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V—1 試験の設定

V—1—1 試験の目的

この試験は，林内での薬剤処理によるブナ丸太の防虫防菌の方法を確立するために，おもに薬剤散布の方法を用いて，昭和27～29年の３ヵ年間，実施したものである。

V—1—2 試験した薬剤の種類

第１年（昭和27年）と第２年（昭和28年）には，防虫防菌に効果があると考えられた数十種の薬剤について，比較試験を行ない，防虫には BHC，防菌には PCP とクレオソート油が有効であるとの結論を得たので，第３年目（昭和29年）にこれらについて再検討した。

V—1—3 試験の方法

原則として伐採直後の丸太に薬剤処理を行なつて林内に設置し，これについて，定期的に虫害，菌害の調査を行なつた。実行にあたつては，試験結果の普遍性をうるために，次のようにした。

i）　試験地：　環境によるちがいを考慮して，３年間に５ヵ所で各種の試験を行なつた。

ii）　試験区の設定：　春季の設定以外に伐採時期別のちがいを考慮して，５～８月の各月に伐採した丸太についても検討し，また，前年11～12月に伐採した丸太を翌年処理するという試験も行なつた。また，同一試験地における位置のちがいによる影響をなくするために，第２年目以後は防虫関係の試験区はラテン方格法により，試験材を配列した。

V—1—4 調査の方法

i）　防虫：　丸太側面につくられた虫孔の数を調査して，薬剤の効果を判定することとした。この場合，穿孔虫の種類による区別はせずに，各種の虫孔に同一の重みをおいて扱つた。

ii）　防菌：　外観のちがいと，木口からの変色および腐朽の深さの大小を調査して，薬剤の効果を判定した。

V—2 試験の結果

林内におけるブナ丸太の防虫防菌のためには，薬剤散布法が比較的簡便で，その効果が期待できるものである。すなわち，ここでは経済効果の計算は行なわなかつたが，１回の薬剤処理に要する諸経費を概算すると，多くの場合，石あたり30～40円程度で相当の防虫防菌効果が認められ，実用上も効果的な方法であるということができる。

V—2—1 選ばれた薬剤の種類

試験の結果を防虫防菌の両面から検討すると，最も効果的な薬剤は次のとおりである。

i） BHC γ 1％・PCP 2％乳剤

ii） BHC γ 1％・クレオソート油18％乳剤

ただし，濃度は使用時のものであつて，散布量は石あたり 0.5 l（1 m^3あたり 1.8 l）である。BHC の濃度は，穿孔虫の生息密度が高い場合は，2％ぐらいにしないと効果が顕著にあらわれないことがある。

V—2—2 薬剤の効果

i） 防虫については多くの場合に，散布後 2 ヵ月の間は虫孔をほとんど生じなかつた。しかし，穿孔虫の生息密度が非常に高い地域では，薬剤処理を行なつた丸太でも，多少虫孔がつくられる傾向がある。たとえば，設置後 2 ヵ月の無処理区の虫孔が，1 m^2 あたり 150 ぐらいの高い密度の場所では，薬剤処理区でも 2 ヵ月後に 1 m^2 あたり 5～6 個の虫孔がみられた場合もあつた。

ii） 防菌については，処理材の外観は無処理材にくらべて，概して清潔であつたが，木口からの変色や腐朽を完全に防ぐことはできなかつた。すなわち，変色についてみれば，散布後 3 ヵ月目には，処理材の木口からの変色の深さは，平均約 15 cm くらいになつた。これは無処理材の約 1/3 に相当した。腐朽については，処理材は無処理材よりも 1 ヵ月ぐらい遅れて満 4 ヵ月くらいからはじまり，5 ヵ月後では処理材は，木口から 10 cm の断面で，腐朽率が10％前後となつている。これは無処理材にくらべて，1/2～1/3 に相当している。

V—3 さらに研究すべき問題点

i） 虫の種類によつて薬剤の効果に差があるかどうかについて：今までの観察ではほとんど差がないようであつたが，非常に重要な条件であるので，特に確認することができるまでの追及が望ましい。

ii） 散布した薬剤の残効期間について：これは，野外試験の裏付けとして別に実験室において試験して確かめておく必要がある。

iii） 穿孔虫が丸太に誘引される機構について：白灯油を散布した丸太に，しばしばきわめて多数の穿孔がみられたことは，誘引機構解明の 1 つの手がかりとなる興味ある現象であり，この誘引機構がわかれば，学術的にも実用的にも新しい分野が開けてくるだろう。

iv） 薬剤散布後に穿入した虫の経過について：残効と関係があるとも思われるが，散布後に穿入した虫が完全な虫孔を形成し，正常な繁殖を営むものかどうかについては，詳しい調査が必要であるが，われわれの試験ではそれができなかつた。しかし，観察によれば，完全な虫孔を形成するまでにいたつていないものが多かつた。

v） 薬剤散布丸太の木口から菌が侵入する機構について：防菌上最も問題となつている木口からの菌の侵入機構が明らかになつていないが，もつと効果的な防菌処理法を考える上にぜひとも解明されなければならない。

vi） 丸太側面から菌が侵入する機構について：樹皮の有無や，木繊維の方向が異なるため木口の場合と異なり，長期にわたる貯木の場合に問題になる事項である。

vii） 生丸太の材中における菌の発育速度について：防除のための薬剤の性状を規定し，さらに防菌効果をあげるために必要である。

V—4　応用上の注意事項

i）　薬剤散布は原則として伐採直後に行なうこと，ただし，冬期間に伐採した丸太に対しては，融雪後なるべく早く実施すること。

ii）　薬剤は丸太石あたり 0.5 l（1 m^3 あたり 1.8 l）を標準とし（細い丸太には多く，太い丸太には少なくてもよい）丸太の全表面に対してむらなく散布し，散布後は木口や樹皮になるべくキズをつけないようにすること。処理前からあつた木口や樹皮面のキズには特にねんいりに散布すること。

