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Article *in* International Journal of Natural Resource Ecology and Management · December 2021

DOI: 10.11648/j.ijnrem.20210604.12

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International Journal of Natural Resource Ecology and Management
2021; 6(4): 171-175
http://www.sciencepublishinggroup.com/j/ijnrem
doi: 10.11648/j.ijnrem.20210604.12
ISSN: 2575-3088 (Print); ISSN: 2575-3061 (Online)

Conservation of Wood and Restoration of Artifacts Against Wood Destroying Organisms

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To cite this article:

Obed Persie Appiah-Kubi, Xinyou Liu, Zhihui Wu. Conservation of Wood and Restoration of Artifacts Against Wood Destroying Organisms. *International Journal of Natural Resource Ecology and Management.* Vol. 6, No. 4, 2021, pp. 171-175. doi: 10.11648/j.ijnrem.20210604.12

Received: November 9, 2021; **Accepted**: December 1, 2021; **Published**: December 9, 2021

Abstract: Conservation of wood and restoration of artifacts against wood destroying organisms has been the greatest priority of any woodworker so far as a man greatly relies on wood products to satisfy almost every need. Since the creation of the universe, wood-destroying organisms have been with us, and have over the years caused great catastrophes that bring bad memories to several people, notable is the dunes of Holland and Columbus. Many research papers have been written by scholars across the globe concerning this topic under discussion. Those materials either talk about insects that cause damage, or the processes of conserving and restoring wood and wood products. In bridging this gap, the study aims at educating people on how to control wood and wood products from getting entirely damaged by insects. In achieving this, the study sought to outline some common but dangerous wood-destroying insects, appropriate preservation materials, and the processes to adopt in controlling the damage. In this regard, the study adopted Content Analysis in the investigation, analyses, and composition of the concept. The study divulged that insect like termites, beetles, ants, bees, etc. as well as fungi and bacteria cause destruction or damage to wood and wood products. Preservation materials like lindane, pentachlorophenol, alkaline chloride, sodium chloride, fluorosilicates, boric acid, potassium dichromate, sodium dichromate, tars, kerosene, Bassa, DDT, etc. were also revealed to be effective and reliable in conserving and restoring wood and wood products by the study. These preservation materials can be applied on wood and wood products by either; fine and coarse spraying, brushing, smoking, soaking or dipping, impregnation, injection, infusion, and so on. If the right preservative is selected and the right application method is employed, treatment will last to achieve the prevention of insects and restoring the damaged wood or wood product into a desirable form. The study is expected to serve as reference material in helping the general public, particularly woodworkers and users of wood items to know how to control certain insects attack using the appropriate, effective and reliable preservation material (s) by employing the right preservation process. As instructive research, the authors recommend extensive further studies be done by singling out each preservation material against the methods of preservation to help craftsmen and product users to know which preservation material is appropriate, its advantages and disadvantages for a particular work while employing the right method.

Keywords: Conservation, Pests, Preservatives, Restoration, Consolidants

1. Introduction

Wood; a sustainable material, the oldest, most valuable, and versatile, is used by people to make simple tools, furniture items, shelter, utensils, cars, ships, musical instruments, weapons, decorative carvings, to mention but a few because they can easily be used with effortless or uncomplicated tools. It soon became evident that the material, irrespective of the species could easily be affected when exposed to the weather for a very long time [2], it could also be affected by living organisms like; termites, beetles, carpenter bees, carpenter ants, marine borers, shipworms, bacteria, decay fungi, to mention but a few, as

fire can also be considered as a destroying agent [9, 2].

Efforts have been made to increase wood durability, even before using it, from regulation of environmental factors, building technology to chemically conserving with preservatives [3]. Early chemical preservation measures included brushing with oil, tar, or pitch, storage in saltwater, charring, etc. [1]. From the time of earth creation, wood borers, decay fungi, termites, and shipworms as persistent pests have threatened the use of wood forcing people to look for ways to conserve the material [4, 7]. A report detailing the fourth voyage of Columbus shows how serious the situation can be: “shipworm infestation is so severe that it looks like a beehive” and “there is no cure for worm infestation.” In addition, the Holland dunes were also hit by the same catastrophic shipwreck, which led to the proverbial saying "Holland in need" in the 18th century.

