# NWPC FIELD TEST WITH WOOD PRESERVATIVES. RESULTS FROM THE TRIALS STARTED IN 1971, 1973, 1975 AND 1977

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## ABSTRACT

This report gives the results from the NWPC field trials started in 1971, 1973, 1975 and 1977. The tests have been performed in co-operation with the Technological Institute, Denmark, the Technical Research Centre of Finland, the Norwegian Institute of Wood Technology and the Department of Forest Products at the Swedish University of Agricultural Sciences. The field trials are carried out according to the NWPC Standard No. 1.4.2.1./71. "Testing of wood preservatives. Mycological tests. Field test -a field test with stakes". The test fields were Tåstrup in Denmark, Vaasa, Vihti and Viikki in Finland, Sörkedalen in Norway and Simlångsdalen in Sweden (Figure 1). In 1986 all the stakes at the test fields of Vaasa and Vihti were moved to Viikki. The stakes used in the trials were made from sapwood of European redwood (**Pinus sylvestris** L.). The preservatives and their chemical formulation and the average index of decay are presented in tables 1-11. Index of decay in relation to the retention of the preservatives is shown in figures 2-8. In the appendix (figures 9-37) the rate of decay is presented for every preservative tested.

## INTRODUCTION

Field tests with wood preservatives have been conducted for many years in each of the Nordic countries. In 1968 the first NWPC test was started. This report gives the results from field trials started in 1971, 1973, 1975 and 1977. The tests are carried out by NWPC in co-operation with the Technological Institute, Denmark, the Technical Research Centre of Finland, the Norwegian Institute of Wood Technology and the Department of Forest Products at the Swedish University of Agricultural Sciences.

## MATERIALS AND METHODS

The field trials are carried out according to the NWPC Standard No. 1.4.2.1./71 "Testing of wood preservatives. Mycological test. Field test - a field test with stakes". The stakes used in the trials were made from sapwood of European redwood (**Pinus sylvestris** L.). The size of the stakes was 20 x 50 x 500 mm.

The location of the Nordic test fields is shown in Figure 1. The soil types of the test fields are:

| | | |
|---|---|---|
| Denmark, | Tåstrup: | Moraine clay. |
| Finland, | Vaasa: | Forest mould containing much organic material. |
| | Vihti: | Clay containing some organic material. |
| | Viikki: | Clay containing organic material. |
| Norway, | Sörkedalen: | Sandy soil containing some organic material. |
| Sweden, | Simlångsdalen: | Sandy soil. |

All the stakes at the test fields Vaasa and Vihti were moved in 1986 to the test field of Viikki.

The extent of decay was graded according to the following scale:

| Condition | Grading of decay | Index of decay |
|---|---|---|
| Sound - no decay | 0 | 0 |
| Slight decay | 1 | 25 |
| Moderate decay | 2 | 50 |
| Severe decay | 3 | 75 |
| Very severe decay (stake rejected, due to failure in bending apparatus). | 4 | 100 |

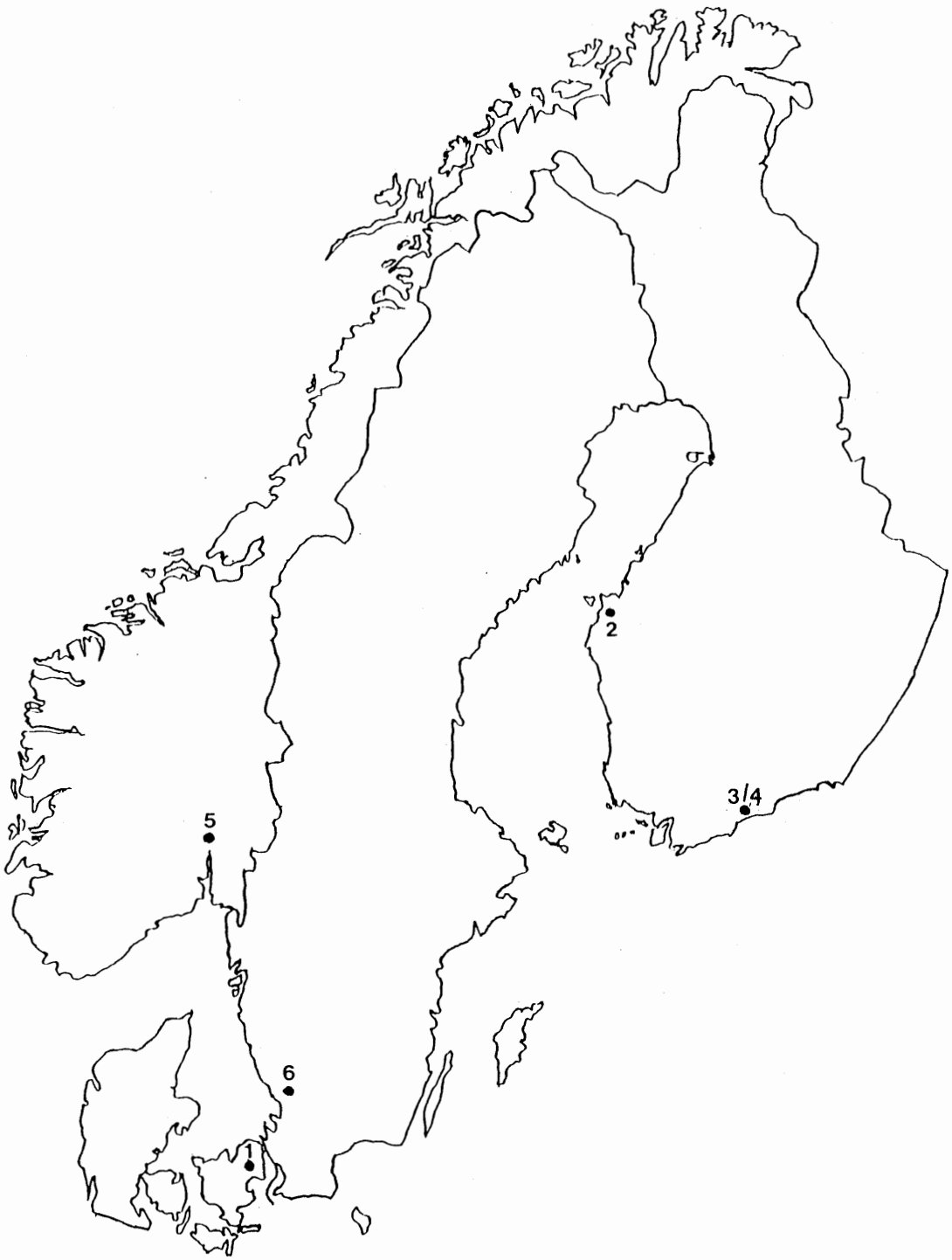



Figure 1. Location of the Nordic test fields.

1. Tåstrup
2. Vaasa
3. Vihti, near Helsinki
4. Viikki, near Helsinki
5. Sörkedalen
6. Simlångsdalen

By adding up the index of decay for the stakes of each group and dividing the sum by the number of stakes the average index of decay for each preservative and retention level is obtained. When all stakes in a group have failed (average index of decay = 100), the average service life is calculated.

The retentions of a preservative are based on the chemical composition which is presented in the tables.

## RESULTS AND DISCUSSION

### Field trial 1971

The preservatives of the 1971 trial and their chemical formulations are listed in Table 1. The test fields used were Simlångsdalen, Vaasa and Sörkedalen. Ten stakes were set out at each test field for every retention level. However, the number of untreated stakes at each test field was 20. In 1986 the remaining stakes at Vaasa were moved to Viikki.

The average index of decay after 5 and 16 years' testing is shown in Table 2 for the preservatives tested at Simlångsdalen and Vaasa/Viikki and in Table 3 for the preservatives tested at Simlångsdalen and Sörkedalen.

Index of decay in relation to the retention of the preservatives is shown in Figure 2 for stakes at Simlångsdalen and Vaasa/Viikki and in Figure 3 for stakes at Simlångsdalen and Sörkedalen. Figures 9-20 in the Appendix give the rate of decay for stakes with various retention levels of the preservatives tested.

The stakes both treated and untreated decayed more rapidly at Vaasa than at Simlångsdalen and more rapidly at Simlångsdalen than at Sörkedalen. This is the case for all preservatives tested in this trial. The service life of untreated stakes was 1.1 years at Vaasa, 3.6 years at Simlångsdalen and 4.1 years at Sörkedalen. The main reason for this variation between the test fields is expected to be soil and climate. The soil at Vaasa is very rich in organic matter while the soil at Sörkedalen is poor (Henningsson 1974, Borsholt 1979).

A comparison of the preservatives at Simlåndsdalen and Vaasa/Viikki (Figure 2) shows that the order of efficacy is somewhat different. At Simlångsdalen Kemira C64 gave the best protection followed by Kemira K64, Celcure M, Tanalith NCA, Celcure SM and KP Cuprinol. The order at Vaasa/Viikki was Kemira K64, Tanalith NCA, Kemira C64, Celcure M, Celcure SM and KP Cuprinol.

A comparison of the preservatives at Simlångsdalen and Sörkedalen (Figure 3) gives almost the same order of efficacy. At Simlångsdalen the

order is Boliden P50, Boliden APUS, CCB A, Cuprinol Tryck and BP SUN/WP and at Sörkedalen Boliden APUS, Boliden P50, CCB A, Cuprinol Tryck and BP SUN/WP. The difference between Boliden APUS and Boliden P50 at the two fields was very small.

Table 1. NWPC Field trial 1971. Preservatives tested and their chemical formulation.

| Wood preservative | Chemical formulation % m/m | | Active components % m/m | | Manufacturer * |
|---|---|---|---|---|---|
| Boliden APUS | CuO | 12.3 | Cu | 9.8 | Boliden AB |
| | $CrO_3$ | 32.4 | Cr | 16.8 | |
| | $As_2O_5$ | 27.4 | As | 17.9 | |
| | $Na_2O$ | 3.4 | | | |
| | $H_2O$ | 24.5 | | | |
| Boliden P50 | CuO | 15.9 | Cu | 12.0 | Boliden AB |
| | $CrO_3$ | 20.0 | Cr | 10.4 | |
| | $P_2O_5$ | 16.6 | P | 7.7 | |
| | $H_2O$ | 47.5 | | | |
| Celcure M | $CuSO_4 \cdot 5H_2O$ | 36.0 | Cu | 9.2 | Rentokil Ltd. |
| | $Na_2Cr_2O_7 \cdot 2H_2O$ | 40.0 | Cr | 14.8 | |
| | $Cr(CH_3COO)_3 \cdot H_2O$ | 4.0 | B | 3.5 | |
| | $H_3BO_3$ | 20.0 | | | |
| Celcure SM | $CuSO_4 \cdot 5H_2O$ | 53.0 | Cu | 13.5 | Rentokil Ltd. |
| | $Na_2Cr_2O_7 \cdot 2H_2O$ | 29.4 | Cr | 10.8 | |
| | $Cr(CH_3COO)_3 \cdot H_2O$ | 2.9 | B | 2.6 | |
| | $H_3BO_3$ | 14.7 | | | |
| Cuprinol Tryck (KP-N) | CuO | 12 | Cu | 9.5 | Hager AB |
| | $C_7H_{15}COOH$ | 4.75 | $C_7H_{15}COOH$ | 4.75 | |
| | $NH_3$ | ~20 | | | |
| | $CO_2$ | ~40 | | | |
| | $H_2O$ | ~25 | | | |
| KP Cuprinol | K-salt 91.3 % | | Cu | 10.9 | Bönnelyche &Thuröe AB |
| | CuO | 15 | Na-PCP | 6.1 | |
| | $NH_3$ | 18 | | | |
| | $CO_2$ | 44 | | | |
| | $H_2O$ | 23 | | | |
| | P-salt 8.7 % | | | | |
| | $C_6HCl_4ONa$(Na-PCP) | 70 | | | |
| | $H_2O$ | 30 | | | |
| Kemira K64 | CuO | 22.9 | Cu | 18.3 | Kemira Oy |
| | $CrO_3$ | 33.6 | Cr | 17.5 | |
| | $As_2O_5$ | 18.3 | As | 11.9 | |
| | $P_2O_5$ | 10.4 | P | 4.5 | |
| | $SO_3$ | 3.6 | | | |
| | $H_2O$ | 11.2 | | | |
| Kemira C64 | CuO | 25.3 | Cu | 20.2 | Kemira Oy |
| | $CrO_3$ | 40.8 | Cr | 21.2 | |
| | $P_2O_5$ | 16.8 | P | 7.3 | |
| | $SO_3$ | 4.4 | | | |
| | $H_2O$ | 12.7 | | | |
| Tanalith NCA (Tancas NCA) | $CuSO_4$ | 29.7 | Cu | 11.8 | Hickson and Welch Ltd. |
| | $Na_2Cr_2O_7$ | 31.7 | Cr | 12.6 | |
| | $As_2O_5 \cdot 2H_2O$ | 26.3 | As | 20.0 | |
| | $Na_4As_2O_7$ | 12.3 | | | |
| CCB A | CuO | 10.8 | Cu | 8.6 | - |
| | $CrO_3$ | 26.4 | Cr | 13.7 | |
| | $H_3BO_3$ | 25.5 | B | 4.5 | |
| | $KHSO_4$ | 35.7 | | | |
| | ZnO | 1.6 | | | |
| BP SUN/WP (CBY) | Mixture of saturated and unsaturated hydrocarbons | | | | The British Petroleum Co Ltd. |
| NWPC Standard Preservative No. 1 | CuO | 19.0 | Cu | 15.2 | - |
| | $CrO_3$ | 36.0 | Cr | 18.7 | |
| | $As_2O_5$ | 45.0 | As | 29.3 | |

* Manufacturer that originally ordered the test.

Table 2. NWPC Field trial 1971. Results after 5 and 16 years' testing

| Wood preservative | Concentration % m/m | Retention kg/m³ | Index of decay and average service life ($\bar{x}$) Simlångsdalen (Sweden) Year 5 | Year 16 | $\bar{x}$ | Vaasa/Viikki (Finland) * Year 5 | Year 16 | $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| Celcure M | 1.4 | 9.9 | 0 | 50 | | 53 | 100 | 8.8 |
| | 2.2 | 16 | 0 | 15 | | 38 | 80 | |
| | 3.0 | 20 | 0 | 18 | | 28 | 73 | |
| | 4.5 | 33 | 0 | 10 | | 0 | 53 | |
| | 6.0 | 42 | 0 | 8 | | 5 | 45 | |
| Celcure SM | 1.0 | 7.3 | 0 | 100 | 14 | 53 | 100 | 7.2 |
| | 1.5 | 11 | 0 | 85 | | 68 | 100 | 8.0 |
| | 2.0 | 15 | 0 | 78 | | 45 | 95 | |
| | 3.0 | 21 | 0 | 33 | | 30 | 83 | |
| | 4.0 | 29 | 0 | 15 | | 8 | 73 | |
| KP Cuprinol | 1.5 | 11 | 0 | 100 | 13 | 40 | 100 | 7.1 |
| | 2.3 | 16 | 0 | 100 | 13 | 48 | 100 | 10 |
| | 3.3 | 25 | 0 | 93 | | 28 | 100 | 14 |
| | 4.3 | 30 | 0 | 43 | | 15 | 88 | |
| | 5.7 | 41 | 0 | 48 | | 15 | 78 | |
| Kemira K64 | 0.8 | 5.5 | 3 | 83 | | 13 | 90 | |
| | 1.2 | 8.1 | 0 | 25 | | 25 | 78 | |
| | 1.6 | 11 | 0 | 10 | | 3 | 55 | |
| | 2.4 | 18 | 0 | 23 | | 0 | 28 | |
| | 3.2 | 23 | 0 | 3 | | 0 | 18 | |
| Kemira C64 | 0.9 | 6.5 | 0 | 38 | | 23 | 100 | 10 |
| | 1.4 | 10 | 0 | 13 | | 15 | 80 | |
| | 1.8 | 12 | 0 | 3 | | 5 | 63 | |
| | 2.7 | 19 | 0 | 8 | | 3 | 40 | |
| | 3.7 | 26 | 0 | 5 | | 0 | 28 | |
| Tanalith NCA (Tancas NCA) | 1.0 | 7.4 | 0 | 93 | | 8 | 95 | |
| | 1.5 | 11 | 0 | 63 | | 10 | 83 | |
| | 2.0 | 14 | 0 | 35 | | 3 | 55 | |
| | 3.0 | 21 | 0 | 23 | | 0 | 30 | |
| | 4.0 | 30 | 0 | 28 | | 0 | 25 | |
| NWPC Standard Preservative No. 1 | 1.3 | 9.4 | 0 | 18 | | 8 | 75 | |
| Untreated | | | 100 | 100 | 3.6 | 100 | 100 | 1.1 |

* The stakes were moved from Vaasa to Viikki in 1986.

Table 3. NWPC Field trial 1971. Results after 5 and 16 years' testing

| Wood preservative | Concentration % m/m | Retention kg/m³ | Index of decay and average service life ($\bar{x}$) Simlångsdalen (Sweden) Year 5 | Year 16 | $\bar{x}$ | Sörkedalen (Norway) Year 5 | Year 16 | $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| Boliden APUS | 1.0 | 7.2 | 0 | 78 | | 0 | 23 | |
| | 1.5 | 11 | 0 | 48 | | 0 | 8 | |
| | 2.0 | 14 | 0 | 45 | | 0 | 5 | |
| | 3.0 | 21 | 0 | 14 | | 0 | 0 | |
| | 4.0 | 29 | 0 | 13 | | 0 | 0 | |
| Boliden P50 | 1.0 | 7.2 | 0 | 93 | | 3 | 50 | |
| | 1.5 | 11 | 0 | 48 | | 0 | 18 | |
| | 2.0 | 14 | 0 | 43 | | 0 | 8 | |
| | 3.0 | 22 | 0 | 10 | | 0 | 5 | |
| | 4.0 | 29 | 0 | 11 | | 0 | 3 | |
| Cuprinol Tryck (KP-N) | 1.6 | 11 | 3 | 100 | 13 | 13 | 65 | |
| | 2.4 | 17 | 0 | 85 | | 3 | 35 | |
| | 3.2 | 23 | 0 | 95 | | 0 | 23 | |
| | 4.8 | 34 | 0 | 45 | | 0 | 28 | |
| | 6.4 | 45 | 0 | 35 | | 0 | 18 | |
| CCB A | 1.3 | 8.7 | 0 | 40 | | 0 | 38 | |
| | 1.9 | 14 | 0 | 38 | | 0 | 3 | |
| | 2.5 | 18 | 0 | 35 | | 0 | 8 | |
| | 3.8 | 27 | 0 | 15 | | 0 | 10 | |
| | 5.0 | 37 | 0 | 0 | | 0 | 0 | |
| BP SUN/WP (CBY) | | 75 | 40 | 100 | 9.1 | 3 | 78 | |
| | | 112 | 25 | 100 | 11 | 3 | 65 | |
| | | 150 | 33 | 98 | | 0 | 38 | |
| | | 225 | 18 | 78 | | 0 | 23 | |
| | | 300 | 13 | 88 | | 0 | 23 | |
| NWPC Standard Preservative No. 1 | 1.3 | 9.6 | 0 | 18 | | 3 | 5 | |
| Untreated | | | 100 | 100 | 3.6 | 100 | 100 | 4.1 |

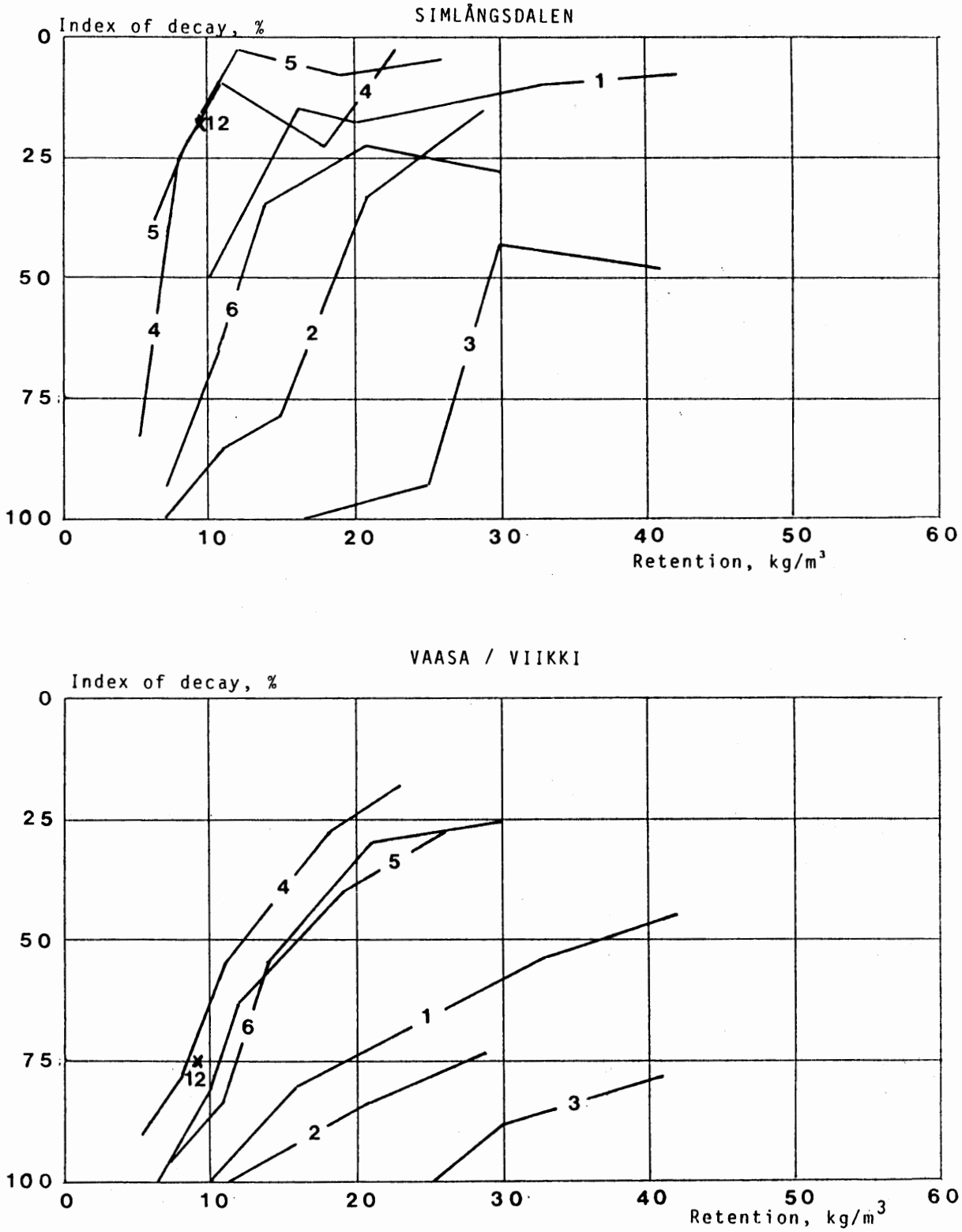



Figure 2. Index of decay in relation to the retention after 16 years.
1. Celcure M, 2. Celcure SM, 3. KP Cuprinol, 4. Kemira K64,
5. Kemira C64, 6. Tanalith NCA, 12. NWPC Standard Preservative
No. 1

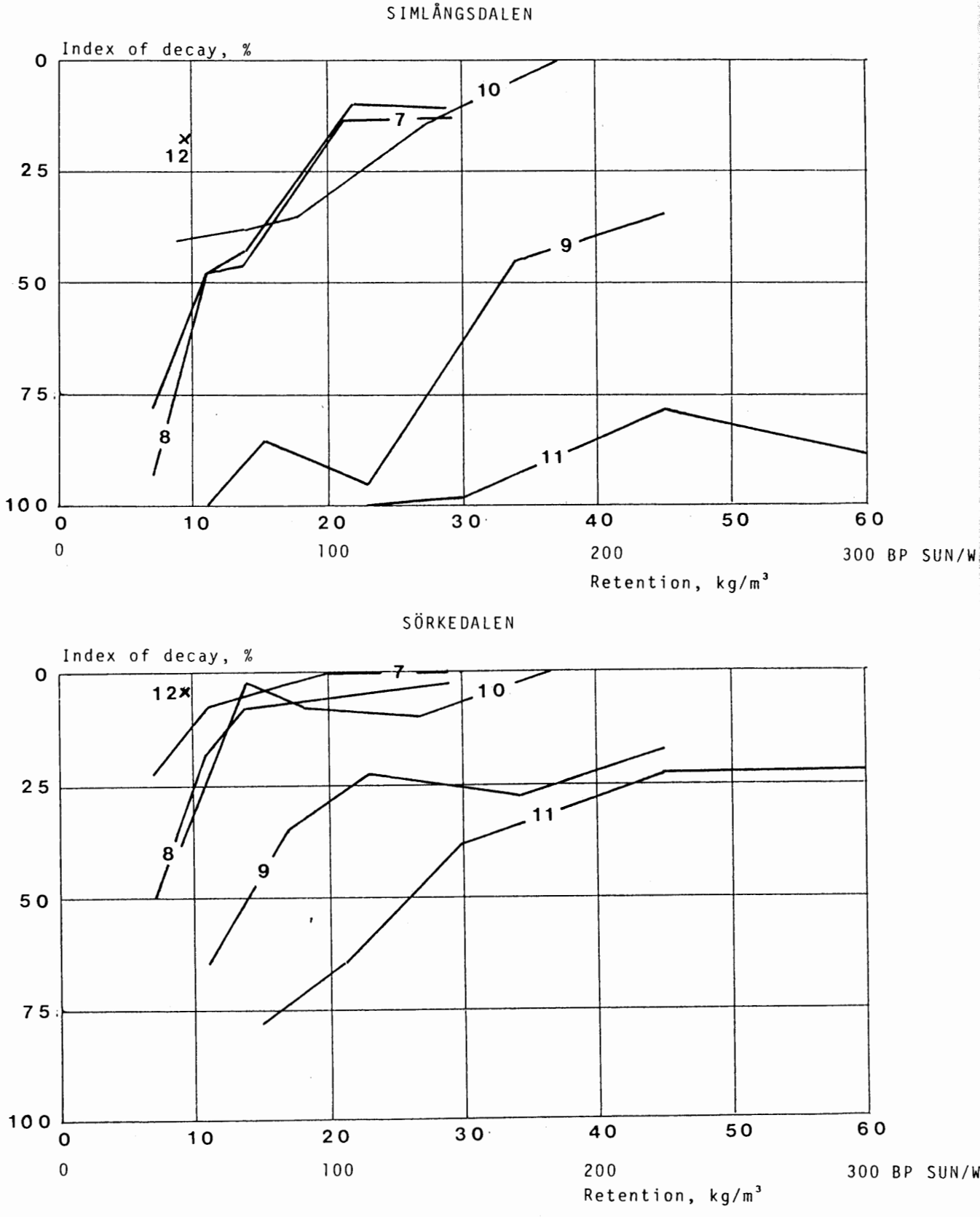



Figure 3. Index of decay in relation to the retention after 16 years. 7. Boliden APUS, 8. Boliden P50, 9. Cuprinol Tryck, 10. CCB A,11. BP SUN/WP, 12. NWPC Standard Preservative No. 1.

