FINSKA KEMISTSAMFUNDETS MEDDELANDEN

SUOMEN KEMISTISEURAN TIEDONANTOJA

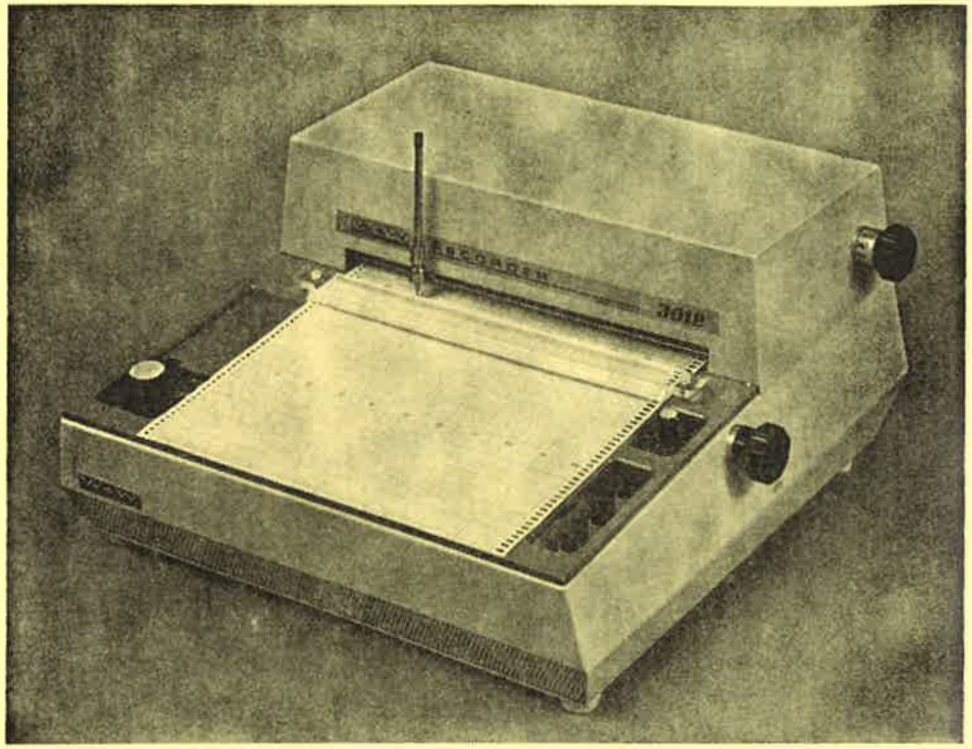
REDAKTÖR — TOIMITTAJA

Gösta Brunow

INNEHÅLL — SISÄLTÖ

N:o 4 · ÅRGÅNG 79 VUOSIK. · 1970

PIIRTUREITA



W+W · ELECTRONIC · · BASEL · SWITZERLAND

Verratkaa — ja valitkaa W + W-laatua

Teknisiä tietoja

- mitta-alueet 1 mV ylöspäin
- tarkkuus parempi kuin 0,2 %
- toistettavuus parempi kuin 0,1 %
- paperileveys 250 mm
- paperinopeus 4 tai 12 eri nopeutta
- piirtonopeus 250 mm/0,4–0,8 S mallista riippuen
- kuulalaakeroitu kynänpidin; **Rotring** tai kuulakärkikynä

STANDARDIPIIRTURIT

- yhden tai useamman alueen lineaariset
- yhden tai useamman alueen LIN/LOG
- yhden tai useamman alueen Integraattorilla varustetut

MONIPUOLINEN LISÄVÄLINEISTÖ

KAUKOMARKKINAT OY

FINSKA KEMISTSAMFUNDETS MEDDELANDEN

SUOMEN KEMISTISEURAN TIEDONANTOJA

79 årg. 1970 N:o 4 79 vuosik.

Utgiven av—Julkaisija—Publisher
Finska Kemistsamfundet — Suomen Kemistiseura — Chemical Society of Finland
Postbox 10476 Postilokero
Helsingfors — Helsinki

Styrelse—Hallitus
KARIN SANDELIN — LARS ANDERSEN — GÖSTA BRUNOW — ELSA EHRNROOTH — TOR-MAGNUS ENARI —TERJE ENKVIST — KAJ HÄSTBACKA — HOLGER SJÖBERG — VERONICA SUNDMAN

Sekreterare—Sihteeri
ELSA EHRNROOTH, S. kajen 6 A 5 E.ranta, Helsingfors 13 Helsinki tel. 63 61 87 puh.

Kassör—Rahastonhoitaja
BJÖRN HOLM, Kaserng. 16 A 9 Kasarmink. Helsingfors 13 Helsinki, tel. 46 04 11, 63 96 70 puh.

Arkivarie—Arkistonhoitaja
ANJA ANDERSEN, N. Hesperiag. 7 A P. Hesperiank. Helsingfors 26 Helsinki, tel. 49 08 78 puh.

Redaktör—Toimittaja
GÖSTA BRUNOW, Universitetets Kemiska Institut, S. Hesperiagatan 4 Helsingfors 10 Yliopiston Kemian Laitos, Et. Hesperiankatu 4 Helsinki 10 tel. 44 01 37 puh.

CONTENTS

Walter Wahl in memoriam

Finska Kemistsamfundets hedersledamot, professor emeritus Walter Wahl, avled 18 oktober 1970 i den höga åldern av 91 år. Han var kanske den sista företrädaren hos oss för en typ av forskare med gamla traditioner, den ekonomiskt oberoende privatmannen med eget laboratorium och eget bibliotek, som forskar på områden han själv väljer. Han var väl också den sista ledamot som var äldre än Finska Kemistsamfundet självt, han var tolv år när samfundet grundades.

Walter Wahl föddes i Viborg som ättling av en släkt med gamla traditioner på träförädlingens område i östra Finland. Firman Wahl var med på sågverksområdet vid Saima-vattnen redan i början av 1800-talet. Som 20-åring var Walter Wahl bland de studenter, som efter februarimanifestet år 1899 i Finlands bygder insamlade namn på den massadress som av den stora deputationen fördes till Rysslands huvudstad för att hos tsaren protestera mot förryskningsåtgärderna. Två år senare följde Wahl med Wilhelm Ramsay på geologiska exkursioner i Ostkarelen och medverkade på så sätt till uppkomsten av det geologiska begreppet Fennoskandia. År 1906 företog han geologiska exkursioner i Förenta Staterna och Kanada och deltog i den internationella geologkongressen i Mexico. Wahl blev fil. kand. i Helsingfors 1903. Som assistent på Kemicum vid Regeringsgatan hörde Wahl till »övre våningens herrar», som på kvalitativa och kvantitativa avdelningarna företrädde den oorganiska kemin och under ledning av mineralsyntetikern A. B. af

Schultén stod i ett visst motsatsförhållande till »nedre våningens herrar», organikerna Hjelt och Aschan. Wahl var sedermera väl den sista från Finland som besökte af Schultén i Paris, där denne under åren före första världskriget levde en enstörings liv.

Wahl var till utbildningen egentligen kemist, men inriktade i hög grad sin forskning på mineralogi och geologi och därifrån på studier av meteoriter och kemiska substanser vid höga tryck. Han disputerade 1908 med en avhandling om pyroxenmineralens kemi och optik. Dessa mineral förekommer såväl i bergarter som i vissa meteoriter. – Wahl arbetade i olika repriser utomlands. 1911 – 1914 var han stipendiat vid Davy-Faraday-laboratoriet i London, där han fick bestående intryck av kärnkemins genombrott och arbetade med bl.a. syrets och vätets kristallografi och optik i fast tillstånd, alltså vid extremt låga temperaturer. Han blev ledamot av Royal Institution of Great Britain 1912. – Under livsmedelsbristen 1918 var Wahl ordförande i statens livsmedelsproduktionskommitté och följande år medlem av den till England, Frankrike och U.S.A. sända handelskommissionen för import från dessa länder. Åren 1918 – 1924 var Wahl professor i kemi vid den nygrundade Åbo Akademi, de tre sista åren också dekanus vid kemisk-tekniska fakulteten. Vid Helsingfors universitet blev han docent 1923 och var 1937 – 1947 personlig e.o. professor. Från 1940 till in på 1960-talet var han chefdirektör för familjebolaget Wahl o. Co och var länge styrelseledamot vid A. B. Centrallaboratorium. Från 1951 var han några år ständig sekreterare för Finska Vetenskaps-Societeten. Från 1949 var han medlem av den internationella atomviktskommissionen och var tio år president i den internationella meteoritkommissionen. Han hann uppleva landstigningen på månen och analyserna av mineralproven därifrån, som intresserade honom på det högsta. – Under 1920- och 1930-talen publicerade han ett antal arbeten om graniterna i det finska urberget. År 1937 ställde han upp den första masspektrografen i Finland och utförde med den serier av åldersbestämningar på fennoskandiska urbergsmaterial.

Utgående från mineralogin intresserade han sig för centrala problem på kemins olika områden, särskilt det stereokemiska. Han arbetade med siliciums och bors valensförhållanden, silikaternas rymdstruktur och byggnaden hos hemoglobin och klorofyll samt undersökte isotopsammansättningen hos koppar och andra metaller i blodet hos olika havsdjur. För detta ändamål bedrev han länge laboratorieundersökningar i Monaco och i Neapel. En tid arbetade han med de kemiska substansernas förhållande vid extremt höga tryck.

I Finska Kemistsamfundet var han ordförande åren 1929 och 1941 och han har representerat samfundet i Centralrådet för

Finlands Kemister. År 1926 var han generalsekreterare för Nordiska kemistmötet, som då för första gången hölls i Finland.

När Wahl vid ca 80-års ålder sålde sin firma var hans vitalitet ännu obruten. Han föresatte sig att resa till alla de länder han velat besöka men ej fått tillfälle att se. Han reste därefter bl.a. till Tanzania, där han drabbades av malaria, som han botade i Marocko, och sedan jorden runt via Nya Zeeland, Australien och Indonesien. Blott Singapore gick han miste om, till sin stora förtrytelse, på grund av den politiska oron i sydöstra Asien. — Walter Wahl hade under sitt långa liv sett mycket av länder och folk och vetenskapens store. Han hade humor av snarast brittisk typ och kunde berätta mycket fascinerande om sina upplevelser. Så skildrade han hur han i England träffade en ung man, som satt i en laboratoriekorridor på en fastskruvad trampcykel och alstrade elektricitet med muskelkraft för sina experiment. Den mannen var Aston, uppfinnaren av masspektrografen!

Vi ser att Wahl i hög grad hade förmågan att arbeta på egna uppslag på aktuella, okonventionella och betydelsefulla forskningsområden. I detta avseende höll han sig i främsta ledet av den internationella forskningen. Tyvärr är det i våra dagar icke lätt för en mer eller mindre ensam forskare att genomföra program av nödig omfattning. Walter Wahl var dock en forskare av format och hans idérikedom är ett stimulerande föredöme.

Terje Enkvist

Lignin Determination in Gmelina Arborea

Femi Odeyemi

Chemistry Department, University of Lagos, Nigeria.

