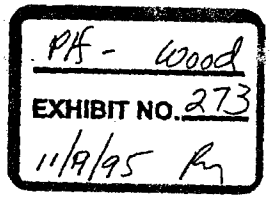
112.

CURRICULUM VITAE OF DAVID WOOD

60000110

NAME:	David Wood
NATIONALITY:	British
PLACE OF BIRTH:	Stamford, Great Britain
DATE OF BIRTH:	August 2, 1939
ADDRESS:	Av. Washington Luis 2500, Casa 9 04662 São Paulo Brazil
EDUCATION:	St. Martin's Elementary School, Stamford Great Britain - 1944 to 1949 Stamford School, Stamford, Great Britain - 1949 to 1957 Trinity College, Cambridge University, Cambridge, Great Britain - 1957 to 1960, B.A. Honours Chemistry and Part II Law Tripos
PROFESSIONAL ACTIVITIES	Assistant Technical Salesman, Engineering Chemicals Group, Monsanto Chemicals Ltd., London, Great Britain - May 1, 1961 to June 30, 1966 Sales Supervisor, Dielectric Fluids, Monsanto Europe S.A., Brussels, Belgium - July 1, 1966 to October 31, 1966 Product Supervisor, Dielectric Fluids, Monsanto Europe S.A., Brussels, Belgium - November 1, 1966 to January 6, 1968 Market Supervsior, Food and Fine Chemicals, Monsanto Europe S.A., Brussels, Belgium - January 7, 1968 to January 4, 1972 Product Manager, Fine Chemicals, Monsanto Europe S.A., Brussels, Belgium - January 5, 1972 to February 20, 1974 International Market Manager, Fluids Functional Products, Monsanto Company, St. Louis, Missouri, U.S.A. - February 21, 1974 to March 31, 1975 Market Manager, Dielectric, MIC Specialty Chemicals, Monsanto Company, St. Louis, Missouri, U.S.A. - April 1, 1975 to December 31, 1975 Industry Manager, Dielectric, MIC Specialty Chemicals, Monsanto Company, St. Louis, Missouri, U.S.A. - January 1, 1976 to December 31, 1977



Market Manager, Heat Transfer and Process Chemicals, MIC Specialty Chemials, Monsanto Company, St. Louis, Missouri, U.S.A. - January 1, 1978 to December 31, 1979

LAST JOB — Manager, Raw Materials Purchases, EM&M, Corporate Purchasing, Monsanto company, St. Louis, Missouri, U.S.A. - January 1, 1980 to April 30, 1982

ACTUAL JOB — Director, Chemicals & Plastics, Industrias Monsanto S.A., São Paulo, Brazil - May 1, 1982

./.

cc: Mr. D.S. ameron - ME

RISING & STRAND

AKTIEBOLAG

OP/BO

TELEFON: 34 01 88 TELEGRAM: HENRIS TELEX: 1624
POSTGIRO: 9 44 43 BANKGIRO: 73-0448

STOCKHOLM VA
SVEAVÄGEN 47

November 28, 1966

Monsanto Europe
BRUSSELS 3
Belgium

For the attention of Mr. D. WOOD

Dear David,

re: AROCLORS

As mentioned, there has been some publicity in Sweden concerning investigations made at the Institution of Analytical Chemistry at the Stockholm University. These have revealed that a group of products called Polychlorinated Bi-Phenols - PCB for short - accumulated in certain organs of animals. They are said to be related to DDT and equally poisonuous.

The findings were discussed at a meeting of scientists at the Wenner-Gren Centre in Stockholm on November 22. Below please find a translation of an article in the Swedish daily paper "Dagens Nyheter":-

"It is found in salmon and in pike. It is found in sea eagle living on fish. It is found on the surface of the needles of the fir trees, that is in the air. It is found in the hair of a five months baby...

The scientists working with biocides have for a long time seen this something as unknown "peeks" on their gas chromatographs and at a meeting at the Wenner-Gren Center, Research Assistant Sören Jensen of the Institution for Analytical Chemistry at the Stockholm University could reveal the identity of these peeks. It has been found that they consist of a group of poisons, Polychlorinated Biphenols (for short PCB) which are closely related to, and equally poisonous as, DDT.

PCB is broken down considerably slower than DDT and gives rise to damage of liver and skin. PCB is not

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TRAN 056461

PLAINTIFF'S EXHIBIT 200

used as a herbicide. It is not manufactured in Sweden but is supposed to used by the industry to quite some extent. No special industry can so far be accused of being the source of contamination.

Research Asst. S. Jensen has tested 200 fishes and a number of birds. He has taken several samples of air and has reached the conclusion that PCB is equally common in Nature as chlorinated hydrocarbons of the type of DDT, DDE, and Lindane. Even fish in Laddjojaure in Lapland contain PCB. Mr. Jensen has also found that PCB does not appear in animals living on a vegetarian diet, such as the elk.

In the course of his work, Mr. Jensen has not found anything indicating that the source of contamination comes from agricultural additives. It is, however, obvious already now that PCB is most frequently found in organisms living in water or feeding from water animals. In all examined pikes PCB was found. In a sea eagle found dead outside Stockholm it was found that the liver contained 30 mg of mercury per kilo, 76 mg DDT and considerably more PCB. The exact figure has not yet been determined.

PCB is found in water and in air, and not only in the Swedish air, but also in e.g. London air. Mr. Jensen has not yet been in London for sampling but could identify the poison by studying a gas chromatogram of air published in a British technical journal.

Mr. Jensen har also examined the hair of his family and himself and has found PCB on all samples. Most PCB was found in the hair of his wife but most sensational was that the girl aged 5 months had more PCB in her hair than her brothers and sisters of 3 and 6 years. Probably the girl had got the poison via the mother's milk.

In the State Museum Mr. Jensen has examined the whole collection of sea eagles dating back to 1880. By testing it could be established that PCB was present only in birds from 1944 and thereafter while birds collected before 1944 were quite free from PCB.

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The use of PCB in Sweden is not established in detail. According to American sources these types of products are used in the manufacture of a variety of heat-resistant materials. They are used for electrical insulation, for fire-proof heat transport in hydraulic oils, in lubricating oils used at high

TRAN 056462

temperature and pressure, in paints and as pigments in various plastics. PCB is not imported only as such. It is also part of several finished products. Nothing is known as to the way in which it reaches the water and the air. According to Mr. Jensen, products containing PCB should have this openly declared.

PCB is equally harmful whether absorbed via the skin, through the food, or by inhalation. In contact with the skin it can cause œdema. For DDT the highest permissible concentration in the air has been set at 0.5 - 1 mg/cu.metre. For PCB it has been mentioned to be 0.5 mg/cu.metre. Mr. Jensen will now try to get more complete analytical material. He hopes eventually to be able to disclose the source of the contamination and will also increase his cooperation with toxocologists and geneologists."

Another daily paper, Svenska Dagbladet, has a similar article. Here it is mentioned that Mr. Jensen, working under Laborator (Professor) Gunnar Widmark, has disclosed facts which will have far-reaching importance since the findings have proved a new source of pollution of the nature.

One of the participants at the meeting was Dr. A.V. Holden of Scotland, scientific contact man between the twelve O.E.C.D. countries, who has established coordinated analysis of chemicals used and found in nature.

I suppose there is no doubt that what has been termed Polychlorinated Biphenyls is equal to Aroclor. There is also no doubt that the published facts will cause considerable unrest in several quarters. We probably will have to have Aroclor registered with the Swedish Board of Poisonous Substances and the industry will have to be particularly careful in handling the material. The problem in some cases of course may be the disposal of used material. I understand that there hardly exists a convenient method of destroying Aroclor and that possibly burying unuseable material may be the only answer.

We shall be glad to hear from you soon.

Yours sincerely, TRAN 056463

COMPANY CONFIDENTIAL

RISING & STRAND [illegible]LAG
HENRY STRAND

Brussels, Belgium

1st December, 1966

Aroclor Sweden

DW:gb

G. R. Buchanan - St. Louis

THIS COPY FOR

A. Arpino - Brussels
Dr. Emmet Kelly - St. Louis
D.V.N. Hardy - London
R.A. Steenrod - St. Louis

Dear George,

I attach a copy of a letter received from Ola Palm in Stockholm. I have sent copies of this letter also to the appropriate departments within our own organisation. In consideration of the importance we are placing on development of the Swedish market for Aroclor over the next five years, we would be grateful if you could arrange for this information to be considered by the appropriate departments in St. Louis and their comments transmitted to us as soon as possible.

Based on the recommendations made by our medical departments we shall have to decide whether to arrange for publication of data in Sweden or not.

In relation to the specific problem mentioned of disposal of used materials, we would be interested to learn how this problem is handled in America. In the U.K. many companies have been burying material in drums, material in the drums having been absorbed into vermiculite or some similar porous material. Has any entirely safe method been developed for the disposal of waste Aroclor ?

Best wishes.

GB.

Yours sincerely,

D. Wood.

P.S. Thinking of the total quantities of Aroclor used in Sweden compared with the much larger volumes of Pentachlorophenol and Sodium Pentachlorophenate, for water treatment in the paper industry and sapstain control in the timber industry. Is it likely that the chlorinated phenols show similar chromatographic traces to the chlorinated bi-phenols?

Plf. - Wood
EXHIBIT NO. 274
11/9/95

STR 017390

Tox - Aroclors

St. Louis

December 12, 1966

AROCLOR SWEDEN

A. Arpino - BRUSSELS
G. R. Buchanan - GBUCH
D.V.N. Hardy - LONDON
R. A. Steenrod - RSTEE

Mr. D. Wood
BRUSSELS

I do not believe that we can glibly accept Aroclors as a synonym for polychlorinated phenols that were discussed at the meeting of scientists at the Wenner-Gren Centre in Stockholm on November 27.

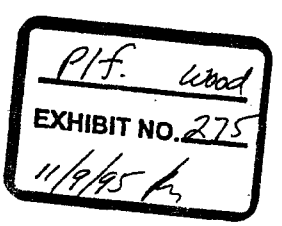
There are polychlorinated phenols which presumably could include derivitives from, or impurities in pentachlorophenol and, especially, 2,4-D and 2,4,5-T. These compounds would be much more liable to appear in salmon, pike, and sea eagles than any derived from Aroclors.

There are many chlorinated polyphenyls that can be formed during the manufacture of 2,4,5-T and probably pentachlorophenol, as well. Our only problem is whether or not we want to bring these facts up and have our herbicide program receive another black eye. This, I will have to leave to your judgment.

I think the question here is primarily an analytical problem. How can we find out what product Mr. Jensen is talking about? Can we compare these chromatographic peaks that Mr. Jensen is describing with anything found in Aroclors, pentachlorophenol, 2,4,5-T, etc? I admit I am out of my depth here but I think another compound is indicted rather than Aroclor.

R. Emmet Kelly, M. D.

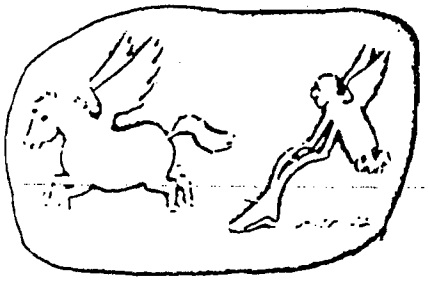
REK/ln



TOXICITY / INFLAMMABILITY.

NEW SCIENTIST. 15 DEC 1966

NOTES ON THE NEWS *continued*



for various purposes such as hoeing. At the National Institute of Agricultural Engineering, Howden, Midlothian, some interesting new attitudes are developing, however. For one thing herbicides have eliminated the need for close manual procedures which means that it is no longer necessary to grow all crops in single rows. There would be distinct advantages in growing potatoes, for instance, in beds as wide as three or four rows. It would be more economical of land, earthing-up could be done quicker, and the soil would suffer less from the compressional damage done by agricultural machinery.

There is a drawback, however. Traditional tractor design does not permit the use of wide strips; and no one elsewhere seems to have given much thought to ways in which tractors could be improved. At NIAE engineers have had a hard look at what farmers are going to need in the future and have designed an impressive "*self-propelled, multi-purpose toolframe*", which could well come to dominate our rural landscapes in a few years' time. Essentially it consists of a large box frame, supported at chest-height on conventional tractor wheels—a large pair at the front and small pair at the rear corners. At the front of the frame in the centre is a powerful, 70-horsepower tractor engine coupled to the driving wheels by independent oil-driven hydrodynamic motors.

The driver sits high up on the rear member of the box frame in a seat that can be hydraulically shifted from side to side, or turned right round to face the reverse direction. He has two levers at his left hand: both forward gives a range of forward speeds; both backward, reverse speeds. By moving them independently the wheels will revolve at different rates and assist turning. The rear wheels are telescopically mounted and can be raised or lowered hydraulically. They are self-levelling over uneven ground. Agricultural implements are mounted—without the need for soil-damaging wheels—in the centre of the box frame. Implements, likewise, can be designed for hydraulic operation and the frame is equipped with two large oil tanks at each front corner and several hydraulic take-off valves. The whole contrivance is simplicity itself to control.

A planting unit has now been constructed that will plant and ridge four rows of potatoes in one operation. Work is also in progress on a double-row harvester.

That tractor wheels are indeed harmful to soil has emerged from a unique field study at the institute. Using a gamma-ray probe and detector, researchers there have been able to observe for the first time the actual local profiles of soil density across tractor ruts, plough furrows and the like. They have related these to the failure of plants such as raspberry canes to grow where the soil has become compacted. Clods are also typically the result of the passage of heavy machinery across the soil so that cutting down the extent to which tractors and wheeled vehicles run over the soil will undoubtedly improve production.

This is by no means the only application of modern methods of science to farm mechanization at NIAE. Novel work under way aims at automated singling of sugar beets. Again it is herbicides like paraquat that have made such advances possible. Manual thinning by hoe is tedious and expensive. The plan is to use a machine equipped with photoelectric detectors sensitive to the spectral absorption lines of the green chlorophyll pigment in leaves. Signals from this device, indicating the density of foliage, will control a paraquat spray which will squirt the excess plants, leaving only those required at specified intervals for optimum growth.

Engineering data during field trials on new equipment is about to be collected by radio telemetry, and modern data-processing methods are under development at NIAE.

REPORT OF A NEW CHEMICAL HAZARD

A Swedish research worker has expressed concern over the increased amounts of polychlorinated biphenyl (PCB) entering the air, presumably from industrial smoke and rubbish-dump smoke, and being absorbed by water and taken up by fish and later humans. PCB which is related to and as poisonous as DDT was detected by Mr Sören Jensen of the Institute for Analytical Chemistry, University of Stockholm, in some 200 pike taken from different parts of Sweden, fish and fish-spawn throughout the country, an eagle which was found dead in the Stockholm Archipelago, and in his own, his wife's and his baby daughter's hair. As the baby is only five months old her father concludes that she got her dose of PCB with her mother's milk.

It is not known at present how much of this substance is dangerous or even fatal. If it is comparable with DDT then the limit would be 0.5 mg per cubic metre of air—and, for comparison, the dead eagle had at least 10 times as high a concentration in its body. For purposes of elimination Mr Jensen has obtained feathers from eagles preserved at the Swedish National Museum of Natural History since 1880 and has detected PCB first in an eagle from 1944.

In Sweden, PCB is known to be used in electrical insulations, hydraulic oils, high-temperature and high-pressure lubricating oils, paints, lacquers and varnishes, and as pigments in various plastics. It does not seem to be used as an insecticide. It is not destroyed by incineration and may enter the body directly through the skin, by breathing, or by way of food (especially fish). It is particularly harmful to the liver, and also the skin this has been demonstrated by experiments on mice. PCB is much harder to break down than DDT and there is every reason to suppose that it is much more difficult to get it out of the system. The substance has also been detected in the air over London and Hamburg and also in seals caught off Scotland. It can therefore be presumed to be widespread throughout the world.

LOAVES AND FISHES

The famine which now threatens parts of India has tended to focus the attention of the developed countries on that sub-continent's chronic inability to feed its teeming people, but a warning note came last week from another less publicized area. Dr B. R. Sen the Indian Director General of the UN Food and Agriculture Organization was addressing a regional conference at Punta del Este, Uruguay. He lambasted the governments of Latin America for their unwillingness to face what could be "a very serious situation indeed". It would take, he said, an increase in food production of four per cent a year to stem "social and political unrest which still prevails", or even to prevent it from worsening.

Dr Sen's warning comes none too soon. Malnutrition if not actual hunger is widespread in Latin America, where per-capita food production has dropped by four per cent in the past six years. At the same time the population is expected to double itself (to 422 million) by 1985. Dr Sen believes the four-per-cent rise to be technically feasible, if an all-out effort is made now.

Apart from the struggle to increase food supplies to keep pace with population however, efforts are also being made to overcome traditional prejudices against various foods which may be plentiful though neglected.

In the waters of Lake Victoria, for instance,—they cover an area about the size of Ireland—there are vast shoals of tilapia, a firm white fish, weighing about 8 oz and very tasty. European firms have already asked the Tanzanian government about the possibilities of sending frozen fillets to Europe but the local people are by no means as keen to eat this so-called fare.

~~FYI~~ Bob Keller 12/29/66

INSTITUTE OF ANALYTICAL CHEMISTRY
UNIVERSITY OF STOCKHOLM
Roslagsvägen 90, Stockholm 50, Sweden

Stockholm, December 29, 1966

Copy sent to:
R. Barker
L. M. Parks
J. A. Speziale

Mr. Ford
Monsanto Chemical Co
800 Lindbergh Road
St Louis, Missouri 63177
USA

Dear Mr. Ford.

Last year I had the great pleasure of visiting you at the Monsanto Co in St.Louis to discuss analytical problems of the phenolic composition of TCP. We were later kindly supported with samples by Mr. J.S. Thomas and Mr. A.F. Uelner. Our analytical investigations are almost finished and we will send you a reprint of the report when they will be available.

This letter is to inform you that we recently have identified most of the unknown GC-peaks at residue analysis of pesticides in biological samples. By the aid of combined GC and mass spectrometry Mr. Jensen of this institute has found the unknowns to be polychlorinated biphenyls which among other companies are manufactured by Monsanto, trade name Aroclor.

Added to this letter you will find a preprint of the synopsis of our publication which will appear in Acta Chem. Scand. (Summer 1967). Two gas chromatograms are also added to show that the chlorinated biphenyls are enriched in ecological series. - In the sample of the sea eagle were found: Polychlorinated biphenyls 80 ppm; ordinary chlorinated pesticides 80 ppm and meroury (!) 40 ppm.

At present we have no knowledge of the biological significance of the presence of these compounds in living organisms. We have started a collaboration with the Dept. of Toxicology at the Carolin Institute but we should very much appreciate to work with your toxicologists over this problem.

We will be glad to give you any further informations of the results obtained in this laboratory.

Sincerely Yours

Gunnar Widmark

Gunnar Widmark

Plf - Wood
EXHIBIT NO 277
11/9/95

TRAN 056035

HARTOLDMON0011060

Monsanto

D.V.N. Hardy, London

12th January, 1967

Arcolor - Sweden

DVNH/ARW

FILE	✓
Destroy	
JTG	
WHH	✓ ✓
MNJ	✓ ✓
REK	✓ ✓
RAM	
EPW	✓ ✓

JAN 16 1967.

10

P.G. Benignus, St. Louis
G.R. Buchanan, St. Louis
D.S. Cameron, Brussels
Dr. R. Emmet Kelly, St. Louis
G.R. Graham, New York
R.A. Steenrod, St. Louis
D. Wood, Brussels
J.A. Evans, London
R.A. Baxter, Ruabon

On 2nd January 1967 Mr. A. Richardson of Shell Chemicals' Tunstall Laboratory, Sittingbourne, Kent talked with me over the telephone concerning the Swedish Press report relating to the identification of "Polychlorinated Biphenols" as trace contaminant in sea birds, fish etc. Richardson has been working for some years on the similar problem with insecticides such as DDT, which are known to have wide distribution in trace quantities. He had already found that the chlorine-containing residue contained substances more stable than DDT. and just as Sören Jensen reports he has obtained spectrographic evidence that these are very similar if not identical with Aroclors. He has obtained samples of Arcolors 1242, 1254, 1262 and 5460 from us, and would now like to have small samples of any chemically pure Aroclor constituents which we may be able to supply. Milligram quantities would suffice for his purpose.

Mr. Richardson was quite sure that the compounds reported to be "polychlorinated biphenols" are really meant to be polychlorinated biphenyls and as support he has sent me a copy of the synopsis of a paper entitled "Pesticide Analysis: Presence of Polychlorinated Biphenyls at Residue Analysis of Biological Samples" by Sören Jensen and Gunner Widmark (photocopy attached).

I discussed with Richardson the soundness of Jensen's claims, and was assured that his work and findings are sound. Jensen is on the staff of the Institute of Analytical Chemistry, University of Stockholm. A note on the staff and work of the Institute is attached. From this you will see that Jensen is wholly concerned with the analysis of chlorinated pesticides and with the work of stations for routine analysis.

I would be glad if Dr. Baxter and Dr. Buchanan would arrange to send me milligram samples of any pure Arcolor constituents that may be available at Ruabon and St. Louis respectively.

PH - Wood
EXHIBIT NO. 278
11/9/85 K

COMPANY CONFIDENTIAL

D.V.N. HARDY

TRAN 007566

HARTOLDMON0011061

EUROPE S.A.

1/26/67 X

FROM (NAME & LOCATION) : Brussels, Belgium

DATE : 26th January, 1967

SUBJECT : SWEDEN, AROCLOR

REFERENCE : DW:gb

TO : G. R. Buchanan - St. Louis

cc P. G. Benignus - St. Louis
D. S. Cameron - Brussels
Dr. D. V. N. Hardy - London
Dr. R. Emmet Kelly - St. Louis
R.A. Steenrod - St. Louis

Walt Hutchoff - BrS

We recently sent you a translation of a Swedish newspaper article referring to the identification in nature of polychlorinated biphenols. Because some of the uses claimed for the materials fell in line with the uses of our own chlorinated diphenyls, we made a point, during our recent visit to Sweden, of visiting the research institute involved and discussing their particular programme of work.

To eliminate any earlier confusion that there may have been, I should like to emphasise that there is no doubt that the chemical which is the subject of the investigation and the news release, is chlorinated diphenyl i.e. Aroclor.

The company that supplied the mass spectrometer which was used in the research programme, in fact have recently put out a press release on this work. Although I am horrified by some of the headlines in this press release, it does basically describe the research programme carried out in Sweden, and describes in clear terms how chlorinated diphenyls were identified. I therefore, enclose a copy for your files.

Jensens only aim in life as an analytical chemist, was to identify the substances found in his research work on the occurrence of insecticides in nature. The unfortunate aspect of the situation is the comments which have been added to Jensens work. He showed what was present and unqualified people have made statements as to the possible effect of what he has found.

Summarising the publication position, there were original articles covering the Stockholm conference in the Swedish daily press, and these reports were picked up also by the Danish press. You will have seen from D.V.N. Hardy's memo of the 12th January that it has also been picked up by the Shell Chemicals Laboratory in Kent, U.K. Jensen also divulged that he had been contacted by the Swedish American press agency who intended to include information about this research work in their monthly review "The Swedish American Journal". There is additionally the press review issued by LKB Productor AB which I imagine to have been sent to a number of technical journals.

TRAN 085947

.../...

Pf - Wood
EXHIBIT NO 279
11/9/95 kr

Effect in Sweden

This matter was raised with us by every capacitor manufacturer in Sweden that we visited. Fortunately there has not been too much adverse comment as yet from plant workers since they have not associated the polychlorinated biphenols mentioned in the article with Aroclor or Pyralene used in the Swedish factories. Jensen, however, stated that he had been approached personally by several workers associated with chlorinated diphenyls for non-electrical uses and these workers were quite worried as to the possible effect on their health.

Future Research

Arrangements are being made in Sweden for this work to be taken over by one of the medical institutes who hope to study the toxicology of the poloychlorinated diphenyl residues at the levels of concentration found by Jensen. Additionally a geographical survey is to be carried out to try and determine where the highest concentrations of residue are appearing and, if possible, to detect from this the method of escape so that more security precautions can be taken. We were asked by Jensen if it was possible for Monsanto to supply any samples of the pure isomers of chlorinated diphenyl since his work indicated at the moment that the lower chlorinated isomers are fairly easily metabolised, and the potentially more dangerous constituents are the more highly chlorinated members. If he can get hold of pure isomers, he would like to carry out some work on comparitive rates of metabolisation.

Jensen is forwarding me copies of his mass spectrographs and details of sample preparation so that we have all the details of his research work.

The point that I have made to Jensen is the need for care in any further publication of his work which is made. He accepts that the toxicology of chlorinated diphenyls should only be discussed with detailed information about exposure concentrations and exposure times and that generalised statements out of context can only arouse undue public concern. If any technical journal takes up the press release from the LKB Productor Company, there is little that Monsanto could, or should do in the way of publishing rebuttals. We do not want, personally as Monsanto to get too involved in this question. I am hopeful that we

might persuade Jensen himself to write a letter defining the true extent of his own research work and placing his results in their proper perspective. It would certainly be helpful in gaining his further support if we were able to make available to him any small quantities of pure isomers.

Since we are not alone in supplying polychlorinated diphenyls to the Scandinavian market, I have drawn this matter to the attention of the other askarel manufacturers in Europe.

As you will see from the press release one of the major points that is made is the difficulty in disposing of waste chlorinated diphenyls and again I must mention that constructive recommendations for the safe disposal of our materials would be most helpful.

D. Wood.

TRAN 085949

LKB

PRESS RELEASE

IN THE SERVICE OF SCIENCE

F. 1/10/67

Not for release until January 10, 1967

POISON! - LKB HELPS TO MAKE A SAFER WORLD

Swedish firm produces instrument that detects a previously unobserved poison in fish, fowl and mammal

The Nature of the Poison

The poison that has been isolated is a hitherto unobserved chlorinated hydrocarbon having eight chlorines in the molecule. This polychlorinated biphenyl (PCB) was isolated in residue analysis carried out with the LKB Combined Gas Chromatograph-Mass Spectrometer, LKB 9000.