iii）　処理丸太を他の場所に移動した場合は，有効期間内であつても薬剤散布をくりかえすこと。

iv）　木口にしんぬけ，木口割れ，段つき等があつた場合，切り直して平らにしてから薬剤散布を行なうこと。

v）　薬剤処理をした丸太でも，なるべく短い期間内に製材すること。

vi）　丸太にヒワレをつくらないために，土場はなるべく直射日光のあたらないところをえらぶこと。

vii）　丸太がはなはだしくぬれているとき，やむを得ず薬剤散布をした場合，および散布直後に大雨があつたような場合には，材の表面が乾いてから散布しなおすこと。

V—5　試験の結果を省みて

ブナ丸太の防虫防菌はなかなか困難な問題である。しかし農薬化学の進歩は，最も簡便な薬剤散布法を丸太の防虫防菌に対して応用可能なものにした。しかも，われわれの試験は，それがいくつかの薬剤処理法中でも特に有意義な処理法であることを確認することができた。もちろん薬剤の改良，散布法のくふう，丸太材の取扱い法の改善などについて，残された多くの問題があるとしても，ブナ材の合理的利用は丸太時代の薬剤処理を無視してはなりたたないものであると確信するものである。

ブナ材は，元来変色菌，腐朽菌および穿孔虫の被害を最もうけやすい材である。その損失をできるだけ少なくするためには，害虫，害菌のちようりようする時期をさけて伐採し，伐採から利用に至る期間をできるだけ短くするという，以前からとなえられている基本的考え方に従わなければならないことはもちろんであるが，しかし，これだけでは虫菌害を防ぐことができないことも十分に認識しなければならない。また水中貯木，散水処理がきわめて有効であることも疑う余地はない。けれども，一度水からあげられた丸太材は全く無防備の状態になることも周知の事実である。したがつてこれらは改めて薬剤処理を行なわなければ安全を保証することはできないのである。

しかし，薬剤処理の効力にも限度がある。われわれが最も憂慮することは，ともすればおこりがちな一辺倒的な考え方である。それは時によつて薬剤に対する安易な依頼心となり，時としては不当な排斥，けん忌心となる。われわれの知るかぎりでは，ブナ丸太の薬剤処理の効果は，他の樹種——たとえばマツ・エゾマツなどの針葉樹——にくらべてやや劣るようである。特にそれは防菌の効果においてである。しかしその欠点は，林内または土場の衛生環境をよくし，あるいは害菌，害虫の生態を十分に考慮して丸太の取扱いに注意するならば，十分に補うことも可能である。また，さらに薬剤の改良くふうをすれば効果を著しく高めることも可能であろう。

今回の試験は，戦前は全く省みられなかつた薬剤散布という安直な手段が，丸太の保護手段として可能性があるかどうかを明らかにし，同時に今日の薬剤のなかからどのようなものが使用できるかを明らかにする

ことに主要目的がおかれたのである。これによつて散布法それ自体の価値がきわめて高いことを明らかにした。しかし薬剤は日進月歩するものであつて，この試験で選ばれた薬剤は今日の最善ではあつても，明日の最上ではない。

ブナという樹種の材の解剖学的性質，化学的組成，これをおかす各種の変色・腐朽菌の生理生態，また伐採と同時に飛来し穿孔をはじめる各種穿孔虫の種類とその生態などの研究を縦糸とし，伐採，輸送，貯材の機械的方法のくふうを横糸として，薬剤散布法に一層のくふう改良が加えられるならば，その効果はさらに高まるであろう。

ブナ丸太に対する薬剤散布は，今日すでに常識化されつつある。われわれの試験に協力された青森営林局では昭和28年に，第1年目の成績にもとづいて実用にふみ出した。そのときの実用価値は，処理材と無処理材の伐採3ヵ月後の比較入札によつて石あたり100円の開きを示して，処理効果の顕著なことを示した。このことは木材生産者の増収を意味するだけでなく，貴重な木材資源の減耗をそれだけ守つたことを意味し，二重の価値をあらわすものである。

もし年産400万石に上るブナ丸太に対して，保健思想が徹底するならば，それによる利益はけだしはなはだ大なるものがある。またこの薬剤処理法は，ひとりブナ丸太ばかりでなく，各種の家具，建築用材の原木となる伐採丸太に応用すれば，ブナと同等以上に効果をあげうるであろうことも想像するに難くない。

文　献

1) 青島清雄・林康夫：ブナの青変と青変菌について（予報），日林誌，**35**，(1953) p. 268～9.

2) ———：Germination of the basidiospores of *Elfvingia applanata* (PERS.) KARSTEN (*Fomes applanatus*)，林試研報，**67**，(1954) p. 1～18.

3) ———：Decay of beech wood by the haploid and diploid mycelia of *Elfvingia applanata* (PERS.) KARST. (*Formes applanatus*)，林試研報，**68**，(1954) p. 181～202.

4) 青島清雄・林康夫：ブナ変色材の耐朽性，林試研報，**76**，(1954) p. 21～6.

5) ———：オオミコブタケ（*Ustulina vulgaris* TUL.）による生立木の根株腐れ，日林誌，**37**，(1955) p. 254～6.

6) 青島清雄・林康夫：3種のブナの青変菌，日林誌，**38**，(1956) p. 151～6.

7) ———・———：ブナ丸太の変色菌に関する研究（未発表），

8) BACON, L. R. and D. B. CONKLIN : Composition for inhibiting sapstain, U. S. Patent No. 2549358, (1951)

9) BROWNE, F. G. : Protection of timber against powder-post beetles during seasoning, Malay Forester, **13**, (3) (1950) p. 166～7. (For. Abst.)

10) ———: Test of chlordan against ambrosia beetles, Malay Forester, **14**, (2), (1951) p. 98 (For. Abst.)

11) CHRZANOWSKI, R. H. : Thixotropie gels for preserving wood, U. S. Patent No. 2599373, (1952)

12) DOWNS, L. E. : Bleaching wood, No. R 1705, (1950)

13) HATFIELD, J., R. S. SHUMARD, T. H. VAUGHN and E. F. HILL : The unseasoned wood disc

method for evaleating sapstain control chemicals, Phytopathology, **40**, (1950) p. 653～663.