Abstract

The plan to make *Gmelina arborea* a pulpwood in Nigeria calls for an investigation into the determination of the lignin content of the wood species.

Absorptiometric method is used in the estimation of the acid soluble lignin. With respect to the sulphuric acid method the most favourable acid concentration lies between 66 and 74 per cent. A higher percentage (77.1 %) could be used with good results provided the reaction time is less than one hour. The primary hydrolysis reaction could be advantageously carried out under the tropical laboratory room temperature (29 ± 1°C).

The use of a mixture of sulphuric acid (Sp. gr. 1.84) and hydrochloric acid (Sp. gr. 1.18) in the ratio 2:1 or 1:1 by volume is recommended.

The total lignin in the Gmelina samples investigated amounts to 31 ± 1 per cent. The determination of the lignin in the Kraft pulp requires severer conditions.

Purpose of the Investigation

The work of Chittenden et al.[1] has recommended the Nigerian grown *Gmelina arborea* as a pulpwood. Partly upon this recommendation, Nigeria has embarked on a massive cultivation of the species.

While much is known about the silvicultural characteristics of the wood, studies on its chemistry from the point of view of pulping are few. Lignin determination in wood and pulps is essential to a successful pulping. The commonly employed procedure for lignin determination is the Klason or 72 per cent sulphuric acid method. This procedure seems suitable for softwood species which contain no significant amount of the acid-soluble lignin.[2,3]

But investigations [4–6] do show that hardwoods contain varying amounts of the acid-soluble lignin and that the usual acid concentration (72 per cent) is unsuitable for the deciduous woods.[7] Hence this investigation is designed to seek an acceptable procedure for the determination of the lignin content of Gmelina arborea and of the pulp prepared from it.

Experimental

Wood samples

The samples of the *Gmelina arborea* used in this investigation were collected from the Federal Forest Research Institutes plantation at Ibadan. Only three year old gmelina trees were randomly selected.

The samples were reduced into sawdust and were stored in plastic bags. The acepted sawdust was the portion which passed through a 40 — 80 mesh sieve.

Extraction

The sawdust was first extracted with ether for a period of ten hours after which it was extracted with a mixture of benzene and 96 per cent ethyl alcohol in the ratio 2:1 by volume for a period of ten hours.

The sawdust was then washed with hot water and dried in the air.

The lignin determination

For each experiment, about one gram of the sawdust was accurately weighed in a 50ml beaker. This was treated with 15ml (except otherwise stated) of the mineral acid at room temperature (29 ± 1°C) for two hours (except otherwise stated). After this, the reaction mixture was diluted to 3 per cent, with respect to the mineral acid used, and boiled for 3 hours under a constant volume condition by frequently adding hot water to the solution.

The solution was allowed to cool down. The residue was filtered through a previously weighed Gooch crucible of porosity 4 and washed with hot water. The residue was then dried to constant weight at 105°C in an oven. The residue was expressed as a percentage of the extracted oven dried wood. Each experiment was carried out in duplicate. The lignin residue was not cor rected for the ash content.

The estimation of the acid-soluble lignin

In each case, the volume of the filtrate was recorded. The absorbance of the filtrate was determined using Unicam SP 800 Recording spectrophotometer. The absorption maximum which occured between 215 nm and 220 nm was recorded for the lignin estimation.

The spectrophotometer was calibrated with a sample of thiolignin. From this, the acid-soluble lignin was calculated as a percentage based on the oven dried extracted wood.

ESTIMATION OF ACID-SOLUBLE LIGNIN

Gravimetric Method

Some workers extracted the acid-soluble lignin from the acid hydrolysates with alcohols,[8–9] while in some cases the "Zeo-karb 215" column absorption was used to extract the acid-soluble lignin. The column was eluted with alcohol after which the solvent was evaporated and the residue weighed.[6,11] The gravimetric method is slow and in most cases the procedure is non-specific with respect to lignin isolation.

Absorptiometric method

The estimation of the acid-soluble lignin by the absorptiometric method has resulted from the extensive investigations on some lignin preparates.[12–17] And several workers have used the method.[2,5,18 24] The method is rapid.

Lignin usually has absorption maxima in the ultraviolet region about 280 nm, 230 nm, and 215 nm. One of the major sources of error in the method is that the carbohydrate hydrolysis products also absorb in the ultraviolet region especially at 280 nm. This interferes with the lignin absorption.

It has been observed, however, that the absorption of the carbohydrate hydrolysis products is insignificant in the far ultraviolet region.[22–24] For this reason, Lorås and Løschbrandt [2] have recommended the use of the absorbance peak at 220 nm while recently, Pearl and Busche [5] have estimated the acid-soluble lignin from the absorbance measurement at 208 nm. Kyrklund and Palenius also read the absorbance values at 205 nm.[21]

Having found out that the polysaccharide hydrolysis products have no absorbance at 215 nm, the absorbance peak in this region is chosen for the estimation of the acid-soluble lignin in the present work.

Ultraviolet standard

The search for a satisfactory standard is another problem. In absorptiometric behaviour and in structural composition, an ideal standard must be identical with the acid-soluble lignin.

The milled-wood lignin is believed to be similar to the protolignin in wood. Pearl and Busche [5] have compared the absorption curves of milled-wood lignin and lignosulphonate with that for the acid-soluble lignin and have found them similar. Almost quite arbitrarily they have used lignosulphonate as a standard.

Although the structural relationship between the acid-soluble lignin and the lignosulphonate is not clearly elucidated, some authors have been correcting for the sodium sulphonate component of the lignosulphonate each time it is used as a standard.[2,21] It seems doubtfut that the acid-soluble lignin is a pure compound which is equivalent in molecular weight to a corrected lignosulphonate.

In arriving at a decision as to which lignin preparate to use as the standard, the following have been prepared from the wood sample.

(a) Alkali lignin,[25,26]
(b) thiolignin and [25,26]
(c) sodium lignosulphonate.[27]

Their ultraviolet absorption curves are compared with that for the acid-soluble lignin in Figure 1. It can be seen that each

one of them has peaks at 280 nm, 240 nm and about 220 nm. The peak at 240 nm is less noticeable for the acid-soluble lignin than for others. While the peak around 220 nm really occurs at 212 nm for the acid-soluble lignin, those for other lignin

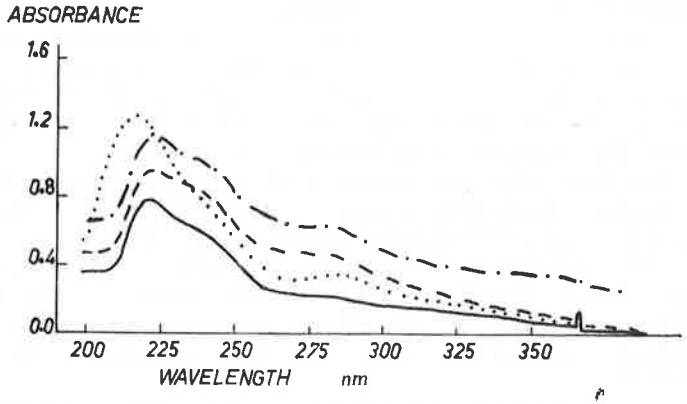


Figure 1. Ultraviolet absorption curves for some lignin preparates.
——————— Thiolignin
— — — Alkali lignin
— - — . — . — lignosulphonate (displaced by 0.2 unit upwards).
. . . . . Acid-soluble lignin from Klason filtrate.

preparates occur at 222 nm for approximately the same value of absorbance. This observation indicates that all the lignin preparates are similar and that the acid-soluble lignin is different from them as far as the position and shape of the far ultraviolet absorbance peak are concerned. This contradicts the experience of Loråas and Løschbrandt.[2]

As the concentration of each of the lignin preparates increases the absorbance peak in the far ultraviolet region shifts towards the higher wave lengths. This is also true, to a lesser extent, of the acid-soluble lignin.

The gmelina thiolignin is chosen as an ultraviolet standard because if there is any structural similarity at all, the acid-soluble lignin from the Klason filtrate of the wood, would most probably resemble the thiolignin more than the alkali lignin which contains no sulphur and more than lignosulphonate which contains sulphonate groups. It can be seen that my choice is also largely arbitrary.

Acid-soluble lignin as a standard

A preliminary work on employing the acid-soluble lignin as a standard was carried out at the later part of this work. From the Klason lignin obtained in the usual procedure, a known weight was subjected to a second Klason treatment. The Klason

residue got was dried and weighed; and the absorbance of the filtrate was taken. From the loss in weight, the concentration of the acid-soluble lignin in the secondary filtrate was calculated. A graph of concentration of the acid-soluble lignin was plotted against the absorbance. This is shown in Figure 2.

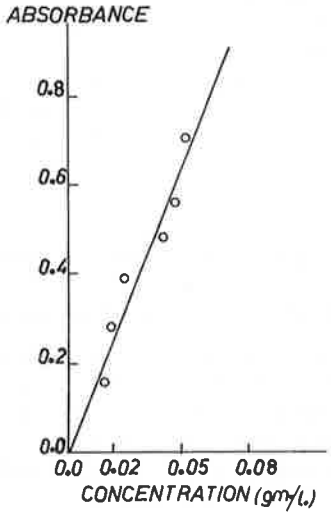


Figure 2. Calibration graph for the acid-soluble lignin.

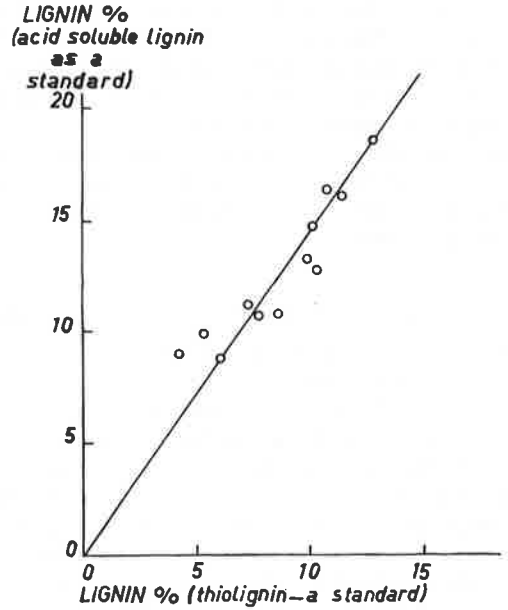


Figure 3. Some acid-soluble lignin values, estimated and plotted on two absorptiometric standards: Thiolignin versus acid-soluble lignin.

The relationship between the values obtained with the thiolignin as a standard on the one hand, and with the acid-soluble lignin as a standard on the other hand is depicted in Figure 3. The deviation of some points from the straight line could be due to the error in using thiolignin as a standard.

The acid-soluble lignin as a standard gives a higher lignin value than the thiolignin; for this reason, the thiolignin was used without any correction as this would decrease the values further. All the values for the acid-soluble lignin recorded in this paper are calculated on the thiolignin as a standard because more work is still needed in order to make the acid-soluble lignin a standard.

