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SUPPLY ENGINEERING DIVISION
U. S. NAVAL SUPPLY RESEARCH & DEVELOPMENT FACILITY
NAVAL SUPPLY DEPOT
PAYSONE, NEW JERSEY

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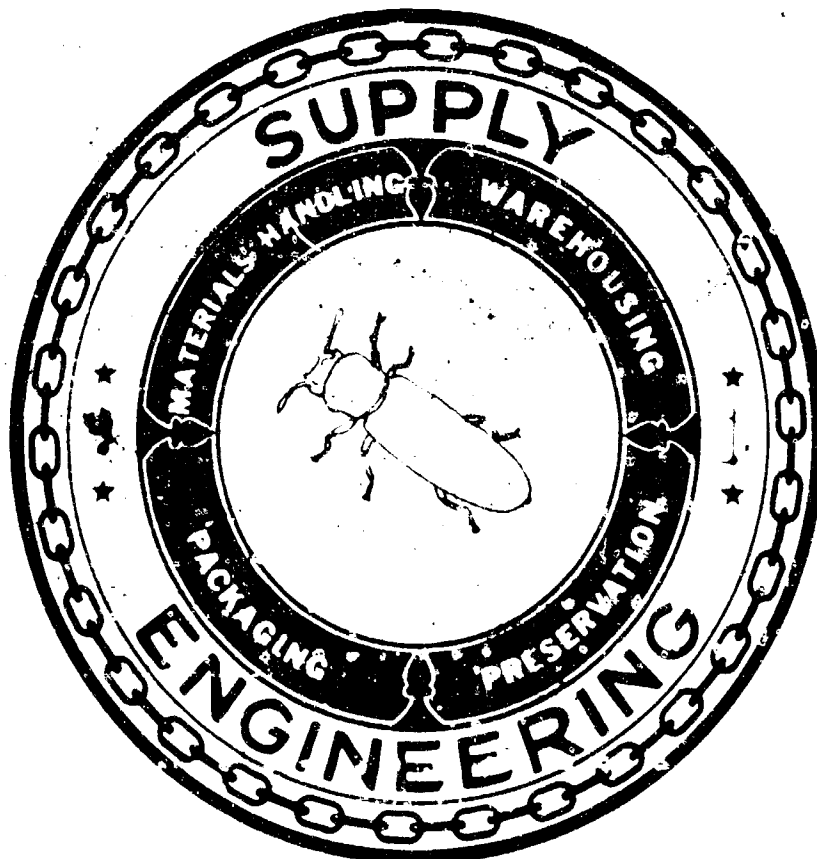
INFORMATIONAL REPORT ON THE LYCTUS POWDER POST BEETLE

