S. Wheeler - FYI JAN 10 1972

Monsanto and others are actively pursuing and continuing toxicology studies to more precisely determine the effect of PCB's in biological systems. We welcome data based on sound experimental designs related to these specific structures (or their biological metabolites). However, in the interest of scientific logic and objectivity, we feel we must challenge data or speculation on compounds claiming only superficial functional group or elemental commonality with PCB structures.

In a letter to C&E News, the author cites data on several Bis-dichloroacetamides, one of which contains an aromatic p-xylylene structure (no aromatic chlorine), relating to their antifertility effects and amoebicidal action, equating these to a vague "anti-growth" property (in biochemical terms, growth usually refers to specific biological effects mediated by pituitary growth hormone). It is then concluded on the basis of similar "polychlorinated bis-compound" structures that PCB's are very likely to have anti-growth properties. In our judgment these are non sequiters.

Numerous studies can be cited of the subtle and complex changes in biological activity and toxicity of compounds which vary widely - depending on [redacted] and structural features, stereo- and st[redacted]es, solubilities, method of administration, spe[redacted]rying elimination and detoxification mechanisms), etc[redacted]of comparing and equating the properties or specific biological activities of a polychloro-aromatic structure, such as PCB's with a fundamentally different structure, substituted dichloro acetamides, including the aromatic p-xylene compound, (related only in chlorine content) we do not believe meets the test of rational chemical or biochemical analysis.

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PCB - Literature

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AGRICULTURE'S RESPONSIBILITY CONCERNING PCB'S

REPORT OF

USDA AD HOC GROUP ON PCB'S

MARCH 1972

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USDA AD HOC GROUP ON PCB'S

The inadvertent contamination of a fish meal with polychlorinated biphenyls (PCB's) from a leaky heat exchanger and the subsequent contamination of poultry feeds in several southeastern States resulted in an acute awareness of the present and future problems posed by these persistent compounds. Accordingly, the Director of Science and Education, USDA, established the Ad Hoc Group on PCB's on August 30, 1971, to address itself to the problem as it relates to agriculture.

The members of the USDA Ad Hoc Group are Dr. Robert C. Riley (CSRS), Chairman; Dr. Gerald F. Combs (S&E), Executive Secretary; Dr. Theodore C. Byerly (S&E); Dr. Fred Dunn (C&MS); Dr. Calvin Golumbic (ARS); Dr. Harry W. Hays (ARS); Dr. George Mountney (CSRS); Dr. John E. Spaulding (C&MS); Dr. Fred H. Tschirley (S&E); and Dr. Bill G. Tweedy (CSRS).

This report on "Agriculture's Responsibility Concerning PCB's" has been developed by this group. Since the PCB problem constitutes the first example of a widespread environmental hazard from a persistent industrial chemical not classed as a pesticide, it is believed that the study of this problem may be helpful in identifying needs equally useful in coping with the hazards of other similarly persistent industrial chemicals, especially as related to the protection of our food supply.

On September 1, 1971, an Interdepartmental Task Force also was created to conduct a study on PCB's. This task force is coordinated by the Office of Science and Technology and Council on Environmental Quality and includes representatives from USDA, EPA, FDA, NIEHS, USDC, and [illegible].

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Dr. Harry W. Hays, Dr. John E. Spaulding, and Dr. Bill G. Tweedy.

The interdepartmental 6-month study has been completed and a report compiled entitled "PCB's and the Environment." In conjunction with this study, the National Institutes of Environmental Health Services organized a meeting on PCB's, December 20-21, 1971. The proceedings of this meeting will be available in April 1972. In addition, the Hazardous Chemicals Task Force of the Council for Environmental Quality has prepared a draft report on PCB's. These sources of information have been drawn upon heavily in the preparation of this report by the USDA Ad Hoc Group.

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I. Introduction

The polychlorinated biphenyls (PCB's) are a group of chlorinated hydrocarbons widely used as industrial compounds. The commercial products contain 50 or more of 210 different compounds which are theoretically possible when biphenyl is chlorinated. The most common mixtures contain between 40 and 60 percent chlorine. All PCB's used in the U.S. are manufactured by Monsanto Chemical Company and are sold under the trade name of Aroclor. The complex mixture of isomers is identified by the percent of chlorine by weight in the total product; e.g. Aroclor 1254 contains 54% chlorine.

Despite the fact that PCB's have been available for 40 years, they were not detected as environmental contaminants until 1966 in Sweden and 1967 in the U.S. In the spring of 1967, Monte Kirven of the San Francisco Natural History Museum was searching the Northwest for peregrine falcons. One single, unhatched egg was brought to a laboratory and analyzed for DDT. The egg was found to contain 5 mg. of DDT but other related products were present, and these could not be identified. These same compounds had been present in the analysis of other species of birds and fish. Because of the importance of the peregrine falcon, an attempt was made to identify the compounds. Widmark (1966) had reported that a compound, which contained chlorine, similar to DDT in identification and analysis created a problem in isolation and identification of residues of DDT. With this information and additional results, the unknown compounds were identified as polychlorinated biphenyls. Subsequently, the PCB's have been found to be [illegible] in the world ecosystem.