RESULTS AND DISCUSSION

The Influence of the acid concentration

Table 1 shows the effect of the sulphuric acid concentration, during the primary hydrolysis of the polysaccharides, on the values of Klason lignin and the acid-soluble lignin. For the 65 per cent sulphuric acid, the value of the Klason residue is high. As the percentage of the acid is further decreased, the polysaccharides of the wood is not completely hydrolysed and as a result, the Klason residue increases. Between 66 per cent and 72 per cent, the value of the Klason residue does not vary much. The lowest value (25.9 per cent) recorded is obtained with 68.3 per cent sulphuric acid. For percentages higher than 74, the value of the Klason lignin gradually increases, and the colour becomes darker. This is generally attributed to the sorption of sulphuric acid into the lignin.

With respect to the acid-soluble lignin, however, below 65 per cent, the values decrease. This is due to an incomplete hydrolysis. As the percentage of the sulphuric acid increases, so the acid-soluble lignin decreases.

The time of impregnation with the concentrated sulphuric acid

The effect of time is illustrated in Table 2. It appears that, under the same experimental conditions, the longer the time of impregnation, the higher the value of Klason lignin and the lower the value of the acid-soluble lignin obtained. The darker appearance and the increase in the Klason lignin got with a high concentration (77.1 per cent) can be avoided by reducing the time of impregnation from two hours to one hour or less. From the values of the acid-soluble lignin in Table 2, one tends to infer that the acid-soluble lignin is completely liberated at the initial stage of the reaction and after this, somehow, the

acid-soluble lignin is gradually precipitated out of the solution probably through some form of polymerisation with the Klason residue or other hydrolysis products under the influence of the sulphuric acid.

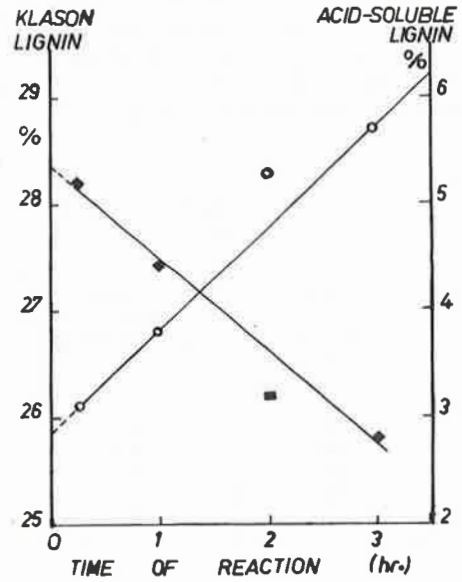


Figure 4. Plot of the Klason lignin and the acid-soluble lignin versus the time of hydrolysis with 77.1 per cent sulphuric acid.
■——■ Acid-soluble lignin
○——○ Klason lignin

Table 1. The influence of acid concentration on the lignin values.

Sulphuric acid % by weight	Klason residue % on O. D. Wood A	Acid-soluble lignin % on O. D. Wood B	Total A + B % on O. D. Wood
57.2	75.2	9.1	84.3
60.4	73.7	9.5	83.2
65.3	31.6	10.2	41.8
66.5	26.3	—	
68.3	25.9	8.3	34.2
70.2	27.2	5.2	32.4
71.0	26.0	4.1	30.1
72.0	27.8	3.9	31.7
74.0	28.6	4.6	33.2
76.0	28.9	4.2	33.1
77.1	28.3	3.2	31.5
81.4	30.6	2.1	32.7
83.7	31.2	1.4	32.6
86.4	39.3	1.1	40.4

The Klason residue is plotted against the time of imprenation in Figure 4. The graph is a straight line for the value of the reaction time below three hours. On extrapolating to zero time, the value of the Klason lignin reads 25.85 while the extrapolated value of the acid-soluble lignin is 5.35. This brings the total lignin to 31.2 per cent. The effect of time is also demonstrated by using 68.3 per cent sulphuric acid which gives the lowest value for Klason lignin in Table 1. Below a reaction time of one hour, the hydrolysis is incomplete (Table 3).

Table 2. Time of the sulphuric acid treatment and the lignin values. sulphuric acid concentration: 77.1 %.

Time of acid treatment (hr.)	Klason residue % on O. D. Wood A	Acid-soluble lignin % on O. D. Wood B	Total A + B % on O. D. Wood
0.25	26.1	5.2	31.3
1	26.8	4.4	31.2
3	28.7	2.8	31.5
10	33.5	1.6	35.1
24	37.9	0.9	38.8

Table 3. Time of the sulphuric acid treatment and the lignin values. sulphuric acid: 68.3 %.

Time (HR)	Klason residue % on O. D. Wood A	Acid-soluble lignin % on O. D. Wood B	Total % on O. D. Wood A + B
0.25	66.2	10.4	76.6
0.5	50.5	11.2	61.7
1	26.0	5.8	31.8
1.5	26.4	9.3	35.7

The Temperature of reaction

The Tappi standard Method [28] recommends that the temperature of the reaction during the acid treatment be kept at 18 to 20°C. The room temperature in the laboratory at the time of the experiment was 29 ± 1°C. This was also the temperature of the mineral acids used. The experiments whose results are recorded in Table 4 have been carried out to ascertain the effect of using the high tropical temperature in the laboratory.

Table 4. Effect of the reaction temperature on the lignin values using 68.3 % sulphuric acid.

Temperature of reaction °C	Klason residue % on O. D. Wood A	Acid-soluble % on O. D. Wood B	Total A + B % on O. D. Wood
−5	79.2	6.4	85.6
8	71.2	10.1	81.3
18	43.8	8.0	51.8
29	26.0	8.4	34.4

It was observed that on adding the sulphuric acid to the sawdust, the temperature rises from 28°C (the temperature of the sulphuric acid) to 29.8°C. After some minutes, the temperature gradually falls to 28°C. On stirring, the rise in temperature is noticed. To maintain the reaction temperature at 20°C leads to a higher value of Klason lignin.

Action of the hydrochloric acid

The effect of using the 36 per cent (sp. gr. 1.18) hydrochloric acid instead of the usual 38 per cent (sp. gr. 1.19) is also investigated. The result is compiled in Table 5. After 4 days, only about 32 per cent of the wood has gone into solution and the incomplete hydrolysis notwithstanding, the values of the acid-soluble lignin are high. Obviously, 36 per cent hydrochloric acid is too weak for the determination of the lignin content of this species; It appears therefore that the liberation of a high amount of the acid-soluble lignin does not depend on a complete hydrolysis of the polysaccharides as is the case for the use of the sulphuric acid.

Table 5. Action of the concentrated hydrochloric acid (sp.gr. 1.18) on Gmelina wood dust.

Time of reaction (HR.)	Dissolved Substance % on O. D. Wood	Acid-soluble lignin % on O. D. Wood
24	26.6	11.6
48	29.4	11.1
72	31.6	10.9
96	30.6	10.9

Sulphuric acid-Hydrochloric acid lignin

The results of the determination of the lignin with mixtures of sulphuric acid (sp. gr. 1.84) and hydrochloric acid (sp. gr. 1.18) are set out in Table 6. The two acids were first mixed together in a fume cupboard before use.

Table 6. Determination of lignin with mixtures of hydrochloric acid and sulphuric acid.

Sulphuric acid:	98 %	Sp. Gr. 1.84
Hydrochloric acid:	35 %	Sp. Gr. 1.18
Volume of the mixture:	30 ml.	
Time of reaction:	2 hours	

Mixture				Residue % on O. D. Wood (A)	Acid-soluble lignin (B)	Total A + B % on O. D. Wood
Sulphuric acid		Hydrochloric acid				
* %	Vol.	%	Vol.			
by wt.	(*ml.*)	by wt.	(*ml.*)			
9.8	2	32.1	28	70.8	11.0	81.8
23.3	5	27.5	25	62.5	10.0	72.5
42.9	10	20.2	20	27.9	10.8	38.7
59.7	15	14.1	15	25.0	12.8	37.8
74.4	20	8.7	10	29.6	4.3	33.9

* Percentage on the total weight of the mixture.

When the percentage of the sulphuric acid in the mixture, is low (probably below 30 per cent), the hydrolysis is not complete. With a concentration higher than 40 per cent of the mixture, the values obtained indicate that the reaction has gone to completion. It is of interest to note that when the percentage of the sulphuric acid is raised to 74.4 per cent, the effect of the hydrochloric acid (8.7 %) is not noticeable because the results obtained are similar to those obtained with 74 per cent sulphuric acid (Table 1). The influence of the hydrochloric acid is most significant when 10ml. of sulphuric acid (42.9 % on the total weight) is mixed with 20ml. of the hydrochloric acid (20.2 %). The total content of the two acids in the mixture amounts to 63.1 per cent. This mixture yields a lignin residue of 27.9 per cent, and this value is lower than that obtained with the pure 65.3 per cent sulphuric acid. Hydrochloric acid, it appears, posesses some catalytic behaviour.

The lowest value of lignin residue is obtained with a ratio of 1:1 by volume. In this mixture, the sulphuric acid amount to 59.7 per cent and the hydrochloric acid is 14.1 per cent of the mixture. From Figure 5, one also has the impression that the hydrochloric acid acts as a catalyst. The two acids amounts to 73.8 per cent of the mixture and this gives 25.0 per cent lignin — a value which is considerably lower than the value for the 74 per cent sulphuric acid (Table 1). But the value of the acid-soluble lignin is high.

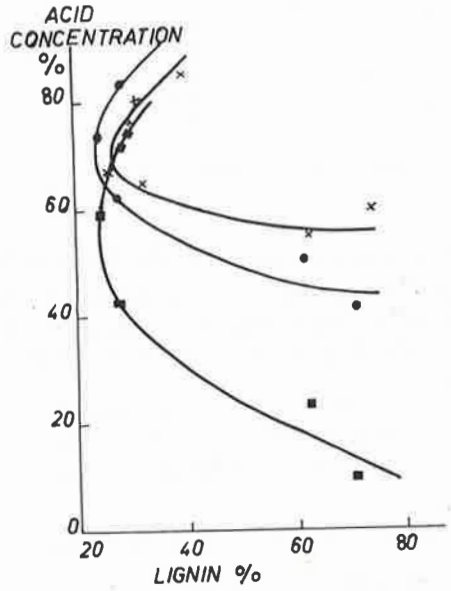


Figure 5.

×——× Klason method: Acid concentration versus Klason residue.

●——● Total acid concentration (HCl-H_2SO_4) in the mixture of hydrochloric acid and sulphuric acid versus the lignin residue.

■——■ Percentage of the sulphuric acid component of the mixture versus the lignin residue.

Table 7 emphasises the same observation about the catalytic action of the hydrochloric acid.

Table 7. Determination of lignin with mixtures of hydrochloric acid and sulphuric acid.

Sulphuric acid: 72 %
Hydrochloric acid: 36 %
Total volume of mixture: 50 ml.

