested item inside a black plastic bag which was then placed in full sun exposure outdoors during the month of August. The next method involved sealing an infested item in a container with one of three solid fumigants: naphthalene (moth balls), para-dichlorobenzene (PDB moth balls), or dichlorvos (Vapona®). The final method involved anoxia test in which one of three inert gases, either nitrogen (N_2), carbon dioxide (CO_2), or argon (Ar) gases were used to displace the air in a sealed bag holding an infested item.

Resumo: A *Cryptotermes brevis* é uma térmita extraordinária na sua capacidade única de atacar madeira extremamente seca. É igualmente extraordinária na capacidade de atacar uma grande variedade de tipos de madeira, o que nos leva a concluir como sendo a única espécie de térmitas que é facilmente encontrada em mobílias. Como tal, é muito fácil a sua dispersão aquando do transporte de mobílias infestadas de lugar para lugar, e esta é uma das principais razões pela qual esta térmita consegue ter uma distribuição tão ampla em áreas urbanas, em praticamente todo mundo. É muito provável que a sua introdução nos Açores tenha sido através de mobília infestada e que a dispersão contínua que se tem verificado de cidade para cidade seja devido a essa razão. Ou seja, o tratamento de mobílias é uma componente importante de um programa integrado para lidar com o controle e contenção desta espécie de térmita. O objectivo deste trabalho é apresentar os resultados obtidos de três tipos de experiências para tratamento de mobílias infestadas com

Cryptotermes brevis. A primeira experiência consistiu num método muito simples envolvendo o selar de um objecto infestado dentro de um saco de plástico preto, sendo este colocado num local fora do laboratório afim de se encontrar em plena exposição solar durante o mês de Agosto. O método seguinte consistiu em selar um objecto infestado num recipiente com um de três tipos de fumigantes sólidos: bolas de naftalina, para-dichlorobenzeno ou dichlorvos (Vapona®). O último método envolveu um teste de anóxia em que um de três tipos de gases inertes, azoto (N_2), dióxido de carbono (CO_2) ou árgon (Ar) foram usados para substituir o ar existente dentro de um saco plástico (bolha) selado, contendo um objecto infestado.

1. Introduction

Cryptotermes brevis is an extraordinary termite in its unique ability to attack extremely dry wood. It is also unique in its ability to attack a wide variety of wood species. This leads to it being one of the only termites of the world which is commonly found attacking furniture. As such, it is easily moved when people move their furniture from place to place and this is one of the reasons why this termite has become widely dispersed to urban areas around the world. It is very likely it was first introduced into the Azores with furniture and that its continued dispersal from island to island and town to town will be by the further movement of infested furniture. Therefore furniture treatment is an important component of an integrated program for dealing with the control and containment of this pest species.

Control of drywood termites is straightforward. Since these species form small colonies, the biggest problem is finding the nest location. The location can be in furniture or inside of wall studs or framing. Drywood termites can chew away wood until only the thin sheet remains separating them from the environment. Treatments for this pest include whole-structure applications or fumigants, heat, spot treatments of chemicals, or treatments that use heat, freezing, microwaves, or electricity (Lewis, 2001*)*.

The objective of this presentation is to explain the results of three types of experimental furniture treatment that we conducted. The first of these was a simple method involving the sealing of an infested item inside a black plastic bag which was then placed in full sunlight exposure outdoors during the month of August. The next method involved sealing an infested item in a container with one of three solid fumigants: naphthalene (moth balls), para-dichlorobenzene (PDB moth balls), or dichlorvos (Vapona®). The final method involved anoxia test in which one of three inert gases, either nitrogen (N_2), carbon dioxide (CO_2), or argon (Ar) gases were used to displace the air in a sealed bag holding an infested item.

The perception exists that termite control requires the use of pesticides. However in many cases termites could be built-out or retro-fitted out with little or no chemical pesticide. The key to termite control is not toxicity but impenetrability.

2. Heat Treatment (sun light)

2.1. Methods

Heat is a nonchemical option for whole-structure treatments. Excessive heat kills drywood termites by disrupting cellular membranes and denaturing enzymes needed for their survival (Lewis, 2002).

