Tendencies of Termites of the *Genera Anacanthotermes Jacobson* to Damage the Wooden Parts of Buildings

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Abstract: - We have focused our research on determining whether the timbers used as a building material by the population today are resistant or nonresistant to termite damage. The main purpose of this was to learn which types of trees cannot be used as building materials for houses or other structures. In this, we used *Salix, Populus, Aleagnus, Ulmus, Pinus, and Betula* wood species. We carried out research both in the laboratory and in the field (termite nests and residential buildings). In this case, damage by termites of these pieces of wood placed around termite nests accounts for one year. *Salix* and *Populus* wood materials were 86.6±6/50.0±4 percent in laboratory conditions, 93.3±5/90±5 in home, and *Pinus* and *Betula* wood materials were 6.6±0.7/0 in laboratory conditions and 13, 3±2/3.3±0.8 percent in home were damage noted. The causes of serious damage to wooden materials by termites are mainly due to the increase of humidity and the growth of fungi. When fungal cultures were isolated from damaged wood and their morphological characteristics were studied, it was found that wood decay fungi belonging to the genera *Alternaria* and *Cladosporium* were present. When studying the content of substances difficult to decompose by enzymes and microorganisms in the wood materials, it was found lignin that 20.1±0.3% was present in *Salix* and 41.2±0.3% in *Betula* wood. It has been found that in areas with high humidity, wood materials are decomposed by fungi and other microorganisms and the microorganisms multiply faster, As a result, wood more damage by termites. Lignin and some of its compounds prevent the growth of microorganisms. Wood materials made from trees belonging to the genera *Pinus* and *Betula* are resistant to termite damage due to their high lignin content.

Key-Words: - termite, feed, wood, house, lignin, microorganism, decomposition, susceptibility, durability. Uzbekistan, Khorezm

Received: May 2, 2023. Revised: July 19, 2023. Accepted: September 14, 2023. Published: October 10, 2023.

1 Introduction

Termites destroy all wooden elements in various constructions, such as architectural and cultural monuments, strategically important constructions, hydraulic structures and residential and administrative buildings. One termite family consisting of 25 thousand individuals and occupying a space of 100 cm^3 consumes an average of 50,000 cm^3 of different types of cellulose. Termites are common in all tropical and warm countries, [1]. They live in a nest built on the ground, forming a large community consisting of many thousands of individuals. In structure, the population of the termite species under consists of three groups, imagos, larvae and nymphs, each of which has specific characteristics (size, birth rate, death rate, gender ratio, spatial distribution and others). Termites *Anacanthotermes* (*A.turkestanicus* and *A.ahngerianus*) extend their habitat in urban and natural ecosystems under the influence of ecological and human factors. The life of a termite family begins with nuptial flight, which takes place in the nests of termites, in spring. The winged male and female meet in the air; they settle and pair, and then they prepare a nest, a termitarium, thereby establishing the foundation of a new colony, [1], [2], [3], [4]. After landing on the ground, they break their wings and pair (male, female) termites start building their chamber at a depth of 3-5 cm and start a new family. In termite families found in desert and forest landscapes of Karakalpakstan and Khorezm region, their number is from 9,754 to 5,9267, and 67-90% of them are working individuals, [5], [6]. The females are extremely prolific. The ‘queen’ of *A. ahngerianus* lays from 800 to 3150 eggs during one day, and that of *A. turkestanicus* from 710 to 2175 eggs. The female can live up to several years, which results in millions of eggs. *Anaconthotermes ahngerianus* one-year nest contains 1800-2700 termites, and 15300-18142 termite individuals are found in families with two or more years of development. In the course of their development all termites go through several phases separated by ecdysis to reach a certain age(castes consisting of the larva, worker, nymph and pro soldier). The number of larvae in such families increased from 37.1% (in July) to 54% (in December). The number of workers was 37% in March, 62.1% at the beginning of the autumn season, and 40% in December, [2], [4], [5], [6]. The damage caused by termites around the world is growing year after year. Termites cause huge economic losses by infesting buildings. The countries of Western Africa spend about 10% of the finance assigned for the repair of constructions on buildings damaged by termites. Global economic damage from termites is estimated at 40 billion US dollars, 80% of the total damage is caused by underground termites, [7].