**Field trial 1973**

The preservatives of the 1973 trial and their chemical formulations are listed in Table 4. The number of stakes of every retention level at the test fields were:

| | |
|---|---|
| Vaasa | 10 |
| Tåstrup | 10 |
| Sörkedalen | 10 |
| Simlångsdalen | 20 |

In 1986 the remaining stakes at Vaasa were moved to Viikki.

The index of decay after 5 and 14 years' testing is shown in Table 5 for Simlångsdalen and Tåstrup, Table 6 for Simlångsdalen and Vaasa/Viikki and in Table 7 for Simlångsdalen and Sörkedalen.

Stakes treated with NWPC Standard Preservative No. 1 were set out at every test field in 1973. However, it was later found that a wrong concentration had been used in the treatment. Thus no results from stakes treated with NWPC Standard Preservative No. 1 are presented. The results of NWPC Standard Preservative No. 1 in the field trials of 1971 or 1975 may be used for comparisons.

Index of decay in relation to the retention of the preservatives is shown in Figure 4 for stakes at Simlångsdalen and Tåstrup, in Figure 5 for stakes at Simlångsdalen and Vaasa/Viikki, and in Figure 6 for stakes at Simlångsdalen and Sörkedalen. Figures 21-28 of the Appendix give the rate of decay for stakes with various retention levels of the preservatives tested.

The service life of untreated stakes in this trial was also shortest at Vaasa, (1.0 year), followed by Tåstrup (3.8years) Simlångsdalen (4.4 years) and Sörkedalen (4.8 years).

A comparison of the preservatives at the test fields Simlångsdalen and Tåstrup (Figure 4), Simlångsdalen and Vaasa/Viikki (Figure 5) and Simlångsdalen and Sörkedalen (Figure 6) reveals the same order of efficacy.

Table 4. NWPC Field trial 1973. Preservatives tested and their chemical formulation

| Wood preservative | Chemical formulation % m/m | | Active components % m/m | | Manufacturer* |
|---|---|---|---|---|---|
| ACCA | CuO | 7.4 | Cu | 5.9 | - |
| | $CrO_3$ | 4.0 | Cr | 2.1 | |
| | $As_2O_5$ | 4.0 | As | 2.6 | |
| | $NH_3$ | 19.0 | | | |
| | $CO_2$ | 39.0 | | | |
| | $H_2O$ | 26.4 | | | |
| Boliden P50B | CuO | 11.2 | Cu | 8.9 | Boliden AB |
| | $CrO_3$ | 15.8 | Cr | 8.2 | |
| | $P_2O_5$ | 13.2 | P | 5.8 | |
| | $B_2O_3$ | 14.1 | B | 4.4 | |
| | $H_2O$ | 45.7 | | | |
| Celcure AP5 | CuO | 13.1 | Cu | 10.5 | Boliden AB |
| | $CrO_3$ | 34.4 | Cr | 17.9 | |
| | $As_2O_5$ | 27.5 | As | 17.9 | |
| | $H_2O$ | 25.0 | | | |
| Kemira KC-73 | CuO | 25.5 | Cu | 23.5 | Kemira Oy |
| | $CuSO_4$ | 8.3 | | | |
| | $CrO_3$ | 66.2 | Cr | 34.4 | |
| Kemira KCA-73 | CuO | 21.6 | Cu | 19.3 | Kemira Oy |
| | $CuSO_4$ | 5.4 | Cr | 28.0 | |
| | $CrO_3$ | 53.8 | As | 12.5 | |
| | $As_2O_5$ | 19.2 | | | |
| Kemira KFN-73 | $Cu(NH_4)_4CO_3$ | 13.5 | Cu | 4.3 | Kemira Oy |
| | $NH_4HCO_3$ | 9.9 | Cr | 7.5 | |
| | BON-$NH_4$** | 4.8 | F | 7.9 | |
| | $NH_4OH$ | 2.6 | BON-$NH_4$ | 3.9 | |
| | $NH_4F$ | 15.3 | | | |
| | $(NH_4)_2CrO_4$ | 22.1 | | | |
| | NaOH | 0.9 | | | |
| | $H_2O$ | ~31 | | | |
| Hylosan PT (Permapruf T) | TBTO | 10 | TBTO | 10 | Penarth Research Centre |
| | Benzalkyl trimethyl ammoniumchloride (BA) | 40 | BA | 40 | |
| | Additives | ~ 6 | | | |
| | $H_2O$ | ~44 | | | |

* Manufacturer that originally ordered the test.
** BON = Beta-oxy naphthoic acid.

Table 5. NWPC Field trial 1973. Results after 5 and 14 years' testing

| Wood preservative | Concentration % m/m | Retention kg/m³ | Index of decay and average service life ($\bar{x}$) Simlångsdalen (Sweden) Year 5 | 14 | $\bar{x}$ | Tåstrup (Denmark) Year 5 | 14 | $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| Boliden P50 B | 1.3 | 8.4 | 33 | 78 | | 18 | 50 | |
| | 1.8 | 12 | 16 | 68 | | 13 | 28 | |
| | 2.5 | 17 | 0 | 43 | | 3 | 22 | |
| | 3.5 | 24 | 0 | 28 | | 3 | 20 | |
| | 5.0 | 34 | 3 | 23 | | 3 | 6 | |
| Kemira KCA-73 | 0.5 | 3.7 | 1 | 51 | | 5 | 43 | |
| | 0.8 | 5.2 | 1 | 41 | | 5 | 30 | |
| | 1.1 | 7.4 | 0 | 19 | | 3 | 20 | |
| | 1.5 | 10 | 0 | 15 | | 0 | 5 | |
| | 2.1 | 15 | 0 | 25 | | 8 | 13 | |
| Untreated | | | 93 | 100 | 4.4 | 95 | 100 | 3.8 |

Table 6. NWPC Field trial 1973. Results after 5 and 14 years' testing

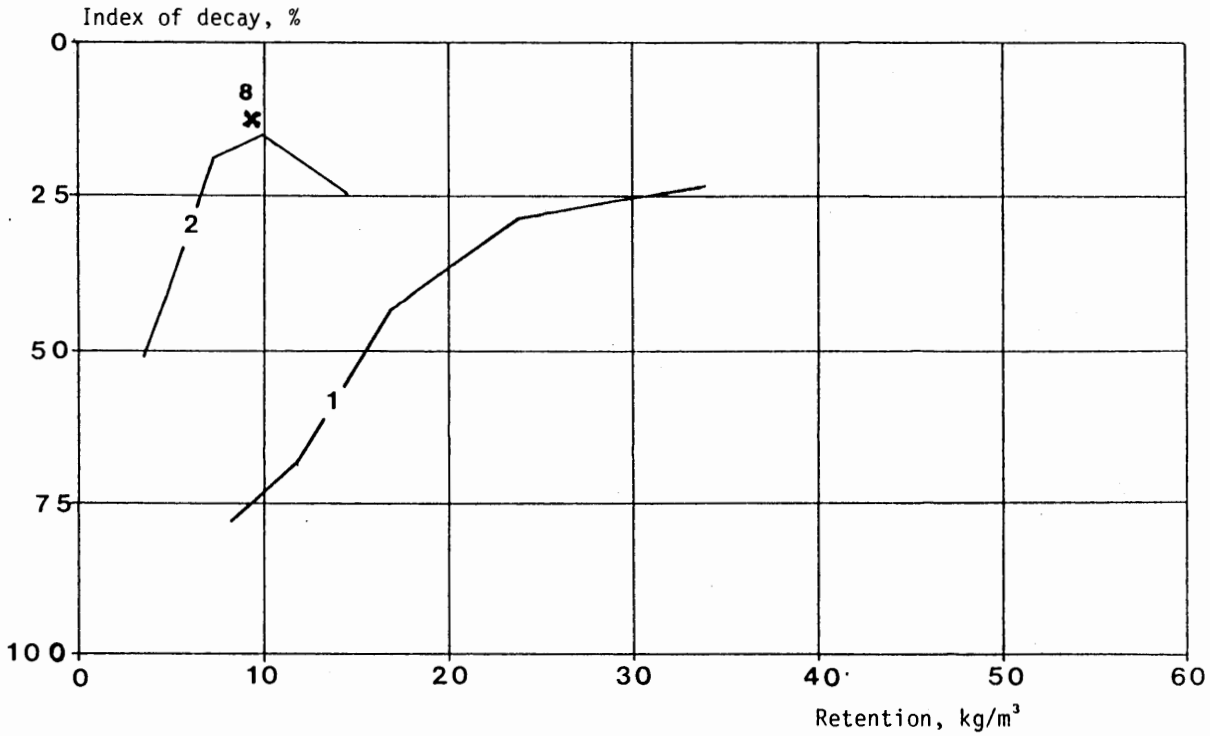
| Wood preservative | Concentration % m/m | Retention kg/m³ | Index of decay and average service life ($\bar{x}$) Simlångsdalen (Sweden) Year 5 | 14 | $\bar{x}$ | Vaasa/Viikki (Finland)* Year 5 | 14 | $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| ACCA | 2.1 | 14 | 16 | 96 | | 43 | 93 | |
| | 3.0 | 20 | 4 | 90 | | 25 | 73 | |
| | 4.3 | 29 | 4 | 58 | | 10 | 83 | |
| | 6.0 | 41 | 0 | 26 | | 15 | 58 | |
| | 8.5 | 59 | 0 | 28 | | 20 | 45 | |
| Celcure AP5 | 1.0 | 6.2 | 0 | 59 | | 25 | 73 | |
| | 1.4 | 9.0 | 0 | 41 | | 10 | 65 | |
| | 2.0 | 13 | 0 | 38 | | 3 | 38 | |
| | 2.8 | 19 | 0 | 17 | | 3 | 28 | |
| | 4.0 | 28 | 0 | 16 | | 0 | 18 | |
| Hylosan PT (Permapruf T) | 1.0 | 6.8 | 18 | 100 | 10 | 25 | 88 | |
| | 1.5 | 10 | 8 | 92 | | 18 | 74 | |
| | 2.0 | 14 | 10 | 67 | | 5 | 68 | |
| | 3.0 | 16 | 8 | 69 | | 5 | 58 | |
| | 4.0 | 23 | 4 | 53 | | 0 | 38 | |
| Untreated | | | 93 | 100 | 4.4 | 100 | 100 | 1.0 |

* The stakes were moved from Vaasa to Viikki in 1986.

Table 7. NWPC Field trial 1973. Results after 5 and 14 years' testing

| Wood preservative | Concentration % m/m | Retention kg/m³ | Index of decay and average service life ($\bar{x}$) Simlångsdalen (Sweden) Year 5 | 14 | $\bar{x}$ | Sörkedalen (Norway) Year 5 | 14 | $\bar{x}$ |
|---|---|---|---|---|---|---|---|---|
| Kemira KC-73 | 0.5 | 3.6 | 20 | 70 | | 8 | 23 | |
| | 0.8 | 5.2 | 15 | 64 | | 0 | 18 | |
| | 1.1 | 7.4 | 3 | 36 | | 0 | 15 | |
| | 1.5 | 10 | 0 | 28 | | 0 | 3 | |
| | 2.1 | 15 | 0 | 33 | | 0 | 0 | |
| Kemira KFN-73 | 1.9 | 12 | 0 | 98 | | 20 | 58 | |
| | 2.6 | 18 | 0 | 78 | | 10 | 25 | |
| | 3.7 | 25 | 0 | 58 | | 18 | 40 | |
| | 5.2 | 29 | 24 | 75 | | 18 | 20 | |
| | 7.4 | 42 | 16 | 63 | | 10 | 10 | |
| Untreated | | | 93 | 100 | 4.4 | 93 | 100 | 4.8 |

SIMLÅNGSDALEN




TÅSTRUP

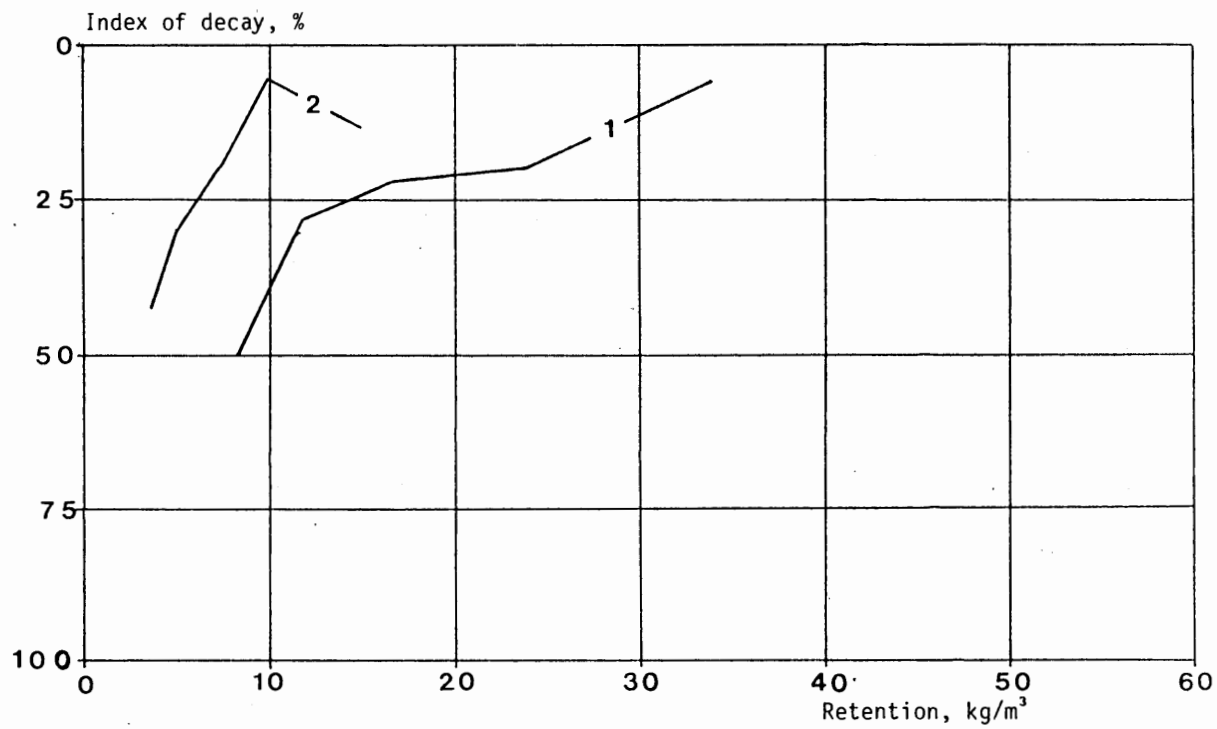
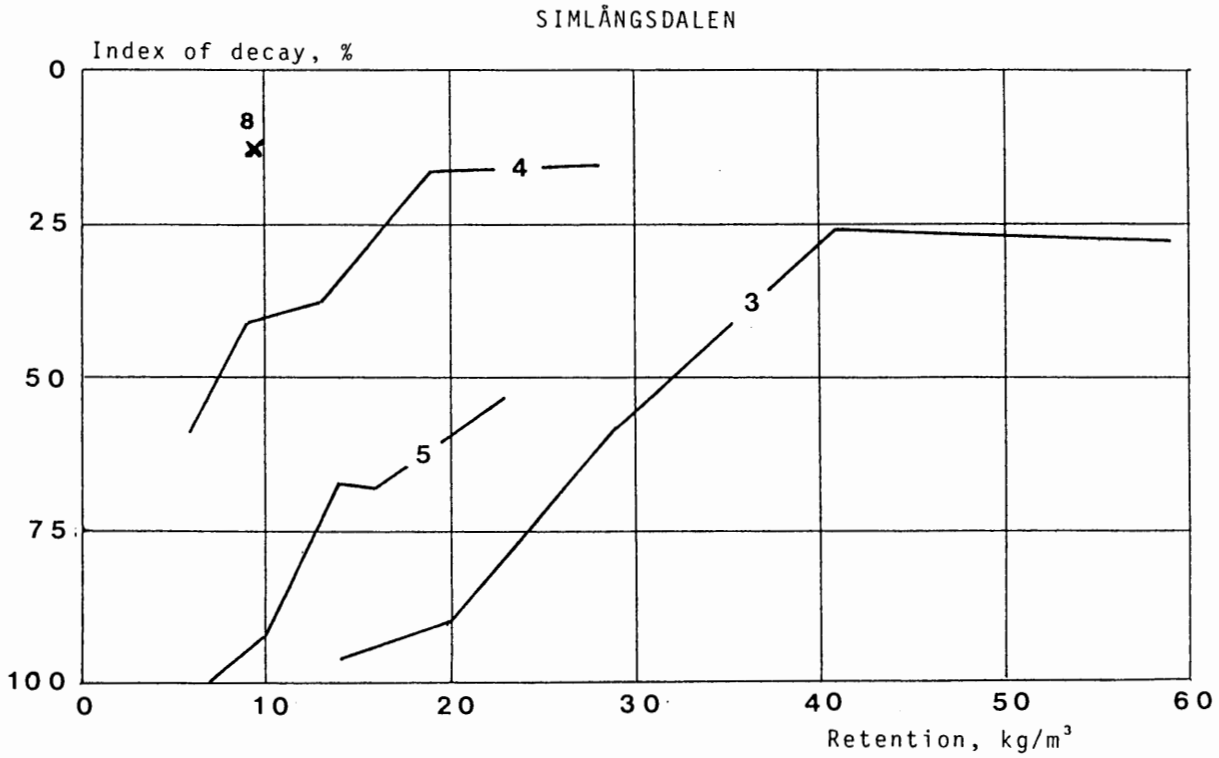



Figure 4. Index of decay in relation to the retention after 14 years.

1. Boliden P50 B, 2. Kemira KCA-73. 8. NWPC Standard Preservative No. 1 (note, results from field trial 1971).



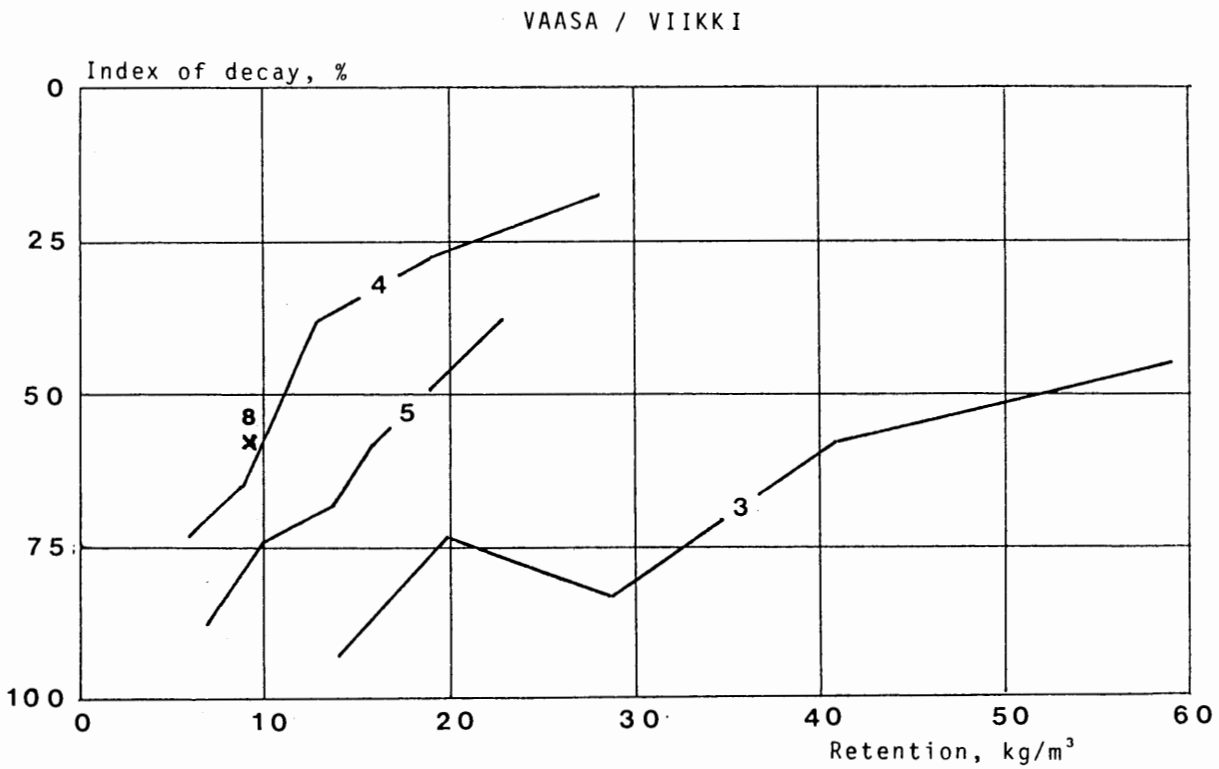
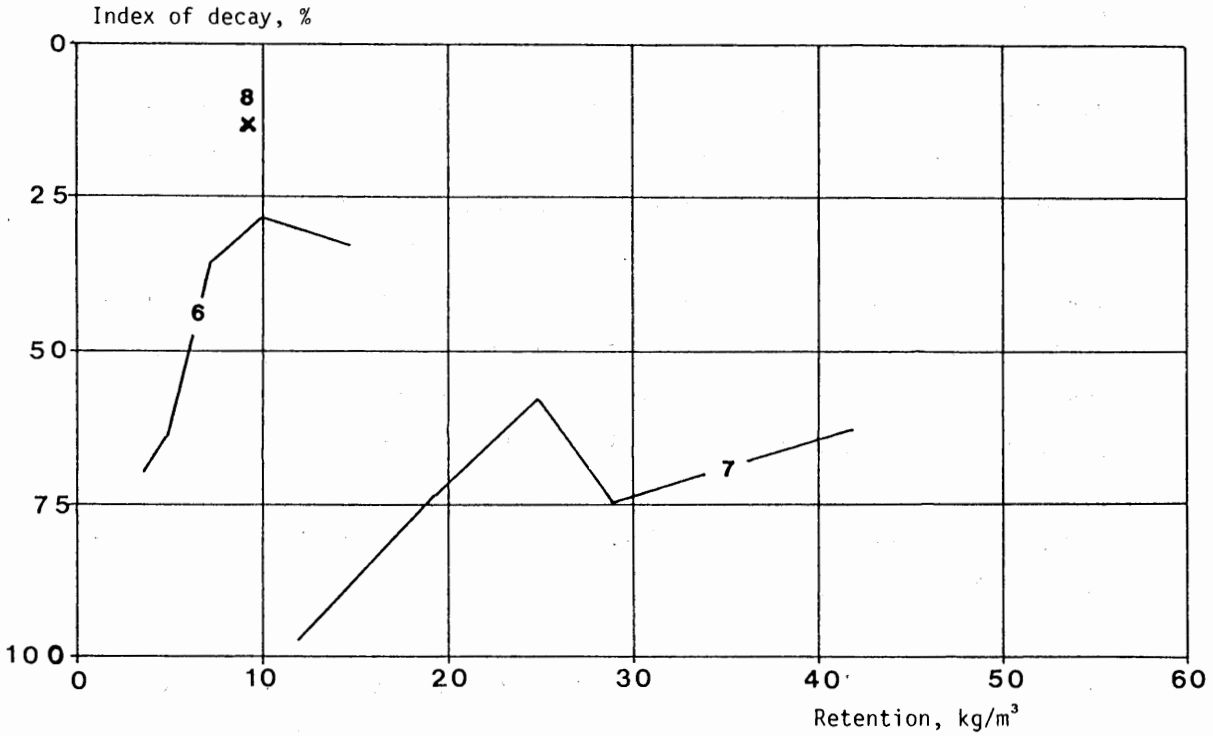




Figure 5. Index of decay in relation to the retention after 14 years. 3. ACCA, 4. Celcure AP5, 5. Hylosan PT. 8. NWPC Standard Preservative No. 1 (note, results from field trial 1971).

