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Polycyclic Aromatic Hydrocarbons

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INTRODUCTION

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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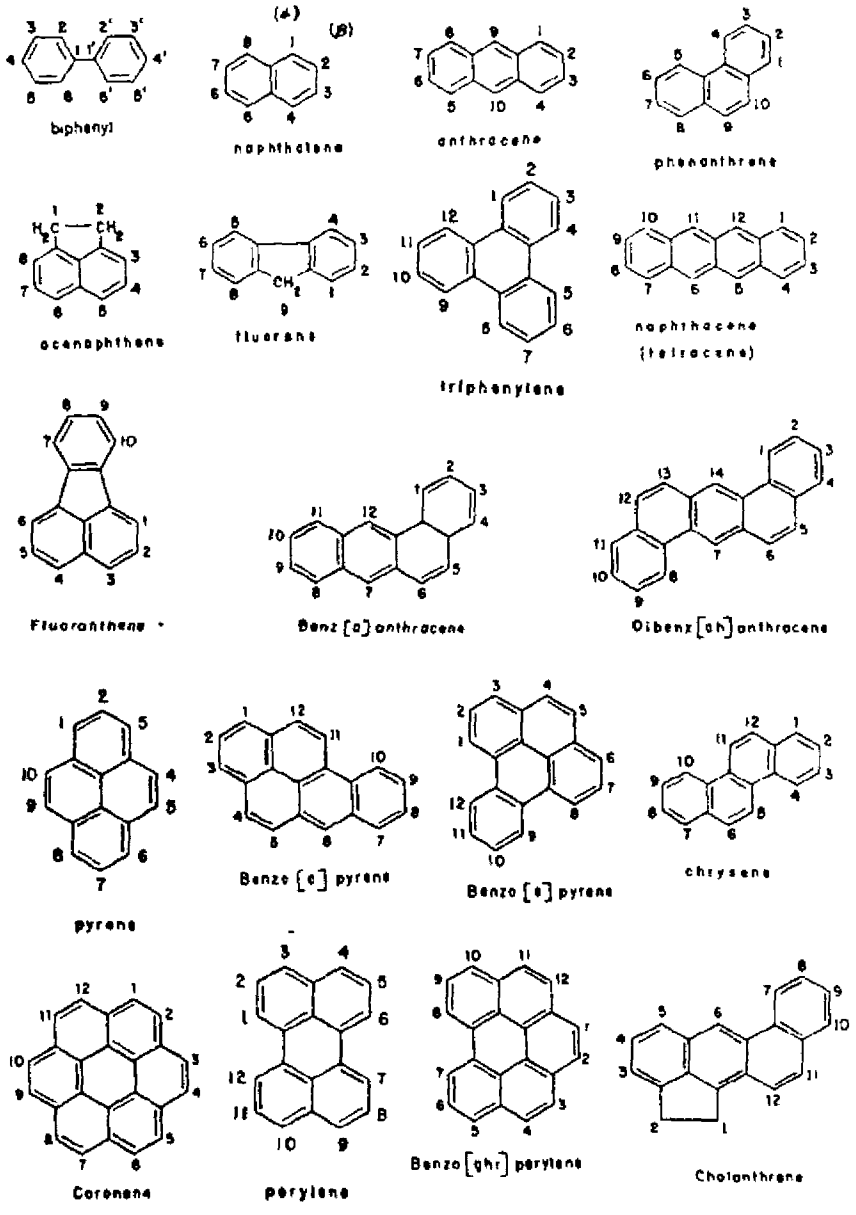
Fig. 1 Common names structure and numbering of basic ring systems



The reactivity of polycyclic hydrocarbons towards addition reactions can be explained and predicted qualitatively by Clar's π -sextett 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

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TABLE 1
Polycyclic hydrocarbons in man's environment*

Benzo [a] pyrene in city air (mcg/1000 m³)	
Los Angeles	5
London	88
Bonn	133
Benzo [a] pyrene in food (mcg/kg)	
Vegetables	10
Smoked foods	1-10
Carcinogenic Polycyclic Hydrocarbons in water (mcg/m³)	
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.

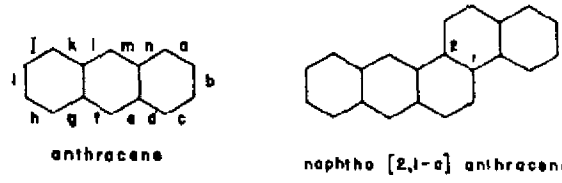


Fig 2. Nomenclature for more highly condensed ring systems.

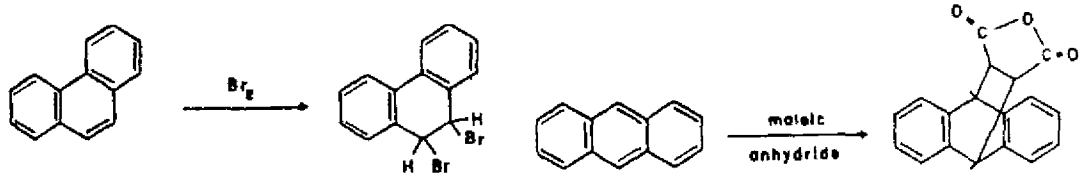
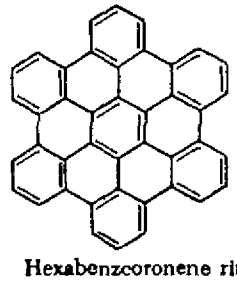


Fig. 3. Examples for addition reactions occurring with PAH.



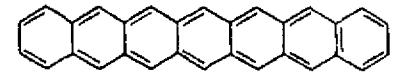


Fig. 5. Heptacene ring system.

Fig. 4. Hexabenzocoronene 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).

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OCCURRENCE OF PAH

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 nation-wide emmission 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 almost universal and numerous analyses show their presence (5, 18, 24-29) in air (particularly soot samples), water and soil. Polycyclic hydrocarbons and hetero-aromatic 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, 33-43). 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).

