Termites, Their Damage, and Methods of Control

by

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PREFACE

The idea for my thesis originally came from a short course in forest entomology from Professor W. J. Chamberlain. Since I took this course I have been confronted with the problem of termite control several times.

While visiting friends in Los Angeles, California, I discovered that their home was infected with termites, and I helped them to plan the method of eradication.

In July of 1946, I found damp-wood termites in a summer cottage near Coos Bay, Oregon. In this case the insects had done their job so well that it would have taken extensive and expensive repairs to have restored the dwelling to its former status, so the termites were left to proceed with their destruction.

Though I have come across numerous circulars and bulletins on the subject of termites, I found that the majority of these are mere repetitions, they present the same material over and over again. It is this writer's opinion that the University of California's Agricultural Experiment Station Circulars give by far the best presentation of the termite problem.
Though the topic of termites and their destructive work may sound rather dull and insignificant, it has proved a fascinating subject to the author.
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TERMITES, THEIR DAMAGE, AND METHODS OF CONTROL

INTRODUCTION

Termites, popularly called white ants, eat cellulose such as the fibrous structure of wood. The damage which they do to wooden structures and other cellulose material is conservatively estimated at $40,000,000 a year. No section of the United States is immune to their attack, and few species of wood resist them unless treated.

Contrary to popular opinion, termites are not "new" insects imported from the tropics. They have been present in this country for centuries. But it is only lately that the general public has become aware of them as destructive insects. As the forests are gradually being removed and the termite is being deprived of its natural habitats, they seek other sources of wood for food and shelter.

Because these termites shun light and remain hidden from view, the damage which they accomplish often reaches an advanced stage, with the infested lumber becoming structurally weak and unsafe, before the termites are even discovered.
The serious damage which termites cause to a great variety of wood products can be prevented. This report gives a description of these insects, their habits and damage, and shows how losses from this source may be avoided.

I. BIOLOGICAL INFORMATION CONCERNING TERMITES

Description of termites.

Termites or "white ants," order Isoptera, form a small group of insects very destructive to wood and wood products.

Termites are small, flat, soft-bodied insects with biting mouth parts; with or without eyes; and usually pale grayish, light, yellow-brown, or black in color. They have gradual metamorphosis, developing from eggs through nymphal forms to a number of specialized castes: workers, soldiers, or sexual adults. Termites have a horny outer covering, which is shed or molted at various times during development to allow for increase in size. This covering is much thinner in the termites than in insects living an exposed life. Most of the castes are wingless, but the migrating sexual forms or alates, which are usually dark brown or black, develop two pairs of
similar long, narrow wings, which are folded flat over the
back when at rest. When these adults establish a new
colony the wings are broken off, and only the stubs are
left.

The termites as a group are very ancient. Their
nearest relatives are the cockroaches, from which they
have probably been distinct for many millions of years.
Fossil termites, of the very genus whose species are
doing damage all over the United States, have been found
in deposits known to be millions of years old.¹

Termites are not ants, nor as pointed out above,
are all species and forms white. The term "white ant"
should be eliminated as it leads to serious errors in
identity, habits, and methods of control.

Living habits.

Termites are social insects, living in colonies, and
dividing their essential activities among specialized forms
or castes.

Not only are termites social, living in colonies, but
each colony lives entirely shut off from the outside world

¹. California circular No. 314, p. 5
and from interconnection with other colonies of termites, even of the same species. The dwelling of the colony consists either of intercommunicating cavities within wood or of connecting passageways within both the ground and the wood.

Termites thus live in darkness, in narrow passageways, where the temperature, the moisture, and probably the oxygen pressure are to some extent under their control.²

Food habits.

The principal food of termites is cellulose, obtained from wood and other plant tissues. All castes except the soldiers have mandibles adapted to cutting off fragments of wood.