Their migration into buildings also depends on the type of wooden materials of the building. Experiments conducted in dry forest regions of Colombia revealed that termite species composition and numbers were higher in wet regions than in dry regions. In conclusion, it has been shown that vegetation cover in wetlands is favorable for termite development due to its high species composition and biomass, [8], [9]. Termites do not feed on all plants, for example: plants can be used to control them. Such plants include *Z.officinale*; examples include *A.indica*, *S.indica*, and *J.adhatoda*, [10], [11]. They can quickly and easily find and damage certain plants and wooden parts of the building. Less damaging to other types of wood materials.

It has been determined that the development of termites spread in Uzbekistan has a high temperature and relative humidity of 100% when the temperature is 25^{0}C, [6], [12], [13], so it can be assumed that termites are more attracted to places with high humidity of the atmosphere, walls and ceilings. It has been observed that these factors are also important in the use of chemical pesticides. *Reculitermes flaxipes* and *Saptotermes formasanus* The effects of different temperatures on the effectiveness of indoxacarb and filponil pereparats against termites were studied. These termite species are soil dwellers. Experiments were conducted at temperatures of 16, 22 and 28^{0}C. According to the results of the experiment, termites at a temperature of 16-22^{0}C were observed to die more, [12], [13], [14], [15].

The effectiveness of chlorfeproin and chlorantrapyrrol substances from chemical preparations against termites living underground was studied and found to be highly effective [8]. Boric acid and sulfur-containing wastes in chemical control were studied, as well as methods of use in the control of termites, [16], [17], [18]. The effectiveness of the microbiological method in the fight against termites has also been studied. Fungus, bacteria, and viruses can attack termites and kill them, [1], [19], [20].

2 Material and Methods

Study area.

The area is lowland located in the Northwestern part of Uzbekistan, along the lower reaches of the Amudarya River, between 60’-61’ longitude and 41’-42’ latitude, at 113-138 m above sea level. The vegetation period of plants is 200–210 days. The climate is extremely continental, with an average annual precipitation of 80-90 mm. Average temperature in January is -5^{0}C, in July + 30^{0}C, [21], [22], [23]. The climate of the oasis is greatly influenced by the deserts of Kyzylkum and Karakum. The region is in the steppe zone, in the western part of the Khorezm oasis and in the southern part of the Aral Sea, 100 m above sea level. The relief consists of a low plain. It is the old Amudarya delta and consists of river sediments. The western and southwestern parts connecting with Karakum are covered with sand. Of the minerals, there are limestone, sand, clay and other building materialsn, [24], [25], [26]. The study of the route covered all districts of the Khorezm region (Figure 1).

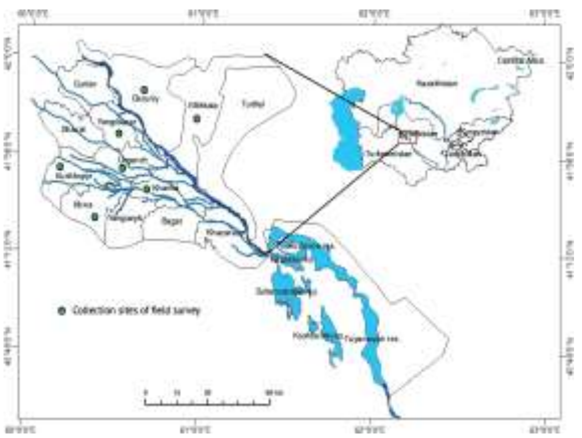

Fig. 1: Location of Khorezm region

Methods. Route studies covered almost all regions of Khorezm egion. Termites of the genus *Anacanthotermes* were collected using common entomological methods and the Exterra device. The insects were collected every year in spring, summer, autumn and winter. The termites' distribution in the natural and urban zones of Khorezm region. was determined with the help of GPS.

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When collecting the samples the inspected the galleries in termitaria, mud structures and the soil surface. Captured at least 50-100 specimens of termites (larvae, nymphs, soldiers, workers and imagos) in every gallery. The gathered a total of 10,525 individuals of two termite species, *Anacanthotermes ahngerianus*.

Wood materials were taken as an indicator of termite infestation as their clay plaster formation. When the mud plastered materials were unplastered, termite marks were seen inside them. The type of wooden parts of damaged houses was analyzed. The type of wood the logs were made from was determined by asking the owner of the house and comparing them to logs from a known species in the laboratory. To determine which types of wood are most affected, 10 boards of 20x30cm of each type of tree were prepared in the laboratory from *Populus, Ulmus, Salix, Aleagnus, Pinus,* and *Betula* trees and installed in 3 replicates in buildings where termites are common. Samples were examined after 1 year. Found to be infested with termites.