14) 函館営林局利用課：ブナ材の林内予備防腐防虫剤の 効果試験，函館営林局弘報，**59**，(付録パンフレット) (1953)

15) ―――：同（第2報）.（パンフレット）(1955)

16) 今関六也：マイタケ属，植研雑，**19**, (1949) p. 381～390.

17) ―――・田窪健次郎・永井行夫・慶野金市・青島清雄：ブナ丸太の林内予備防腐防虫試験(予報)，林試青森支場第4回研究発表会記録, (1952) p. 97～103.

18) 井上元則：ブナ材の取扱について，北海道林試集報，**56**. (1948)

19) 岩成範雄：ブナ丸太穿孔虫の蝕害防止に関する研究（第1報），林試彙報，**42**, (1938) p. 23～50

20) ―――：同（第2報），林試彙報, **44**,（1938）p. 25～46

21) JACQUIOT, C. : Le blauissement des bois abattus ou débités, Étude tech. Inst. nat. Bois No. 10 (1952). (For. Abst.)

22) JOHNSTON, H. R. : Insect control. Practical method for the control of insects attacking green logs and lumber, Southern Lumberman, **184**, (2307), (1952) p. 37～9.

23) 亀井専次：筆者の一人青島への私信

24) 慶野金市：立木注入試験について（未発表）

25) 北島君三：ブナ丸太変色の原因をなすエンドコニディオフォラー及びこれが発生防止に関する研究，林試報，**35**,（1936）p. 1～134.

26) 菊谷光重：ブナ材の防虫防腐について（第1報），岐阜県林試報，**2**,（1957）p. 52～8.

27) KOLLMANN, F., R. KEYLWERTH und H. KÜBLER : Verfärbungen des Vollholzes und der Furniere bei der künstlichen Holztrockung, Holz als Roh- und Werkstoff, **9**, (1951) p. 382～391.

28) KOWAL, R. J. : Control of wood boring insects in green logs and lumber, Proc. U. S. For. Prod. Res. Soc., **3**, (1948) p. 469～79 (For. Abst.)

29) ―――: BHC protects logs and lumber from pin hole borers, J. For., **48**, (8), (1950) p. 333.

30) 前橋営林局作業課：ブナ材における PCP 及びクレオゾール No. 2, No. 3 の防虫試験(中間報告), (1954).

31) 三沢吉五郎：PCP 乳剤によるブナ丸太防腐防虫の成果について，蒼林，**6**,（4），（1955） p. 12～21.

32) ―――：環境因子が PCP 乳剤に及ぼす影響について，第3回秋田営林局直営生産事業研究発表論文集，(1956) p. 144～150.

33) 三宅豊：ブナ生立木の防腐について，蒼林，**3**,（1），（1952）p. 21～30.

34) MULLER. H. R .A. : Ambrosia fungi of tropical Scolytidae in pure culture, In Dutch. verd. Afd. Ned. Ostindie, nedent ver., **1**, (4), Amsterdam, (1933) (Rev. appl. Ent. **21**, p. 186～7)

35) MUNRO, J. W. : Beetles injurious to timber, Bull. For. Comm., **9**, (1928) pp. 29. (ibid. **16**, p. 183～6)

36) 村山譲造：日本領土内に産するナガキクイムシの種類及び喰害について，日林誌，**11**,（12），(1929)

p. 669～682.

37) 永井行夫・青島清雄・林康夫：伐採季節を異にしたブナ材の耐朽性，林試研報，**77**，(1955) p. 21～3.

38) 長岡営林署：ブナ材における薬剤による防虫防腐効果について，(パンフレット) (1956)

39) PARTANSKY, A. M. : Field testing of Mold-resistant properties of interior oil paints, Ind. Eng. Chem. Anal. Ed., **14**, (1942) p. 527～32.

40) 林業試験場，青森営林局：薬剤によるブナ丸太の林内予備防腐防虫試験の経過，(1953)

41) ――― ：同，(1954)

42) RITCHIO, W. H. : Fungicides in paints and other protective coatings, Paint tech., **16**, (1951) p. 481～4.

43) SALMAN, K. A. : Recent experiments with penetraiting oil sprays for control of bark beetles. Jour. Econ. Ent., **31**, (1938) p. 119～123.

44) SANDERMANN, W. und M. LUTHGENS : Untersufungen über verfärbungen von Holzern, Holz als Roh- und Werkstoff, **11**, (1953) p. 435～440.

45) SCHEFFER, T. C. and R. A. ZABEL : Storage of beech logs and bolts in the Northeast, Beech utilization series No. 2, (1951)

46) SCHULZ, G : Versuche über Bläuschutz-behandlung von Kiefernstamm- und Schnitholz, Holz als Roh- und Werkstoff, **11**, (1953) p. 66～8.

47) 新庄稔・川崎俊郎：パルプ用原木丸太の簡易防腐処理について，木材工業，**11**，(1956) p. 138～142.

48) 高橋良雄：ブナの穿孔虫について（第1報），蒼林，**3**，(5)，(6)，(1952)

49) TECHNICAL NOTE : Cause and prevention of blue stain in wood, No. 225 (1941)

50) ――― : Chemical brown stain in Pine, No. 254, (1946)

51) 矢沢亀吉・樋口隆昌：名古屋営林局管内のブナ材に関する研究（第1報），(パンフレット) (1953)

52) ―――・―――・藤吉俊雄・坪井静馬：同上（第2報），(1954)

53) ―――・―――・―――：同上（第3報），(1955)

54) ―――・―――・村山章：同上（第4報），(1956)

55) ―――・―――・町井茂：同上（第5報），(1957)

56) VERRALL, A. F. and P. V. MOOK : Research on chemical control of fungi in green lumber, 1940～1951, Tech. Bull. U. S. Dept. Agr. 1046. (1951) p. 1～60

57) WILFORD, B. H. : Chemical impragnation of trees and poles for wood preservation, Circular, No. 717, (1944)

58) ZYCHA, H. : Die Bewertung pilzhemmender Eigenschaften von Grundieranstrichen, Holz als Roh- und Werkstoff, **10**, (1952) p. 41～3.

