

Analabs, Inc. Research Notes

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In recent years there has been increasing concern about the possible harmful effects of organic compounds in the environment. An important class of pollutants are the polycyclic aromatic hydrocarbons (PAH) which have been shown to occur in air, water and food (see Table 1) via automobile and engine exhausts, the burning of fossil fuels, oil spills, food processing, tobacco smoking, and from natural sources. Moreover several PAH have been shown to possess carcinogenic (1-4) and mutagenic (5, 6) properties. This review is designed as an introduction to the general literature on PAH with particular emphasis on environmental analysis of these compounds.

NOMENCLATURE

Although several systems of nomenclature for polycyclic aromatic hydrocarbons have coexisted in the past (7, 8) the IUPAC system (9) is becoming generally accepted now.

Common names for the basic ring systems are retained (see Fig. 1 on page 2). For the construction of more highly condensed aromatic hydrocarbons the basic system is lettered (a, b, c, etc., (see Fig. 2 on page 3) and the "added" rings numbered in the fashion shown in Fig. 2.

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REACTIONS AND REACTIVITY

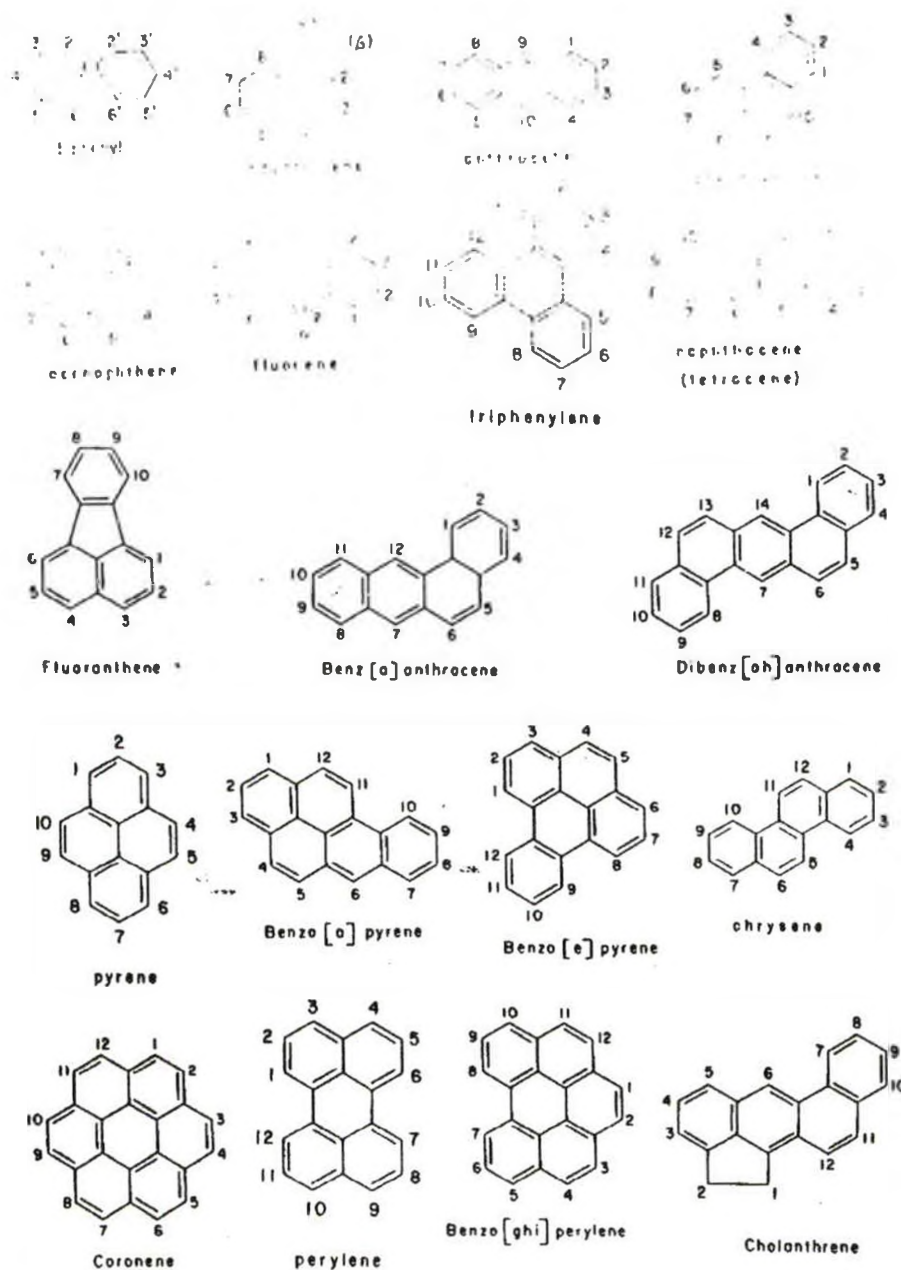
The standard reference books on the chemistry of polycyclic hydrocarbons are Clar's two volumes (10) and chemical-technical aspects of diphenyl and the terphenyls are discussed in an encyclopedia article (11). The analysis of PAH has been reviewed (12).

Most polycyclic hydrocarbons undergo the typical substitution reactions which are known from the parent compound, benzene.

In addition, many of the polycyclic hydrocarbons show a tendency for addition reactions (cf. Fig. 3 on page 3) ("fixed double bonds").

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Fig. 1. Common names, structures, and numbering of basic ring systems.



The reactivity of polycyclic hydrocarbons towards addition reactions can be explained and predicted qualitatively by Clar's π -sextet theory (13, 14). A quantum mechanical explanation of Clar's theory has been given (15, 16).

The stability of polycyclic aromatic hydrocarbons depends on the structure as well as on the number of rings. Hexabenzocoronene (Fig. 4) for example is an extremely

POLYCYCLIC HYDROCARBONS IN MAN'S ENVIRONMENT

Benzo [a] pyrene in city air (mcg/1000 m ³)	
Los Angeles	5
London	68
Bonn	133
Benzo [a] pyrene in food (mcg/kg)	
Vegetables	10
Smoked foods	1-10
Carcinogenic Polycyclic Hydrocarbons in water (mcg/m ³)	
Groundwater	1-10
Waste water	100,000
Benzo [a] pyrene in cigarette smoke	
1 mcg in the smoke of 40 cigarettes	

*Adapted from M. Zander, "Analysis of Polycyclic Aromatics" presented at the "Third Annual Symposium on Recent Advances in the Analytical Chemistry of Pollutants," Athens, Ga., May 1973.

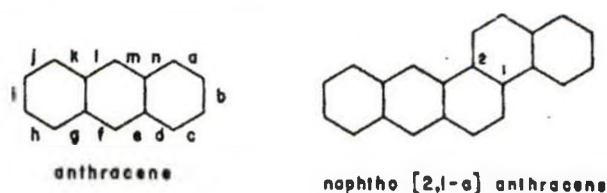


Fig. 2. Nomenclature for more highly condensed ring systems.

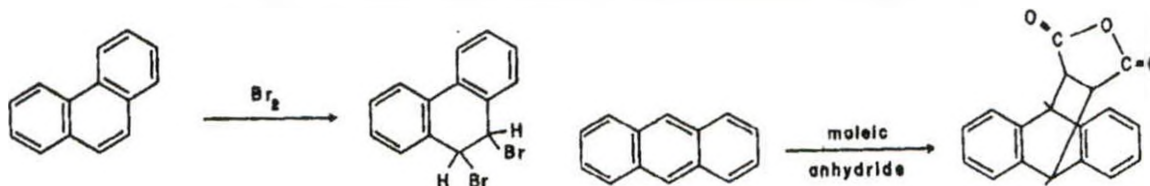


Fig. 3. Examples for addition reactions occurring with PAH.



Fig. 4. Hexabenzcoronene ring system.

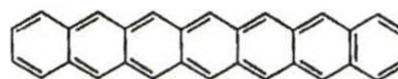


Fig. 5. Heptacene ring system.

stable hydrocarbon; even at 700°C neither decomposition nor melting takes place. Heptacene (Fig. 5) on the other hand, is extremely unstable with a reactivity that surpasses many free radicals.

The photochemical stability of a number of PAH has been investigated (17); the literature on the photodecomposition of the carcinogen benzo [a] pyrene is discussed in reference (18).

PAH occur naturally in petroleum and are also synthesized by living organisms such as higher plants, algae and microorganisms (cf. 18, 19).

PAH are formed as pyrolysis products at high temperatures (20-22) and can, therefore, be found in coal tar, automobile exhaust, in emission from burning fossil fuels and tobacco smoke.

A panel, studying particulate polycyclic organic matter (POM) concluded recently that the nationwide emission of benzo [a] pyrene in the US amount to 500 tons from heat and power generation, 600 tons from refuse burning, 200 tons from coke production and 20 tons from motor vehicles (23).

The distribution of PAH is also uneven and the highest concentrations are found in urban areas (24, 25) in air, particularly soot samples (26, 27) and in soil. Polycyclic aromatic and heteroaromatic compounds, known to occur in coal tar and pitch, are listed and described in references (30-32).

Because of the direct intake in human nutrition, much work has been carried out to develop analytical methods and determine levels of polycyclic aromatic hydrocarbons in foods (25, 33-35). Levels are highest in smoked foods (occasionally values > 10 ppm total polycyclic hydrocarbon are observed), whereas levels in unsmoked food products are generally lower than 1 ppm.

A large number of polycyclic aromatic (including benzo [a] pyrene) and heteroaromatic hydrocarbons as well as related compounds have been identified in tobacco smoke (44-46).

Polycyclic hydrocarbons are also released into the environment from general oil pollution and the ever-increasing oil spills (47, 48). Analytical methods for the identification of hydrocarbon pollutants on seas and beaches are reviewed in reference (49). The uptake and effect of oil (including the polycyclic aromatic hydrocarbons) on marine life is of increasing concern (50-52).

ANALYSIS

The extraction, separation (clean-up) and analysis of PAH have been extensively investigated (53-56) and a review article on chromatographic procedures gives a useful comparison of the various methods (57).

As is general for the analysis of any trace component, the need is felt (97) for an extended collection of reference standards of polynuclear hydrocarbons and their alkyl and hydro derivatives. The later type of derivatives is of great importance since it is not ordinarily discovered by the conventional UV or fluorescence methods and is best identified and measured by MS. The alkyl derivatives are in many instances more carcinogenic than the parent compound.

The carcinogenic PAH benzo [a] pyrene has understandably been studied in some detail and a thorough comparison of the analytical methods used in the determination of this compound from air particulates has been reported by Sawicki (58). Analysis of benzo [a] pyrene in cigarette smoke (59), air (60), bitumen and plants (61) and water and other commodities (62) has recently been described.