PROJECT GROUP #003-001
SEDR - 006

20 December 1949



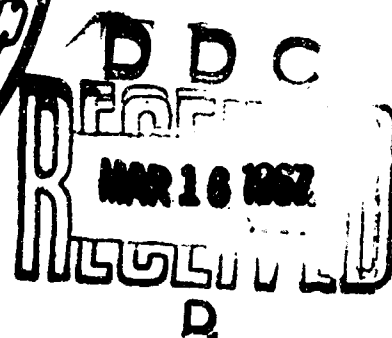
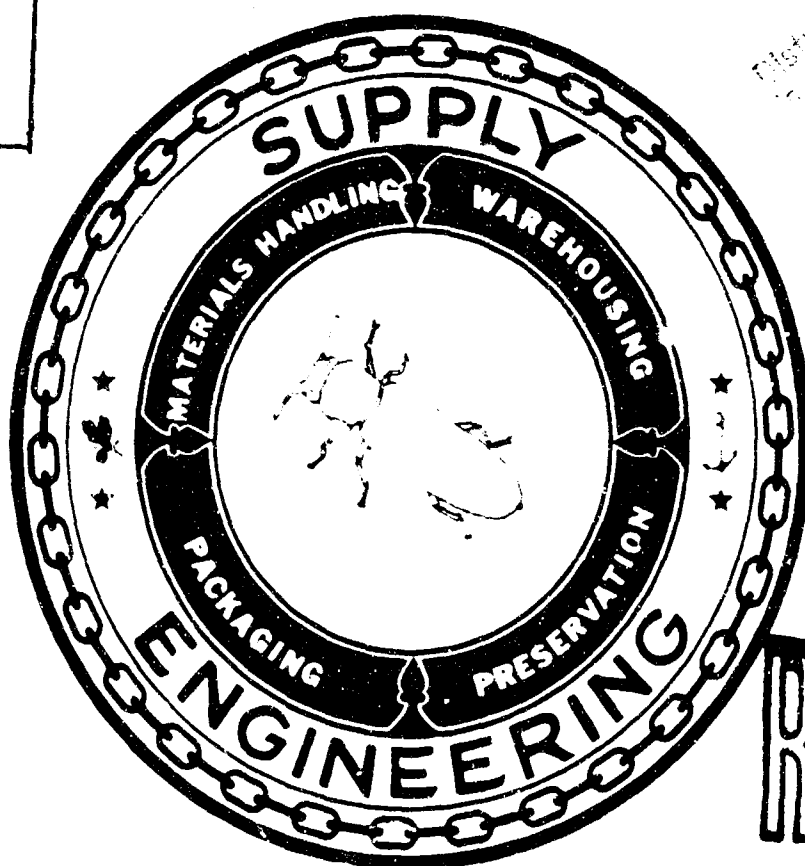
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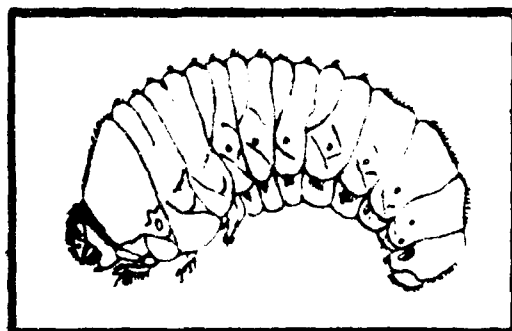
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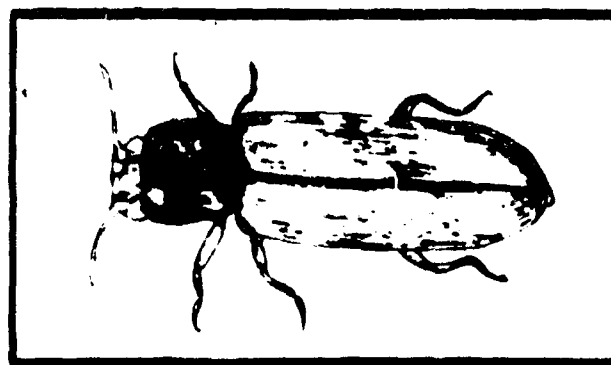
U S Naval Supply Research & Development Facility
Bayonne, New Jersey



Egg of a powder post beetle, *Lycus planicollis*, in pore of wood; pore opened to show egg. Highly magnified. (After Snyder).



Larva of a powder post beetle enlarged. (After Craighead and Boving)



Winged adult of a powder post beetle *Lycus planicollis*. Greatly enlarged. (After Snyder)

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INFORMATIONAL REPORT
ON THE
LYCTUS POWDER POST BEETLE
PROBLEM

PART I

LYCTUS PLANICOLLIS

INTRODUCTION

Mr. R. H. Smith, Entomologist of the Department of Agriculture's Bureau of Entomology and Plant Quarantine, Agricultural Research Center, Beltsville, Maryland, visited this activity on 6 and 7 December 1949 for conference and consultation on the problem of infestation of pallets and other hardwood implements by the Lyctus Powder-Post Beetle.

During his visit, Mr. Smith, along with Messrs. Toscano and Brennan of this activity's engineering staff, made a survey of representative storage areas at NSD Bayonne to determine the degree of infestation by Lyctus.

The following report is divided into two parts: the first part contains background information on the Lyctus Beetle, its life and activities, and proposed methods of control. Much of this information was drawn from current reports submitted to the Department of the Army by the Bureau of Entomology and Plant Quarantine on research work done by the latter in cooperation with the Corps of Engineers; the second part contains details of the findings of the survey along with comments and recommendations.

I. BIOLOGY:

The Powder Post beetle, Lyctus planicollis, is a small member of the order Coleoptera measuring about 3/16 inches in length (adult) and are reddish-brown to nearly black. The adult females lay their eggs in the pores of suitable wood, and the larvae which hatch from them are small (up to 1/8 inch in length) white grubs. The larvae burrow through the wood parallel to the grain, digesting the wood to a fine flourlike powder. The larvae winter in the wood, changing to pupae (the resting stage) early in the spring. During the pupal stage the metamorphosis occurs, and in late spring or early summer the adult beetles emerge and fly about. The adult females soon lay their eggs and die.

In buildings such as warehouses, the life cycle may be less than the ten to twelve months usual in natural out-of doors conditions and frequently several staggered cycles may be co-existent.

Under ideal laboratory conditions a single, non-recurrent life cycle has been obtained in nine weeks.

II. ECOLOGY:

1. Geographical distribution -

Lyctus planicollis is found in most temperate zones of the world such as the United States and Australia.