Previous research on heat tolerance studies was conducted against *Cryptotermes brevis* to determine heating time requirements for controlling structural infestations. Complete mortality of *C. brevis* was obtained following exposure times of 4 and 10 min at 50°C and 48ºC, respectively (Scheffrahn et al., 1997). Based on this study and others and to find a simple method that people could do themselves, an experiment was conducted in our laboratory using different pieces of infested wood with C. *brevis*, a simple plastic black bag and sun light exposure (Figures 1, 2 and 3).

This experiment took place during the month of August of 2006. Infested boards were marked off into 15 cm lengths and alternately labeled "A" for treatments and "B" for controls. Black plastic garbage bags were cut to the appropriate size for holding four infested boards and then sealed using an electric heat sealer. The treatment bags were laid out in the balcony of the laboratory in full sun exposure. Four replicates were made for each of four dismantling times: 1, 2, 3 and 4 weeks, giving a total of 16 test bags with infested wood. The 16 control bags were set up identically but left inside the laboratory in a shaded location away from the windows.

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Figure 1. Cutting the plastic bag.

Figure 2. Plastic bag sealed.

Figure 3. Plastic bags on the balcony of the laboratory exposed to sun light with bricks holding them because of the wind.

2.2. Results and conclusions

Figure 4 shows the results after dismantling of the test and bags. In the heat treatment mortality was about 30% after the first week, with no difference to the control. By the second and subsequent weeks mortality was 100% in the treatment bags compared to 40% or less in the controls. Mortality in the control is due in part to the process of dismantling and extracting the termites. We conclude that this method might be a viable method for furniture treatment and one that people could do themselves with simple materials and no chemical pesticides. However, further research investigation should be done to see if it could also work during other summer months and cooler seasons of the year and with real items of furniture. In future experiments it would be desirable to use a temperature data logger to determine the temperatures inside the bags.

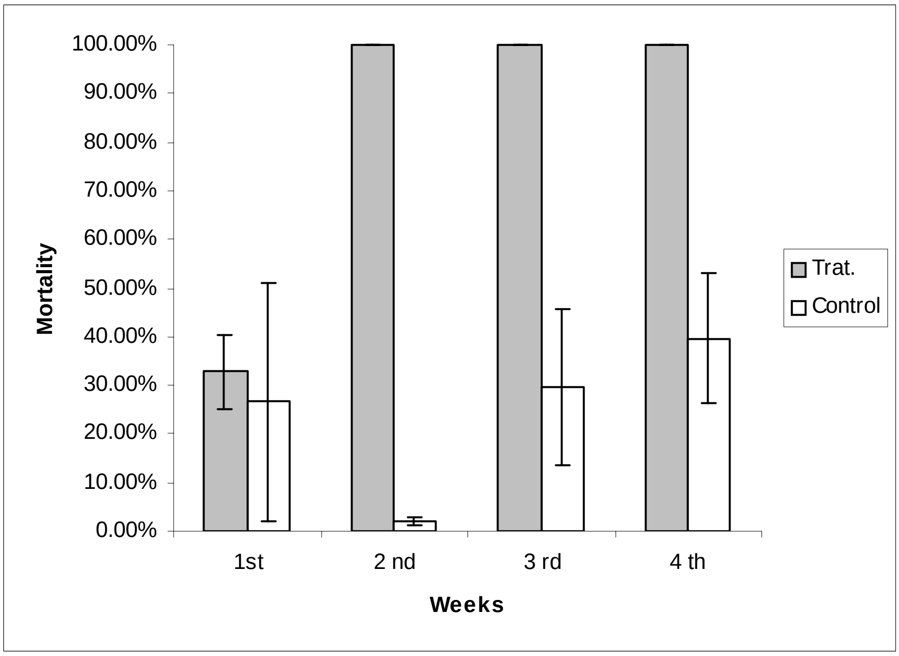

Figure 4. Mortality percentage observed in the plastic bags exposed to sun light and in the controls

3. Method involving solid fumigants

3.1. Methods

The next experiment involved placing a Petri dish with 10 termites on filter paper in sealed plastic boxes (0.5 or 30 liter capacity) with one of three solid fumigants, naphthalene, para-dichlorobenzene, or dichlorvos (ca. 10 grams). There were 3 replicates for each treatment and control. The half liter container experiments were read hourly, and the 30 liter containers were read daily. In this experiment the objective was to determine the lethal time to kill 100% of the termites (LT_{100}).