Thin layer and paper chromatography - TLC and paper chromatography has been used successfully for the separation of polycyclic hydrocarbons (57, 63). Cellulose, acetylated cellulose and aluminum oxide (64) and silica are the preferred layers. A methanol-ether-water (4:4:1) mixture (65) has been recommended for acetylated cellulose layers. A typical chromatogram employing this system is shown in Fig. 6. (66) Paper chromatography on acetylated paper has been used for the chromatography of PAH with solvents similar to the TLC separation on acetylated cellulose powder (67).

Electron acceptor reagents can be used to visualize PAH on paper and thin layer chromatograms. The hydrocarbons can be recovered unchanged from the characteristically colored charge transfer complexes (see section on mass spectrometry). The native fluorescence or phosphorescence of PAH, however, offers a much more sensitive method of detection (see section on luminescence spectroscopy).

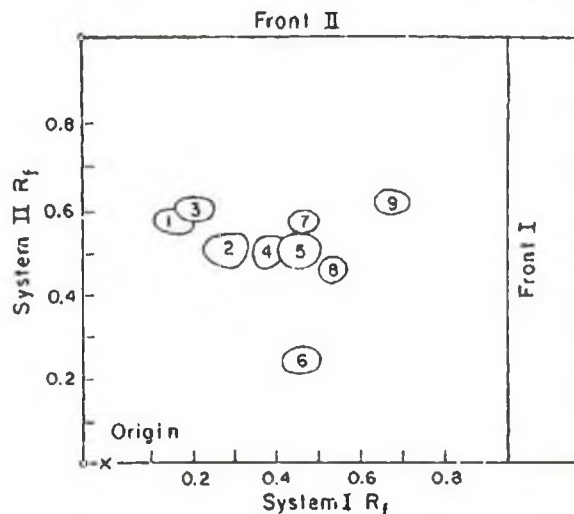


Fig. 8. Two dimensional thin layer chromatogram. Layer: acetylated cellulose - aluminum oxide, 1:2. Solvents: System I, n-hexane, n-pentane, toluene (90:5:5). System II, methanol, ether, water 4:4:1: Compounds 1, dibenzo [a, e] pyrene; 2, dibenz [a, h] anthracene; 3, dibenz [a, c] anthracene; 4, perylene; 7, benzo [e] pyrene; 8, pyrene; 9, anthracene.

Liquid chromatography - The behavior of 18 polycyclic hydrocarbons on two column materials (Durapak OPN and 40% cellulose acetate) were investigated using an ultraviolet detector (68). Although neither system could resolve all components of the mixture, the method was shown to be of potential utility. A number of polynuclear aza-heterocyclic hydrocarbons were separated by high pressure liquid chromatography using Zipax packing impregnated with silver ions (69) and a chemically bonded phase (70). Polycyclic aromatic hydrocarbons were also separated by liquid chromatography using Corasil I impregnated with the complexing reagent 2, 4, 7-trinitrofluorenone (71). A number of column packings have been compared in the separation of polynuclear hydrocarbons in engine oils (72).

Gas chromatography - Ultraviolet absorption and luminescence analysis have dominated the analysis of polycyclic hydrocarbons for some time, more recently gas chromatography has played an important role in the separation, detection and identification of these compounds (57, 73-77).

The use of capillary gas chromatography with its great resolution potential has markedly increased the analytical potential of this technique. Application of capillary G. C. have been reported in the analysis of polycyclic aromatic hydrocarbons and related compounds in anthracene oil (78), cigarette smoke (45, 79), air and car exhaust (80, 81), soot samples (75) as well as for quantitative determinations (82). Gouw *et al.* (83) have shown that PAH can be separated effectively on short capillary columns (10 m). A typical capillary column chromatogram is shown in Fig. 7 (see Table 2).

Ultraviolet spectroscopy - U.V. spectra of PAH show in the spectral range accessible by commercial instruments three electronic transitions which are differentiated by oscillator-strength polarisation and temperature dependency. The most intense bands in the U. V.-spectra of PAH are the so-called β - or 1B_b -bands which show a molar extinction coefficient of ca. (10^5) . The extinction coefficient for the para - or 1L_a -bands and the γ - or 1L_b -bands are ca. $10^4 - 10^6$ and $(10^2 - 10^3)$ respectively. For analytical purposes, the para-bands are the most suitable.

U. V. spectra are usually recorded in liquid solution at room temperature. It is sometimes advantageous, to measure the U. V. spectra in a solid matrix at low temperatures, frequently the bands are more intense and very narrow (84).

No. Compounds

- 1 Naphthalene
- 2 Azulene
- 3 Diphenyl
- 4 Acetylnaphthalene
- 5 Anthracene
- 6 Fluorene
- 7 1-Methylanthracene
- 8 4H-Cyclopenta [def] phenanthrene
- 9 1-Methylphenanthrene
- 10 9-Methylanthracene
- 11 Fluoranthene
- 12 Pyrene
- 13 11H-Benzo [a] fluorene
- 14 11H-Benzo [b] fluorene
- 15 7H-Benzo [c] fluorene
- 16 1-Methylpyrene
- 17 3-Methylpyrene
- 18 Benzo [g, h, i] fluoranthene
- 19 Benzo [c] phenanthrene
- 20 Benzo [a] anthracene

No. Compounds

- 25a Chrysene
- 25b Triphenylene
- 26 Naphthalene/Tetracene
- 27 7-Methylbenz [a] anthracene
- 28a Benzo [b] fluoranthene
- 28b Benzo [k] fluoranthene
- 29 1-Methyl-7-methylbenz [a] anthracene
- 30 1-Methyl-9-methylbenz [a] anthracene
- 31 Benzo [a] pyrene
- 32 Benzo [b] pyrene
- 33a 6-Methylcholanthrene
- 33b 26-Methylcholanthrene
- 34 Dibenz [a, j] anthracene
- 35a Dibenz [a, c] anthracene
- 35b Dibenz [a, h] anthracene
- 36 Benztetraphene
- 37a Benzo [g, h, i] perylene
- 37b Perylene
- 38 Anthanthrene
- 39 Dibenz [a, e] pyrene
- 40 Coronene
- 41 Dibenz [a, e] pyrene
- 42 Dibenz [a, i] pyrene
- 43 Dibenz [a, h] pyrene

Quantitative analysis of PAH by U. V. spectroscopy is possible after separation (e. g. by T.L.C). For the analysis in mixtures the qualitative composition must be known and a large number of key bands be measured. Mathematical treatment of data is usually done by computer (85). A collection of U. V. spectra including a large number of polycyclic compounds is available (86).

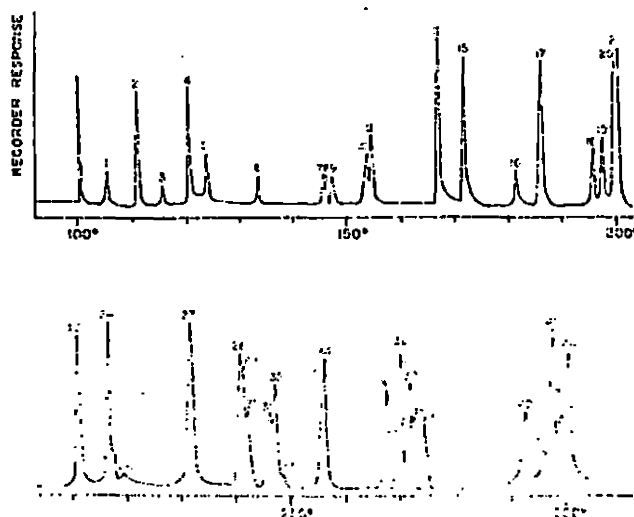


Fig. 7. Chromatogram of a standard mixture of hydrocarbons. Glass capillary column coated with SE-52. Linear programmed temperature 100-300 °, rate 1.8/min. Numbers correspond to compounds in Table 2.

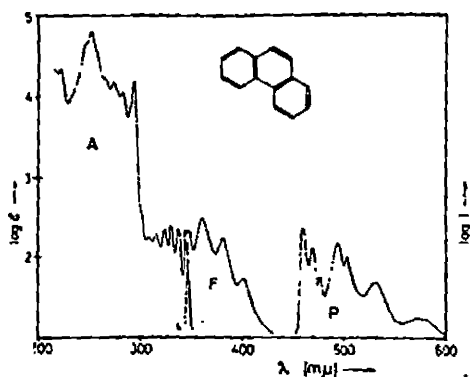


Fig. 8. Electronic spectra of phenanthrene. A, absorption (UV) spectrum (cyclohexane); F, fluorescence spectrum (benzene); P, phosphorescence spectrum (ethanol, isopentane, ether, 2:5:5; 77°K).

Luminescence spectroscopy—The fluorescence quantum yield for most PAH is relatively high to make fluorimetry a very sensitive and therefore widely used analytical method for these compounds. (For spectra of polycyclic hydrocarbons see (87). Fluorescence of individual members of a mixture can be observed when their absorption spectra differ and selective excitation wavelengths are used (88).

Fluorescence spectra are usually recorded in solution at room temperature. Spectra obtained at low temperature in a suitable matrix (*n*-alkanes, *n*-pentane to *n*-decane; cyclohexane) frequently give very characteristic spectra showing many bands (Shpol'skiispectra).

An interesting new technique is the so-called "quenchofluorimetry" (89) of multicomponent mixtures. This method is based on the fact that the fluorescence of some compounds is quenched more than of others if a "quencher" is added to the mixture. PAH with the fluoranthene ring system (89; quencher: nitromethane) and perylene (90; quencher: methyl iodide) for instance can be determined in complex PAH mixtures by this method.

Phosphorescence spectra which are measured in solid solution at low temperatures usually show a higher selectivity than fluorescence spectra. Fig. 8 shows the U.V.-fluorescence and phosphorescence spectrum of phenanthrene. A comparison of U.V.-fluorescence and phosphorescence spectroscopy is given in Table 3. For the analysis of PAH in the environment separation prior to analysis by U. V. or luminescence spectroscopy is necessary. The most commonly used combination is TLC fluorescence. Samples for quantitative analysis can either be eluted from the TLC plates or more elegantly determined by *in situ* measurements (91).

Mass spectrometry—Mass spectrometric analysis plays an important role in the identification of polycyclic aromatic hydrocarbons (92-96) and this technique is particularly useful in combination with gas chromatography. The combined GC-MS

TABLE 3
Comparison* of U.V. fluorescence and phosphorescence spectroscopy

Method	Selectivity	Sensitivity	Reproducibility
U. V.	+	+	++
Fluorescence	++	+++	++
Phosphorescence	+++	+++	++
		+++ excellent	
		++ good	
		+ average	

*Adapted from M. Zander, "Analysis of Polycyclic Aromatics" presented at the "third Annual Symposium on Recent Advances in the Analytical Chemistry of Pollutants," Athens, Ga., May 1973

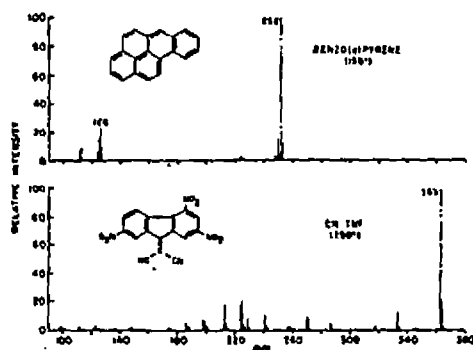


Fig. 9. 70 eV mass spectrum of benzo [a] pyrene 9-cyanomethylene-2, 4, 7-trinitrofluorene complex eluted from TLC at different sample temperatures (as indicated); (a), benzo [a] pyrene (b). CNTNF.

technique (97) has been used in studies in which the identity of the observed gas chromatographic peaks has been confirmed by the characteristic mass spectra of the components.