There are several undocumented catastrophic happenings as a result of wood-destroying organisms getting in contact with wood, causing the material to be invaluable, and it is not surprising, therefore, that people upon knowing how easily the material can deteriorate, have tried and still trying so hard by any appropriate means to improve the durability of the material for all kinds of production.

The study became necessary because day in day out, wood destroying organisms are threatening the use of the material, hence, important to find solutions to curb this challenge. Again, Scholars have written several books and research papers concerning this topic under discussion, but the materials end up either talking about destroying organisms that damage wood and wood products, or the processes of controlling the damage. This is a bit worrying since the two should go together in helping the general public have a better knowledge of how to control certain organism attacks on wood and wood products with the appropriate preservatives and the right preservation processes.

In this regard, the study aims at educating the public by outlining some common but dangerous wood-destroying organisms, the appropriate preservation materials, and the right processes to adopt in controlling damage on the material and it end-products.

2. Materials and Methods

The study made use of Content Analysis in the investigation, analyses, and composition of the concept.

2.1. Common But Dangerous Wood Destroying Organisms

Of all the countless species of common house organisms, there is one that homeowners fear most, and that is wood-killing insects [13, 8, 15]. Threats to homes around the world, the most destructive insects belonging to the order Coleoptera (beetles), Isoptera (termites), and other insects such as Carpenter bees and ants [8, 17]. These are the main destroying organisms of wood and are also called wood-eating insects. They are extremely destructive in contact with wood, and records show that they create an estimated $5 million annual property damage in the United States of America [19].

In addition to wood-eating insects, there exist second pests [11]. The second pests are wood-boring insects, a common example of which are ambrosia beetles, colonizing insects, and those that attack stored objects. Wood-destroying insects are divided into groups; dry wood and damp wood insects [14, 11].

Commonly known as wood-destroying insects, both primary and secondary insects have mysterious powers that first quietly pounce on wood found in windows, beams, furniture, floors, support columns, stairs and banisters, altars, photo frames, sculptures, panel paintings, organ houses, and other structures used to ensure the sustainability of the largest investment (building blocks).

All insects are harmful but termites are problematic and destructive. Termites are divided into three groups depending on the preference of the nest: dry wood, underground wood, and wet wood [20, 6]. The subterranean or underground wood insect species are the most destructive species of termites, using their jaw that looks like scissors to chew on wood for all hours in a day. With up to two million members in the colony, underground termites can bite enough wood over time to collapse or destroy an entirely wooden structure [20, 12].

That said, wood beetles are still widely distributed even over termites. They are found in all provinces; however, they are second to termites when it comes to the destruction of wood and all kinds of wood products [7, 5]. The powder post beetle, which falls into the category of wood-destroying beetles, attacks hardwoods - the same wood material used in many homes.