The wood-inhabiting termites have in their intestines a very remarkable assemblage of small plant and animal microorganisms including Protozoa, spirochaetes, and bacteria. Each species has been found to have its own particular group of microorganisms, which may be found in the intestines of every member of the colony. It is believed

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2. California circular No. 318, p. 5
that these serve the purpose of helping to digest the cellulose taken in by the termites and making it available for use.

They also have a number of fungi associated with them. These grow upon the walls of their tunnels, upon the fecal pellets, and are found in the intestine of the termites, indicating that they form a common element in their diet. To what extent these fungi help in breaking down the wood and making it available for food has not been fully determined, but it is probable that some such relationship exists.\(^1\)

**Grooming habits.**

An important habit of termites is the constant licking or grooming of their bodies and the bodies of other members of the colony. This is extremely important in the dissemination of dust poisons through the colony. It has been found that if one individual is dusted with white arsenic and placed with 149 others in a space of 20 square inches all will be dead in about 30 hours.\(^2\)

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1. *Forest Insects*, Doane, Van Dyke, Chamberlain, and Burke, p. 411
2. California circular No. 318, p. 9
Termite castes.

Termites have developed a system of division of labor. Each colony consists of various kinds of individuals especially fitted in form and by instinct to carry on diverse activities. These different forms of individuals are known as castes. There are three castes: reproducitives, workers, and soldiers. Certain termites have no specially developed workers, but the grub-like young individuals of the other castes, known as nymphs, do the work of the colony.

The reproductive caste. The reproducitives are male and female termites which are much more like ordinary insects than are the other castes. They emerge as winged reproducitives, or alates, at definite seasons of the year in all normal ten-month and older colonies. The winged reproducitives are developed from eggs in a relatively few weeks preceding their flight. So long as they remain in the colony, the members of this caste are sexually immature; it is only after they have emerged, completed their flight, and mated that they become functional reproducitives. These alates either dig into the earth, or wood in the earth, or into wood above the ground to become primary kings and queens of new colonies.
The worker caste. The workers are by far the most numerous members of a termite colony. They are wingless individuals with soft bodies and large unchitinized heads. Since they always live within the burrows and are never exposed to the light, they are pale and usually blind. They do most of the work in the colony, their duties consisting of excavating the tunnels, and feeding and caring for the young, the king and queen, and the soldiers.

The soldier caste. Wingless, blind, and sterile, the soldier, never-the-less, is an awesome sight to behold. The huge, rectangularly shaped head, covered with a hard, thick armor and armed with large, elongated, and grotesquely toothed jaws are the colonies means of defense.

These soldiers function chiefly in cases of emergency, as when the colony burrows are opened by some chance, and the termites are attacked by their arch enemies, the true ants. The soldiers' huge head blocks up the passageway, while their jaws destroy the enemy. Protected from flank attack, the soldier is extremely effective, but once he is outflanked, his slow movements and unprotected body make him easy prey for the true ants.
Distribution of termites.

Termites are world wide in distribution within the limits of the tropical, sub-tropical, and temperate zones. More than twelve hundred species are known. There are 50 species of termites in the United States, 13 of these species are found in the Pacific Coast States, and 3 species are found in Oregon. Termites are divided into three distinct habit groups which have been given common names as follows:

1. Damp-wood termites.
2. Dry-wood termites.
3. Subterranean termites.

As both damp-wood termites and dry-wood termites are wood dwelling and never burrow into the earth, they are often grouped together and called non-subterranean termites.

Damp-wood termites.

Distinguishing characteristics: Our largest termites; winged forms reddish-brown or black-brown, with brown wings, about an inch or more in length with wings; wings twice as long as body. Soldiers about three-fourths of an inch in length with large reddish-brown heads and massive black mandibles. Nymphs a light yellowish gray-brown, abdomen mottled with dirty gray-brown, head and abdomen large, head considerably wider than thorax, abdomen wider than head. Unused
portions of ingested wood deposited as large oval pellets.