PAH may be located on TLC plates by the characteristic color they form with electron acceptor reagents. The complexes may be transferred directly to a mass spectrometer sample tube and individual spectra of the compounds be obtained by thermal dissociation and fractional sublimation in the ion source of a mass spectrometer (98). Mass spectra of benzo [a] pyrene and the complexing agent 9-dicyanomethylene-2, 4, 7-trinitrofluorene obtained at different sample temperatures from the complex are shown in Fig. 9.

The mass spectra of most polycyclic aromatic hydrocarbons exhibit several common fragmentation pathways; i.e.:

- 1) The molecular ion is usually the most abundant ionic species and this greatly facilitates the determination of the molecular formula of the hydrocarbon.
- 2) In addition, the $M^+ - 1$, $M^+ - 2$ and $M^+ - 3$ species are also relatively intense.
- 3) Methyl substituted aromatic hydrocarbons exhibit $M^+ - 15$ ions.
- 4) Doubly-charged ions are observed for most of the aforementioned ionic species.

These characteristics indicate that mass spectrometry does not readily distinguish between isomeric polycyclic aromatic hydrocarbons since very few fragment ions are produced and the molecular ion tends to dominate the spectra. This characteristic can, however, be an advantage with the GC-MS technique since the separation of many isomeric hydrocarbons can readily be effected by gas chromatography and the resulting mass spectra gives confirmation of the GC assignments.

Infrared spectra - IR spectra are useful for identifying alkyl derivatives of naphthalene. IR spectra, do not, however, have any advantages over U.V. spectra in the identification of unsubstituted PAH, but are very useful in the structure determination of new compounds (12).

Nuclear Magnetic Resonance Spectra

Proton magnetic resonance spectroscopy can be used for the identification of PAH and their alkyl derivatives (12, 14). Experimental difficulties exist with the highly condensed systems because of their low solubility.

220 MHz Proton magnetic resonance spectrum of benzo [a] pyrene has recently been published (99) and C-13 NMR spectra of several simple condensed systems have been recorded (100).

BIOLGICAL ACTIVITY AND METABOLISM

It is now generally accepted (101) that to be carcinogenic, polycyclic aromatic hydrocarbons undergo metabolic activation. Epoxides (102, 103) may be involved and reaction with nucleic acid components (99, 103, 104) have been suggested. The

Metabolism of polycyclic aromatic hydrocarbons (45, 108, 109) in mammals and in *in vitro* preparations yield oxygenated derivatives. Hydroxy compounds are often formed and epoxides (102, 109, 110) have been shown to be intermediates. The synthesis, properties and metabolism of PAH-epoxides has recently been extensively reviewed (111).

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76. A. G. Ewing, C. G. W. Ellis, B. L. New, W. H. Cline, M. J. J. Cantow, P. J. F. Harris, J. R. Williams, J. A. G. Rees, C. L. Cornish, A. L. Duff and A. G. Ewing, *J. Chem. Soc., Perkin Trans. II*, (1969).
77. D. Maher, J. and M. Corn, *Anal. Chem.* 38, 131 (1966).
78. C. Laborty, B. R. and R. Lewis, *Environ. Sci. Technol.* 1, 526 (1967).
79. Ishida, K., *Anal. Chem.* 43, 699 (1971).
80. Evans, J., *J. Chrom.* 4, 45, 432 (1972).
81. J. A. T. Osborn, *Chromatogr. Zentr.* 7, 105 (1966).
82. J. A. T. Osborn, *J. Chrom.* 4, 45, 432 (1972).
83. J. A. T. Osborn, *J. Chrom.* 4, 45, 432 (1972).
84. J. A. T. Osborn, *J. Chrom.* 4, 45, 432 (1972).
85. J. A. T. Osborn, *J. Chrom.* 4, 45, 432 (1972).
86. J. A. T. Osborn, *J. Chrom.* 4, 45, 432 (1972).
87. J. A. T. Osborn, *J. Chrom.* 4, 45, 432 (1972).
88. Sawicki, E., T. R. Hauser, u. T. W. Stanley, *Intern. J. Air Pollution* 2, 253 (1960).
89. Sawicki, E., T. W. Stanley, u. W. C. Elbert, *Talanta* 11, 1433 (1964).
90. Zahler, M., *Z. anal. Chem.* 203, 19 (1973).
91. Sawicki, E., and J. D. Pfaff, *Anal. Chim. Acta* 32, 521 (1965).
92. Majer, J. R., Perry, R. and Reade, M. J., *J. Chrom.*, 48, 328 (1970).
93. Lao, R. C., Thomas, R. S., Monkman, J. L. and Pottie, R. F., Symposium on the Identification and Measurement of Environmental Pollutants, National Research Council, Ottawa, Canada, 141 (1971).
94. Perry, R., Symposium on the Identification and Measurement of Environmental Pollutants National Research Council, Ottawa, Canada, 130 (1971).
95. Lao, R. C., Thomas, R. S. and Monkman, J. L., *Intern. J. Environ. Anal. Chem.*, 1, 157 (1972).
96. Safe, S., and O. Hutzinger, "Mass Spectrometry of Pesticides and Pollutants" CRC press, Cleveland, in press.
97. Lao, R. C., Thomas, R. S., Oja, H. and Dubois, L., *Anal. Chem.* 45, 908 (1973).
98. Hutzinger, O., and S. Safe, unpublished data.
99. Cavallieri, E. and M. Calvin, *Proc. Nat. Acad. Sci. USA*, 68, 1251 (1971).
100. Stothers, J. B., "Carbon-13 NMR Spectroscopy," Academic Press, New York, 1972, p. 90.
101. Miller, J. A., *Cancer Res.* 30, 559 (1970).
102. Selkirk, J. K., E. Huberman and C. Riedelberger, *Biochem. Biophys. Res. Commun.* 43, 1010 (1971).
103. Grover, P. L. and P. Sims, *Biochem. J.* 129, 41P, (1972).
104. Cavallieri, E. and M. Calvin, *Photochem. Photobiol.* 14, 641 (1971).
105. Popp, F. A., *Z. Naturforsch.* 27b, 731 and 850 (1972).
106. Feldmeister, A., D. Tsai and N. D. Weiner, *J. Pharm. Pharmacol.* 61, 1065 (1972).
107. Johnson, M.D. and Calvin, M., *Nature*, 241, 271 (1973).
108. Williams, R. T., "Detoxication Mechanisms" Chapman & Hall, London, (1959).
109. Daly, J. W., D. M. Jerina and B. Witkop, *Experientia*, 28, 1129 (1972).
110. Keyell, G. R., J. Booth, P. Sims P. L. Grover and A. Hewer, *Biochem. J.*, 129, 41P, (1972).
111. Waterfall, J. F. and P. Sims, *Biochem. J.* 128, 265-277 (1972).
112. Sims, P., *Xenobiotica*, 2, 469 (1972).
113. Sims, P., *Biochem. J.* 130, 27 (1972).
114. Sims, P., *Biochem. J.* 131, 405 (1973).

	Product	Synonym	Min. Purity	Price
RNH001	Acenaphthene		99%	7.00/100mg
RNH002	Acridine		99%	14.00/100mg
RNH003	Anthracene		99%	45.00/10mg
RNH004	Benzo (a) anthracene		99%	7.00/100mg
RNH005	Benzo (b) anthracene		99%	10.00/10mg
RNH006	Benzo (k) fluorene		99%	7.00/10mg
RNH007	Benzo (a) carbazole	5H-Benzo (h) carbazole	98%	7.00/100mg
RNH008	1, 2-Benzocarbazole	See 2, 3-Benzocarbazole	95%	14.00/10mg
RNH009	1, 2-Benzodiphenylsulfide		99%	12.00/100mg
RNH010	Benzo (h) fluoranthene		95%	13.00/100mg
RNH011	Benzo (g, h, i) fluoranthene		95%	17.00/100mg
RNH012	1, 2-Benzofluorene		99%	10.00/10mg
RNH013	2, 3-Benzofluorene		99%	10.00/10mg
RNH014	Benzo (g, h, i, j) perylene	1, 12-Benzoperylene	99%	10.00/10mg
RNH015	1, 12-Benzoperylene	See Benzo (g, h, i) Perylene		
RNH016	9, 10-Benzophenanthrene	See Triphenylene		
RNH017	Benzo (a) pyrene	3, 4-Benzopyrene	98%	17.00/100mg
RNH018	3, 4-Benzopyrene	See Benzo (a) pyrene		
RNH019	5, 6-Benzoquinoline	Benzo (f) quinoline or β -Naphthoquinoline	99%	10.00/100mg
RNH020	Benzo (h) quinoline	See 5, 6-Benzoquinoline		
RNH021	1, 1'-Binaphthyl		95%	10.00/100mg
RCS001	Diphenyl		99%	7.00/500mg
RNH011	Carbazole		99%	7.00/100mg
RNH012	Chrysene		99%	14.00/100mg
RNH013	Coronene		98%	18.00/10mg
RNH014	1, 2, 3, 4-Dibenzanthracene	Dibenz (a, c) Anthracene	99%	10.00/10mg
RNH015	1, 2, 5, 6-Dibenzanthracene	Dibenz (a, h) Anthracene	99%	7.00/10mg
RNH016	1, 2, 7, 8-Dibenzanthracene	Dibenz (a, j) anthracene	95%	12.00/10mg
RNH017	Dibenz (a, c) anthracene	See 1, 2, 3, 4-Dibenzanthracene		
RNH018	Dibenz (a, h) anthracene	See 1, 2, 5, 6-Dibenzanthracene		
RNH019	Dibenz (a, j) anthracene	See 1, 2, 7, 8-Dibenzanthracene		
RNH020	2, 3, 5, 6-Dibenzfluoranthene		98%	14.00/10mg
RNH021	3, 4, 5, 6-Dibenzcarbazole		95%	8.00/10mg
RCS007	Dibenzo-p-dioxin		99%	15.00/50mg
RCS070	Dibenzofuran		99%	7.00/500mg
RNH021	1, 2, 4, 5-Dibenzopyrene		98%	17.00/100mg
RNH014	Dibenzothiophene	Diphenylenesulfide	99%	7.00/100mg
RNH015	1, 2, 8, 9-Dibenzpentacene		99%	14.00/10mg
RNH022	9, 10-Dihydroanthracene		99%	17.00/100mg
RNH023	10, 15-Dihydro-5H-Diindeno (1, 2a-f', 2'-c') Fluorene	See Triazene		