This experience involved 12 plastic boxes, 12 Petri dishes, paper filters and termites. In a plastic box (fig 5) a ball of naphthalene was put along with a Petri dish, paper filter and 10 termites. The same thing was done for paradichlorobenziene, but in this case 2 balls were put in each box and the same thing happened with the solid fumigant Vapona using a small strip. Three replicates were done for each.

Figure 5. Experiment with PDB in 30 liter containers.

3.1. Results and conclusions

In the half liter containers LT_{100} was 9, 7 and 2 hours for naphthalene, PDB, and dichlorvos, respectively. In the 30 liter containers LT_{100} was 8, 2, and 1 day for naphthalene, PDB, and dichlorvos, respectively. We caution that such materials should only be used in enclosed containers, or inside bags, and as directed on the label to prevent human inhalation. Further laboratory and field testing of these materials is needed to determine whether they would have any efficacy on termites inside their galleries in infested wood.

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4. Method involving Anoxia Gas Bubbles

4.1. Methods

Anoxia treatment is an important tool for the control of termites and wood-boring beetle infestations. This method is routinely used in libraries and museums to preserve books and artifacts and to keep them free of infestation. This method has no harmful secondary effect on objects that are treated nor does it constitute a health risk for operators or users. Inert gas is used, usually nitrogen, which causes insect death by asphyxiation and dehydration. Anoxia eliminates insects at all stages of their development - egg, larva and adult. Drywood termites such as *Cryptotermes brevis* are the principal target of structural fumigations with poisonous gases in North America and Hawaii. A limited study with *C. brevis* suggested that this drywood termite is susceptible to carbon dioxide fumigation. (Delate et al., 1995). With the assistance of a company (EXPM) that has performed anoxia treatments only on beetle infestation in the mainland Portugal, an experiment was conducted using the same method but on termites.

Disinfestation using the EXPM Anoxia Gas Bubble involves isolating the material to be treated in a bubble of plastic film that is highly impermeable to oxygen. Air inside the bubble is replaced with an inert gas (nitrogen, argon or carbon dioxide). EXPM inert gas bubbles provide a made-to-measure ecological, non-toxic solution for occasional needs to disinfest documents or objects. This technique allows local treatment to be carried out at places where documents and collections are stored, eliminating security risks and the integrity of the material, while also allowing objects of various shapes and sizes to be treated with the same efficiency.

The company was contacted and requested to come to the University and help us conduct an experiment using wood infested with *C. brevis*. This method involved anoxia test in which one of three inert gases, either dinitrogen, carbon dioxide, or argon gases were used to displace the air in sealed bags holding infested items, either boards or pieces of furniture.

Figure 6. Sequence of the making of a "Gas Bubble": a) Cutting the infested wood; b) Taping the ends, c, d) Cutting and sealing all ends of the plastic; e) Reinforcement with tape; f) Applying silicone caulk.; g) Tightening the valve stem; h) Bubble ready to be used; i) Putting the pieces of wood inside the bubble; j) Sealing the bubble; k, l) Attachment of the valves on to the valve stems; m) Pressure gauge linked up to the gas cylinder n) gas meter; o) Filling the bubble with gas; p) Gas bubble filled with carbon dioxide; q) Bubbles displayed on the shelf; r) Plastic bubble empty; s) Bubble with the chair and drawer.

The company was contacted to come to the University of Terceira and help us conduct an experiment using wood infested with *C. brevis*. This method involved anoxia test in which one of three inert gases, either dinitrogen, carbon dioxide, or argon gases were used to displace the air in a sealed bag holding an infested item, either boards or items of furniture.