SIMLÅNGSDALEN




SÖRKEDALEN

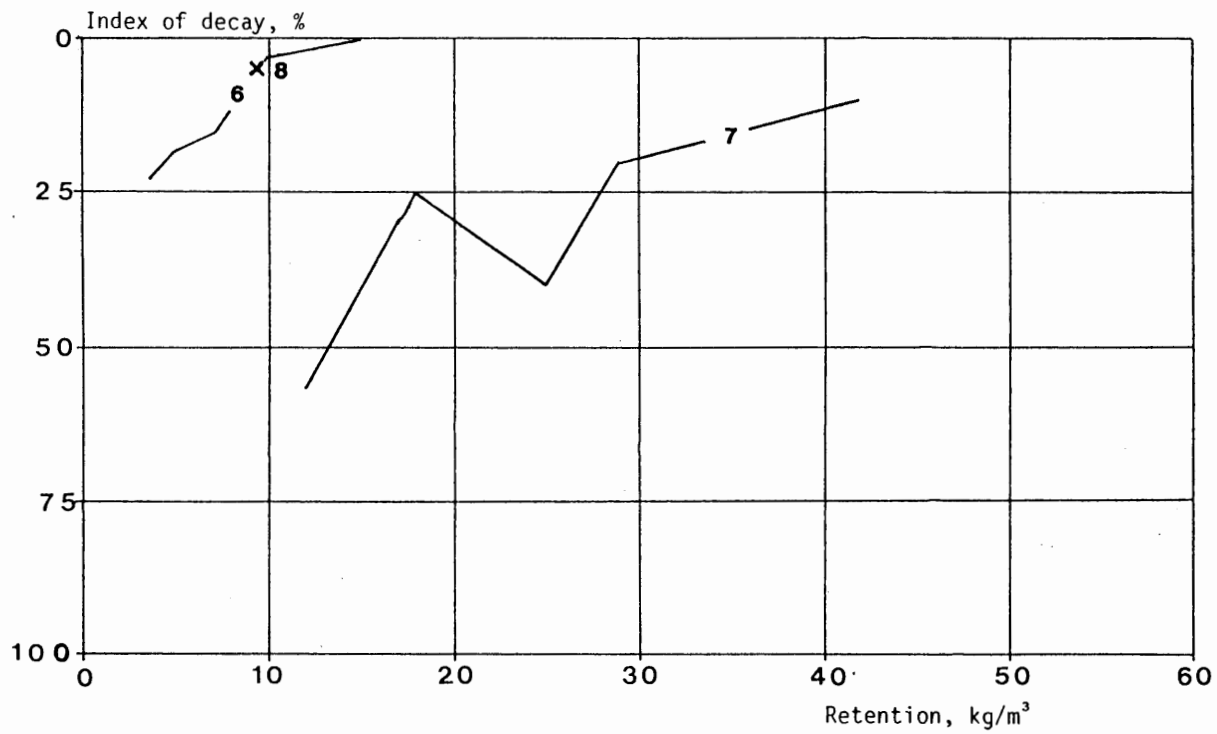



Figure 6. Index of decay in relation to the retention after 14 years. 6. Kemira KC-73, 7. Kemira KFN-73. 8. NWPC Standard Preservative No. 1 (note, results from field trial 1971).

**Field trial 1975**

The preservatives of the 1975 trial and their chemical formulations are listed in Table 8. For every retention level of the preservatives tested, 20 stakes were set out at Simlångsdalen and 10 stakes at Tåstrup.

The index of decay after 5 and 12 years' testing is shown in Table 9. Figure 7 presents index of decay in relation to the retention of the preservatives tested. The rate of decay for stakes with various retentions of the preservatives is shown in Figures 29-33 of the Appendix.

The service life of untreated stakes was 3.8 years at Simlångsdalen and 3.6 years at Tåstrup.

Both at Simlångsdalen and Tåstrup, Basilit KM showed the best efficacy while the rank between the other preservatives tested was not truly apparent (Figure 7).

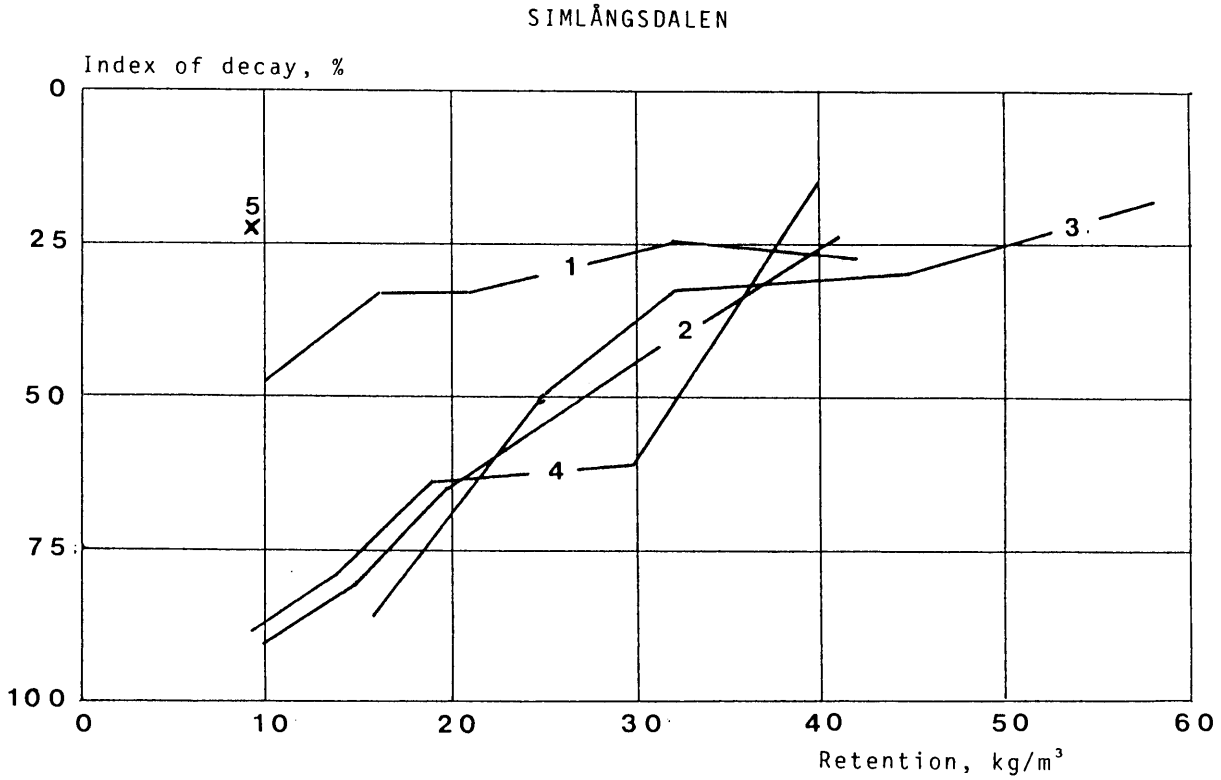
Table 8. NWPC Field trial 1975. Preservatives tested and their chemical formulation

| Wood preservative | Chemical formulation % m/m | | Active components % m/m | | Manufacturer* |
|---|---|---|---|---|---|
| Basilit KM | $CuSO_4 \cdot 5H_2O$ | 49.5 | Cu | 12.6 | Desowag-Bayer |
| | $CrO_3$ | 1.7 | Cr | 17.8 | Holzschutz GmbH |
| | $K_2Cr_2O_7$ | 47.8 | | | |
| | Anticorrosive | 1.0 | | | |
| Gufa 521 | CuO | 13.8 | Cu | 11.1 | Gullviks Fabriks AB |
| | $H_3BO_3$ | 4.0 | B | 0.7 | |
| | $C_2H_5COOH$ | 5.1 | | | |
| | $NH_3$, $CO_2$, $H_2O$ | rest** | | | |
| Kemira K-75 | Copper thallate (9.5 % Cu) | 43.1 | Cu | 5.7 | Kemira Oy |
| | Copper naphthenate (9.5 % Cu) | 16.9 | | | |
| | $CH_2Cl_2$ | 40.0 | | | |
| Kemira KB-75 | $Cu(NH_4)_4CO_3$ | 30.2 | Cu | 9.8 | Kemira Oy |
| | $CH_3COONH_4$ | 5.0 | B | 4.8 | |
| | $(NH_4)_2B_4O_7$ | 24.0 | | | |
| | $NH_4HCO_3$ | 40.0 | | | |
| NWPC Standard Preservative No. 1 | CuO | 19.0 | Cu | 15.2 | - |
| | $CrO_3$ | 36.0 | Cr | 18.7 | |
| | $As_2O_5$ | 45.0 | As | 29.3 | |

* Manufacturer that originally ordered the test.
** Not specified in detail.

Table 9. NWPC Field trial 1975. Results after 5 and 12 years' testing.

| Wood preservative | Concentration % m/m | Retention kg/m³ | Index of decay and average service life ($\bar{x}$) Simlångsdalen (Sweden) Year | | | Tåstrup (Denmark) Year | | |
|---|---|---|---|---|---|---|---|---|
| | | | 5 | 12 | $\bar{x}$ | 5 | 12 | $\bar{x}$ |
| Basilit KM | 1.5 | 10 | 1 | 48 | | 13 | 18 | |
| | 2.3 | 16 | 0 | 34 | | 10 | 15 | |
| | 3.0 | 21 | 0 | 34 | | 5 | 5 | |
| | 4.5 | 32 | 0 | 25 | | 0 | 3 | |
| | 6.0 | 42 | 0 | 28 | | 0 | 0 | |
| Gufa 521 | 1.5 | 10 | 0 | 91 | | 18 | 45 | |
| | 2.3 | 15 | 0 | 81 | | 25 | 38 | |
| | 3.0 | 20 | 0 | 65 | | 5 | 20 | |
| | 4.5 | 30 | 1 | 45 | | 5 | 13 | |
| | 6.0 | 41 | 0 | 24 | | 10 | 10 | |
| Kemira K-75 | | 16 | 0 | 86 | | 10 | 35 | |
| | | 25 | 0 | 51 | | 0 | 25 | |
| | | 32 | 0 | 33 | | 5 | 10 | |
| | | 45 | 0 | 30 | | 0 | 5 | |
| | | 58 | 0 | 18 | | 0 | 0 | |
| Kemira KB-75 | 1.5 | 9.5 | 0 | 89 | | 40 | 53 | |
| | 2.3 | 14 | 0 | 79 | | 8 | 25 | |
| | 3.0 | 19 | 0 | 64 | | 13 | 28 | |
| | 4.5 | 30 | 0 | 61 | | 5 | 10 | |
| | 6.0 | 40 | 0 | 15 | | 3 | 5 | |
| NWPC Standard Preservative No. 1 | 1.3 | 8.9 | 0 | 23 | | 0 | 8 | |
| Untreated | | | 100 | 100 | 3.8 | 100 | 100 | 3.6 |



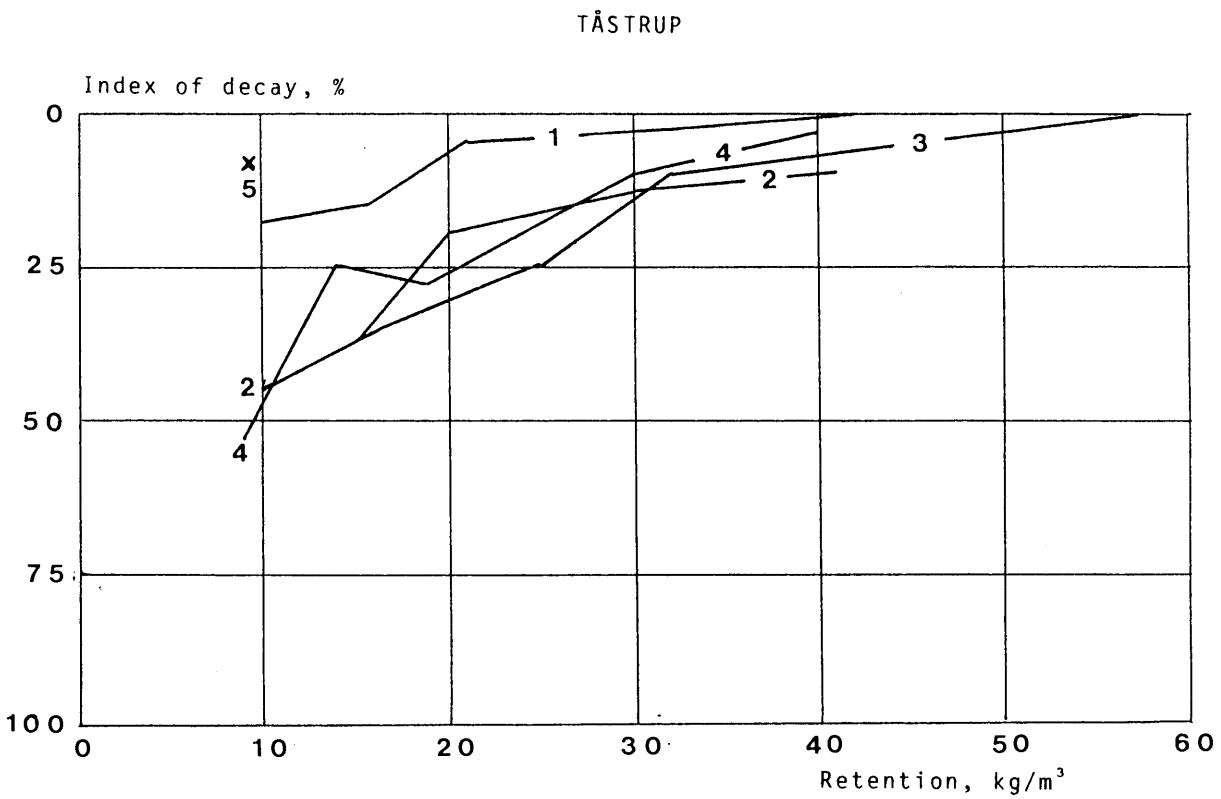




Figure 7. Index of decay in relation to the retention after 12 years.

1. Basilit KM, 2. Gufa 521, 3. Kemira K-75, 4. Kemira KB-75, 5. NWPC Standard Preservative No. 1.

**Field trial 1977**

The preservatives of the 1977 trial and their chemical formulations are listed in Table 10. For every retention level of the tested preservatives, 10 stakes were set out at each of the test fields Simlångsdalen, Vaasa and Vihti. In 1986 the stakes at Vaasa and Vihti were moved to Viikki.

The index of decay after 5 and 10 years testing is presented in Table 11. In this trial four retention levels were prepared for NWPC Standard Preservative No. 1. Figure 8 shows index of decay in relation to the retention of the preservatives tested. The rate of decay of stakes with various retentions of the preservatives is shown in Figures 34-37 of the Appendix.

The service life of untreated stakes was 3.8 years at Simlångsdalen, 2.3 years at Vaasa and 2.0 years at Vihti.

The NWPC Standard Preservative No. 1 shows the highest efficacy and Cuprinol Tryck the lowest efficacy at all the three test sites (Figure 8).

Table 10. NWPC Field trial 1977. Preservatives tested and their chemical formulation

| Wood preservative | Chemical formulation % m/m | | Active components % m/m | | Manufacturer* |
|---|---|---|---|---|---|
| Basilit CCB | $CuSO_4 \cdot 5H_2O$ | 34 | Cu | 8.7 | Desowag-Bayer |
| | $K_2Cr_2O_7$ | 39 | Cr | 14.3 | Holzschutz GmbH |
| | $CrO_3$ | 1 | | | |
| | $H_3BO_3$ | 26 | B | 4.5 | |
| Boliden P50** | CuO | 15.9 | Cu | 12.0 | Rentokil Ltd |
| | $CrO_3$ | 20.0 | Cr | 10.4 | |
| | $P_2O_5$ | 16.6 | P | 7.7 | |
| | $H_2O$ | 47.5 | | | |
| Cuprinol Tryck** | CuO | 12 | Cu | 9.5 | Hager AB |
| (KP-N) | $C_7H_{15}COOH$ | 4.75 | $C_7H_{15}COOH$ | 4.75 | |
| | $NH_3$ | ~ 20 | | | |
| | $CO_2$ | ~ 40 | | | |
| | $H_2O$ | ~ 25 | | | |
| NWPC Standard | CuO | 19.0 | Cu | 15.2 | - |
| Preservative | $CrO_3$ | 36.0 | Cr | 18.7 | |
| No. 1 | $As_2O_5$ | 45.0 | As | 29.3 | |

* Manufacturer that originally ordered the test or at the time when the test was started produced the preservative.
** Preservative introduced by the NWPC in the test.

Table 11. NWPC Field trial 1977. Results after 5 and 10 years' testing

| Wood preservative | Concentration % m/m | Retention kg/m³ | Index of decay and average service life ($\bar{x}$) Simlångsdalen (Sweden) Year | | | Vaasa/Viikki Year | | | Vihti/Viikki (Finland)* Year | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 5 | 10 | $\bar{x}$ | 5 | 10 | $\bar{x}$ | 5 | 10 | $\bar{x}$ |
| Basilit CCB | 1.0 | 7.0 | 55 | 100 | 6.5 | 75 | 93 | | 40 | 75 | |
| | 2.0 | 14 | 35 | 58 | | 43 | 83 | | 25 | 45 | |
| | 3.0 | 21 | 18 | 43 | | 20 | 25 | | 25 | 40 | |
| | 4.0 | 28 | 15 | 23 | | 5 | 20 | | 10 | 28 | |
| | 5.0 | 34 | 13 | 18 | | 5 | 28 | | 5 | 17 | |
| Boliden P50 | 1.0 | 6.9 | 63 | 100 | 5.6 | 28 | 70 | | 43 | 60 | |
| | 2.0 | 14 | 30 | 38 | | 33 | 45 | | 28 | 40 | |
| | 3.0 | 21 | 15 | 25 | | 30 | 50 | | 23 | 48 | |
| | 4.0 | 28 | 15 | 20 | | 5 | 13 | | 3 | 25 | |
| | 5.0 | 34 | 15 | 23 | | 5 | 20 | | 20 | 25 | |
| Cuprinol Tryck | 1.5 | 9.8 | 53 | 91 | | 90 | 98 | | 50 | 78 | |
| (KP-N) | 2.5 | 17 | 40 | 65 | | 35 | 63 | | 25 | 53 | |
| | 3.5 | 23 | 5 | 30 | | 33 | 55 | | 33 | 62 | |
| | 4.5 | 30 | 15 | 25 | | 53 | 78 | | 15 | 25 | |
| | 6.5 | 44 | 10 | 20 | | 40 | 55 | | 18 | 19 | |
| NWPC Standard | 0.4 | 2.6 | 50 | 100 | 6.9 | 58 | 78 | | 18 | 73 | |
| Preservative No. 1 | 0.8 | 5.1 | 18 | 55 | | 35 | 53 | | 15 | 53 | |
| | 1.1 | 7.8 | 13 | 23 | | 25 | 28 | | 5 | 29 | |
| | 1.5 | 10 | 8 | 33 | | 20 | 33 | | 13 | 19 | |
| Untreated | | | 95 | 100 | 3.8 | 100 | 100 | 2.3 | 100 | 100 | 2.0 |

* The stakes were moved from Vaasa and Vihti to Viikki in 1986.