100 (ng) of residue from 20 mg of fat, taken from a Sea Eagle found dead in the Stockholm archipelago, was used in the analysis which was made by Sören Jensen, of the Institute of Analytical Chemistry of the University of Stockholm, who has been engaged on this type of research for some considerable time. The dramatic importance of this discovery can best be understood by studying the main characteristics of PCB:

1. Very high stability. Capable of being boiled with nitric acid without destruction.
2. Has hardly any metabolism in living organisms. Can have a steady build-up in the human body and traces have been found in both adults and children.
3. If more than four chlorines are present PCB is non-inflammable.

As well as isolating a poison this research has drawn attention to the need for close co-operation in two parallel lines of investigation. The study of the persistency and toxic effects of herbicides, pesticides and related chemicals, which for some time now has caused general concern throughout the world, and the quest for improved methods of assessing the pollution of industrial waste.

How the Substance was Identified

Initial research seemed to indicate that this, then unknown, poison occured as a result of the use of insecticides; the usual organochlorines present in insecticide research were detected pp^1-DDT, pp^1-DDE and pp^1-TDE and certain unknown compounds

TRAN 085950

were thought to be metabolites of the insecticides The location of the poisons in fish, in birds and on pine needles appeared to strengthen this theory. Further investigations however, including electron capture techniques, gave indications that this supposition was incorrect.

It was, at this stage, decided to use the LKB 9000 Combined Gas Chromatograph-Mass Spectrometer to obtain more definite knowledge of the chemical nature of these unknown compounds, their molecular weight, and number of chlorines for instance, as this was known to be the only method currently available which could give the highest degree of positive identification. Analysis had so far produced a chromatogram from which it was possible to estimate that the Eagle sample, previously mentioned, contained DDT and DDE in extractable fat at a concentration up to 13 g per kg and the unknown compounds in more or less the same quantities. Many of the retention times however were not in agreement with those for any known pesticides and a high proportion of unknown peaks were present. The purified sample from the Sea Eagle was injected on the LKB 9000 and the mass spectrograms which were obtained of the unknown peaks showed their mass numbers to be as follows: 426, 392, 358 and 324. The molecular difference in each case being 34 mass units thereby showing a family relationship between the unknowns

Chlorine exists as a mixture of two isotopes with atomic weights 35 and 37 in proportions of 75:25. If the molecule has one chlorine, two peaks will be obtained, one for Cl_{35} and one for Cl_{37}. If there are two chlorines it is possible to have one peak with only Cl_{35}, one with both Cl_{35} and Cl_{37} and one with two Cl_{37} and so on, so the relationship between the peaks on the mass spectrogram were found to be:

Molecular weight:	324	358	392	426
Chlorine content:	5	6	7	8

Having obtained this information it was possible to calculate the molecular weight of the parent hydrocarbon (PHC) and this was found to be 154. The most probable formula for a compound having carbon and hydrogen and giving the molecular weight of 154 is $C_{12}H_{10}$ and this can only be satisfied when the parent hydrocarbon is biphenyl and the unknown polychlorinated biphenyl.

Once this fact had been established an approach to industry elicited the answer that PCB was fairly extensively used, and when a sample was obtained and run through the LKB Combined Gas Chromatograph - Mass Spectrometer it was found that the gas chromatograph gave the same retention time for both the Eagle sample and the industrial sample, and the mass spectrometer gave exactly matching peaks, thus providing absolute verification of the previous analyses.

To cross check on the results and to more fully evaluate their significance, the feathers from a stuffed Sea Eagle (circa 1880), from a Stockholm museum were also ana-

...was discovered of poison of any kind was discovered. This research was continued

with other dated specimens and the first trace of DDT and its metabolized DDT was discovered in a specimen circa 1948/49 and PCB in 1942.

It has been mentioned earlier that traces of PCB were found on pine needles which seemed to indicate wind-blown insecticide, but this is undoubtedly due to the fact that where PCB has 40% or more chlorines it is not consumed when industrial waste is burnt but is thrown out in the smoke and air-borne over considerable distances.

The effect of this poison on man is not yet fully known. In 1936 tests showed that 23 out of 24 men employed in manufacturing PCB suffered from an acne, which appeared 6 to 8 months after handling the substance, and in 1939 it was partly responsible for the death of three young workers. Tests so far carried out on animals indicate that in all cases the liver degenerates and that generally the skin and the liver are the parts of the body susceptable to the poison.

Current Research

Jefferies and Walker of the Monks Wood Experimental Station in England have recently carried out experiments to determine the survival and reproduction of Bengalese Finches and have found a high proportion contain organochlorines. They are investigating the possibility of using the residue content of the liver as an indicator of the dose consumed.

Simmons and Tatton of the Laboratory of the Government Chemist, London, England have investigated organochlorine residues in human gallstones and have found them present in 28 patients from 2 hospitals.

These two lines of investigation have been concerned with insecticide and pesticides but they do serve to show the wide field in which traces of organochlorines occur.

Some twelve O.E.C.D. nations, among whom are the Scandinavian countries, U.S.A., Great Britain, France and Holland are co-operating in research into the prevalence of this virulent and dangerous substance.

LKB

LKB-Produkter AB is fully sensible of the dedication of the scientists taking part in this work in which it has had the honour and privelege to play an important role by providing an instrument, the LKB 9000 Combined Gas Chromatograph-Mass Spectrometer, to give them their first break-through by providing positive identification of PCB.

TRAN 085952

Publicity Department

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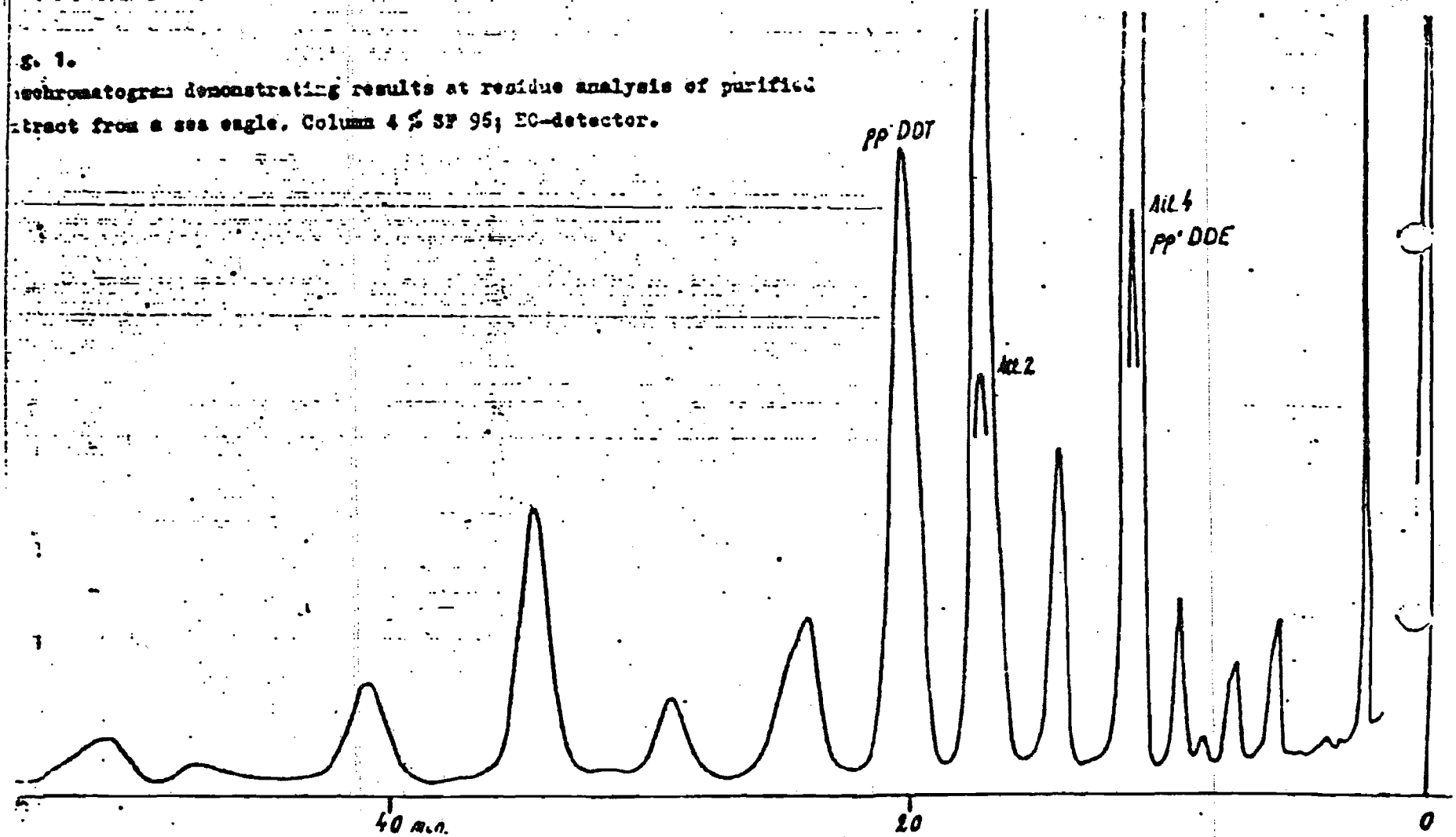
echromatogram demonstrating results at residue analysis of purified
xtract from a sea eagle. Column 4 % SF 95; EC-detector.



TRAN 085953

Mr Chairman, Ladies and gentlemen.
In honor to our Brittish guest I will try to hold this lecture in English.

As the title of this lecture states, I am today going to tell about the discovery of some hitherto unobserved chlorinated hydrocarbons having up to eight chlorine in the molecule and found in residue analysis. The chemical name of polychlorinated bifenyls (In the following called PCB). To get familiar with PCB I will start with the chemistry and toxicologi.

Chemistry

Th

The main characteristic of PCB is 1. Their very high stability. As an example they can be boiled with nitrin acid without being destroyed. 2. They are hardly metabolised in living organism. 3. if more than 4 chlorine are present they are non inflamable. It is clear that these three characteristics does it easy to understand that when they have entered the living organism the will have a low persistence . But it is difficult to explain how they find their way into the living organism. One thing seems to be clear, they don't come from agricultural use, but from a technical one and most probable it comes to the nature via wastes that are tried to be burnt up, because then we have them at once in the air, because of their non inflamability.

Toxicologi

The PCB were introduced in 1929 and as early as 1936 Jones and Alden reported that 23 out of 24 men employed in manufacturing of PCB suffered from an acne form eruption of the skin. Acne did not appear until 6 to 8 months after the material was first used. In 1937 Drinker reported that rats exposed to chlorinated biphenyls in concentration of approximately 1 mg/m^3 for 16 hours a day for 6 weeks showed damage of the liver. After that time the allowed concentration of PCB in air is 0,5 mg/m^3. (For DDt the same value is 0.5 - 1 mg/m^3). The same authors finished their experiments in 1938, and related that these compounds have an injourious effect, manifested solely in the liver. Chlorinated bipehnyls appeared to be the most injourious chlorinated compounds of all tested.

Greenburg, Mayer and Smith 1939 reported that PCB and polychlorineted naphtalenes are blamed for the death of three young workers, and that pregnant women and persons who have at any time had any liver diseases are particularly suspectible.

Wedel, Haller and Denton gave 1942 animals PCB including administration by inhalation, ingestion and skin absorbtion. Histological examination of the viscera showed important toxic effect only in the skin and liver, and the degeneration effects in the liver are essentially the same whatever was the method for the administration. Paribok (1955/ found as an occupational poison in the electrical industry, mixed tetra and penta chlorobiphenyl causes folliculitis, comedo, pyodermia and other skin affections, and that its principal toxic effect is fatty degeneration of the liver.

Miller (1944) injected 69 mg PCB (4 and 5 chlorine) subcontaneously in 32 guinea pigs. Eight to ten days after injection, fat droplets were noted in the liver cells, and after 16 days they were present in moderate or very large numbers. Rabbits and rats were also tested in this investigation, as well as the PCB was administated both continously, subcontinously or ingested in the food. In the feeding experiment 8 guinea pigs received 2 doses of 69 mg of the chlorinated biphenyl 1 week apart. Death occurred in 11 to 29 days.

Finally Mc Laughlin 1964 reported a method to test the chemical toxicity and teratogenic effect by injection into the yolk sac of fertile eggs prior to incubation. PCB was found between the eight compounds among 100 tested having the highest order of toxicity. No hatch was found at a level of 25 mg pr egg. At a level of 10 mg per egg, one chick hatched out of 20 injected eggs, but died 2 days later. Some embryos which were examined after they died, showed weak deformities (often a short upper brak) and growth retardation. Lead acetate resulted as an example in no hatch at a level of 1 mg per egg. Autopsy of the dead embyos have showed extensive brain damage. Mercuric chloride showed no hatch even at a level of 0,5 mg por egg.

As the analytical chemistry is a pronounced service science I have been in contact with many scientists from other fields during the work with residue analysis, and I have always found this contact very stimulating for my own work. This co-operation often demands that we are talking the same scientific language. Because of this need I will today try to give a lecture in low level analytical chemistry for biologists, illustrated by the residue analysis of polychlorinated biphenyls.

The lecture will be divided in the following three sub-divisions:

1. Chemistry of PCB and their toxicology.
2. Analytical methods for residue analysis and proof of structures.
3. Behaviour of PCB in nature, differencies in metabolising rate of the PCB components, potensation in an ecological serie, concentration levels and examples of samples which have been proved to contain PCB.

A residue analysis can be divided in:

1. Extraction of the pesticides from the biological material, followed by a careful cleaning-up to take away interferring substances, most often fats.
2. Identification analysis by mean of gas chromatography. Thin-layer chromatography and mass spectrometry.
3. Quantitative analysis.

At an ecological laboratory in Riksmuséet in Stockholm 1-2 g of a sample is cut out of the biological material and transferred into a weighed and carefully cleaned test tube, and stored at -20° until analysis. Smaller samples have been used, min. 5 mg of body fat, and with dry materials such as hair, feathers, pine needles 100 mg are sufficient to reach the desired 10 ng/g level in residue analysis. In cases of water proofs 1 l. is used for reaching the 10 pg/g. level.

B.1(homog) In order to facilitate complete extraction of the fatty materials from the biological sample, the doulbe amount of finely powdered anhydrous magnesium sulphate is added to the sampling tube, and the whole is homogenised with an insertable homogenizer. The resulting powder is transferred into a special Soxhlet extractor. After 4 hours of extraction the solvent is evaporated, leaving the fat in a small weighed test tube at the bottom
Sox.-tube) of the extractor. This fat is dissolved in methylene chloride in such a way that 100 ul (0,1 ml) contain 20 mg of fat.

The 100 ul solution is now transferred to a little object glass, 3 x 7 cm, covered with a silicagel layer 1 mm thick, in order to form a line 0,7 cm from one end of the slide. Inserting this thin-layer plate into a vessel the bottom of which is covered by a few mm of methylene chloride, the solvent will be sucked up in the dry layer of silicagel, and at least reach the upper end of the plate. The fact is that the fat has a greater affinity to the powder on the plate than the chlorinated hydrocarbons have. - and we get a separation. The fat being more polar than the chlorinated hydrocarbons will never go longer than 2 cm before the

solvent reaches the upper part of the glass.

ELUTION tube

The front of the fat appears quite visible against a lamp, and with the aid of a razor blade the zone above the fat is transferred to the elution tube and the chlorinated biocides absorbed on the powder can now be eluted by one ml of ether. The concentration is sufficient for detection of the chlorinated hydrocarbons down to the 10^{-12} g level.

The next step in the analytical procedure concerns the separation of the

5 go

different chlorinated hydrocarbons that the sample may contain. As a matter of fact, this is a troublesome task. It is easy to estimate what is not present, but more difficult to say exactly one is present. We suffer from the negative demonstration, as will be shown later.

At first a few words about the separation of the components present in the sample and their visualization.

6 ge

The separation is accomplished by mean of a gas chromatograph fitted to a detector that transfers its impulse to a recorder.

The system is shortly described:

A spirally formed glass tube with an inner diameter of 2 mm and about 2 m in length is filled up by a support, covered with an thin layer of an oil. The tube is heated in the chromatograph to about 200°. Through the tube a stream of nitrogen continously follows. When about 10 ul (1/100 of 1 ml) of the purified sample is injected into the tube, the components of the sample will be evaporized and go forward through the column with the gas stream. As the constituents have different affinity to the column filling they will pass the column with different speed and it will take different time for them to reach the detector at the other end of the glass tube. If the temperature and the nitrogen flow are held constant this time, the retention time, has a specificvalue for a certain compound. This is true, but unfortunately it is also a fact that two components can have the same retention time. This is one of the bigger problems in gas chromatographic analysis of unknown samples, as will soon be obvious.

To make it possible to estimate the retention time it is necessary to visualize the chlorinated hydrocarbons. For that purpose more or less specific detectors are used. The detector most often used in posticide analysis is the so called electron capture detector, which can detect down to one picogram (= 10^{-12} g of lindan). Unfortunately this detector is not specific for chlorine, bu gives answer also for oxygencontaining compounds. The response here is much lower but can be counterbalanced if the concentration of the oxygen containing is much higher.

TRAN 056039

The principle for the electron capture detector is shortly:

At the end of the gas chromatographic tube is placed a little tube containing a foil made of titanium tritide. This is an-radiant. The b-

particles are reacting with the nitrogen molecules coming from the column. Then we get $+ N_2 \rightarrow e^- + N_2^+$. Over the detector we have a tension of 90 volt and by mean of the electrons we will get a constant electrical current over the detector. This standing current is transferred to a one-mV recorder as a constant baseline. When now a chlorinated hydrocarbon leaves the column this compound has a high affinity to the electrons and this means that the amount of electrons will diminish, and they will diminish proportionally to the amount of chlorine. The electrical current will also diminish and this is noted as a peak on the recorder. The area of the peak will be proportional to the amount of substance in the sample. By mean of a standard injection it is now possible to compare the retention time and the area of an unknown component with the retention time and area of the known standard. As said before this detector is not specific for chlrine but anyhow very useful, because of its high sensitivity. The system described has, as we have seen, two disadvantages:

1. Two different compounds can have the same retention time and be detected as one peak.

2. A registrated peak does not need to be chlorinated , because the detector is not specific.

If the sample is injected in two different columns with different chemical properties we have increased the chance for a good separation. If two compounds have the same retention time on one column they may not have it on another. When a result seems doubtful, - if the compound being responsible for a certain peak contains chlorine or not - it is possible to concentrate the sample and analyse it on a less sensitive detector such as the microcloumetric one, which is specific for chlorine. The compound is burned in a furnace and teh generated chlorine titrated directly.

As is seen from the two last mentioned possibilities it is anyhow possible to get a rather high degree of certainty in residue analysis, but it is a rather time-consumeing work.When using this method just described, we very often found that many chromatograms from residue analysis of most carefully purified samples still contain a large number of peaks. Many of these have retention times that do not agree with any known chlorinated pesticides, or their metabolites. This chromatogram con serve as an example. It was obtained by residue analysis of a sea-eagle found dead in the archipelago of Stockholm. In the range of the known peaks, there are so many unidentified that there also must be an obvious risk of the known peaks to be covered by unknown ones.

If this remark is found true, the reported results of many previous quan-

titabive analysis must be brought into question. In the present investigation it is shown that most of the unknown peak of chromatograms at residue analysis of chlorinated pesticides are due to polychlorinated biphenyls.

I will show a chromatogram of human fat analysed on a so called SP 96 column, the most often used type in pesticide analyses. Early retention times were in agreement with DDE, DDTop and DDTpp. Next slide shows the same sample analysed on a QF-1 column. Now the former 2 DDT peaks have divided into 4 peaks, and two of them are still in agreement with DDTpp and op., the two new were unknown.

Logically, these unknown components were at first thought to be metabolites of the insecticides. Against that spoke that neigther treatment nor concentrated sulfuric acid in other. This treatment made it rather sure that the compounds did not contain oxygen. In Sweden residues of organic mercury have been investigated rather intensively in the Swedish fauna. As these compounds give very high responses to the electron capture detector it was also investigated if the unknown peaks could have a mercuric origin.

It was found that the water-ecological series had high residues of both mercury (Westermark, Johnels) and the unknown ones, when the same individuals were analysed. Anyhow, the pheasant suffering most from mercury poisoning only contained low levels of electron capturing compounds and these belonged
to the normal insectisides. Therefore the unknown could hardly be mercurials or metabolites of them.

As the eagle sample giving the chromatogram shown in fig. 10. could be estimated to contain DDT and DDE up to 13 g/kg in extractable fat, the amount of unknown compounds also were suggested to be in the same range, and tehn sufficiently high to do a run on the combined gas chromatograph - mass spectrometer. If this could be done successfully it would be possible to get very important informations about the chemical nature of the unknown, for ex. the molekular weight numbers of chlorine etc. This method is up to now the method giving the highest degree of certainty in the low level analytical chemistry, amounts of 100 ng substance being enough.

As this method for identification of totally unknown residues surely will be very important in the future (when f.ex. a biologist has found that fishes in a river die) it may be possible by mean of this method to find out exactly what compounds are responsible for the death.
For this reason, I will go into some details with this method.
In the actual case we took the extract from 20 mg eagle and concentrated

it as much as possible and made an injection on the gas chromatograph combined with the mass spectrometer. The result was the chromatogram shown on the next slide. Every time the recorder showed that a compound is leaving the column, the effluent is led to the mass spectrometer. Now just a few words about the mass spec.

The molecules leaving the column are bomded with electrons at E. We have now got the molecule positive charged, but with the same mass as before. This M^+ is accelerated in a vacuum and will then get a kinetic energi.

where is the speed. Next comes the magnetic field that tries to bend the direction of the molecule. This will be big for a small molecule and less for

If we have a sieve in the other end we can directly read the molecular weight. Added to this parent molecule M^+ we will also get addition informations, because of the fact that M^+ may not be stable, a part of them will be broken down before they reach the sieve in the other end.

P.ex. M^+_{DDT} $M^+_{DDT} - CCl_3$

Mass spectrograms from the different unknown peaks in the eagle sample as shown. The mass numbers equal to the molecular weights of the unknowns could be read to 426,392, 358, 324. Astonishingly, the molecular differences were constantly 34 mass units. This difference shows a familarity in origin of the unknown. Now the fact is that chlorine exsists as a mixture of two isotopes with atom weights 35 and 37 in proportion 75:25. If the molecule has one chlorine, this will give two molecule peaks, one for Cl_{35} and one for Cl_{37}. If there are two chlorine we have the possibility of one with only Cl_{35}, one with both Cl_{35} and 37 and one with 2 Cl_{37} and therefore

The relation of the peaks found on the different mass spec were:

Molecular weight	324	358	392	426
Chlorine content	5	6	7	8

An explanation of the familiarity of the compounds can be given if one substance is built from the former by substituting a hydrogen with chlorine

$$RH + Cl_2 \rightarrow RCl + HCl$$
$$M^+ \quad M^+ + 34$$

Then it is possibl to calculate the molecular weight of the parent hydrocarbon PHC.

$M_{PHC} = M - x\,M_{Cl} + x\,M_H$, where M is the molecular weight of the componont having x chlorine atoms. F.ex. for m = 426 and 8 Cl we will get M_{PHC} = 426 - 280 + 8 = 154 and equal with the other molekyls.

The most probable formula with carbon and hydrogen giving this molecular weight is $C_{12}H_{10}$ and this can only be satisfied when the parent-hydrocarbon is biphenyl, and the unknown being polychlorinated biphenyls.

This explanation was later fully verified by injection of a synthetic PBC on the mass spec.

Furthermore extensive gas chromatographic investigations proved that the PBC standard gave peaks with the same retention time as the unknown peaks from the sea eagle.

With the method just described I suppose that we have a new possibility to study the residues in the air because the pine needles can allways be . We have had great difficult: in quantifying the PCB, but when getting a little more time it will be possible. We have done a few calculations on a few species, and I suppose they are right within a factor 2. We have found the residue to be from

It has been my statement here to-day to present this method for studies of defiling of the nature, and with this method a new typo of defiling agents has been found to be present in nature, and a few experiment have shown where they may be found.

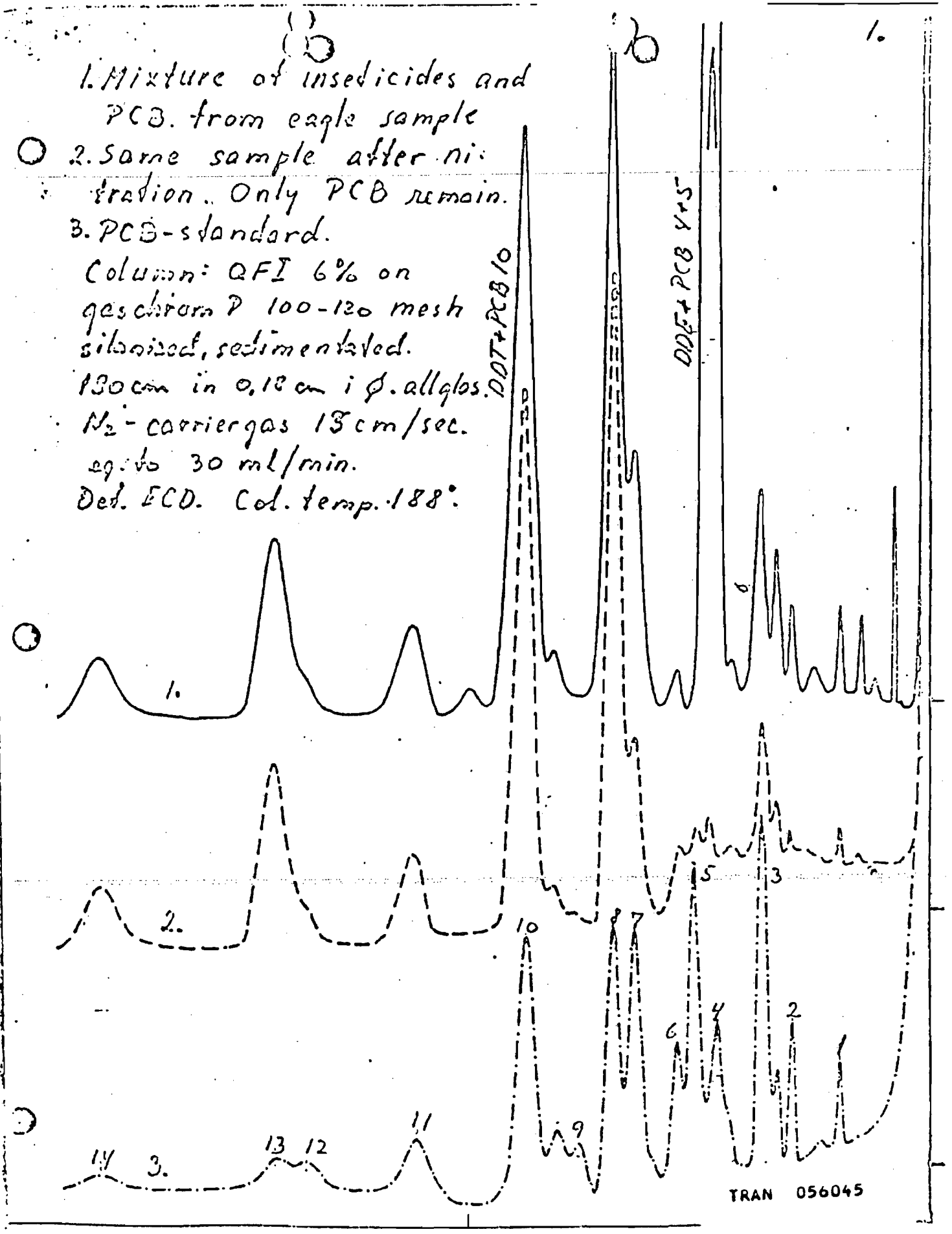
Now this method is going to be used in the first hadn to estimate how the situation is in nature as a whole, and in the other hand to find the leaks throug which they find its way to nature. Soem maybe are present here today to get news about the leaks, and to them I want to say come back in a year.