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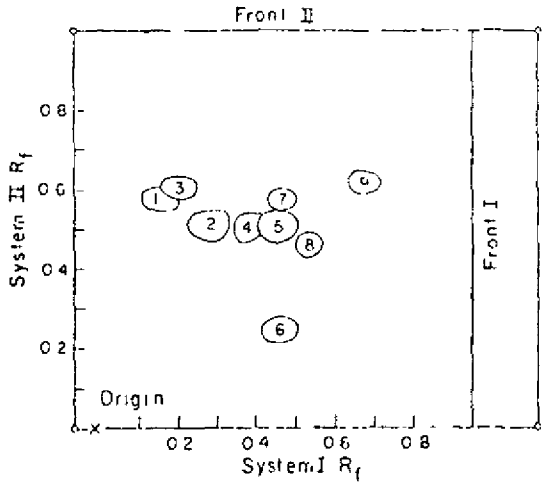

Fig. 6. Two dimensional thin layer chromatogram. Layer acetylated cellulose – aluminum oxide, 1·2. Solvents: System I, n-hexane, n-pentane, toluene (90.5 5). System II, methanol, ether, water 4.4 1 Compounds 1, dibenzo [a, e] pyrene; 2, dibenz [a, h] anthracene, 3, dibenz [a, c] anthracene, 4, perylene, 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 ^{1}Bb-bands which show a molar extinction coefficient of *ca* (10^5). The extinction coefficient for the para – or ^{1}La-bands and the γ – or ^{1}Lb-bands are *ca* $10^4 \cdot 10^5$ and ($10^3 \cdot 10^4$) 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).

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TABLE 2
Compounds separated on capillary column

No	Compounds	No	Compounds
1	Naphthalene	25a	Chrysene
2	Azulene	25b	Triphenylene
3	Diphenyl	26	Naphthacene/Tetracene
4	Acetylnaphthalene	27	7-Methyl-benz [a] anthracene
5	Acenaphtene	28a	Benzo [a] fluoranthene
6	Fluorene	28b	Benzo [b] fluoranthene
7	2-Methylfluorene	29	Benzo [k] fluoranthene
8	1-Methylfluorene	30	7, 12 Dimethyl-benz [a] anthracene
9	Trans-stilbene	31	Benzo [e] pyrene
10	Phenanthrene	32	Benzo [a] pyrene
11	Anthracene	33	Perylene
12	2-Methylanthracene	34a	3-Methylcholanthrene
13	4H-Cyclopenta [def] phenanthrene	34b	20-Methylcholanthrene
14	1-Methylphenanthrene	35	Dibenz [a, j] anthracene
15	9-Methylanthracene	36a	Dibenz [a, c] anthracene
16	Fluoranthene	36b	Dibenz [a, h] anthracene
17	Pyrene	37	Benzotetraphene
18	11H-Benzo [a] fluorene	38a	Benzo (g, h, i) perylene
19a	11H-Benzo [b] fluorene	38b	Picene
19b	7H-Benzo [c] fluorene	39	Anthanthrene
20	1-Methylpyrene	40	Dibenzo [a, e] pyrene
21	3-Methylpyrene	41	Coronene
22	Benzo [g, h, i] fluoranthene	42	Dibenzo [a,e] pyrene
23	Benzo [c] phenanthrene	43	Dibenzo [a, i] pyrene
24	Benzo [a] anthracene	44	Dibenzo [a, h] pyrene

Quantitative analysis of PAH by U. V. spectroscopy is possible after separation (*e. g* by TLC) 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).

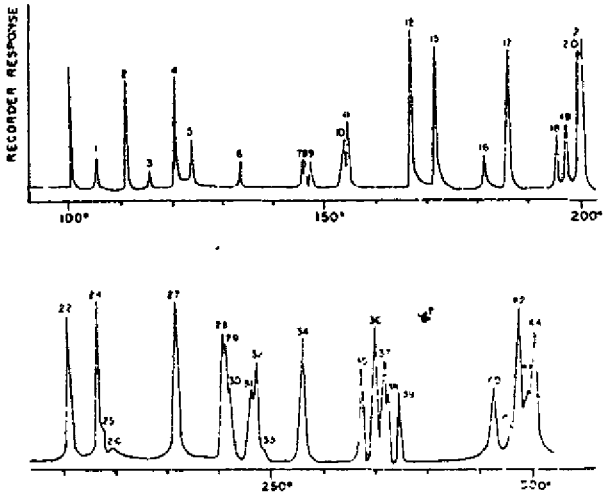

Fig 7. Chromatogram of a standard mixture of hydrocarbons Glass capillary column coated with SE-52 Linear programmed temperature 100-300°, rate 1 8/min Numbers correspond to compounds in Table 2.

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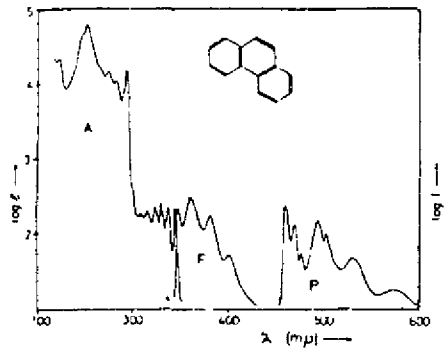

Fig. 8. Electronic spectra of phenanthrene A absorption (UV) spectrum (cyclohexane), F, fluorescence spectrum (benzene); P, phosphorescence spectrum (ethanol, isopentane, ether, 2 5 5, 77°K).

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 phosphoresence 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

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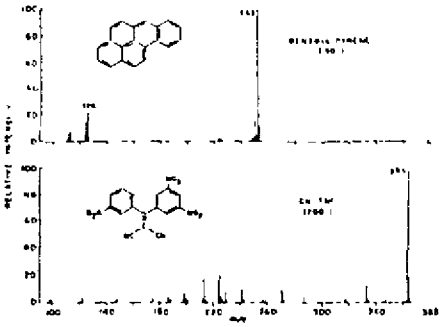

Fig 9 70 eV mass spectrum of benzo [a] pyrene 9-cyanomethylene-2, 4, 7-trinitrofluorene complex eluted from TLC at different sample temperatures (as indicated): (a), benzo [a] pyrene (b). CNTNF.

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).

BIOLOGICAL 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

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molecular properties and chemical reactivity of carcinogenic hydrocarbons with respect to their biological activity has been intensively studied (for references see 99, see also 105-107).

Metabolism of polycyclic aromatic hydrocarbons (45, 108, 109) in mammals and microsomal enzyme preparations yield oxygenated derivatives. Hydroxy compounds are usually formed and epoxides (102, 109, 110) have been shown to be intermediates. The synthesis, properties and metabolism of PAH-epoxides has recently been extensively studied (111-114).