Studies on the Protection of Beech Green Log from Insect and Fungus Attacks

The Green Log Protection Research Group

Preface

The log is the final product of forestry. It is the fruit of many years' efforts of men and of the grace of nature. The log must be treated with more caution, regard and consideration.

During the growing period of the tree, the wood substance is protected from its enemies, such as injurious insects and fungi, by the natural resistance ability endowed within the living organism itself. But, immediately after cutting, the same substance changes its nature as to be rapidly attacked by insects and fungi.

To protect the green logs from deterioration caused by insect and fungus attacks is a fundamentally important problem, for the sake of accomplishing the reasonable utilization of wood. In spite of this, the importance has been apt to be neglected in general.

The amount of culls disclosed in a year both in the field and lumberyard might be estimated as 5 ～ 20 per cent. They are variably estimated in compliance with the purpose and objects for which they will be used. The amount of deterioration is too much to be neglected. All the efforts to increase lumber production will not accomplish the virtue of ending in success, unless the efforts are directed also to the perfect protection and preservation of green logs during the period from cutting to mill.

Among many kinds of useful trees in Japan, the logs of pine and beech succumb most easily to the attacks by injurious organisms. Annual yield of beech logs amounts to 1,300,000 m^3 and that of pine to 13,000,000 m^3. Hence, the amounts of their annual deterioration must be remarkably voluminous.

In order to find out the most practical and effective method of protecting green logs, the "Green Log Protection Research Group" was formed in 1951. The Group consists of the following members, specialists in the fields of forest entomology, mycology, insecticide and fungicide. The first problem of the Research Group was the protection of the beech green log. For this purpose, the following members got together:

Group chief	Rokuya IMAZEKI
Entomologists	Masatoshi NITTO
	FUSAO YAMADA
	Shigeyoshi KIMURA
Mycologists	Rokuya IMAZEKI
	Kiyowo AOSHIMA
Chemists	Kin-ichi KEINO
	Hiroshi ABE

Needless to say, both the insect and fungus attacks on the green log are inseparable joint actions, because the insects not only bear fungus spores directly upon their bodies, but also bore the holes in the log which become the entrance of fungus invasion. This fact suggests that one must use fungicide and insecticide, in order to prevent the green log from the fungus attacks. Based on this fundamental biological view, the members of the Group have always kept intimate cooperation with each other.

The experiments were carried out chiefly in the field for three years from 1952 to 1954, using numerous test logs. The experimental plots were settled at five different places in three different districts. The main purpose of the Group was to establish an effective method, and to ascertain its general effectiveness throughout the beech forest regions with different site conditions in the shortest period. Through the three years' experiments, the Group found that the deterioration could be remarkably prevented by spraying a liquid containing 1 ~ 2 per cent γ-BHC and 2 ~5 per cent PCP or 15 ~ 30 per cent coal tar creosote soon after the trees were cut down.

Experiment Plots:

1) "Tokura A" exp. plot. (1952, 1953)

Locality: Tokura, Katashina-mura, Tone-gun, Gunma Pref.

Site condition: A gentle slope facing north, 900 *m* above sea, under the forest stands being chiefly *Fagus crenatus* and *Quercus crispula,* covered with almost closed crown.

2) "Matsukusa" exp. plot. (1952, 1953)

Locality: Matsukusa, Kadoma-mura, Shimoheii-gun, Iwate Pref.

Site condition: A flat or slightly sloped place, about 700 *m* above sea, among beech forests where felling operations had been carried on for several years, many branches and stumps being scattered there.

3) "Sittaigawa" exp. plot. (1952)

Locality: Yokokawame-mura, Waga-gun Iwate Pref.

Site condition: A narrow, riverside, flat place, between steep slopes, about 400 *m* above sea. The surrounding forest consisting of *F. crenatus, Q. crispula,* etc., no cutting operation having been taken, with short sunshine hours.

4) "Tokura B" exp. plot. (1953)

Locality: Same as "Tokura A".

Site condition: Newly cutover open area of 1.5 *ha,* located on a gentle slope on hillside, among untouched beech forest, about 1,100 *m* above sea. Dry and sufficient sunshine.

5) "Neri" exp. plot. (1954)

Locality: Neri, Akagine-mura, Tone-gun, Gunma Pref.

Site condition: Open cutover area, about 1,000 *m* above sea; the surrounding forest chiefly consisting of beech mixed with some fir trees (*Abies firma*). Many logs, branches and stumps lay scattered in the plot.

I. Control of insects

1. Observation on the ambrosia beetles

The investigations for protecting beech logs from ambrosia beetles were carried out at five places in two prefectures, Gunma and Iwate. The ecological observations obtained on the wood-borers from these experiments were as follows:

1) In these experiments 15 species of ambrosia beetles which had entered freshly cut logs were collected. They caused not only mechanical defects to the log, but also the invasion of blue-stain or woodrotting fungi from their entrance holes. Among them, 12 species were of Scolytidae and belonged to the following genera: *Xyleborus* 6 species, *Xyloterus* 1, *Scolytoplatypus* 5. The remaining 3 species belonged to Family Platypodidae of the following 2 genera: *Platypus* 2, *Crossotarsus* 1.
2) In comparing the species of ambrosia beetles between two prefectures, Iwate and Gunma, 12 species among 15 were very commonly found in both areas but the remaining 3 were rarely found.
3) In considering the injury caused by these beetles according to the depth and density of their galleries, it seemed that the most injurious species were *Crossotarsus niponicus* and *Scolytoplatypus shogun*. Besides them the important species were *Platypus severini, Scolytoplatypus daimio, Xyleborus germanus* and *X. saxesini.*
4) The beetles entered into the beech log during a long period from the middle of May to the beginning of October, and no great difference of the period was recognized between the experimental places. The heaviest attacking season varied depending on the difference in the activity of the dominant species in each place, but it appeared between June and August as a whole.
5) The number of species and the density of the beetles was closely related with the environmental conditions of the places where beech logs were laid. They were abundant in the cutover valley, where especially *Xyleborus* species were numerous. At the front of the cutover forest or the bare place near the stands attacks of the beetles belonging to *Scolytoplatypus* and *Crossotarsus* were conspicuous; on the contrary *Xyleborus* species were very few. In the forest, only *Scolytoplatypus shogun* was observed but its population was not abundant.