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We started out by cutting pieces of infested wood (Fig. 6a) numbered and labeled, "A" for treatment and "B" for control. The ends were also taped so the gas would not have an easy way to get in (Fig. 6b). After cutting the plastic with the size of the wood to be treated, all sides were sealed with an electric heat sealer device leaving one side open (Figs. 6c and 6d). The plastic used is called *polyskin*. It is made of various layers of specific plastic and is specifically formulated to be gas tight. Reinforcement with ordinary tape (Fig. 6e) was made in two ends of the bubble and then two holes cut with the size of the valve stem. After putting the valve stem through the hole, it was sealed with silicone caulk (Figs. 6f and 6g) to prevent gas from escaping. After having the bubble made (Fig. 6h) we put the infested wood inside along with a Petri dish with a paper filter and 10 termites. After putting the pieces of wood along with the Petri dish the bubble was sealed with the heat sealer (Fig. 6i and 6j). Figures 6k and 6l show the attachment of the valves on to the valve stems prepared previously. At this point the bubble is ready to receive gas. In this experiment we used 3 gases: carbon dioxide, nitrogen and argon. Three bubbles were filled with each gas. A pressure gauge was linked to the gas cylinder which monitored the humidity and the pressure (Fig. 6m). After having the gas flow into the bubble, the gas register shown in figure 6n allowed us to see the decline of oxygen concentration in the bubble gas and the increase of the gas used. Once the concentration of oxygen in the bubble reached 0,05% and the concentration of the gas used 99.95% we then turned off the valves leaving the inflated bubble full of gas as shown in Figs. 6o and 6p. When all three bubbles for each treatment were filled with the gas they were linked to each other with plastic tubes and left in a shelf (Fig. 6q). Being linked to each other made it easier to refill as needed in case of any slight leakage.

Three bubble replicates were made for each type of gas. One bubble from each type of gas was dismantled after a week, a second bubble after two weeks and a third bubble after three weeks. After reaching the time required for each gas, the valves were opened permitting all the gas to come out and one of the sides of the bubble cut off (Fig. 6r). After treatment, each piece of infested wood was carefully dismantled with a hammer, chisel and shears to completely extract and count the live and dead termites.

Using the same procedures but only using carbon dioxide we did an experience using two pieces of infested furniture, a chair and a drawer (Fig. 6s).

4.2. Results and Conclusions

The results of this method were a total mortality in all bubbles for the three types of gas within one week. Replicates dismantled after the second and third weeks also as expected showed 100% mortality.

This method can be a potential key to resolve problems of furniture infested with termites. It has many positive aspects:

- It can be done at any time of the year;
- People do not have the need for there infested furniture to be moved from their house which is important because this prevents the dispersal of alates,
- The conditions in which the inert gases are used are not toxic to people,
- Since these gases are not toxic they do not have to be government registered in the same manner as pesticides.
- The termites are killed after one week, which is much shorter than the month long period required to kill certain types of beetle larvae;
- Further experiments should be done to determine if even shorter time periods would be adequate for termite control.

Although we used three different types of inert gases to see which one would cause higher mortality all of them were effective. Fortunately, another convenience of this method is that it works with the cheapest inert gas, carbon dioxide.

A further advantage is that the company that is offering this method is a Portuguese company. However at this moment there is not yet a local applicator in the archipelago of the Azores doing this kind of anoxia treatment, meaning we would have to appeal to a company in the main land to come and do the job, however through subcontracting arrangements, this may change making such treatments more economical. In the mainland the cost of this treatment on beetles is about 170 euros per cubic meter.

We can say that successful termite management requires many special skills, including a working knowledge of building construction and an understanding of termite biology and identification can help a homeowner detect problems and understand methods of control.

A great amount of beautiful antique furniture and other wooden artifacts of historic significance exist in the Azores and it is hoped that this nontoxic method of anoxia treatment will be useful in preserving these aspects of our culture from the ravages of this serious exotic invasive termite pest.

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