The damp-wood termites are confined to western North America, ranging along the Pacific Coast, from British Columbia to Lower California. These are the largest termites and are common in logs and moist or decaying wood in or near the ground. They do not enter the ground, and while sometimes found working in sound wood, are dependent upon a constant moisture supply.

The large brown winged males and females escape from the colony on the evenings of the warmer days in September. They swarm in great numbers and in some localities are called "rain bugs" because of the apparent relation of their swarming to the early rains. They are strong flyers and reach considerable heights, as is evidenced by an attack on the wet wood of a water tank on top of a seven-story building.

**Dry-wood termites.**

Distinguishing characteristics: Intermediate in size, smaller than the damp-wood termite and larger than the subterranean termite. Winged forms about one-half inch or somewhat more in length, with wings. Soldiers about three-eights to one-half inch in length; head reddish or brown, about as
wide as rest of body, antennae short; mandibles black, toothed. Nymphs grub-like, pale whitish-gray with variously mottled abdomens; abdomen long and about the same width as head. Pellets about half as large as those of the damp-wood termites.

The termites of this group live in dry sound wood, of trees, poles, posts, timbers of derricks, and of buildings, from Northern California south and southeast into Arizona and Mexico. They rarely if ever enter the ground and require no special moisture supply as do the damp-wood termites.

The alates of this species swarm in small numbers during the months of August, September, October, and November. The winged males and females are strong flyers, rising to considerable height and covering distances of some hundreds of yards. They seldom enter a smooth exposed surface, but seek cracks and crevices or crawl between boards to gnaw into one of them. They dig out a round hole which they plug up soon after entering. They will enter exposed new lumber at this time and care should be taken to protect lumber in the pile at this season.

Subterranean termites.

Distinguishing characteristics: Very small in size,
winged forms about one-half inch in length with the wings; soldiers and workers less than one-fourth inch in length. Soldier head light yellow, elongated, quadrangular, mandibles of soldiers straight save at tip, untoothed. Thorax of worker considerably narrower than head and abdomen.

This species is common throughout most of the eastern half of the United States and along the Pacific coast into Oregon, but are abundant from Massachusetts south along the Atlantic coast and the Gulf of Mexico, in the Ohio River Valley, in the southern part of the Missouri and the Mississippi River Valleys, and in Southern California.

The subterranean termites live partly or almost entirely within the ground and always maintain a ground connection. They attack sound or decaying wood in or on the ground or build covered runways over impenetrable foundations to reach wood above the ground. Their feces are deposited in the form of liquid drops, which make characteristic spottings in their galleries, but never in the form of pellets as in the case with the wood-dwelling termites. They wall off some of their galleries with compacted masses of earth particles, wood fragments, or debris, cemented with saliva or fecal deposits. This frass is diagnostic of the earth-dwelling termites as
contrasted to the wood-dwelling termites.

This termite attacks wooden structures of all kinds, being responsible for the entire termite problem in many states and a major portion of it in all others.

The small white workers and soldiers of this species are to be expected in almost any piece of untreated wood long left in or on the ground in the coast areas, lower mountain slopes, and along the margins of the central valleys.

The males and female alates are black with grayish wings. Their swarming occurs on the first clear day after each of the first few rains of the autumn. If it is warm enough they fly some distance, toward the sun if not carried elsewhere by the wind, drop to the ground, lose their wings at a preformed basal joint, and assort in pairs. The pairs then seek openings in the earth or damp decayed wood or crevices under wood on the earth and found new colonies.

**Indications of termite presence or attack.**

Termites live a concealed life, but they give external indications of their presence and activities in four important ways:

1. By the failure of wood due to their attacks.

2. By the emergence of the swarming alates.
3. By the characteristic fecal pellets of the wood-dwelling termites dropped from their workings.

4. By the characteristic covered runways and tubes, built by subterranean termites from earth to wood or from wood to earth.

**Signs of the damp-wood and dry-wood termites.**

The work of the wood-dwelling termites is often indicated in its later stages by weak points in the wood where the galleries come close to the surface. Deeper galleries may be detected by tapping the wooden structure.