2. Control by spraying chemicals

In order to examine the prevention effectiveness of various kinds of insecticides for the ambrosia beetles, field tests were carried out during 3 years from 1952 to 1954.

In the first year 3 places were selected for tests, namely, 2 places were situated in Iwate prefecture and another in Gunma prefecture. Tested chemicals to control the ambrosia beetles were as follows: BHC emulsion (0.2, 1.0, and 3.0 % γ isomer), BHC kerosene solution (0.2 % γ isomer), DDT emulsion (0.2 %), DDT kerosene solution (0.2 %), kerosene, and coal tar creosote emulsion (18 and 30 %).

These chemicals were sprayed on recently cut logs, about 130 *cc* per 1 m^2. The logs were 20 ～ 40 *cm* in diameter and 2 ～ 3 *m* long, and arranged on the ground one by one.

The number of the insect entrance holes on the surface of logs were calculated every month afterwards.

These experiments indicated that such low concentration of BHC or DDT as 0.2 per cent did not reduce the number of holes, but the effectiveness of higher concentration of BHC emulsion such as 1.0 or 3.0 per cent γ isomer was conspicuous, while the spraying of kerosene alone resulted in the number of the holes being more than in the control.

In the second year, tests were conducted in Iwate and Gunma prefectures as the first year test but the chemicals were as follows: BHC emulsion—0.2, 0.75 and 2.0 per cent γ isomer; BHC kerosene solution—0.75 and 2.0 per cent γ isomer; BHC emulsion mixed with fungicide—γ-BHC 1.0 and 2.0 per cent plus coal tar creosote 15 per cent or PCP 2 per cent; γ-BHC 2.0 per cent kerosene solution which contained PCP 2.0 per cent.

Results obtained from these tests were as follows:

1) γ-BHC 2 % emulsion was effective to such extent that the entrance holes of the beetles were scarcely found during 1 ～ 2 months.
2) At the place of low beetle population, γ-BHC 1.0 % emulsion spraying gave great promise for protecting logs from beetles.
3) The additional use of fungicides such as coal tar creosote or PCP to BHC emulsion did not lower the insecticidal effectiveness.
4) Many species of beetles attacked beech logs inhabited in these places, but the spraying of 1.0 ～ 2.0 per cent γ-BHC emulsion prevented all species from boring.
5) In the case of spraying kerosene on the logs, wood borers' holes were very abundant on the surface, but the oil containing γ-BHC 2 per cent kept the logs free from the attack by beetles.

In the third year, an experimental place was settled in Gunma prefecture and tests were done with 1.0 or 2.0 per cent γ-BHC emulsion and kerosene solution. The spraying method and the arrangement of logs were partly changed. The logs were carried after being treated with chemicals to another place and arranged in a Latin Square, and logs treated with emulsion and with kerosene were kept separated from each other.

From these experiments, we ascertained that BHC emulsion was as effective as in the results obtained for two previous years, and the holes of beetles on the logs with kerosene were somewhat more abundant than in the control, but the BHC 2.0 per cent γ isomer kerosene solution showed the conspicuous effects as the emulsion.

II. Prevention of fungi

1. Control by spraying chemicals

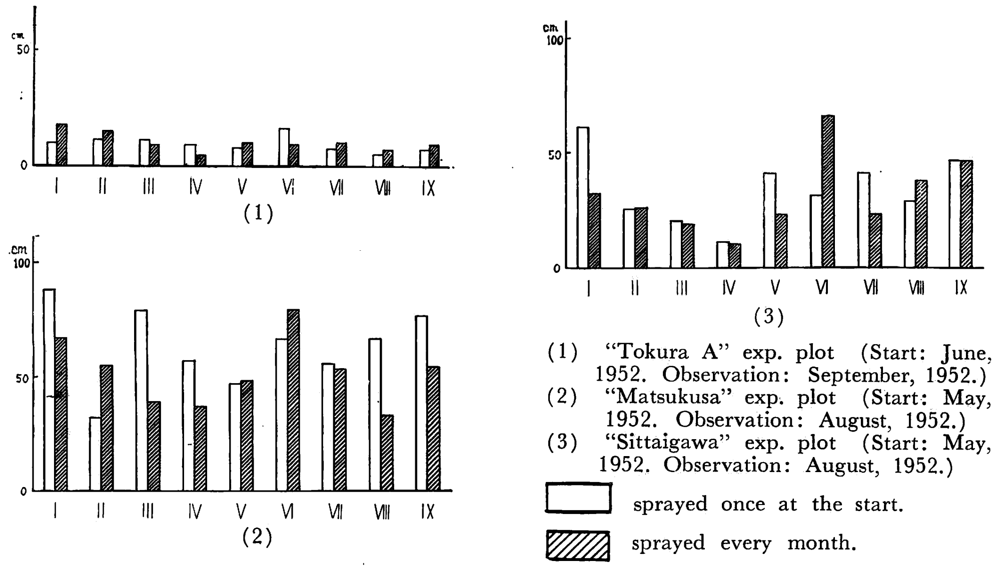
The important species of wood-staining fungi found in the cut ends of the experimental logs were *Ophiostoma pluriannulatum* and *O. piceae* which caused blue stain, and *Endoconidiophora* *moniliformis* which caused brown discoloration. *Ophiostoma stenoceras* was sometimes found associated with bark beetles and caused blue stain. Wood-rotting fungi which entered from the cut ends of logs in the earlier stages were *Schizophyllum commune*, *Stereum purpureum*, *Coriolus hirsutus*, *C. versicolor* and *Lenzites betulina* and some other fungi.

In order to prevent beech logs from staining and rotting fungi, a trial spray of chemicals was given to the logs and results examined during the three years, 1952 ~ 1954.