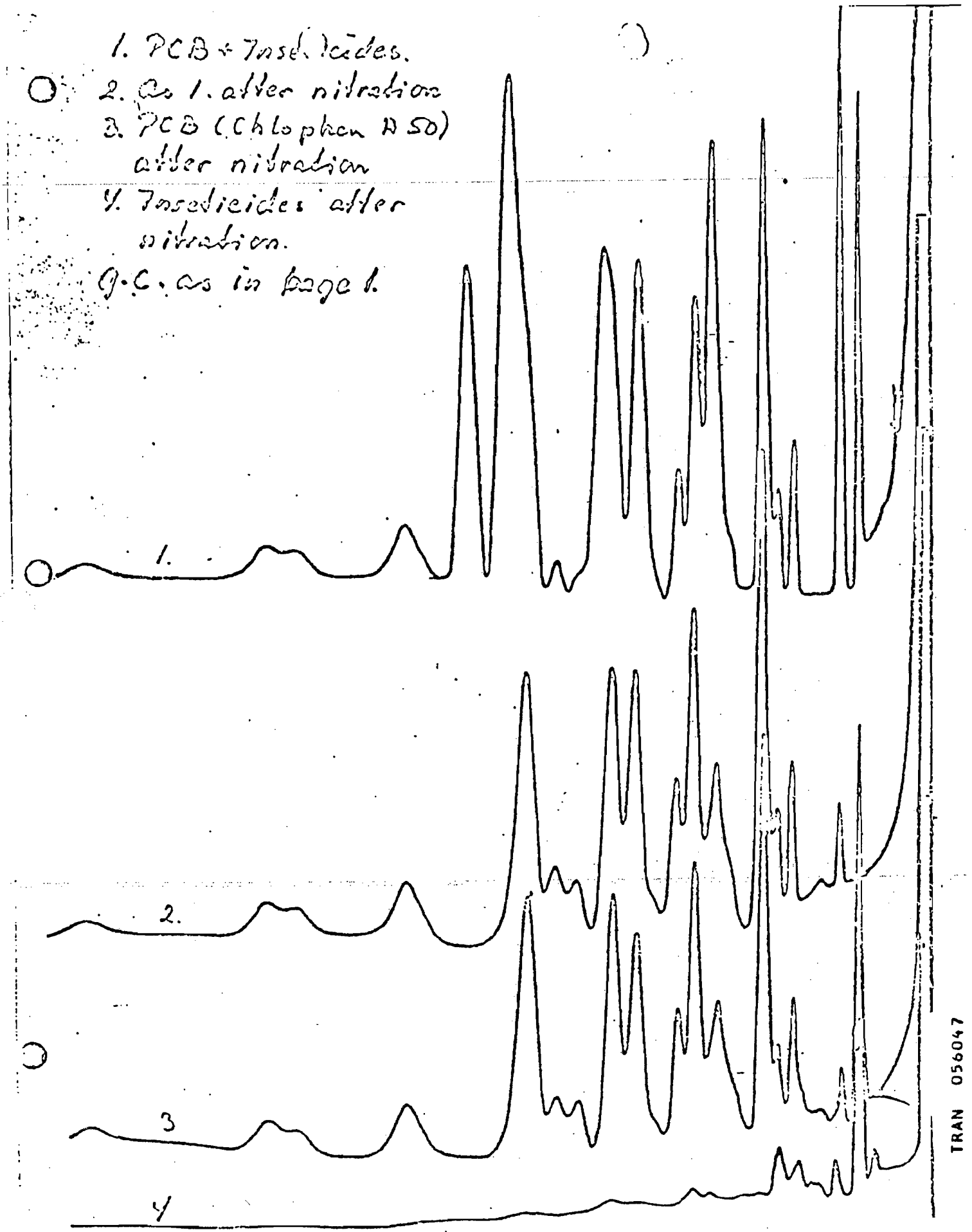
TRAN 056043

So much I think I can say again that the PCB hardly can come from agriculture. As suppoft for this suggestion I can say that we have found PCB in eagle feathers from Riksmuseet from 1944, where hardly any chlorinated pesticides were used in agricultrue. One more thing that I find important to say is that in contrast to the mercury problem this does not seem to be a pure Swedish problem. I have just studied chromatograms taken from London air, and they clearly contain PCB, and dr. Holden has told me that he also find them in his fishsamples. But finally in waiting at more results I should like to point out one morething. It is proved that PC comes to nature, we dont know now where they are used, but they are very persistant to chemicals and to fire. I think the poison jury should try to state that a content of PCB shall always be found in an open declaration.

1. Mixture of insedicides and PCB. from eagle sample
2. Same sample after nitration. Only PCB remain.
3. PCB-standard.

Column: QFI 6% on gaschrom P 100-120 mesh silanized, sedimentated. 130 cm in 0,12 cm i ϕ. allglas.
N_2 - carriergas 15 cm/sec. eq. to 30 ml/min.
Det. ECD. Col. temp. 188°.





Curve 4

Curve 3

Curve 2

Curve 1

TRAN 056048

p,p'-DDT

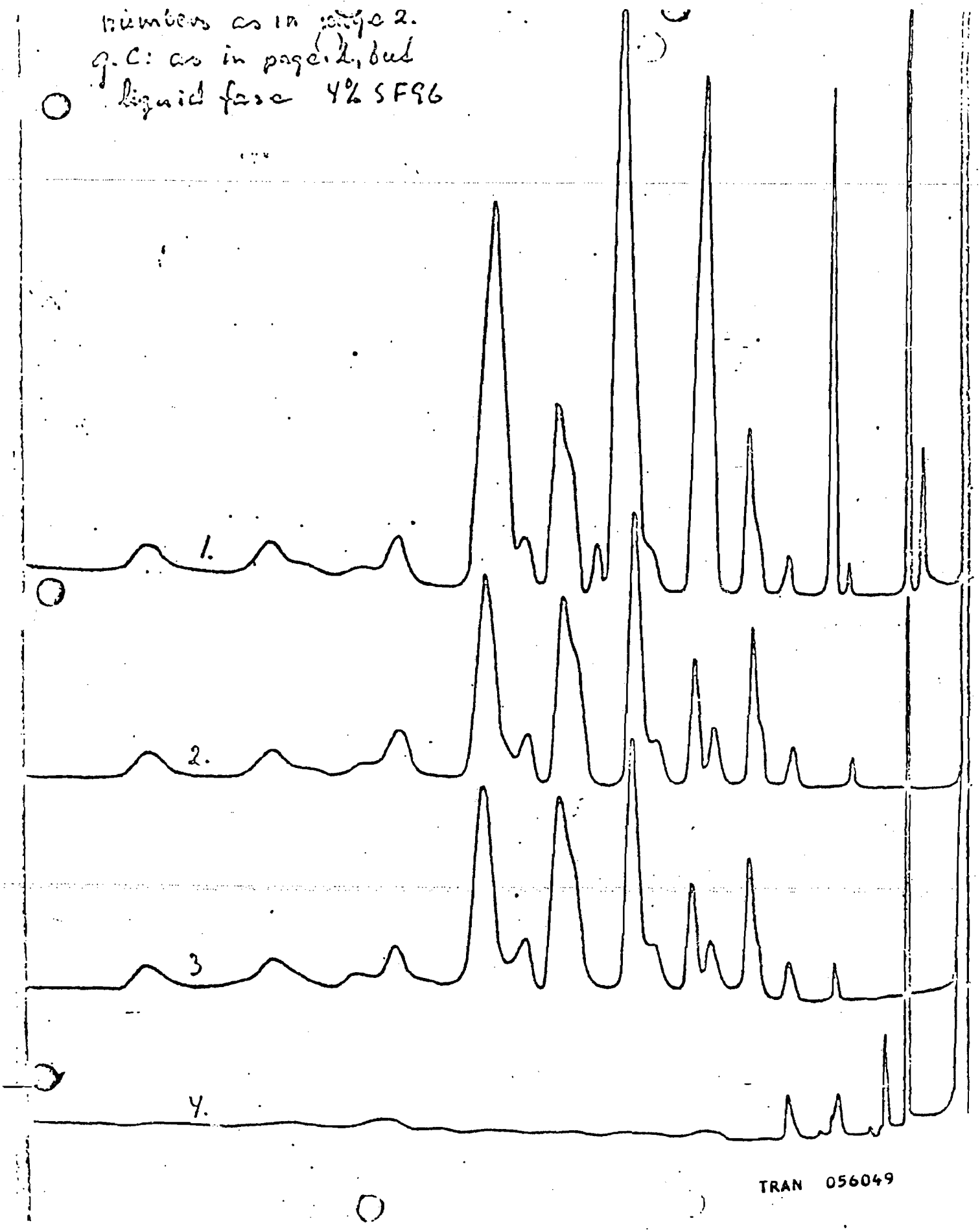
p,p'-DDE

o,p'-DDT+7

DIELDRIN

ALDRIN

LINDAN



p.p.DDD

DIELDRIN
+
P.P.DDE

ALDRIN

LINDANE

10 + p.p'-DDT

o.p'-DDT

LINDANE

Curve a

Curve b

Curve c

Curve d

TRAN 056050

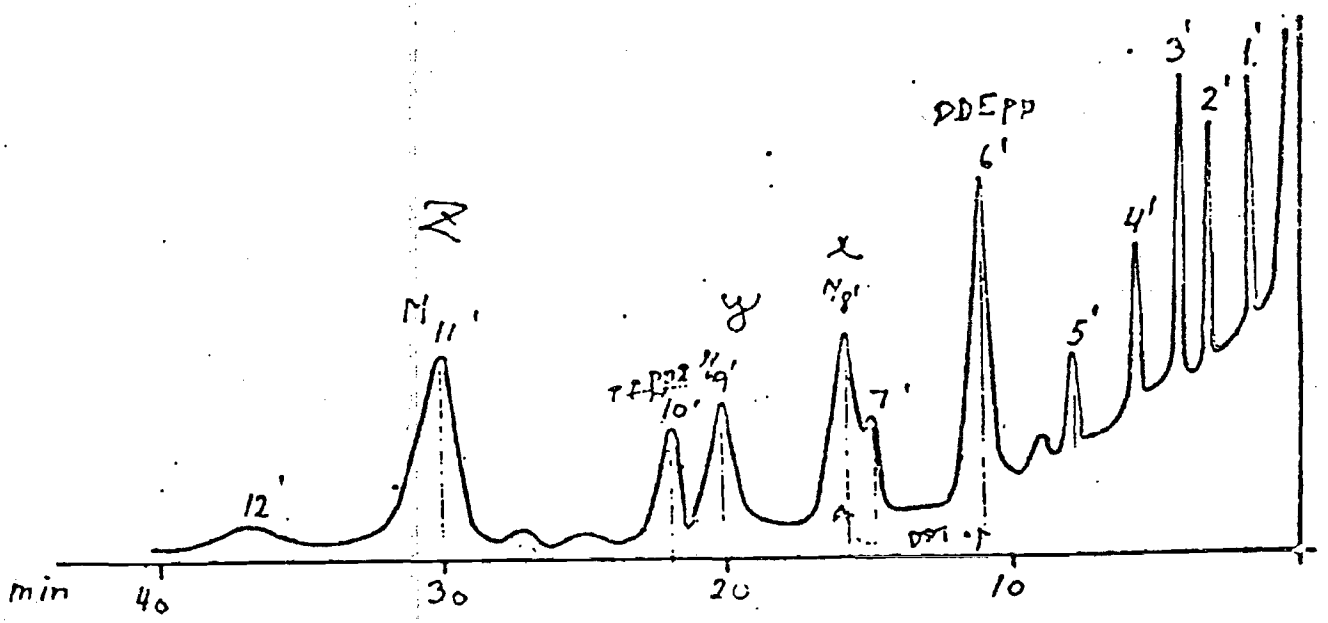
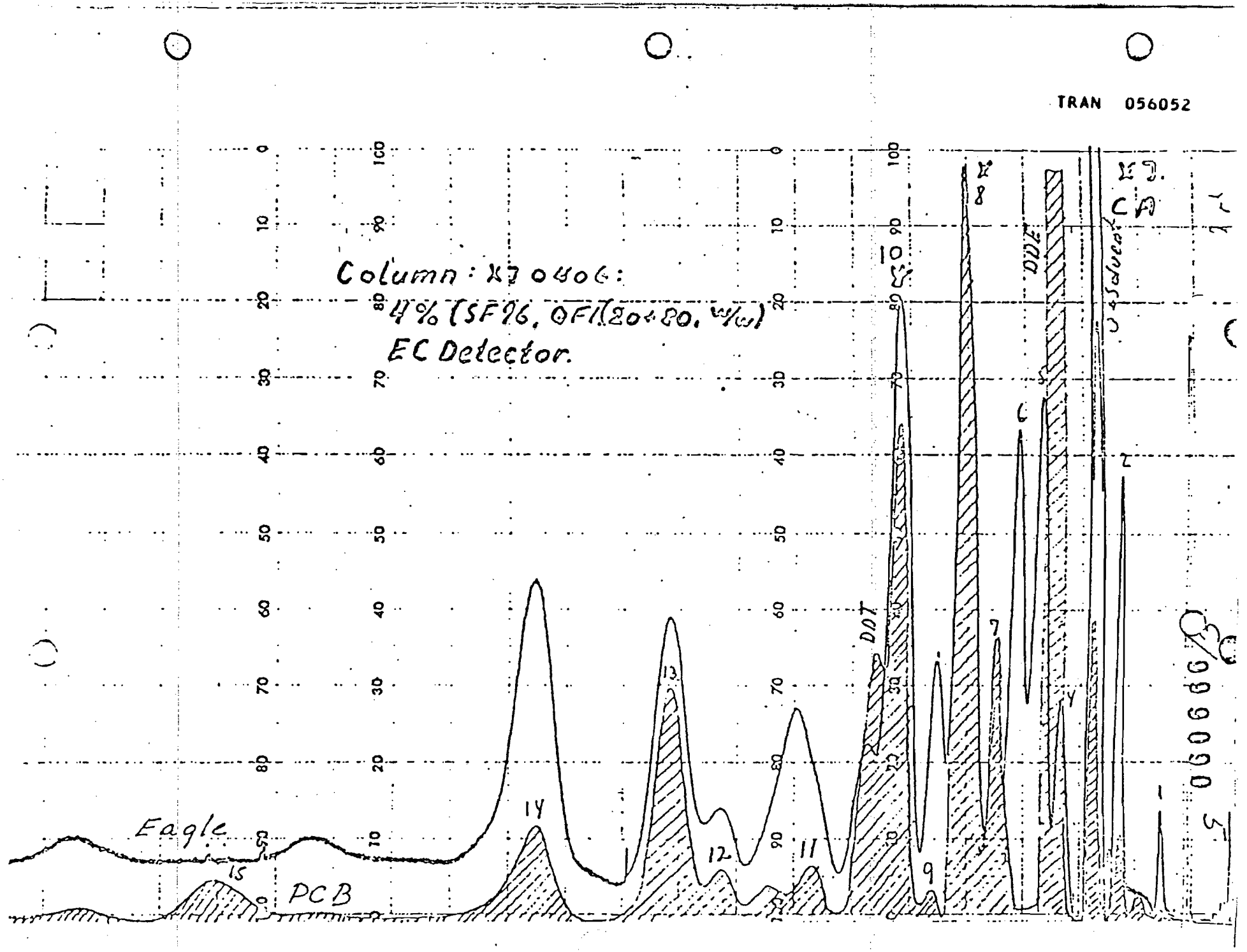
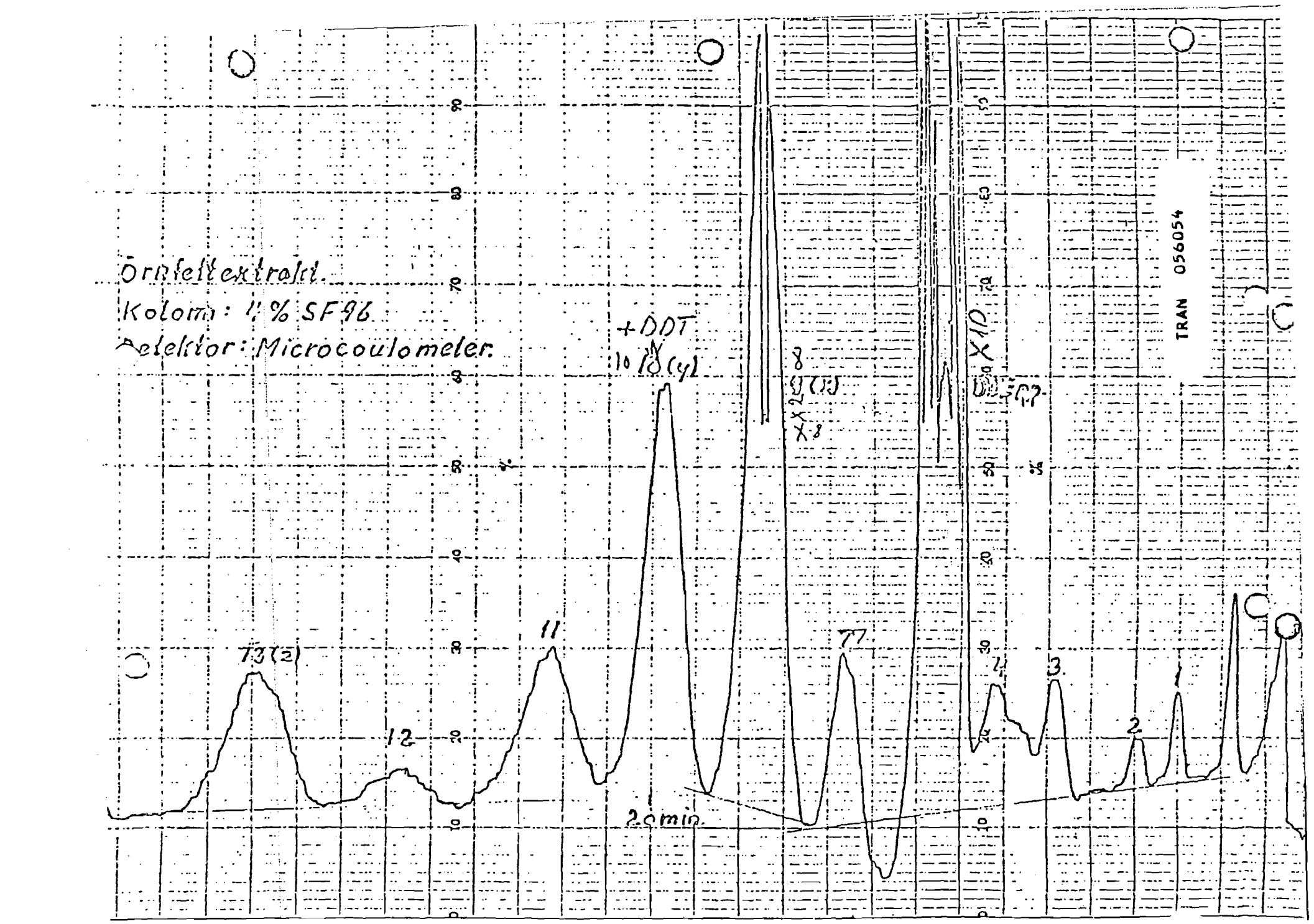
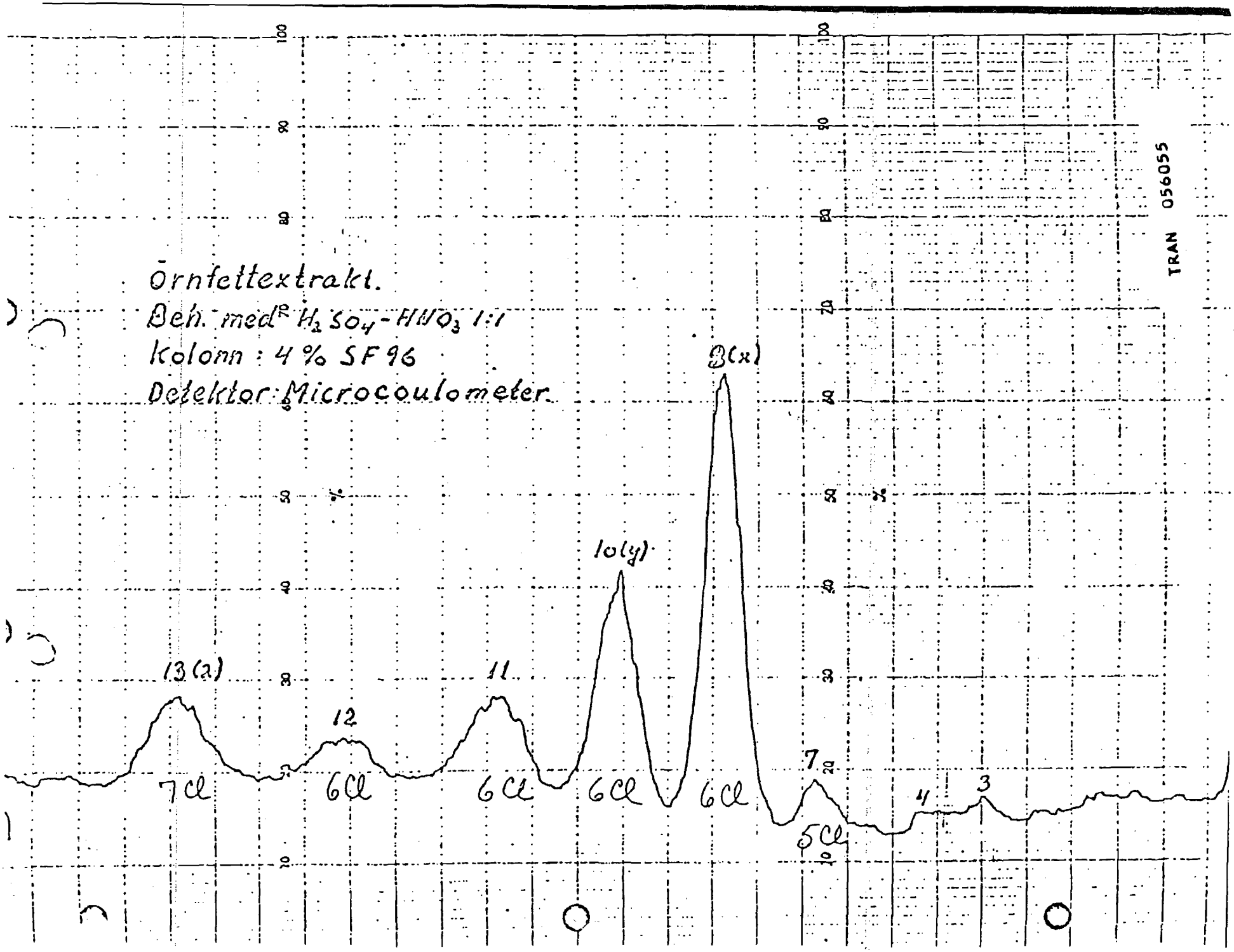


Fig 3. GC-MS chromatogram from eagle sample. Peak numbers represent time points of scanning.