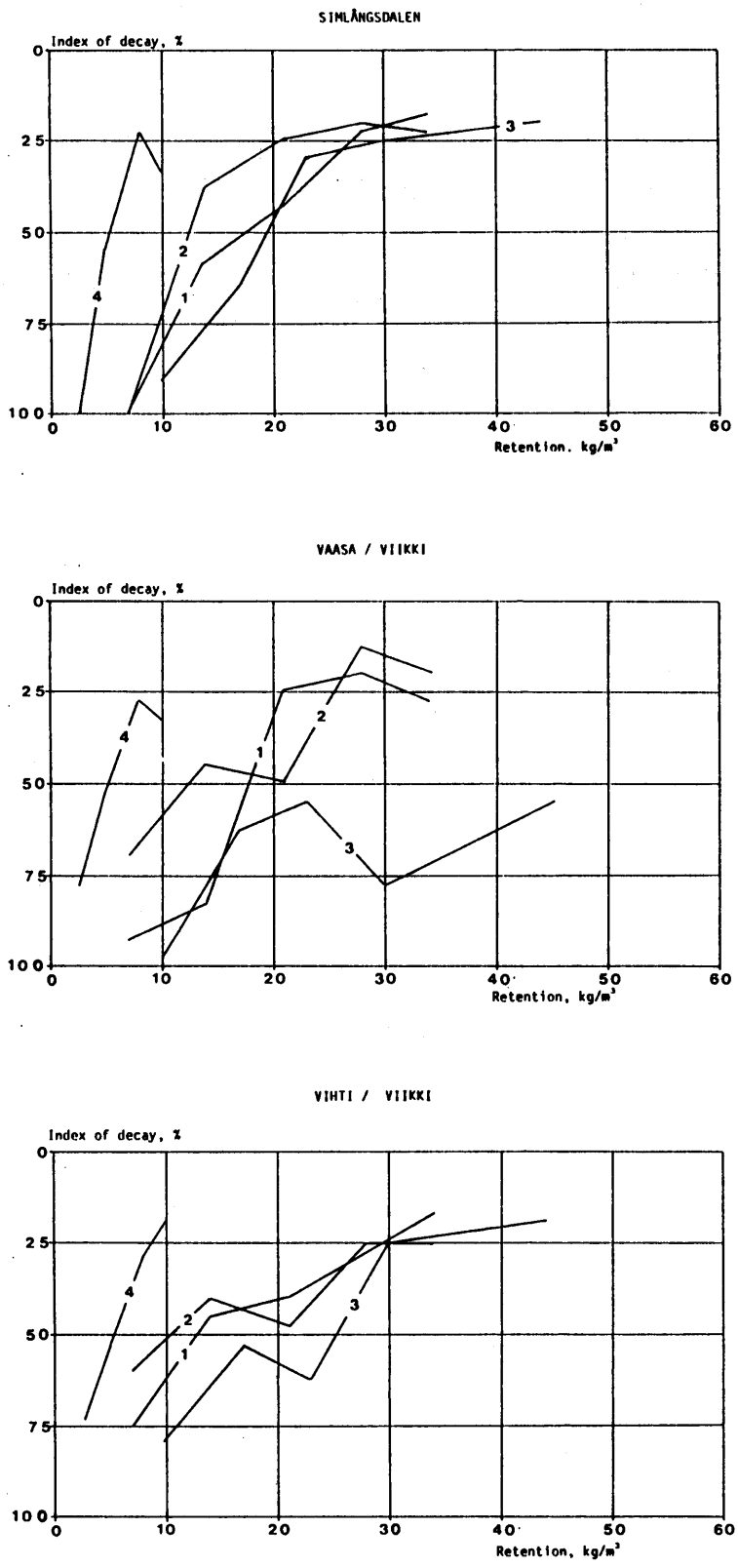



Figure 8. Index of decay in relation to the retention after 10 years. 1. Basilit CCB, 2. Boliden P50, 3. Cuprinol Tryck, 4. NWPC Standard Preservative No. 1.

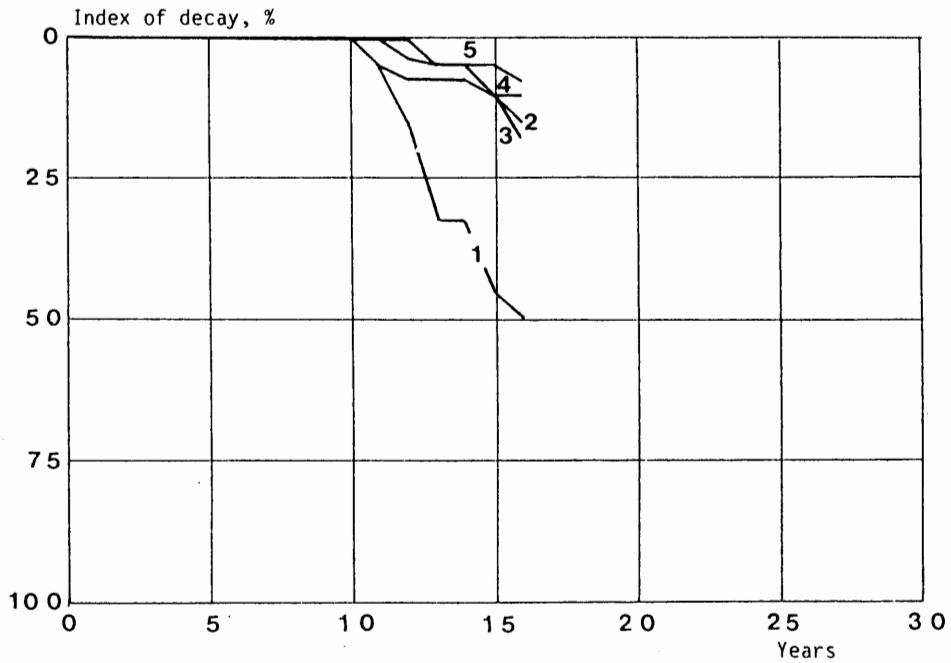
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Borsholt, E. (1979). NWPC - Field tests No. 1 with pressure preservatives. Results during 10 years' testing. NWPC - INF No. 9 1979.

Henningsson, B. (1974). NTR fältförsök Nr 1 med tryckimpregneringsmedel. (NWPC Field test No. 1 with pressure preservatives. Results after 5 years' testing). NWPC - INF No. 6 1974.

# APPENDIX

SIMLÅNGSDALEN




VAASA / VIIKKI

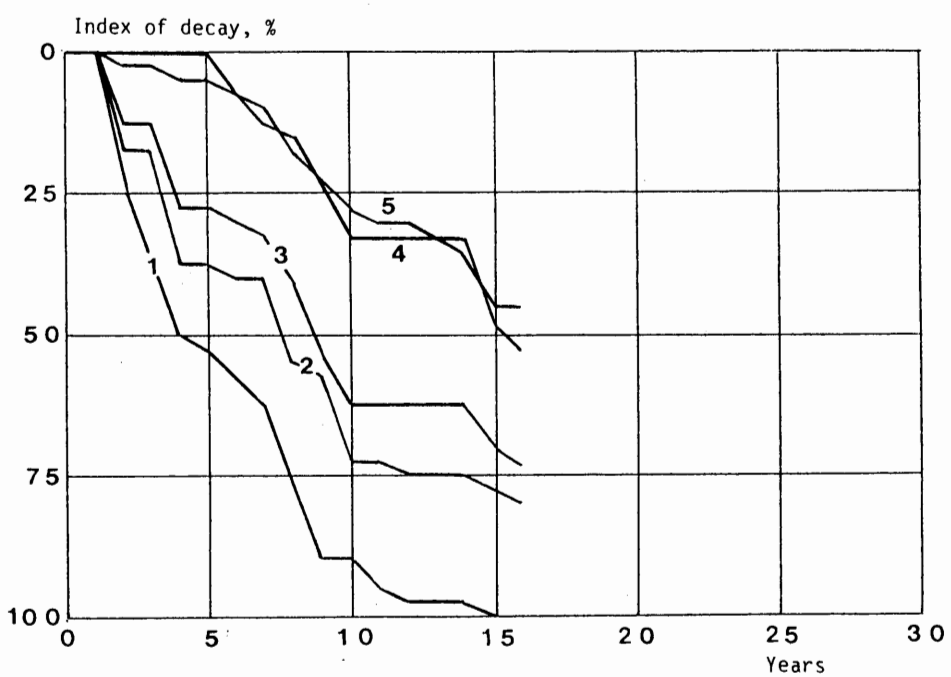
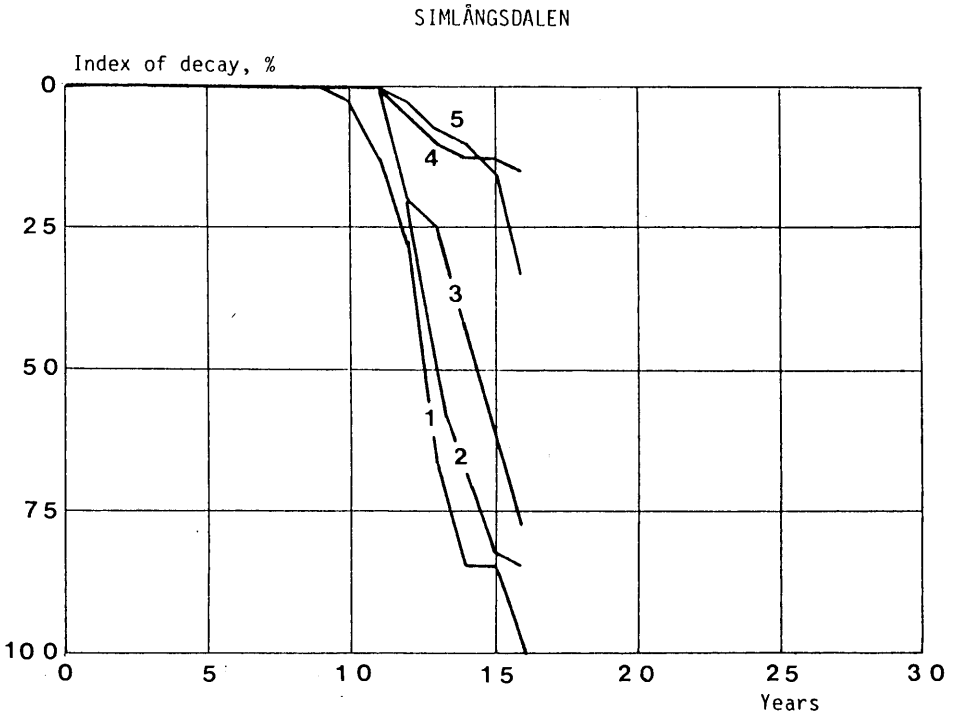



Figure 9. Rate of decay for stakes treated with Celcure M at the following retentions (kg/m$^3$):1. 9.9, 2. 16, 3. 20, 4. 33, 5. 42.



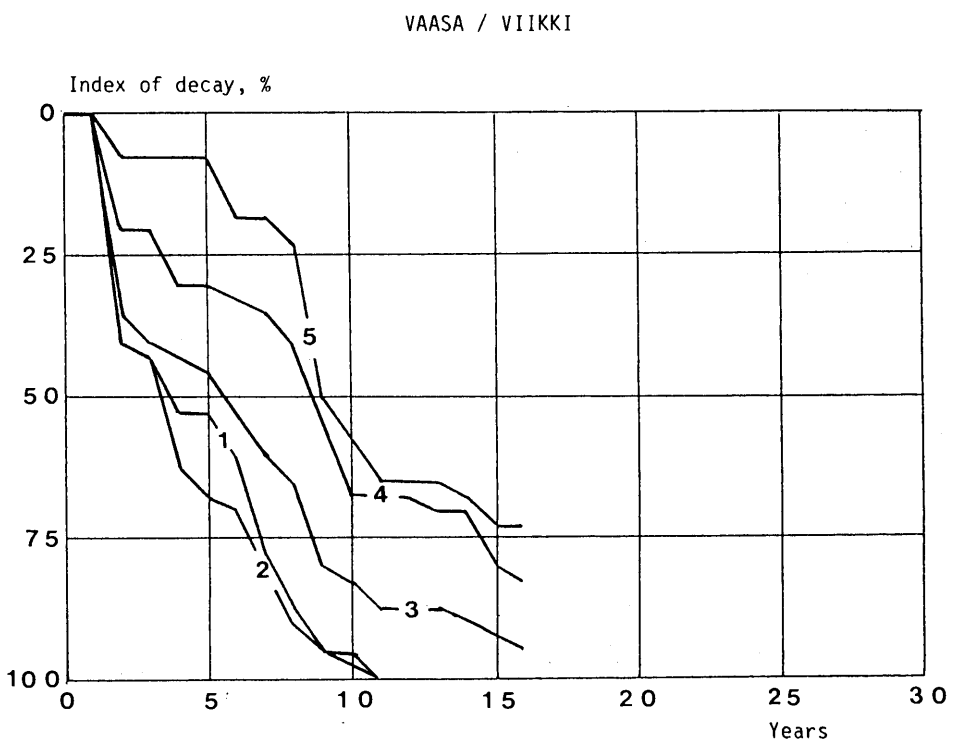
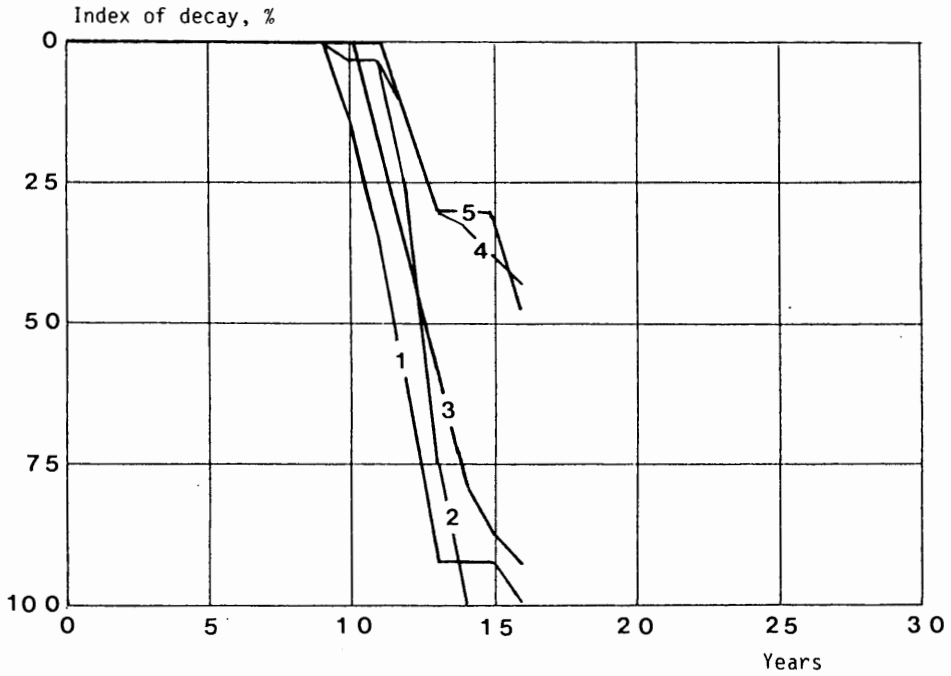




Figure 10. Rate of decay for stakes treated with Celcure SM at the following retentions ($kg/m^3$):1. 7.3, 2. 11, 3. 15, 4. 21, 5. 29.

SIMLÄNGSDALEN




VAASA / VIIKKI

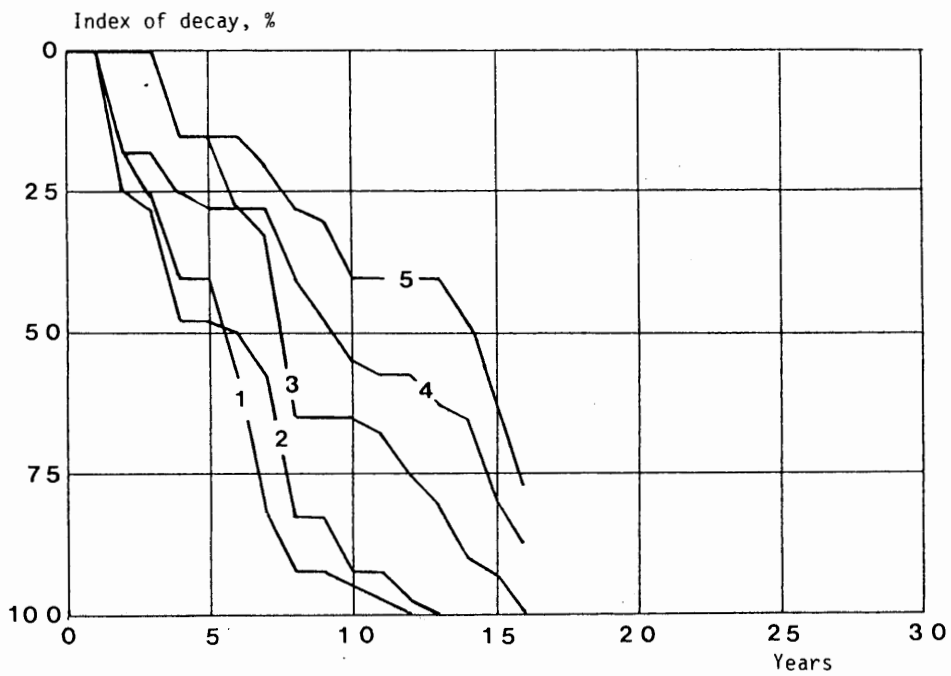



Figure 11 Rate of decay for stakes treated with KP Cuprinol at the following retentions (kg/$m^3$):1. 11, 2. 16, 3. 25, 4. 30, 5. 41.

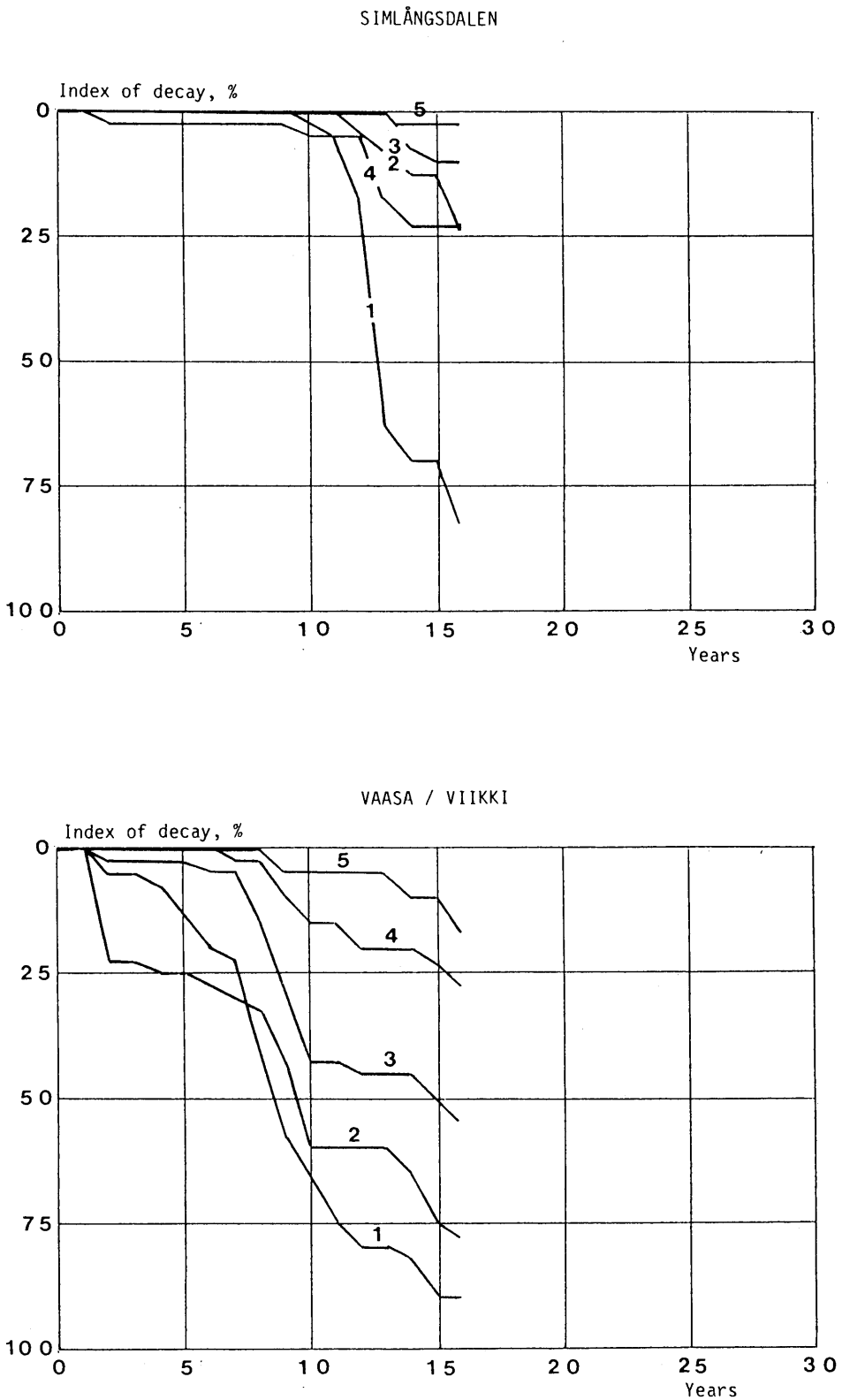



Figure 12. Rate of decay for stakes treated with Kemira K64 at the following retentions (kg/m$^3$):1. 5.5, 2. 8.1, 3. 11, 4. 18, 5. 23.

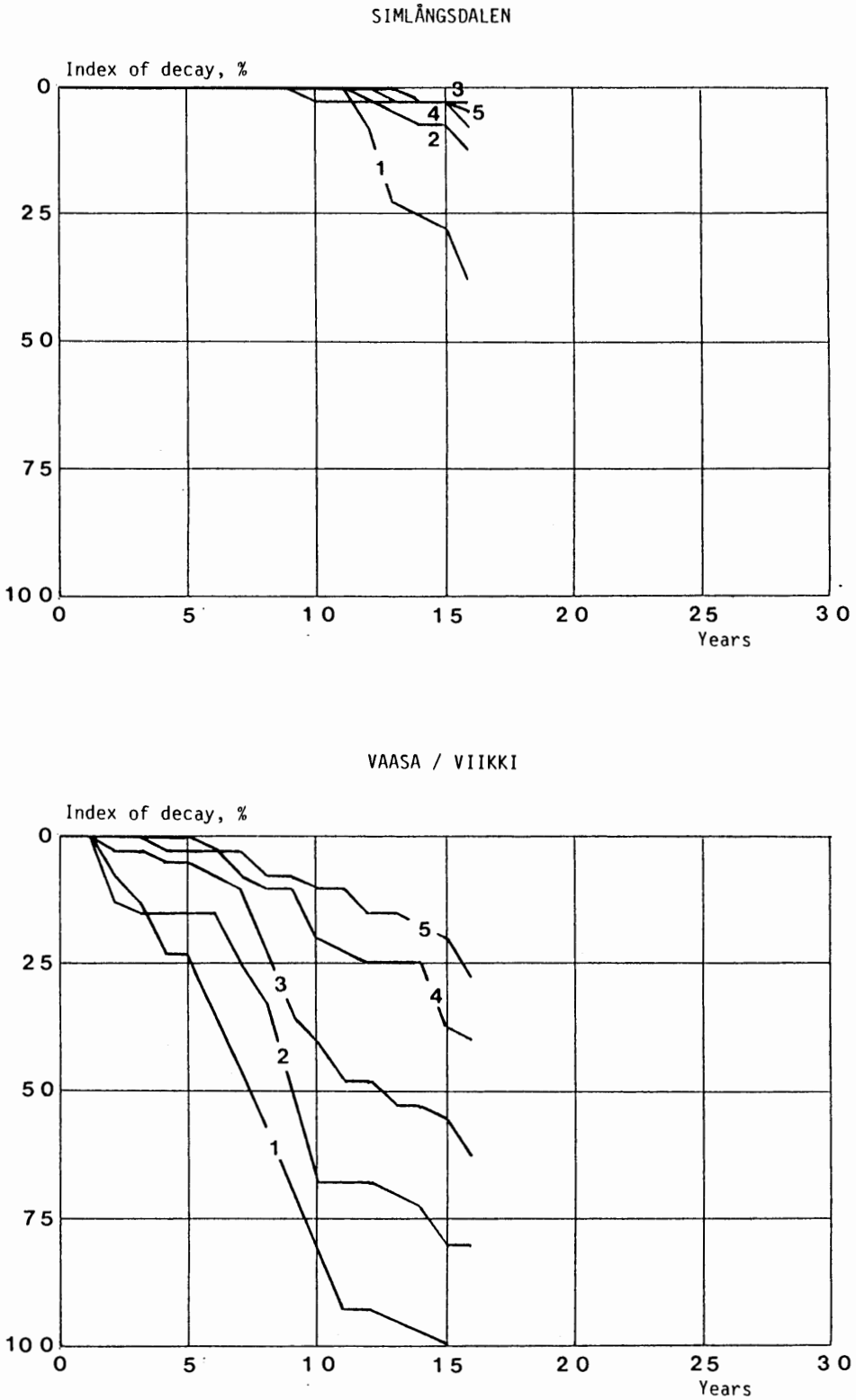
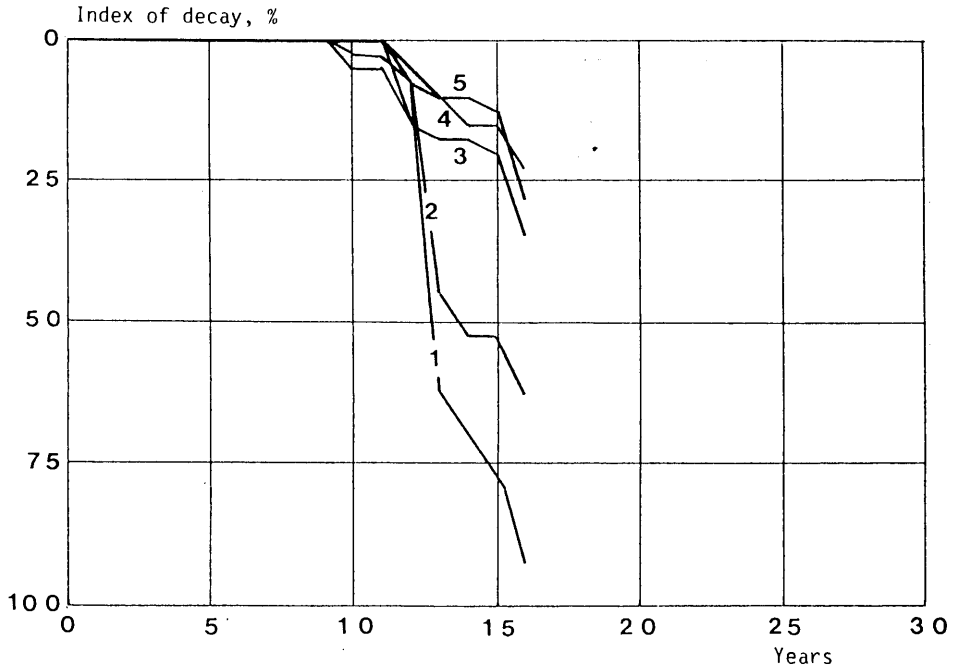



Figure 13. Rate of decay for stakes treated with Kemira C64 at the following retentions ($kg/m^3$):1. 6.5, 2. 10, 3. 12, 4. 19, 5. 26.