Mixture				Residue % on O. D. Wood	Acid-soluble lignin % on O. D. Wood	Total A + B % on O. D. Wood
Sulphuric acid		Hydrochloric acid				
* %	Vol.	%	Vol.			
by wt.	*ml.*	*by wt.*	*ml.*	A	B	
9.4	5	31.3	45	38.6	9.3	47.9
18.2	10	26.9	40	33.0	7.0	40.0
34.2	20	18.9	30	29.4	5.7	35.1
41.5	25	15.3	25	29.1	6.2	35.3
54.7	35	9.3	15	28.6	6.7	35.3

* Each component is expressed as a percentage by weight of the whole mixture.

Lignin determination in the Kraft pulp

The Kraft pulp was produced in Jebba by the Nigerian Paper Company. The unbleached pulp has a Kappa number of 40.3. On the basis of the Tappi 236m – 60 method, the Klason lignin would be 6.05.

Table 8 shows the effect of the concentration of the sulphuric acid. The lowest value of Klason lignin is obtained with 72 per cent for a reaction time of 4 hours. A comparison between

Table 8. Determination of lignin in the Kraft pulp of Gmelina.

Volume of acid: 15 ml.
Time of reaction: 2 hours

Sulphuric acid concentration %	Klason residue % on O.D. pulp
68.3	9.3
66.5	11.4
65.3	31.2
60.4	82.3
Volume of acid:	30 ml.
Time of reaction:	4 hours
72.0	6.6
68.3	7.3
66.5	10.1

Table 8 and Table 1 shows that the determination of the lignin content in the Kraft pulp requires stronger conditions.

The mixtures which give good results in Table 6 have been tried on the pulp. The results are in Table 9. A mixture of the sulphuric acid and the hydrochloric acid in the ratio 1:1 by volume gives a good result.

Table 9. Treatment of the Kraft pulp with the mixtures of sulphuric acid and hydrochloric acid.

Mixture		
Sulphuric acid % of total wt.	Hydrochloric acid % of total wt.	Residue % on O. D. pulp
42.9	20.2	8.5
59.7	14.1	6.8

The ultraviolet absorption curve of the filtrate has only one peak at 280 nm and this is generally believed to belong to the carbohydrate hydrolysis products. The sulphate pulp does not contain any acid-soluble lignin.

The investigation is being continued.

Acknowledgements

The author is grateful to the Central Research Committee of the University of Lagos for research grant; to Professor A. Akisanya for his encouragement; and to Messrs R. Obasi, A. Odumosu and E. A. Bamgboye for technical assistance.

Literature

1. Chittenden, A., Coursey, D. and Rotibi, J. *Tappi* **27** 12 (1 964) 186A—192A
2. Lorås, V. and Løschbrandt, F. *Norsk Skogsindustri* 10 (1956) 402.
3. Browning, B. L. and Bullitz, L. O. *Tappi* **36** (1953) 452.
4. Richtzenhain, H. and Dryselius, E. *Sv. Papperstidn.* **56** (1953) 324.
5. Pearl, I. A. and Busche, L. R. *Tappi* **43** (1960) 961.
6. Campbell, W. G. and McDonald, R. C. *J. Chem. Soc.* **1952** 3180.
7. Brauns, F. E. *The Chemistry of Lignin* Academic Pres, New York 1952, 55.
8. Giertz, H. W. *Sv. Papperstidn.* **46** (1943) 152.
9. Cohen, W. F. *F. A. O. Symposium Tropical woods and Agricultural Residues as sources of Pulp* Rome 1953.
10. Migita, N. and Kawamura, M. *Chem. Abstr.* **43** (1949) 733a.
11. Mackenzie, A. W., McPherson, J. A., and Stewart, C. M. *Holzforsch.* **9** (1955) 109.
12. Glading, R. E. *Techn. Ass. Papers* **24** (1941) 556.
13. Giertz, H. W. *Sv. Papperstidn.* **48** (1954) 485.
14. Patterson, R. E. and Hibbert, H. *J. Am. Chem. Soc.* **65** (1943) 1869.

15. Aulin-Erdtman, G. *Sv. Papperstidn.* **48** (1945) 75, **55** (1952) 745, **56** (1953) 287, **57** (1954) 745.
16. Björkman, A. *Sv. Papperstidn.* **59** (1956) 477.
17. Björkman, A. and Person, B. *Sv. Papperstidn.* **60** (1957) 158.
18. Marraccini, L. M. and Kleinert, T. N. *Holzforschung* **13** (1959) 43.
19. Browning, B. L. and Bublitz, L. O. *Tappi* **36** (1953) 452.
20. Loràs, V. and Løschbrandt, F. *Norsk Skogind.* **15** (1961) 7, 302.
21. Kyrklund, B. and Palenins, I. *Paper and Timber* **46** (1964) 513.
22. Kleinert, T. N. and Joyce, C. S. *Tappi* **40** (1957) 813.
23. Kleinert, T. N. and Joyce, C. S. *Tappi* **41** (1958) 372.
24. Kleinert, T. N. and Dlouhy, R. M. *Pulp Paper Mag. Can.* **59** (1958) 67.
25. Ekman, K. H. and Enkvist, T. *Paper and Timber* **37** (1955) 369.
26. Ekman, K. H. *Commentationes Physico-Mathematicae XXIII* **1** (1958).
27. Forss, K. The composition of a spent Spruce Sulfite liquor. Dissertation Åbo Akademi (1961).
28. Tappi Standard Method T 13m—54.

Received October 26, 1970.

Studies on Components in Wood

4. Mass Spectrometric Identification of Sandaracopimaric Acid in the Oleoresin of Norway Spruce (*Picea abies*)

Rainer Ekman and *Göran Pensar*

The Institute of Wood Chemistry and Pulping Technology, Åbo Akademi, Åbo, Finland

Abstract

Sandarcopimaric acid has been identified in the resin acid fraction in the oleoresin from Norway spruce by a technique of gas chromatography and mass spectrometry.

Introduction

The resin acids are tricyclic terpenoid compounds with either an abietane or a pimarane skeleton (fig. 1) occuring as the major nonvolatile constituents in the oleoresin of coniferous species. The acids of the former type are characterized by an isopropyl side chain at carbon atom number 13 while the acids of the latter type have methyl and vinyl substituents at that position.[1] The determination of the composition of the resin acids in oleoresin and other sources has been complicated by their similarity in structure and the lack of analytical methods suitable for the separation of such complex mixtures. Kahila[2] used the classic method of amine salt precipitation and ultraviolet spectroscopy to determine the resin acid composition of oleoresin from Norway spruce and reported the occurence of five acids of the abietic type and two of the pimaric type (see table 1). Using partition chromatography Bruun and coworkers[3,4] isolated a new acid of the abietic type, palustric acid, from spruce oleoresin. They also confirmed the presence of the acids reported by Kahila, with the exception of dihydroabietic acid (see table 1), and also reported the percentage composition found. In studies on the gas chromatographic separation of resin acids as methyl esters Pensar and Bruun[5,6] also examined samples of oleoresin from Norway spruce obtaining seven compounds in the chromatogram. By comparing the relative retention times for the peaks with those for pure methylated resin acids six of the compounds were easily identified (see table 1). The seventh compound was eluted as a peak with a retention time corresponding either to methyl dihydroabietate or methyl sandaracopimarate. Thus the peak could represent the acid reported

by Kahila or be a new resin acid not found before in the oleoresin of Norway spruce. Therefore it was of interest to verify the identity of the compound giving arise to the peak in question. This identification was made possible by means of a combinated technique of gas chromatography and mass spectrometry as here reported.

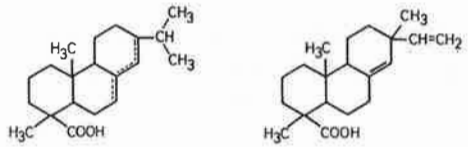


Fig. 1. Dihydroabietic acid (left) and sandaracopimaric acid (right).

Table 1. Composition of the oleoresin from Norway spruce.

Resin acid	Kahila [2]	Bruun and co-workers [3,4]	Pensar and Bruun [5,6]
Abietane skeleton			
Abietic acid	+	+	+
Neoabietic acid	+	+	+
Dehydroabietic acid	+	+	+
Levopimaric acid	+	+	+
Palustric acid		+	+
Dihydroabietic acid	+		?
Pimarane skeleton			
Pimaric acid	+	+	+
Isopimaric acid	+	+	+
Sandaracopimaric acid			?

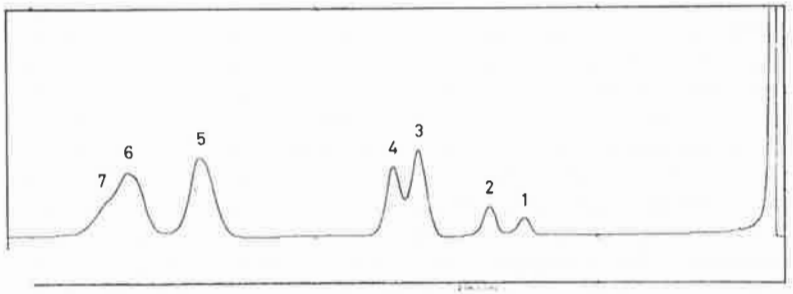


Fig. 2. Gas chromatographic separation of the resin acid fraction from spruce oleoresin. The peaks represent the methyl esters of (1) pimaric acid, (2) unknown acid, (3) palustric acid and levopimaric acid, (4) isopimaric acid, (5) abietic acid, (6) dehydroabietic acid and (7) neoabietic acid.

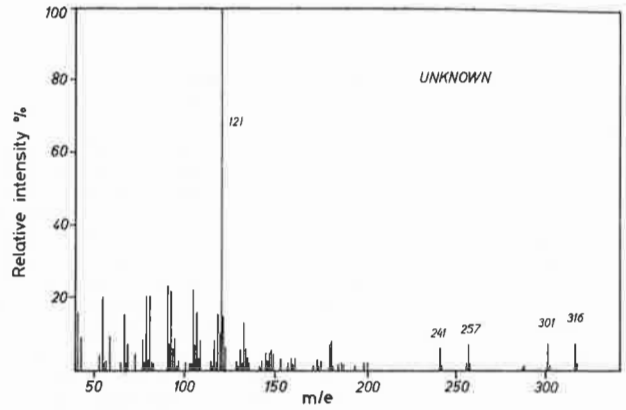


Fig. 3. Mass spectrum of the unknown component in the resin acid fraction.

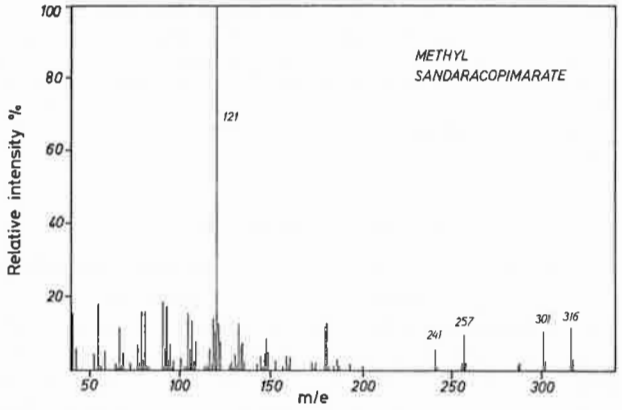


Fig. 4. Mass spectrum of an authentic sample of methyl sandaracopimarate.