In the United States, no section of the country is completely free from the insect. The far northern states, however, suffer less since an extremely cold winter may kill the larvae in wood which is out-of-doors. A subsequent summer may bring a re-infest-

ation, and larvae which are in buildings are usually able to emerge as sources of re-infestation for wood which was exposed to the cold. Damage has been recorded as far north as the state of Maine. The southern parts of the United States, with their more favorable climate do not seem to produce a beetle of higher virulence or of greater destructive potential.

2. Susceptible woods -

Most domestic hardwoods, including hickory, ash, oak, elm, birch, beech, walnut, maple, cherry, locust, sassafras, orange, persimmon, and osage orange are subject to damage.

The attack of the beetle is limited to seasoned, sapwood portions of the various species which contain considerable amounts of starch.

The moisture content of the wood, if below the fibre saturation point, does not appear to affect the degree of susceptibility. It has been recently found that successful attack can be made in wood of extremely high starch content when the moisture content is below 6% but ordinarily successful attack does not occur below a moisture content of 6 to 8%.

Work done by both Australian and American entomologists has proven that regardless of other satisfactory conditions, Lyctus will not attack wood which is low in starch content.

Not much is known of the bio-chemistry of starches in wood. Observation, however, has led to the theory that starches are stored by a living tree in the branches and the outer portions of the trunk, and that this starch is most abundant just prior to and during the winter (dormant)

state. The concentration of stored starches is a maximum in the sub-cambial parenchymous tissue and decreases rapidly, in mature trunks, reaching a non-susceptible level near the eighth previous annular ring (fifth in oak, tenth in hickory). This latter data, however, has been obtained from a limited number of trees so it may not be applicable if a more intensive study were made. In branch wood, however, the concentration of starch may be higher at all points and in small, new aerial growth it may be persistently high through the entire cross section.

The starches which are contained in a living tree are subject to numerous physico-chemical conditions which may alter their chemistry to such an extent that they will not support Lyctus infestations. It has been found that the conditions to which a tree is exposed after cutting have many and various effects on the starch content of the wood. An ash tree found by test borings to contain an unusually great amount of starch was cut, branched, and allowed to air dry to the fibre saturation point, was found to contain practically no starch after it was sawed in the spring of the year.

The increased demand for wood in recent years has led to the practice of utilizing small trees and those parts of large trees which were formerly discarded. The high starch content portion of a tree bole may comprise only the outer inch (measured radially) but a 2" x 4" made from a five inch tree would contain 50% susceptible wood while a similar timber taken from an 8 to 12 inch tree might contain no susceptible wood. Similarly, a board made from a slab or having considerable wane might be 100% susceptible.

3. Parasites and Predators -

At least one natural parasite is known to exist. This is a small wasp-like Hymenopteral braconid, Monolexis Lycti cross, which kills the Lyctus in the wood by depositing eggs in or near the larvae. The eggs of the Monolexis hatch into larvae which attack the Lyctus larvae and eventually pass through the pupal stage and emerge as adults.

The presence of this enemy of Lyctus is not readily discernible until after the first emergence of the adult. At that time, the presence of minute holes (about .025 inches diameter) in the wood betray the activity of the Monolexis parasite.

Although the Monolexis does produce emergence holes, often in considerable numbers, the structural damage is usually small. The presence of this parasite does not preclude Lyctus damage because by the time the Monolexis reaches such a point that the Lyctus is endangered, several seasons may have elapsed and Lyctus has done its damage. A predator Tarsostenus Univittatus Rossi is abundant and can cause appreciable reductions in Lyctus population. It is a beetle about the size of Lyctus. Both the adult and larval stage are predaceous.

III. REMEDIAL TREATMENT:

1. Submergence in water -

If infested wood is completely submerged in water for a period of time long enough to saturate all portions of the wood, the larvae of the Lyctus will be killed. Submergence for a period of four months or over will render the wood immune to attack by converting or leaching out the starch in the wood.

2. Steaming -

Treating infested stock, at either atmospheric or higher pressure, in a kiln at a temperature of 130° F., by introducing live steam is an effective remedy. Wood should be treated for two hours per inch of thickness after all parts have reached the ambient temperature.

Steaming may also become a preventative measure if the treatment is made at such temperatures and pressures and for such lengths of time as to alter the chemistry of the wood starches.

Weakening and discoloration of the wood may result from steaming thus making this process generally impractical.

3. Kiln Drying -

Subjecting seasoned wood to a temperature of 180° F. in dry kilns is also an effective remedy. Lyctus are able to survive the commercial dry-kiln processes; it is necessary to extend these processes by raising the kiln temperature to 180° F. for a short period just prior to removal.