Polynuclear Hydrocarbon Standards

Catalog #	Product	Synonym	Min. Purity	Price
RNH023	Diindeno [1, 2, 3-cd-1', 2', 3'-im] Perylene	Periflanthene	98%	9.00/100mg
RNH024	3, 6-Dimethylphenanthrene		99%	7.00/10mg
RNH025	9, 10-Diphenylanthracene		99%	7.00/100mg
-----	Diphenylsulfide	See Diacenzothiophene		
RNH044	Dodecacyclotriphenylene		99%	7.00/100mg
RNH044	Durene	1, 2, 4, 5-Tetramethylbenzene	99.9%	7.00/100mg
RNH046	1-Benzanthracene		99%	7.00/100mg
RNH047	1-Fluorene		99%	14.00/100mg
RNH048	11-Methylbenzene		99%	7.00/100mg
-----	Indeno [1, 2, 3-cd] pyrene	See o-Phenylene pyrene		
RNH049	2-Methylanthracene		99%	8.00/100mg
RNH049	9-Methylanthracene		99.99%	14.00/100mg
RNH041	4-Methyl Biphenyl	4-Phenyltoluene	98%	10.00/100mg
RNH042	4, 5-Methylphenanthrene		99%	19.00/100mg
RNH043	2-Methylfluorene		95%	7.00/100mg
RNH044	1-Methylphenanthrene		99%	7.00/100mg
RNH045	2-Methyl phenanthrene		99%	7.00/100mg
RNH046	3-Methyl phenanthrene		95%	7.00/100mg
-----	Naphthalene	See Tetracene		
RCS072	Naphthalene		99%	7.00/500mg
-----	β -Naphthoquinoline	See 5, 6-Benzoquinoline		
RNH047	Octadecahydrochrysene		95%	14.00/100mg
RNH048	Pentacene		98%	18.00/10mg
-----	Perilanthene	See Diindeno [1, 2, 3-cd-1', 2', 3'-im] perylene		
RNH049	Perylene		99%	14.00/100mg
RNH050	Phenanthrene		99%	7.00/100mg
RNH051	Phenanthrenequinone		95%	14.00/100mg
RNH052	9-Phenylanthracene		98%	14.00/100mg
RNH053	o-Phenylene pyrene	Indeno [1, 2, 3-cd] pyrene	99%	7.00/10mg
RNH054	2-Phenylanthracene		99%	19.00/100mg
RNH055	4-Phenyltoluene	4-Methyl biphenyl	99%	
RNH056	Picene			12.00/100mg
RNH057	Pyrene		99%	7.00/100mg
RNH058	p-Quaterphenyl		98%	14.00/10mg
RNH059	m-Quinquephenyl		95%	32.00/10mg
RCS059	o-Terphenyl		99%	7.00/100mg
RCS060	m-Terphenyl		99%	7.00/100mg
RCS061	p-Terphenyl		99%	7.00/100mg
RNH060	Tetracene	Xaphracene	99%	14.00/10mg
RNH061	Tetradecahydrophenanthrene		95%	18.00/100mg
RNH062	1, 2, 3, 4-Tetrahydrofluoranthene		99%	18.00/100mg
-----	1, 2, 4, 5-Tetramethylbenzene	See Durene		
-----	Tetrapheno	See 1, 2-Benzanthracene		
RNH063	1, 2, 3, 4-Tetraphenylanthracene		97%	7.00/100mg
RNH064	Triphenylene	9, 10-Benzophenanthrene	99%	10.00/10mg
RNH065	Triptycene	9, 10-o-Benzeno-9, 10-dihydroanthracene	98%	18.00/10mg
RNH066	Triuxene	10, 15-Dihydro-5H-diindeno [1, 2-a 1', 2', -c] fluorene	95%	14.00/100mg

THE SOLUBILITIES OF TWENTY-ONE CHLOROBIPHENYLS IN WATER

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Commercial PCB preparations consist of complicated mixtures of chlorobiphenyls with different chlorine content and their isomers. The composition of these technical products has only recently been established ¹⁻⁴.

A knowledge of the solubilities of PCB components is necessary for experiments involving individual isomers and may also be useful for the evaluation of PCB distribution in natural waters.

Considerable differences in the solubilities of chlorobiphenyls with different numbers of chlorination as well as positional isomers were indicated by change in the GC peak pattern of Aroclor 1254 re-extracted from aqueous solutions with hexane⁵. Solubilities of five mono- and dichlorobiphenyls also vary widely⁶.

We wish to present the results of our study on the solubilities of twenty-one chlorobiphenyls in water. Most of the compounds investigated are major components of commercial PCB preparations. Since water soluble humic substances were recently reported to act as carriers for lipophilic compounds including pollutants^{7, 10} the solubility of 4, 4'-dichlorobiphenyl in aqueous extracts of humic acid was also measured. The solubility of this compound was also determined in the presence of different concentrations of Tween 80. Aroclor preparations have an increased solubility in water in the presence of solubilizers¹¹ and the presence of the biologically relatively inert Tween 80 (e.g. 2% Tween 80 in nutrient solution showed no measurable growth inhibition in a number of microorganisms¹²) may allow the use of higher concentrations of chlorobiphenyl in many experiments.

EXPERIMENTAL

Instrumentation. Gas chromatography (GC) was carried out on a Varian 1800 instrument using a glass column (5 ft. x 2 mm i.d.) packed with 1.5% XE-60 on Anakrom Q operated at temperatures of 160-190°C depending on the compound. Carrier gas was nitrogen at a flow rate of 30 ml/min. Injector and electron capture detector were kept at 220°C.

Chemicals. Chlorobiphenyls (99% pure) were either Synthesized or obtained from Analabs Inc. (North Haven, Conn., U.S.A.). Humic acid was purchased from Aldrich Chem. Co. (Milwaukee, Wisc., U.S.A.).

Methods. An example for the determination of the solubility of one chlorobiphenyl in water is given below.

A hexane solution of the chlorobiphenyl (1 mg) was pipetted into a 300 ml Erlenmeyer flask and the solvent evaporated to give a thin film of the compound. Water (100 ml) was added, the flask sealed with parafilm and the mixture shaken at 30°C for 10 days. After this time the aqueous suspension was allowed to equilibrate at 22-24°C for 3 hr. Contact of aqueous chlorobiphenyl solution with glass was kept to a minimum after this step because of the known adsorption effects¹³. An aliquot (10 ml) was drawn using a syringe carrying a small filter compartment and immediately

extracted with hexane (2 x 10 ml). The hexane extract was concentrated to 10 ml and samples were injected into the gas chromatograph. Quantitative evaluation was obtained by measuring the peak height using calibration curve of known amounts of chlorobiphenyl standard in hexane. Sampling and analyses were carried out in duplicate.

In view of the problems with adsorption and low solubility the experiments were designed to give solubility data as absolute physical constants but were intended to give comparable values of reasonable accuracy for biological experiments. The solubility of polychlorobiphenyls in water are shown in Table 1.

TABLE 1
Solubility of chlorobiphenyls in water

Compound	(mg)	Solubility (ppm)
Monochlorobiphenyls		
2-.....	6.0	5.8
3-.....	3.35	3.8
4-.....	1.20	1.17
Dichlorobiphenyls		
2, 4-.....	1.40	1.40
2, 2'-.....	1.56	1.44
2, 4'-.....	1.90	1.85
4, 4'-.....	0.08	0.07
Trichlorobiphenyls		
2, 4, 4'-.....	0.085	0.085
3, 4, 2'-.....	0.075	0.080
Tetrachlorobiphenyls		
2, 2', 5, 5'-.....	0.046	0.046
2, 3, 2', 3'-.....	0.037	0.030
2, 3, 2', 5'-.....	0.170	0.170
2, 4, 2', 4'-.....	0.070	0.065
2, 4, 3', 4'-.....	0.055	0.060
2, 5, 3', 4'-.....	0.041	0.041
3, 4, 3', 4'-.....	0.175	0.175
Pentachlorobiphenyls		
2, 3, 4, 2', 5'-.....	0.021	0.023
2, 4, 5, 2', 5'-.....	0.035	0.028
Hexachlorobiphenyl		
2, 2', 4, 4', 5, 5'-.....	0.0088	0.0088
Octachlorobiphenyl		
2, 3, 4, 5, 2', 3', 4', 5'- ..	0.0088	0.0072
Decachlorobiphenyl		
4, 4'-Dichlorobiphenyl	0.015	0.015
+ Tween 10 0.1%	6.2	5.5
+ Tween 80 1%	10.0	10.0
+ Humic acid extract	0.075	0.06

We thank Dr. Freed for supplying data prior to publication. P.R.W. expresses his gratitude to the "Deutsche Forschungsgemeinschaft" for financial support. Part of this work was carried out while O. H. was on leave at the Bayerische Landesanstalt. This author would like to thank the "Deutsche Akademische Austauschdienst" for the invitation to Germany and financial aid.

1. O. Hesse and D. Welf, J. Chromatogr. 60, 17 (1971).
2. R. G. Webb and A. C. McCall, J. Ass. Offic. Anal. Chem. 55, 749 (1972).
3. T. S. Ota, A. Tsunoe, K. Oguri, H. Yoshimura and M. Hamada, Tokoku Igaku Zasshi 62, 21 (1971); Chem. Abstr. 74, 146294 (1971).
4. A. C. Tas and B. H. deVos, Environ. Sci. Technol. 5, 1216 (1971).
5. A. C. Tas and R. J. C. Klempool, Bull. Environ. Contam. Toxicol. 6, 32 (1972).
6. D. E. Willis and R. F. Addison, J. Fish. Res. Bd. Canada 29, 592 (1972).
7. V. H. Freed, personal communication (Some physical chemical properties of the polychlorinated biphenyls-Aroclor 1254; manuscript).
8. R. G. Webb, PCB Newsletter (1970).
9. G. Ogner and M. Schmitzer, Science 170, 317 (1970).
10. K. Matsuda and M. Schmitzer, Bull. Environ. Contam. Toxicol. 6, 200 (1971).
11. V. Zitko, Fish. Res. Bd. Canada, Manuscript Report Series No. 1083 (1970).
12. H. J. Rehm, S. Laufer-Heydenreich and P. Wallnofer, Z. Lebensm. Unters. Forsch. 135, 117 (1966).
13. M. L. Hattula, Dansk. Tidskr. Farm. 45, 259 (1971).