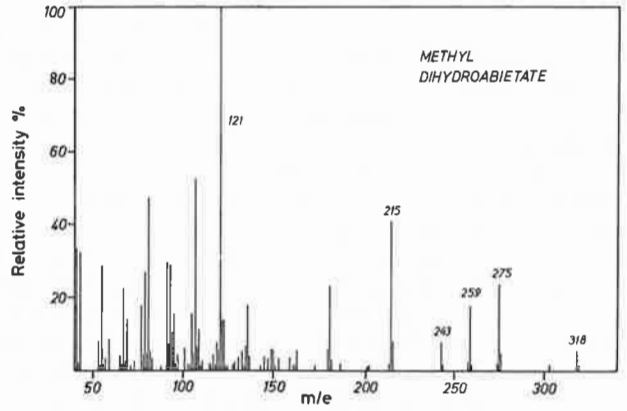


Fig. 5. Mass spectrum of an authentic sample of methyl dihydroabietate.

Experimental

Using small glass capillaries a sample of oleoresin was collected direct from the resin canals in a cross section of a trunk of a 35 year old spruce (*Picea abies*). This cross section was taken at the height of two meters from a trunk of a tree cut in February in the south of Finland (Kotkanniemi). The sample was dissolved in petroleum ether and the resin acid fraction was isolated in a two-step separation on thinlayer plates coated with silica, using the "micro-transfer" technique earlier described [7]. In the first step the crude oleoresin was fractionated with a solvent composed of petroleum ether-diethyl ether-acetic acid (85:15:1, vol/vol). The fraction with a R_f-value corresponding to that of a sample of pure resin acids chromatographed on the same plate, was scraped off and eluted from the adsorbent with methanol-diethyl ether (1:9, vol/vol) and the treated with fresh diazomethane for methylation of the acids. In the second step, this "crude" fraction of resin acids was chromatographed with petroleum ether- diethyl ether as solvent (95:5, vol/vol) for isolating the resin acids from nonacidic components. The spot containing the methylated resin acids was scraped off, the acids were eluted from the adsorbent and taken into a syringe for instaneous injection into a gas chromatograph on-line coupled to a mass spectrometer. An LKB-9000 instrument was used to achieve the separation of the individual resin acids and record their mass spectra. The gas chromatograph was equipped with a 10′ × 1/8″ glass column packed with Chromosorb W (80/100 mesh), coated to 5 % by ethylene glycol succinate. The separation was performed isothermally at 175 °C and the helium carrier gas had a flow rate of 20 ml/minute. The mass spectra were recorded under the following conditions: electron energy 70 eV, ion source temperature 270 °C and scan speed m/e 10—m/e 350 in 3 seconds.

Results and Discussion

The gas chromatographic separation of the methylated resin acids from the spruce oleoresin is shown in figure 2. The peak 2 in the chromatogram represents the unknown compound, which judged from its retention time could be either methyl sandaracopimarate or methyl dihydroabietate. A mass spectrum recorded from the effluent corresponding to this peak is shown in a normalized form in figure 3. Spectra of authentic samples of the two methylated resin acids, recorded under the same conditions are given in figures 4 and 5. The similarity between the spectra of methyl sandaracopimarate and the unknown compound is nearly perfect. Both show a molecular ion peak at m/e = 316 (Mwt of methyl sandaracopimarate = 316) and the fragmentation pattern is the same. The most abundant peak, the base peak, is found at m/e = 121 and the high mass ends of the two spectra show intense peaks at m/e 301, 257 and 241. On the other hand methyl dihydroabietate gives a mass spectrum with a molecular ion peak at m/e = 318 (Mwt of methyl dihydroabietate = 318), the base peak being at m/e 121. Intense peaks are found at m/e 275, 259, 243 and 215, whereas no correspondence at these mass numbers can be found in the spectrum of the unknown compound. Thus the unknown peak in the gas chromatogram of the resin acids from spruce oleoresin is proved to be solely due to the methyl ester of sandaracopimaric acid. The

occurence of minor amounts of this acid in the oleoresin of various species among the coniferes has been reported by Gough [8] and by Joye and Lawrence [9]. The finding of sandaracopimaric acid also in the oleoresin of Norway spruce confirmes that this acid probably must be considered a normal component of conifer oleoresin.

Literature:

1. Mutton, D. B., Chapter 10 in "*Wood Extractives and Their Significance to the Pulp and Paper Industries*" (edited by W. E. Hillis), Academic Press, New York — London 1962.
2. Kahila, S. K., *Paperi ja Puu — Papper och Trä* **39** (1957) 7.
3. Bruun, H. H., Gåsland, S. and Lundqvist, G., *Acta Chem. Scand.* **13** (1959) 1039.
4. Bruun, H. H. and Gåsland, S., *Acta Acad. Aboensis* **B22:1** (1960) 1.
5. Pensar, G. and Bruun H. H., *Acta Acad. Aboensis* **B24:4** (1964) 1.
6. Pensar, G. Unpublished results.
7. Pensar, G., *Finska Kemists. Medd.* **78** (1969) 11.
8. Gough, L. J., *Chemistry and Industry* (1964) 2055.
9. Joye, N. M. and Lawrence, R. V., *J. Chem. Eng. Data* **12** (1967) 279.

Received November 2, 1970

Förteckning över Finska Kemistsamfundets och Kemiska Sällskapet i Åbo medlemmar 31. 12. 1970

Suomen Kemistiseuran jäsenluettelo 31. 12 1970

Hedersledamöter — Kunniajäsenet

* Ekwall, Per	FD, prof.	Ytkemiska laboratoriet, IVAs försöksstation, Drottning Kristinas väg 47, Stockholm Ö, Sverige
Enkvist, Terje	FD, prof.	Runebergsg. 30 A, H:fors 10
Fredga, Arne	FD, prof.	Institutionen för organisk kemi, Uppsala Universitet, Uppsala, Sverige
Holmström, Ragnar	FM, ing.	Munksnäsallén 2 B, H:fors 33
* Jorpes, Erik	MD, prof.	Karolinska Institutet, Stockholm, Sverige
* Ringbom, Anders	TkD, prof.	Vårdbergsg. 8, Åbo
Smedslund, Tor	FD	Petersgatan 4 B 51, H:fors 14
Virtanen, Artturi I.	FT, prof.	Biokemiallinen Tutkimuslaitos, Kalevank. 56, H:ki 18

Hedersledamöter i Kemiska Sällskapet i Åbo

Aspelund, Helge	TkD, prof.	Humlegårdsg. 13 C 46, Åbo
Ekwall, Per	FD, prof.	Ytkemiska laboratoriet, IVAs försöksstation, Drottning Kristinas väg 47, Stockholm Ö, Sverige
Jorpes, Erik	MD, prof.	Karolinska Institutet, Stockholm, Sverige
Ringbom, Anders	TkD, prof.	Vårdbergsgatan 8, Åbo
Söderblom, Arne	DI	Rievägen 3 A 14, H:fors 33

Övriga medlemmar — Muut jäsenet

Adlercreutz, Herman	MD, bitr. prof.	Savilag. 3 B, H:fors 25
Ahlers, Per-Erik	FM	Centrallaboratorium Ab, Box 10136, H:fors 10
Ahlström, Bengt	FM	Kantelevägen 16—18, H:fors 42
* Ahola, Tom	FM	Klaukkala
Adolfsson, Maj-Len	FK	Mechelingatan 49 A 23, H:fors 10
Aimonen, Berit	FM	Käinby
v. Alfthan, Georg	DI	Fjälldalsg. 4, H:fors 10
Alfthan, Magnus	FM	Strandst. 4, H:fors 33
Alfthan, Per Göran	DI	Hagbacken 4 K, Hagalund
Alm, Aarnio	FM	Mellang. 24, Borgå
Alm, Bjarne	FM	Frihetsv. 7, Ekenäs
* Aminoff, Claes Fredrik	FM	Masku
Aminoff, Gustav	DI	Parkg. 11 A, H:fors 14
Aminoff, Helena	FM	Alpg. 3 A 32, H:fors 53

* = medlem även i Kemiska Sällskapet i Åbo

Aminoff, Jutta	FM	Gräsav. 9, Grankulla
Aminoff, Maja	FM	Gräsav. 9, Grankulla
Andersén, Anja	FM	N. Hesperiag. 7 A, H:fors 26
Andersén, Lars	FD	N. Hesperiag. 7 A, H:fors 26
Aschan, Lars Johan	TkD	Älgvägen 14, S-13700 Västerhaninge, Sverige
Aschan, P. J.	DI	Kivinebbsv. 30, Bredvik
Ashorn, Theodor	FD	G. A. Serlachius Oy, Lielahti
* Augustson, Anne-Marie	FM	Henriksg. 4 A, Åbo
* Avela, Eero	FD	Auragatan 15 B, Åbo
* Backas, Henrik	DI	Pargas Kalkbergs Ab, Pargas
Backlund, Carita	FM	Grävlingsv. 2 C 28, H:fors 81
Backman, Ove	DI	Laukontori 8 B, Tampere
* Bagge, Marita	FM	Kaarninkov. 52—54 F, Åbo
Bagge, Tor	FM	Toppelundsvägen 7 C 30, Mattby
Bang, H.	Dir.	N. Hesperiag. 5 A, H:fors 26
* Le Bell, Casimir	DI	Havskantv. 40, Åbo
* Berg, Folke	DI	Skolg. 17 B, Åbo
* Berg, Kurt	DI	W. Rosenlew & Co Ab, Björneborg
* Bergfors, Lars-Erik	DI	Väinöläntie 40, Nådendal
Berglund, Ulf-Stefan	FK	Olsbackavägen 9 B 14, H:fors 94
Bergström, Åke	FD, DI	Cygnaeusg. 16, H:fors 10
Biese, Björn	FK	Lutherg. 14 A 13, H:fors 10
Biström, Per-Åke	FM	Borgåg. 19 B, H:fors 51
Björkenheim, Björn	Kemist	Satakunnank. 19 D. Tammerfors
Björkman, K.	Apot., FD	c/o Apoteket Örnen, Lönnrotsg. 9, H:fors 12
Björkstén, Fred	FD	N. Hesperiag. 21 A 14, H:fors 26
Björkstén, Johan	FD	P.O. Box 265, Madison Wisconsin, USA
Björnström, Harriet	FM	Tirholmsv. 28 B 6, H:fors 20
Blomqvist, Gunnar	FD	Äänekoski
Blomqvist, Hj.	FM	Enkullav. 14, Boxbacka
Boucht, Gunnar	DI	Rusthållarv. 11 A, H:fors 91
Bredenberg, Johan B.son	TkD, doc.	Sibeliusbulev. 3 A 9, Borgå
Brehmer, Tor Erik	FM	Lotsg. 9 A, H:fors 16
Brenner, Mårten	FD, prof.	Svartmunkegr. 2, Åbo
Brofeldt, M.	FM	Dunckerg. 4 C, H:fors 26
* Broms, Bengt	DI	Sotalaisk. 1 A 7, Åbo
* Broms, Meri	DI	Sotalaisk. 1 A 7, Åbo
Brunow, Gösta	FD	Sommarö, Finnå
* Bruun, Carl-Erik	DI	Korsbergsvägen 31, Kantvik
* Bruun, Henrik	TkD, prof.	Multavierug. 1 C 27, Åbo
* Brännback, Tor	DI	Brunnsdäld, Pargas
Bröckl, H.	DI, industriråd	Pargas Kalkbergs Ab, Villmanstrand
Bröderman, T.	FM	Björneborgsv. 5 B 27, H:fors 35
Bäck, Ragnar	FM	Sjötullsgatan 32 B 9, H:fors 17
Böök, H.	FM	Skillnadsg. 5, Ekenäs
Cajander, H. W.	DI	Ruusulank. 11 A, H:ki 26
* Candolin, Carl-Johan	DI	Talinkorpivägen 9 A 14, Åbo
Carlberg, Gunnel	FK	Stationsvägen 10 A, Grankulla
Carlstedt, B.	DI	Dickursby
Castrén, Eva	FM	Bernhardsg. 5 A 5, H:fors 13
Clopatt, Arthur	FM	Kaptensg. 8—10 D, H:fors 14
Collander, Runar	FD, prof.	Köpmansg. 3 B 13, H:fors 16
Cronström, Birgitta	NaK	Marieg. 20 B 27, H:fors 17
* Danielsson, Ingvar	FD, prof.	Stenhuggaregatan 4 C, Åbo
* Doepel, Christian	DI	Geneve, Schweiz