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Polynuclear Hydrocarbon Standards

Catalog #	*Product*	*Synonym*	*Min Purity*	*Price*
RNH001	Acenaphthene		99%	7 00/100mg
RNH002	Acridine		99%	14 00/100mg
RNH003	Anthanthrene		99%	45 00/10mg
RNH004	Anthracene		99%	7 00/100mg
RNH005	Azulene		99%	10 00/10mg
RNH006	1, 2-Benzanthracene	Tetraphene	99%	7 00/10mg
RHN007	Benz [a] anthracene-7, 12-Dione	Benzanthraquinone	80%	14 00/100mg
———	2, 3-Benzanthracene	See Tetracene		
———	Benzanthraquinone	See Benz [a] anthrancene-7, 12-dione		
———	9, 10-o-Benzeno-9, 10-dihydroanthracene	See Triptycene		
RNH026	2, 3 Benzocarbazole 5H-Benzo [b] carbazole	5H-Benzo [b] carbazole See 2, 3-Benzocarbazole	96%	7 00/100mg
RNH027	1, 2-Benzocoronene		95%	14 00/10mg
RNH028	1, 2-Benzodiphenylene-sulfide		99%	12 00/100mg
RNH029	Benzo [b] fluoranthene		95%	13 00/100mg
RNH030	Benzo [g, h, i] fluoranthene		95%	17 00/100mg
RNH008	1, 2-Benzofluorene		99%	10 00/10mg
RNH031	2, 3-Benzofluorene		99%	10 00/10mg
RNH032	Benzo g,h,i, (gl), perylene	1, 12-Benzoperylene	99%	10 00/10mg
———	1, 12-Benzoperylene	See Benzo [g, h, i] Perylene		
———	9, 10-Benzophenanthrene	See Triphenylene		
RNH033	Benzo (a) pyrene	3, 4-Benzopyrene	98%	17 00/100mg
———	3, 4-Benzopyrene	See Benzo [a] pyrene		
RNH009	5, 6-Benzoquinoline Benzo [f] quinoline	Benzo [f] quinoline or β -Naphthoquinoline See 5, 6-Benzoquinoline	99%	10 00/100mg
RNH010	1, 1'-Binaphthyl		95%	10 00/100mg
RCS001	Biphenyl		99%	7 00/500mg
RNH011	Carbazole		99%	7 00/100mg
PRH012	Chrysene		99%	14 00/100mg
RNH013	Coronene		98%	18 00/10mg
RNH016	1, 2, 3, 4-Dibenzanthracene	Dibenz [a, c] Anthracene	99%	10 00/10mg
RNH017	1, 2, 5, 6-Dibenzanthracene	Dibenz [a, h] Anthracene	99%	7 00/10mg
RNH018	1, 2, 7, 8-Dibenzanthracene	Dibenz [a, j] anthracene	95%	12 00/10mg
———	Dibenz [a, c] anthracene	See 1, 2, 3, 4-Dibenzanthracene		
———	Dibenz [a, h] anthracene	See 1, 2, 5, 6-Dibenzanthracene		
———	Dibenz [a, j] anthracene	See 1, 2, 7, 8-Dibenzanthracene		
RNH019	2, 3, 5, 6-Dibenzfluoranthene		98%	14 00/10mg
RNH020	3, 4, 5, 6-Dibenzocarbazole		95%	8 00/10mg
RCS067	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
———	10, 15-Dihydro-5H-Diindeno [1, 2a-1', 2'-c] Fluorene	See Truxene		

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Polynuclear Hydrocarbon Standards

Catalog #	*Product*	*Synonym*	*Min Purity*	*Price*
RNH023	Dindeno [1, 2, 3-cd-1', 2', 3'-lm] Perylene	Perflanthene	98%	9 00/100mg
RNH024	3, 6-Dimethylphenanthrene		99%	7 00/10mg
RNH025	9, 10-Diphenylanthracene		99%	7 00/100mg
———	Diphenylenesulfide	See Dibenzothiophene		
RNH034	Dodecahydrotriphenylene		99%	7 00/100mg
RNH034	Durene	1, 2, 4, 5-Tetramethylbenzene	99 9%	7 00/100mg
RNH036	Fluoranthene		99%	7 00/100mg
RNH037	Fluorene		99%	14 00/100mg
RNH038	Hexamethylbenzene		99%	7 00/100mg
	Indeno [1, 2, 3-cd] pyrene	See o-Phenylenepyrene		
RNH039	2-Methylanthracene		99%	8 00/100mg
RNH040	9-Methylanthracene		99 99%	14 00/100mg
RNH041	4-Methyl Biphenyl	4-Phenyltoluene	98%	10 00/100mg
RNH042	4, 5-Methylenephenanthrene		99%	19 00/100mg
RNH043	2-Methylfluorene		95%	7 00/100mg
RNH044	1-Methylphenanthrene		99%	7 00/100mg
RNH045	2-Methylphenanthrene		99%	7.00/100mg
RNH046	3-Methylphenanthrene		95%	7.00/100mg
———	Naphthacene	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
	Perflanthene	See Dindeno [1, 2, 3-cd-1', 2', 3'-lm] 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-Phenylenepyrene	Indeno [1, 2, 3-cd] pyrene	99%	7.00/10mg
RNH054	2-Phenylnaphthalene		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-Terpenyl		99%	7 00/100mg
RCS061	p-Terphenyl		99%	7.00/100mg
RNH060	Tetracene	Naphtacene	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		
———	Tetraphene	See 1, 2-Benzanthracene		
RNH063	1 2, 3, 4-Tetraphenylnaphthalene		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
RNH068	Truxene	10, 15-Dihydro-5H-diindeno [1, 2-a 1', 2'-c] fluorene	95%	14.00/100mg

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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 [1-6].

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 hexane[7]. Solubilities of five mono-and dichlorobiphenyls also vary widely[8].

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 hydrophylic compounds including pollutants[9, 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 solubilizers[11] 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 microorganisms [12]) 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 Synthetized 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 effects[13]. An aliquot (10 ml) was drawn using a syringe carrying a small filter compartment and immediately

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

RESULTS AND DISCUSSION

In view of the problems with adsorption and low solubility, the experiments were not designed to give solubility data as absolute physical constants but were intended to yield comparable values of reasonable accuracy for biological experiments

The data for twenty-one chlorobiphenyls in water are shown in Table 1.

TABLE 1

Solubility of chlorobiphenyls in water

Compound	Solubility (mg)	Solubility (ppm)
Monochlorobiphenyls		
2-	6.0	5.8
3-	3.35	3.6
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
Tetrachlorohiphenyls		
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 0068	0.0072
Decachlorobiphenyl	0.015	0 015
4, 4'-Dichlorobiphenyl + Tween 10 0.1%	6.2	5.5
+ Tween 80 1%	10.0	10 0
+ Humic acid extract	0.075	0.06

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ACKNOWLEDGMENTS

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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 PCBs in their 181-page May 1972 Report (Com-7_2-10419) 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

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instance, Willis and Addison[1] report that the major components of Aroclor 1221 accounting for 92.3 weight per cent are biphenyl, 2-Cl, 4 Cl, 2, 2'-Cl_2, 2, 4'-Cl_2 (all available from Analabs stock). From Sissons and Welti's[2] list of the major components of the more important Aroclor 1254 (we list more than half). Methods have been developed[3] 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 chromatography[4].