PROGRESS REPORTS ON PCB ISOMERS

By: Michael Bolgar

Given the toxicity and persistence of the widely dispersed polychlorinated biphenyls (PCB's) it seems logical that the U.S. Interdepartmental Taskforce on PCB's in their 181-page May 1972 Report (Com-72-10419) would include as part of their recommendation (page 18) the following additional studies, (*italics are ours*):

1. *Toxicological evaluation of a select number of representative, purified PCB isomers as well as purified trace contaminants such as the chlorinated dibenzofurans.*
2. *Definitive mammalian elaboration of the kinetics, absorption, distribution, metabolism, and excretion of the technical PCBs as well as a number of key isomers and the chlorinated dibenzofurans.*
3. *Elaboration of the subcellular and intracellular actions of the technical PCBs as well as a number of representative isomers and chlorinated dibenzofurans.*
4. *More definitive epidemiological studies of the PCBs with both more representative population sampling and standardization on the basis of lipid content of the tissues.*

In our list of biphenyls and 50 isomers of the 209 possible chlorobiphenyls we included a great number of the major components present in the commercial mixtures. For

instance, Willis and Addison¹ report that the major components of Aroclor 1221 accounting for 92.3 weight per cent are biphenyl, 2-Cl, 4-Cl, 2, 2'-Cl₂, 2, 4'-Cl₂ (all available from Analabs stock). From Sissons and Welt's² list of the major components of the more important Aroclor 1254 (we list more than half). Methods have been developed³ to recover PCB's present in waste and river water and to increase detectability by perchlorinating the samples sensitizing them to electron-capture detection by gas chromatography⁴.

We have made the tools available (polyurethane foam plugs and perchlorination kits).

Assembled below is data of melting points taken of our pure isomers and taken from the literature. This list reveals interesting features of configuration/physical property correlation.

MELTING POINTS OF POLYCHLORINATED BIPHENYLS

<i>Chlorine Position</i>	<i>Melting Points</i>
<i>Mono</i>	
2-Cl	32.0-32.5°C
3-Cl	Oil
4-Cl	75.5-77.0°C
<i>Di</i>	
2, 3-Cl ₂	Oil (Lit. 27.7-28.2°C)
2, 4-Cl ₂	Oil (Lit. 24-25°C)
2, 5-Cl ₂	Oil (Lit. 22-23°C)
2, 6-Cl ₂	34-35°C
3, 4-Cl ₂	47-48°C
3, 5-Cl ₂	Oil (Lit. 31-32°C)
2, 2'-Cl ₂	60-61°C
3, 3'-Cl ₂	25-26°C
4, 4'-Cl ₂	148-149°C
2, 3'-Cl ₂	Lit. Oil
2, 4'-Cl ₂	42.5-43.5°C
3, 4'-Cl ₂	Lit. Oil
<i>Tri</i>	
2, 3, 4-Cl ₃	101-102°C
2, 3, 5-Cl ₃	Lit. 41°C
2, 3, 6-Cl ₃	58-60°C
2, 4, 5-Cl ₃	76-78°C
2, 4, 6-Cl ₃	62.0-63.5°C
2, 3, 2'-Cl ₃	Lit. 28-29°C
2, 3, 4'-Cl ₃	Lit. 73°C
2, 4, 4'-Cl ₃	57.0-57.5°C
2, 5, 2'-Cl ₃	43-44°C
2, 5, 3'-Cl ₃	40.0-40.5°C
2, 5, 4'-Cl ₃	63.5-64.5°C
3, 4, 2'-Cl ₃	60.0-60.5°C
3, 4, 4'-Cl ₃	Lit. 87-88°C
3, 5, 2'-Cl ₃	Lit. 58°C
3, 5, 4'-Cl ₃	Lit. 88°C

MELTING POINTS OF POLYCHLORINATED BIPHENYLS

Chlorine Position	Melting Points
Tetra	
2, 3, 4, 5-Cl ₄	91.5-92.5°C
2, 3, 5, 6-Cl ₄	77.0-77.5°C
2, 3, 4, 4'-Cl ₄	Lit. 141-142°C
2, 4, 5, 4'-Cl ₄	Lit. 125°C
2, 3, 2' 3'-Cl ₄	119.5-121.5°C
2, 3, 2' 5'-Cl ₄	46.5-47.0°C
2, 4, 2' 4'-Cl ₄	41-42°C
2, 4, 2' 5'-Cl ₄	64-66°C
2, 4, 3' 4'-Cl ₄	127-128°C
2, 5, 2' 5'-Cl ₄	86-87°C
2, 5, 3' 4'-Cl ₄	104-107°C
2, 6, 2' 6'-Cl ₄	190-200°C (sublimes)
3, 4, 3', 4'-Cl ₄	182-184°C
3, 5, 3', 5'-Cl ₄	Lit. 164°C
Penta	
2, 3, 4, 5, 6-Cl ₅	123-125°C
2, 3, 4, 5, 4'-Cl ₅	Lit. 98-99°C
2, 3, 4, 2', 5'-Cl ₅	111.5-113.0°C
2, 3, 4, 3' 4'-Cl ₅	Lit. 101-105°C
2, 3, 6, 2' 5'-Cl ₅	97-98°C
2, 4, 5, 2' 3'-Cl ₅	81-82°C
2, 4, 5, 2' 5'-Cl ₅	76.5-77.5°C
2, 4, 5, 3' 4'-Cl ₅	Lit. 105-107°C
Hexa	
2, 3, 4, 5, 6, 2'-Cl ₆	Lit. 134-137°C
2, 3, 4, 5, 6, 3'-Cl ₆	Lit. 97-100°C
2, 3, 4, 5, 6, 4'-Cl ₆	Lit. 160-165°C
2, 3, 4, 5, 2' 4'-Cl ₆	Lit. 77-78°C
2, 3, 4, 5, 2' 5'-Cl ₆	89-91°C
2, 3, 5, 6, 2' 5'-Cl ₆	100-101°C
2, 3, 4, 2' 3' 4'-Cl ₆	155-8°C
2, 3, 4, 2' 4' 5'-Cl ₆	78.5-80.0°C
2, 3, 5, 2' 3' 5'-Cl ₆	Lit. 128-129°C
2, 3, 6, 2' 3' 6'-Cl ₆	115-117°C
2, 3, 6, 2' 4' 5'-Cl ₆	Lit. Oil
2, 4, 5, 2' 4' 5'-Cl ₆	102-104°C
2, 4, 5, 2' 4' 6'-Cl ₆	Lit. Oil
2, 4, 6, 2' 4' 6'-Cl ₆	119.5-114.5°C
3, 4, 5, 3', 4' 5'-Cl ₆	Lit. 198

MELTING POINTS OF POLYCHLORINATED BIPHENYLS

Chlorine Position	Melting Points
<i>Hepta</i>	
2, 3, 4, 5, 6, 2' 5'-Cl ₇	147-150°C
2, 3, 4, 5, 6, 3', 4'-Cl ₇	Lit. 116-118°C
2, 3, 4, 5, 2', 3', 4'-Cl ₇	Lit. 134.5-135.5°C
2, 3, 4, 5, 2' 3' 6'-Cl ₇	Lit. 130.5-130.7°C
2, 3, 4, 5, 2' 4' 5'-Cl ₇	Lit. 109-110°C
2, 3, 4, 5, 2' 4' 6'-Cl ₇	Lit. 152-153°C
2, 3, 4, 5, 3' 4' 5'-Cl ₇	Lit. 162-163°C
<i>Octa</i>	
2, 3, 4, 5, 2' 3' 4' 5'-Cl ₈	158-159°C
2, 3, 4, 6, 2' 3' 4' 6'-Cl ₈	Lit. 132°C
2, 3, 5, 6, 2' 3' 5' 6'-Cl ₈	161-162°C
<i>Nona</i>	
2, 3, 4, 5, 6, 2' 3' 4' 5'-Cl ₉	204.5-206.5°C
<i>Deca</i>	
2, 3, 4, 5, 6, 2' 3' 4' 5' 6'-Cl ₁₀	300-310°C (sublimes)

All melting Points taken on a Fischer-Johns melting point stage.

REFERENCES

1. D. E. Willis and R. F. Addison, J. Fish. Res. Board Canada, 29, No. 4, 592-595 (1972)
2. D. Sessions and D. Welti, J. Chromatography, 60, 15-32 (1971)
3. H. D. Gesser, A. Chow, F. C. Davis, J. F. Uthe and J. Reinke, Anal. Lett., 4, 883-8 (1971)
4. V. Zitko, O. Hutzinger and S. Safe, Bull. Environ. Contam. Toxicol. 6, 160 (1971)

99% Pure PCB Isomers

For clarity we have kept the position numbering separate for each ring. For Chemical Abstracts nomenclature transpose numbers listing lowest number first.