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VAASA / VIIKKI

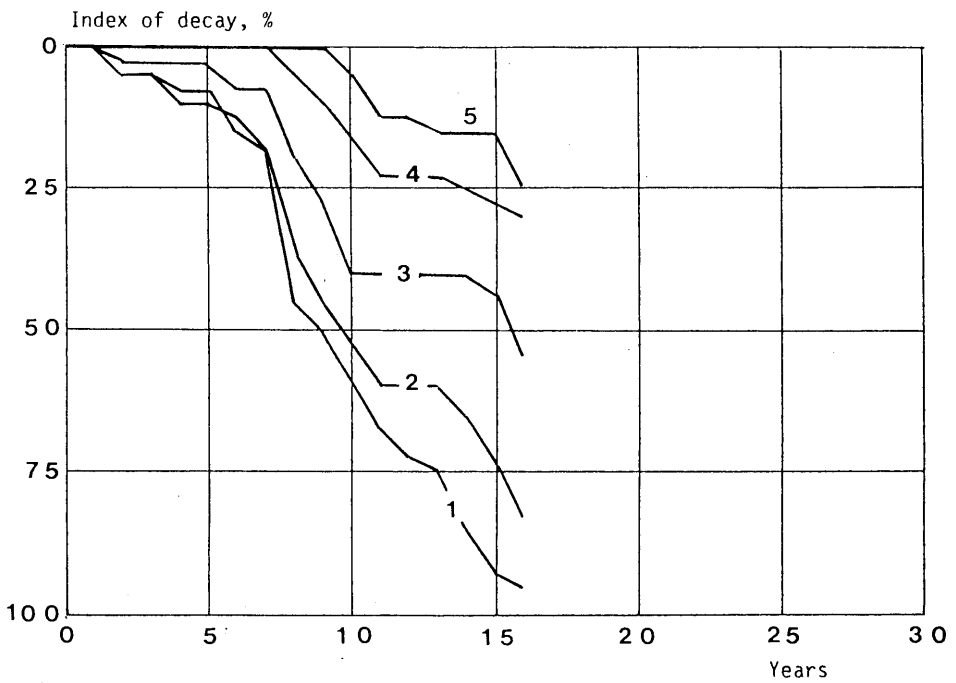
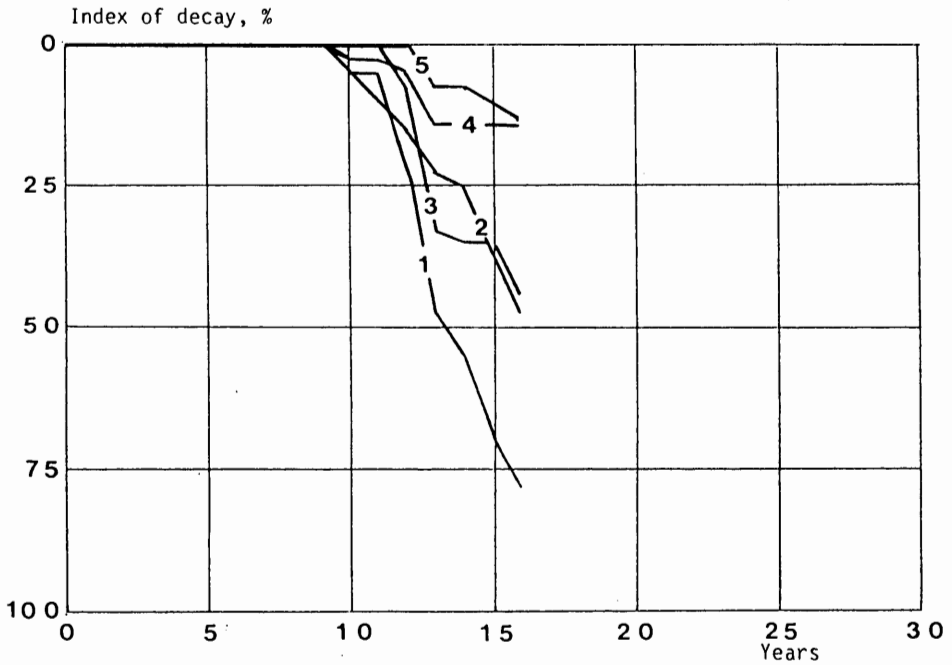



Figure 14. Rate of decay for stakes treated with Tanalith NCA at the following retentions ($kg/m^3$):1. 7.4, 2. 11, 3. 14, 4. 21, 5. 30.

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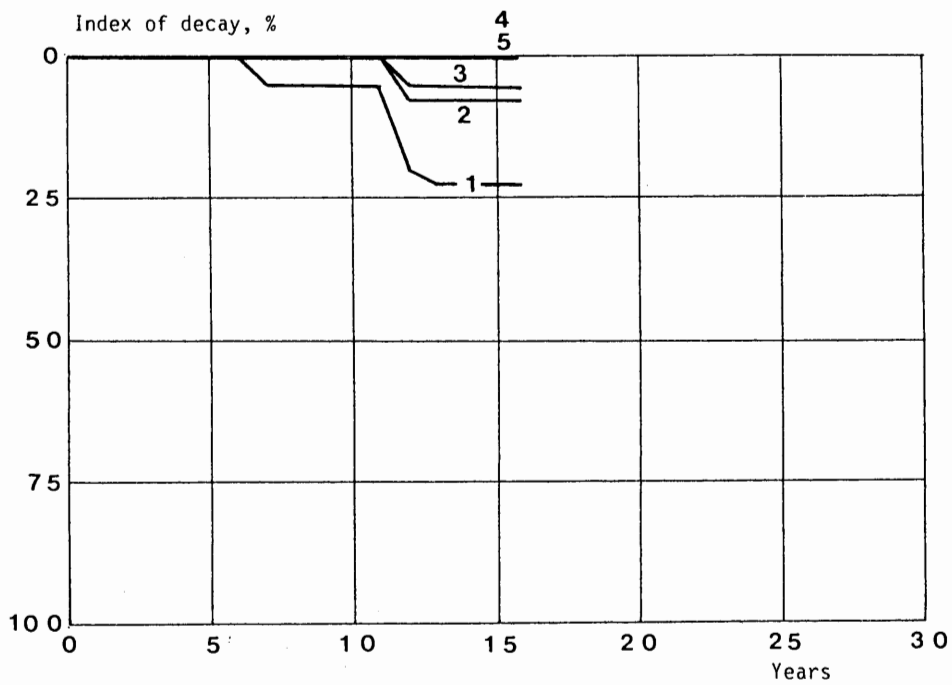
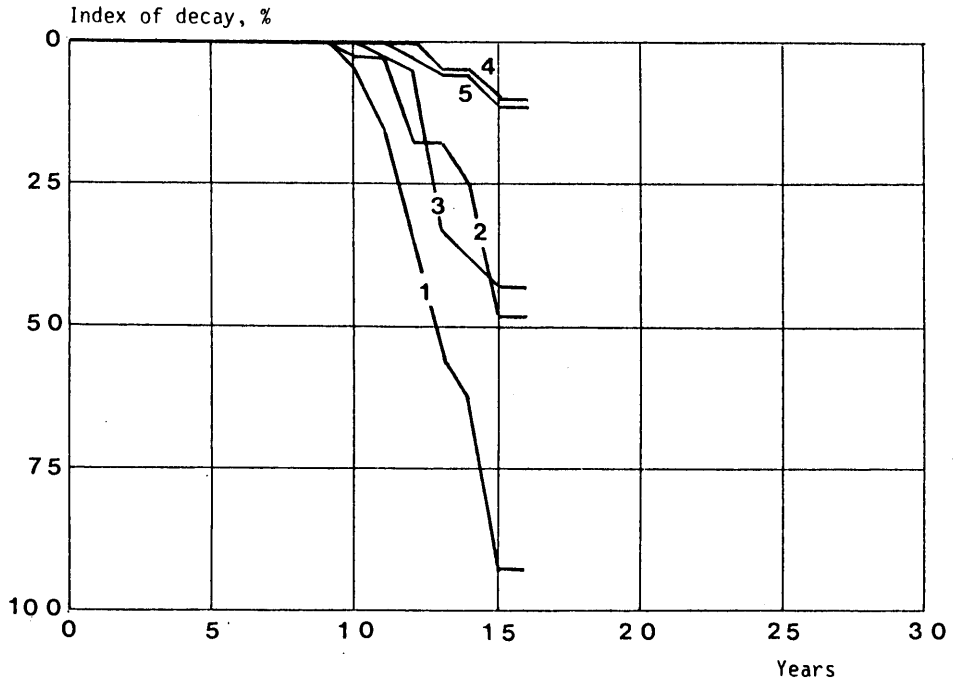



Figure 15. Rate of decay for stakes treated with Boliden APUS at the following retentions ($kg/m^3$): 1. 7.2, 2. 11, 3. 14, 4. 21, 5. 29.

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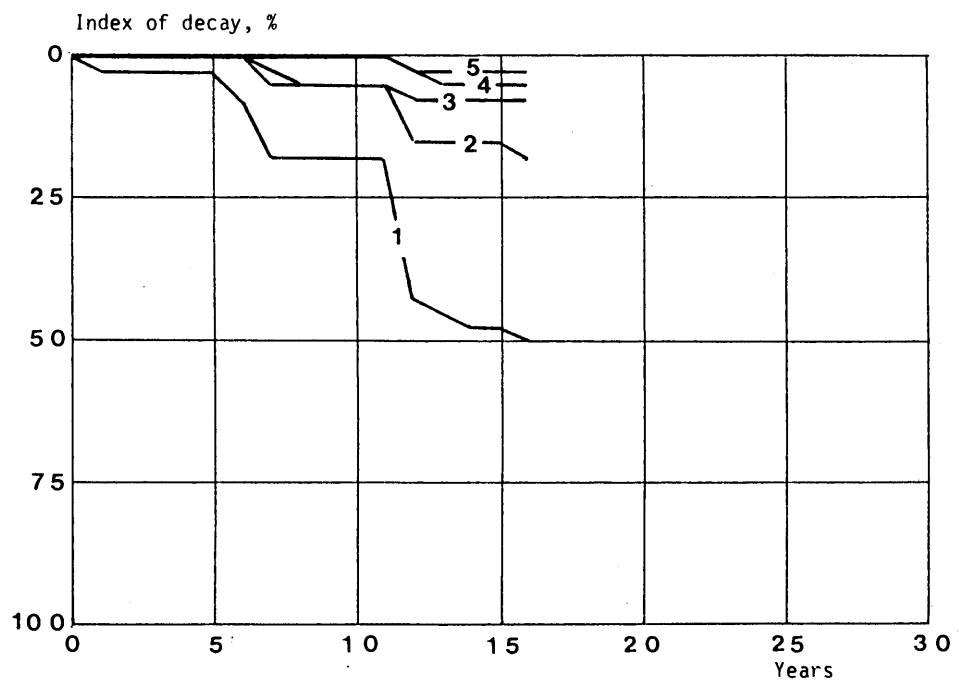
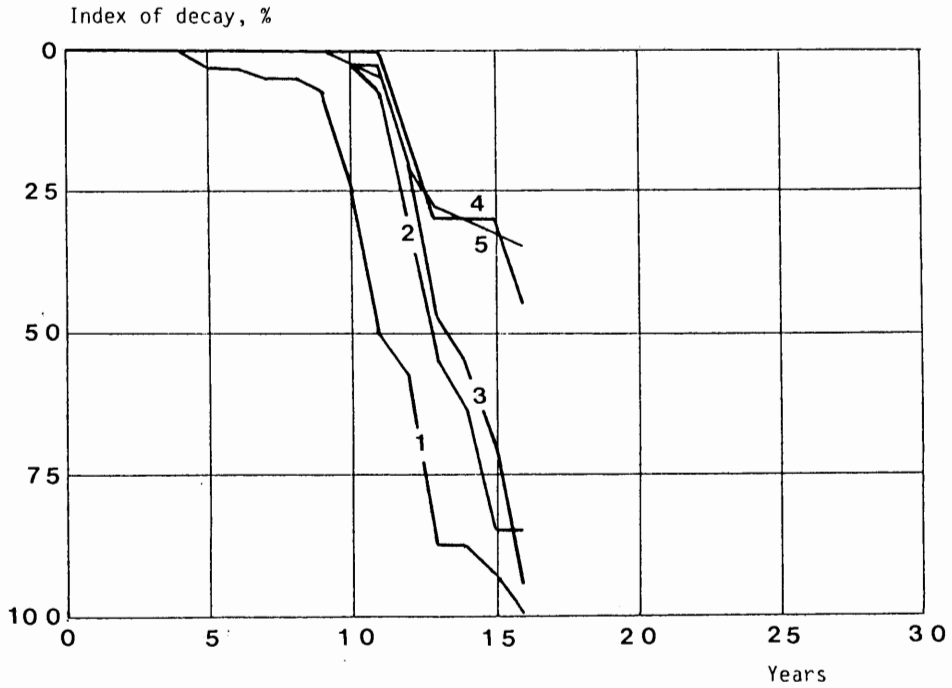



Figure 16. Rate of decay for stakes treated with Boliden P50 at the following retentions ($kg/m^3$):1. 7.2, 2. 11, 3. 14, 4. 22, 5. 29.

SIMLÅNGSDALEN




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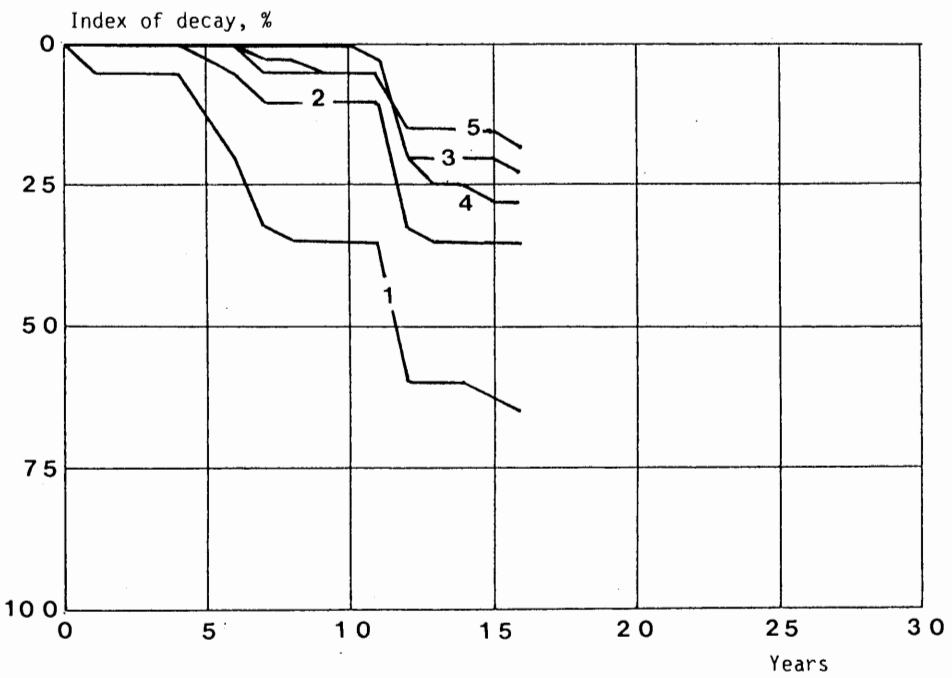
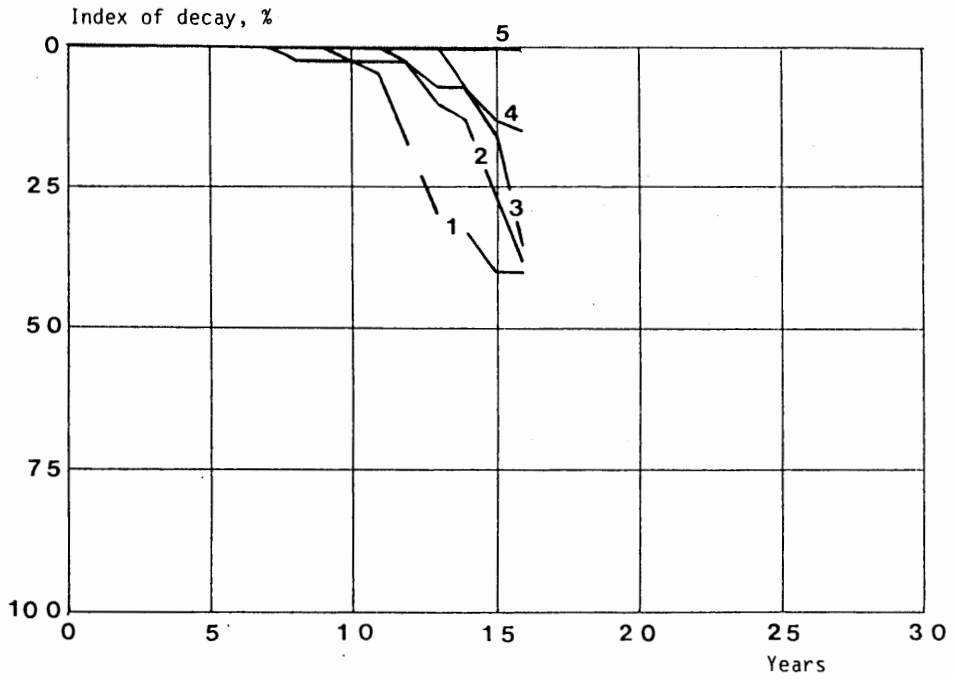



Figure 17. Rate of decay for stakes treated with Cuprinol Tryck at the following retentions (kg/m$^3$):1. 11, 2. 17, 3. 23, 4. 34, 5. 45.

SIMLÅNGSDALEN




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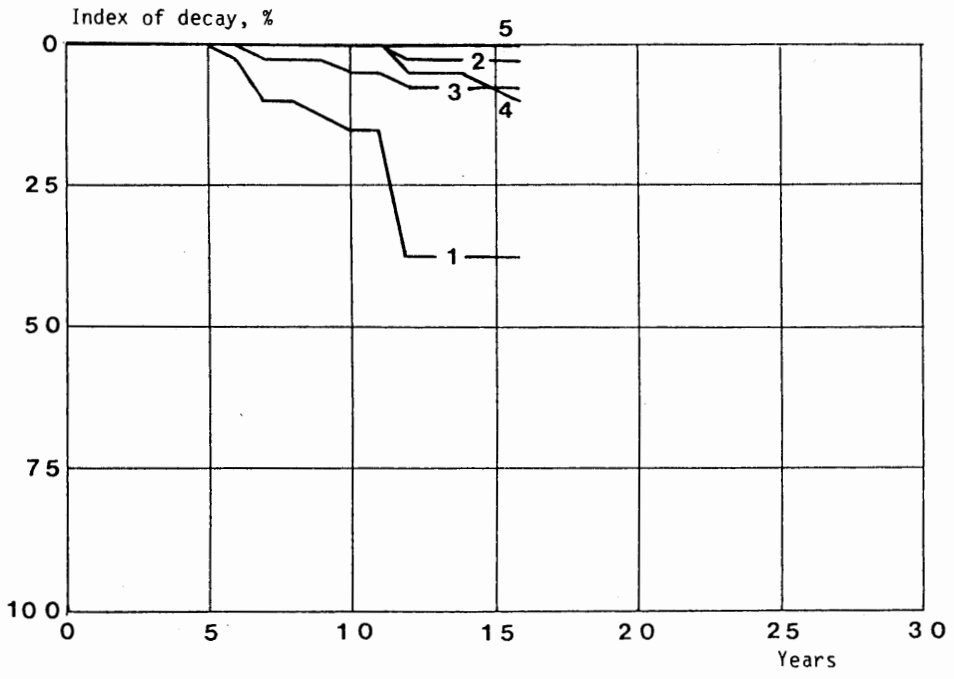
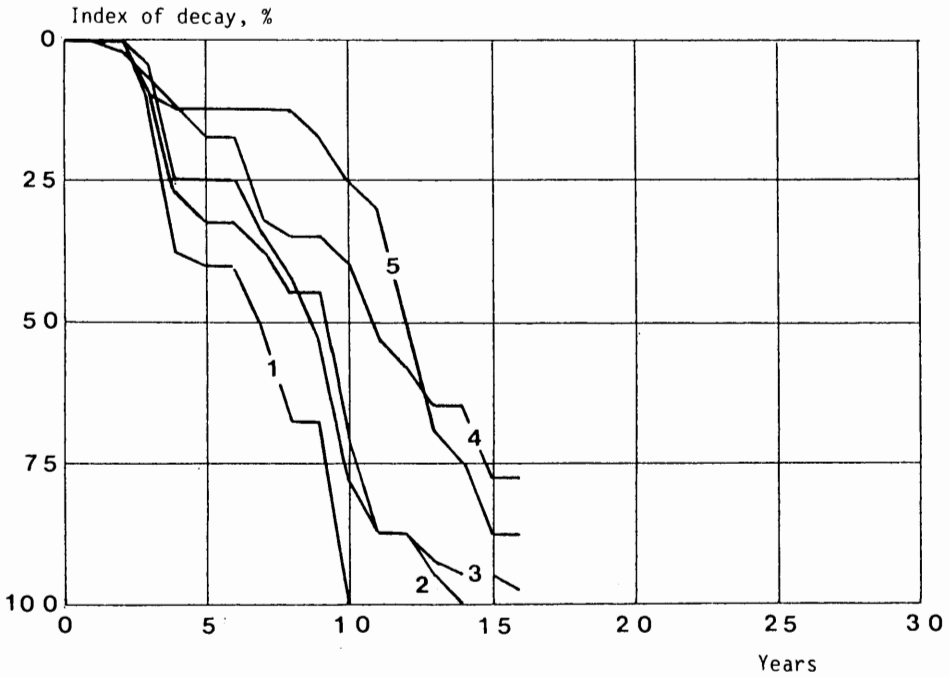



Figure 18. Rate of decay for stakes treated with CCB A at the following retentions ($kg/m^3$):1. 8.7, 2. 14, 3. 18, 4. 27, 5. 37.