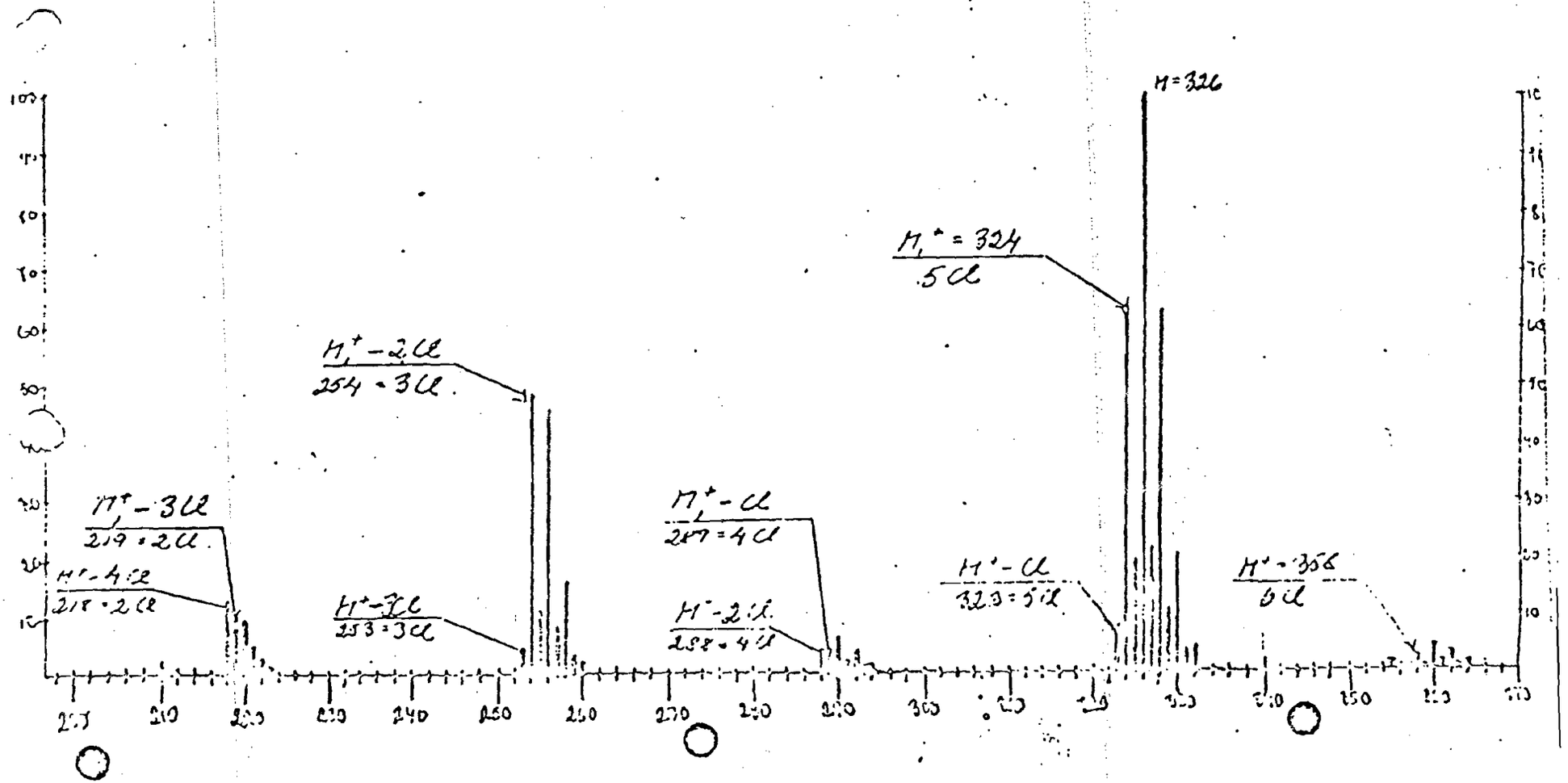




Clophen A50
topp nr. 7

TRAN 056056

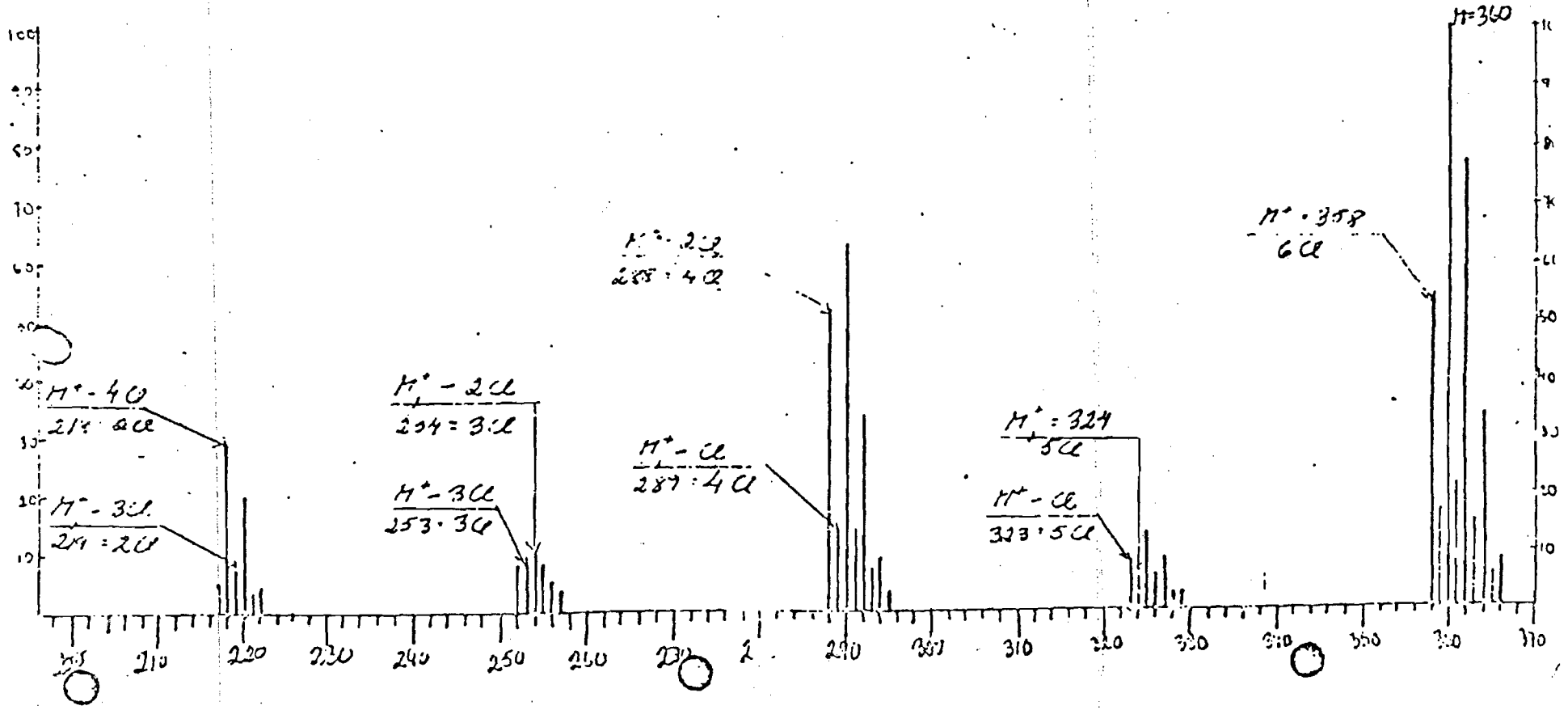
HARTOLDMON0011089



TRAN 056057

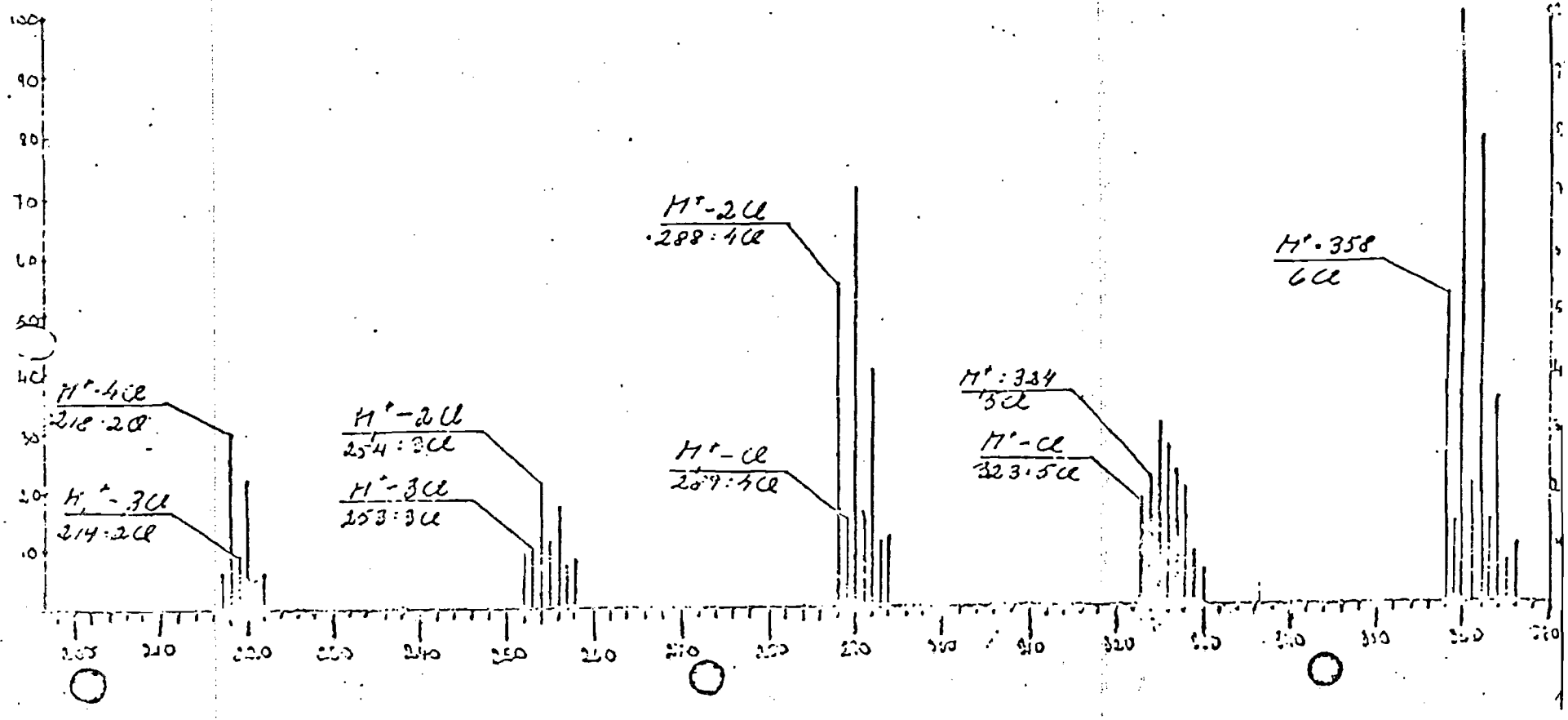
Clophen A50
lopp nr 10

TRAN 056058



Clophen A50.
topp nr. 11.

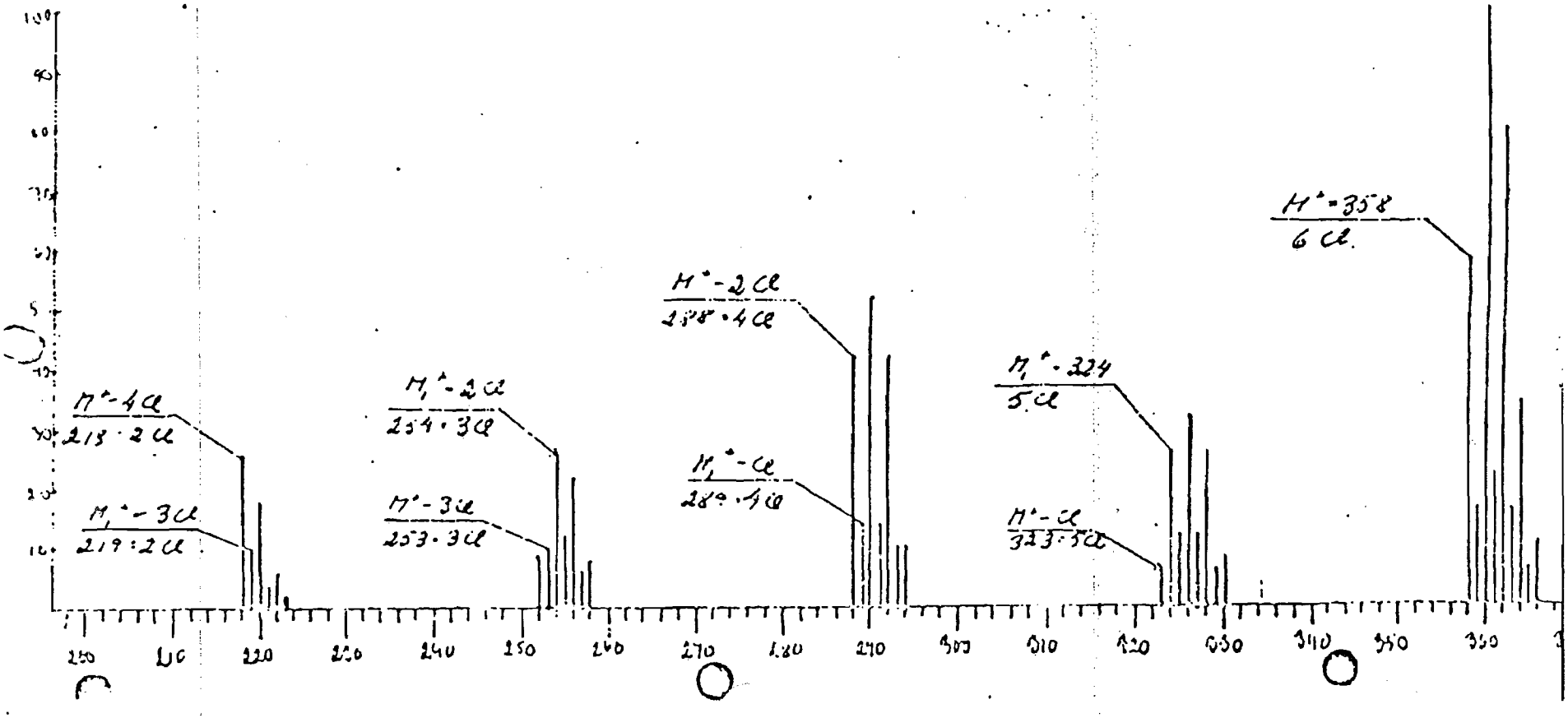
TRAN 056059



Clophen A50

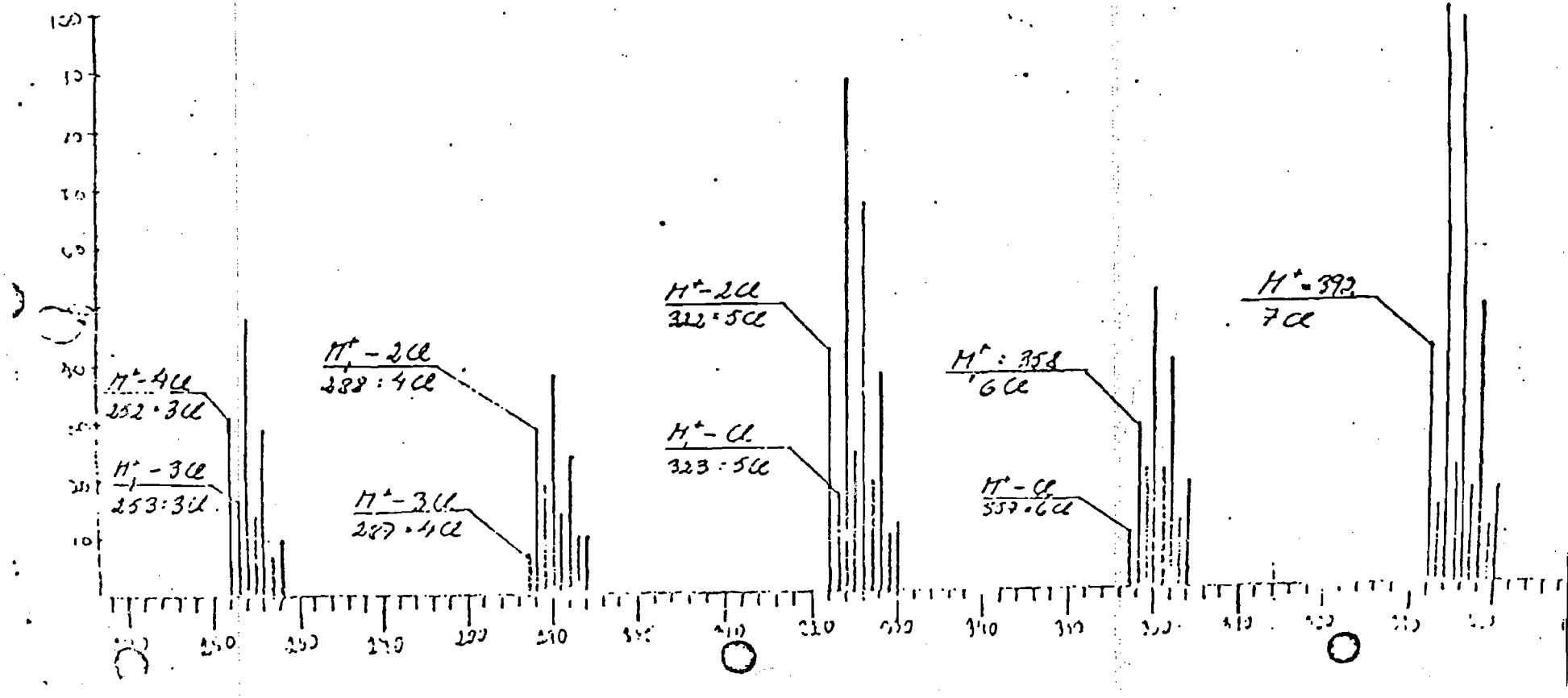
Topp nr. 12

TRAN 056060



Clophen A50
topp nr. 13

TRAN 056061



Conservationists have another chemical to worry about, one that apparently accumulates in fish, birds, animals and people much like DDT. Called polychlorobiphenyl (PCB) in Sweden where its presence in nature was first discovered, the chemical is known as chlorinated biphenyl in the U.S. Though not made in Sweden, the chemical is used worldwide in transformer oils, lubricants, paints and solvents.

A Swedish scientist says PCB first appears in museum-preserved sea eagles dating from 1944, and that it is now present in high concentrations in fish, fish spawn, birds, seals, and human adults and children. The Swedes attribute widespread distribution of PCB—it has been detected in the air of London and Hamburg, and in seals off Scotland—to air pollution resulting from industrial uses and from incineration, which does not destroy the chemical. The extent of the hazard, if any, is not known. And U.S. sources say they are not aware of any such problem in this country.

"Take me to the moon" remains a wish in song only for most women, except for the dozen or so who joined about nine hundred men in answering the National Aeronautics and Space Administration's (NASA) latest call for scientists-astronauts (*Chementator*, Sept. 28, 1966, p. 59). At the deadline, Jan. 8, only 939 doctorate engineers and scientists had filed applications out of an estimated 20,000 qualified persons in the country. Engineers comprised 27% of the applicants.

The National Academy of Sciences (NAS) will pre-screen the applicants for NASA, which will select twelve of the survivors before August 15. No estimate of the women applicants' chances of selection is available.

Even as the United Steelworkers asked the U.S. Supreme Court to overturn an injunction that forced striking members back to work at Union Carbide Corp.'s Kokomo, Ind., plant (*Chementator*, Jan. 16, p. 81), the company appealed last week to a W. Va. court to set aside an unemployment compensation award to its Alloy, W. Va., employees. The W. Va. Dept. of Employment Security said on Jan. 6 that 1,060 Alloy employees were entitled to compensation for the nearly three months the plant was shut down between July 2 and Sept. 22, 1966. The National Labor Relations Board had branded that shutdown as an illegal lockout (*Chementator*, Nov. 7, 1966, p. 97). When Carbide reopened the plant, the employees struck. They are still striking.

Power plants and the state of New Jersey got most of the blame for high sulfur dioxide (SO_2) levels in the New York-New Jersey metropolitan area—the power companies because they produce most of the pollutant, and New Jersey because it has no rules to cope with the problem.

These were among the conclusions of the lengthy N.Y.-N.J. Interstate Air Pollution Abatement Conference held in New York this month (*Chementator*, Jan. 16, p. 82). The Conference, though recessed, technically remains in session until a permanent body is established. Among the recommendations were these:

- Federal representation, with a vote equal to the states, on the interstate body. The U.S. wants an entirely new agency, while the conferees prefer to expand the authority of the existing Interstate Sanitation Commission.
- Application of New York's ambient-air quality objectives to the entire area.
- Power plants not to burn fuel exceeding 1% sulfur after Oct. 1, 1969, unless the plants are equipped to deal adequately with SO_2 emissions.
- No new generating plants to be permitted unless a 20-yr. supply of low-sulfur fuel can be guaranteed.
- New sources of SO_2 emission to be limited to 500 ppm., and existing sources limited to 2,000 ppm.

St. Louis

February 10, 1967

G. R. Buchanan - GBUCH
J. Filer - BRUSSELS
D.V.N. Hardy - LONDON
Eugene Wilde - EWILD

Mr. D. Wood
LONDON

We have had a rather extensive meeting, which included the St. Louis individuals receiving copies of this memorandum, on Aroclor in the air and in various fish and other living reservoirs.

The decision was that more information had to be gained, and whether this would necessitate a trip from someone in the Medical Department to the various agencies working on this problem in Europe would depend upon how easily obtainable these gaps in our knowledge are by other means than personal communication.

We are very worried about what is liable to happen in the states when the various technical and lay news media pick up the subject. This is especially critical at this time because air pollution is getting a tremendous amount of publicity in the United States.

We have been receiving quite a few communications from our customers, but the most critical one is NCR, who are very much involved with their carbonless carbon paper.

I have listed a number of points referring to information I would like to have. Some of these may be easy to answer; others might take a little bit of investigation and some might not be feasible to answer at this time. However, please let me know your ideas on each one of the following items:

1. Can we get the original articles in the Swedish press, including Dagens Nyheter? I have a good fluent Dane who translates Swedish very well and is a physician and investigator, so nothing will be lost in the translation.

2. Who were the participants in the ~~contest~~ CONFERENCE referred to in your memorandum to Mr. Buchanan of January 26? Under whose auspices was it held and were there any reports issued? What were the conclusions of the conference and was any action decided upon?

COMPANY CONFIDENTIAL

TRAN 056619

Plf - Wood
EXHIBIT NO. 282
11/9/95 kn

3. What was the medical institute in Sweden that was going to do the toxicological work referred to in the same memorandum to Mr. Buchanan? Who was going to pay for it and what was the scope of the investigation?

4. In LKB press release of January 10, they stated that 12 OECD nations were going to do work on this problem. Can anything be found out about the extent of this work? Who is doing it, and at what institutes?

5. What is known about the work in England at the Monks Wood Experimental Station and the Laboratory of Chemistss in London? How long has this gone on? Is it an ongoing study? What are the perimeters of the study?

6. Do we have the complete paper in Swedish of Jenssen and Widmark entitled "Pesticide Analysis--Presence of Polychlorinated Biphenyls and Residual Analysis of Biological Samples"? This was referred to in D.V.N. Hardy's letter of January 12, 1967. I would like to get this original paper with the bibliography in Swedish.

7. Can I have more information about the Carlin Institute of Toxicology which was referred to in Mr. Widmark's letter to Mr. Ford of December 29, 1966? What do they intend to do? Who is the contact, and is it located in Stockholm?

By copy of this memorandum, I am asking Dr. Hardy to find out what the situation is in the two English contacts referred to in item 5.

The consensus in St. Louis is that while Monsanto would like to keep in the background in this problem, we don't see how we will be able to in the United States. We feel our customers, especially NCR, may ask us for some sort of data concerning the safety of these residues in humans. This obviously might be opening the door to an extensive and quite expensive toxicological/pharmacological investigation. Before starting this, we certainly want to find out what is going on and not duplicate any of the work. I have tried to call you for the last two days and I will be out of town next week, but I would like to call you the week of the 20th. Perhaps by then you might have some answers to some of the questions.

COMPANY
CONFIDENTIAL

R. Emmet Kelly, M. D.

REK/ln

TRAN 056620

RISING & STRAND

GP/BO AKTIEBOLAG

TELEFON: 34 01 55 TELEGRAM: HENRIS TELEX: 1624
POSTGIRO: 5 44 43 BANKGIRO: 73-0446

STOCKHOLM VA
SVEAVÄGEN 47

February 17, 1967

Mr. David Wood
Monsanto Europe
BRUSSELS 3
Belgium

Dear David,

re: AROCLORS

Reference is made to our telephone conversation and I have tried to dig out the information you asked for. Before going into any detail, however, I would like to refer to your letter to Mr. Sören Jensen , dated February 8.

Mr. Jensen would be interested in samples of as many isomers as you can put at his disposal. The quantities of course are very small indeed and he would need only about 10 mg of each. In theory you could put the lot behind a stamp and mail it to Mr. Sören Jensen but in actual practice it is of course not as easy as that.

Anyway, Mr. Jensen would be interested in both the low-chlorinated and the high-chlorinated types since this would help him to get a better picture of the metabolism.

Now to the various points you raised. Enclosed you will find the original articles as published in "Dagens Nyheter" and "Svenska Dagbladet" on November 23, 1966. The people who organised the meeting where Mr. Jensen's paper was presented was a Committee - 1964 års Naturvårdskommitté - operating under Statens Naturvetenskapli Forskningsråd (The Swedish Natural Science Research Council). The Committee (for Conservation of Natural Resources of 1964) is working under the chairmanship of a Dr. B. Lundholm.

The meeting was organised under the auspices of Naturvårdskommittén and was called apparently only in order to give Mr. Sören Jensen an opportunity to publish his findings. The timing was made so as to coincide with a visit of Dr. A. Holden from Scotland.

COMPANY CONFIDENTIAL

TRAN 056616

PA - Wood
EXHIBIT NO. 283
11/9/95 k

Dr. Alan Holden - address Fresh Water Fisheries Laboratory, Pitlochry Pearcher, Scotland - is the coordinator for the twelve OECD countries, as far as the influence of biocides on Nature goes. Dr. Holden apparently is a specialist on such questions and particularly on fish. There is no intention that Dr. Holden, or the group of twelve OECD countries as such, should carry on any further investigations on the particular problem unearthed by Mr. Jensen. Any continuation will be carried on in Stockholm by Mr. Jensen or cooperating Swedish laboratories.

The meeting of November 23 offered only one paper, i.e. that of Mr. Jensen. No decisions were made on any further action.

The work done by Mr. Jensen was paid for by the above-mentioned Committee for Conservation of Natural Resources. The further studies planned for on toxicology have not been started on yet since there is no money available. It is possible, however, that the same Committee of 1964 will be asked to subsidise even that work.

If toxicological studies are to be made, these probably will be carried out at Karolinska Institutet, Division of Toxicology under Professor Bo Holmstedt. The full address of this institute is

Kgl. Karolinska Institutet
Avd. Toxikologi
Solnavägen 1
Stockholm 60.

Since no decision has been made on toxicological investigations, obviously no information can be given as to the scope of the planned investigations.

The LKB press release of January 10, 1967 mentioned the research of twelve OECD countries. As was mentioned above, there is no question of any central investigations to be made under the auspices of the twelve countries. There is only the question of coordinated efforts by way of interchange of information.

Enclosed you will find photo copies of the original paper of Mr. Sören Jensen. We have taken this copy here and Mr. Jensen apologizes for the state of the paper which is his own typing. He has not yet had an opportunity to have it properly retyped for publication.