* Doepel, Henning	DI	Malmnäs, Pargas
Egnér, H.	FD, prof.	Lantbrukskem. Laboratoriet Ultuna, 750 07 Uppsala, Sverige
Ehrnrooth, Elsa	FK	S. Kajen 6 A 9b, H:fors 13
Ehrnrooth, Johan	NaK	Jalmarvägen 5 E, Hagalund
Ehrnrooth, Magnus	FD	S. Kajen 6 A 7, H:fors 13
Ehrström, Anders	Kemist	Ö. Brunnsparken 9 B, H:fors 14
* Ekblad, Max	DI	Betaniag. 8 B, Åbo
Ekholm, Karl-Erik	TkD h.c., bergsråd	Edelfeltsvägen 10, H:fors 15
Eklund, Anneli	DI	Högbergsgatan 17 A 6, H:fors 13
Eklund, Dan	TkD	Sportv. 8 F 4, Grankulla
Eklund, Eeva	DI	Sportvägen 8 F 4, Grankulla
Eklund, Eva	AFL	Dunckergatan 4 C, H:fors 26
Eklund, Hans	NaK	Storsvängen 9a A 1, H:fors 20
Ekman, Kurt	FD	Lundagatan 16 C 33, Borgå
Ekstam, Klara-Stina	NaK	Stationsvägen 17, Grankulla
Ekstam, Torsten	FM	Stationsvägen 17, Grankulla
Elfving, Sirkka	FK	Stugberget 1 C 44, H:fors 57
Elg, Peter	FK	Kopparbergsvägen 4 O, H:fors 44
Ellfolk, Nils Erik	FD, bitr. prof.	Helsingfors Universitet, Biokemiska institutet Unionsg. 35, H:fors 17
Enari, Tor-Magnus	FD, prof.	Morsviksv. 1 H 45, H:fors 20
Enebäck, Carl	TkD, doc.	Björneborgsv. 5 R, H:fors 35
Enebäck, Ulla	DI	Björneborgsv. 5 R, H:fors 35
Enkvist, Reinhold	DI	Edis 2 B, Kantvik
Erdtman, Holger	FD, prof.	Valhallav. 71, 114 27 Stockholm, Sverige
Eriksson, Brita	FM	Kranksv. 8 A, H:fors 40
* Eriksson, Lars	DI	A. Ahlström Oy, Varkaus
Falck, Per	FM	Tammelundsv. 20, H:fors 83
Finnilä, Ernst-Gustaf	FM	Dragonv. 5 B 13, H:fors 33
von Flittner, Sara	FM	Auragatan 5 A 10, Åbo
Fogelberg, B. C.	FM	Storsvängen 15 a B 33, H:fors 20
* Fontell, Krister	FL	Ytkemiska laboratoriet, Drottning Kristinas väg 47, Stockholm, Sverige
Fontell, Nils	FT, prof.	Vänrikki Stoolink. 11 B 36, H:ki 10
Forsander, Olof	FD	Oy Alkoholiliike Ab, Östersjög. 51, H:fors 18
Forsblom, Christina	DI	Kvarnbergsg. 11, Borgå
Forsman, W. R.	FD	Fredsg. 13, H:fors 17
* Forss, Bengt	TkD	Malmnäs, Pargas
Forss, Kaj	FD	Snårv. 6 B, H:fors 63
Forsskåhl, Ingegerd	FM	Soltorp, Tavastby
* Frants, Rune	FM	Olofsvägen 2 B 19, Åbo
* Franzén, Sven	DI	Regementsvägen 43 lok. 23, Åbo 5
Frejman, Torsten	DI	Oy Finlayson—Forssa Ab, Vasa Bomull, Vasa
Fremer, Kaj Erik	FK	Smedjeviksv. 6 A 7, H:fors 20
Friberg, Sven	FM	Vinkelg. 1, Hangö
Frostell, Ralf	DI	Backv. 3 C 20, Dickursby
Fuchs, Mauritz	FM	Lillängsv. 15, H:fors 57
Fugleberg, Sigmund	DI	Kielok. 106, Björneborg
Fuhrman, Agneta	FK	Herdeflöjtstigen 7 B 16, H:fors 42
Furuhjelm, Henrik	DI	Dickursby

Gadd, G. O.	FM	Tempelg. 2 D 37, H:fors 10
Gadd, Nelli	FM	Stenbäcksg. 4 A, H:fors 25
Gadd, Olof	Övering.	Strandvejen 87 B III, Köpenhamn, Ö, Danmark
Geitlin, Svante	DI	Brändö parkv. 42 A, H:fors 57
* Geust, Gustav	FM	Finska Forcit och Dynamit Ab, Hangö
Ginman, Mariam	FK	Museigatan 9 B, H:fors 10
Ginman, Rolf	FM	Nallikallio A, Masaby
Glad, Fjalar	FM	Ab Malakta, Malax
Gref, Brita	FK	Apollog. 5 B 41, H:fors 10
Gref, Carl-Gustaf	FK	Apollog. 5 B 41, H:fors 10
Gripenberg, Jarl	TkD, bitr prof.	Rönnv. 12—14 A, H:fors 27
Gripenberg, Stina	FD	1 Rue Paul Séjourné, Paris 6, France
Groth, Bertil	FD, prof.	Askrikeg. 19, 115 29 Stockholm, Sverige
Grundt, Inger	FM	Övre Sollien 96, Bergen, Norge
* Grägg, Bengt	DI	Broborg, Pargas
Gräsbeck, Ralph	doc.	Korekuja 4 E, Gäddvik, Mattby
Grönvik, Anna	DI	Cygnaeusg. 7 D 35, H:fors 10
* Gustafsson, Brage	FM	Köpmansg. 2 C 49, Åbo
Gustafsson, Charley	FD	Trollstensv. 1 F, Hagalund
* Gustafsson, Folke	DI	Juhaninkuja 13 C, Raisio
Gustafsson, G. R.	DI	Risviksv. 3 B, H:fors 20
Hackman, Robin	AFK	Ekallén 13 A, H:fors
Hakulin, Bertel	DI	Lipparinne 8
* Halonen, Nils-Pekka	DI	Pargas Kalkbergs Ab, Pargas
Hamberg, Ulla	FD	Fjälldalsg. 16 C, H:fors 10
* Hammar, Erik	DI	Olofsvägen 2 A 16, Åbo
Hansen, Sture	DI	Skarpansv. 21 B 18, Mariehamn
Hansson, Sven	Övering.	Strandg. 13, Borgå
* Harju, Leo	FM	Österlångg. 10, Åbo
Harjulin, Christer	FK	Fjälldalsgatan 7, H:fors
Harva, Olavi	Prof.	Skeppareg. 29 B 18, H:fors 15
* Hausen, Hans	Prof.	Armas Lindgrensvägen 5, H:fors 57
Heikel, Anna	FM	Gyldensv. 8 A 19, H:fors 20
* Heikius, Bengt	FM	Hipposvägen 33 O 264, Åbo
* Heinrichs, Lennart	DI	Kärsämäkiv. 68 C, Åbo
Helander, Elisabeth	FD	Kaptensgatan 14 A, H:fors 14
Henriksson, Anita Marg.	FK	Ymmersta, Grankulla
Hernberg, Gunilla	NaK	Georgsgatan 8 A 8, H:fors 12
Hernberg, Gunnar	Bergsråd	Simmarst. 2, H:fors 33
Hindsberg, Lars Erik	DI	Lielahti
* Hofman, Erik	FM	Slottsgatan 1 B, Åbo
Holm, Birgitta	FM	Kaserng. 16 A 10, H:fors 13
Holm, Björn	FM	Kaserng. 16 A 10, H:fors 13
Holmberg, Ann-Marie	FM	Topeliusgatan 3 a A 6, H:fors
* Holmberg, G.-A.	FD, prof.	Slottsg. 33 A 13, Åbo
Holmberg, Helena	FK	Stugberget 1 F 88, H:fors 57
* Holmbom, Bjarne	DI	Inst. för Träkemi, Åbo Akademi, Åbo
Holmström, C. G.	Apot.	Apoteket, Korpo
Holmström, Maj	FM	Dragonv. 18 lok. 13, H:fors 33
Hortling, Bo	FK	Karlavägen 3 A, H:fors 20
Hortling, Lars	FK	Brändövägen 6, H:fors 57
* Hummelstedt, Leif	Prof.	Lilla Tavastgatan 12 a A 16, Åbo
Hynninen, Yrsa	FK	Lillstuvägen 5 B 24, H:fors 39