1) In the first year's experiment, the fungicides used were emulsion of PCP and coal tar creosote and water solution of Wolman salt, and as insecticides BHC and DDT, were given. Experimental logs were made from trees immediately after cutting down the living and sound trees of Japanese beech. Their size was as follows: 20 ~ 40 *cm* in diameter and 2 ~ 3 *m* long. These logs were laid down on the forest floor of different site condition as above mentioned, that is, in experimental plots "Tokura A", "Matsukusa" and Sittaigawa".

On these logs of each division, chemicals of different kinds already mentioned above were sprayed 130 *cc* per 1 m^3, respectively. For some division of logs spraying was made every month and for others only once at the start of the experiment. One month after spraying, some of the experimental logs which were selected from every division were cut and sawn in order to examine the stain and decay that had entered from the cut ends.

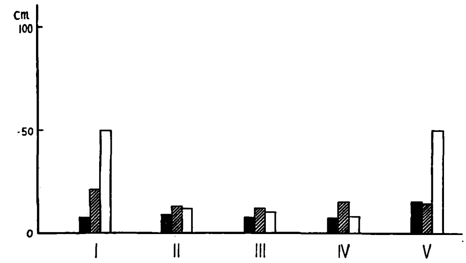
Fig. 1 shows the average depth of stain of logs entered from the cut ends which had been induced by wood-staining fungi and by other non-parasitic causes including chemical stain. It was concluded that spraying chemicals may result in decreasing discoloration of logs, if they are laid down on the forest floor and are free from insect attack as seen in this graph. Discolo-



I—Control; II—PCP (2%) + γ-BHC (0.2%) kerosene sol.; III—PCP (2%) + DDT (0.2%) kerosene sol.; IV—Kerosene only; V—PCP (2%) + γ-BHC (0.2%) emulsion; VI—PCP (2%) + DDT (0.2%) emulsion; VII—Coal tar creosote (18%) emulsion; VIII—Pine oil solution of PCP (5%); IX—Wolman salt.

Fig. 1 Depth of discolored area entered from the cut ends of beech logs ration of logs including chemical stain was apt to be more prevalent in logs kept in dry and denuded areas.

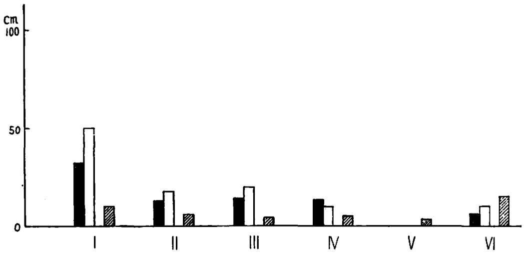
2) From May to August of 1953, the second year of this experiment, beech trees were cut down every month and the freshly cut logs were sprayed with chemicals by the same method as in the previous test directly after the experimental logs were made. In all the cases of this experiment, chemicals were sprayed only once at the start. The experimental plot was "Tokura B". Two months after construction of the test log in each experimental division differing in their cutting month, some of the logs were picked up and their inner stain entered from the cut ends examined. From three months after setting the log, the examination was carried out monthly till autumn of the same year. The results are shown graphically in Figs. 2 and 3. In these series of experiment, it is concluded that spraying some chemicals is effective to prevent stain of beech logs entered from the cut end. These chemicals are PCP or Na-PCP (the effect is almost the same in concentration of from 5 to 20 per cent), pine root oil solution of 0.4 ~ 1.6 per cent of lignasan oleate, and 30 per cent of coal tar creosote. It may be definitely stated, however, that protection of stain entered from the cut end by means of spraying chemicals only is insufficient.



The start of the experiment was in June, 1953, and observations were done in August (■), September (▨) and in October (□), respectively.

I—Control; II—PCP (5%) + γ-BHC (2%) kerosene sol.; III—PCP (5%) + γ-BHC (2%) emulsion; IV—Na-PCP (5%) + γ-BHC (2%) emulsion; V—Na-PCP (5%) + γ-BHC (1%) emulsion; VI—Coal tar creosote (30%) + γ-BHC (2%) emulsion.

Fig. 2 Depth of discolored area entered from the cut ends of beech logs



The start of the experiment was in July, 1953, and observations were done in September (■) and in October (□), respectively. ▨ shows that the start was in August, 1953, and observation was in October, 1953.

1—Control; II—PCP (5%) + γ-BHC (2%) 1953, and observation was in October, 1953. kerosene sol.; III—PCP (5%) + γ-BHC (2%) emulsion; IV—Na-PCP (5%) + γ-BHC (2%) emulsion; IV—Na-PCP (5%) + γ-BHC (1%) emulsion; VI—Coal ter creosote (30%) + γ-BHC (2%) emulsion.

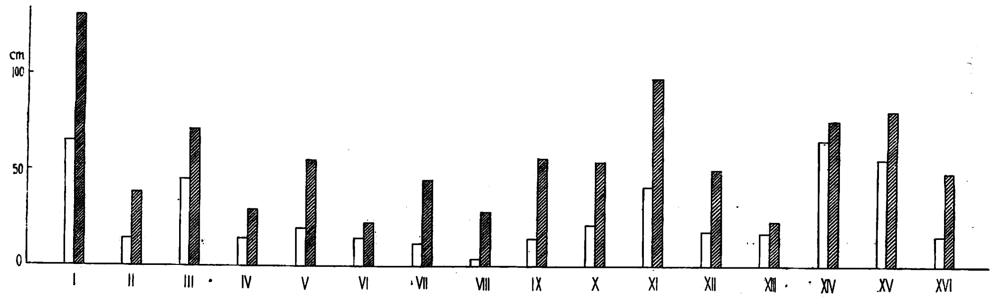
Fig. 3 Depth of discolored area entered from the cut ends of beech logs

2. Control by end coating

As stated in the previous chapter, that method of spraying chemicals had a limit in controlling stain of beech logs. Therefore, the end coating method was examined. It has been already established by the late K. Kitajima that the stain of beech logs by coating of fungicidal paste onto the cut end of beech logs can be prevented. The end coating chemicals were originally created by him and designated as Kitajima No. 18. From the establishment of Kitajima No. 18 in

1935, the paste has been used in some regions of beech forest areas. The effectiveness of this paste to prevent stain entering from the cut end was at first established by him and its effect was ascertained by the present experiments. The end coating paste, Kitajima No. 18 is a mixture of rosin, coal tar creosote, asbestos and some other materials, which, however, is not easy for the foresters to use in the mountainous region forests, and moreover, there exist some economic difficulties. From the time when KITAJIMA created the end coating paste to prevent discoloration of logs of Japanese beech, more than twenty years have passed, and during these years chemistry of fungicide has made remarkable progress. On the other hand, the diffusion method has been tested widely in the field of studies on wood preservations. These are the reasons why we conducted some additional series of experiment concerning the examination of the same kinds of chemicals for the purpose of controlling staining fungi entering from cut ends of beech logs.