I hope the above answers your questions.

Yours sincerely,

Enc.

COMPANY CONFIDENTIAL

TRAN 056617

P.S.

David:-

For the sake of good order, I would like to mention that Mr. Sören Jensen has sent us these papers with the understanding that they are only for internal use within the Monsanto organisation.

Ola.

COMPANY CONFIDENTIAL

TRAN 056618

2/21/67

St. Louis

February 21, 1967

G. R. Buchanan - CBUCH

R. E. Keller - QUEENY

Mr. Gene Wilde
GWILD

I talked to Dave Wood in Brussels this morning and I list below the salient features of our conversation:

1. He has 90% of the information asked for in my letter of February 10 and will have the rest obtained in the next day or so and will forward the bundle to me. It should arrive within a week.

2. His customers in Europe are seemingly less concerned than they were, especially since there has been no particular government activity and no increase in the newspaper articles. The customers would like some reassurance on the toxicity of Aroclor (I explained to Dave that there just was no information available on the action of nanograms of Aroclor in the human body over a lifetime). There is no toxicological work going on at present in Sweden and it appears there is some likelihood that it will not be able to obtain financing and might not be done. Everybody over there is 100% convinced that what Jenssen and Widmark found was Aroclor.

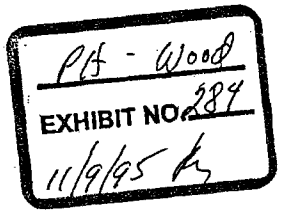
3. There is no necessity at present for anyone from St. Louis to contact the Swedish people. In fact, it would be unwise at present.

I am to get in touch with Mr. Wood after I receive the bundle of information he is sending me. Unless something unusual happens in the United States, I would be of the opinion that we should do no further action until we have time to evaluate this information.

R. Emmet Kelly, M. D.

REK/ln

TRAN 085966



Ministry of Technology
LABORATORY OF THE GOVERNMENT CHEMIST
Cornwall House, Stamford Street, LONDON S.E.1
Telephone: WATERloo 7900, ext. 507

Please address any reply to THE GOVERNMENT CHEMIST and quote:
Your reference:

23rd February, 1967.

Dear Dr. Hardy,

With reference to your letter of 20th February to the Government Chemist and our discussion on the telephone the following day, I can confirm that we are very interested in this Laboratory in the suggestion by Jensen of the University of Stockholm that chlorinated biphenyl compounds occur in wildlife.

As you are aware, we have for some years been examining selected foods, human tissue, wildlife, etc. for organochlorine pesticide residues. The work on food and human tissue has been carried out on a systematic basis for the Scientific Sub-committee on Poisonous Substances used in Agriculture and Food Storage, while the wildlife work is for the Nature Conservancy. We have found that wildlife, in particular, often contains a number of compounds which produce a series of peaks on gas chromatograms when using electron-capture detectors. These peaks do not correspond to pesticides or their known breakdown products or metabolites but they sometimes interfere with the determination of the pesticides. We have spent some time attempting to identify these unknown compounds which occur at quite low levels, probably parts per million at most. Their close similarity has prevented us from isolating individual compounds but, collectively, we know they have a high chlorine content - about 50% - similar to the organochlorine pesticides. This led us to think that they might be derivatives of such pesticides as DDT or dieldrin because we never seemed to find them without one of these also being present in substantial amounts. We also considered that they might be compounds of the pesticides with sterol or protein material or be polymers or inter-condensation products of the pesticides, or their metabolites.

Experimental work failed to confirm any of these hypotheses and being short of staff we abandoned the work until we obtained a positive lead.

Jensen's announcement caused us to examine a sample of Arocolor Resin which we found in another section of the Laboratory. We find it gives peaks on the gas chromatograph fairly close to those which are given by avian liver and we are now carrying out further work which looks promising but which it would be foolish to prejudge. Even if we find Arocolor compounds to be responsible it will raise a number of important questions such as how does it get there and why mainly bird life, and some marine life like seals, and so seldom in man or his foods such as milk, butter, etc.

We shall be pleased to examine any further samples of Arocolor which you send us and let you know the results.

I enclose a reprint of the section of the 1965 Annual Report of this Laboratory which may be of interest to you.

Yours sincerely,

J.O'G. Tatton

Dr. D.V.N. Hardy,
Monsanto Chemicals Ltd.,
10-18 Victoria Street,
S.W. 1.

PESTICIDE ANALYSIS

PRESENCE OF POLYCHLORINATED BIPHENYLS AT RESIDUE ANALYSIS OF BIOLOGICAL SAMPLES.

Sören Jensen and Gunnar Widmark

Institute of Analytical Chemistry, University of Stockholm,
Stockholm 50, Sweden

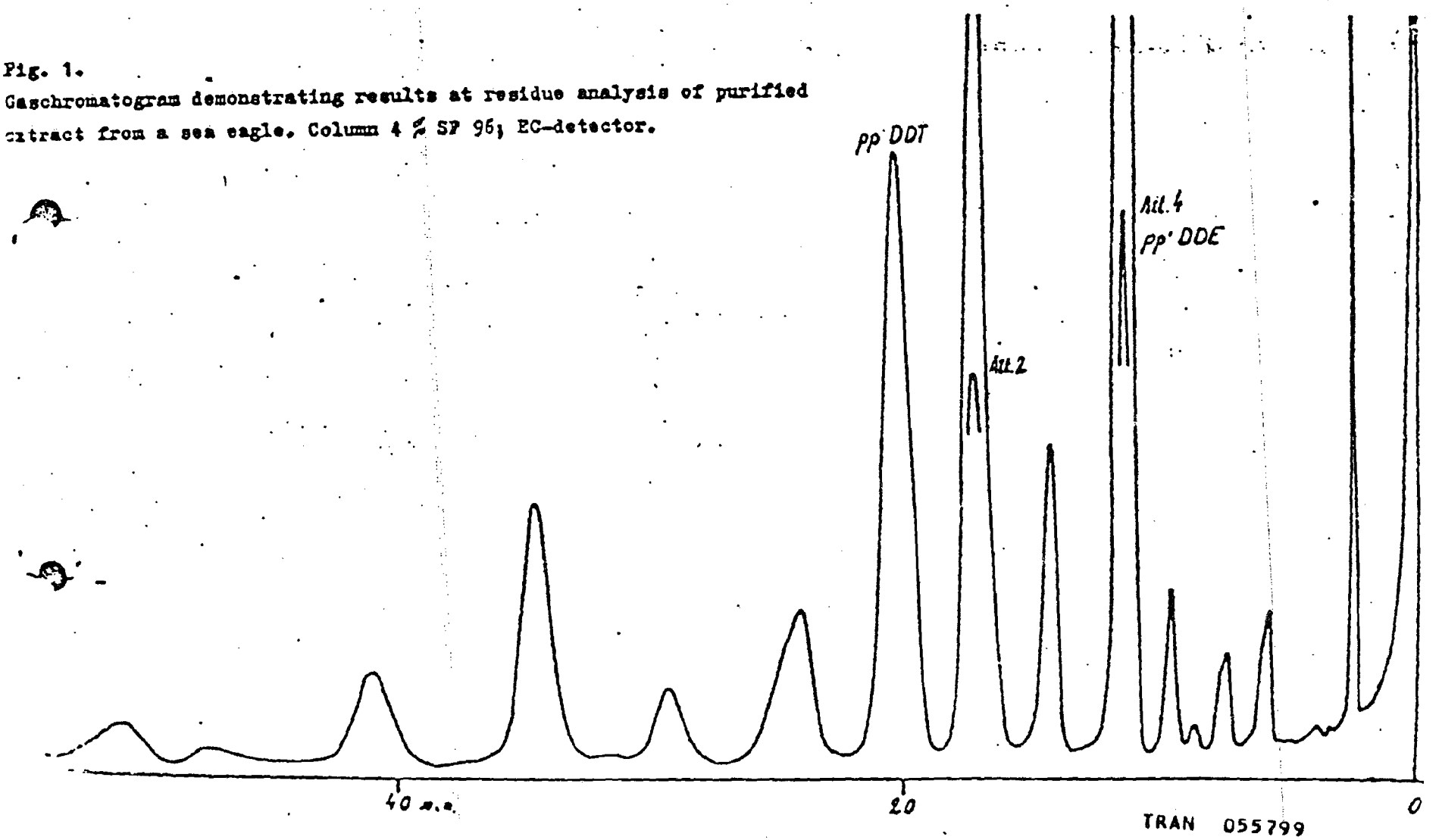
(Synopsis)

At analysis of samples from the Swedish wild-life fauna by means of gas chromatography, using both electron capture detector and micro coulometric detector, a large number of unknown but chlorine containing compoun have been detected together with the ordinary pesticides. Massspectra of some of these compounds obtained at a combined gas chromatograph mass spectrometer (LKB-9000) indicate that most of the unknown compounds are polychlorinated biphenyls, potentiated somewhat in nature towards those of higher degree of chlorination.

A large number of samples have been examined, and polychlorinated biphen are found especially in fish and in sea birds but also in needles of con fers and in some samples of human depot fat. Two hundred samples of soil and water did not contain detectable amounts of chlorinated biphenyls no did twenty samples of terrestrial mammals.

By the use of a nitration method most of the ordinary pesticides can be removed from extracts, leaving the polychlorinated biphenyl unaffected. Using this method, it has been shown that two of the major peaks of the chlorinated biphenyls overlap the two peaks of ppDDT and opDDT respectiv ly. This is found true for SF-96 columns, most frequently used for the quantitative residue analyses reported in literature; not in case of QF-1 columns.

Fig. 1.
Gaschromatogram demonstrating results at residue analysis of purified extract from a sea eagle. Column 4 % SP 96; EC-detector.



INSTITUTE OF ANALYTICAL CHEMISTRY
UNIVERSITY OF STOCKHOLM
Roslagsvägen 90, Stockholm 50, Sweden

Stockholm, February 27, 1967

Mr Gene C.Wilde
Plasticizer Sales Dept.
Monsanto Co
800 Lindbergh Bld
St Louis, Missouri 63166, USA

Dear Mr Wilde,

Thank you for your letter of January 24, which was on my desk when I returned from a lecture trip to Germany. During this trip I gave a lecture at Bayer AG, Leverkusen, a company manufacturing polychlorinated biphenyls under the trade name of Clophen A 50 and A 30. During the intense discussion which followed my lecture there were no objections to our analytical findings except for the possibility of one of the PCB isomers to be formed at the decomposition of Lindane; over three chloro benzene. Although we do not have a scientific proof against this assumptio made by an application chemist of Bayer - I think the reaction is very unlikely and only responsible for one of the PCB isomers. - The chromatogr added to this letter demonstrates the increase of the higher chlorinated PCB's through a food chain and the decrease of the lower ones; this is against the "lindane-theory". Remark also the non-presence of PCB in a non-aquabic animal.

At present we are discussing the plans for the toxilogical investigations to be done in collaboration with prof. Bo Holmstedt, head of the Toxilogical Dept. of the Carolin Institute. However, it is my firm impression that the toxilogical work to be done is of such a great extent that it has to be divided between more toxilogical laboratories. Moreover, more analytical work has to be done to aid the toxicological work.

During my visit to Germany your Swedish representant, Riding and Strand Co (Mr O.Palm) has been in contact with Mr Sören Jensen of this institute. At their discussion Mr Palm was given a manuscript of a lecture which Mr Jensen recently gave for the board of the Swedish Committee of Natural Resources. A copy of this lecture has been sent to Monsanto. It has to be

underlined that, according to the agreement between these two gentlemen this manuscript must only be in use inside Monsanto. Please inform your collegues of Monsanto of this limitation.

Sincerely Yours

Gunnar Widmark

TRAN 055793

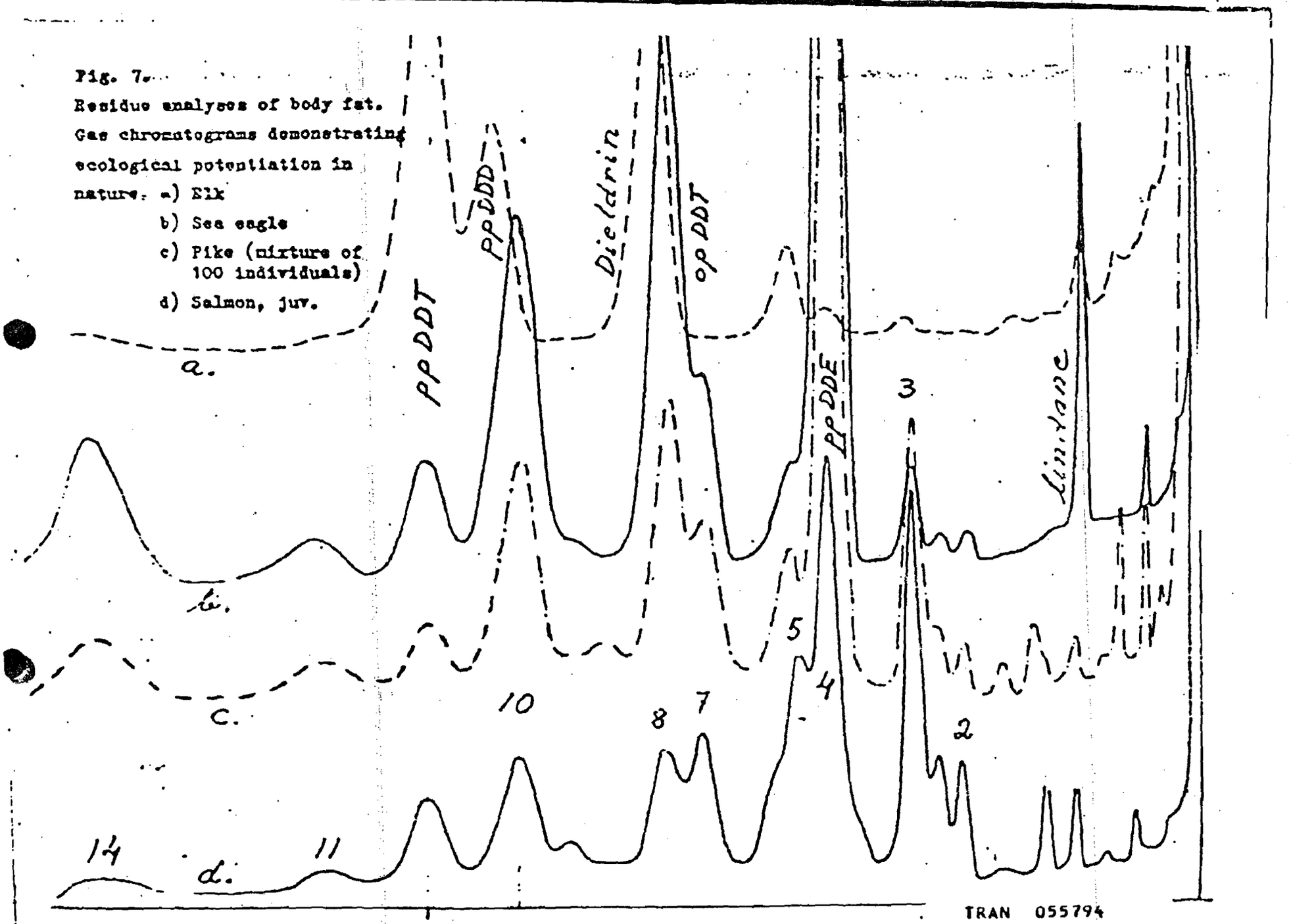


Fig. 7.
Residue analyses of body fat.
Gas chromatograms demonstrating ecological potentiation in nature. a) Elk
b) Sea eagle
c) Pike (mixture of 100 individuals)
d) Salmon, juv.

3/16/67

Gene Wilde - General Offices

March 16, 1967

POLYCHLORINATED BIPHENYLS

UNIVERSITY OF STOCKHOLM

Dr. R. E. Kelly

G. R. Buchanan
Dr. W. H. Hunt
R. E. Keller - JPQ
W. F. Maychoff

Attached is the latest communique that I have received from Gunnar Widmark. I thought you would be interested in receiving a copy of this about Widmark's visit at Bayer. As you can see he says that there was quite an intense discussion, which I can imagine, about the recent publicity from the University of Stockholm and that there was only one objection which involved the possibility of one of the polychlorinated biphenyl isomers to be formed at the decomposition of Lindane. I suppose the most important thing in this letter is the second paragraph. Here he outlines future investigations at the Carolin Institute and he believes there will have to be more laboratories brought into the project to complete the work.

If any of you have any comments or thoughts on something which should be done now, please let me know immediately. I have heard nothing more from our customers or from the field since our meeting in your office. The only U. S. publication that carried the story to date has been "Chemical Engineering".

Thank you for your cooperation in helping us follow this so that we can protect our interests properly.

Gene Wilde

/ch

TRAN 085999

Plf - Wood
EXHIBIT NO. 288
11/10/95

PESTICIDE RESIDUES

IUPAC Commission on the Development, Improvement, and Standardization of Methods of Pesticide Residue Analysis

By H. EGAN, *Secretary to the Commission* (Laboratory of the Government Chemist, Cornwall House, Stamford St., London, S.E.1, England)

The first meetings of the above Commission of the Pesticides Section of the Applied Chemistry Division of IUPAC were held in Geneva in November 1966 under the chairmanship of Dr. R. A. E. Galley. The following account of the proceedings is based on the minutes of the meeting and on the appendixes presented by the members and associate members of the Commission as indicated.

1. Fumigant Residue Analysis

The Commission agreed that it was desirable to develop rapid, sensitive multidetection systems of analysis for residues of fumigants such as methyl bromide, ethylene dibromide, ethylene dichloride, ethylene oxide, acrylonitrile, carbon tetrachloride, carbon disulfide, and phosphine. A study of the application of gas-liquid chromatographic methods was thought to be worthwhile. A need for simple and reliable "on site" test equipment was also discussed and attention was drawn to limitations in the use of commercial indicator tubes for measurement of residues in treated produce.

2. Diphenyl Residue Analysis

The Commission discussed progress in the study of methods of sampling and analysis of citrus fruit for residues of diphenyl. A preliminary report of the Netherlands Central Institute for Nutrition and Food Research T.N.O. indicated that, of the two methods studied, the gas chromatographic method was the faster and more accurate; however, the thin layer chromatographic method followed by ultraviolet spectrophotometry was also suitable. Work on sampling boxed fruit had been completed and investigation of sampling procedures for shiploads and other consignments was in progress. Both methods of residue analysis appeared to the Commission to be acceptable.

3. Organomercury Fungicide Residue Analysis

Regulatory methods for organomercury residue analysis were discussed; it was indicated that while radioactivation facilities for this were adequate in Scandinavia, gas-liquid chromatography offered considerable promise both for high sensitivity and high specificity. The neutron activation methods were probably the best where facilities were available but, like the newer cold vapor atomic absorption techniques which were likely to be cheaper and just as sensitive, did not distinguish the form in which the mercury was bound. In the United States, the Food and Drug Administration made a direct comparison between cold vapor atomic absorption and neutron activation techniques; the Association of Official Analytical Chemists had recently appointed a new referee for mercury residue analysis.

4. Organochlorine Pesticide Residue Analysis

(a) Evaluation—by J. William Cook (Division of Food Chemistry, Food and Drug Administration, Washington, D.C. 20204)

Much progress has been made in the development and refinement of methods of analysis by which any or all of a large number of pesticide residue chemicals can be detected and measured in one general operation. They have come to be known as "multidetection" methods of analysis. The following discussion includes DDT, γ-BHC, aldrin, dieldrin, heptachlor, endrin, chlordane, endosulfan, and many other chemicals. There are a few hundred pesticide chemicals in use; some of these consist of more than

one compound and some convert to a series of alteration products which may appear in residue analysis. Therefore, there is a large number of chemicals which can show up in a multidetection method of analysis. Whether or not they are significant as residues, their presence must be recognized in order not to confuse them with significant pesticide chemicals. Ideally, a general method of analysis which would measure and identify all of the significant residues in all food products with a minimum of analytical effort and time would be desirable. This is not possible at the present time but some important achievements in that direction have been obtained to date.

The developments so far have made it possible to extract, clean up, measure quantitatively, and give a high degree of certainty to the identity of the compounds for up to 100 pesticide residue chemicals obtained from a great variety of food crops and products all in one general operation. This has been done with either extracts from individual products or composites of a large number of products, e.g., "total diet" or "market basket" samples. The development of such procedures has required a tremendous amount of effort. At each point along the way choices had to be made. As a consequence of these choices, adjustments in the total procedure have also had to be made. The choices may not necessarily have been the best ones, but as the total procedure developed, the more difficult it became to undertake any substitutions. Many of the steps add to the certainty of the identity of the chemicals as well as to the quantitative measurement. The extraction and the clean-up procedures must yield quantitative recoveries of the chemicals. The gas chromatographic systems—that is, combinations of column packing, liquid phase, temperature of operation, kind of detector, and operating parameters—are all highly important when one is attempting to obtain quantitative response from a number of chemicals. Conditions which may be satisfactory for quantitative results on an individual chemical or a small number of chemicals may not yield adequate quantitation for all of many chemicals.

The collaborative study of multidete methods is not as straightforward as "wet" methods of analysis. The relat simple procedure that has been usec AOAC and other groups for design execution of collaborative studies is gen not applicable to these multidetection cedures. It has been the experience of I and some other groups that if the de of the procedure are not described exa and if they are not followed closely, g variations in the analytical results are tained. At the last AOAC meeting, a spe conference was held to discuss the prob involved in collaborative studies on t methods. It was decided that a special ref for collaborative studies would be appoint he would work with the specialist in meth ology for the organochlorines, organopl phates, herbicides, etc., to come up with t procedures which are ready for collaborat study if possible, and then describe th procedures, obtain collaborators, subs samples, receive and tabulate data, etc. was proposed and accepted that if memb of IUPAC were available to participate this collaborative effort they would be w comed by AOAC. It is anticipated that t program will become effective early in 19 It will probably include extraction, cleanu thin layer chromatography, and gas chr matography.

Gas chromatography will involve the u of an electron capture detector and a the mionic detector on a split stream or in ta dem so that a separate but simultaneo readout for both organochlorines and organ phosphates will be made. The simultaneo readout from the two detectors adds to th certainty of the identity of the compound For instance, parathion gives a large re sponse on the thermionic detector due to th phosphorus and a much smaller response o the EC detector due to the NO_2 group. Th presence and ratio of these two peaks alon with retention time are quite characteristic Likewise, trithion gives response by bot detectors because of the phosphorus and th chlorine in the molecule. Again the retentio time and ratio of the two responses enhance identification of the compounds bein analyzed.

(b) Possible Interference by Chlorinated Biphenyls—by G. Widmark (Institute of Analytical Chemistry, University of Stockholm, Roslagsvagen 90, Stockholm 50, Sweden)

A large number of unknown but chlorine-containing compounds have been detected in addition to the ordinary pesticides in the analysis of samples, using both the electron capture and the microcoulometric detector. Mass spectra of some of these compounds obtained with a combined gas chromatograph-mass spectrometer (LKB-9000) indicated that most of the unknown compounds are polychlorinated biphenyls, potentiated somewhat in nature towards those of higher degree of chlorination. A large number of samples have been examined. Polychlorinated biphenyls are found especially in fish and in sea birds, but also in conifer needles and in some samples of human depot fat. Two hundred samples of soil and water and twenty samples of terrestrial mammals contained no detectable amounts of chlorinated biphenyls. Typical GLC traces are given by Jensen and Widmark (1). By using a nitration method, most of the ordinary pesticides can be removed from extracts and the polychlorinated biphenyl will be unaffected. In this way, it has been shown that two of the major chlorinated biphenyl peaks overlap the peaks of *p,p'*-DDT and *o,p'*-DDT, respectively. This overlap is found with SF-96 columns, most frequently used for the quantitative residue analyses reported in literature, but not with QF-1 columns.

(c) Confirmation of Identity—by K. E. Elgar (Shell Research Ltd., Woodstock Agriculture Research Centre, Sittingbourne, Kent, England)

Multidetection methods would seem to be essential for the analysis of organochlorine residues because of the number of chlorinated components which can be present in any one sample. However, there are problems of interpretation even when techniques are used with the resolution and sensitivity of electron capture GLC. For example, the resolution of the GLC column may not be sharp enough to separate components; or impurities present in the technical pesticide or other natural products present in the extract may complicate the analysis; or some insecticides may thermally or catalytically decompose during the analysis.

For these reasons, residues of organochlorine compounds should be confirmed by other analytical methods. If enough material can be isolated, infrared spectroscopy or mass spectroscopy can give powerful evidence of identity. However, with other methods in common use the physical basis underlying separation is very similar. Robinson *et al.* (2) reported a highly significant concordance between the "p-values" for pesticides in the various partition systems described by Beroza and Bowman (3). Similarly, retention times on different GLC stationary phases and R_f of pesticides in various TLC or paper chromatographic systems are highly correlated. Furthermore, R_f values in paper chromatography are closely correlated with R_f values in TLC and with p-values. It is possible to do a great deal of work with the intention of establishing the identity of a compound, but very little additional evidence will be gained because the results from the methods used were not independent. GLC retention time, an R_f value from TLC or paper chromatography (or a p-value), a GLC retention time of a derivative formed by chemical reaction, and pesticidal activity against a susceptible organism are considered to be independent parameters giving significant evidence of identity.

5. Organophosphorus Insecticide Residue Analysis

The Commission concluded that while the regulatory methods were adequate for parathion and malathion, clarification of the terminal residue situation would be welcome in some instances. However, more work on the cleanup stage for malathion residues in eggs, milk, and dried fruit was indicated.

6. Dichlorvos Residue Analysis

By R. A. E. Galley (Shell Research Ltd., Woodstock Agricultural Research Centre, Sittingbourne, Kent, England)

Five different approaches have been developed for the determination of traces of dichlorvos: total phosphorus (4, 5), colorim-

etry using dinitrophenylhydrazine (6), alkaline resorcinol (7, 8), specific bioassay (9), cholinesterase inhibition (10–12), and gas-liquid chromatography with the thermionic detector (13) and the microcoulometric detector (14).