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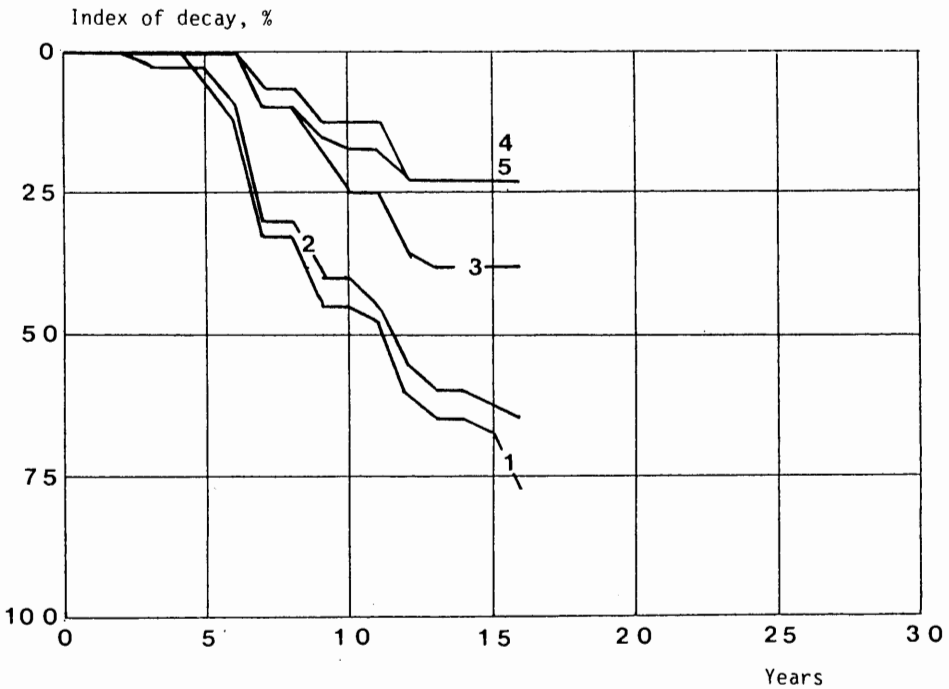



Figure 19. Rate of decay for stakes treated with BP SUN/WP at the following retentions (kg/$m^3$):1. 72, 2. 112, 3. 150, 4. 225, 5. 300.

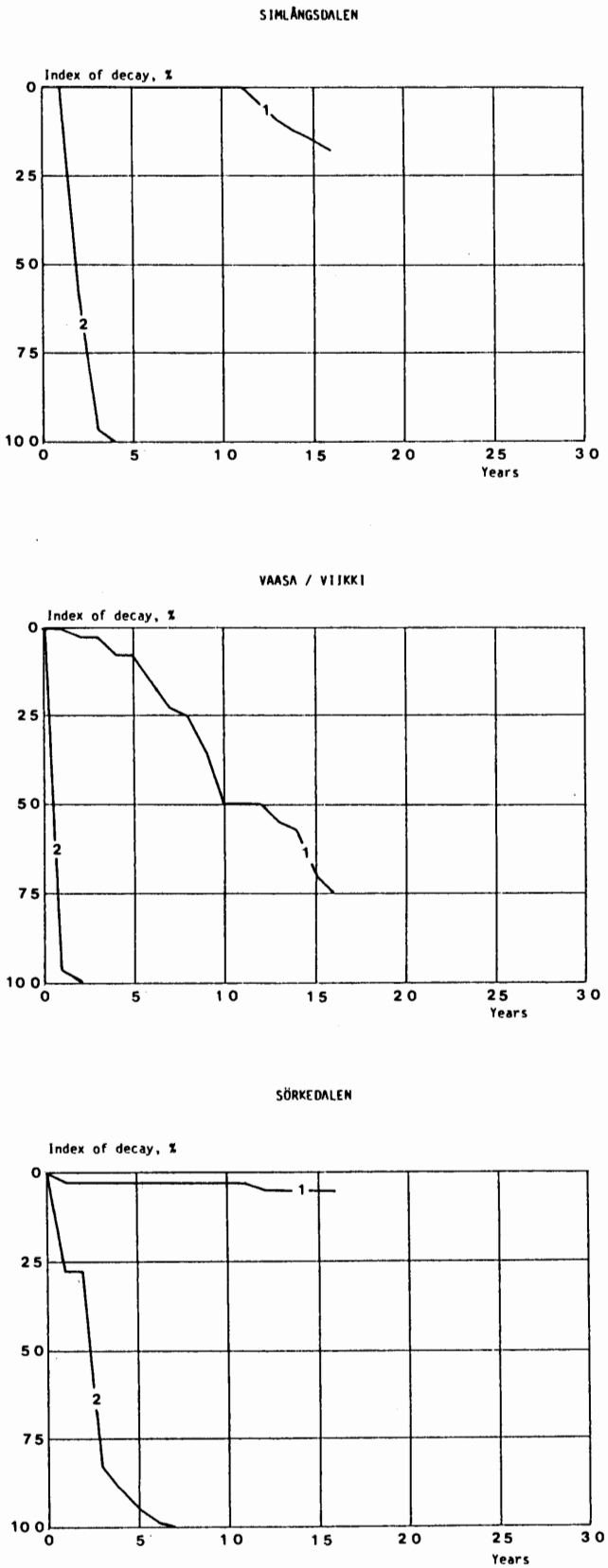



Figure 20. Field trial 1971. Rate of decay for stakes treated with 1. NWPC Standard Preservative No 1 at a retention of 9.5 kg/m$^3$. 2. Untreated stakes.

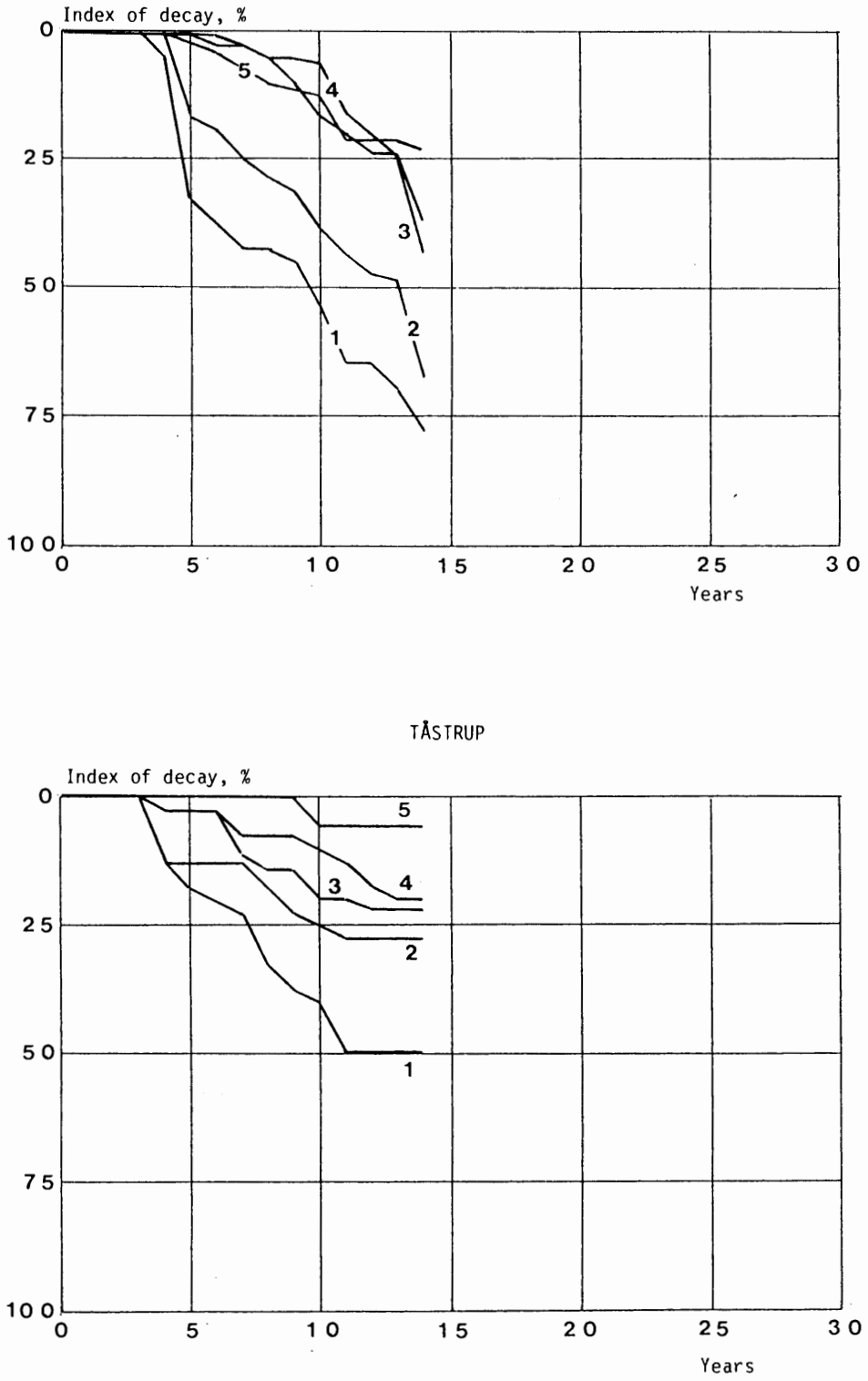
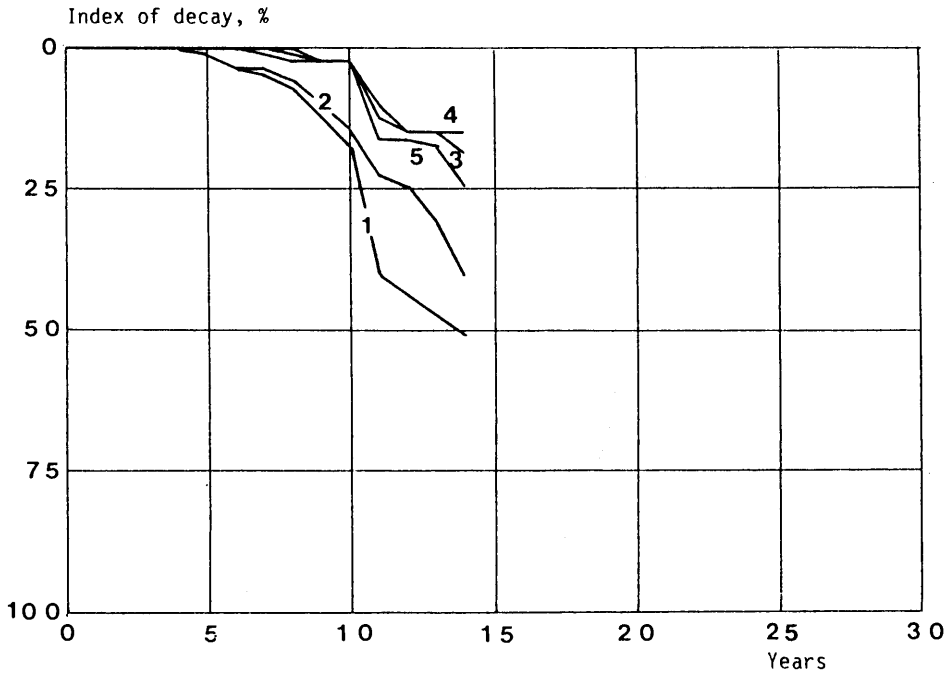



Figure 21 Rate of decay for stakes treated with Boliden P50 B at the following retentions ($kg/m^3$):1. 8.4, 2. 12, 3. 17, 4. 24, 5. 34.

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TÅSTRUP

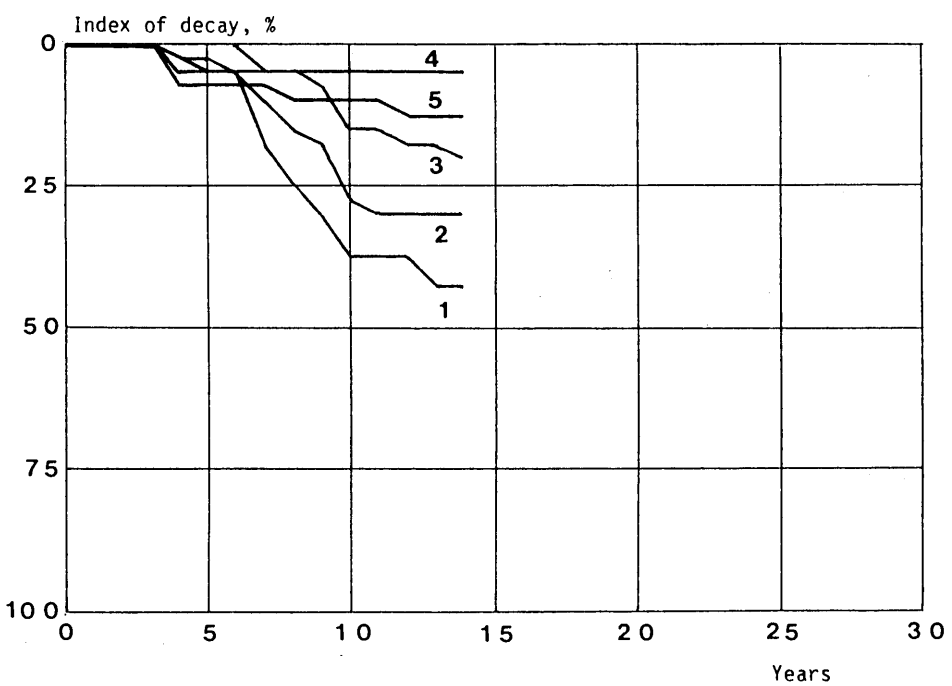



Figure 22. Rate of decay for stakes treated with Kemira KCA-73 at the following retentions (kg/m$^3$):1. 3.7, 2. 5.2, 3. 7.4, 4. 10, 5. 15.

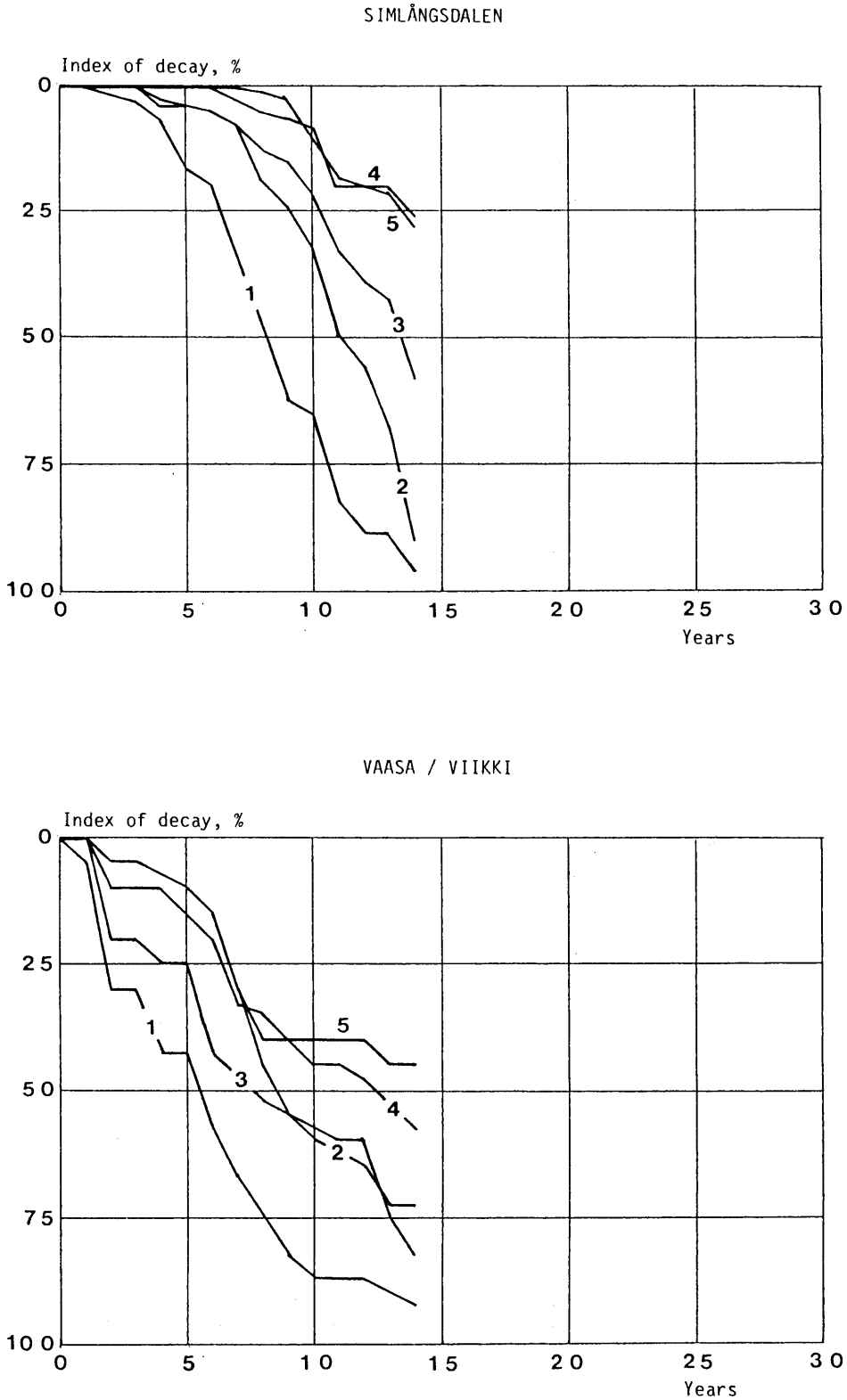
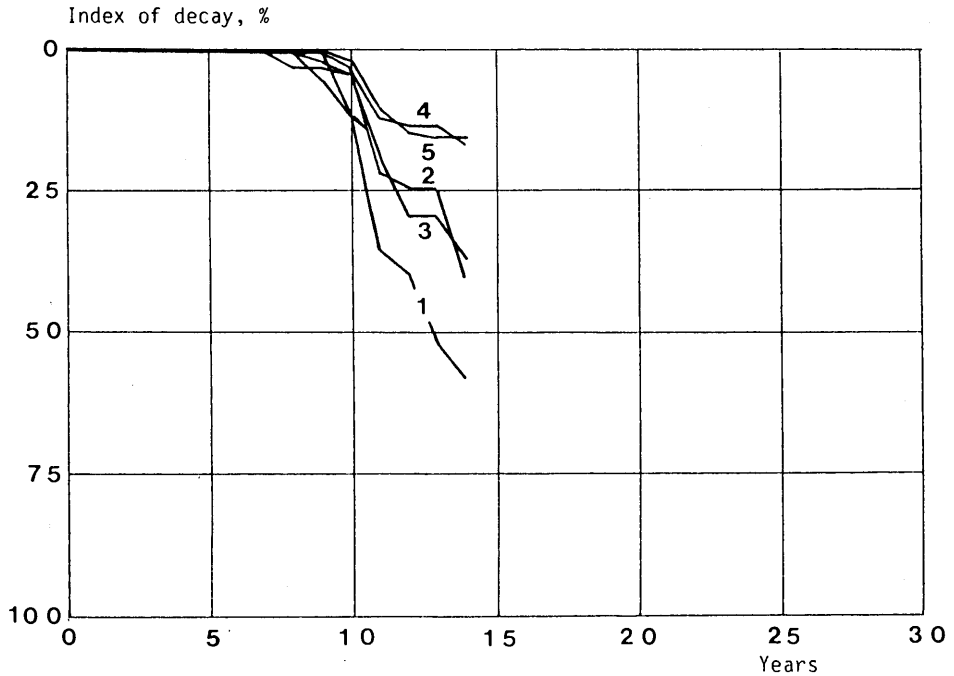



Figure 23. Rate of decay for stakes treated with ACCA at the following retentions ($kg/m^3$):1. 14, 2. 20, 3. 29, 4. 41, 5. 59.

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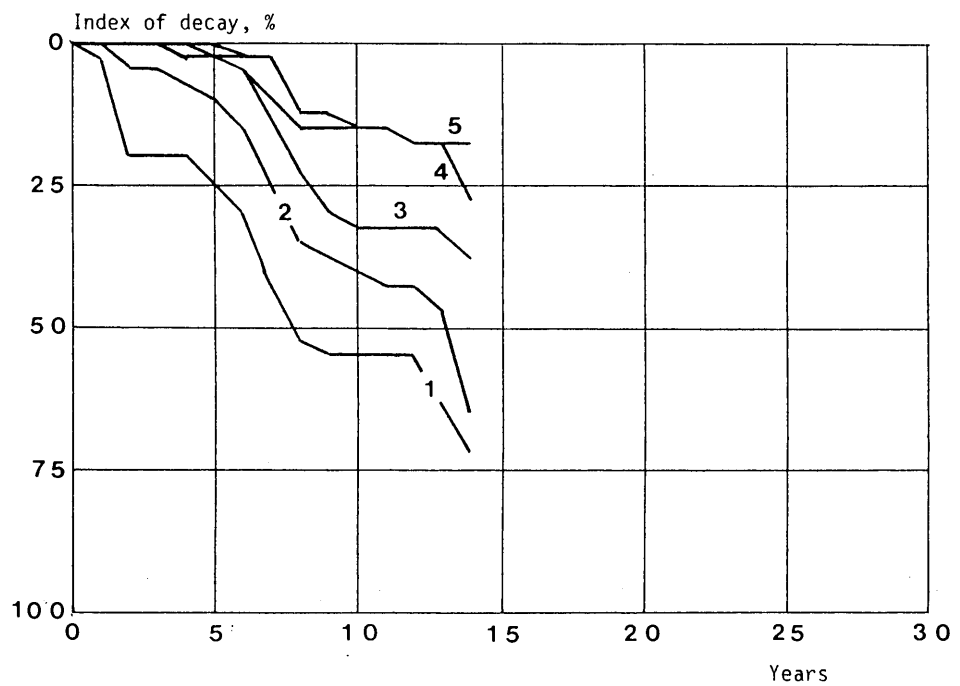



Figure 24. Rate of decay for stakes treated with Celcure AP5 at the following retentions (kg/m$^3$):1. 6.2, 2. 9.0, 3. 13, 4. 19, 5. 28.