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

Chlorine Position	*Melting Points*
Mono	
2-Cl	32.0-32.5°C
3-Cl	Oil
4-Cl	75.5-77.0°C
Di	
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
Tri	
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

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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	113.5-114.5°C
3, 4, 5, 3', 4' 5'-Cl_6	Lit. 198

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MELTING POINTS OF POLYCHLORINATED BIPHENYLS

Chlorine Position	*Melting Points*
Hepta	
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
Octa	
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
Nona	
2, 3, 4, 5, 6, 2′ 3′ 4′ 5′-Cl_9	204 5-206.5°C
Deca	
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.

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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'-Tetrachlorobiphemyl	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	20.00/20mg
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

MONS 206134

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 C. 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

MONS 206135

POLYCHLORINATED BIPHENYL MIXTURES

RCS066	PCB-Kit (1 gm each of Aroclor 1232, 1242, 1248, 1254, 1260 and 1268)	9 00/kit

99% POLYCHLORINATED NAPHTHALENES

RCS072	Naphthalene	$ 7 00/500 mg
RCS073	1-Chloronaphthalene	7 00/100 mg
RCS074	2-Chloronaphthalene	7.00/100 mg
RCS075	1,2,3,4,5,6,7,8-Octachloronaphthalene	15 00/50 mg
RCS076	Halowax kit (1 gm each of 1031,1000, 1001, 1099, 1013, 1014, 1051)	10 00/kit

Halowax Number	1031	1000	1001	1099	1013	1014	1051
Approx. % Chlorine	22	26	50	52	56	62	70

Number of Chlorines	1	2	3	4	5	6	7	8
% of Chlorine	21.85	36 40	46.00	53.38	59.07	63.6	67 2	70 3

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

99% POLYCHLORINATED DIBENZO-P-DIOXINS

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-dioxin	25/50 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-Dichlorodibenzofuran	36/20 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).

OTHER POLLUTION STANDARDS

RCS077	Hexachlorophene [2,2'-Methylenebis-(3,4,6-trichlorophenol)]	$ 5 00/1 mg
RCS078	Perchlorinated p,p'-DDE	20 00/50 mg

MONS 206136

PESTICIDE STANDARDS

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)

Catalog #	Product	Synonym	Active Ingredient	% A.I.	Price
———	AAT	See Parathion			
———	Acequinite	See Trichloroniumethane			
———	Acricide	See Binapacryl			
———	Acti-Dione	See Cycloheximide			
RSP050	Alanap	NPA	N-1-Naphthylphthalamic Acid	Tech	[illegible] g
RSP001 *	Aldrin	Octalene	1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo-exo-5,8-dimethano naphthalene	90%	16.00/g
RSP057	Aldrin tech		1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4-endo-exo-5,8-dimethano naphthalene	90%	8.00/g
———	Alkron	See Parathion			
RSP059	Allyl Alcohol		Allyl Alcohol	97%	8.00/g
RSP058	Ametryne		2-Methylmercapto-4-ethylamino-6-isopropylamino-S-triazine	96.5%	16.00/g
RSP060	Ametryne, tech		2-Methylmercapto-4-ethylamino-6-isopropylamino-S-triazine	Tech	8.00/g
———	Ammocarb	See Matacil			
RSP061	Amitrole		3-Amino-1,2,4,-triazole	99%	20.00/100mg
RSP062	Amitrole tech		3-Amino-1,2,4,-triazole		8.00/g
RSP063 *	Amobam		Diammonium ethylene bisdithiocarbamate	42%	12.00/g
———	Aprocarb	See Baygon			
RSP064	Aramite		2-(p-tert-Butylphenoxy)-1-isopropyl-2-chloroethyl sulfite	92%	20.00/100mg
———	Arathane	See karathane			
RSP002 *	Atrazine	Gesapelm	2-chloro-4-ethylamino-6-isopropylamino-s-triazine	99%	18.00/mg
RSP065	Atrazine, tech		2-chloro-4-ethylamino-6-isopropylamino-s-triazine		8.00/g
RSP066	Avadex	Diallate	S-2,3-Dichloroallyl-N,N-diisopropyl-thiol carbamate	Tech	12.00/g
RSP067	Azinphosmethyl	Guthion Cothion Methylguthion	O,O-Dimethyl-S-[4-oxo-1,2,3-benzotriazin-3-(4H)-yl-methyl] phosphorodithioate	90%	16.00/g
RSP068	Azinphosmethyl tech		O,O-Dimethyl-S-[4-oxo-1,2,3-benzotriazin-3-(4H)-yl-methyl] phosphorodithioate		8.00/g
RSP069	Azobenzene		Diphenyldiimide	99%	12.00/100mg
RSP070	Bandane		Polychlorodicyclopentadiene isomers	Tech	12.00/100mg
RSP071	Banvel D	Dicamba	3,6-Dichloro-o-anisic acid	90%	20.00/100mg
———	Baron	See Erbon			
———	Basudin	See Diazinon			
RSP078	Baygon	Aprocarb Unden	o-Isopropoxyphenyl methylcarbamate	Tech	16.00/g
RSP073	Benzyl Benzoate		Benzyl Benzoate	99%	16.00/g
RSP003 *	BHC mix		Hexachlorocyclohexane isomer mix	Tech	8.00/g
RSP049	α-BHC		Alpha-1,2,3,4,5,6-Hexachlorocyclohexane	99%	20.00/100mg
RSP074	β BHC		Beta-1,2,3,4,5,6-Hexachlorocyclohexane	90%	20.00/100mg
———	γ BHC	See Lindane			
RSP044	δ BHC		Delta-1,2,3,4,5,6-Hexachlorocyclohexane	99%	20.00/100mg
RSP075	Binapacryl	Acricide Monocide	2-sec-Butyl-4,6-dinitrophenyl-3,3-dimethylacrylate	99%	10.00/g
RSP076	Bobtan		2,6-Dichloro-4-nitroaniline	Tech	16.00/g
———	Bromonal	See Bromosymul			
RSP077	Bromosymul	Bromonal Bustryl	3,5-Dibromo-4-hydroxybenzonitrile	98%	16.00/100mg
———	Bustryl	See Bromosymul			
RSP078	Bulan		2-Nitro-1,1-bis-(p-chlorophenyl)-butane	96%	16.00/100mg
———	Butasan	See Piperonyl Butoxide			
———	Caparol	See Prometryne			