Fecal pellets present in the wood or near it, indicate that it is the damp-wood or the dry-wood termite rather than the subterranean termite, since the latter does not produce pellets. The pellets of the damp-wood termites are larger and less regularly formed than those of the dry-wood termites.

**Signs of the subterranean termites.**

Aside from a general failure of the wood, the work of the subterranean termites is indicated either by a frayed-out condition of the wood at ground level or by the characteristic earthen-like covered runways or tubes.

Plugs and other masses of earth-like frass within the galleries or along the surfaces of wood attacked are characteristic of this termite.
Dry rot.

Sagging floors and walls and the consequent difficulties with doors and windows are the most commonly noted results of wood failure in buildings. Most wood failure is generally attributed to dry rot. In many cases this failure is actually due to the attacks of termites of various types, and it seems possible that some of the actual dry-rot damage is due to the introduction and spread by the termites of the fungus and the moisture necessary to its development.¹

II. ECONOMIC IMPORTANCE OF TERMITE DAMAGE

While termites damage a great variety of wooden structures, stored books, documents, paper, and other material, the principal and most serious damage is to foundation timbers and the woodwork of buildings. To place a monetary value upon the total damage that this insect does each year is a difficult problem, but Dr. Thomas E. Snyder, Senior Entomologist of the United States Bureau of Entomology and Plant Quarantine, has placed the total loss at more than $40,000,000 annually.

The so-called "subterranean termites" cause the major part of the damage throughout the United States, however,

¹. California circular No. 314, p. 22
here in the Pacific Northwest the damp-wood termite is becoming of increasing importance from an economic standpoint. To cite one example, in 1936 The Portland Dock Commission reported $25,000 damage to Municipal Terminal No. 4 by the attacks of the damp-wood termite.

As more and more of the forests and woodlots are converted to farmland and suburban housing areas the termite, driven from its natural habitat, will become of increasing importance as it invades man-made structures.

III. METHODS OF CONTROL

Preventive measures in new construction.

The most satisfactory method of termite control is prevention of termite attack. Proper construction of buildings is the best insurance against attacks by termites.

**Destruction of breeding places about the building site.**

If buildings are to be constructed on recently cleared woodland, the ground should be cleared of all wood before starting construction. All refuse wood, stumps, roots, etc. should be burned immediately.

Additional protection can be gained if the ground of the building site is treated with one of the following chemicals:

1. coal-tar creosote and fuel oil, mixed in equal parts.
2. a five per cent solution of pentachlorophenol in fuel oil.

3. a ten per cent solution of sodium arsenite.

Preliminary tests have shown that, when properly applied, these chemicals may be expected to give protection for at least five years.¹

Proper construction of buildings.

Termites will infest not only old buildings but also improperly constructed new buildings. It is not the age of the building but the manner in which it has been constructed that renders it liable to attack.

Insulation.

Complete insulation from the ground of all untreated woodwork of buildings is the only effective permanent remedy against attack by subterranean termites. This insect requires more moisture than seasoned wood will furnish and the only important source of supply is the ground. When contact with their moisture supply in the earth is cut off, the subterranean termite quickly dies.

Foundations, supports, etc.

In planning a foundation wall, whether or not a cellar

¹. Farmers bulletin No. 1911, p. 34
is to be used, keep the ground level on the outer wall at least six inches from the top of the foundation. To prevent subterranean termites from reaching the woodwork of buildings from their tunnels in the ground, the foundations of buildings should be constructed entirely of brick, concrete, or timber impregnated with coal-tar creosote. No untreated wood should come in contact with the ground.

Wherever foundation walls meet or intersect they should be adequately tied together with steel rods. This is to prevent the opening of joints or cracks due to shrinkage of concrete during setting.

If wood posts are used the bottom of the post should never be below the finish floor when the floor is of concrete.