RCS-001	Biphenyl	\$7.00/500mg
RCS-002	2-Chlorobiphenyl	7.00/100mg
RCS-003	3-Chlorobiphenyl	7.00/100mg
RCS-004	4-Chlorobiphenyl	7.00/100mg
RCS-005	2, 2'-Dichlorobiphenyl	18.00/100mg
RCS-006	3, 3'-Dichlorobiphenyl	18.00/100mg
RCS-007	4, 4'-Dichlorobiphenyl	18.00/100mg
RCS-008	2, 4'-Dichlorobiphenyl	32.00/50mg
RCS-009	2, 3-Dichlorobiphenyl	14.00/100mg
RCS-010	2, 4-Dichlorobiphenyl	14.00/100mg
RCS-011	2, 5-Dichlorobiphenyl	14.00/100mg
RCS-012	2, 6-Dichlorobiphenyl	14.00/100mg
RCS-013	3, 4-Dichlorobiphenyl	14.00/100mg
RCS-014	3, 5-Dichlorobiphenyl	14.00/100mg
RCS-015	2, 4, 4'-Trichlorobiphenyl	26.00/20mg
RCS-052	2, 4, 3', 4'-Tetrachlorobiphenyl	32.00/20mg
RCS-016	2, 5, 2'-Trichlorobiphenyl	28.00/50mg
RCS-017	2, 5, 3'-Trichlorobiphenyl	28.00/50mg
RCS-018	2, 5, 4'-Trichlorobiphenyl	28.00/50mg
RCS-019	3, 4, 2'-Trichlorobiphenyl	28.00/50mg
RCS-020	2, 3, 4-Trichlorobiphenyl	26.00/50mg
RCS-021	2, 3, 6-Trichlorobiphenyl	36.00/50mg
RCS-022	2, 4, 5-Trichlorobiphenyl	22.00/100mg
RCS-023	2, 4, 6-Trichlorobiphenyl	26.00/100mg
RCS-024	2, 3, 2', 3'-Tetrachlorobiphenyl	28.00/100mg
RCS-025	2, 4, 2', 4'-Tetrachlorobiphenyl	28.00/100mg
RCS-026	2, 5, 2', 5'-Tetrachlorobiphenyl	28.00/100mg
RCS-027	2, 6, 2', 6'-Tetrachlorobiphenyl	28.00/100mg
RCS-028	3, 4, 3', 4'-Tetrachlorobiphenyl	28.00/100mg
RCS-029	2, 3, 2', 5'-Tetrachlorobiphenyl	35.00/50mg
RCS-030	2, 4, 2', 5'-Tetrachlorobiphenyl	22.00/20mg
RCS-031	2, 5, 3', 4'-Tetrachlorobiphenyl	35.00/50mg
RCS-032	2, 3, 4, 5-Tetrachlorobiphenyl	20.00/50mg
RCS-033	2, 3, 5, 6-Tetrachlorobiphenyl	20.00/50mg
RCS-034	2, 3, 4, 2', 5'-Pentachlorobiphenyl	25.00/20mg
RCS-035	2, 3, 6, 2', 5'-Pentachlorobiphenyl	22.00/10mg
RCS-036	2, 4, 5, 2', 3'-Pentachlorobiphenyl	22.00/10mg
RCS-038	2, 4, 5, 2', 5'-Pentachlorobiphenyl	35.00/50mg
RCS-039	2, 3, 4, 5, 6-Pentachlorobiphenyl	28.00/100mg
RCS-040	2, 3, 4, 2', 3', 4'-Hexachlorobiphenyl	32.00/20mg
RCS-041	2, 3, 4, 2', 4', 5'-Hexachlorobiphenyl	28.00/10mg
RCS-042	2, 3, 6, 2', 3', 6'-Hexachlorobiphenyl	36.00/20mg
RCS-043	2, 4, 5, 2', 4', 5'-Hexachlorobiphenyl	36.00/100mg
RCS-044	2, 4, 6, 2', 4', 6'-Hexachlorobiphenyl	32.00/50mg
RCS-045	2, 3, 4, 5, 2', 5'-Hexachlorobiphenyl	28.00/10mg
RCS-046	2, 3, 5, 6, 2', 5'-Hexachlorobiphenyl	28.00/10mg
RCS-047	2, 3, 4, 5, 6, 2', 5'-Heptachlorobiphenyl	36.00/10mg
RCS-048	2, 3, 4, 5, 2', 3', 4', 5'-Octachlorobiphenyl	26.00/20mg
RCS-049	2, 3, 5, 6, 1', 3', 5', 6'-Octachlorobiphenyl	26.00/20mg
RCS-050	2, 3, 4, 5, 6, 2', 3', 4', 5'-Nonachlorobiphenyl	36.00/10mg
RCS-051	2, 3, 4, 5, 6, 2', 3', 4', 5', 6'-Decachlorobiphenyl	7.00/100mg

Discount on single order of any 5 PCB's-10% 10 PCB's-15%
Bibliography on PCB Literature available on request.

POLYURETHANE-FOAM PLUGS

For complete extraction of pesticides and PCB's from environmental water samples (for instance -- river water).

References:

1. The extraction and recovery of polychlorinated biphenyls (PCB) using porous polyurethane foam. H. D. Gesser, A. Chow, F. C. Davis, J. F. Uthe, and J. Reinke. Anal. Lett., 4, 883-6 (1971).
2. Extraction of organochlorine pesticides from water by porous polyurethane. J. F. Uthe, J. Reinke and H. Gesser, Environmental Letters, 3, 117-135 (1972).

Written procedure for extraction of pesticides and PCB's from water samples will be supplied with each order or on request.

Polyurethane-foam plugs (22mm x 38mm)

RCS-083	Untreated	\$10.00/50
RCS-084	Washed	12.00/12
RCS-085	Treated with 0.5% DC-200	12.00/12

Chromatographic Tubes (20mm ID, 400mm long)

RCS-086	Tube without fritted disc	\$13.00/2 tubes
RCS-087	Tube with fritted disc	11.00/each

Perchlorination Kits for Analysis of Polychlorinated Aromatics

References:

1. Analysis of chlorinated aromatic hydrocarbons by exhaustive chlorination: Qualitative and structural aspects of the perchloro derivatives of biphenyl, naphthalene, terphenyl, dibenzofuran, dibenzodioxin and DDE. O. Hutzinger, S. Safe, and V. Zitko.
International Journal of Environmental Analytical Chemistry, 2, 95 (1972).
2. Column chromatographic separation of polychlorinated biphenyls from chlorinated hydrocarbon pesticides, and subsequent gas chromatographic quantitation in terms of derivatives. O. W. Berg, P. L. Diosady and G. A. V. Rees
Bulletin of Environmental Contamination and Toxicology, 7, #6, 338-347, (1972).
3. Screening method for the detection of chlorodibenzo-p-dioxins in the presence of chlorobiphenyls, chloronaphthalenes, and chlorodibenzofurans. D. T. Williams and B. J. Blanchfield, JAOAC. 55, 93-5 (1972).

RCS079	Perchlorination reagents A ₁ and A ₂	\$10.00
For PCB's, PCDD's, PCF's, and p,p'-DDE (in equal volumes).		
RCS080	Perchlorination reagent B	6.00
For PCB, PCT and p,p'-DDE		
RCS081	Perchlorination reagent C	6.00
For PCN's		
RCS082	Perchlorination kit (A ₁ , A ₂ , B, C)	16.00

Detailed perchlorination procedures will be supplied on request and with each order.

RCS006 PCB-K9 1 gm each of Aroclor
1252, 1253, 1254, 1255 and 1256) 1.00/kit

RCS007 Nardol \$ 7.00/500 mg
RCS008 1-Chloro 7.00/500 mg
RCS009 2-Chloro 7.00/500 mg

Number of Chlorines	1	2	3	4	5	6	7	8
% of Chlorine	21.85	36.40	46.00	53.36	59.07	63.6	67.2	70.3

Reference: Behavior of chlorinated naphthalenes in analytical methods for organo-chlorinated pesticides and polychlorinated biphenyls. J. A. Armour and J. A. Burke, JAOAC, 54, 175-7 (1971).

RCS053... 1-Chlorodibenzo-p-dioxin.....20/50 mg
RCS054... 2-Chlorodibenzo-p-dioxin 20/50 mg
RCS067... Dibenzo-p-dioxin \$15.00/50 mg
RCS055... 2, 3-Dichlorodibenzo-p-dioxin.....25/50 mg
RCS068... 2, 7-Dichlorodibenzo-p-dioxin..... 25.00/50 mg
RCS069... 1, 2, 3, 4, 6, 7, 8, 9-Octachlorodibenzo-p-dioxin.. 20.00/50 mg
RCS056... 1, 2, 4-Trichlorodibenzo-p-dioxin25/50 mg
RCS057... 1, 2, 3, 4-Tetrachlorodibenzo-p-dioxin.....25/50 mg

References:

1. Thin-layer chromatographic separation of two chlorodibenzo-p-dioxins from some polychlorinated biphenyls and organochlorine pesticides. D. T. Williams and B. J. Blanchfield, JAOAC, 54, 1429-31 (1971).
2. Determination of polychlorodibenzo-p-dioxins in chlorophenols and lipids. D. Firestone, Paper presented at the 162nd National ACS Meeting, Pesticide Div., Sept. 12-17, 1971.

99% POLYCHLORINATED DIBENZOFURANS

RCS070 Dibenzofuran \$ 7.00/500 mg
RCS058 3, 6-Dichlorodibenzofuran36/20 mg
RCS071 1,2,3,4,5,6,7,8-Octachlorodibenzofuran 15.00/50 mg

Reference: Identification and toxicological evaluation of chlorinated dibenzofuran and chlorinated naphthalene in two commercial polychlorinated biphenyls. J. G. Vos, J. H. Koeman, H. L. van der Maas, M. C. Ten Noever de Brauw and R. H. de Vos, Food Cosmet. Toxicol., 8, 625-633 (1970).

RCS077 Hexachlorophene [2,2'-Methylenbis-(3,4,6-trichlorophenol)] \$ 5.00/1 mg
RCS078 Perchlorinated p,p'-DDE 20.00/50 mg

The list of pesticide standards that follows is possibly the most extensive compilation offered. For your convenience we have also listed the synonyms and a cross reference for different trade names. If the pesticide you need is not listed, please inquire. (*Available also in solution concentrations of .1 to 1000 PPM in powers of 10).

NEV 036865

PESTICIDE STANDARDS

Catalg #	Product	Synonyms	Active Ingredient	% A. I.	Price
RSP079	Caplan	Orthoide	N-Trichloromethylbis(4-cyclohexene-1,2-dicarboxide)	99%	18.00/g
—	Carbaryl	See Sevin			
—	Carbophenothion	See Tribitox			
—	Carbophos	See Malathion			
—	Cardibe	See Ethyl Hexano Diol Sulfide			
RSP080	Chlorfenids	Chlorfenacide Chlorfenaphacide	p-chlorobenzenyl-p-chlorophenyl	99%	12.00/100mg
—	—	Mitox			
RSP084	Chlorfens	Creacher	1, 2, 3, 4, 5, 6, 7, 8-Octachloro-2a, 4, 7, 7a-tetrahydro-4, 7-methano indene Chloroacetic Acid	Techn.	14.00/g
RSP081	Chloroacetic acid	Mouchochloroacetic Acid		99%	6.00/g
RSP082	Chlorobenzilate		Ethyl-4, 4'-dichlorobenzilate	99%	16.00/g
RSP083	Chlorobenzilate, tech.		Ethyl-4, 4'-dichlorobenzilate	45%	4.00/g
—	Chloroxiprin	See Trichlorfon			
—	Chloroxiprin Chlorophosphate	See Trichlorfon			
—	Chloroxiprin Chlorophosphate	See Chlorbenzide			
RSP084	Cloftrin	See Chlorbenzide			
RSP085	Co-Ral	Coumaphos	α-N-methyl benzyl-β-(dimethoxyphenylmethyl)-α-crotonate O,O-Diethyl-O-(3-chloro-4-methyl-2-oxo-3H-1-benzopyran-7-yl) phosphorothioate O,O-Diethyl-O-(3-chloro-4-methyl-2-oxo-3H-1-benzopyran-7-yl) phosphorothioate	85% 99%	16.00/g 23.00/100mg
RSP086	Co-Ral, tech.				6.00/g
—	Coumaphos	See Waftrin			
—	Coumaphos	See Co-Ral			
RSP088	Cyachlanide	Acid-dione	3,12-(3, 5-Dimethyl-3-oxocyclohexenyl)-2-hydroxyethyl glutarimide	Techn.	18.00/g
—	Cyox	See Dimethoate			
—	Cyox	See Zinophor			
RSP087	Cyox	Dodine	n-octadecylguanidine acetate	100%	20.00/100mg
RSP088	Cyox, tech.		n-octadecylguanidine acetate		6.00/g
RSP089	2, 4-D Acid		2-(2, 4-Dichlorophenyl) acetic acid	99%	18.00/100mg
RSP090	2, 4-D Acid		2-(2, 4-Dichlorophenyl) acetic acid methyl ester	99%	16.00/100mg
RSP091	Methyl Ester	DCPA	Dimethyl-2, 3, 5, 6-tetrachloro-2, 3-dichloropropionic Acid	99%	12.00/g
RSP092	Dalapon	See Methyl Parathion			
—	Dalf	Mylens	2, 5-Dimethyl-1, 3, 5, 5-tetrachloro-1,3,5-triazine-2-thione	99%	20.00/100mg
RSP093	Decomet				12.00/g
—	DCPA	See Dacthal			
RSP098	DDU mls	TDE mix	1, 1-Dichloro-2, 2-(chlorophenyl) ethane	Techn. (homomer mls)	3.00/g
RSP094	. p-DDD	α, p-TDE	1, 1-Dichloro-2-(o-chlorophenyl)-2-(p-chlorophenyl) ethane	99%	13.00/100mg
RSP095	p. p-DDD	p. p-TDE	1, 1-Dichloro-2, 2-bis (p-chlorophenyl) ethane	99%	20.00/100mg
RSP097	α, p-DDD	α, p-DDX	1, 1-Dichloro-2-(o-chlorophenyl)-2-(p-chlorophenyl) ethane	99%	20.00/100mg
RSP098	α, p-DDD	p. p-DDX	1, 1-Dichloro-2, 2-bis (p-chlorophenyl) ethane	99%	21.00/g
RSP099	α, p-DDD	p. p-DDX	1, 1, 1-Trichloro-2, 2-bis (chlorophenyl) ethane	Techn. (homomer mls)	8.00/g
RSP100	p. p-DDD		1, 1, 1-Trichloro-2-(o-chlorophenyl)-2-(p-chlorophenyl) ethane	99%	23.00/g
RSP101	DVT mls		1, 1, 1-Trichloro-2, 2-bis (p-chlorophenyl) ethane	99%	12.00/g
RSP102	α, p-DDT				
RSP103	p. p-DDT				
—	DDVP	See Dielderros			
—	p. p-DDX	See α, p-DDD			
—	p. p-DDX	See p. p-DDD			
RSP103	DEET	Dielderros	N, N-Diethyl-m-tolamide	95%	12.00/g