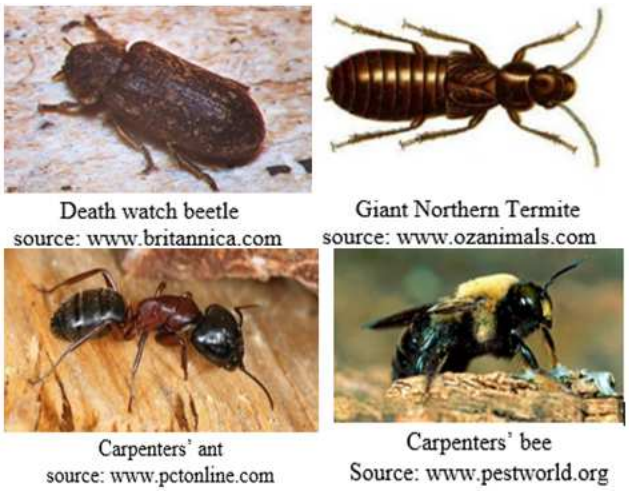

Figure 1. *Shows some common but dangerous wood destroying insects.*

Carpenter ants and bees are another type of insect that destroys wood. Their names alone mean everything. Carpenter ants and bees are found in countries like the United State of America, Germany, Indonesia, Russia, Japan, and so on, but they are often found in cool, humid climates in the northern provinces. Ants build tunnels in wet or rotten wood to build their nests. The tunnels are usually found on door frames and window frames, as well as in crawlspaces under

roofs, sinks, bathtubs, and chimneys. It is very difficult to see with the naked eye, but the homeowners can see lots of pieces of wood and sawdust around the area, both of which are signs of ants.

Figure 2. *Shows some common wood-destroying insects attacking wood.*

Figure 3. *Shows the effect of insects' attack on wood and wood products.*

2.2. Wood Conservation, Products Restoration, and the Preservation Processes

The conservation and restoration of wood and the wooden product is a process by which conservationists restore and maintain the wood and wooden products to sustain their condition and the information it contains [10, 18]. The process covers steps that can be taken by conservationists, archaeologists, and other museum experts to conserve wood and products made of wood. This practice includes understanding the structure, form, or species and the degradation agents of the wood, as well as protective conservation measures and interventions that can be adopted.

Wood conservation includes all measures designed to permanently prevent damage or deterioration of wood and wood products by insects, fungi, bacteria, and marine borers. These measures can prevent or control active attacks. The conservation measures are categorized into; physical, chemical, and structural conservation measures [13, 11, 1].

Among the steps involved in construction (structural), the choice of wood types that can withstand the details of protecting the wood from moisture accumulation and the effects of climate. Physical conservation methods include the installation of heatwaves, cold, and electromagnetic waves such as microwaves and gamma rays. Chemical protection methods include the use of preservatives or explosives.

In the past, various methods of protecting wood from extinction were introduced, and today a combination of different materials and processes has emerged to meet economic and environmental needs for efficient use. Integrated wood preservation methods are designed to protect the wood's durability concerning its intended purpose and its aesthetic appearance using measures that are well suited to environmental concerns.

By paying close attention to the chemical preservation method, the methods are classified as waterborne and solvent-borne based on the vehicle [16, 21]. mainly involves wood treatment with inorganic biocides embedded in an aqueous solution [16]. These preservatives are especially good for light wood and wet wood, but they can also be used for dry wood. Liquid preservatives can be used in a variety of ways; pressureless: brushing, smoking, fine and coarse spraying, and soaking and foam application, pressure: include treating in pressure vessels and vacuum impregnation, and special methods are used to treat high-risk areas. Special procedures for diffuse treatment, injection, etc. [7, 2].

Liquid preservatives applied by brushing do not penetrate wood completely, and in most cases, only the surface layers are treated. The preservatives are suitable for unpainted structural timber used in architectural conservation, but not for valuable works of art and cultural property [9, 7].

Solvent-borne, also known as oil-borne preservatives, usually contain natural biocides that are least dissolved in organic solvents. They are especially suitable for the treatment of dry or semi-dry wood in the form of undercoatings, decorative preservative coatings, and for impregnation. After treatment, the solvent evaporates, while the biocides ideally remain in the wood and cannot be leached with water.

The solvent-borne preservatives are now much less malodorous than they were in the past. They penetrate wood well and, depending on the type of solvent, swell wood less as compared to waterborne preservatives [3, 16].

Fumigation is a part of wood preservation and is used mainly for the control of wood-destroying insects, but sometimes also to control decay fungi. Fumigation is an immediate control of insects in wooden objects by suitable fumigants like methyl bromide, sulphuryl fluoride, ethylene

oxide, etc. Ethylene oxide is generally recommended because it has the least bad effects on cultural property. The permeability of the fumigants into wood is $SO_2F_2 > CH_2Br > (CH_2)_2O$. Ethylene oxide is the most powerful in exterminating insects and is used in combination with carbon dioxide or Freon gas.