Pipes that come up through a foundation or concrete floor into a concealed space should fit tightly into the concrete. No openings, however minute, should be left in the concrete around the pipes.

Window sills and frames in the basement should be laid over concrete and the woodwork should not come in contact with the ground.

Metal termite shields.¹

Metal termite shields should be considered only as a

¹. This section taken from Farmers bulletin No. 1911, p. 27
supplement to good construction and not as a substitute for it. Where it is desired to use every possible means of avoiding infestation by termites it may be desirable to use shields as an additional precaution. If used, they must be very carefully designed and installed, otherwise they will be ineffective. The installation of termite shields should never be regarded as an excuse for allowing or accepting construction practices that favor the development of a large population of termites in the soil beneath or adjacent to a building.

Recent experience has shown that the great majority of shields now in use have been poorly designed and incorrectly installed, giving the owner a false sense of security. It should be remembered that shields, even when properly installed, will give protection only during the period that the metal lasts.

Recent laboratory experimental work with various types of termite shields has shown that no shield developed thus far is absolutely effective in preventing the passage of termites. A properly made and installed shield will, however, force the termites into the open where they can be seen and thus act as an effective barrier to hidden attack. Termites
may construct tubes on the lower surface of a shield, and occasionally one of these tubes will be extended around the edge and up and over the upper surface. Frequent inspection for the presence of such tubes, therefore is essential.

**Avoid dampness.**

Complete dryness of foundation timbers and basement walls and flooring is an important aid in rendering buildings safe from attack by both subterranean and damp-wood termites. At least two square feet of openings for each 25 lineal feet of exterior foundation wall is recommended. A deep air space should be left between the ground and wooden flooring. An air space should also be left between the concrete floor and a wooden floor laid over it, and the concrete floor should be laid on a gravel base, which will prevent it from cracking.

**Form lumber.**

All wooden forms on foundations and chimney bases should be removed from masonry work, and grading stakes should be removed before laying concrete floors.

**Remedial measures in old buildings.**

**Location of damage.**

The annual emergence of large numbers of the winged termites

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1. California circular No. 318, p. 62
reproductives is an indication as well as a warning that the building is infested, and the point of emergence indicates the approximate location of the infested timbers. Frass and earth thrown out of crevices through which the insects emerge are also evidences of their presence. Another warning is the presence of branching shelter tubes of small diameter made of earth mixed with finely powdered wood. These tubes are found on foundation timbers, or over the surface of stone, concrete, or other impenetrable foundation material through which the insects travel from the ground to the woodwork. These tubes should be broken off and the ground where they originate chemically treated. (see p. 15)

In the case of non-subterranean termites, which infest wood directly, evidences that they are damaging wood are the impressed pellets of excrement which are expelled from the wood. Other evidences are the holes, similar in size to BB shot, where the insects entered the wood.

Disconnecting wood from the ground.

Subterranean termites infesting beams or other wood will die out if the wood is disconnected from the ground. Knowledge of this fact will save time and expense, especially in the case of old frame buildings, where extensive
repairs would be unwarranted. Disconnecting untreated foundation timbers from contact with the soil will also cause the death of subterranean termites in the other woodwork and stored material in the building. These timbers need not be removed or replaced unless seriously weakened structurally.

Replacing with concrete.

Concrete floors should be substituted for wood. Untreated beams penetrating through concrete floors into the earth and the lower parts of door jambs and casings, should be cut off at least six inches above the ground or floor and replaced with cement plinths. The plinths should project one-quarter of an inch beyond the jambs and casings. Wooden thresholds, window sills, and stools in the basement or ground floor should be removed and placed on concrete.

Chemical treatment of infested wood.¹

Many attempts have been made to apply chemicals to wood in place in buildings, with the object of controlling existing termite infestations and preventing future damage. No effective control by spraying or fumigation has proved to be possible.

¹. Farmers bulletin No. 1911, p. 37
It is not considered practical to obtain effective penetration by injecting chemicals under pressure through bored holes without boring so many holes that the strength of the timber is seriously weakened. Such methods of control are therefore not recommended.