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PESTICIDE STANDARDS

Catalog #	Product	Synonym	Active Ingredient	% A.I.	Price
RSP079	Captan	Orthocide	N-Trichloromethylthio-4-cyclohexene 1,2-dicarboximide	99%	18.00/g
———	Carbaryl	See Sevin			
———	Carbophenothion	See Trithion			
———	Carbophos	See Malathion			
———	Cardite	See Ethyl Hexane Diol			
RSP080	Chlorbenside	Sulfide Chlorpaucide Chlorosulphacide Mitox	p-chlorobenzyl p-chlorophenyl	99%	12.00/100mg
RSP004 •	Chlordane	Octachlor	1,2,3,4,5,6,7,8,8-Octachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene	Tech	14.00/g
RSP081	Chloroacetic acid	Monochloro-acetic Acid	Chloroacetic Acid	99%	6.00/g
RSP082	Chlorobenzilate		Ethyl 4,4'-dichlorobenzilate	99%	18.00/g
RSP083	Chlorobenzilate tech		Ethyl 4,4'-dichlorobenzilate	45%	4.00/g
———	Chlorophos	See Trichlorfon			
———	Chloropicrin	See Trichloronitromethane			
———	Chlorosulphacide	See Chlorbenside			
———	Chlorparacide	See Chlorbenside			
RSP084	Cuodrin		α-Methylbenzyl-3-(dimethoxyphosphinylcis)-crotonate	85%	16.00/g
RSP005 •	Co-Ral	Coumaphos	O,O-Diethyl O-(3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl)phosphorothioate	99%	2.00/100mg
RSP085	Co-Ral tech		O,O-Diethyl O-(3-chloro-4-methyl-2-oxo-2H-1-benzopyran-7-yl)phosphorothioate		6.00/g
———	Coumalene	See Warfarin			
———	Coumaphos	See Co-Ral			
RSP086	Cycloheximide	Acti-dione	3-[2-(3,5-Dimethyl-2-oxycyclohexyl)-2-hydroxyethyl]glutarimide	Tech	12.00/g
———	Cygon	See Dimethoate			
———	Cynen	See Zinophos			
RSP087	Cyprex	Dodine	o-dodecylguanidine acetate	99%	20.00/100mg
RSP088	Cyprex tech		o-dodecylguanidine acetate		8.00/g
RSP006 •	2,4-D Acid		2-(2,4-Dichlorophenoxy)acetic acid	99%	12.00/100mg
RSP007 •	2,4-D Acid Methyl Ester		2-(2,4-Dichlorophenoxy)acetic acid methyl ester	99%	18.00/100mg
RSP089	Dacthal	DCPA	Dimethyl-2,3,5,6-tetrachloroterephthalate	99%	18.00/g
RSP090	Dalapon		2,2-Dichloropropionic Acid	99%	20.00/100mg
———	Dall	See Methyl Parathion			
RSP091	Daromet	Mylone	3,5-Dimethyl-1,3,5,2H-tetrahydrothiadiazine-2-thione	95%	12.00/g
———	DCPA	See Dacthal			
RSP008	DDD mix	TDE mix	1,1-Dichloro-2,2-(chlorophenyl)ethane	Tech (isomer mix)	3.00/g
RSP092 •	p,p-DDD	o,p-TDE	1,1-Dichloro-2-[o-chlorophenyl]-2-[p-chlorophenyl]ethane	99%	12.00/100mg
RSP009 •	p,p-DDD	p,p-TDE	1,1-Dichloro-2,2-bis-(p-chlorophenyl)ethane	99%	20.00/100mg
RSP047	o,p-DDE	o,p-DDX	1,1-Dichloro-2-(o-chlorophenyl)-2-(p-chlorophenyl)ethylene	99%	20.00/100mg
RSP010 •	p,p-DDE	p,p-DDX	1,1-Dichloro-2,2-bis-(p-chlorophenyl)ethylene	99%	25.00/g
RSP011 •	DDT mix		1,1,1-Trichloro-2,2-bis-(chlorophenyl)ethylene	Tech (isomer mix)	2.00/g
RSP012 •	o,p-DDT		1,1,1-Trichloro-2-(o-chlorophenyl)-2-(p-chlorophenyl)ethane	99%	25.00/g
RSP013 •	p,p-DDT		1,1,1-Trichloro-2,2-bis-(p-chlorophenyl)ethane	99%	12.00/g
——— •	DDVP	See Dichlorvos			
———	o,p-DDX	See o,p-DDE			
———	p,p-DDX	See p,p-DDE			
RSP093	DEET	Delphene Detamide	N,N-Diethyl-m-toluamide	95%	12.00/g

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PESTICIDE STANDARDS

Catalog #	Product	Synonym	Active Ingredient	% A.I.	Price
RSP015 *	DEF		S, S, S Tributyl phosphorotrithioate	94%	22.00/100mg
———	Delphene	See DEET			
RSP016 *	Demeton	Systox	Mix of O,O-Diethyl-O-2-(ethylthio) ethyl phosphorothioate and O,O-Diethyl-S-2-(ethylthio) ethyl phosphorothioate	Tech	20.00/100mg
———	Detmide	See DEET			
RSP094	Dexon		p-Dimethylaminobenzenediazo sodium sulfonate	84%	12.00/100mg
———	DFA	See Diphenylamine			
———	Di Allate	See Avadex			
RSP017 *	Diazinon	Basudin	O,O-Diethyl-O-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate	99%	12.00/100mg
RSP095	Diazinon Tech		O,O-Diethyl-O-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate	48%	6.00/g
RSP018 *	Dibrom	Naled	1,2-Dibromo-2,2-dichloroethyl dimethyl phosphate	93%	12.00/100mg
RSP008	Dibutylphthalate		Dibutylphthalate	99%	12.00/g
———	Dicamba	See Banvel D			
———	Dicaptan	See Diexpthon			
RSP097	Dicapthon	Dicaptan	O-(2-Chloro-4-nitrophenyl)-O,O-dimethyl phosphorothioate	99.8%	12.00/100mg
———	Dichlone	See Phygon			
RSP098	o-Dichlorobenzene		o-Dichlorobenzene	99%	6.00/g
RSP099	p-Dichlorobenzene		p-Dichlorobenzene	99%	6.00/g
RSP100	2,4-Dichlorophenol		2,4-Dichlorophenol	99%	6.00/g
———	Dichlorprop	See 2,4-DP Acid			
RSP014	Dichlorvos	DDVP Herkol Vapona	O,O-Dimethyl-O-(2,2-dichlorovinyl) phosphate	99%	12.00/100mg
———	Dicofol	See Kelthane			
RSP019 *	Dieldrin	Hexd	1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endoexo-5,8-dimethanonaphthalene	85%	16.00/g
RSP101	Dilolatan		N-(1,1,2,2-Tetrachloroethylsulfenyl)-cis-Δ-4-cyclohexene-1,2-dicarboximide	99%	12.00/100mg
———	Dimecron	See Phosphamidon			
RSP102	Dimethoate	Rogor Cygon Fostion	O,O-Dimethyl-S-(N-Methylcarbamoylmethyl) phosphorodithioate	99%	22.00/g
RSP103	Dimethyl Phthalate		Dimethyl Phthalate	99%	12.00/g
———	Dimezip	See Karathane			
RSP104	Dinoseb	DNBP	2,4-Dinitro-6-sec-butyl phenol	99%	12.00/100mg
RSP105	Diphacin	Diphacinone	2-Diphenylacetyl-1,3-indandione	Tech	12.00/100mg
———	Diphacinone	See Diphacin			
RSP106	Diphenamid	Dymid Enid	N,N-Dimethyl-2,2-diphenylacetamide	Tech	12.00/g
RSP107	Diphenyl-Amine	DFA	Diphenylamine	99%	12.00/g
———	Dipterex	See Trichlorfon			
———	Dipterex	See Trichlorfon			
———	Disulfoton	See Di-Syston			
RSP108	Di Syston	Disulfoton	O,O-Diethyl-S-2-(ethylthio) ethyl phosphorodithioate	97%	16.00/g
———	Dithane Manganese	See Maneb			
———	Dithane-Zinc	See Zineb			
———	DMPA	See Zyton			
———	DNBP	See Dinoseb			
———	DNTP	See Parathion			
———	Dodine	See Cyprex			
———	Dowco 132	See Ruelene			
RSP109	2,4-DP-Acid	Dichlorprop	2-(2,4-Dichlorophenoxy) propionic acid	99%	12.00/100mg
———	DTMC	See Kelthane			
———	Duphar	See Tedion			
RSP110	Dursban		O,O-Diethyl-O-(3,5,6-trichloro-2-pyridyl) phosphorothioate	99%	12.00/100mg