If the elevated temperature is not maintained for longer than an hour the mechanical properties of the wood will not be impaired. However kiln drying of hardwood will not usually prevent subsequent attack by Lyctus.

4. Fumigation -

A thoroughly effective remedy for Lyctus infestation is fumigation at both atmospheric and lower pressure with methyl bromide or Acrylon (a mixture of acrylonitrile and carbon tetrachloride). Large quantities of tool handle stock and Army cots were recently fumigated under tarpaulins

by the Army Engineers with excellent results. Three to four pounds of methyl bromide per thousand cubic feet of space was admitted and allowed to remain 72 hours. At the end of this time no live Lyctus were found and evidence was found that a minor infestation of bostrichid had been eliminated.

Fumigation with either methyl bromide or Acrylon is only remedial and will provide no protection against subsequent attacks.

5. Chemical dips and sprays -

Chemical dips and sprays offer what is probably the best prospect for the control of Lyctus. Many of the chemicals which may be effectively used as remedial measures are of such nature that their biocidal properties are retained and they continue to be effective as preventatives against subsequent reinfestation.

The Department of Agriculture has been conducting extensive tests on remedial chemicals for the past four years. To date, two general groups of treatments have been effective: toxics in petroleum solvents and petroleum base solvents alone. A third group has been generally poor: aqueous solutions, suspensions, or emulsions of toxics. There are, of course, exceptions.

Appendix A lists some of the compounds and mixtures which have been tested or are under test. It should be noted that many of the treatments listed also appear in Appendix B as preventatives. This is because of their retention of biocidal properties over a period of time longer than that required to kill the larvae already present in the wood.

When remedial treatments are applied after emergence holes have appeared, the effect is usually more marked. This is presumably due to the more complete penetration afforded by the holes. Penetration of uninfested wood by liquids is a subject of controversy. The depth of penetration is dependent upon the porosity of the wood, the moisture content, the temperature, viscosity, and osmotic pressure of the liquid as well as the hydrostatic pressure present during application. Colloids, suspensions, and emulsions present a different problem, namely, particle size. Generally, it is advantageous to have a solution with low viscosity and high osmotic pressure. Such solutions are characterized by the use of solvents such as deobase and xylene.

Since remedial treatments, per se, offer no protection against subsequent reinfestation, the use of a preventative which is also effective as a remedy is preferred.

IV. PREVENTATIVE TREATMENTS:

Those treatments which prevent attack by Lyctus can be divided into two categories: those treatments which rely on toxics or repellants that deter oviposition and those treatments which render the wood immune by making it an unsuitable medium.

1. Repellants -

One of the oldest preventatives used in the control of Lyctus is coal-tar creosote. This is both a preventative and remedial measure and has been employed successfully in many applications. However, the residual brown stain and odor limit the field of uses for creosote.

Where the wood was to be used in finished products (furniture, etc.) fillers or paints were used. This treatment was intended to fill the pores of the wood and prevent oviposition. Such things as varnish, shellac, paraffin, boiled linseed oil and lacquers give a certain degree of protection but are generally unreliable because any minute hole or abrasion will permit initial oviposition and the emergence holes will provide fertile spots for subsequent infestations.

As previously mentioned, the increased use of susceptible wood during the war years made the problem more acute and great quantities of work have gone into the development of suitable treatments.

The Lyctus problem was great in Australia where most of the native woods are highly susceptible. The Queensland Forest Service co-operated in the development of an effective treatment which involved dipping boards fresh from the saw in a hot solution of borax or boric acid. While effective, this treatment was not permanent; the borax compound is water soluble and will leach out. Also, the dip must be applied hot while the boards are freshly sawn. These points make the process unduly costly.

With the development of new insecticides such as DDT and benzene hexachloride the researchers have turned their attentions in those directions.

The United States Department of Agriculture has been conducting tests on various chemical dips and sprays for about three years. Appendix B gives a partial list of the formulations tested or under test.

Only incomplete results are available at the present time, but definite patterns appear to be forming. Generally, the treatments can be classified into three groups: "good", "fair", and "poor". This classification is based on the mortality of beetles when placed on treated wood.

In the "good" category are:

5% DDT aqueous emulsion

1% benzene hexachloride in Velsicol AR 50

1/2% benzene hexachloride in Velsicol AR 50

5% DDT solution in Velsicol AR 50 and kerosene

1% DDT solution with pyrethrum in deobase

1% DDT solution with thanite in deobase

when applied as 3-minute dips.