On the basis of sensitivity, selectivity, speed, and possibility of multidetection, the most suitable technique is GLC. Its sensitivity (in the nanogram range with the more sensitive detectors) is approached only by the cholinesterase inhibition procedure, and it is unmatched on the other counts. However, there are two aspects in the analysis of traces of dichlorvos by GLC in which improvements are needed. These are the suppression of decomposition of dichlorvos on the GLC column, and the selection of the best detector from (*a*) electron capture, (*b*) thermionic, (*c*) microcoulometric, and (*d*) flame photometric.

The other sensitive method which is in widespread use (and which, together with GLC, offers additional evidence of identity) is the cholinesterase inhibition procedure. This is a general method for anticholinesterases; to analyze mixtures of inhibitors, separation before the analysis is required. However, the volatility of dichlorvos is such that it can be steam distilled from extracts even when they contain a high proportion of fatty material. It is possible, therefore, to obtain a degree of specificity in the analysis for dichlorvos by cholinesterase inhibition by incorporating a steam distillation step before the determination.

Procedures for the collection of dichlorvos vapor from the air, extraction of residues from crops and tissues, and cleanup are available. Dichlorvos may be quantitatively removed from air by bubbling through distilled water. Chloroform, methylene chloride, and benzene have been used to extract dichlorvos residues. Partitioning from an organic solvent into water, column chromatography on silica gel, and steam distillation provide adequate cleanup from fatty and nonfatty materials.

7. Piperonyl Butoxide Residue Analysis

The Commission recognized the need for reliable methods for residues of piperonyl butoxide and certain allied materials su allethrin and MGK 245.

8. Radioactivation Methods of Analys

The Commission was informed that International Atomic Energy Agency (IA had indicated that it would be prepare (*a*) provide facilities for co-ordinating laborative studies of existing radioactivat methods, (*b*) assist organizations in the of activation techniques for the evaluat of analytical methods in general, and help laboratories wishing to establish rac chemical techniques (15). It was agreed t while radiochemical methods of anal were useful for mercury and for brom residue determinations, they were very pensive and not necessarily more sensitive more specific than some other metho Moreover, although they were often use in metabolic or field residue trial studi radiochemical methods were in general i appropriate to regulatory methods of anal sis; the development of various other metho of regulatory residue analysis was far mo suitable.

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IUPAC Commission on Terminal Residues

By H. EGAN, *Secretary to the Commission* (Laboratory of the Government Chemist, Cornwall House, Stamford St., London, S.E.1, England)

The first meetings of the above Commission of the Pesticides Section of the Applied Chemistry Division of IUPAC were held in Geneva in November 1966 under the chairmanship of Dr. H. Hurtig. The following account of the proceedings is based on the minutes of the meeting and on the appendixes drawn up by members and associate members of the Commission as indicated.

1. Terminal Carbamate Residue

The commission discussed the present position regarding knowledge of the nature of the terminal residues of carbamates, including carbaryl, as indicated in the evaluations below, and set up a working group to further this knowledge with particular regard to the uses of carbamates in food production.

(a) Evaluation—by J. William Cook (Division of Food Chemistry, Food and Drug Administration, Washington, D.C. 20201)

In the earlier studies on carbaryl residues, both carbaryl and its hydrolytic product, 1-naphthol, were considered. Residue studies on many crops showed that the quantity of 1-naphthol was small and difficult to separate from carbaryl. Thus, it was considered that 1-naphthol need not be measured separately from carbaryl. Tolerances for carbaryl established in the United States are based on the assumption that the major part of the residue is the intact carbamate. Since the establishment of the initial tolerances for carbaryl, work has been done which may have some bearing on the quantitative and qualitative aspects of the residue.

Light, including artificial light and sunlight, changes carbaryl. In the formulated state it slowly degrades under the influence of ultraviolet and sunlight to give several unidentified products (1). Crosby *et al.* (2) reported that ethanol or hexane solutions of some methylcarbamate insecticides, including carbaryl, gave a variety of cholinesterase-inhibiting derivatives when exposed to either artificial light or sunlight. The products were separated but not identified. Abdel-Wahcb and coworkers reported that the nature of the surface, the light, and the compound affected the rate of conversion of carbaryl and other carbamates *in vitro* in the solid state.

Since neither the qualitative nor quantitative aspects of photodecomposition of carbamates have been established, the significance of these studies in relation to current and future tolerances for carbaryl must await further study.

Whitehurst *et al.* (4), using the colorimetric method of analysis sensitive to carbaryl, 1-naphthol, and 1-naphthol conjugates, concluded that when cows were fed a diet containing carbaryl, no residues, to the limit of the method, were found in milk. This was

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c) Possible Interference by Chlorinated Biphenyls—by G. Widmark (Institute of Medical Chemistry, University of Stockholm, Roslagsvagen 90, Stockholm 50, Sweden)

A large number of unknown but chlorine-containing compounds have been detected in addition to the ordinary pesticides in the analysis of samples, using both the electron capture and the microcoulometric detector. The spectra of some of these compounds obtained with a combined gas-chromatograph-mass spectrometer (LKB-9000) indicated that most of the unknown compounds are polychlorinated biphenyls, potentiated somewhat in nature towards those of higher degree of chlorination. A large number of samples have been examined. Polychlorinated biphenyls are found especially in fish and in wild birds, but also in conifer needles and in some samples of human depot fat. Two hundred samples of soil and water and twenty samples of terrestrial mammals contained no detectable amounts of chlorinated biphenyls. Typical GLC traces are given by Jensen and Widmark (1). By using a nitration method, most of the ordinary pesticides can be removed from extracts and the polychlorinated biphenyl will be unaffected. In this way, it has been shown that two of the major chlorinated biphenyl peaks overlap the peaks of *p,p'*-DDT and *o,p'*-DDT, respectively. This overlap is found with SF-96 columns, most frequently used for the quantitative residue analyses reported in literature, but not with QF-1 columns.

d) Confirmation of Identity—by K. E. Elgar (Shell Research Ltd., Woodstock Agriculture Research Centre, Sittingbourne, Kent, England)

Multidetection methods would seem to be essential for the analysis of organochlorine residues because of the number of chlorinated components which can be present in any one sample. However, there are problems of interpretation even when techniques are used with the resolution and sensitivity of electron capture GLC. For example, the resolution of the GLC column may not be high enough to separate components; or impurities present in the technical pesticide or other natural products present in the extract may complicate the analysis; or some insecticides may thermally or catalytically decompose during the analysis.

For these reasons, residues of organochlorine compounds should be confirmed by other analytical methods. If enough material can be isolated, infrared spectroscopy or mass spectroscopy can give powerful evidence of identity. However, with other methods in common use the physical basis underlying separation is very similar. Robinson *et al.* (2) reported a highly significant concordance between the "p-values" for pesticides in the various partition systems described by Beroza and Bowman (3). Similarly, retention times on different GLC stationary phases and R_f of pesticides in various TLC or paper chromatographic systems are highly correlated. Furthermore, R_f values in paper chromatography are closely correlated with R_f values in TLC and with p-values. It is possible to do a great deal of work with the intention of establishing the identity of a compound, but very little additional evidence will be gained because the results from the methods used were not independent. GLC retention time, an R_f value from TLC or paper chromatography (or a p-value), a GLC retention time of a derivative formed by chemical reaction, and pesticidal activity against a susceptible organism are considered to be independent parameters giving significant evidence of identity.

5. Organophosphorus Insecticide Residue Analysis

The Commission concluded that while the regulatory methods were adequate for parathion and malathion, clarification of the terminal residue situation would be welcome in some instances. However, more work on the cleanup stage for malathion residues in eggs, milk, and dried fruit was indicated.

6. Dichlorvos Residue Analysis

By R. A. E. Culley (Shell Research Ltd., Woodstock Agricultural Research Centre, Sittingbourne, Kent, England)

Five different approaches have been developed for the determination of traces of dichlorvos: total phosphorus (4, 5), colorim-

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etry using dinitrophenylhydrazine (6), alkaline resorcinol (7, 8), specific bioassay (9), cholinesterase inhibition (10–12), and gas-liquid chromatography with the thermionic detector (13) and the microcoulometric detector (14).

On the basis of sensitivity, selectivity, speed, and possibility of multidetection, the most suitable technique is GLC. Its sensitivity (in the nanogram range with the more sensitive detectors) is approached only by the cholinesterase inhibition procedure, and it is unmatched on the other counts. However, there are two aspects in the analysis of traces of dichlorvos by GLC in which improvements are needed. These are the suppression of decomposition of dichlorvos on the GLC column, and the selection of the best detector from (*a*) electron capture, (*b*) thermionic, (*c*) microcoulometric, and (*d*) flame photometric.

The other sensitive method which is in widespread use (and which, together with GLC, offers additional evidence of identity) is the cholinesterase inhibition procedure. This is a general method for anticholinesterases; to analyze mixtures of inhibitors, separation before the analysis is required. However, the volatility of dichlorvos is such that it can be steam distilled from extracts even when they contain a high proportion of fatty material. It is possible, therefore, to obtain a degree of specificity in the analysis for dichlorvos by cholinesterase inhibition by incorporating a steam distillation step before the determination.

Procedures for the collection of dichlorvos vapor from the air, extraction of residues from crops and tissues, and cleanup are available. Dichlorvos may be quantitatively removed from air by bubbling through distilled water. Chloroform, methylene chloride, and benzene have been used to extract dichlorvos residues. Partitioning from an organic solvent into water, column chromatography on silica gel, and steam distillation provide adequate cleanup from fatty and nonfatty materials.

7. Piperonyl Butoxide Residue Analysis

The Commission recognized the need for reliable methods for residues of piperonyl butoxide and certain allied materials such as allethrin and MGK 245.

8. Radioactivation Methods of Analysis

The Commission was informed that the International Atomic Energy Agency (IAEA) had indicated that it would be prepared to (*a*) provide facilities for co-ordinating collaborative studies of existing radioactivation methods, (*b*) assist organizations in the use of activation techniques for the evaluation of analytical methods in general, and (*c*) help laboratories wishing to establish radiochemical techniques (15). It was agreed that while radiochemical methods of analysis were useful for mercury and for bromide residue determinations, they were very expensive and not necessarily more sensitive or more specific than some other methods. Moreover, although they were often useful in metabolic or field residue trial studies, radiochemical methods were in general inappropriate to regulatory methods of analysis; the development of various other methods of regulatory residue analysis was far more suitable.

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St. Louis

February 27, 1967

Mr. Dave Wood
BRUSSELS

Thank you for the information you sent me. I am having our analytical people, as well as NCR here in the states, evaluate it.

As far as the toxicological part of his report is concerned, he has confused and interchanged the experience on chlorinated biphenyl, chlorinated naphthalene, and a combination of both. This really is not too important, however, as there is no question but that Aroclor does possess a certain amount of toxicity. All our literature says this, but whether nanogram quantities mean anything is an entirely different matter.

I think we should fight the battle of the analytical method first before we get too involved with toxicology.

R. Emmet Kelly, M. D.

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Fractions and Multiples

fraction	prefix	symbol
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

multiple	prefix	symbol
10	deka	da*
10^2	hecto	h*
10^3	kilo	k
10^6	mega	M
10^9	giga	G
10^{12}	tera	T

*To be restricted as much as possible.

Compound prefixes should not be used. Thus 10^{-9} metre is represented by 1 nm, not 1 mμm. The attaching of a prefix to a unit in effect constitutes a new unit, so that

$1\ km^3 = 1\ (km)^3 = 10^9 m^3$

not $1\ k(m^3) = 10^3 m^3$.

Where possible any numerical prefix should appear in the numerator of an expression.

Examples of Units Contrary to SI, with their Equivalents

physical quantity	unit	equivalent
length	ångström	10^{-10} m
	inch	0·0254 m
	foot	0·3048 m
	yard	0·9144 m
	mile	1·609 34 km
	nautical mile	1·853 18 km
area	square inch	645·16 mm²
	square foot	0·092 903 m²
	square yard	0·836 127 m²
	square mile	2·589 99 km²
volume	cubic inch	$1·638\ 71 \times 10^{-5}$ m³
	cubic foot	0·028 316 8 m³
	U.K. gallon	0·004 546 092 m³
mass	pound	0·453 592 37 kg
	slug	14·593 9 kg
density	pound/cubic inch	$2·767\ 99 \times 10^4$ kg m⁻³
	pound/cubic foot	16·0185 kg m⁻³
force	dyne	10^{-5} N
	poundal	0·138 255 N
	pound-force	4·448 22 N
	kilogramme-force	9·806 65 N
pressure	atmosphere	101·325 N m⁻²
	torr	133·322 N m⁻²
	pound (f)/sq.in.	6894·76 N m⁻²

Organochlorine Pesticides in Seals and Porpoises

by
A. V. HOLDEN
K. MARSDEN
Freshwater Fisheries Laboratory, Pitlochry, Perthshire

Seals and porpoises in Scotland and Canada, far from the sites of application of pesticides, can accumulate high concentrations of residues in their blubber. These chemicals are spreading through the long food chain which ends with seals and porpoises and obviously cannot be confined to their place of discharge.

THE presence of organochlorine residues in marine life in many areas of the world, including the Antarctic, has been reported recently[1-3]. In British waters the accumulation of residue in the eggs of sea birds[4] and the process of concentration of pesticides through certain food chains in the marine environment[5] have been studied. Analyses of various species of marine fish and mammals from Scottish waters during the past 5 years[6-8] have shown that organochlorine residues are now a normal occurrence, the highest concentrations being found in organs or tissues with the highest lipid content. Thus the muscle tissue of salmonids, the livers of cod and the blubber of seals act as storage sites for these residues.

The aquatic mammals, such as whales, seals and porpoises, have a relatively high proportion of the body weight in the form of subcutaneous fat (blubber). Seals feed chiefly on gadoids and salmonids, and porpoises chiefly on small gadoids and clupeoids. The process of concentration of pesticides through their food chain might be expected to result in high pesticide levels in the fat of these mammals, and samples analysed at this laboratory confirm this expectation. In recent years, specimens of the grey seal (*Halichoerus grypus*), common seal (*Phoca vitulina*) and porpoise (*Phocaena phocaena*) have been sampled from the coasts of Scotland. Samples of blubber were available for all the specimens examined, and in a few cases other organs were also available. As well as recognized pesticide residues, other electron-capturing substances have been detected by gas-liquid chromatography and, in order to establish whether such substances are as widely distributed as the pesticides, blubber samples from grey seals and harp seals (*Phoca groenlandica*) on the Canadian Atlantic coast have also been examined and the results of these analyses are reported here. Examination of samples of seal blubber from other areas is continuing in order to assess the variation between different regions of the marine environment.

All tissue samples from Scottish waters were frozen at −18° C until required for analysis. The Canadian samples were preserved in 10 per cent formalin, which showed no evidence of any influence on the analytical procedure, and in this and other cases involving fish it has not affected the efficiency of recovery of pesticide residues. Aliquots of the samples (5 g) were ground to a powder with anhydrous crystalline sodium sulphate (AR grade) and extracted in a Soxhlet apparatus with re-distilled AR grade *n*-hexane (previously tested and found to be free of electron-capturing materials by gas chromatography). The hexane extracts were made up to 100 ml. and 25 ml. aliquots were subjected to clean-up by the hexane-dimethylformamide partition method of de Faubert Maunder *et al.*[9], followed by column clean-up using alumina containing 5 per cent water. The loss of pesticide residues from fat extracts so treated is up to 20 per cent, but, as is customary in pesticide analyses, no correction has been made for such losses in the results presented here.

The cleaned-up hexane extracts were analysed by gas-liquid chromatography on a Varian 'Aerograph 3(65-2)' instrument employing two glass columns 6 ft. long × ¼ in. outer diameter. One column was packed with 'Chromosorb *W AW/DMCS* 80–100' mesh coated with 10 per cent

DC-200 silicone oil, and the other with the same support coated with 5 per cent *DC*-200 + 7·5 per cent *QF*-1 fluorosilicone. The oven temperature was 200° C, the nitrogen gas flow 60 ml./min and the column conditions for dieldrin equivalent to 1,000 theoretical plates. There was no significant degradation of DDT on the columns. While complete separation of the common pesticide residues is possible on one or other of these columns, interference by polychlorinated biphenyl (PCB) residues[9] with *p,p'*-TDE and *p,p'*-DDT peaks necessitated a further analytical stage. Aliquots (5 ml.) of some of the extracts were evaporated to dryness in a stream of cold filtered air, and the residues refluxed with 2 ml. of 2·5 per cent alcoholic potassium hydroxide for 15 min on a warm water-bath. After cooling, 5 ml. of *n*-hexane was added, with mixing, followed by 40 ml. of 2 per cent sodium sulphate solution. The supernatant hexane layer was then analysed by gas liquid chromatography. By this technique, quantitative conversion of *p,p'*-DDT to *p,p'*-DDE, and of *p,p'*-TDE to *p,p'*-MDE (= DDMU), is obtained, and the conversion products confirm the identity of the original residues. The residual peaks in the *p,p'*-DDT and *p,p'*-TDE positions, where present, can be subtracted from the values of the pesticides originally determined in these positions. Hydrolysis also destroys α and γ-BHC, where present, but polychlorinated biphenyls are unaffected. A cyanosilicone (*XE*-60) column[10] has also been used to separate *p,p'*-DDT and *p,p'*-TDE from PCB interference, confirming the latter.

The principal pesticide residues found in all samples examined were those of the DDT group, with dieldrin in much smaller quantities. Canadian seals contained lower concentrations of dieldrin than Scottish seals, while Scottish porpoises contained remarkably high concentrations of all pesticide residues (see Table 1). Interference on the *DC*-200 silicone column in the *p,p'*-TDE position caused by a non-hydrolysable residue was responsible for about 25 per cent of the total estimated *p,p'*-TDE in the Canadian and Scottish samples examined. In the *p,p'*-DDT position, the non-hydrolysable residue constituted about 10 per cent in the Canadian samples and about 30 per cent in the Scottish samples examined for this interference, the total amount of non-hydrolysable material being smaller in the Canadian samples. The values in Table 1 have not been corrected for this interference, for only a proportion of the samples were hydrolysed. Results from the various species of seals were not noticeably different in a given area, and have been combined in Table 1.

Table 1. CONCENTRATION RANGES OF ORGANOCHLORINE RESIDUES IN FAT OF SEALS AND PORPOISES (p.p.m.)
(Means in parentheses)

Area and type of sample	No. in sample	Dieldrin	*p,p'*-DDE	*p,p'*-TDE	*p,p'*-DDT
E. Scotland, adult seals (1965–66)	18	0·15–2·1 (0·79)	1·0–11·1 (5·6)	0·27–3·0 (1·3)	1·5–22·8 (7·9)
S. and W. Scotland, adult seals (1965–66)	6	0·06–0·33 (0·20)	1·2–7·0 (3·9)	0·17–0·83 (0·47)	1·7–7·7 (3·8)
S. and W. Scotland, seal pups (1966)	9	0·06–0·44 (0·19)	1·0–4·0 (2·6)	0·18–0·69 (0·32)	1·1–3·7 (2·3)
Canada, Magdalen Is., juv. and adult seals (1967)	8	0·02–0·04 (0·03)	0·67–1·8 (1·3)	0·09–0·18 (0·13)	0·09–0·33 (0·20)
Canada, Cabot Strait, juv., (nurs. and adult seals (1967)	6	0·06–0·10 (0·07)	1·2–17·2 (5·9)	0·34–2·1 (0·73)	1·1–19·9 (5·5)
Scotland, Orkney, adult porpoise (1967)	1	0·50	1·1	0·50	2·2
E. Scotland, adult porpoises (1965, 1967)	5	4·6–13·0 (9·0)	9·8–16·2 (12·3)	5·2–14·3 (8·9)	13·1–25·7 (21·1)

Contamination by pesticides is greater in the seals on the east coast of Scotland (taken in an area roughly from Aberdeen to the Tay estuary) than in specimens from the west and north coasts, including the Orkney Islands. Seal pups from the Orkney and Harris (west coast) breeding grounds contained only slightly lower residues than adults from the same areas. By comparison, the Canadian samples from the Magdalen Islands (Gulf of St. Lawrence) contained very low levels of both dieldrin and the DDT group, while seals from the Cabot Straits (Gulf of St. Lawrence) contained little dieldrin but higher DDT group residues, similar to those of Scottish seals. Of the few porpoises examined, that from Orkney was the least contaminated, but the three taken on the east coast of Scotland had markedly higher contents of all the residues measured. One specimen contained a total residue concentration (dieldrin and DDT group) of 73·3 p.p.m. Analyses of a few tissues other than the blubber have been made, but concentrations in the blubber have always been found to be the highest (Table 2). Concentrations in other tissues seem likely to be consistent with their lower lipid contents.

Table 2. TOTAL DDT CONCENTRATIONS (p.p.m.) IN VARIOUS TISSUES

Sample	Blubber	Liver	Brain	Kidney	Spleen	Muscle
Grey seal	5·6	0·77	0·26	—	—	—
Grey seal	9·2	0·38	0·16	—	—	—
Grey seal	14·8	0·97	0·24	—	0·53	—
Grey seal	2·4	0·46	0·17	—	0·13	—
Grey seal	2·4	0·11	0·07	—	0·06	—
Porpoise	3·5	0·58	0·02	0·04	0·10	0·56

The proportion of blubber extractable by hexane was determined for some samples. Values ranged from 72 to 86 per cent (mean 80 per cent) for the Canadian seals, and from 88 to 98 per cent (mean 93 per cent) for Scottish seals samples on the breeding grounds off the west coast. (Values for other seal samples were not estimated.) Concentrations of pesticides in terms of extractable fat for these samples would thus be up to 40 per cent greater than the values in Table 1, but the general comparison is not significantly affected. The lower extractable fat values for the Canadian samples may possibly be a result of being preserved in formalin.

Concentrations of pesticide residues in the extractable fat of various organs and tissues of one porpoise show an important relationship (Table 3). While the concentrations of the DDT group in the original tissues vary widely, those expressed in terms of extractable fat are in much closer agreement, with the sole exception of the brain. A similar anomaly for tissues of trout was described by Holden[11]. It seems likely that a large proportion of the lipid fraction of the brain may not contain pesticides, and the brain lipid composition is known to differ considerably from that of depot fat.

Table 3. CONCENTRATIONS OF TOTAL DDT (p.p.m.) IN TISSUES OF A PORPOISE

Tissue or organ	Blubber	Muscle	Liver	Spleen	Kidney	Brain
Concentration in tissue	3·6	0·56	0·58	0·13	0·04	0·02
Percentage extractable fat	67·0	6·1	13·2	5·1	1·4	8·3
Concentration in extractable fat	5·6	9·2	4·3	2·4	3·9	0·27

The unidentified peaks on the chromatograms seem to be similar to those produced by polychlorinated biphenyls and, to enable comparison to be made, the ratios (*Rx*) of the retention times of all regularly occurring peaks (relative to dieldrin = 100) have been calculated for the operating column temperature of 200° C, these values being temperature-dependent. The *Rx* values of PCB compounds from commercial PCB formulations were also determined for both types of column (Table 4). At least seven PCB-type peaks were found, including those which interfere with *p,p'*-TDE and *p,p'*-DDT. Heptachlor epoxide and *p,p'*-MDE could not be confirmed on both columns and are not therefore recorded.

The most significant aspect of the results is that, although seals and porpoises inhabit an environment far removed from the site of application or discharge of pesticides, they can contain much greater concentrations of dieldrin and DDT group residues than those recorded for most other species, including man. Robinson and Hunter[12] found a mean concentration of dieldrin of 0·22 p.p.m. (range 0·10–0·73 p.p.m.) and a mean total con-

centration of DDT of 4·0 p.p.m. (range 1·0–11·0 p.p.m.) in samples of human depot fat in England in 1964. No evidence of any significant change was found during 1962–65.

Table 4. RELATIVE RETENTION VALUES (R_x) OF RESIDUES (DIELDRIN = 100)

Residue	*DC-200* column	Sample	Residue	*DC-200/QF-1* column	Sample
PCB	= 66·5	66	PCB	= 66·5	70
P,P'-DDE	= 100	100	P,P'-DDE	= 84	83·5
Dieldrin			Dieldrin	= 100	100
PCB	= 121	121	P,P'-TDE	= 131	131
P,P'-TDE	= 129	129	PCB	= 122	122
PCB	= 148	149	PCB	= 146·5	—
P,P'-DDT	= 170	171	P,P'-DDT	= 147	147
PCB	= 174	176	PCB	= 224	201
PCB	= 203	205	PCB	= 202	276
PCB	= 242	237			
PCB	= 239	238			

The seals and porpoises from the east coast of Scotland were usually more seriously contaminated than those from the north and west coasts. This, at least in respect of seals, may be because, as is believed, the populations in the two areas come from different breeding sites. The seals south of Aberdeen breed principally on the Farne Islands, off the north-east coast of England, while the seals of north and west Scotland are primarily from the breeding grounds of the Orkney Islands in the north, and other islands off the west coast of Scotland. The sea off eastern Scotland is also likely to receive more contamination from estuarine discharges than that off north and west Scotland. Similarly, the two separate seal populations sampled off the east coast of Canada may inhabit areas with different levels of contamination. Pups contain pesticide residues in concentrations only slightly lower than in the parent population. Common seals in Holland have been found with concentrations of residue similar to those of seals on the Scottish east coast[12].

While the residue concentrations in subcutaneous fat are high, those of other tissues and organs are found to be much lower. This suggests that there is no risk of physiological effects, unless the metabolism of much of the fat in times of stress leads to a considerable increase in the concentration of the residue in circulating lipids, and thus in residue concentrations in other organs or tissues.

Grey seals on the coast of the Scottish mainland feed primarily on salmon (*Salmo salar*) and cod (*Gadus morrhua*)[14]. The highest concentrations of pesticide in salmonids in the marine environment have so far been found in sea trout (*S. trutta*) on the east coast with up to 0·2 p.p.m. (dieldrin + total DDT) in muscle tissue[11], and salmon from the same area would probably have similar contents. Cod examined from the east coast have contained up to 0·35 p.p.m. (dieldrin + total DDT) in muscle tissue (mean 0·12 p.p.m.) and from the west coast up to 0·56 p.p.m. (mean 0·22 p.p.m.), while cod livers contained up to 4·0 p.p.m. and 12·0 p.p.m., respectively. Grey seals are estimated to eat about 15 lb. of food daily, and thus an adult seal could consume its own weight in food in 20–30 days. Assuming a high proportion of the pesticide intake to be stored in body fat rather than to be excreted or metabolized, an increase of two orders of magnitude in pesticide concentration from food to body fat within a few years is feasible. This degree of accumulation of residue in an environment not deliberately contaminated, and in species ecologically far distant from the target organisms of persistent pesticides, underlines the impossibility of confining such chemicals to the areas of application.