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PESTICIDE STANDARDS

Catalog #	Product	Synonym	Active Ingredient	% A.I.	Price
-----	Dylox	See Trichlorfon			
-----	Dyanid	See Diphenamid			
-----	Endosulfan	See Thiodan			
RSP020 •	Endrin		1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-endo-5,8-dimethanonaphthalene	99%	16.00/g
RSP111	Endrin tech		1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-endo-5,8-dimethanonaphthalene	97%	6.00/g
-----	Enid	See Diphenamid			
RSP021 •	EPN		O-Ethyl-O-p-nitrophenyl phenyl phosphorothioate	97%	12.00/100mg
RSP112	Ethon	Baron	2-(2,4,5-Trichlorophenoxy)-ethyl-2,2-dichloropropionate	Tech	8.00/g
-----	Estomite	See Ovex			
RSP022 •	Ethion	Nialate	O,O,O,O-Tetraethyl-S,S-methylene-biphosphorodithioate	95%	22.00/100mg
RSP113	Ethyl Hexanediol	Cardite	2-Ethyl-1,3-Hexanediol	Tech	12.00/g
-----	Ethion	See Parathion			
RSP115	Eugenol		Eugenol	80%	12.00/g
RSP114	Fenitrothion	Folithion Sumithion	O,O-Dimethyl-O-(4-nitro-m-tolyl) phosphorothioate	99%	20.00/100mg
RSP053	Fenitrothion tech		O,O-Dimethyl-O-(4-nitro-m-tolyl) phosphorothioate	95%	12.00/g
RSP116	Fenthion		O,O-Dimethyl-O-14-(methylthio)-m-tolyl phosphorothioate	Tech	16.00/100mg
-----	Fenoprop	See Silvex			
-----	Folidol	See Parathion			
-----	Folithion	See Fenitrothion			
-----	Folpet	See Phaltan			
-----	Fosfan	See Mocetan			
-----	Fosfon	See Dimethoate			
RSP117	Fumazone		1,2-Dibromo-3-chloropropane	Tech	8.00/g
-----	Gesafrim	See Prometone			
-----	Gesafol	See Propazine			
-----	Gesaprim	See Atrazine			
-----	Gesagard	See Eumetryne			
-----	Gesatop	See Simazine			
-----	Gosathion	See Azinphosmethyl			
-----	Guthion	See Azinphosmethyl			
-----	HCB	See Hexachlorobenzene			
-----	HEOD	See Dieldrin			
RSP024 •	Heptachlor	Methanoindene	1,4,5,6,7,8,8-Heptachloro-1a,4,7,7a-tetrahydro-4,7-methanoindene	97.4%	16.00/g
RSP025 •	Heptachlor		1,4,5,6,7,8,8-Heptachloro-2,3-epoxy-3a,4,7,7a-tetrahydro-4,7-methanoindan	99%	35.00/100mg
-----	Herkol	See Dichlorvos			
RSP051	Hexachlorobenzene	HCB	Hexachlorobenzene	99%	10.00/g
RSP118	Iondan		O,O-Dimethyl-S-phthalimidomethyl phosphorodithioate	95%	16.00/g
RSP119	IPC		Isopropyl-N-phenylcarbamate	Tech	6.00/g
-----	Isoethane	See Karathane			
RSP120	Karathane	Arathane Dinocap Isocothane Mildex	2-(1-Methylheptyl)-4,8-dinitrophenyl crotonate	85%	20.00/g
-----	Karbofos	See Malathion			
RSP026 •	Kelthane	Dicofol DTMC	1,1-bis-(4-Chlorophenyl)-2,2,2-trichloroethanol	99%	17.00/g
RSP121	Kelthane tech		1,1-bis-(4-Chlorophenyl)-2,2,2-trichloroethanol		8.00/g
RSP045	Lannate	Methomyl	S-Methyl-N-[(Methylcarbamoyl)oxy]thioacetimidate	99%	16.00/g
RSP122	Lethane 384		2-(2-Butoxyethoxy)-ethyl thiocyanate	53%	12.00/g

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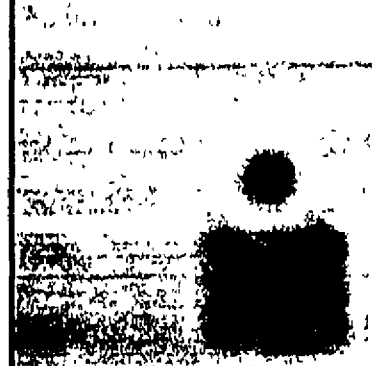
PESTICIDE STANDARDS