In the "fair" to "good" category are:

5% DDT aqueous suspension

5% Toxaphene in Velsicol AR 50

1% DDT solution in Velsicol AR 50

2% Chlordane in deobase

when applied as 3-minute dips.

In the "poor" category are the solvents xylene, Velsicol AR 50, No. 2 fuel oil, kerosene, and deobase and

2% copper naphthenate in deobase

3.7% pentachlorophenol

5% naphthenic acid in kerosene

when applied as 3-minute dips.

Large scale operations by the Corps of Engineers using a 3-minute dip of 5% pentachlorophenol in No. 2 fuel oil have shown that treatment to be effective.

All of the chlorinated phenols are extremely toxic, producing acute toxemia when taken internally and severe dermatitis on external contact. Elaborate precautions are required when handling penta.

There remains one large problem for which an answer is not yet available. The effects of time and environment on the efficiency of the various repellants are unknown. Tests are presently under way which should yield an answer. After a period of two years many of the chemical treatments still look effective.

One safety factor must be considered when choosing a dip or spray, namely, the fire and explosion hazard. It is generally accepted that a formulation with a flash point under 100°F is too dangerous for general use. An ideal solution would have a flash point in the neighborhood of 140°F.

2. Immunization -

Wood that contains no starch is not susceptible to Lyctus attack. It is therefore evident that the use of poisons and objectionable compounds could be obviated if the starch in wood could be removed or converted into some unattractive chemical.

Starch can be converted by chemical action or by physical conditions. It has been observed that the starch content of wood can be materially lowered by certain conditions during seasoning. Inasmuch as

no positive relation has been established between the conditions prevailing during seasoning and the starch content of the seasoned lumber, investigations are under way by the Department of Agriculture to determine if controlled seasoning can be universally effective and to determine the necessary conditions.

Other investigations are being directed toward the development of suitable chemical (or enzyme) formulations which can convert starch without adversely affecting the physical properties of the wood, and which can be economically applied as a dip or spray. One such compound being investigated is diastase.

If an economical treatment can be developed which will eliminate starch in the wood, the problem will be solved.

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INFORMATIONAL REPORT
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LYCTUS POWDER POST BEETLE
PROBLEM

PART II

REPORT OF SURVEY OF
NAVAL SUPPLY DEPOT
BAYONNE, NEW JERSEY

I. DAMAGE TO HARDWOOD IMPLEMENT HANDLES:

1. Areas covered -

Spot checks were made of the storage areas (principally 5th deck, Building 42) which houses hardwood implement handles such as axe, shovel, hoe, and hammer handles. The stock of each item was checked carefully for the presence of Lyctus and where infestation was discovered complete counts were made.

2. Damage found -

One item - sledge hammer handles, stock No. 41-H-1487 was found to contain an apparently active infestation.

The handles of seasoned hickory were stored on the 5th deck of Building 42 in the manner shown in photo 308-3.

The total stock numbered 716 and the handles showing emergence holes numbered 49.

Two of the most heavily damaged specimens were removed from stock and examined for extent of damage. An iodine test showed these handles to be high in starch content. One of the handles had 270 emergence holes and the other 120. Photo 308-1 shows the gross damage to two handles. The specimen in the foreground was broken by holding one end in a vise and pulling with one hand; it was later sawed and a section split. Photo 308-2 shows the same handle in cross section; the lighter areas are the powder filled galleries made by Lyctus. It is estimated that 80% of the cross sectional area has been eaten away.

Piles of frass (boring dust) on the handles in the racks and on the floor indicated that the infestation was active.

Other handle stock stored in the same area showed no sign, on gross examination, of infestation. A large quantity of axe handles (Photo 308-4) stored close-by showed no sign of Lyctus and an iodine test¹ showed them to be low in starch content. Most of the handle stock with the exception of the sledge hammer handle was either painted, waxed, or lacquered and was free from Lyctus.

II. DAMAGE TO HARDWOOD PALLETS:

1. Areas covered -

The following areas were carefully inspected for signs of Lyctus infestation:

1. 5th deck, Building 42
2. Building 73
3. Building 22
4. Lot 93 (outdoor pallet storage area north of Building 22)