Levels of 1 ppm occurred in nearly half the people sampled in Michigan and higher residues have been reported. One entry to man is via the birds and mammals which have fed on contaminated fish. Another route is through residues on food which have been wrapped in papers and plastics containing PCB's. A third route is through milk.

The contamination of milk is currently a problem of concern. Such milk is coming from cows which have been fed silage from silos coated with PCB-containing paint. The herd feeding from silage from one of these silos usually will exceed the 5 ppm in milk fat which is the guideline set by the FDA. The levels usually observed in these herds range from 5 to 10 ppm. Of course, PCB contamination in milk is diluted when mixed with uncontaminated milk coming from other herds.

The exact nature of PCB entry into the environment is not understood, but several scientists have speculated on possible major sources. Sewage outfalls and industrial disposals into waterways are two principal means suggested by scientists. It has been estimated that 4,000 tons per year entered waterways from dumpage and leakage of lubricants, hydraulic fluid, and heat transfer fluids. In most cases contamination can be traced to some industrial area. Residues have been found in water, sewage sludge, and bottom sediments. Levels in water are usually less than a part per billion; in sewage and sediments, tens to hundreds of parts per billion; and in sewage sludge, a few parts per million.

Although the rivers and streams appear to be the primary routes into the environment, the atmosphere also appears to be a major means of entry. It has been estimated by Adel Sarofim of MIT that approximately 1500 tons have escaped into the atmosphere in past years from plasticized materials containing PCB's. Burning PCB-containing materials results in volatization unless the temperature exceeds 980 F. Some of the oxides are more toxic than the parent materials. PCB's have been found in precipitation and in airborne particulates in the United States and in snow collected in Sweden. The levels found in these studies were in insufficient quantities to determine the specific levels. At the point of manufacture and the plants where PCB products are processed, they can escape through ventilation and exhaust systems.

The physical properties of PCB's vary slightly with the chlorine content. Those with low chlorine content are fluid liquids and those with high chlorine content are highly viscous liquids. The color of these low chlorine containing mixtures is clear, but the color for those containing 50% or more chlorine is light yellow. All PCB's have a very low solubility in water. Volatility is low and decreases with increases in chlorination. They are stable in water and are not easily subject to acid or alkaline hydrolysis. These characteristics lend them to be quite persistent in the environment.

Because of their low flash point and inertness, they have been widely used as dielectric fluids in capacitors and transformers, hydraulic fluids and heat transfer fluids. Since 1963 more than 50 minor uses have been cited in Chemical Abstracts. These include

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plasticizers and solvents in adhesives, printing ink, sealants, moisture retardants, paints and as pesticide carriers. Of all the uses cited, the most difficult one to replace would be their use as dielectric fluids. The best replacement would require that capacitors be rebuilt and that the size would be 50 percent larger. All of the minor uses in the U. S., such as in adhesives, sealants, paints, etc., have been reported by Montsanto to have been replaced with other compounds.

The persistence of the PCBs in the environment can be attributed to the lack of chemical and biological degradability. This usually results in an environmental contamination and contamination in fish, wildlife and in some instances, domesticated animals for human consumption. Like DDT, they will enter an organism, be stored in the depot fat, and thus be transferred through the food chain at increasing concentrations. Fish, for example, can concentrate PCBs more than 100,000 times that found in the ambient solution.

Since their introduction in 1930, the use of PCB in the U.S. steadily increased to 34,000 tons in 1970, but has fallen off in 1971 to 20,000 tons. The cumulative production over the years is estimated at 400,000 tons. PCBs are also produced in Europe, Japan and U.S.S.R. The manufacturers in foreign countries producing PCBs can be identified but their total production is unknown. In France the manufacturer is Prodelec (Phenochlore), in Germany it is Bayer (Colphen) and in Japan, the product is Kanechlor.

Methods of analysis are very similar to those used for the organochlorine pesticides and because of this, plus the fact that there are numerous isomers of the PCBs, positive quantitative and qualitative determinations are difficult. Currently a procedure is available (Armour and Burke 1970) to separate PCBs from organochlorine pesticides and permit separate determinations of the two groups of chemicals. Although this method and others are available, expertise and good judgement are necessary and analytical methods for the PCBs are by no means simple and definite. Identification of the PCBs is very difficult because their chemical properties are very similar to the organochlorine pesticides and both groups occur as a multicomponent mixture. It is probable that the PCBs have been confused with the organochlorine pesticides in the past.