Häggman, Lars-Erik		Unionsgatan 45 H 123, H:fors 23
Häggman, Jarl	FM	Svinhufvudsv. 6 A 12, H:fors 57
Hästbacka, Kaj	FD	Cygnaeusg. 9, Borgå
Idman, Edvard	DI	Rådmansg. 8 C 24, Borgå
Ingman, Brita	FM	Tölög. 14 A 10, H:fors 10
* Ingman, Folke	FL	Köpmansg. 21 A 26, Åbo
Jaatinen, Ingmar	DI	Dalv. 1 B, Grankulla
Jalkanen, Anneka	NaK	Pukkilav. 4 B 9, H:fors 65
Janson, Gustave	FM	Högbergsg. 2 a, H:fors 14
Jansson, Henrik	FK	Åminne, Kyrkslätt
* Jansson, Ossian	DI	Nylandsg. 9 B, Åbo
Janson, Jan	FL	Kvarnbergsvägen 6 B 23,H:fors 20
* Jensen, Waldemar	TkD, prof.	c/o Centrallaboratorium Ab, Postbox 10136, H:fors 10
Jernström, Olof	FM	Kotitie 16, Korso
Johanson, Monica	FM	Eriksg. 1 B 13, H:fors 10
Jokinen, Kirsti	FM	Saunalahdent. 11, H:ki 33
Jungebrand, Thorvald	FK	Mejlans 27 B, H:fors 25
* Jurvelius, Erik	DI	Lapinniemi, Tammerfors
Juselius, Arne	DI	Jätterösv. 1 B, H:fors 34
* Juup, Gösta	DI	Almv. 23, Åbo
Kahila, Seppo	FL	Repoaho 12, Mankkaa
Kahlson, T.	FM	Fredriksg. 77 A, H:fors 10
* Kajander, Lisa	FM	Klockringareg. 15, Åbo
Kari-Hietala, Sigrid	FM	Alkuv. 5, H:fors 66
Karsten, J. O.	DI	Valkeakoski
Katritzky, A. R.	Prof.	Univ. of East Anglia, School of Chemical Sciences, University Plain, Norwich, Nor 88 C, England
Kauko, Yrjö	TkT, prof.	Lahnus
Kauppinen, Veli	FT	Urheiluk. 48, H:ki 25
Keller, Camilla	FD	Breisacherstr. 22, Basel, Schweiz
Kihlman, Bengt	FK	Högbergsg. 19 A 7, H:fors 13
Kihlström, Torsten	Apoteksråd	Lönnrotsskvären 5, H:fors 12
* Kjellman, Ingvald	DI	Trädgårdsg. 3, Åbo
Klenberg, Dorrit	FD	Kalevag. 27 A 11, H:fors 10
Klingstedt, Gustav	DI	Lauttakatu 12 B 13, Kuusankoski
* Klockars, Mats-Erik	DI	Pihlava
Knutson, B.	DI	Norrtullsgatan 29, 113 27 Stockholm, Sverige
Koroleff, Folke	FD	Havsforskningsinstitutet Observatorieg. 2, H:fors 14
Krauel, Herman	EK, FM	Beckasinv. 9 A 8, H:fors 20
Krieger, Hans	Prof.	Kastellintie 17 D, Oulu
Krohn, Väinö	FT	Suviranta, Hamina
Kuve, Boris	DI	Båggr. 1 D 31, H:fors 94
Kyrklund, Börje	FM	Källstrand 1 C, Källstrand
Kyrklund, Gunnar	FM	Bofinksvägen 21, Råby, S-72470, Västerås, Sverige
* Lagerbohm, Erik	DI	Puistonkulma, Littois
Lagerbohm, Max-Åke	FK	Forsbyv. 9 E 44, H:fors 61
* Laiho, Stiven	DI	Tempelg. 3 C, Åbo
* Langh, Lars	DI	Humlegårdsg. 17 B, Åbo
Larinkari, Jori	TkT	Mäkipellontie 7, H:ki 32
* Lassenius, Folke	DI	Euran Paperi, Kauttua
Lassenius, T.	DI	Kallviksv. 31, H:fors 96

* Lauren, Carl-Gustav	DI	Köpmansgatan, Pargas
* Laurén, Henning	DI	Pargas Kalkbergs Ab, Pargas
Laurén, Ingeborg	DI	Solnav. 26 C 51, H:fors 33
Laurén, Rabbe	FM	Klåvusv. 16 C 28, H:fors 91
Laurent, Stig-Olav	FK	Rosag. 8 A, H:fors 25
Laxén, Rea	FK	Brändö Parkväg 46 B 32, H:fors 57
* Lehtonen, Eino	DI	Vattenverket, Hallis, Åbo
* Lerche, Henry	DI	Brunnsg. 8, Hangö
Levlin, Jan-Erik	FM	Soläng F 27 Källstrand
Levon, Harry	FM	Handelskemiska Laboratoriet, Vasa
Liljelund, Rolf	Kemist	Freeseg. 2 B, H:fors 10
Lindberg, J. J.	FD, prof.	Flintstensst. 1 G, H:fors 44
Lindberg, Jarl	DI	G. A. Serlachius Oy, Lielahti
Lindberg, Kalevi	DI	Linnankoskig. 10 A 9, H:fors 25
Lindberg, Märta	NaK	Linnankoskig. 10 A 9, H:fors 25
Lindahl, Essi	DI	Sydvästpassagen 2 A, H:fors 20
Lindahl, Ralf	TkD	Sydvästpassagen 2 A, H:fors 20
* Lindblad, Lars-Gustav	Dir.	Pargas Kalkbergs Ab, Pargas
Lindewald, Carin	FM	Grankulla
* Lindfors, Lars-Eric	TL	Allég. 14 a B 42, Åbo
Lindfors, Tor	FM	Petersg. 10 A 6, H:fors 14
Lindgren, Lewie	DI	Björkdungevägen 39 A 5, H:fors 63
* Lindholm, Allan	DI	Brokulla, Pargas
Lindholm, Maj Lis	Apot.	Karkkila
Lindholm, Nils	FK	Oy Esso Ab, S. Kajen 12, H:fors 13
Lindroos, Kristian	FK	Palokankaantie 37 D, Kouvola
Lindros, Kai	FK	Norra Kajen 22 B 31, H:fors 17
* Linko, Erkki	FM	PK-Asuntola 9 B, Lappeenranta 5
Linko, Pekka	FT	Otakallio 2 B, Otaniemi
Linkomo, Sonja	FK	Barnhemsgatan 7 A 22, H:fors 18
Lühr, Håkan	DI	Östra Allén 20 B 9, H:fors 14
Lund, Ole	DI	Fack 2, Lottefors, Sverige
* Lundberg, Bo	FM	Backgårdsgatan 16, Åbo
Lundell, Ralf	DI	Enåsv. 6 B 19, H:fors 20
Luther, Fred	FM	Kauttua
Lydén, Ragnar	FD, bitr. prof.	Esbo, Domsby
Lönegren, Holger	FM, apot.	Apoteket, Sunila
Lönnberg, Bruno	DI	Drumsövägen 32 A 14, H:fors 20
Löfgren, Barbro	FL	Gungvägen 9 B 46, H:fors 94
* Lövgren, Timo	FM	Multavierug. 2 A 24, Åbo
Majani, Corrodi	FK	Vi Carlo de Bildt 11, Roma, Italia
* Malmström, Folke	DI	Klostergatan 6 A 4, Åbo
* Mandell, Leo	FM	Ytkemiska laboratoriet Drottning Kristinas väg, 47, Stockholm, Sverige
Mannström, Bo	DI	Forsellesv. 8 C, Grankulla
Martelin, Jarl-Erik	FM	Kantelev. 16—18 I 77, H:fors 42
* Masalin, Erik	DI	Högbergsg. 10, Hangö
* Mattson, Björn	FM	Söderbyhus B 23, Pargas
Mickos, Elisabet	DI	Kyrkov. 19 B, Grankulla
Monnberg-Brehmer, Birgit	FD	Lotsg. 9 A, H:fors 16
* Monnberg, Ragnar	DI	Kanavak. 10, Raumo
Morelius, Harry	FM	Biskopsg. 6 D, Borgå
* Murola, Mikko	DI	Tallkottsvägen 2 D, Åbo
Mårtensson, Camilla	FK	Arm. Launisvägen 3 A, Alberga

* Mäkilä, Eino	DI	Joutseno-Pulp Oy, Joutseno
Mäklin, Carl	FD	Pyynikintori 1, Tammerfors
Neimo, Leo	FK	Hiidenkiukaantie 3, H:ki 34
* Nikander, Bo	DI	Pargas Kalkbergs Ab, Pargas
Nikus, John	DI, FM	Dalsbruk
Nizowsky, Boris	FM	Gyldensv. 14 A, H:fors 20
Nordman, Göran	FL	Gyldénsv. 6 B 10, H:fors 20
Nordman, Lars	DI, TkD h.c.	St. Robertsg. 16 A, H:fors 12
* Nordström, Carl Gustav	FD, doc.	Olofsv. 2 A 9, Åbo
Nordström, Svante	FK	Kyösti Kallios väg 6 B 1, H:fors 57
Nupponen, Heikki	FK	Mäki-Soljala A 8, Kangasala Kk
Nyberg, Harald	DI	P.O. Box 6054, H:fors
* Nylander, Arne	FM, apot.	Aurag. 15 A, Åbo
* Nylander, Rune	DI	Klosterg. 14 C 29, Åbo
Nyman, Gösta	TkD, prof.	Skolvägen, Domsby
* Nymark, Fredrik	DI	Högbergsg. 10, Hangö
Nyström, Berit	FM	Bäverv. 14 A 19, H:fors 80
Odeyemi, Femi	FD	School of Mathematical & Physical Sciences, Faculty of Science, Univ. of Lagos, Nigeria
Oila, Ulla	DI	Runeberginkatu 57 A, Hki 26
Olsen, Einar	DI	Joutseno
* Otterström, Bengt	DI	Betaniagatan 4 lok. 34, Åbo
Otterström, Stig	DI	Oy Medica Ab, Box 10325, H:fors 10
* Paatero, Jaakko	DI	Hämeentie 20 A 14, Turku 10
* Palm, Carl-Olof	FM	Nylandsg. 12 A a, Åbo
Palmén, Synnöve	FM	Högbergsg. 1 B, H:fors 14
Passinen, Kaapo	TkL	Kaskilaaksontie 1 B 27, Soukka
Peldán, Kerttu	Apot.	Eriksgatan 16 B, H:fors 10
* Pellas, Eero	FM	Hyvinkäänk. 1 Hyvinkää
* Pensar, Göran	FD	Nylandsg. 3 C 47, Åbo
Penttilä, Aneri	TkD	c/o Oy Medica Ab, Box 10325, H:fors 10
Petander, Sigurd	DI	Strandst. 9 A 3, H:fors 33
Petrell, Ingegerd	DI	Fredsg. 16 D, Åbo
Pettersson, Nils	FM	Sinebrychoffsgatan 13 lok. 17, H:fors 12
* Pettersson, Ragnar	DI	Slottsg. 10, Åbo
Pipping, Gisela	FM	Parksvängen 9, H:fors 20
Pirhonen, Ilpo	FM	Rinnetie, Rivitalo B 21, Mankkaa
Portin, Lars-Olof	DI	Oy Schildt & Hallberg Ab, Dickursby
Qvickström, Berit	FK	Stationsv. 15, Grankulla
* Ramberg, Marianne	AFK	Klosterg. 6 B, Åbo
Rautalin, Edvard	DI	Kiskov. 17 lok. 9, H:fors 28
Reims, S.-G.	FM	Koivukyläntie 9 C 107, Sandkulla
Remmer, Eila	DI	Notgr. 4, H:fors 33
Remmer, Fjalar	DI	Notgr. 4, H:fors 33
* Renvall, Ilkka	TkL	Typpi Oy, Oulu
Renvall, Åge	FM	Gullbräckavägen 5, Dickursby
Rosenlöf, Sture	DI	Oy Schildt & Hallberg Ab, Dickursby
Rosenqvist, Gustav	DI	Kymmene Ab, Kuusankoski
Rosquist, Ossian	DI	Skeppareg. 35 A, H:fors 15
Runeberg, Jarl	FL	Hasselbacksvägen 4, 3, S-444 00 Stenungsund, Sverige
Rutanen, Pirkko	FK	Hakarinne 2 R 210, Tapiola