PLISTIDE STATIONS

Catalog #	Product	Synonym	Active Ingredient	% A.I.	Pctn
NSP015 • DEE	Deephine	See DEET	S, S, S-Tributyl phosphorothioate	94%	22.00/100mg
NSP016 • Dremin	Dremin	Syston	Mix of 0.10, 0-Dichloro-2-(ethyl thio) ethyl phosphorothioate and 0.10, 0-Dichloro-S-(ethylthio) ethyl phosphorothioate]	Tech.	\$0.00/100mg
NSP094	Dreminde Dremin	See DEET	p-Dimethylaminoacetazuriaz sodium sulfonate	94%	12.00/100mg
NSP017 • Dri-Akale	Dri-Akale	See Diphemylamine See Ayvexa Burdin	0, 0-Dichloro-1, 2, 4-tripropyl-6-methyl-4-pyrimidinyl) phosphorothioate 0, 0-Dichloro-1, 2, 4-tripropyl-6-methyl-4-pyrimidinyl) phosphorothioate 1, 2-Dichloro-2, 2-dichloromethyl diethyl phosphite Dihetylphthalate	99%	12.00/100mg
NSP094	Dremin, tech.	Naled		95%	6.00/g
NSP018 • Dlinema	Dlinema	See Bawel D See Dilep Phoo	D-(2, Chloro-4-nitrophenyl)-0, 0-dichloroethyl phosphorothioate	99.5%	12.00/100mg
NSP098	Dibutylythiolate	See Phygion	o-Dichlorobenzene p-Dichlorobenzene p-Dichloroacetate 2, 4-Dichlorophenol	99%	6.00/g
NSP097	Dicaphoon	See Phygion	0, 0-Dichloro-1, 2, 4-tripropyl-6-methyl-4-pyrimidinyl) phosphorothioate	99%	6.00/g
NSP098	Dichlorobenzene	See Phygion	0, 0-Dichloro-1, 2, 4-tripropyl-6-methyl-4-pyrimidinyl) phosphorothioate	99%	6.00/g
NSP099	p-Dichlorobenzene	See S, 4-DIP-Acid	0, 0-Dichloro-1, 2, 4-tripropyl-6-methyl-4-pyrimidinyl) phosphorothioate	99%	6.00/g
NSP100	Dichlorophenol	See S, 4-DIP-Acid	0, 0-Dichloro-1, 2, 4-tripropyl-6-methyl-4-pyrimidinyl) phosphorothioate	99%	6.00/g
NSP014	Dichloroprop	See S, 4-DIP-Acid	0, 0-Dichloro-1, 2, 4-tripropyl-6-methyl-4-pyrimidinyl) phosphorothioate	99%	12.00/100mg
NSP019 • Didekita	Didekita	See Kelthane See Kelthane Hood	1, 2, 3, 4, 10, 10-Hexachloro-7-epoxy-1, 4, 4, 5, 9, 7, 8, 8a-octahydro-1, 4-endo-3, 8-dimethanonaphthalene N-(1, 1, 3, 3-tetrachloro-2-hydroxy-1-methyl)-2, 4-dichlorobenzene-1, 2-dichlorobenzene 0, 0-Dimethyl-S-(N-Methyl carbamoyl-methyl) phosphorodithioate	81%	16.00/g
NSP101	Difololan	See Phosphamidon	0, 0-Dimethyl-S-(N-Methyl carbamoyl-methyl) phosphorodithioate	99%	12.00/100mg
NSP103	Diflocron Diflocrobs	Rogor Cyron Foston	0, 0-Dimethyl-S-(N-Methyl carbamoyl-methyl) phosphorodithioate	99%	22.00/g
NSP105	Difluraly Phthalate	See Kelthane DNBP	Difluraly Phthalate	99%	16.00/g
NSP104	Diflocro	See Kelthane DNBP	2, 4-Dichloro-2-methyl phenyl	99%	12.00/100mg
NSP105	Diflocro	See Kelthane DNBP	2-Dichloro-2-methyl-1, 3-dichlorobenzene	Tech.	12.00/100mg
NSP106	Diphenamide Diphenamide	See Diphacin Dymid EPA	N, N-Dimethyl 2, 2-diphenylacetamide	Tech.	12.00/g
NSP107	Diphenyl- Aniline	See Trichlorfon See Trichlorfon See Trichlorfon Dilalation Dilalation	0, 0-Dichloro-S-(2-ethylthio) vinyl phosphorodithioate	97%	16.00/g
NSP108	Diphenyl- Diphenyl Dilalation	See Trichlorfon See Trichlorfon See Trichlorfon Dilalation Dilalation	0, 0-Dichloro-S-(2-ethylthio) vinyl phosphorodithioate	97%	16.00/g
NSP109	Diphenyl- Diphenyl Dilalation	See Trichlorfon See Trichlorfon See Trichlorfon Dilalation Dilalation	0, 0-Dichloro-S-(2-ethylthio) vinyl phosphorodithioate	97%	16.00/g
NSP110	Diphenyl- Diphenyl Dilalation	See Trichlorfon See Trichlorfon See Trichlorfon Dilalation Dilalation	0, 0-Dichloro-S-(2-ethylthio) vinyl phosphorodithioate	97%	16.00/g

PESTICIDE STANDARDS

Catalog #	Product	Synonym	Active Ingredient	% A.I.	Price
-----	Dyax	See Trichlorfon			
-----	Dynid	See Diphemamid			
RSP030	Endosulfan	See Thiodan			
RSP111	Endrin, tech.		1, 2, 3, 4, 10, 10-Hexachloro-7, 8, 9, 10-tetrahydro-1, 4-endo, endo-3, 8-dimethanonaphthalene	99%	10.00/g
-----	-----		1, 2, 3, 4, 10, 10-Hexachloro-7, 8, 9, 10-tetrahydro-1, 4-endo, endo-3, 8-dimethanonaphthalene	97%	0.00/g
RSP031	End	See Diphemamid	O-Ethyl-O-p-nitrophenyl phenyl phosphorodithioate	97%	12.00/100mg
RSP113	Ethion	Ilunon	2-(2, 4, 6-Trichlorophenonyl) ethyl 2, 2-dichloropropionate	Tech.	0.00/g
RSP032	Esimilla	See Oxa	O, O, O'-Tetraethyl-S, S'-methyl-oxaphosphorodithioate	95%	22.00/100mg
RSP115	Ethion	Nielite	2-Ethyl-1, 3-Hexanedithiol	Tech.	12.00/g
RSP116	Ethyl Hexanedithiol	See Parathion			
RSP115	Eugenol	Mallinon	Eugenol	80%	12.00/g
RSP114	Fenitrothion	Sumithion	O, O-Dimethyl-O-(4-nitro-m-tolyl) phosphorothioate	99%	21.00/100mg
RSP033	Fenitrothion, tech.		O, O-Dimethyl-O-(4-nitro-m-tolyl) phosphorothioate	95%	12.00/g
RSP116	Fenitrothion		O, O-Dimethyl-O-(4-methylthio-m-tolyl) phosphorothioate	Tech.	10.00/100mg
-----	Fenproph	See Silvex			
-----	Folidol	See Parathion			
-----	Folilors	See Fenitrothion			
-----	Folget	See Phialin			
-----	Fonlan	See Monroton			
-----	Fonlan	See Dimethoate			
RSP117	Fenoxone		1, 2-Dichloro-3-ethoxypropane	Tech.	0.00/g
-----	Gesafra	See Prometone			
-----	Gesafra	See Propazine			
-----	Gesafra	See Altrazine			
-----	Gesafra	See Prometone			
-----	Gesafra	See Silvex			
-----	Gesafra	See Azinphosmethyl			
-----	Gesafra	See Azinphosmethyl			
-----	Gesafra	See Hexachlorobenzene			
-----	Gesafra	See Dieldrin			
RSP034	Heptachlor	Nitrobenzodene	1, 2-Dichloro-3-ethoxypropane	Tech.	0.00/g
RSP035	Heptachlor		1, 4, 5, 6, 7, 8, 8-Heptachloro-1, 4, 7, 7-tetrahydro-1, 2-methanone	97.4%	18.00/g
RSP031	Heptachlorobenzene		1, 4, 5, 6, 7, 8, 8-Heptachloro-2, 3-epoxy-3, 4, 4, 7, 7-tetrahydro-4, 7-methanone	90%	35.00/100mg
RSP118	Imidan		Hexachlorobenzene	90%	10.00/g
RSP119	IPC		O, O-Dimethyl-S-phthalimido-methyl phosphorodithioate	95%	10.00/g
RSP120	Karathane		Isopropyl N-piperidyl carbamate	Tech.	0.00/g
-----	-----	See Karathane			
RSP036	Karathane	Amilone	2-(1-Methyl-4-ethyl-4, 6-dithiophenyl) carbamate	85%	20.00/g
-----	-----	Amilone			
RSP121	Kelthane, tech.	Amilone	1, 1, 1-tris (4-Chlorophenyl)-2, 2, 2-trichloroethanol	90%	17.00/g
RSP045	Lannate	Amilone	1, 1, 1-tris (4-Chlorophenyl)-2, 2, 2-trichloroethanol	90%	6.00/g
RSP122	Lethane 384	Amilone	5-Methyl-N-[(1-Methyl-4-ethyl-4, 6-dithiophenyl) carbamate]	90%	10.00/g
-----	-----	Amilone	2-(2-Butoxyphenyl) ethyl thiocyanate	53%	12.00/g