Fifteen kinds of end coating mixtures of chemicals were used including Kitajima No. 18 and some of its allies. The experimental logs were made from newly cut trees without defects, and end coating was done immediately after the fresh cut surfaces of the logs were made. The experimental plot was "Neri" and the experiment was begun in May 1953, the final observation taking place at the end of the same year. The result is shown graphically in Fig. 4. From this it may be concluded that a half of the end coat mixtures tested was effective in preventing fungus staining. End coating mixtures which contained coal tar had a tendency to give better results.



The start of the experiment was in June, 1954 and observations were done in August (☐) and in October (▨) of the same year.

I—Control; II—PCP (5%)+NaF (10%)+white linseed oil paint (85%); III—PCP (5%)+NaF (10%)+water soluble vinyl paint; IV—PCP (5%)+NaF (10%)+vinyl paint; V—PCP (10%)+NaF (10%)+phenol resin; VI—PCP (5%)+NaF (10%)+pine oil (75%)+kieselguhr (5%)+asbestos (5%); VII—Modified Kitajima No. 18 (kieselguhr instead asbestos); VIII—Kitajima No. 18; IX—Na-PCP (10 parts)+NaF (50 parts)+kieselguhr (5 parts+urea resin (5 parts)+water (20 parts); X—marine paint (NaF 10%); XI—coal tar creosote (20 parts)+coal tar (30 parts)+kieselguhr (20 parts); XII—Na-PCP (15 parts)+NaF (30 parts)+coal tar creosote (15 parts)+coal tap (15 parts)+kieselguhr (5 parts)+water (20 parts); XIII—Wolman salt (30 parts)+coal tar (20 parts); XIV—Wolman salt (30 parts)+coal tar (20 parts)+kieselguhr (5 parts); XV—Wolman salt (50 parts)+urea resin (15 parts+kiselguhr (5 parts)+water (20 parts); XVI—NaF (10 parts)+coal tar (50 parts)+kieselguhr (5 parts).

Fig. 4 Depth of discoloration entered from the cut ends of the beech logs

III. The chemicals used in these experiments

The contents and correlation of chemicals used during the test period from 1952 to 1954 are given in the Tables 1 and 2.

Table 1. Chemicals sprayed from 1952 to 1954

1952	1953	1954
PCP (2%)+DDT (0.2%) kerosene sol.		
PCP (2%)+γ-BHC (0.2%) kerosene sol. ..... →	PCP (5%)+γ-BHC (2%) kerosene sol. γ-BHC (0.75, 2.0%) kerosene sol. .... →	γ-BHC (1.0, 2.0%) kerosene sol.
PCP (5%) pine oil sol. PCP (1%) kerosene sol. .... →	PCP (5, 10, 20%) pine oil sol.	
Kerosene .... →	Kerosene .... → Light oil Heavy oil	Kerosene
PCP (2%)+DDT (0.2%) emulsion		
PCP (2%) +γ-BHC (0.2, 1.0, 3.0%) emulsion.. →	PCP (5%)+γ-BHC (2%) emulsion Na-PCP (5%) +γ—BHC (1, 2%) emulsion →	PCP (2%)+γ-BHC (1%) emulsion
	γ-BHC (0.2, 0.75, 2.0%) emulsion......... →	γ-BHC (1.0, 2.0%) emulsion
Coal tar creosote (18, 30%) emulsion .... →	Coal tar creosote (30%)+γ-BHC......... (2%) emulsion → Monochloronaphthalene (50%) kerosene sol. Trichloronaphthalene (50%) kerosene sol.	Coal tar creosote (30%)+γ-BHC (2%) emulsion
Na-PCP (1%) water sol. .... →	Na-PCP (5, 20%) water solution	
	Phenyl mercuric phosphate (0.4, 0.8, 1.6, 3.0%) water sol.	
	Phenyl mercuric oleate (0.4, 0.8, 1.6, 3.0%) pine oil sol.	
Wolman salt (A) DNP (10%)+NaF (87%)+ SbF_3 (3%) (B) DNP (10%)+NaF (85%)+ $Na_2Cr_2O_7$ (5%) (C) DNP (12.5%+NaF (25%)+ $K_2Cr_2O_7$ (37.5%)+(A)$Na_2As_2O_3$ } (2%) water sol.		