Catalog #	Product	Synonym	Active Ingredient	% A.I.	Price
RSP027	• Lindane	Gamma BHC (γ BHC)	Gamma 1, 2, 3, 4, 5, 6 Hexachlorocyclohexane	99%	20.00/g
RSP028	• Malathion	Carbophos Karbolos	S 1, 2 bis (Ethoxycarbonyl) ethyl O, O dimethyl phosphorodithioate	99%	20.00/g
RSP123	Malathion, tech		S 1, 2 bis (Ethoxycarbonyl) ethyl O, O dimethyl phosphorodithioate	95%	6.00/g
-----	Malix	See Thiodan			
RSP124	Maneb	Dithane manganese Manzate	Ethylenebisdithiocarbamate manganese	80%	12.00/100mg
-----	Matizate	See Maneb			
RSP125	Matacil	Aminocarb	4 Dimethylamino 3 tolyl N methyl carbamate	96%	12.00/100mg
RSP126	Mirnon		(N Methylmercuri) 1, 4, 5, 6, 7, 7 hexachlorobicyclo 12 2 1 1 hept 5-ene 2, 3 dicarbonide	99.7%	20.00/100mg
RSP127	Metasystox R	Oxydemeton methyl	O, O Dimethyl S 12 (ethylsulfinyl) ethyl phosphorothioate	50%	12.00/g
-----	Methoxyl	See Launate			
RSP029	• Methoxychlor	Methoxy DDT DMDT	1, 1, 1 Trichloro 2, 2-bis (p-methoxyphenyl) ethane	96%	17.00/g
RSP128	Methoxychlor, tech		1, 1, 1 Trichloro 2, 2 bis (p-methoxyphenyl) ethane	89.5%	6.00/g
-----	Methoxy Propazine	See Prometone			
-----	Methyl Guthion	See Azinphosmethyl			
RSP129	Methyl Parathion		O, O Dimethyl O p-nitrophenyl phosphate	98%	12.00/g
RSP052	Methyl Parathion	Dalf Nitrox	O, O Dimethyl O p-nitrophenyl phosphorothioate	99%	12.00/100mg
RSP130	Methyl Parathion, tech		O, O Dimethyl O p-nitrophenyl phosphorothioate	85%	6.00/g
-----	Mecinphos	See Phosdrin			
-----	Mildex	See Karathane			
-----	Mintacol	See Para oxon			
RSP050	Mirex		Dodecachloroethydio 1, 3, 4 methene 2H cyclobutene 1 pentalene	98%	16.00/g
-----	Mitox	See Chlorbenside			
-----	Monochloroacetic Acid	See Chloroacetic Acid			
RSP131	Morestan, tech	Forstan	6 Methyl 2 oxo-1, 3 dithio (4, 5-h) quinoxaline	87%	12.00/g
-----	Morocide	See Binapacryl			
-----	Naled	See Dibrom			
-----	Neguvon	See Trichlorfon			
-----	Nemafos	See Zinophos			
-----	Nialate	See Ethion			
-----	Niran	See Parathion			
-----	Nitrostigmine	See Parathion			
-----	Nitrox	See Methyl Parathion			
-----	NPA	See Alanap			
-----	Octachlor	See Chlordane			
-----	Octalene	See Aldrin			
-----	OMPA	See Schradan			
-----	Orthocide	See Captan			
RSP132	Ovex	Estimode Ovochlor Ovotran	p Chlorophenyl p chlorobenzene sulfonate	99%	12.00/g
RSP133	Ovex, tech		p Chlorophenyl p chlorobenzene sulfonate		4.00/g
-----	Ovochlor	See Ovex			
-----	Ovotran	See Ovex			
-----	Oxydemetonmethyl	See Metasystox R			
RSP134	Panogen		Methylcarbamate dicyandiamide	min 90%	12.00/g
RSP030	• Para oxon	Mintacol	O, O Diethyl p nitrophenyl phosphate (oxygen analog of parathion)	99%	12.00/100mg
RSP135	Paraquat Dichloride		1, 1 Dimethyl 4, 4 dipyridinium dihydrochloride	99%	12.00/100mg

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PESTICIDE STANDARDS

Catalog #	Product	Synonym	Active Ingredient	% A.I.	Price
RSP031	Temephos	Abate Abathion Agrothion Anvil Difos Dotan Eltex Fenthion Fenthion-ethyl Fenthion-methyl Lebaycid Mercaptophos Metacide Metasystox Methyl Parathion Novathion Nuvanol Orthophosphate Penncap-M Phosphothion Phosphothion-methyl Rogor Supracide Supracide 2E Supracide 25W Supracide 40WP Supracide 80WP Supracide Concentrate Supracide Technical Supracide-2E Supracide-25W Supracide-40WP Supracide-80WP Supracide-Concentrate Supracide-Technical Supracide-W Supracide-W 25 Supracide-W 40 Supracide-W 80 Supracide-W Concentrate Supracide-W Technical Supracide-W-25 Supracide-W-40 Supracide-W-80 Supracide-W-Concentrate Supracide-W-Technical Supracide-W25 Supracide-W40 Supracide-W80 Supracide-WConcentrate Supracide-WTechnical Supracide-WW Supracide-WW 25 Supracide-WW 40 Supracide-WW 80 Supracide-WW Concentrate Supracide-WW Technical Supracide-WW-25 Supracide-WW-40 Supracide-WW-80 Supracide-WW-Concentrate Supracide-WW-Technical Supracide-WW25 Supracide-WW40 Supracide-WW80 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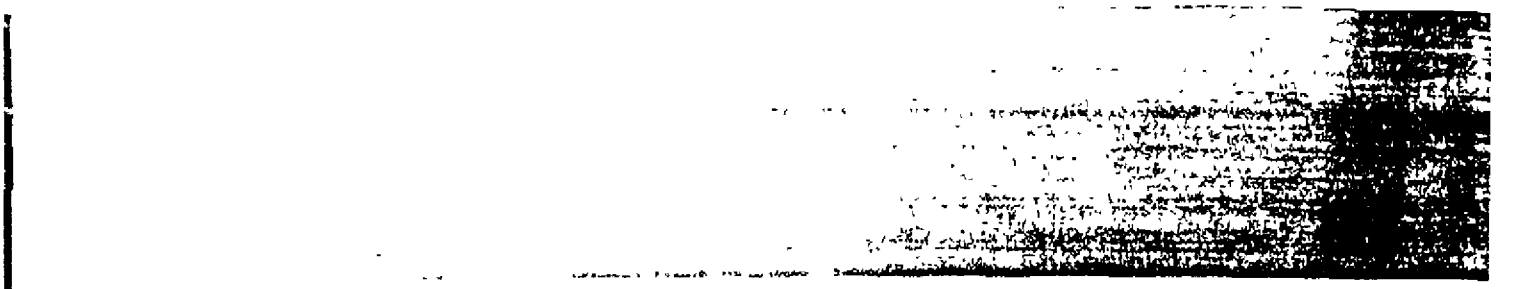