PESTICIDE STANDARDS

[illegible]

PESTICIDE STANDARD

Catalog #	Product	Synonym	Active Ingredient	% A. I.	Price
RSP038	• Schradan	OMPA Pestox Sytan	Octamethylpyrophosphoramide	99.8%	14.00/g
RSP173	Schradan, tech.		Octamethylpyrophosphoramide	95%	8.00/g
RSP170	• Sevin	Carbaryl	1-Naphthyl N-methyl carbamate	95%	21.00/100mg
RSP171	Silva	Fenoprop	2-(2, 4, 5-Trichlorophenoxy) propionic Acid	99%	16.00/100mg
RSP172	Silva, tech.		2-(2, 4, 5-Trichlorophenoxy) propionic Acid		6.00/g
RSP039	• Simazine	Genetop	2-chloro-4, 6-bis (ethyl amino)-5-triazine	99.3%	11.00/100mg
-----	SNP	See Parathion			
RSP174	Spurgon	Chlwanil	Tetrachloro-p-benzoquinone	Tech.	6.00/g
RSP175	Stroben		Terpene polychlorinated	65% Chloride	16.00/g
-----	Sulfo-Cide	See Sulfonide			
RSP176	Sulfonide	Sulfonyl Sulfo-cide	1, 2-Methylendioxy-4-[2-(octyl sulfinyl) propyl] benzene	88%	12.00/g
-----	Sulfonyl	See Sulfonide			
-----	Sunthion	See Fenitrothion			
-----	Systox	See Demeton			
-----	Sytan	See Schradan			
RSP177	2, 4, 5 T-acid		2, 4, 5-Trichlorophenoxyacetic Acid	99%	16.00/100mg
RSP178	2, 4, 5 T-acid		2, 4, 5-Trichlorophenoxyacetic Acid	Tech.	6.00/g
-----	TCDS	See Tediou			
-----	TDE mix	See DDD-mix			
-----	u, p-TDE	See o, p-DDD			
-----	p, p' TDE	See p, p'-DDD			
RSP155	Tediou	Diphar Tetradifon TCDS	p-Chlorophenyl 2, 4, 5-trichlorophenyl sulfone	99%	19.00/g
RSP157	2, 3, 4, 6 Tetrachlorophenol		2, 3, 4, 6 Tetrachlorophenol	99%	22.00/100mg
-----	Tetradifon	See Tediou			
RSP156	Thimet	Phorate	O, O Diethyl S-(ethylthio) methyl phosphorodithioate	99.5%	16.00/g
RSP159	Thimet, tech.		O, O Diethyl S-(ethylthio) methyl phosphorodithioate	91%	6.00/g
RSP040	• Thiodan	Endosulfan Maltix	0, 7, 8, 9, 10, 10-Hexachloro-1, 3, 3a, 6, 8, 8a-hexahydro-6, 9-methano 2, 4, 3-benzodioxathiepin 3-oxide	98%	23.00/100mg
-----	Thiomiazin	See Zinophos			
-----	Thiophal	See Phaltan			
-----	Thiophos	See Parathion			
RSP041	• Tuxaphene	Phenacide Phenatox	Polyethoximated camphene	Tech.	17.00/g
RSP042	• Trichlorfon	Tugon Chlorophos Diptera Dylox Nagavan Diptetes	O, O Dimethyl (1-hydroxy-2, 2, 2-trichloroethyl) phosphonate	98%	12.00/g
RSP160	Trichloro- nitromethane	Chlorophenol Acetylato	Trichloronitromethane	99%	12.00/g
RSP161	2, 4, 5 Tri- chlorophenol	Preventol I	2, 4, 5 Trichlorophenol	99%	10.00/100mg
RSP162	2, 4, 6 Tri- chlorophenol		2, 4, 6 Trichlorophenol	99%	10.00/100mg
RSP035	Trithion	Carbophenothion	S-[1 p-Chlorophenyl] thio methyl O, O diethyl phosphoro- dithioate	93%	16.00/g
-----	Tugon	See Trichlorfon			
-----	Unden	See Baygon			
-----	Vapona	See Dichlorvos			
RSP103	Vorlex		Methyl isothiocyanate	20%	12.00/g
RSP043	• Warfarin	Commufeno	3-(3- α -Acetoxylbenzyl-4-hydroxy coumarin	Tech.	10.00/100mg

NEV 036871

PESTICIDE STANDARDS

Catalog #	Product	Synonym	Active Ingredient	% A. I.	Price
RSP164	Zectran		4-dimethyl amino-3, 5-xylyl-N-Methyl carbamate	99%	16.00/g
RSP165	Zectran, tech.		4-dimethyl amino-3, 5-xylyl-N-Methyl carbamate	95%	6.00/g
RSP166	Zineb	Dithione-zinc Fenoxate	Zinc ethylene bisdithiocarbamate	75%	20.00/g
RSP167	Zinophos	Tidomiazin Cyren Nemafos UNIPA	O, O-Diethyl-O-2-pyrazinyl phosphorothioate	99%	16.00/100mg
RSP168	Zytron		O-(1, 4-Dichlorophenyl)-O-methyl isopropyl phosphoramidodithioate	99%	12.00/100mg
RSP169	Zytron, tech.		O-(1, 4-Dichlorophenyl)-O-methyl isopropyl phosphoramidodithioate	Tech.	6.00/g

PRECOATED TLC PLATES from ANALABS

Analabs TLC plates are of precision quality. They are precoated using procedures developed by leading chromatographic investigators.

The prescored 20 x 20 cm plate can be snapped in sections for two 10 x 20 cm, or four 5 x 20 cm plates. Scoring on the uncoated side makes snapping the plates easy. A clear edge on the plate allows the plate to be grasped without disturbing the coating. Separation information can be marked in this area.

ORDERING INFORMATION

20 x 20 cm PRECOATED PLATES 250 μ thick. 25 PLATES/BOX

NUMBER CATALOG	TLC PLATE TYPE	PRESCORED PRICE		UNSCORED PRICE
		5 x 20 cm	10 x 20 cm	20 x 20 cm
TLP-001	Anasil G	\$30	\$26	\$22
TLP-002	Anasil GF (254)	\$30	\$26	\$22
TLP-003	Anasil H	\$30	\$26	\$22
TLP-004	Anasil HF (254)	\$30	\$26	\$22
TLP-005	Silica Gel G	\$30	\$26	\$22
TLP-006	Silica Gel GF (254)	\$30	\$26	\$22
TLP-007	Microcrystalline Cellulose (Avicel)	\$31	\$27	\$23
TLP-008	Microcrystalline Cellulose, F (254) (Avicel)	\$31	\$27	\$23

Analabs precoated plates are guaranteed to arrive at your laboratory in condition for immediate use. Any plates that arrive damaged will be replaced at no cost to you and no troublesome paperwork.

NEV 036872

PESTICIDEGRADE SOLVENTS

Pesticidegrade Solvents are certified to contain no interfering substance greater than that equivalent to 10 parts per trillion of a chlorinated pesticide.

Catalog #	Solvent	Unit	Price
SSP001	Acetone, Pesticidegrade		
	Water 0.05% max.	1 Liter	\$14.00
SSP002	Acetonitrile, Pesticidegrade		
	Water 0.05% max.	1 Liter	15.00
SSP003	Benzene, Pesticidegrade		
	Water 0.03% max.	1 Liter	12.00
SSP004	2-Butanone, Pesticidegrade		
	Water 0.05% max.	1 Liter	13.00
SSP005	Butyl Alcohol, Pesticidegrade		
	Water 0.05% max.	1 Liter	12.00
SSP006	iso-Butyl Alcohol, Pesticidegrade		
	Water 0.05% max.	1 Liter	15.00
SSP007	Carbon Tetrachloride, Pesticidegrade		
	Water 0.02% max.	1 Liter	16.00
SSP008	Chloroform, Pesticidegrade		
	Water 0.02% max.	1 Liter	17.00
SSP009	Cyclohexane, Pesticidegrade		
	Water 0.02% max.	1 Liter	16.00
SSP010	Dichloromethane, Pesticidegrade		
	Water 0.02% max.	1 Liter	16.00
SSP011	N, N-Dimethylformamide, Pesticidegrade		
	Water 0.05% max.	1 Liter	19.00
SSP012	p-Dioxane, Pesticidegrade		
	Water 0.05% max.	1 Liter	17.00
SSP013	Ether, Pesticidegrade		
	Water 0.05% max.	1 Liter	12.00
SSP014	Ethyl Acetate, Pesticidegrade		
	Water 0.05% max.	1 Liter	13.00
SSP015	Ethyl Alcohol, Pesticidegrade		
	Completely Denatured		
	Water 0.05% max.	1 Liter	12.00
SSP016	Heptane, Pesticidegrade		
	Water 0.03% max.	1 Liter	13.00
SSP017	Hexane, Pesticidegrade		
	Water 0.02% max.	1 Liter	12.00
SSP018	Methanol, Pesticidegrade		
	Water 0.05% max.	1 Liter	11.00
SSP019	Methylsulfoxide, Pesticidegrade		
	Water 0.05% max.	1 Liter	21.00

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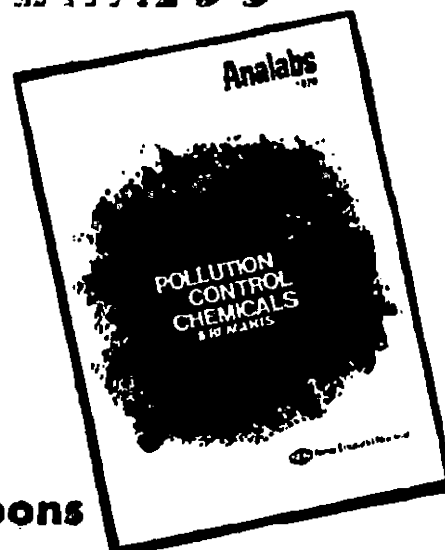
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ANALABS ANNOUNCES for 1974 A POLLUTION CHEMICAL STANDARD CATALOG

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PCT's
PCB's
PCN's
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Pesticides
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Polynuclear Hydrocarbons



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