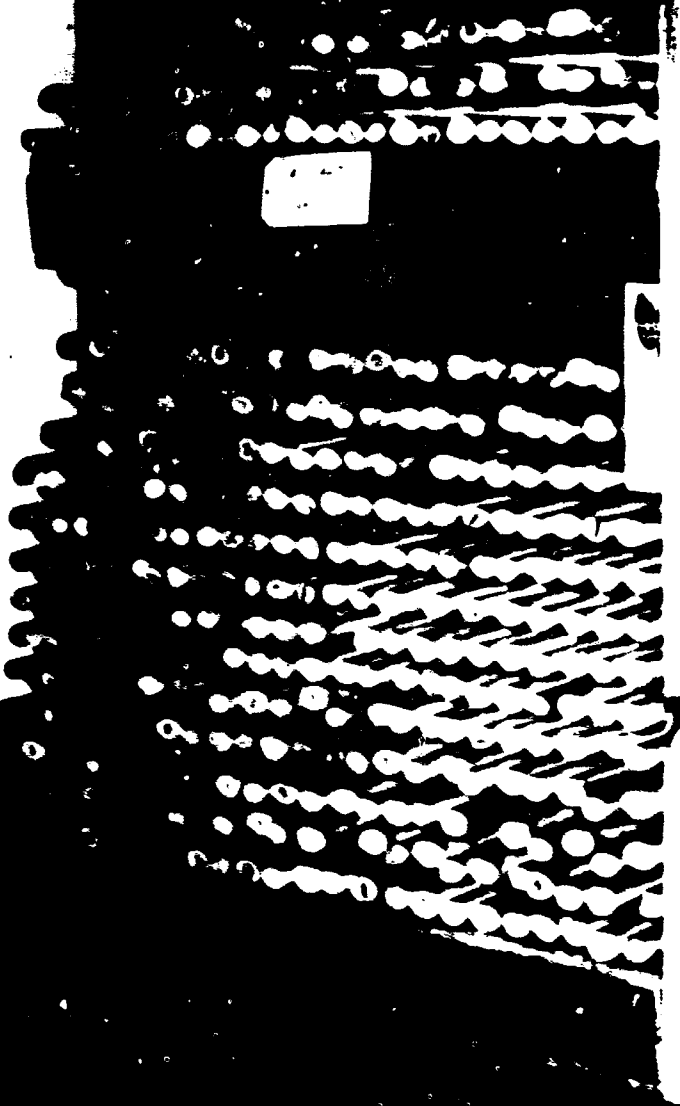
2. Damage found -

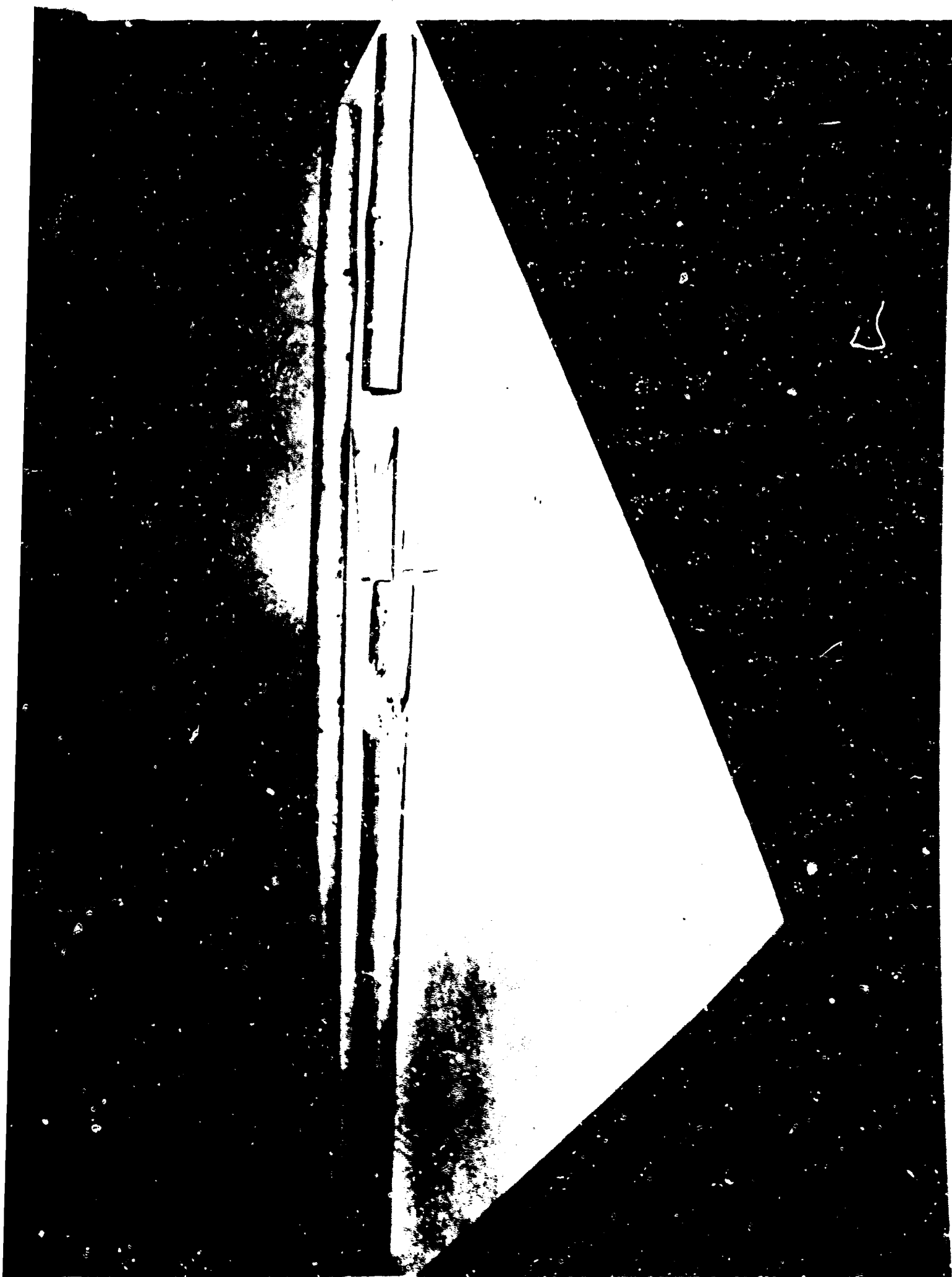
The only Lyctus damage in Building 42 was to the handle stock as noted above. No signs of damage to pallet were found.