In the case of cultural properties, CO_2 and Freon gas should not be used. [8] recommended a mixture of methyl bromide-ethylene oxide (87:13 by wt.) in Japan, [9, 21] suggested carbon disulfide and carbon tetrachloride in the ratio of 1:1 or 1:3 respectively for effective control against wood borers.

The fumigation processes are best carried out in a specially equipped chamber. The standard amount of methyl bromide used is 30-50g/m^3 at 20-30°C for 24 hours, but this may be reduced to 2-3 hours if equipment for providing a vacuum is installed which is also safe. Fumigants penetrate wood faster, more deeply, and more uniformly than liquid wood preservatives.

Figure 4. *Shows the conservation processes of wood and wood products.*

Although preservatives applied by several means aim at protecting and restoring the state of the wood and wood products, most end up damaging the materials during the treatment processes due to the reactivity of the insecticides or fumigants, which depends on the chemical composition, the structure of the specific compound as well as improper application of the preservatives. Some wood, wood-works, and cultural properties after treatment, change in colour, swell, shrink, have an unpleasant smell, become very toxic and all these effects can be attributed to the improper composition of the chemical intended for the treatment, not knowing the right compound for a specific material and the improper application processes of the preservatives on the materials.

It is important, however, to decide before treatment, whether the objects should be merely stabilized or completely restored. Consolidants that are to serve only for substance stabilization and protection are easier to choose than those which are to serve as a basis for additional restoration treatments. Consolidants used as part of a complete restoration treatments should be as compatible as possible with the usual colouring and inpainting materials and adhesives and should permit traditional methods of working.

Either gaseous or liquid media can be considered for the consolidation of works of art and cultural property, all that matters is knowing the state of the wood or the wood product, the type and extent of insect attack, the right preservative to be used and the appropriate treatment processes to be employed.

3. Conclusion

Wood destroying organisms have existed since the creation of the universe and their existence has propelled woodworkers and researchers to seek appropriate physical, structural and chemical preservatives, and the right mechanisms in preserving and restoring wood and all products made of wood.

Destroying organisms like termites, beetles, carpenter ants, carpenter bees, marine borers, shipworms, etc. as well as decay fungi and bacteria cause damage to wood.

Through the adaption of Content Analysis for the study, the study divulges the appropriate preservation materials and the right preservation processes to enable woodworks and cultural properties to be controlled from complete damage. Preservation materials like lindane, pentachlorophenol, alkaline chloride, sodium chloride, fluorosilicates, boric acid, potassium dichromate, sodium dichromate, tars, kerosene, Bassa, DDT, etc. to be effective and reliable materials in conserving and restoring wood and products made of wood by either fine and coarse spraying, brushing, smoking, soaking or dipping, impregnation, injection, infusion and so on.

The study concludes that, if the right preservation material(s) is selected to fight organisms attack, and the right application method is employed, treatment will last to achieve the prevention of destroying organisms and restoring the damaged wood or wood product into a desirable form. This research work will serve as reference material in helping the general public especially woodworkers and wood products users to know how to control certain destroying organisms attack using the appropriate, effective and reliable preservation material (s) by employing the right preservation process.

4. Recommendation

As instructive research, the authors recommend to other researchers for further studies to be done by singling out each

preservation material against the methods of preservation to extensively write on them to help woodworkers and users of wood products to know which preservation material is appropriate, as well as its advantages and disadvantages for a particular work while employing the right method.

Authors' Contributions

O. P. A. K came up with the research topic after reading some course materials given by X. L. The research topic was then approved by X. L and Z. W; course teacher and programme supervisor respectively. After successful approval, O. P. A. K, X. L, and Z. W wrote the manuscript under the supervision of X. L and ZW. All the authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare that they have no competing interests.

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