**Treated lumber.**

Most of the wood-preserving methods now in use may be classified roughly as either nonpressure processes, which are carried out without the use of artificial pressure, or pressure processes, in which the wood is placed in a treating cylinder or retort and impregnated with preservatives under considerable force.

Treated wood which is to be in contact with the ground should contain a preservative which will not be leached from the timber by the action of rains or ground moisture. For timber in contact with the ground the most effective chemical preservative treatment is pressure impregnation with coal-tar creosote. For wood not in contact with the ground, pressure impregnation with pentachlorophenol or zinc chloride has proven effective. Dipping timber in a vat containing boiling preservative and allowing it to remain for several hours while the liquid continues to boil is a method which will give some
protection. Cold brush applications are not effective and hot brush treatment only of slight protection.

The initial cost of non-pressure treatment may save a small amount of money but in the long run the cost of maintenance and replacement will far exceed the difference in cost of thoroughly impregnating the wood by a pressure process.

In regions where dry-wood termites are prevalent it is a good idea to impregnate even the interior woodwork with a preservative.

Wood-pulp products, such as the various wood-fiber boards, can be protected from termite attack by adding certain poisons, zinc meta-arsenite or pentachlorphenol, to the pulp in the course of manufacture.

Preventing termite attack on posts and poles.¹

In regions where the dry-wood termite is not prevalent a creosote butt treatment will protect a pole or post against attack from damp-wood and subterranean termites. Where these products are subject to the attack of dry-wood termites, a full-length pressure treatment with creosote will prevent attack.

¹. California circular No. 318, p. 48
SUMMARY

Termites cause an estimated damage of over $40,000,000 annually to crude and finished forest products. As more and more of the forest lands are converted to agricultural land and housing areas and the termite is forced to find other sources of wood for food and shelter they will become an increasing problem.

The subterranean termites cause the major part of the damage throughout the United States, but the damp-wood termite is of significance in the Pacific Northwest.

Termites are especially injurious to foundation timbers, the woodwork of buildings, and material stored in buildings to which they have gained entrance. Damage to timber in contact with the ground is especially serious in the Southern, Southwestern, and Pacific Coast States.

The best insurance against termite attack is by proper construction methods. These insects can be eliminated where already established in buildings by removing wood in contact with the ground and replacing it with chemically treated wood.

Since subterranean termites always require access to damp earth, this source of moisture should be shut off. The insects will then be unable to extend their galleries farther and will perish.
In regions where dry-wood and damp-wood termites are common, all exposed wood should be chemically treated. All wood in contact with the ground should be impregnated under pressure with coal-tar creosote. For wood not in contact with the ground impregnation with pentachlorophenol or zinc chloride will prevent termite attack.

General Recommendations:

Eliminate all waste wood. In the case of alteration and repair and in new construction, remove stumps, roots, scraps, refuse, shoring timbers, and refuse wood of all description.

Remove all form lumber. All wooden forms on foundations and chimney bases should be removed from masonry work, and grading stakes should be removed before laying concrete floors.

Burn removed wood containing termites. In repair work it is not necessary to remove all wood that has been attacked by subterranean termites unless it is in contact with the ground or has been so damaged that it is structurally unsafe. If subterranean termites are shut off from any source of moisture supply they will soon die. Removed wood containing termites should be burned at once.

Insure adequate ventilation. Adequate ventilation under the first floor should be provided. At least two square feet of
openings for each 25 lineal feet of exterior foundation wall is required. Where there are spaces under floors near the ground they should be excavated so that there will be no soil within 24 inches of the joists. Cross ventilation should be provided.

Make periodic inspections. In existing structures careful inspections at frequent intervals will greatly reduce the likelihood of termite damage. Such inspection alone or in conjunction with other inexpensive prevention methods mentioned above will in many cases give adequate protection.
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