We thank Dr B. B. Rae for obtaining the Scottish samples, and Dr C. J. Kerswill for the Canadian samples.

Received December 15, 1967.

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The North Pacific: an Example of Tectonics on a Sphere

by
D. P. McKENZIE
R. L. PARKER

Institute of Geophysics and Planetary Physics, University of California at San Diego

Individual aseismic areas move as rigid plates on the surface of a sphere. Application of the Mercator projection to slip vectors shows that the paving stone theory of world tectonics is correct and applies to about a quarter of the Earth's surface.

Two linear magnetic anomalies[1,2] which parallel all active ridges can only be produced by reversals of the Earth's magnetic field[3] if the oceanic crust is formed close to the ridge axis[4]. Models[5] have shown that the anomalies cannot be observed in the North Atlantic unless most dyke intrusion, and hence crustal production, occurs within 5 km of the ridge axis. The spreading sea floor[4] then carries these anomalies for great horizontal distances with little if any deformation. The epicentres of earthquakes also accurately follow the axis and are offset with it by transform faults[1,2]. The structure of island arcs is less clear, though the narrow band of shallow earthquakes suggests that crust is consumed along a linear feature. These observations are explained if the sea floor spreads as a rigid plate, and interacts with other plates in seismically active regions which also show recent tectonic activity. For the purposes of this article, ridges and trenches are respectively defined as lines along which crust is produced and destroyed. They need not also be topographic features. Transform faults conserve crust and are lines of pure slip. They are always parallel, therefore, to the relative velocity vector between two plates—a most useful property. We have tested this paving stone theory of world tectonics in the North Pacific, where it works well. Less detailed studies of other regions also support the theory.

Monsanto

FEB 26 1968

D.V.M. Hardy, London

23rd February, 1968

Aroclors

DVMH/JS

TO W.B. Richard, St. Louis

File cc	✓		
Destroy		W. Barratt	London
CDB	✓	D. Wood	Brussels
WEC	✓	A. Baxter	Huabon
[illegible]	✓	E. Kelly	St. Louis ✓
[illegible]	✓	K. Keller	J.F. Queeny
[illegible]	✓	E. Eaton	St. Louis
REH	✓	L. Parks	St. Louis
PAW	✓	K. Wilde	St. Louis
[illegible]	✓		

With reference to your letter to Dr. Baxter we note that your available quantities of di- and trichlorobiphenyl isomers are very small indeed. As you know we have already provided samples for Jensen and Widmark (Stockholm), Richardson (Shell, England) and Tatton (Government Laboratory, England,, and the residual quantities are now to be reckoned in terms of milligrams. I assume you will be writing appropriately to the Syracuse University Research Corporation.

On your request for information concerning the tests made by the above workers on our samples I can summarize as follows:-

(a) Jensen and Widmark I have seen no development since Widmark's letter of February 27th 1967 addressed to Gene Wilde.

(b) Tatton Copies of a paper entitled 'Chlorinated Hydrocarbons in British Wildlife' by D.C. Holmes, J.H. Simmons and J.O'G. Tatton. Nature Vol 216, Oct 21, 1967 pp. 227-229 were passed to Messrs. Wilde and Buchanan with my letter of 4th November, 1967. This paper confirms the work of Jensen and in particular shows close similarity between gas-liquid chromatograms of (a) extracts of Kestrel liver oil and (b) a commercial polychlorobiphenyl resin.

(c) Richardson Richardson has not published anything so far, but J. Robinson, also of Shell Research Ltd., Tunstall Laboratory, Sittingbourne, Kent has published a paper entitled 'Residues of Organochlorine Insecticides in Dead Birds in the United Kingdom, Chemistry and Industry 1967, pp. 1974-1986. This is a comprehensive review but as far as I can see it does not suggest that any of the residues contain chlorinated polyphenyls.

However, I was in correspondence with Richardson in November, 1967 (copies herewith) which showed that he was satisfied that octochlorobiphenyl was present and that his results are substantially in line with those of Tatton et al. You will note also that he believes that the contamination of bird life is in the valley of our river Witham.

I have judiciously followed up this clue with a view to locating the source of the contamination: there appears to be no operation of any size involving Aroclors within the Witham valley. The nearest is at Kings Lynn with users for electrical purposes. As NCR represents the greatest off-take of Aroclor and as there is likely to be at least some wastage in the process my suspicion is that it is either in making NCR or possibly in dealing with the scrap that the contamination arises.

So far there is no indication that the Public Authorities are worried.

D.V.M. HARDY

COMPANY CONFIDENTIAL

TRAN 086029

PLAINTIFF'S EXHIBIT 199 10-25-95

D.V.N. Hardy, London

23rd February, 1968

Aroclors

DVNH/SS

W.R. Richard, St. Louis

J.W. Barrett London
D. Wood Brussels
R.A. Barter Ruabon
R.E. Kelly St. Louis
R. Keller J.F. Queeny
C. Paton St. Louis
R. Parks St. Louis
G. Wilde St. Louis

With reference to your letter to Dr. Barter we note that your available quantities of di- and trichlorobiphenyl isomers are very small indeed. As you know we have already provided samples for Jensen and Widmark (Stockholm), Richardson (Shell, England) and Tatton (Government Laboratory, England), and the residual quantities are now to be reckoned in terms of milligrams. We assume you will be writing appropriately to the SyracuseUniversity Research Corporation.

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So far there is no indication that the Public Authorities are worried.

D.V.N. HARDY

COMPANY CONFIDENTIAL

TRAN 086030

Monsanto

B/H June 21 X

FROM (NAME & LOCATION) C.R. COLEMAN - Ruabon

DATE : 11th June, 1968.

cc: P.J.A. Marsh - London
D. Wood - Brussels

SUBJECT : PYROCLOR DISPOSAL - Your memo 30.5.68.

REFERENCE : CRC/EMH

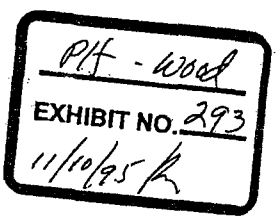
TO : J.M.M. THOMSON - London

The only reference that I have to the pollution of the atmosphere and rivers by chlorinated diphenyl is New Scientist, 15 Dec 1966, p.612. I do not have any of the original papers by Dr. Jensen.

I would suggest that you contact Dr. Hardy who deals with toxicity questions, and was directly involved.

CRC

COLIN R. COLEMAN



TRAN 058004

1/30/69

E. Scott Tucker - Applied Sciences Section - R&D Laboratories

January 30, 1969

R. E. Keller
W. R. Richard
E. Wheeler

CHLORINATED BIPHENYL IN WILDLIFE

Dave Wood
Brussels, Belegium

FF
aroclor

Would you please bring us up to date on chlorinated biphenyl in wildlife. More activity is going on in the States. We have some analytical work and some biological work underway to see if Aroclor is really present.

Has Baeyer, Progil and Kuhlman done any identification work? Has Jensen confirmed his initial publication? What chlorinated biphenyl isomers did we actually supply Jensen? Did Jensen ever forward any more analytical data or details to you?

E. Scott Tucker

js

Plf - Wood
EXHIBIT NO. 294
11/10/95 kj

TRAN 058757

1.5

Monsanto

FROM (NAME & LOCATION) D. Wood - Brussels

DATE 4th February, 1969.

cc R.E.Keller - St. Louis
W.R.Richard - St. Louis
E.Wheeler - St. Louis

SUBJECT Chlorinated Biphenyl in Wildlife.

REFERENCE DW/ec

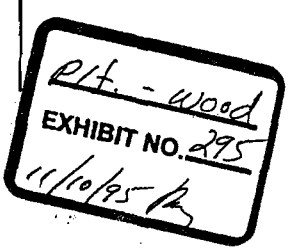
TO : E.Scott Tucker - Applied Sciences Section, R & D Laboratories, St.Louis.

Thank you for your memo dated January 30th. At the time that Jensen in Sweden first published his assertions about the presence of Aroclor in wild life we met with him and discussed his work. As a result of these discussions he admitted that possibly some of his conclusions regarding the hazards associated with the chlorinated biphenyl that he had found were publicized out of proportion. I don't think at that time we questioned that he had in actual fact found chlorinated biphenyl in the sea eagles' livers but questioned his incorrect quotation of certain medical information. Since he had appreciated this point we then let the matter rest, not wanting to stir up further agitation in other countries. There has been little more happening in Europe until about a month ago, when an article appeared in a Danish newspaper discussing Jensen's work. We are trying to find out at the present time whether this covers new work or whether it is merely a re-hash of his original paper. At such time as we get any further data we shall certainly let you have this.

Best wishes,

D. Wood.

TRAN 058495



Monsanto

FROM (NAME & LOCATION): E. P. Wheeler - Medical Dept.

DATE: April 16, 1969

SUBJECT: POLYCHLORINATED BIPHENYLS IN THE ENVIRONMENT

REFERENCE:

TO: R. E. Soden - Brussels

cc: J. W. Barrett - London
D. N. V. Hardy - London
R. A. Baxter - Ruabon
H. R. Newman - Newport
D. Wood - Brussels
J. Haggert - Brussels
W. R. Richard
R. E. Keller
R. E. Kelly

Perhaps you have heard that Bob Keller from Organic Research and I plan to visit a number of people in Great Britain, Sweden, the Netherlands and Germany concerning the recent identification of polychlorinated biphenyls in wildlife tissues in various parts of Europe and the United States. Your people in Europe were the original contacts in late 1966 and early 1967 with scientists in university and government laboratories who identified PCBs as interfering substances when determining chlorinated pesticide residues in fish, sea eagles, pine needles, etc.

During 1967 and 1968 there were brief comments in the U.S. technical and trade journals concerning the PCBs but not until February of this year did the story break in the public press (see enclosures).

Beginning in mid-summer of last year a considerable research effort has been underway in the Organic Division and in consulting laboratories to develop data to protect the sales and uses of our PCBs. It has been concluded that before committing even greater expenditures, we should determine what efforts are underway by those people who have been in contact with Monsanto requesting samples of our Aroclors, reporting findings and mentioning specific continuing analytical and toxicological research.

I have enclosed a list of the individuals Bob Keller and I hope to call on and an itinerary which is farily definite at this point. Dr. Barrett has been most helpful in arranging for our visits in Great Britain. We in St. Louis have made direct contacts with the scientists in Sweden and in Amsterdam and I hope Dave Wood or others in your group will advise us as to whom we should see in Beyer at Leverkusen. There is general agreement here that it would be desirable to determine whether or not Beyer is as concerned about the potential problems for the marketing of polychlorinated biphenyls and whether or not they have equivalent research efforts underway.

I believe Dr. Kelly went into this subject in some detail with Dave Wood but he is not sure that he discussed it at length with you last month.

Elmer P. Wheeler

TRAN 058769

EPW:cjs
Enclosures

Plf. - Wood
EXHIBIT NO. 296
11/10/95

IM-10 REV. 11-65

RECD 1 1 SEP 1967 Toxicology Analysis

R.P.W. KUP, RUABON

8th September, 1967.

D. Wood, Brussels
D.V.N. Hardy, London ✓
H.R. Newman, Newport

SANTOTHERM

RPWK/HM

V.J. HEROUFOSSE, BRUSSELS

Your memo to Doug. Hardy has been referred to me as Doug is on holiday.

I presume that the query from M. Schuitema of the Hague does not refer to Santotherm 130 or 190 as the Aroclor booklet is mentioned, although of course they would be much more irritant to skin than the Aroclors.

The chlorinated diphenyls are not normally associated with skin irritation although they could de-fat the tissues and give rise to the "solvent" type of skin lesion. This should be treated with a lanoline based cream, possibly in conjunction with a steroid, at the discretion of the medical practitioner.

There is very little information in M.Schuitema's note as to how the Santotherm is being handled and what its use is in connection with the W-kerk ships, but it is very important that the aroclors should not be in contact with skin because they may be absorbed through it and systemically they can be liver poisons.

RPWK

R.P.W. KUP

TRAN 058014

Plf - Wood
EXHIBIT NO. 297
11/10/95 Pr

St. Louis - General Offices

March 25, 1968

FF

Therminol/Santotherm Contamination of Cooking Oil - Smith Potato Crisps, Holland

D. S. Cameron - BRUSSELS
M. Schuitema - THE HAGUE
NTJ/RD/SS
T. Denton-Roberts - LONDON

D. Wood - BRUSSELS

Dave, I have affixed copies of two reports from Dr. Keller's group on subject cooking oil contamination. The latest memo dated March 7, 1968, indicates that there is less than 20 parts per million Therminol/Santotherm FR-1 in the used peanut oil. Also indicated is the need for more sensitive measurements, which will be made when the analytical equipment has been repaired.

Dr. Keller's group is cognizant of the problem we have with chlorinated biphenyl contamination in the food processing industry and have been doing a fine job with this very difficult analytical problem. I shall notify you of further developments in this area when the information is available.

Best regards.

Don Roush

DR:lh
Attach.

Plf - Wood
EXHIBIT NO. 298
11/10/95 kn

COMPANY
CONFIDENTIAL

TRAN 057807

Monsanto

FROM (NAME & LOCATION) C.R. COLEMAN - Ruabon

DATE 5th August, 1968

SUBJECT PHOSGENE FROM DECOMPOSITION OF TRANSFORMER ASKAREL

REFERENCE CRC/EMH

TO : P.G. BENIGNUS - St. Louis

cc: D. Wood - Brussels
J.M.M. Thomson - London
R.H. Munch - St. Louis

A prospective user of transformer askarel has drawn my attention to the book 'Transformer Engineering' by L.F. Blume, A. Boyajian, G. Camilli, T.C. Lennox, S. Minneci, V.M. Montsinger, all of General Electric Company, Pittsfield, Mass. (John Wiley & Sons, Inc., New York, 1951). On page 434 there is a table of the decomposition products of transformer askarel showing that 0.01% of phosgene is produced in an electric arc through air-saturated askarel at 25°C. It was most disturbing to come across this information, particularly in a book published by G.E. personnel, since this is a variance with reports published in France and Germany, in addition to our own publications.

For comparison, I give the complete table from this book together with 2 other sources on the subject:-

Gas	G.E. Book	Clark*	Monsanto 'Black Book'
HCl	97.50%	97.0	97.3
O_2	0.60	0.25	0.6
Unsaturated hydrocarbons	-	0.50	-
CO_2	0.28	0	0.3
CO	0.28	0.25	0.3
Phosgene	0.01	-	-
Saturated hydrocarbons	-	0	-
H_2	-	-	-
Cl_2	-	0	-
Inert (N_2)	1.33	2.0	1.5
	100.0	100.0	100.0

* F.M. Clark, 'Nonflammable organic compounds'; Ind. Eng. Chem., Vol. 29 (June 1937) pp. 689-702.

Pltf. - Wood
EXHIBIT NO. 299
11/10/95 K

PLAINTIFF'S EXHIBIT
179 Civil
Monsanto 8-18-81

BIR 002173

2

6200064

HARTOLDMON0011128

The following investigators have sought phosgene but failed to find it:

P. Jay, 'Étude de la formation de phosgène par décomposition dans l'arc électrique des hydrocarbures chlorés'; Chimie et Industrie, Vol. 92, No. 5 (November 1964).

Anon, 'Opinion on the behaviour of clophens in thermic and electrical treatment'; Report from Chemisch-Technische Reichsanstalt, Berlin, 21 May 1940, Register No. 176/40C.

Both these investigations used aniline-water saturated with diphenyl urea for detecting the presence of phosgene. I am not an expert in analytical methods and wonder if this method is sufficiently sensitive to detect 0.01% of phosgene among the other decomposition products.* Perhaps another investigation using sensitive physical methods of analysis would be worthwhile, particularly if it could be scrutinized by an impartial observer, from some official organization.

Any background information that you can give us on this topic and this G.E. book and its authors would be very welcome.

See you in September when you visit U.K.

Regards,

Colin.

COLIN R. COLEMAN

* I hear that there is a colorimetric method sensitive below 100 ppm.

BIR C02174

PCB UK Agencies

MONSANTO CHEMICALS LIMITED

MAY 15 1969

PRODUCT TOXICOLOGY - AROCLORS

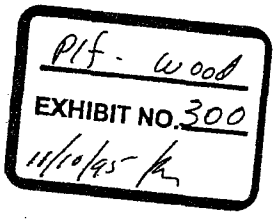
Report summarising present knowledge concerning chlorine-containing residues in wild life and visits made to organisation implicated therewith during the period April 28th - May 1st, 1969.

by: D.V.N. Hardy*

Circulation

J.W. Barrett, London.
R.A. Baxter, Ruabon.
H.A. Vodden, Ruabon.
H.R. Newman, Newport.
A.C.W. Pemberton, Newport.
W.J.S. Budd, London.
J. Herefousse, Brussels.
D. Wood, Brussels.
R.E. Keller, St. Louis.
E.P. Wheeler, St. Louis.
R.E. Kelly, St. Louis.
W.R. Richard, St. Louis.
H.S. Bergen, St. Louis.

*Formerly Research Services Manager, MCL, and now Consultant to MCL in the area of Product Toxicology and Safety in the Use of the Company's products.



INTRODUCTION

The wide agricultural usage of insecticides in the post-World War II period and consequent effects on wild life have led in certain circles to apprehension concerning the overall effect on man. The situation has been under study for many years and Government agencies and manufacturers of insecticides have been implicated in the various aspects, particularly in the assay of such residues in many species of wild life. Fish, fish-eating birds and mammals have been subjected to wide ranging study, and it became clear that terrestrial usage of insecticides could have far reaching and hitherto unsuspected effects on wild life, part of it making an important contribution to the diet of man and domestic animals.

The size of the wild life specimens and the minute concentrations of insecticides therein demanded highly sensitive methods of assay, which have been progressively refined. Gas liquid chromatography using electron-capture or microcoulometric detection has become established as the most suitable technique. It appears that the chromatograms of the residues showed not only the peaks corresponding to the insecticides and their known metabolites, but additional peaks of unknown chlorine-containing substances.

Towards the end of 1965 these unknown substances were identified by Sören Jensen, a research worker at the Institute for Analytical Chemistry, University of Stockholm, under the direction of Gunnar Widmark. Using a combined gas chromatograph mass spectrometer (LKB-9000) it was shown that the peaks are due to polychlorinated biphenyls (PCB's). The evidence and reasoning are available and the conclusion can hardly be in doubt.

Unfortunately the announcement was coupled with sensational statements concerning the poisonous nature of the PCB's, which were calculated to cause misgivings both to public authorities and to the general public.

Jensen and Widmark found PCB's in specimens of pike from different parts of Sweden, fish spawn, a dead eagle and in human hair, and even on fir cones! The conclusion reached was that the PCB's originated from burning industrial wastes and were washed down by the rain. Examination of feathers from museum specimens of sea birds suggested that contamination commenced in 1944.

The original work of Jensen and Widmark has been extended and generally confirmed, notably by workers at the following establishments and much of the detail has been published:-

Great Britain

1. Laboratory of the Government Chemist,
   Cornwall House,
   London, S.E.1.
   (Notably Mr. O'G. Tatton)

2. Freshwater Fisheries Laboratory, (Ministry of
   Faskally, Agriculture, Fisheries
   Pitlochry, Scotland. and Food)
   (Mr. A. Holden)

3. Tunstall Laboratories,
   Shell Research Limited,
   Sittingbourne, Kent.
   (Dr. J. Robinson and Mr. A. Richardson)

4. Monks Wood Experimental Station, (*Nature Conservancy)
   Abbots Ripton,
   Huntingdonshire.
   (Dr. N.W. Moore)

*Established by Royal Charter to (1) provide scientific advice on the conservation and control of the natural flora and fauna of Great Britain, (2) establish, maintain and manage natural reserves in Great Britain including maintenance of physical features of scientific interest, (3) develop research and scientific services related thereto.

At 30th September, 1963 there were 144 scientifically qualified staff and in 1963-4 there was a Government grant-in-aid of £701,000.

Holland

5. University of Utrecht
   (Professor H. Van Genderen)

U.S.A.

6. University of California
   (Drs. R.W. Riseborough, P. Rieche and S.G. Herman)

7. Cornell University
   (D.B. Peakall)

8. San Diego Natural History Museum
   (M.N. Kirven)

This report is written following discussions with staff from Establishments 1, 2 and 3 in which Dr. R.E. Keller and Dr. E.P. Wheeler (1 and 3 only) were associated. Drs. Keller and Wheeler are proceeding to visit 5, University of Stockholm, to see Jensen and Widmark. They are also visiting Bayer to ascertain its reactions as manufacturers of PCB's (Clophens).

SUMMARY

1. There can be no doubt that traces of PCB's (Aroclors) are to be found in wild life, fish and certain items of human diet.

2. There is little evidence to show how serious this minor contamination will prove to be, but what evidence there is is reassuring.

3. There is little evidence to show how the PCB contamination arises. It may be by run off of wastes into rivers, or by burning of industrial wastes with consequent washing down by rain. It is remotely possible that the PCB's might arise by biochemical action on insecticides and other chlorine-containing materials which are similarly discharged into the rivers, seas and oceans. It could be that among the vast quantities of materials destroyed on land and at sea during the 1939-45 war, significant quantities of Aroclors and Aroclor-containing materials found their way into the rivers, seas, etc., and are being slowly released by corrosion, extraction, etc. (see footnote at end of report).

4. A considerable Monsanto effort will be necessary to obtain the necessary analytical and toxicological information for dealing with this threat to our commercial operations.

A. Visit to Freshwater Fisheries Laboratory, Pitlochry*
Monday, April 28th, 1969.

Mr. A.V. Holden - Officer in Charge.
Dr. R.E. Keller - MC
Dr. D.V.N. Hardy - MCL

This visit was made not so much on account of contributions made to the subject but because Mr. Holden acts as Co-ordinator

*Dr. E.P. Wheeler was prevented from taking part in this visit due to the sudden indisposition of Mrs. Wheeler.

for the programmes of the O.E.C.D. countries concerned with the influence of biocides on natural environments, wild life, etc. He might therefore be expected to have a wider appreciation of the overall problem and of its assessment in terms of the hazard to man. On this latter aspect he was of the opinion that there had been a tendency to overplay the hazard to man of insecticides and PCB's, and that it was very doubtful whether the toxicities of PCB's were greater or similar to those of the insecticides. Experiments with rainbow trout in water containing 1 part of DDT in 10^9 of water had shown that death occurred in six weeks after which the concentration in the fish muscle was 1 in 10^6. In other words there was a concentration factor of 1000 in 6 weeks: this would take place mainly by absorption in the gills. He believed that some similar experiments with Aroclors had been carried out in the Ministry's London laboratory, and phoned for confirmation but was unable to get this during our visit. I am therefore endeavouring to get the answer to this perhaps significant experiment.

Mr. Holden's analytical work has been concerned largely with extracts of seals and fish taken in Scottish waters, and he has observed similar peaks to those found by Jensen and the Government Laboratory. Extracts from freshwater and seawater fish show fairly low amounts of PCB's, while seal blubber contains considerably more. Reprints of relevant papers were given to Dr. Keller and there was a discussion on analytical work, much of which was carried out for other bodies, e.g. the Nature Conservancy. Much of the work remains unpublished and he saw little chance of rectifying the situation.

B. Visit to Tunstall Laboratories, Shell Research Ltd., Sittingbourne, Kent.
Tuesday, April 29th, 1969.

Dr. J. Robinson - Biologist
Mr. A. Richardson - Analyst
Dr. Stevenson - In charge of Experimental Animal House.
Mr. De Corsen - Laboratory Administrator.

Dr. R.E. Keller - MC
Dr. E.P. Wheeler - MC
Dr. D.V.N. Hardy - MCL

Shell has naturally been concerned with the problem of insecticidal residues from the outset and the cost of the analytical effort and its interpretation must have been very considerable. To Shell the PCB aspect has been simply one of analytical complication, and although at times there have been suggestions from their commercial people that the focus of

toxicological interest might be transferred from insecticides to PCB's, there has been no attempt to do so. In fact papers by Robinson do not refer to PCB's but make a very sound approach to the insecticides problem and to its true perspective. Nevertheless they had collected some information on possible usage of Aroclors, for example, they had noted that the Coal Board disposes of 1,000,000 gals. of high pressure lubricant each year. Did this contain Aroclor? We thought it unlikely but questions concerning safety in use of Aroclors had certainly been referred to MCL by the Coal Board and it was therefore likely that some minor uses have been developed. There might conceivably be a small content of Aroclors in the high pressure lubricant. Usage of insecticides was of a high order, and in Kent alone 1000 tons of DDT had been consumed since its introduction after the 1939-45 war. Reference was also made to usage of Aroclors in cutting oils; the Government Laboratory had suggested that this was a possible source of contamination. Cutting oils are normally sold as proprietary formulations and it would be difficult to estimate how much Aroclor is consumed in this form.

Shell would much prefer to have a direct method for estimating insecticides. Now, owing to the stability of PCB's, it was necessary to estimate insecticides and PCB's, then PCB's by destroying or removing the insecticides and getting the insecticides by difference.

Aroclor 1254 had been fed to chicken at 100 parts per million of the diet and no adverse effect observed over a period of 12 months. The Nature Conservancy has carried out feeding tests on Bengalese Finches with DDT and found no adverse effects, and similar results have been with chicken and quail fed on 10 and 20 parts per million of Dieldrin. Other workers found some effect on mallards and chicken. At the Government Laboratory it has been shown that human fat (from mothers' milk) may contain PCB. Reference was also made to the work of Mr. Alabaster, Ministry of Agriculture, Fisheries and Food, on toxicological levels with fish.

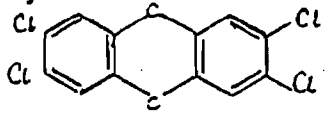
It was agreed that many of the specimens submitted for analysis were not representative of the total population, e.g. predators were heavily weighted, and of the sick and dead birds, were most frequently collected. There must be large numbers of each predator much less contaminated than those submitted for analysis.