We selected 586 specimens for microbiological analysis with the purpose of determination of the termites' microflora using the common mycological methods, [8]. Samples for microbiological analysis were taken from damaged specimens and wooden parts of the building and analyzed in the laboratory. Nutrient media for microorganisms were prepared in the following order:

The media was prepared by mixing 10 ml of Chapek concentrate with 1 gm of K_2HPO_4, 30.00 gm of Sucrose, 17.5 gm of Agar and the volume as completed to 000 ml by Distilled water. The medium was autoclaved at 121ºC and 15 bar for 15min Microbiological analyzes and sampling procedure, [27], [28]. It was carried out based on the methods presented in the literature. The discovered cultures were identified on the basis of micromorphological characteristics and using the automated microorganism identification system Vitek-60 (manufactured by BioMereux) [1]. We obtained the biomass and propagated entomopathogenic fungus using bioreactor Bioengineering AGat the laboratory of the Khorezm academy of Mamun.

Morphological characteristics of fungi were compared with the species present in the laboratory collection and compared, [27], [29], [30], based on photographs. Wood's chemical composition was determined according to the methods described in, [31], [32].

3 Results and Discussion

We conducted research in 2022-2023 to determine which types of trees cannot be used as building materials. For this purpose, tree pieces placed in termite nests were counted after 1 year. It was observed that the inner part of the wooden samples was damaged more at first. It was observed that the part of them covered with mud was carried away by termites. When their outer parts are smeared with mud, it means that they are infested with termites. Since termites are secretive organisms, they live a more active life under watered clay. It was observed that the wooden samples were also plastered with clay plaster (Figure 2).

Fig. 2: Specimens of Ropulus tree infested by termites (with mud plasters removed**)**

You can see a picture (Figure 3) of a board made of *Poplus* wood plastered with mud by termites. It was found that termites were carrying boards to their nests under mud plaster. In other parts of this log house, materials made from different types of trees were used. Termites damaged only boards made of poplar wood (Figure 3 a,c). It was found that when the material made from the *Salix* tree was used to cover the building, only that wood was damaged (Figure 3c).

a **b** **c**

Fig. 3: Damage by termites to flooring materials made from *Populus* (a,c) *Salix* (b) trees

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The degree of damage was studied on the example of the wood parts of the trees and on the pieces of trees prepared in the laboratory of different species (Table 1).

Table 1. Damage rate of wood chips in termite nests (%)

№	Studied tree species	Degree of damage to samples	Degree of damage to the wooden part of the house
1	*Salix*	86,6±6	93,3±5
2	*Populus*	50,0±4	90±5
3	*Aleagnus*	10,0±2	33,3±3
4	*Ulmus*	6,6±0.8	16,6±2
5	*Pinus*	6,6±0.7	13,3±2
6	*Betula*	0	3,3±0.8

The vast majority of damaged trees have previously undergone some degree of moisture damage. It was found that 93.3% of the materials made from *Salix* trees, and 86.6% of the experimental samples were infected. The wooden parts of the building, made of *Populus* trees, were 90.0%, and the pieces placed as samples for the experiment were damaged by 50.0%. Materials from *Aleagnus* trees were 33.3% infected, while experimental samples were 10.0% infected. *Ulmus* trees prepared from locally grown trees were observed to be less infected than others. It was observed that 16.6% of the materials made from *Ulmus* trees used in the construction of the building were damaged by 6.6% of the samples placed for the experiment. Materials made from pine trees are widely used locally. 13.3% of the wooden materials in the building made of this tree, 6.6% of the experimental samples were damaged. Among the studied wood materials, the materials made from *Betula* tree were the least affected, accounting for 3.3%. The samples put for the experiment were not damaged at all. Pure cultures of fungi that appeared under the influence of moisture in termite-infested trees were isolated and their morphological characteristics were studied (Figure 4).

Fig. 4: Morphology of a common fungus in termite-infested wood

One of the fungi isolated from the wood material 3 colonies of Figure 4 A-B, gray conidiabands short, simple, olivaceous. Conidia are 3-6 cross-barred, olive or dark brown, collected in a chain, easily separated. Their size is 30-50x14-19 μm, 17-22x10-20 μm. Because of this, we found them to be immature fungi belonging to the genus *Alternaria*. The second fungus 4 pictures S-D Conidia bands are simple, some of them are bud-like, straight, slightly bent base thickened towards the top, shiny light brown, up to 200 μm conidia are one-celled 12-47x4-10 μm elliptical shape, it is a fungus belonging to the genus *Cladosporium* we found.