Table 2. Chemicals used for end coating

	1953	1954
Paint type	PCP (2, 5, 10%) + cellulose acetate	
	White linseed oil paint + PCP (5%) .... →	PCP (5%) + NaF (10%) + white linseed oil paint (85%)
	Marine paint (CuO_2, Cu–naphthenate contained) .... →	Marine paint (NaF 10% contained)
	PCP (5%) + chlorinated rubber	
	Vinyl paint + PCP (2, 5, 10%) .... →	Vinyl paint + PCP (5%) + NaF (10%) Water soluble vinyl paint + PCP (5%) + NaF (10%)
	Phenol resin + PCP (2, 5, 10%) Phenol resin (with hardner) Phenol resin (no hardner) Water soluble phenol resin (with hardner) Water soluble phenol resin (no hardner) .... →	Na–PCP (5%) + NaF (20%) + phenol resin (75%)
	Kitajima No. 18 .... →	Kitajima No. 18 Modified Kitajima No. 18 (kieselguhr instead asbestos) PCP (5%) + NaF (10%) + pine oil (75%) + kieselguhr (5%) + asbestos (5%)
	Coal ter creosote 10 parts + pine resin 48 parts + denatured alcohol 26 parts + slaked lime 4 parts + asbestos 10.5 parts	Coal tar creosote (20 parts) + coal tar (30 parts) + kieselguhr (20 parts)
	Urea resin + Na–PCP (5%) + kieselguhr (appropriately)	
	Paraffin (50%) benzol sol.	
	Water glass	
Osmose type	Na–PCP + urea resin + kieselguhr .... →	Na–PCP (10 parts) + NaF (50 parts) + kieselgruhr (5 parts) + urea resin (5 parts) + water (20 parts) Na–PCP (10 parts) + NaF (50 parts) + kieselguhr (5 parts) + coal tar (30 parts) + water (5 parts) Na–PCP (15 parts) + NaF (30 parts) + coal tar creosote (15 parts) + coal tar (15 parts) + kieselguhr (5 parts) + water (20 parts)
	Wolman salts + urea resin + kieselguhr .... →	Wolman salt (30 parts) + coal tar (20 parts) Wolman salt (30 parts) + coal tar (20 parts) + kieselguhr (5 parts) Wolman salt (50 parts) + urea resin (15 parts) + kieselguhr (5 parts) + water (20 parts) osmosalt and osmoplastic

IV. Conclusion

From these experiments in the three years 1952 ～ 1954, it may be concluded that spraying mixed emulsion of 2 ～ 5 % PCP or 15 ～ 30 % coal tar creosote and 2 % γ-BHC, 130 *cc* per m^2 is effective in reducing deterioration of beech logs from insects and fungi during the warm and rainy season in central Honshu, Japan. But, the treated logs should preferable be placed under the shady and wet condition in order to increase the effect of treatment. Needless to say, the application of end coating in addition to spraying gives better results, especially for the control of fungus deterioration.

←

(a) 供試木の並べ方

→

(b) 戸倉(A)試験地

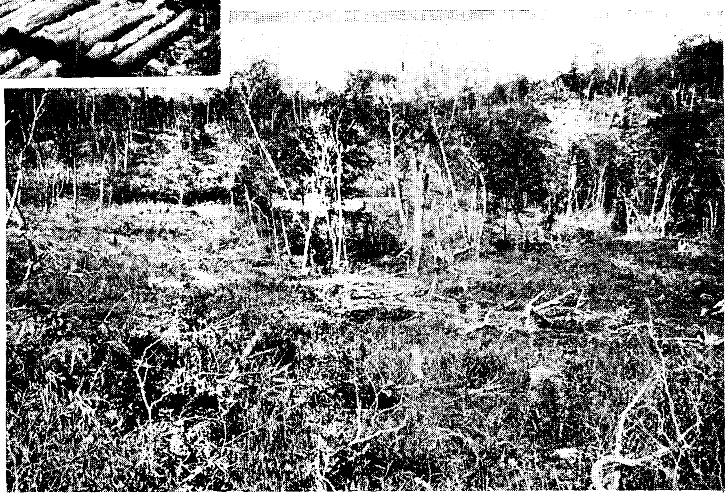
←

(c) 松草試験地

—Plate 2—

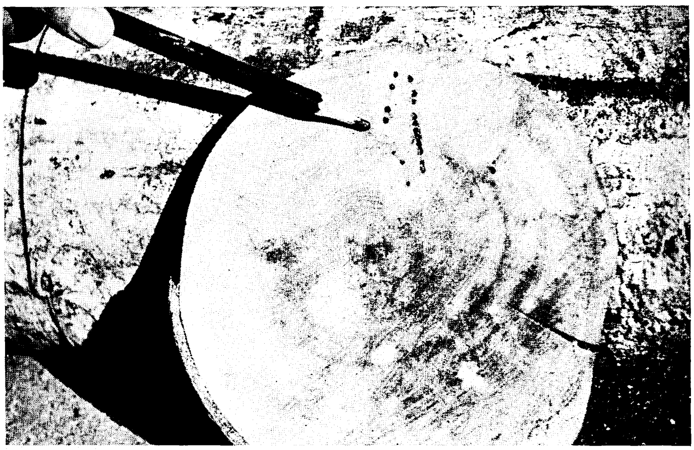
(a) 尻平川試験地
↓

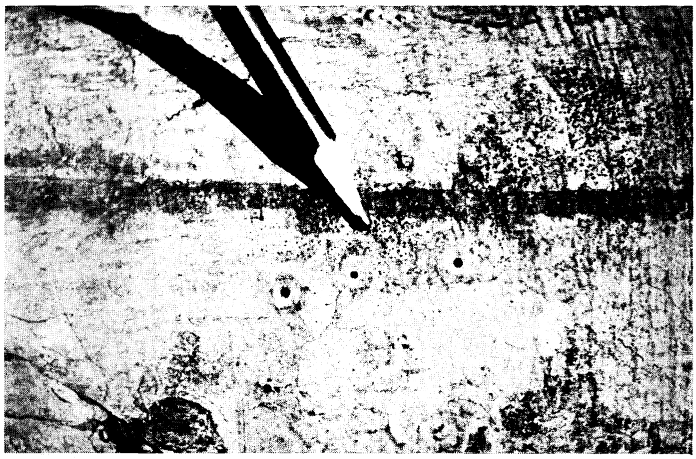
↑
(b) 戸倉（B）試験地



→
(c) 根利試験地

シナノキナガキクイ *Platypus severini* の食痕


ダイミヨウキクイ *Scolytoplatypus daimio* の食痕（幼虫孔）


樹 皮 面 の 穿 入 孔

—Plate 4—

無　処　理

白 灯 油 散 布

PCP・BHC の白灯油溶液散布

Plate 4, 5, 6 は，昭和27年4月下旬に設置した松草試験地の，毎月散布試験における処理後6ヵ月目の外観を示す。

クレオソート油乳剤散布

松根油（PCP を含む）乳剤散布

PCP・DDT 乳剤散布

—Plate 6—

マレニット水溶液散布

PCP・DDT 白灯油溶液散布

PCP・BHC 乳剤散布