Rydberg, Jarl	FM	Centrallaboratorium Ab, Postbox 10136, H:fors 10
Rönnblad, Gretel	FM	Räisälävägen 23, Bredvik
Rönnlöf, Björn	DI	Stockholmsgatan 19 B 14, H:fors 27
Saarnio, Väinö	Apt.	Korppi Apteekki, E. Esplanaadink. 2, H:ki 13
Sahlberg, Ulla	FK	Högbergsg. 19 A 6, H:fors 13
Salomaa, Henrica	FK	Esbogård, Köklax
* Salonen, Eila	DI	Femte linjen 8 D 57, H:fors 53
Salovius, Birgit	FM	Topeliusg. 29, H:fors 25
Salovius, Hugo	FM	Idrottsg. 28, H:fors 25
Sandberg, B. E.	DI	Rönnv. 44 B 47, H:fors 27
Sandelin, Karin	FM	c/o Hellström, N. Hesperiagatan 5 A, H:fors 26
Saris, Nils-Erik	FD	Fänrik Stålsgatan 9 A 23, H:fors 10
* Saxén, Arne	DI	Lasarettsg. 8 B, Åbo
v. Schalien, Randolf	Prof.	Institutet för Värmeteknik, Åbo Akademi, Åbo
Schalin, Olle	DI	c/o Oy Kaukas Ab, Kaukas
* Schauman, Lennart	TkD	Gäddnätet 6-8/17, Gäddvik, Mattby
Schjerfbeck, M.	FM	Mannerheimv. 37 B, H:fors 25
* Schröder, Inga	ML	Karis
Schütt, Christer	DI	Högbergsg. 1 B, H:fors 14
Sederholm, Harriet	AFK	Magnus Hagelstamsvägen 3 D, Grankulla
Selin, Johan-Fredrik	FK	Döbelnsg. 4 B 30, H:fors 26
Seppovaara, Ossi	FD	Honkavaara E, Viherlaakso
Setälä, Inger	FM	Mannerheiminv. 64 B 33, H:fors 26
Sievers, Gunnel	FL	Tölög. 44 E 78, H:fors 25
* Siitonen, Soini	FM	Suvilahdenkatu 3—5 A 15, H:ki 50
Silén, Gösta	TkD	Munksnäsallén 20 A, H:fors 33
* Simberg, Nils-Henrik	DI	Pirttilähdev. 8, Åbo
Simons, Arnold	FM	Kaptensg. 2, Mariehamn
Simons, Lennart	FD, prof.	Mörskomv. 2, H:fors 60
Sirén, Arne	FD	Torgfogdev. 4 B 13, H:fors 64
Sjöberg, Holger	FM	Oy MODO Ab, N. Esplanadgatan 33, H:fors 10
* Sjöblom, Lars	Prof.	Kaskisg. 1 B, Åbo
* Sjöholm, Risto	DI	Piispanristi såg, Åbo
Sjöström, Eero	Prof.	Helenagränd 1 B, Grankulla
Skogman, Rurik	TkL	Alholmen B 1, Jakobstad
* Skrifvars, Bengt	FM	Georgsgatan 3 C 41, Åbo
Slotte, W.	DI	Salligatan 1 A 3, H:fors 25
* Somersalo, Arne	FL	Neste Oy, Sköldvik
Spåre, Carl-Gustaf	FK	Parkg. 11 B, H:fors 14
Starck, Brita	Frk.	Mannerheimv. 52 A 3, H:fors 26
Starck, Paul	FK	Smedjesviksv. 17 B 32, H:fors 20
Stelwagen, Patrik	FK	Runebergsg. 17 D 63, H:fors 10
Sten, Birgitta	DI	Björneborgsv. 5 B 38, H:fors 35
* Stendahl, Stig	DI	Slottsgatan 22 D 60, Åbo
* Stenius, Per	FL	Tavastgatan 30 B 19, Åbo
Stenius, Åke	FM	Höguddsv. 29, S-181 62 Lidingö Sverige
Stenmark, Erik	FM	Källstrand 14 H, Källstrand
Stenlund, Bengt	TkD	Djurbergsgränd 6 D 31, H:fors 32
Sternberg, Holger	FM	Eriksg. 9 A 21, H:fors 10

* Stigell, Jarl	DI	Slottsg. 5 A, Åbo
Stolpe, Erik	DI	Lundag. 16 C, Borgå
Stolpe, Tor	FM	Karkkila
Storhannus, E. R.	FM	Kyrkogatan 6, S-641 00 Katrineholm, Sverige
Strandell, Gunnar	DI	Rusthållsvägen 2 H 70, Åbo 5
Strandström, Helena	FD	Skådespelarv. 22 G 82, H:fors 40
Ström, Hjorvard	Apot.	Hovrättsesplanaden 2, Vasa
Sundberg, Gunvor	FM	Hoplaksvägen 9 B 20, H:fors 33
Sundblom, Nils-Olof	FK	Säästölahti B 24, Gäddvik
Sundgren, Ernst	FM	Drumsöv. 15 B 19, H:fors 20
Sundholm, Franciska	FD	Ådv. 5 A 5, H:fors 20
Sundholm, Göran	TkD	Ådv. 5 A 5, H:fors 20
* Sundman, Frey	DI	A. Ahlström Oy, Kauttua
Sundman, Jacobus	TkD	N. Hesperiag. 5 A, H:fors 26
* Sundman, Lars-Olav	FD	Klosterg. 14 A 3, Åbo 6
Sundman, Veronica	prof.	N. Hesperiagatan 5 A, H:fors 26
Sundström, E.	DI, FM	Eriksgatan 26 B, H:fors 10
Swanljung, Patrik	FK	Franstorpsvägen 6, 17238 Sundbyberg, Sverige
Swanljung, Helena	FK	Franstorpsvägen 6, 17238 Sundbyberg, Sverige
Söderberg, Per-Olof	DI	Hurmekallio, Korso
Söderlund, Bo	FM	Tjäderv. 17, Korso
Tallgren, Gunnar	DI	21 N Pelham, Rhinelander, Wisconsin, USA
* Toijala, Kurt	DI	Slottsg. 49 B, Åbo
* Troupp, Angelique	FM	Fredsg. 19—21 E 117, Åbo
Trygg, Holger	DI	Koskenmäki 15, Nokia
Therman, Elmar	DI	Bulevarden 9 B 25, H:fors 12
Thodén, Inga	FK	Topeliusgatan 11 A 56, H:fors 25
Thodén, Lars-Olof	FK	Topeliusgatan 11 A 56, H:fors 25
Turunen, Johannes	FT	Luotsink. 2 B, Rauma
Tybeck, Ethel	FK	Linnankoskig. 1, H:fors 25
Tylli, Henrik	FL	H. U. Kemiska Institut H, S. Hesperiag. 4, H:fors 10
Törnblom, H. N. E.	FM	Hemmansv. 2 A 5, H:fors 30
Tötterman, Harald	FD	St. Robertsg. 35—37 B, H:fors 12
Udd, Karin	FM	Kyrkoesplanaden 7 C 18, Vasa
Uggla, Rolf	TkD	Fabriksg. 5 A 10, H:fors 14
Ulfsparre, Sixten	TkD	Ankdammsv. 19, S-171 43 Solna Sverige
Wahlroos, Örn	FD	Ukonvaaja 2 C 59, Hagalund
Waldonen, Thure	DI	Ritobergsvägen 7 lok. 1, H:fors 33
Waller, Christine	FM	Fabriksgatan 32 e, H:fors 15
Waller, Richard	FM	Fabriksgatan 32 e, H:fors 15
Wallgren, Henrik	FD	Grundsundsv. 17 B, H:fors 83
Wallin, Göta	FK	Esbo gård, Köklaks
Wasastjerna, Jarl	Prof., bergsråd	Idrottsg. 36, H:fors 25
* Waselius, Peter	DI	Lilla Tavastgatan 9 C 65, Åbo 2
von Weissenberg, Benjamin	DI	Sportvägen 8 F a 7, Grankulla
* von Weissenberg, Bernhard	DI	Kaskisgatan 6 B 4, Åbo
Westerholm, Kerstin	FK	Hemmansvägen 11 B 18, H:fors 30
Vestman, Tor-Björn	FM	Finska Forcit-Dynamit Ab, Hangö
* von Weymarn, Per-Olof	FM	Pargas Kalkbergs Ab, Pargas
* Wickström, Göran	DI	Pargas Kalkbergs Ab, Pargas

Widlund, Rolf	FM	Jokivarsi, Nybacka, Korso
Wigren, Gunnar	DI	Ab Kaukas Fabrik, Kaukas
Wiik, H. Birger	FD, doc.	Björkvägen 5, Westend
* Viinamäki, Erkki	DI	Box 53, Hangö
Wilenius, Maj-Len	FM	Klåvusv. 4 H, H:fors 91
Willberg, Anita	FM	Mecheling. 45, H:fors 25
* Willberg, Jorma	DI	Brokulla, Pargas
Williamson, Harry	AFK	Bredavägen, Grankulla
* Vittasmäki, Tuure	DI	Betsocker Ab, Nådendal
Wolff-Nessler, Nelly	FD	Joukolav. 3 D, H:fors 61
Wrede, Kenneth A.	DI	Ö. Brunnsparken 3 B, H:fors 14
* Wänninen, Erkki	TkD, prof.	Slottsg. 5 B, Åbo
Yrjas, Brita	FK	Frihetsv. 2—4 A 7, Ekenäs
Yrjas, Klaus	FK	Frihetsv. 2—4 A 7, Ekenäs
Åberg, Gunnar	Herr	Oy Sandoz, Hallonnäsgatan 8, H:fors 21
Ålander, Paul	DI	Topeliusg. 11 A 44, H:fors 25
Öhblom, Helmer	Apot.	Dalsbruk
* Öhman, Ann-Marie	DI	Mätareg. 4, Åbo
Öhrnhjelm, Kaj	DI	Kullo
Örnhjelm, Runar	DI	Gyldensvägen 14 A, H:fors 20
* Österman, Karl-Erik	DI	Lemminkäineng. 36 B 2, Åbo
Österman, Walfrid	DI	Skeppareg. 19, H:fors 15

Medlemsantal 454 Jäsenmäärä

Eventuella fel och bristfälligheter i förteckningen kan anmälas till samfundets sekreterare under adress: Postbox 10476, Helsingfors 10 eller till kassören i samband med inbetalning av medlemsavgiften.

Innehåll 1970 Sisältö

Frenckellska Tryckeri Ab, Helsingfors 1971