Samples of fish oils and margarine (supplied by Unilever) have been examined, and while PCB's can be found in the oils, they disappear during the hardening process so that margarine is free.

The decrease in bird populations which is made much of by the Nature Conservancy and others cannot be attributed wholly to organic chlorine compounds. Factors such as exceptionally cold winters (e.g. 1963-4) and the decrease in hedgerows (10,000 miles/year are eliminated in U.K.) must have an important effect.

Reference was also made to wood preservation with PCP and to the possible effects of waste discharging, but this seems an unlikely source of PCB's.

There was some discussion of the chick oedema factor which has been attributed to the use of trichlorethylene as extractant. Here Dr. Wheeler spoke of the highly toxic tetrachlorodiphenylenedioxide



with which the Germans and MC have had experience.

We outlined the main uses for Aroclors as being:-

Dielectrics for condensers, transformers and switchgear,
Industrial hydraulic fluids,
Heat transfer fluids,
Extreme pressure lubricants,
Hot melt adhesives,
Chlorinated rubber paints,

and played down suggestions that they are used as media for insecticides and in jet engine lubricants. No reference was made to N.C.R.

Finally Shell made reference to some work to ascertain whether PCB's might arise through degradation of insecticides. The degradants were chemical agents and no success was obtained but it is still possible that some biological process might be able to bring about such transformations.

We were given a brief opportunity to view the Animal Laboratory where much work was in progress on inhalation studies. Long term tests were in progress with benzene vapour on human volunteers, 8 hours a day with full monitoring of all appropriate factors. This is likely to become the standard reference for safety in factor operations.

C. Discussions with Representatives of the Government Laboratory at Monsanto House
Thursday, May 1st, 1969.

Mr. J.O'G. Tatton - Laboratory of the Government Chemist
Mr. G.B. Collins - " " " "

Dr. R.E. Keller - MC
Dr. E.P. Wheeler - MC
Dr. D.V.N. Hardy - MCL

Mr. Tatton said that the possible danger of Aroclors used as plasticizer (in food packaging and in lacquers for cans) had been considered quite early on and reference is made thereto in the Annual Report of the Government Chemist 1953-4. He will send me a photostat copy. As regards residues in wild life peaks not due to pesticides were observed in 1963-4 and this caused trouble in view of the complicating effect on insecticide determination. Attempts to identify the disturbing material failed until Jensen showed their nature. Jensen's work has been fully confirmed and extended and PCB's have been found in eggs, predatory birds, rarely in human food, and traces in cod liver oil. Human fat seems to be free from PCB but there may be 2 - 12 parts/10^6 of insecticide. Some PCB found in human lung samples. Work has been carried out on air and on circumstantial evidence PCB must be present. 1 part DDT compounds/10^{12} parts of air has been found. The analysis is complicated by the presence of hydrocarbons. Tatton will supply references to this work which was carried out on sample of about 1200 litres. The content of insecticides in air and water is variable, generally higher in London due to soot particles acting as absorbent, and also depending on when spraying is in progress. Dr. Kroll (Water Research Association) has failed to find PCB in river waters at parts per 10^9.

Many samples are sent to the Government Laboratory by the Nature Conservancy, but having carried out the analysis nothing more can be done as the source and significance of the sample are known only to the Nature Conservancy.

The peaks seen in the chromatogram represent only part of those observed in commercial samples of Aroclor 1254. Probably the middle components are favoured by the analytical procedure: certainly peaks due to higher boiling material can be obtained by raising the operating temperature of the column.

Recently high PCB figures have been found on herons (several hundred parts per million in the liver), kestrels, owls

and kingfishers. Dr. N.W. Moore (Monkswood Experimental Station) might be prepared to discuss their significance and the geographical factor. Tatton considers that Jensen's peaks are more in line with Bayer's Clophen. He thinks that some of the bird samples are representative as they were taken from colonies.

Tatton also referred to possible traces of PCB nature in occasional food samples, e.g. milk, mutton and beef fat. He will supply me with copies of all relevant papers, including a report on some new detectors for VPC analysis. Dr. Keller will reciprocate by sending chromatographic curves for the various Aroclors.

I referred to MCL work now starting on the biodegradation of Aroclors and suggested that our workers should contact him on the analytical techniques. He would be most happy to do so.

D. Discussion with Representatives of Cremer & Warner, Consultants, 140 Buckingham Palace Road, London, S.W.1. Thursday, May 1st, 1969.

Sir Frederick Warner	-	Cremer & Warner
Dr. David Train	-	" "
Dr. R.E. Keller	-	MC
Dr. E.P. Wheeler	-	MC
Dr. D.V.N. Hardy	-	MCL

This was a lunch discussion arranged to determine the possible value of this firm of consultants in the assessment of the PCB problem.

Cremer & Warner have contracted with the Port of London Authority (and possibly with others too) to study the effect of certain contaminants in the Thames. They are concerned specifically with detergents and Mr. Cremer is Chairman of the Government Committee which has been advising on the problem due to hard detergents. Cremer & Warner are also advising on atmospheric pollution due to sulphur dioxide and smoke, and on the design and interpretation of data from the recording stations.

They have also acted as consultants for the new potash project in relation to the effluent disposal problem. They have advised that the effluent should be discharged 1 mile from the shore at a minimum depth of 75 feet.

They were interested broadly in our problem and fully appreciated that after all the analytical work had been done it would be necessary to interpret the data and to correlate it to safety standards in a way which would carry conviction with the authorities. They seemed confident that this area was one of their strong suits, but it is far too early to assess their ability to contribute to the present problem.

D.V.N. HARDY

JWB/HMH
6.5.69.

Footnote (See p.4 - Summary, Item 3)

Compare Jensen's findings that no contamination was observed prior to 1944.

Monsanto

FROM (NAME & LOCATION)

DATE: May 26, 1969

SUBJECT: INCINERATION OF CHLORINATED WASTES

REFERENCE: RMK Memo 4/10/69

cc D. A. Olson
A. F. Pier - APIER
W. R. Richard - WRICH

TO : R. M. Kountz - RKOUN

Pollution

Bob, in the Pydraul and Therminol area, we estimate that on an annual basis ~~we could~~ have the following gallonage to incinerate:

Pydraul - 50,000 gallons

Therminol - 18,000 gallons

These are only estimates derived from discussions with men in the Product Group. We have made no attempt to solicite opinion or interest on the part of our customers.

One source we have not polled, and that is Findett. You may want to get from him the amount of material that he discards per year in relation to the amount that he reclaims on both Therminol and Pydraul.

W. R. Fallon

/pke

Plf - Wood
EXHIBIT NO. 301
11/10/95

TNGS 016104

IN 10 REV 11 67

HARTOLDMON0011140

Monsanto

ORGANIC CHEMICALS DIVISION

Monsanto Company
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone: (314) 694-2529

John R. Fallon
Product Manager
Functional Fluids

5/7/69

~~DFS~~
~~DAH~~
~~DLP~~
~~BJB~~ RR

pls peruse Attached
Can you give me an estimate on Pydraul and Therminol? Have would 75-100 M gal/yr. seem? This would be material beyond reclamation which would have to be incinerated

JRF

Assume 30% Therminol in mix up - either lost or reclaimed - if reclaimed appears 15% in cost - so 18,000 gal would be incinerated - leakage is usually lost - reclaimed fluid leaves only bottoms - would think Therminol incineration negligible

A GUESS - MAYBE 50,000 gals of Pydraul
I don't see where we would get any Pydraul except those reclaiming now. DAH

TNGS 016105

R. M. Kountz - General Offices

April 10, 1969 Mr. A. F. Pier

Incineration of Chlorinated Wastes

FB/JF.

Mr. W. A. Kuhn
~~Mr. Dr. A. Olsen~~
Dr. W. R. Richard

Pls discuss during with Kountz

Ou

Some contacts are now being made for chlorinated waste incineration systems. This investigation is taking a three-pronged approach:

1. Outside firms who might incinerate our wastes for a fee.

2. Incineration systems to which we could refer our customers.

3. An incineration system which we might install at either WKG or Anniston.

One of the obvious questions being raised repeatedly for all cases is either what size system do we need or what range of feedrates would we predict. Since we have discussed only material coming from our customers, we need your input. I don't see the practicality of setting up a system for G.E.'s 400 drums and then stopping. I would appreciate your giving some thought to this at your earliest convenience and giving me some feedback. If we could get a handle on the anticipated amount per year or on any reasonable basis we can project a feedrate.

I might add the reason this becomes significant is because of the HCl collection system. A very small system might use a water scrubbing system discharging to the sewer. Another method would be to circulate caustic and yet another larger system might collect the HCl for subsequent sales. Depending on the amount of HCl predicted, economic analysis will indicate the logical choice. We will also consider using the present plant HCl collection systems.

R. M. Kountz

/ab

TNGS 016106

Monsanto

FROM (NAME & LOCATION): David Wood-St. Louis-B2SD

DATE: May 29, 1975

SUBJECT: PCB INCINERATION

REFERENCE:

TO: C. Paton
J. R. Savage
E. M. Potter-B2NK
W. B. Papageorge
R. C. Sprague-B2NG

cc: A. Leisy-1740
G. Johnson-1740
C. Field-B2NE
T. L. Gossage
W. Withers-B2SA
W. Lubic-B1MB

We have all been concerned by the number of incineration shipments which have increasingly resulted in:
a) Need to clean-up trucks
b) Need to specially dispose of solid wastes.

Apart from cost involved and diversion of productive labor, I understand your concern about the risk of increasing PCB in our own effluent due to the special handling involved.

The causes of our problems are:
1. Customer use of old corroded drums.
2. Inadequate securing of bungs.
3. Overfilling of drums - allowing no room for expansion in-transit.
4. Customer does not always segregate solid/liquid waste.
5. Forklift damage to drums in loading at customers.
6. Insufficient inspection of load by carrier (not aware of hazard).
7. Drums not always labeled properly.
8. Drums not loaded securely.

While all the above are familiar to us who deal with delivery of liquids in drums, we need to correct these deficiencies at our customers. I believe that the more irresponsible of our customers will not improve without some financial sanction.

I propose the following action:

A. Modify standard letter covering each return.
1. Clean up costs to customer account.
2. Segregation of solid waste and return to sender to customer account
3. Add instruction sheet for carrier.

I attach present letter (Attachment A) and proposed draft of standard letter (Attachment B) and carrier instruction (Attachment C)

Pltf - Wood
EXHIBIT NO. 302
11/10/95

TRAN 074047

B. Letter giving details of new conditions for incineration (Attachment D).

This letter should be taken by salesmen to responsible management level at each U.S./Canadian approved customer.

It explains our current problem and the potential impact of the irresponsible on the total industry. Draft is attached.

C. New label for returned drums (Attachment E)

This incorporates latest warning statements and gives instructions in event of spill to contact 1) shipper; 2) Monsanto.

D. Guide for customers shipping department.

To improve understanding of procedure at operating level. Draft will be circulated week June 2nd.

Cumming, I would appreciate your and Tom Gossage's approval to the proposed action.

Would all copyees please comment by June 7 in order that we can proceed as quickly as possible?

Thank you.

David Wood

/deb
Attachments

Attachment A (Present)

Monsanto

MONSANTO INDUSTRIAL CHEMICALS CO.
800 N. Lindbergh Boulevard
St. Louis, Missouri 63166
Phone: (314) 694-1000

This will confirm our
concerning incineration of your fluids.
Enclosed are pre-addressed drum return labels
marked "Disposal Only". The drum contents must be
clearly indicated on each label.

To prevent leakage, please use return drums which meet
DOT 17E specifications (55 gallon drums, 18 gauge,
2 bung head; 5 gallon drums, 24 gauge minimum). The
outside of the drums must be clean, free of fluid and
not leaking. Cleanup or other costs affecting the
carrier which are related to fluids leaking from drums
will be charged to the shipper.

Please show Monsanto Identification Number
on the bill of lading and on each drum. The freight
classification is Plastic Liquid NOI and the release
value is 50¢ per pound. Please ship all drums freight
prepaid to:

Monsanto Industrial Chemicals Co.
Department 831 , Incinerator
Sauget, Illinois 62201

Incineration charges are 5¢ per pound, with an $8.00
per drum handling charge for each drum being returned.
Please advise if you want us to invoice these charges
against a specific purchase order number.

TRAN 074049

Solids such as sawdust, rags or sludge and aqueous fluids cannot be handled in our incinerator. For these materials we suggest you check local authorities and your own environmental department for an approved disposal method. Personnel in our Sauget, Illinois, plant have been instructed to refuse receipt of drums containing these materials and to return them to the sender at the sender's expense.

Thank you for your cooperation. If you have additional questions, please phone me (314) 694-3024, or contact me by letter at the above address.

Sincerely,

C. R. Field

C. R. Field
Supervisor
Customer Service Center

Enclosures

TRAN 074050

Attachment B (Suggested New Letter)

New Form Letter for Incineration Returns

This will confirm our ..... concerning incineration of your ..... fluids.

Enclosed are _____ pre-addressed drum return labels marked "Disposal Only." The drum contents must be marked clearly on each label.

To prevent leakage, please use return drums which meet DOT 17E specifications (55 gallon drums, 18 gauge, 2 bung head; 5 gallon drums, 24 gauge minimum). The outside of the drums must be clean, free of fluid and not leaking. Drums should be free from corrosion and bungs tightly sealed. As a condition of return for incineration, clean-up or other costs relating to fluids leaking from drums will be charged to the shipper.

Please show Monsanto identification Number _____ on the bill of lading and on each drum. The freight classification is Plastic Liquid NOI and the release value is 50¢ per lb. Please ship all drums freight prepaid to:

Monsanto Industrial Chemicals Company
Department 831, Incinerator
Sauget, Illinois 62201

Incineration charges are currently 5¢/lb. with an $8.00 per drum handling charge for each drum returned. Please advise us if you want us to invoice these charges against a specific purchase order number.

Please note that solids, such as sawdust, rags or sludge cannot be handled in our incinerator. Additionally, liquids containing more than 1% water can cause damage to the refractory lining of our incinerator and as such, cannot be accepted. For these materials, we suggest you check local authorities and your own environmental department for an approved disposal method. We also refer you to ANSI CIOT Guidelines for handling and disposal of capacitor and transformer askarch containing chlorinated biphenyls. This is available from American National Standards Institute, 1430 Broadway, New York, New York 10018.

It is a condition of shipment to us for incineration that any drums containing solid materials will not be accepted and will be returned to the sender at the sender's expense. Additionally, if we, in our judgement, need to separate and repack unacceptable solids or liquids for safe return to sender, a handling charge of $100 will be billed to sender.

TRAN 074051

We recommend that the attached instruction should be attached to the carrier's copy of the bill of lading, and be brought specifically to the attention of the driver.

We thank you for your cooperation in arranging the appropriate handling of this consignment for incineration. Please call us again to set up any new incineration arrangements which may be needed. We need to send you instructions for each return to ensure that you are familiar with any changes in our procedures.

If you have additional questions, please phone me (314)694-3024 or contact me by letter at the above address.

Sincerely,

C. R. Field

/deb

Attachment C

ATTENTION: DRIVER

This shipment contains POLYCHLORINATED BIPHENYL (PCBs) which some studies have shown may be persistent, an environmental contaminant and possibly injurious to certain forms of bird, aquatic and animal life.

Prevent any entry into the environment through spills, leakage, vaporization or otherwise. Spills and leakage must be collected.

DO NOT STORE with food, animal feedstuffs or pharmaceuticals. Keep containers TIGHTLY closed. In case of leak or spill, contact:

1. Shipper
2. Monsanto Company - call collect (618)271-5835.

IMPORTANT: DO NOT LOAD any drums which are leaking or not tightly sealed.

LOAD securely to prevent drum damage in transit.

TRAN 074053

Attachment D

All Approved U.S./Canadian Dielectric Customers

Dear Sirs:

We wish to bring to your attention problems associated with disposal of waste chlorinated biphenyl products in our incinerator at Sauget, Illinois.

1. Many recent returns have been in completely unsuitable drums which have been severely corroded and unsealed. Some drums have been overfilled so that expansion in-transit has not been contained. Loose stowage in trucks has resulted in movement of the load in-transit.

   The results have been spillage into the truck and in some cases contamination of other goods in the truck, which then had to be destroyed. We have had to hold trucks at our plant for cleaning, attracting demurrage charges and diverting plant personnel from productive tasks.

   The potential cost of clean-up had such leaks in-transit caused detectable environmental contamination would be significant.

   The truck cleaning at Sauget increases the risk of escape of PCB-containing effluent from our own plant which could jeopardize our ability to continue normal controlled production.

   Such irresponsibility on the part of a few can have results which could effect the continued availability of PCBs to the whole capacitor and transformer industry.

   We seek your assistance in ensuring that returns from your company are appropriately packed, sealed and stowed for return.

   As from June 1, 1975, costs incurred in handling inadequately packed returns will be billed to the company involved.

2. We have requested prior contact before EACH return so that we can send the required number of PCB Warning labels. We are still receiving drums without warning labels. In the event of a spill in-transit, the absence of warning labels could be a factor in assessing liability. We seek your help in ensuring that we can send you enough suitable labels for each return.

TRAN 074054

3. We attach a copy of the form letter that we will be sending with labels to advise on correct return procedure.

You will note that this letter advises that our incinerator cannot handle solid waste. It is designed to handle liquid streams only. We still receive drums containing rags, sawdust, and metal and wooden components. In the past, our plant personnel have taken care to separate solid wastes and have arranged separate special disposal of the solid wastes. This will not continue. As from June 1, 1975, a charge of $100 will be made if labor is diverted to separating solid waste. Additionally, the solid waste will be suitably packaged and returned freight collect to the sender.

While we wish to continue to assist the electrical industry in disposal of liquid waste chlorinated biphenyl in our incinerator, we cannot and will not permit the service to become inoperable because of abuse by a small number of companies.

We thank you for your assistance in regulating returns from your company.

David Wood

/deb

TRAN 074055

MONSANTO COMPANY
Department 831
SAUGET, ILLINOIS 62201

TRAN 074056

RETURNED

WASTE FLUIDS

FOR INCINERATION ONLY

PRODUCT NAME

WEIGHT

IMPORTANT:

This product contains POLYCHLORINATED BIPHENYLS (PCB's) which some studies have shown may be persistent, an environmental contaminant and, possibly, injurious to certain forms of bird, aquatic and animal life.

PREVENT ANY ENTRY INTO THE ENVIRONMENT THROUGH SPILLS, LEAKAGE, DISPOSAL, VAPOURISATION, REUSE OF CONTAINERS OR OTHERWISE.

SPILLS, LEAKAGES AND WASTE PRODUCT MUST BE COLLECTED.

~~Use of this product must be restricted to applications which can be controlled so that entry into the environment does not occur and to applications in which it cannot come into contact with food, animal feedstuffs or pharmaceuticals.~~

HARMFUL SUBSTANCE IF TAKEN INTERNALLY OR IF IN PROLONGED CONTACT WITH THE SKIN.

CAUSES IRRITATION OF SKIN AND EYES.

DURING SHIPMENT AVOID SPILLS AND LEAKAGE INTO INLAND WATERWAYS AND THE SEA.

CAUTION!

CONTAINS CHLORINATED HYDROCARBONS

Store away from food, animal feedstuffs and pharmaceuticals.

Keep container tightly closed.

Do not eat or smoke when using.

Avoid breathing vapours, mist or fumes.

Do not wear contaminated clothing.

Wash product from skin with soap and water.

Wash eyes by flushing with water.

SHIPPER
1. SENDER 2. MONSANTO CALL COLLECT 618-271-5835

IN CASE OF LEAK OR SPILL CALL ~~COLLECT 618 271-5835~~

David Wood-St. Louis-B2SD

February 24, 1976

C. Paton
R. G. Potter
[redacted]

PCB INCINERATION

D. L. Sliney

1. I attach a copy of the letter we send to customers inquiring about incineration of PCB fluids.

2. Also, attached is a copy of the label for return product waste and an advise note that we request be given to the carrier.

3. Companies who regularly make returns receive a wall chart to place in their shipping area to focus attention on good handling practice. I attach a reduced copy of the wall chart and a copy of the text.

4. We do have problems with return in bad drums from time to time, and J. C. Weber is developing a procedure to handle these cases.

David Wood

/deb
Attachments

PH-Wood
EXHIBIT NO. 303
11/10/95-PR

TRAN 080447

Monsanto

FROM (NAME & LOCATION): David Wood-St. Louis-B2SC

DATE: July 18, 1974

CC:

SUBJECT: DIELECTRICS SEMINAR
SEPTEMBER, 1974

REFERENCE: MEETING 17TH JULY
PROGRAM COMMITTEE

TO:
P. G. Benignus
T. L. Gossage
W. B. Papageorge
[redacted]
W. R. Richard

It became clear during our discussion that the program should follow a sequence:

1) Definition of Environmental Problems Surrounding PCBs;
2) Indepth Review of the Defense of PCB Continued Use;
3) Conclusion that Use of PCB Can Be Continued.

We wish the program to allow customer participation and to reflect a balance between capacitor and transformer manufacturers, and large and small manufacturers. Ideally, there should also be some contribution from the limited number of overseas manufacturers who may attend.

On the above basis, the following program evolved:

1) Status report on environmental issues concerning PCB around the world. No guest speakers would be involved in this section since we wish to concisely define the problem before the seminar without getting into overmuch discussions of different corporate viewpoints. U.S.A. and Canada would be presented by Bill Papageorge, the European situation by Al Vodden, and other world areas by David Wood.

2) Effect of PCBs in the Environment. We believe that this heading should cover biodegradation, isomer differentiation, and test procedures to satisfy the capacitor industry problems, and secondly, migration of PCBs in soil to reflect the rather different situation of transformer manufacturers. We suggest that this is handled by Scott Tucker and Al Vodden without guest speakers.

TRAN 028069

IN - 10 REV. 1/72

P/f - Wood
EXHIBIT NO. 304
11/10/95

3) Methods of testing PCB in effluent streams. This topic should be divided into four sections:
   A) Presentation by Ed Stewart on clean-up of our own PCB facility;
   B) CED Department - Monsanto ideas for controlling PCB at customer locations;
   C) Capacitor industry comments, preferably by Mr. Hydrick of Sangamo;
   D) Transformer customer comment by Mr. Shepherd of Westinghouse.

4) Disposal of waste Aroclor. We suggest that this be handled by a panel comprising Jim Savage, Bill Papageorge, and Earl Potter, and should aim to cover incineration, transportation, cleaning and disposal of drums, damage to bulk containers in transit.

We anticipate that at the end of Item 4 would form a breakpoint for lunch.

5) New Fluids. Under this heading, we would cover work on Aroclor 1016, Aroclor 1043, and non-PCBs with emphasis being low on non-PCBs; however, as we hope the EPA standards support the continued use of PCBs. We propose that this section be handled by R. Munch and J. G. Bryant.

6) Transformer Fluids. We seek a presentation by G. E. Rome, Jim Kinney covering the search for alternative fire resistant transformer dielectrics to be followed by a presentation by Bill Richard indicating that Monsanto has not neglected transformer fluids in its Research program, but that new major developments have not yet evolved. We shall seek in this presentation to ventilate the Monsanto production problem if there is a general move from higher chlorinated isomers and explore the concept of a transformer fluid based on Aroclor 1248.

Items 2 through 6 are designed to indicate the number of areas in which a defense of continued PCB use can be mounted.

7) Economic influence of askarel use on U. S. economy. Here we seek a presentation by Ed Raab of General Electric of the economic data presented in Washington. We hope to set a positive note with this presentation to support continued use of PCBs.

8) Consumer attitudes. Under this heading, we would seek positive presentations on askarel transformers and askarel capacitors. Our first choice for transformers is Niagara with Ferranti Packard as reserve. Our first choice on capacitors is Jard with Mallory as reserve.

It was suggested that after each section, we should allow a 15-minute period for questions from the floor and that as a last stage, the committee should consider whether there were any specific organizations and questions we wished to introduce into the program.

Would you please let me know if the above fairly reflects the conclusions of the meeting and whether you have any further additional comments to make before we seek final approval of this format.

Dictated, but not read by D. Wood deb

David Wood

/deb

D. Wood (B28D)

November 7, 1974

E. S. Bergen - B28L
W. C. Moore - 1010
W. B. Papageorge

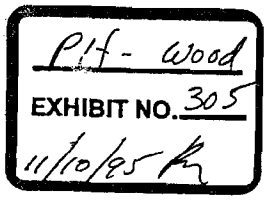
C. Paton

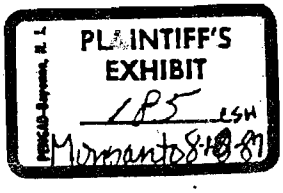
I had a call from John Britton, Engineering Manager of Westinghouse Bloomington, who asked for information about a Monsanto effluent sampling program of which he had been made aware (!)

I told him that we had requests for such a study and that we were currently reviewing what resources Monsanto could apply to such a program and what type of sampling might be required. He accepted that we might be in a position in December to be more positive.

D. Wood

/kl





Bloomington Dx 350 id
11-25-86 cg

300 2612

Monsanto

FROM (NAME & LOCATION): W. B. Papageorge B2SK

DATE: December 6, 1974

SUBJECT: PCBs - CHLORINATED DIBENZOFURANS

REFERENCE:

cc: H. S. Bergen
R. E. Keller
G. J. Levinskas
W. R. Richard
J. R. Savage
P. L. Wright
E. P. Wheeler

TO : J. P. Mieure - T2B

Attached is a copy of a paper which is being offered for publication in the "Bulletin of Environmental Contamination and Toxicology." Dr. Kimbrough has solicited our comments. If you or any of the recipients of copies of this memo have any comments to offer, please submit them to me by December 16.

W. B. Papageorge

W. B. Papageorge/pw

DEC 12 1974 /pw

Bill briefly - what is significance of Chlorodibenzofurans when material was found in Bayou Chodelic product that was pursue its reduce

D. Wood.

Chlorodibenzofurans are very highly toxic. Many effects on birds and animals noted and originally attributed to PCBs when later found to be due to furan content. There is currently no legal or regulatory pressure to reduce. Subject, however, is very emotional and could result in further pressures to eliminate PCBs from all uses. WBPapageorge

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Plf - Wood
EXHIBIT NO. 306
11/10/95