About six pallets in Building 73 were found to have suffered Lyctus damage and only one of those six was damaged to the point of needing repair. Photos 308-5, 6, 7, show the extent of the most severe damage found. The board which was attached had considerable wane along the front edge and the starch content was moderately high. In all other pallets showing infestation, the damage was so slight as to be insignificant; a dozen emergence holes near knots or wane was the usual extent.

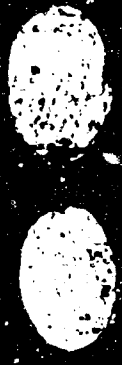
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In no case was the damage by Lyctus as severe as the damage caused by handling equipment.

The extent of Lyctus damage in Building 20 was insignificant; a half dozen pallets showing a few holes near board edges where bark or wane showed.

Again, the damage by Lyctus was insignificant compared to that caused by handling equipment.

Lot 93 is devoted to the outdoor storage of pallets; approximately 5000 pallets are stored there, their ages ranging from one to six years. Close scrutiny of accessible portions of those pallets showed about 2% to have Lyctus infestation. About three times that number showed previous attack by large bostrichids, ambrosia-beetles and a buprestid; none of these are presently active. In all cases the damage by Lyctus was narrow in extent. Photos 308-8 and 308-9 show typical evidence of attack. No evidence of active Lyctus infestation was apparent. In all cases it appeared that the Powder Post Beetle had eaten the desirable portions of the wood and moved.

III. CONCLUSIONS AND RECOMMENDATIONS:

1. Since Lyctus attacks only those wood parts which contain considerable starch, and such parts only occur in certain portions of a tree, only a fraction of usable hardwood lumber is susceptible.

2. Round stock, such as tool and implement handles, is frequently turned from branch-wood or small trees, and such wood is usually high in starch content and highly susceptible. Lumber which is used in pallet manufacture is of such relatively large dimensions that it must be cut from logs of which only a part is starchy, and consequently only certain portions of pallet lumber are





are susceptible. It can be generally concluded that handle-stock presents a potentially greater problem than pallets in frequency and severity of attack.

3. It was shown by the findings of the survey that the problem of Lyc-tus infestation of pallets at the Naval Supply Depot, Bayonne, New Jersey is not serious. Pallets here suffer far greater damage from fork trucks, etc., than Lyctus.

4. A problem, though ostensibly minor, does exist where handle-stock has become infested by Lyctus.

5. No concrete data is available on the magnitude of the Lyctus problem at naval installations other than the Naval Supply Depot, Bayonne, New Jersey. Neither the percentage of pallets attacked nor the extent of the damage on those attacked is known, and since observations indicate that reports may be exaggerated it is recommended that a thorough study be made. A survey of naval installations should afford data on the problem which can be used to plan a future course of action.

6. Since it appears that the cost of dipping or spraying a pallet with a preventative will be a considerable part of the initial cost of the pallet (perhaps 50%), it would be economically unsound to so treat all pallets if only a small fraction of all pallets are susceptible and then only in a minor degree.

7. Inasmuch as no proven preventative is known which will fulfill all the requirements imposed by naval usage, it is recommended that, should the problem be found to be serious, an intensified program be initiated which would supplement work presently being done by the Navy and other government agencies.