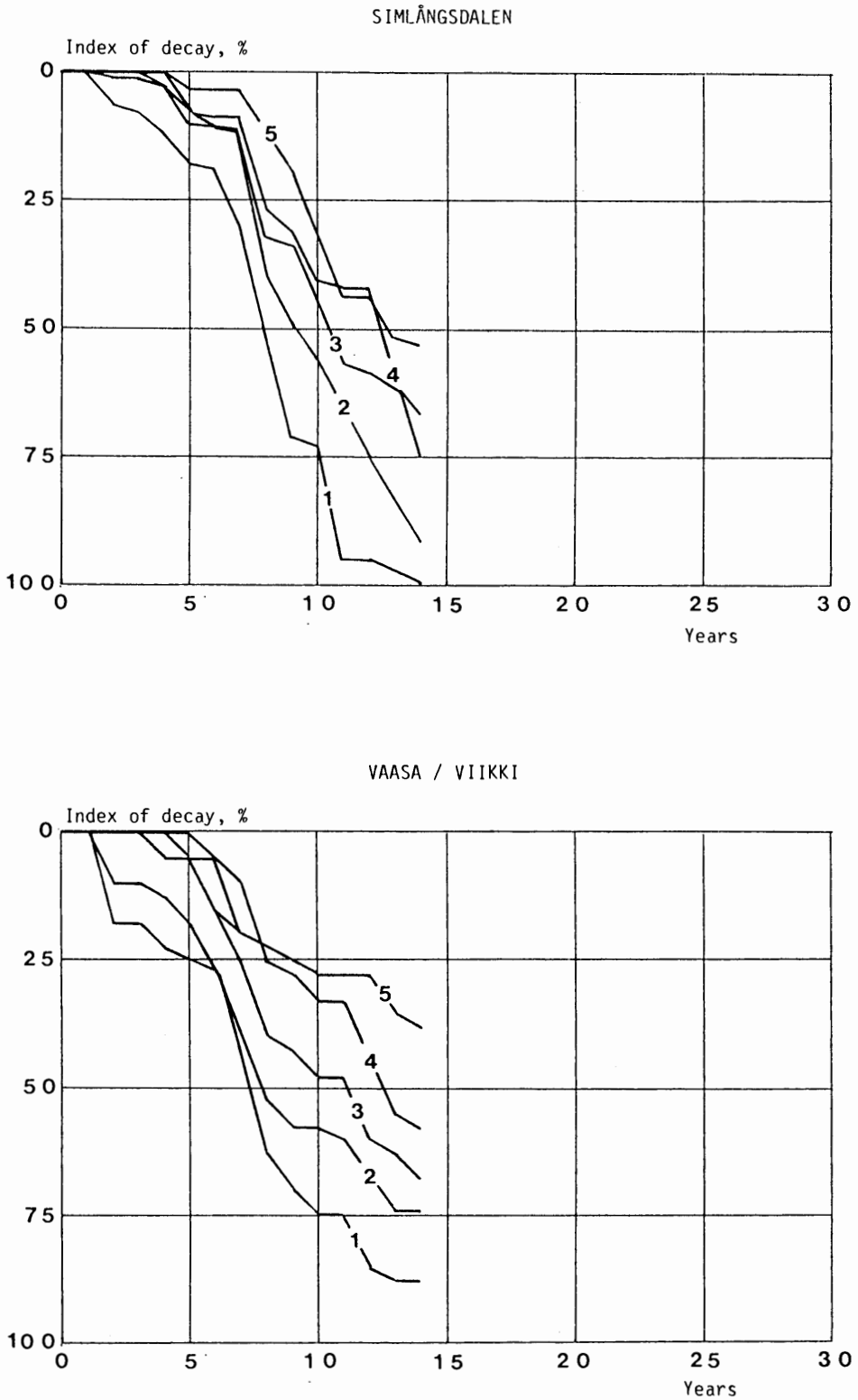



Figure 25. Rate of decay for stakes treated with Hylosan PT at the following retentions ($kg/m^3$):1. 6.8, 2. 10, 3. 14, 4. 16, 5. 23.

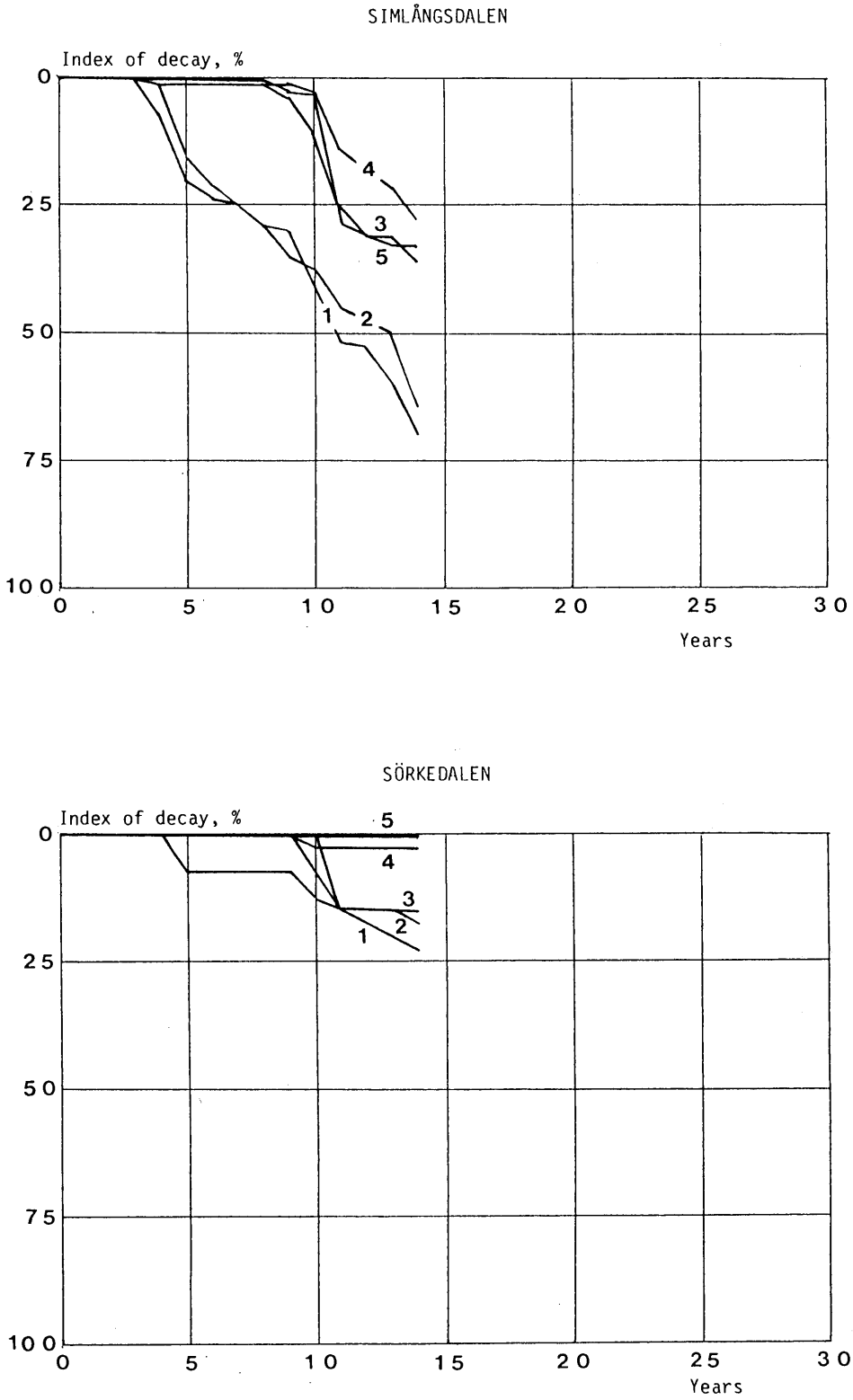



Figure 26. Rate of decay for stakes treated with Kemira KC 73 at the following retentions ($kg/m^3$):1. 3.6, 2. 5.2, 3. 7.4, 4. 10, 5. 15.

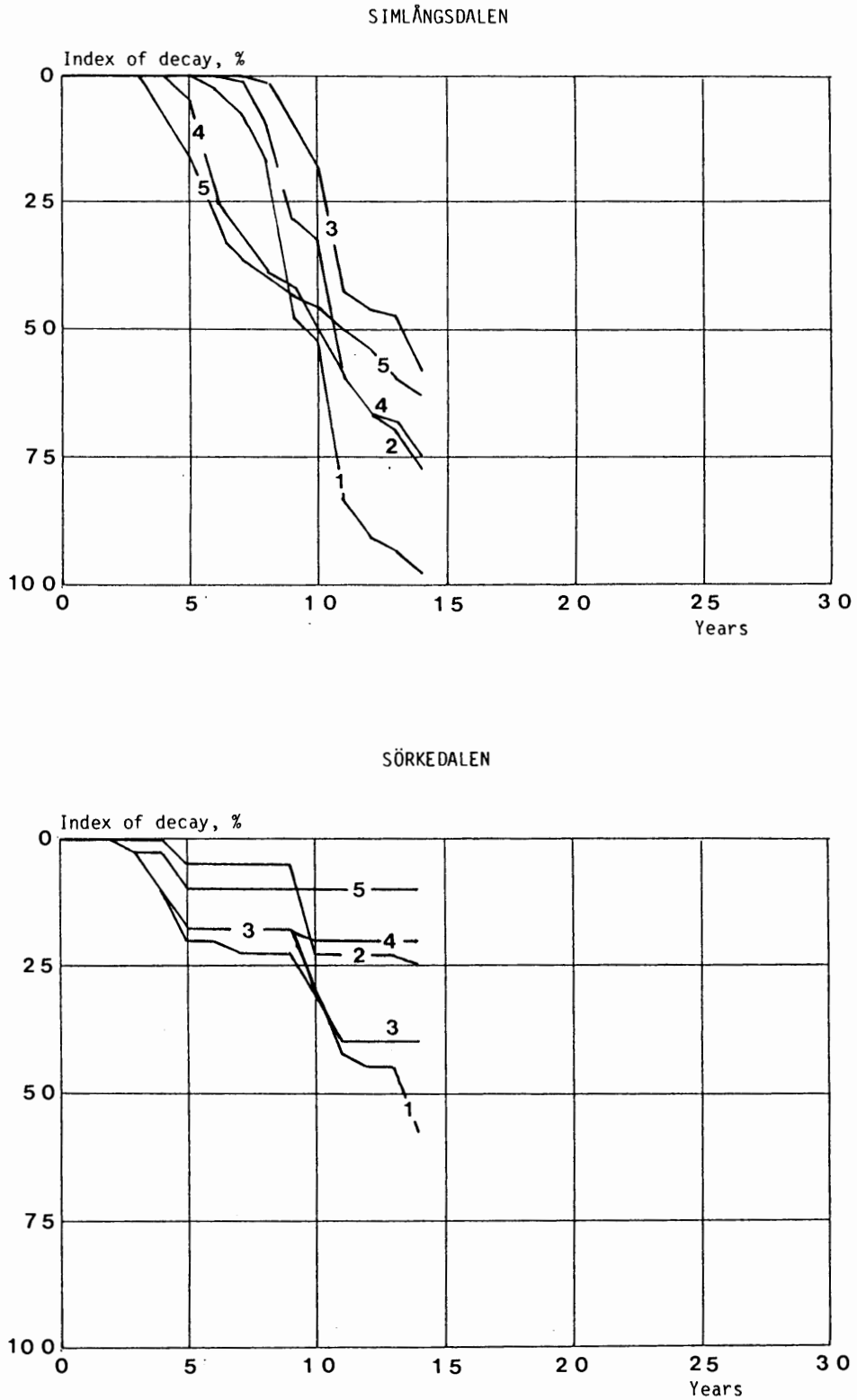
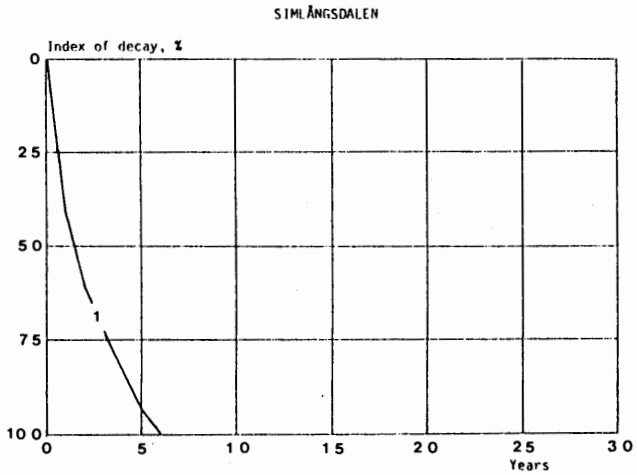
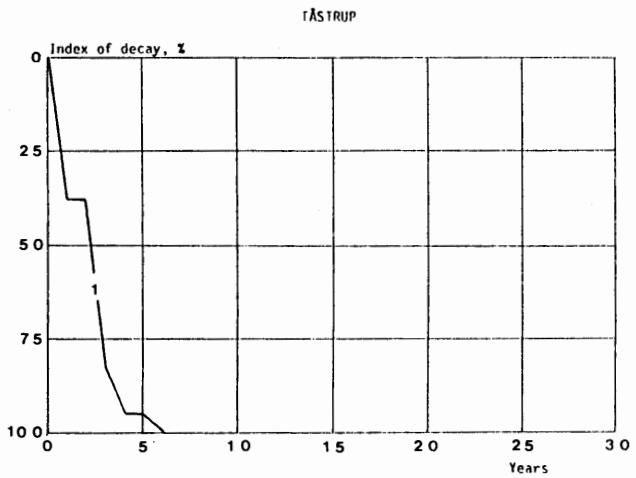
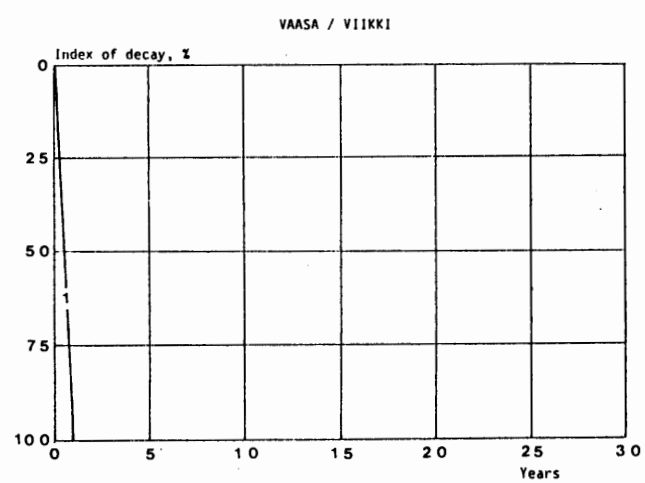



Figure 27. Rate of decay for stakes treated with Kemira KFN-73 at the following retentions (kg/m$^3$):1. 12, 2. 18, 3. 25, 4. 29, 5. 42.



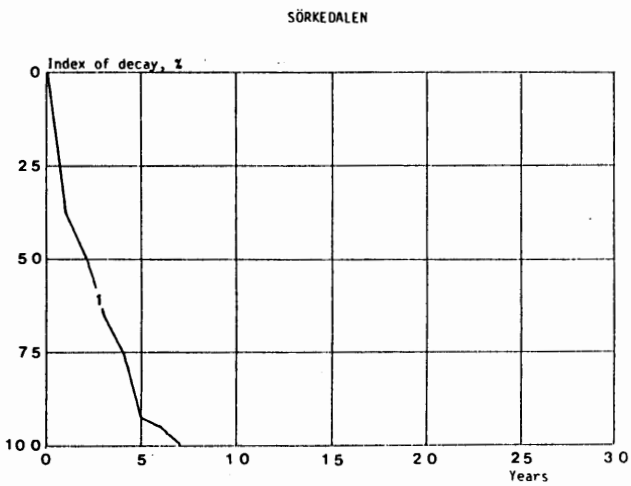
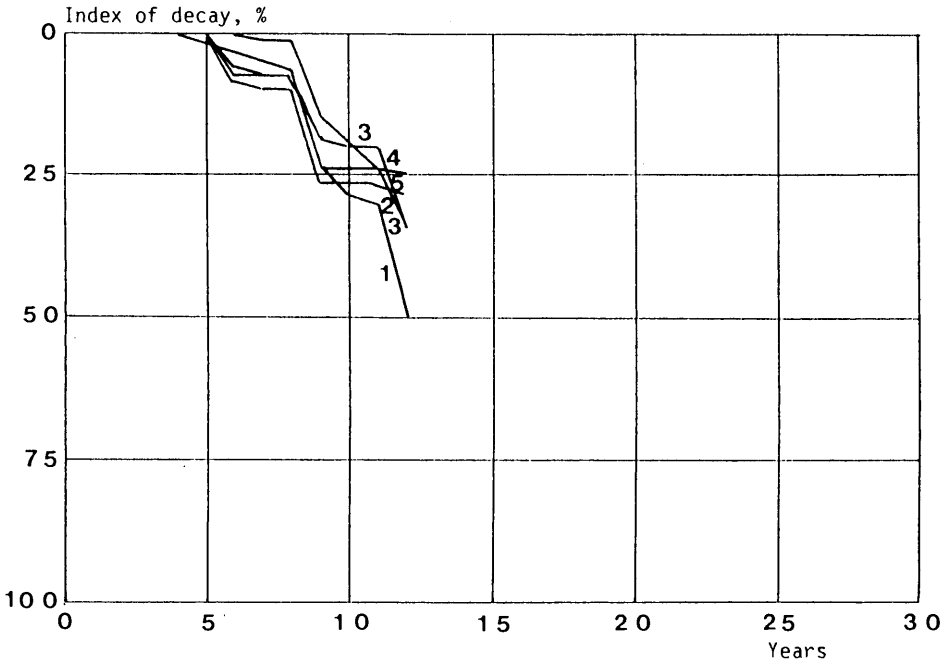




Figure 28. Field trial 1973. Rate of decay for untreated stakes.

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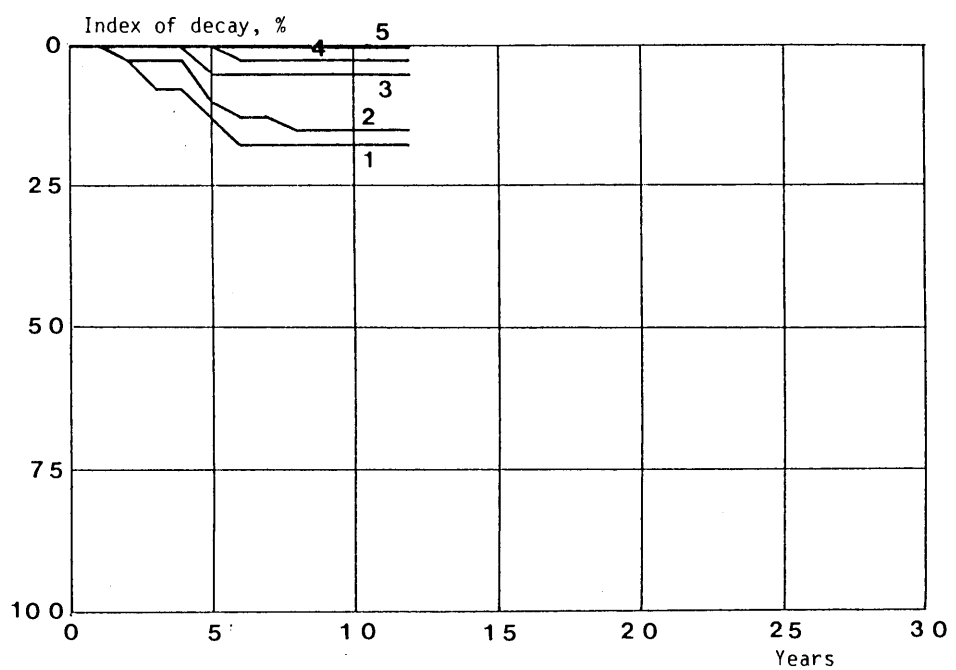
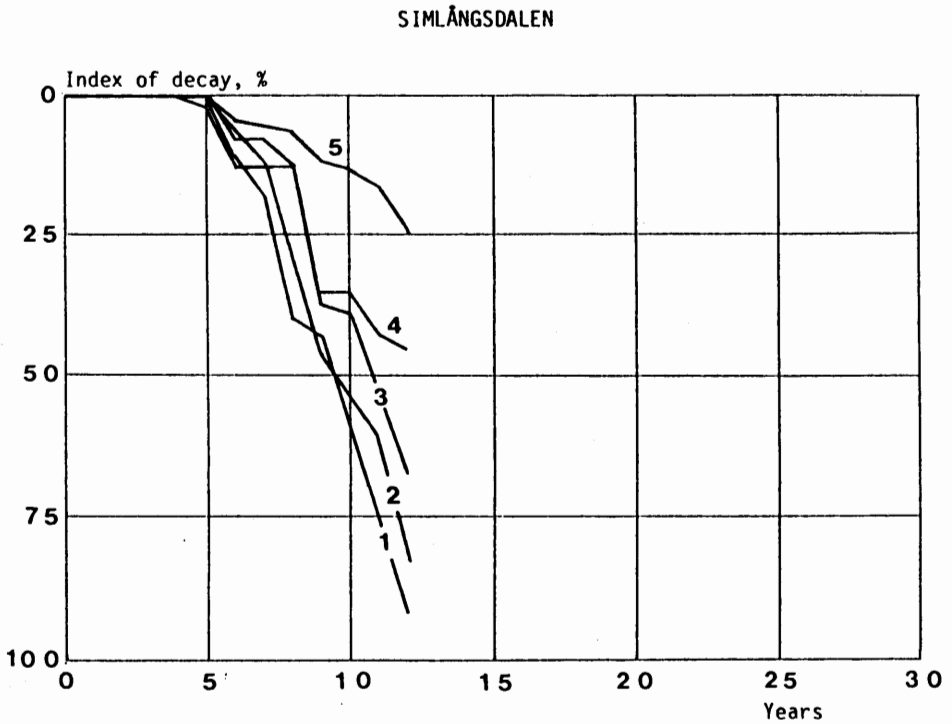



Figure 29. Rate of decay for stakes treated with Basilit KM at the following retentions (kg/m$^3$):1. 10, 2. 16, 3. 21, 4. 32, 5. 42.



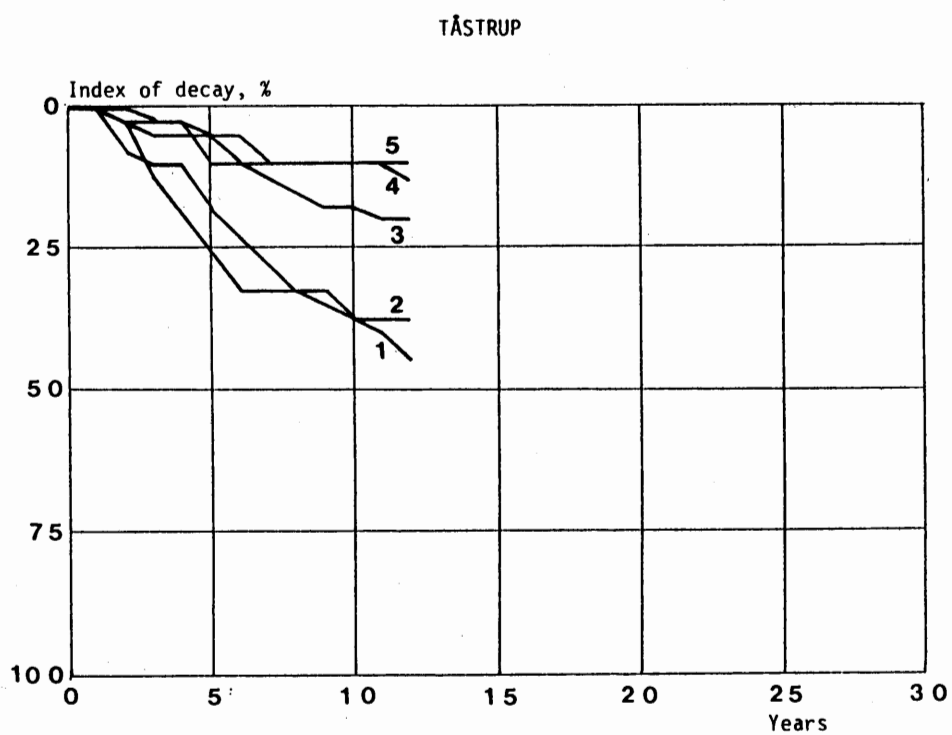




Figure 30. Rate of decay for stakes treated with Gufa 521 at the following retentions ($kg/m^3$):1. 10, 2. 15, 3. 20, 4. 30, 5. 41.