Discussion

It has been studied that termites cannot digest plants independently, the digestion process takes place with the participation of symbiotic microorganisms living in their intestines, [33], [34]. When feeding young larvae, worker termites use plants with special fungi. Some of these fungi enrich food with various proteins and vitamins, while others participate in their digestion, [9]. In the colon of termites, several systematic groups of hermitian animals were found, [35]. The high importance of the bacteria in their intestines in termite feeding can be assumed from the fact that they are found in the substrates where termites feed, [36]. When their nests were dug up and studied, it was found that many mold fungi were found in the chambers. These fungi are mostly found in plant fragments collected as food reserves for termites (Figure 4c). In different termites' nests we discovered that the most common were microorganisms from the genera *Aspergillus* and *Penicillium*. In some cases, we found micromycetes from the *Alternaria alternate* and *Cladosporium brevicompactum (*Figure 5).

Fig. 5: A-Colony of white fungal colonies in termite nest feed stock. B-Fungus-free termite nest feed stock.

These fungi enter the termites' intestines with food and participate in the digestion process. Food is excreted alive in their excrement without being destroyed in the digestive system. These fungi are involved in the decomposition of substances resistant to the action of enzymes that are difficult to digest in the intestines of termites.

The content of lignin substances, which are difficult to decompose by enzymes and microorganisms, and the amount of cellulose, which termites happily feed on, in the composition of wood materials was studied. It is presented in Table 2.

Table 2. The content of cellulose and lignin in wood materials (% of the dry mass of the plant)

№	The name of the wood material	Cellulose	Lignin
1	*Salix*	57,3 ±0.5	20.1±0.3
2	*Populus*	53.1±0.3	22.3±0.2
3	*Aleagnus*	50.1±0.2	23.7±0.6
4	*Ulmus*	44.3±0.2	25.2±0.5
5	*Pinus*	40.2±0.4	36.2±0.2
6	*Betula*	36.4±0.3	41.2±0.3

The amount of cellulose and lignin in the wood material is also considered as one of the factors that determine the susceptibility to damage by termites, because termites like wood decayed by microorganisms, especially fungi. It has been studied that termites cause more damage in places with high humidity, [13]. High humidity accelerates the process of decomposition of wood materials by fungi and other microorganisms and the process of reproduction of microorganisms, which increases the susceptibility of materials to damage by termites. The rate of decomposition of wood materials by microorganisms depends on the substances contained in them. For example: some compounds of lignin can inhibit the growth of microorganisms, [8], [37], therefore, wood with a high lignin content is less susceptible to termite damage. The lignin in the building is gradually decomposed by the microorganisms that keep the wooden parts of the building constantly moist, [38], lignin-degrading fungi have been identified, [39], [40], [41], [42], [43]. Lignin decomposition processes are very slow, therefore, even trees with a high content of lignin, which have been in moisture and sufficient temperature for a long time, can begin to be actively decomposed by cellulose-decomposing fungi and damaged by termites. Lesser amounts of lignin can be broken down by microorganisms in termite guts, [34], [44], [45], [46]. In addition to lignin, the presence of substances that reduce the activity of microorganisms in the wood made from trees belonging to the genus *Betula* has been determined, [46], [47], [48]. Building materials made from this wood are less likely to be damaged by termites due to the presence of substances that inhibit the activity of microorganisms. In our experiments, it was found that these wooden materials are damaged in very old houses that are not protected from rain.

4 Conclusion

Termites, when choosing food, first found wood parts that had been exposed to moisture and fungi and fed on them. For this purpose, when wood materials are decomposed by fungi, termites first damage that wood material. In the conditions of Uzbekistan, wood materials made from *Poplus* and *Salix* trees are prone to damage by termites. It was found that wooden materials made from imported *Pinus*, *Betula*, and *Ulmus* trees growing in Uzbekistan are less damaged. In the conditions of Uzbekistan, we recommend not to use building materials made from *Salix*, *Populus* trees in areas where termites are common.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

Rasul Ruzmetov and other authors conceived of the presented idea. Zafar Matyakubov developed the theory and performed the computations. Other authors verified the analytical methods. All authors discussed the results and contributed to the final manuscript. All authors contributed to the article and approved the submitted version.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

No funding was received for conducting this study.

Conflict of Interest

The authors have no conflict of interest to declare.