PESTICIDE STANDARD

Catalog #	Product	Synonym	Active Ingredient	% A.I.	Price
RSP038 •	Schradan	OMPA Pestox Sytem	Octamethylpyrophosphoramide	99.8%	14.00/g
RSP173	Schradan tech		Octamethylpyrophosphoramide	95%	8.00/g
RSP170 •	Sevin	Carbaryl	1-Naphthyl N-methyl carbamate	99%	21.00/100mg
RSP171	Silvex	Fenoprop	2-(2,4,5-Trichlorophenoxy) propionic Acid	99%	30.00/100mg
RSP172	Silvex tech		2-(2,4,5-Trichlorophenoxy) propionic Acid		6.00/g
RSP039 •	Simazine	Gesatop	2-chloro-4,6-bis-(ethylamino)-S-triazine	99.3%	11.00/100mg
------	SNP	See Parathion			
RSP174	Spergon	Chloranil	Tetrachloro-p-benzoquinone	Tech	6.00/g
RSP175	Strobane		Terpene polychlorinates	85% Chlorine	10.00/g
------	Sulfo-Cide	See Sulfoxide			
RSP176	Sulfoxide	Sulfoxyl Sulfo-cide	1,2-Methylenedioxy-4-(2-(octyl-sulfinyl)-propyl) benzene	88%	12.00/g
------	Sulfoxyl	See Sulfoxide			
------	Sumithion	See Fenitrothion			
------	Systox	See Demeton			
------	Sytem	See Schradan			
RSP177	2,4,5-T acid		2,4,5-Trichlorophenoxyacetic Acid	99%	10.00/100mg
RSP178	2,4,5-T acid		2,4,5-Trichlorophenoxy-acetic Acid	Tech	6.00/g
------	TCDS	See Tedion			
------	TDE mix	See DDD mix			
------	o,p-TDE	See o,p-DDD			
------	p,p-TDE	See p,p-DDD			
RSP156	Tedion	Dophar Tetradifon TCDS	p-Chlorophenyl-2,4,5-trichlorophenyl sulfone	99%	16.00/g
RSP157	2,3,4,6-Tetrachlorophenol		2,3,4,6-Tetrachlorophenol	99%	12.00/100mg
------	Tetradifon	See Tedion			
RSP158	Thimet	Phorate	O,O-Diethyl-S-(ethylthio)-methyl phosphorodithioate	98.8%	10.00/g
RSP159	Thimet tech.		O,O-Diethyl-S-(ethylthio)-methyl phosphorodithioate	91%	6.00/g
RSP040 •	Thiodan	Endosulfan Stalix	6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide	96%	23.00/100mg
------	Thionazin	See Zinophos			
------	Thiophal	See Phaltan			
------	Thiophos	See Parathion			
RSP041 •	Tinsphene	Phenacide Phenatox	Polychlorinated cinephene	Tech	17.00/g
RSP042 •	Trichlorfon	Tugon Chlorophos Dipterex Dylox Neguvon Dipterex	O,O-Dimethyl-(1-hydroxy-2,2,2-trichloroethyl) phosphonate	98%	12.00/g
RSP160	Trichloro-nitromethane	Chloropicrin Aquinite	Trichloronitromethane	99%	12.00/g
RSP161	2,4,6-Trichlorophenol	Preventol-I	2,4,5-Trichlorophenol	99%	10.00/100mg
RSP162	2,4,6-Trichlorophenol		2,4,6-Trichlorophenol	99%	10.00/100mg
RSP055	Trithion	Carbophenothion	S-[(p-Chlorophenyl)-thiomethyl]-(O,O-diethyl) phosphorodithioate	95%	10.00/g
------	Tugon	See Trichlorfon			
------	Unden	See Baygon			
------	Vapona	See Dichlorvos			
RSP163	Vodex		Methylisothiocyanate	20%	12.00/g
RSP043 •	Warfarin	Coumalene	3-(α-Acetonethenyl)-4-hydroxycoumarin	Tech	10.00/100mg

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PESTICIDE STANDARDS

Catalog #	Product	Synonym	Active Ingredient	% A.I.	Price
RSP164	Zectran		4-dimethylamino-3,5-xylyl-N-Methyl carbamate	99%	10.00/g
RSP165	Zectran tech		4-dimethylamino-3,5-xylyl-N-Methyl carbamate	95%	8.00/g
RSP166	Zineb	Dithane zinc Lanzate	Zinc ethylene bisdithiocarbamate	75%	20.00/g
RSP167	Zinophos	Thiomazin Cynem Nemidos	O,O-Diethyl-O-2-pyrazinyl phosphorothioate	99%	16.00/100mg
RSP168	Zytron	DMPA	O-(2,4-Dichlorophenyl)-O-methyl isopropyl phosphoramidothioate	99%	12.00/100mg
RSP169	Zytron tech		O-(2,4-Dichlorophenyl)-O-methyl isopropyl phosphoramidothioate	Tech	8.00/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.

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PESTICIDEGRADE SOLVENTS

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

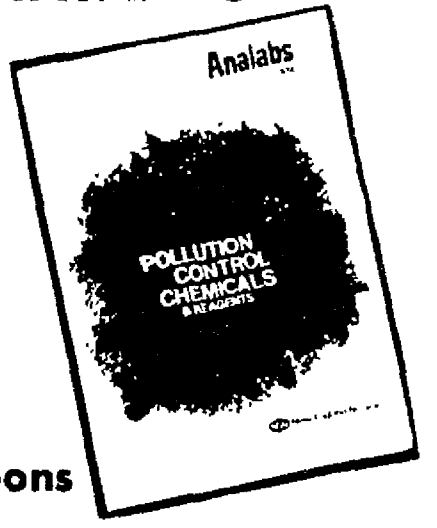
Catalog #	*Solvent*		*Unit*	*Price*
SSP001	Acetone, Pesticidgrade Water	0.05% max.	1 Liter	$14 00
SSP002	Acetonitrile, Pesticidegrade Water	0 05% max	1 Liter	15 00
SSP003	Benzene, Pesticidegrade Water	0 03% max.	1 Liter	12 00
SSP004	2-Butanone, Pesticidegrade Water	0 05% max.	1 Liter	13 00
SSP005	Butyl 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
SSP020	Pentane, Pesticidegrade Water	0 03% max.	1 Liter	15 00
SSP021	Petroleum Ether, Pesticidegrade Water	0.03% max	1 Liter	12 00
SSP022	iso-propyl Alcohol, Pesticidegrade Water	0.05% max	1 Liter	15 00
SSP023	Toluene, Pesticidegrade Water	0.02% max	1 Liter	11 00
SSP024	2, 2, 4-Trimethylpentane, Pesticidegrade Water	0.02% max	1 Liter	16 00

MONS 206145

Analabs ANNOUNCES for 1974 A POLLUTION CHEMICAL STANDARD CATALOG

Contains:

PCT's
PCB's
PCN's
Dioxins
Pesticides
Dibenzo Furans
Polynuclear Hydrocarbons



Send in your name and address for a copy of our Pollution Control Catalog. This catalog will only be sent on request. Available February, 1974.

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Telephone (203) 288-8463 Telex 96-3518

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