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APPENDIX A

There is given below a partial list of the chemical formulations tested as remedies for infestation by Lyctus Powder Post Beetles by the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

1. Formulations solute in petroleum derivatives -

- 25% acetylene tetrachloride in #2 fuel oil
- 0.5% ~~gamma~~ benzene hexachloride (2% ~~gamma~~ in #2 fuel oil)
- 0.5% benzene hexachloride in Velsicol AR-50
- 1% benzene hexachloride in Velsicol AR-50
- 2% chlordane in #2 fuel oil
- 2% chlordane in deobase
- 2% copper naphthenate in #2 fuel oil
- 2% copper naphthenate in deobase
- 5% DDT in #2 fuel oil (7oz. per gallon)
- 5% DDT in 80% kerosene and 15% Velsicol AR-50
- 1% DDT / 2-1/2% Thanite in deobase
- 1% DDT in Velsicol AR-50
- 5% methoxychlor in #2 fuel oil (7 oz. per gallon)
- 10% monochloronaphthelene in #2 fuel oil
- 5% naphthenic acid in kerosene
- 10% Nuodex 136 WR in deobase
- 25% orthodichlorobenzene in kerosene
- 0.4% piperonyl butoxide / 0.5% pyrethrins in #2 fuel oil
- 0.4% piperonyl butoxide / 0.1% pyrethrins in #2 fuel oil
- 3% pentachlorophenol in #2 fuel oil
- 0.4% piperonyl cyclonene 1: #2 fuel oil

- 5% pentachlorophenol in #2 fuel oil
- 25% spirits of turpentine in kerosene
- 25% trichlorobenzene in kerosene
- 5% toxaphene in #2 fuel oil (7 oz. per gallon)
- 5% toxaphene in Velsicol AR-50

II. Petroleum derivatives alone -

- deobase
- #2 fuel oil
- kerosene
- Velsicol AR-50
- Xylene
- Trichlorobenzene
- Orthodichlorobenzene

III. Water soluble or dispersible formulations -

- 5% DDT aqua emulsion
- 5% DDT aqua suspension
- 0.5% loral thiazonyl disulphide (duPont IE-4200) in water

APPENDIX B

Chemical formulations tested as preventatives against infestation by Lyctus Powder Post Beetles, by the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

1. Water soluble or dispersible formulations -

0.96% colloidal sulphur. 8 lbs. per 100 gals. water
(particle size 2 microns)

0.96% wettable sulphur 8 lbs. per 100 gals. water
(particle size 4 - 5 microns)

5% borax

5% borax + 10% isopropyl alcohol

5% borax + Triton X-155 emulsifier

5% boric acid

5% borax + 0.96% colloidal sulphur

10% sodium arsenite

5% wettable DDT

5% colloidal DDT in water

5% DDT emulsion

0.5% gamma benzene hexachloride, wettable

0.5% gamma benzene hexachloride emulsion

2% sodium pentachlorophenate

11. Formulations solute in petroleum derivatives -

2% pentachlorophenol in #2 fuel oil

3.8% pentachlorophenol in #2 fuel oil

5% pentachlorophenol in #2 fuel oil

2% copper naphthenate in #2 fuel oil

- 5% DDT in #2 fuel oil (7 oz. per gallon)
- 0.5% gamma benzene hexachloride (10% gamma) in #2 fuel oil
- 10% monochloronaphthalene in #2 fuel oil
- 5% Toxaphene in #2 fuel oil (7 oz. per gallon)
- 2% chlordane in #2 fuel oil
- 2% Ammonium copper naphthenate in #2 fuel oil
- 2% DDT + 3% chlordane + 0.04% pyrethrum in kerosene (atomized spray)

III. Petroleum derivatives alone -

kerosene

deobase

Velsicol AB-50

#2 fuel oil

APPENDIX C

The quasi-quantitative test for starch in wood used by the Department of Agriculture is as follows:

1. Preparation of solution -

Dissolve in 40 grams of water 2.4 grams of iodine and 4.0 grams of potassium iodide. Dilute this solution with water to a volume of 100 cc.

2. Preparation of Specimen -

A small area should be shaved smooth with a sharp knife. The section should be parallel to the grain.

3. The test -

Apply a small quantity of the iodine solution with a small piece of cotton wool or brush to the prepared section. The appearance of black or purplish stains indicate the presence of starch. The degree of coloration indicates the concentration of starch.

A true quantitative procedure for starch determination can be found in the Testing Methods, Recommended Practices, Specifications of the Technical Association of the Pulp and Paper Industry, Code T419m-45.