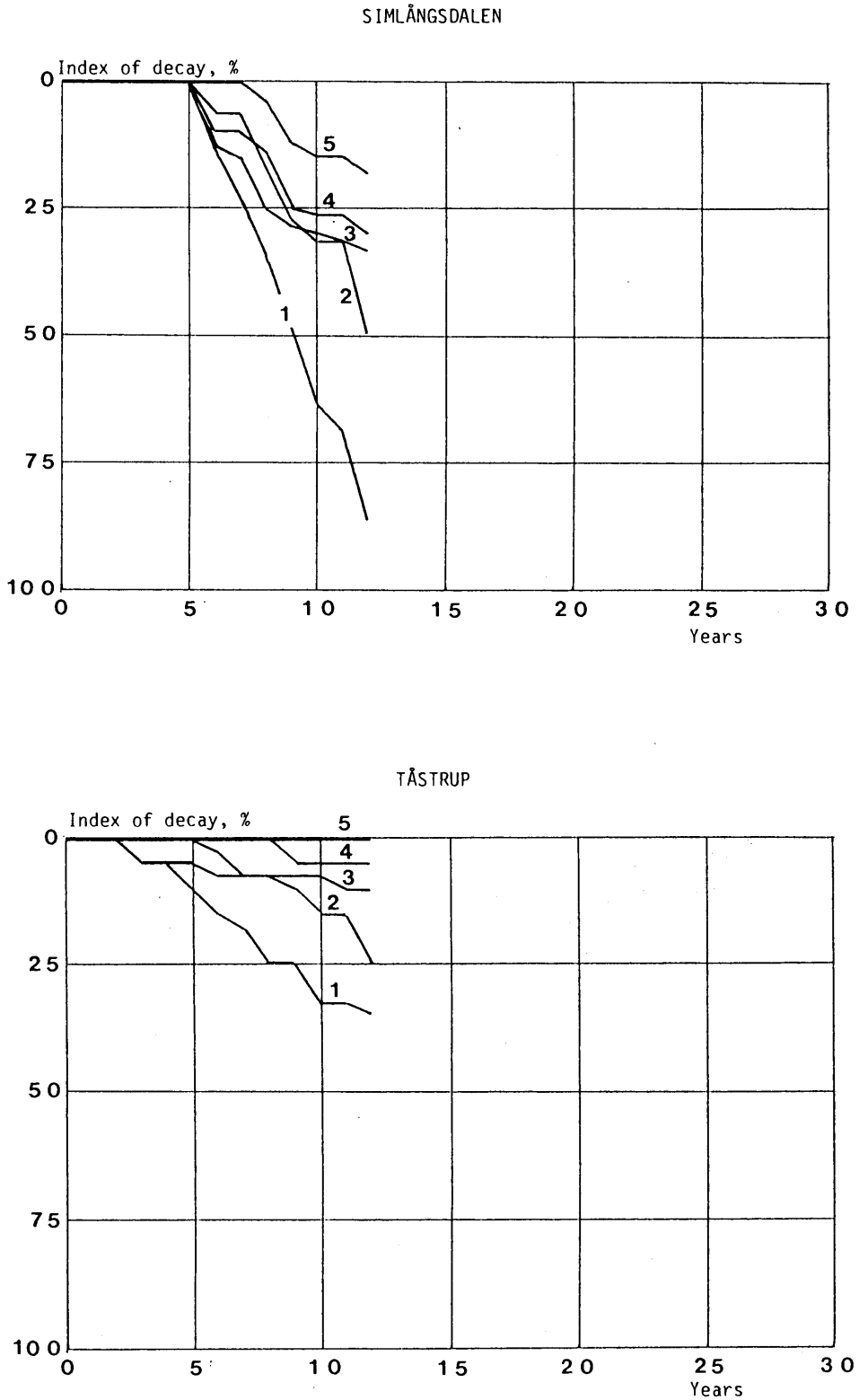



Figure 31. Rate of decay for stakes treated with Kemira K-75 at the following retentions ($kg/m^3$):1.16, 2. 25, 3. 32, 4. 45, 5. 58.

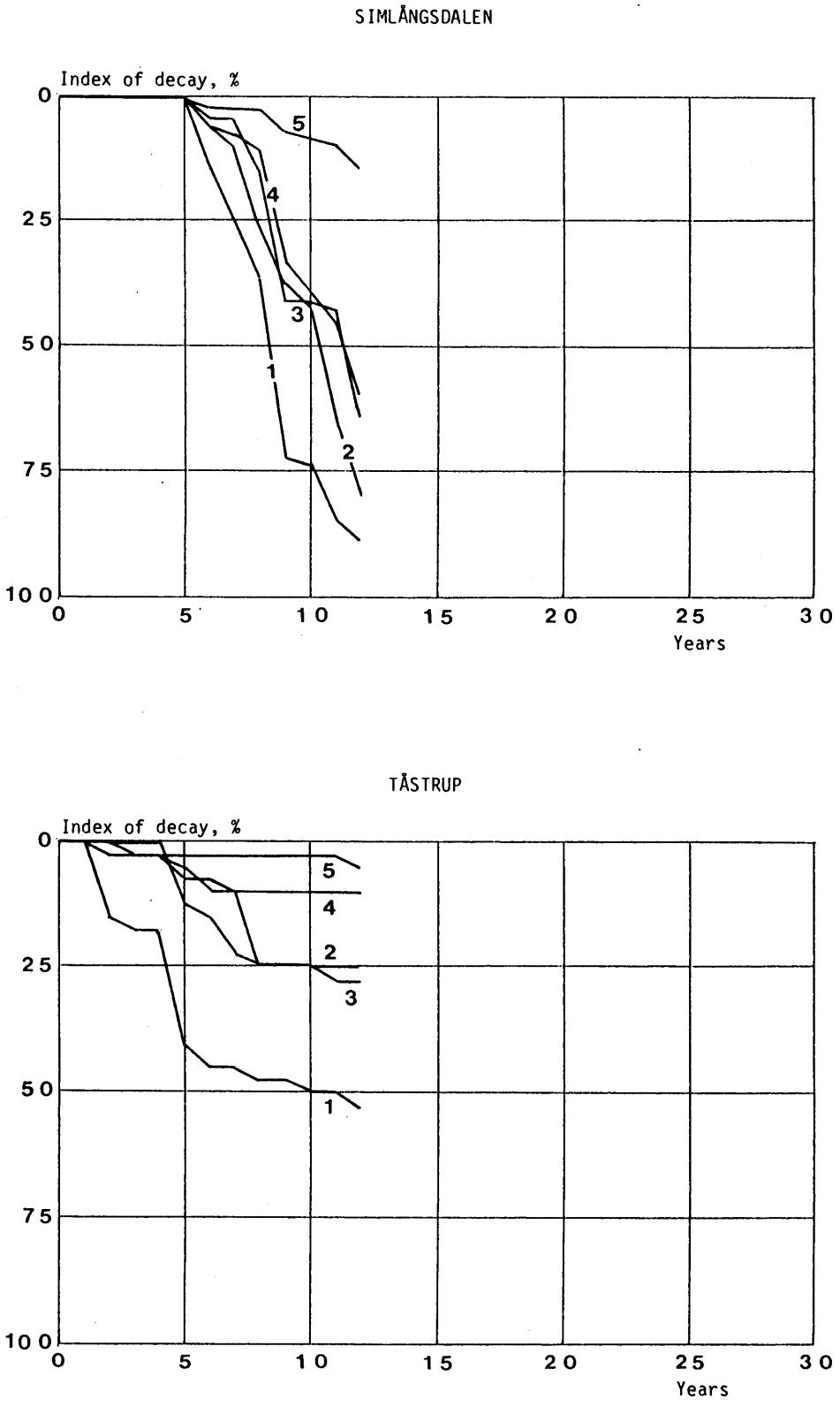



Figure 32. Rate of decay for stakes treated with Kemira KB-75 at the following retentions ($kg/m^3$):1. 9.5, 2. 14, 3. 19, 4. 30, 5. 40.

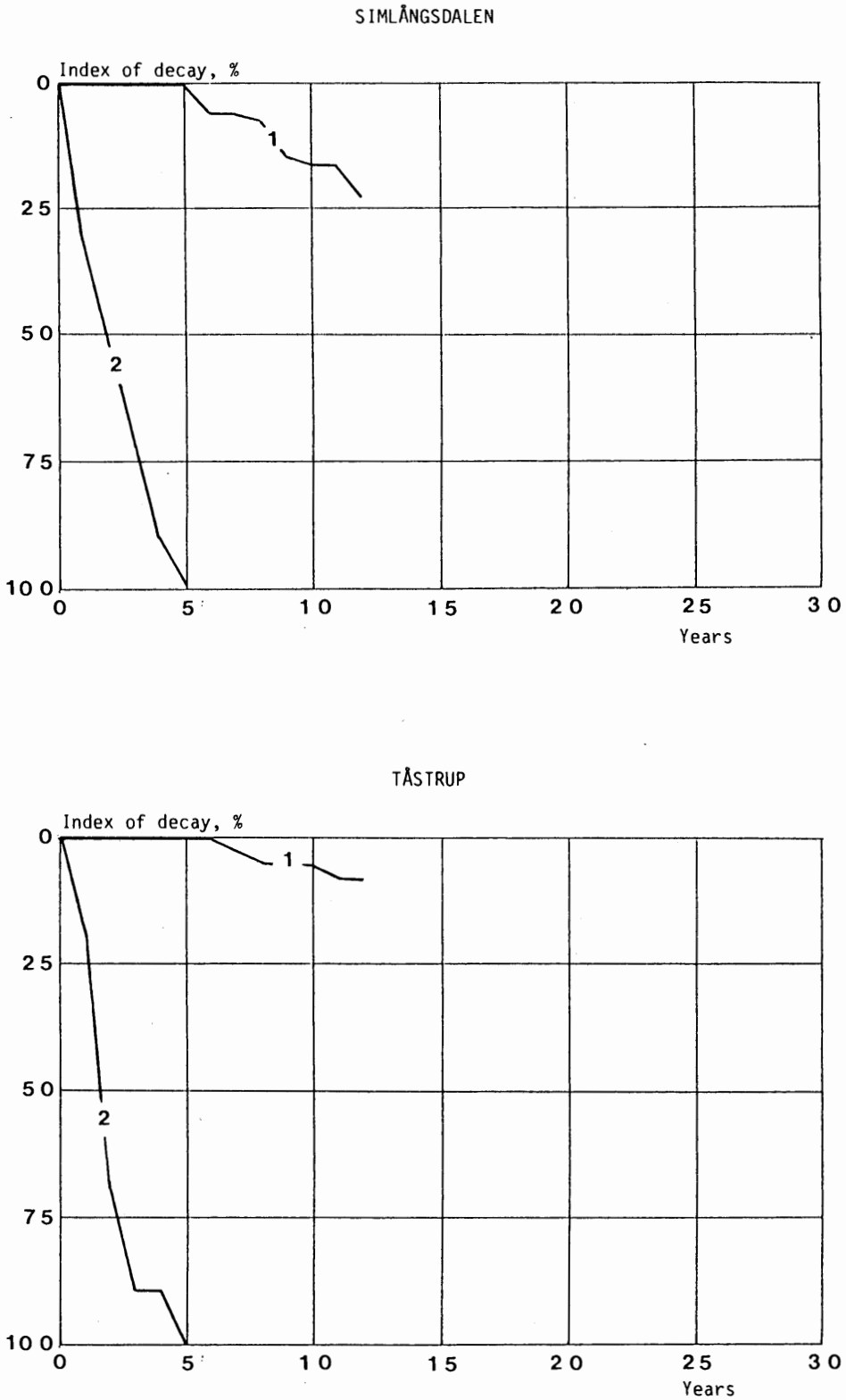



Figure 33. Field trial 1975. Rate of decay for stakes treated with 1. NWPC Standard Preservative No. 1 at a retention of 8.9 kg/m$^3$. 2. Untreated stakes.

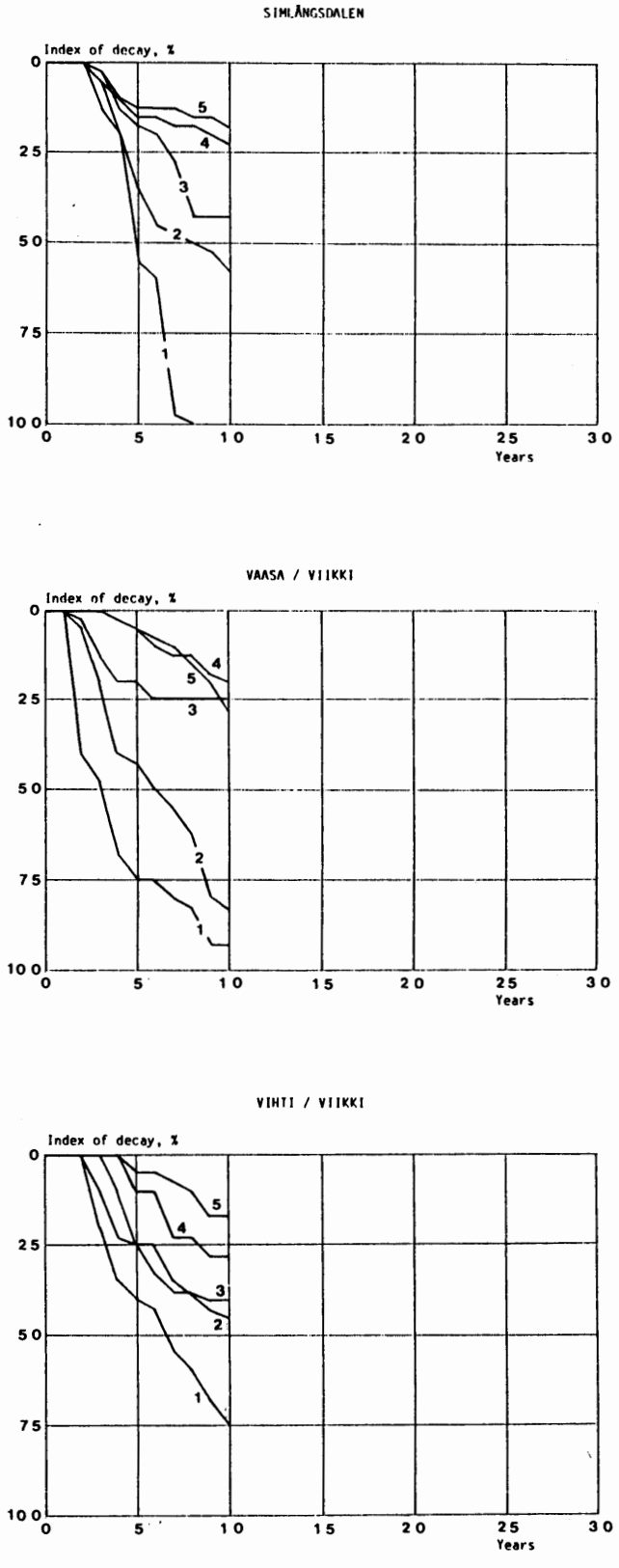



Figure 34. Rate of decay for stakes treated with Basilit CCB at the following retentions ($kg/m^3$):1. 7.0, 2. 14, 3. 21, 4. 28, 5. 34.

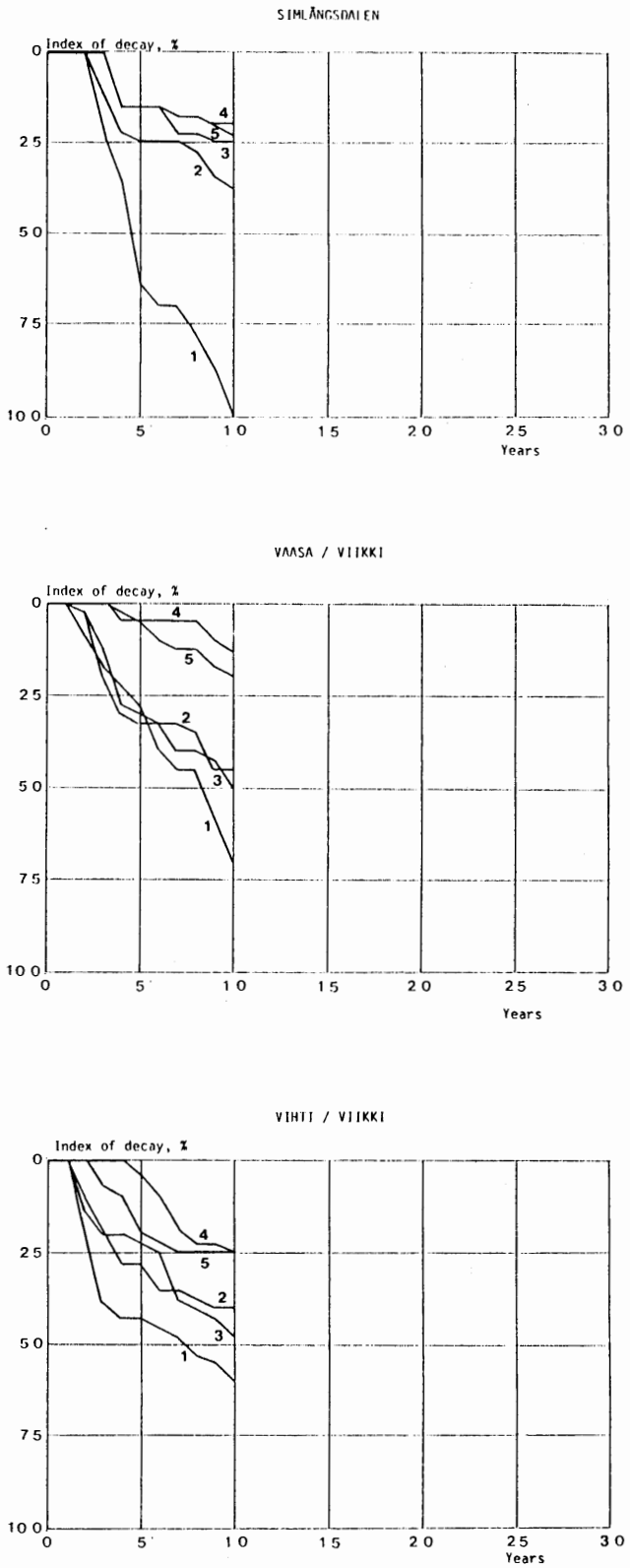



Figure 35. Rate of decay for stakes treated with Boliden P 50 at the following retentions ($kg/m^3$):1. 6.9, 2. 14, 3. 21, 4. 28, 5. 34.

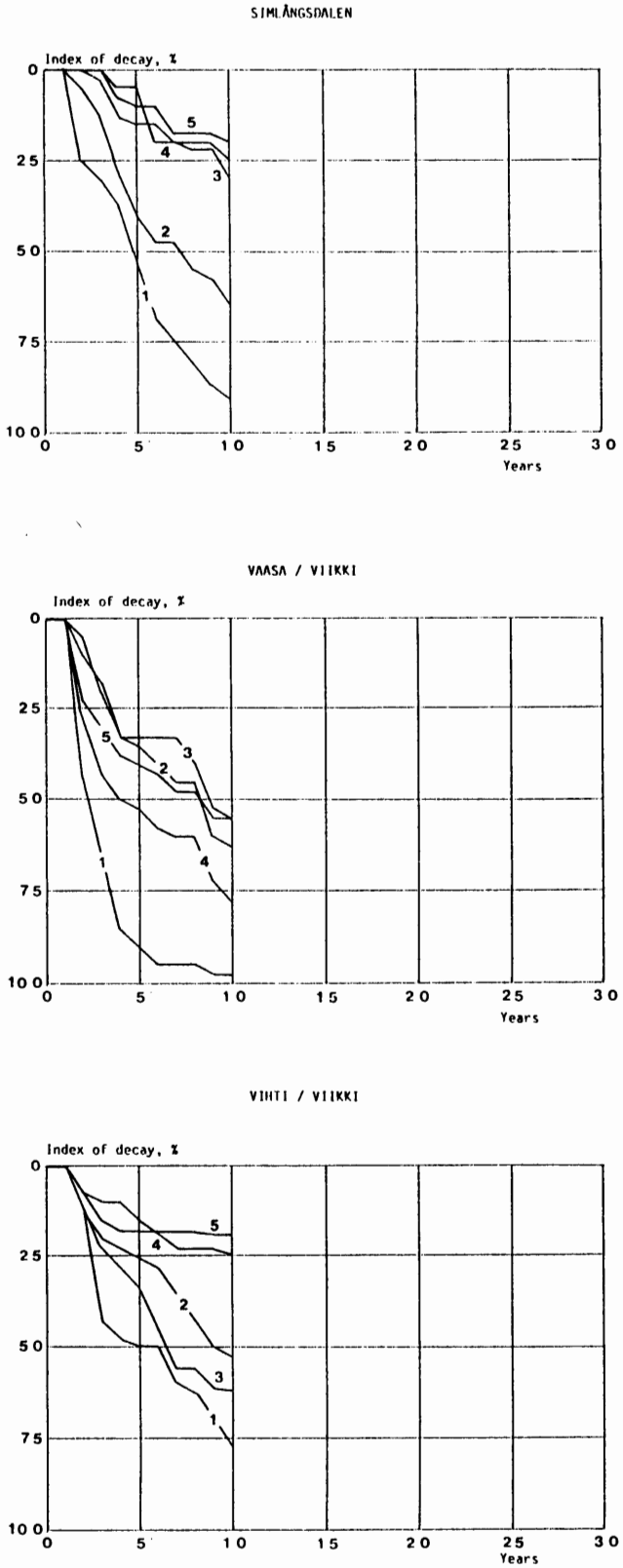



Figure 36. Rate of decay for stakes treated with Cuprinol Tryck at the following retentions ($kg/m^3$):1. 9.8, 2. 17, 3. 23, 4. 30, 5. 44.

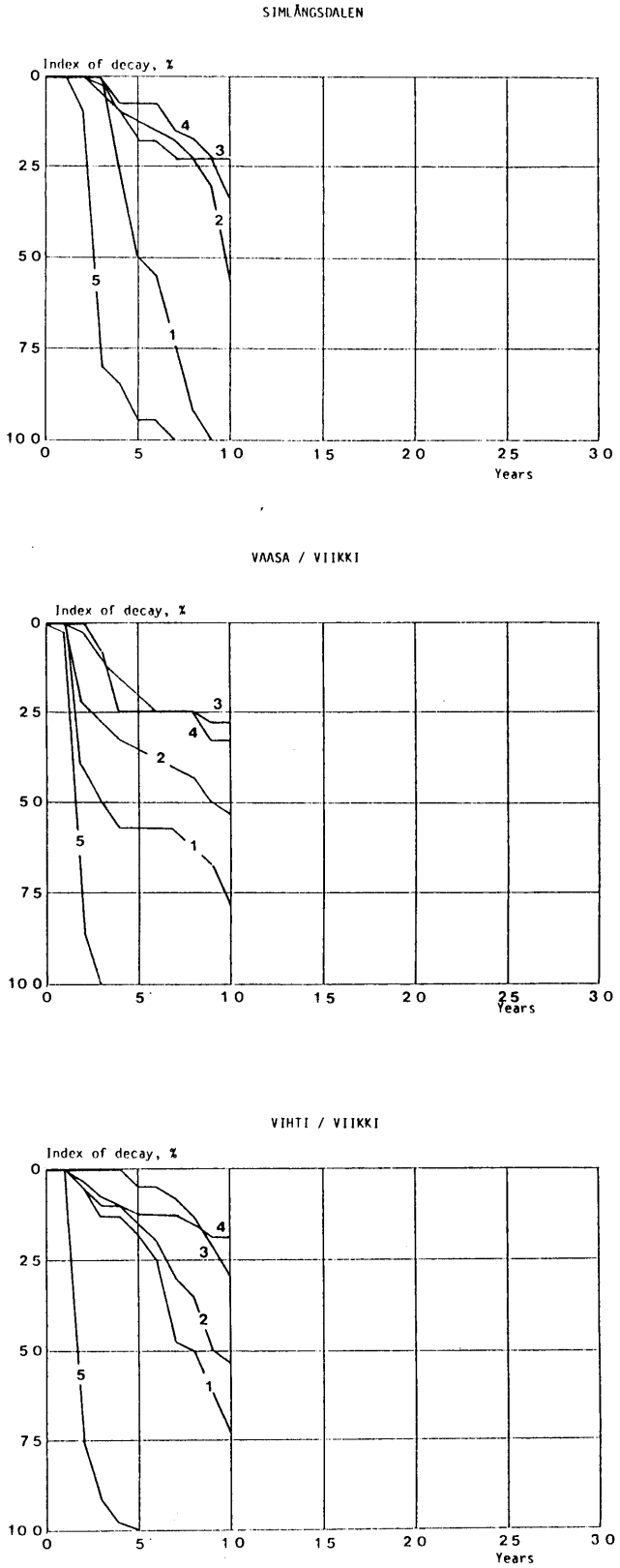



Figure 37. Field trial 1977. Rate of decay for stakes treated with NWPC Standard Preservative No. 1 at the following retentions (kg/m$^3$):1. 2. 6, 2. 5.1, 3. 7.8, 4. 10. 5. Untreated stakes.