There appears to be some variability in biological and chemical activities among the compounds. The PCBs containing the lower percentages of chlorines are more toxic and more reactive than the ones containing higher amounts of chlorine. Highly chlorinated PCBs appear to persist in the environment longer than the low chlorine forms. Recent evidence (Hammond 1972) suggests that some commercial PCB mixtures, especially those manufactured in Europe or Japan, may contain trace quantities of dibenzofuran or other toxic compounds.

There is evidence which demonstrates that chemical changes in the environment does occur. Safe and Hutzinger (Nature 232,641(1971) showed that $2,2^1,4,4^1,6,6^1$ - hexachlorobiphenyl when irradiated at 2537Å in hexane and methanol solutions, chlorine atoms were lost to give rearrangement and condensation products. Hutzinger and Safe

recently reported that relatively large amounts of dechlorinated compounds are formed when the commercial PCBs are irradiated in vapor phase, aqueous suspensions, hexane, methanol and aqueous dioxane solutions and, with this, films of undiluted material. They speculated that the degradation products were hydroxychlorobiphenyls and carboxylic acids. There is also evidence that the chlorodibenzofurans are formed in the environment. Hydroxychlorobiphenyls are probably an intermediate in the formations of these.

Toxicology

The chemical and physiological properties of polychlorinated biphenyls make them potentially significant contaminants of the environment. The chemical properties that make them highly desirable industrial materials are their thermal stability, strong resistance to hydrolysis, and chemical inertness. Their use has gradually increased to such an extent that they can be found in all parts of the environment.

Of particular importance in considering the toxicology of polychlorinated biphenyls is the fact that the commercial preparations are mixtures of compounds having different degrees of chlorination. Since each product may contain many different isomers in varying proportion, they may also show very different properties.

Two features common to both PCB's and organochlorine insecticides is their persistence and accumulation in oil and fat. This combination of persistence and accumulation during transition through the food chain can result in considerable increase in concentration of these compounds. For example, shrimp exposed to 10 ppb of Aroclor 1254 for 48 hours accumulated 1300 ppb of PCB's.

The presence of PCB's in wildlife was first demonstrated in 1966, and since then considerable data have been accumulated to show that they are present in many species of fish, birds, and mammals.

Toxicity studies on birds, using several different PCB formulations, indicate that the toxicity increases with the percentage of chlorine. Bobwhite quail were the most sensitive, followed in turn by pheasants and mallard ducks. The oral administration of PCB's to chicks and quail produces chemical porphyria, hydropericardium, abdominal edema, liver necrosis, and dilatation of the kidney tubules. The rate of estradiol metabolism is greatly increased in pigeons after PCB treatment which may indicate induction of hepatic hydroxylases. Poor hatchability with decreased egg production and thinning of egg shells has been observed with most of the commercial preparations.

Information concerning the effects of PCB residues in fish or the possible hazard posed by such residues has not been determined. Recent studies would indicate that PCB's have a relatively low toxicity in trout and bluegills while shellfish, oysters, and shrimp are many times more sensitive.

Acute oral, dermal, and vapor exposure studies in mammals would indicate that the acute toxicity of PCB's is not a significant factor in evaluating the potential health hazard. The oral LD_{50} for products containing 21 to 68 per cent chlorine is in the range of 4 to 10 grams per kilogram.

Laboratory studies with rats, rabbits, guinea pigs, and mice have shown that ingestion, skin absorption, or inhalation of PCB's may give rise to liver necrosis, hyperplasia, and hyperkeratosis of the follicular epithelium, and hydropic degeneration of the convoluted tubules. Chemical porphyria has been observed in most species.

Recent studies on several commercial polychlorinated biphenyls have shown the presence of tetra- and pentachlorodibenzofuran and hexachloronaphthalene which presumably occurs during manufacture. A single oral dose of 0.5 to 1.0 mg/kg of these chlorinated dibenzofurans produces liver necrosis and chloracne. Therefore, the evaluation of PCB's on the basis of effects and residues in test animals is made extremely difficult because of the difference in toxicity between various isomers and the presence of biologically active contaminants.

Approximately 10 cases of fatal intoxication have been reported among industrial workers who handled or were exposed to chlorinated biphenyls or naphthalenes. Histopathologic examination revealed liver necrosis and cirrhosis. In 1968, six hundred persons were poisoned in Japan after consuming rice oil that was highly contaminated with a polychlorinated biphenyl, Kanechlor 400. The clinical effects included chloracne, visual disturbances, jaundice, numbness, and spasms. Newborn infants from mothers who had been poisoned showed discoloration of the skin which regressed after 2 to 5 months. From the Japanese incident, it was estimated that the minimum dose to produce positive clinical effects in man was 500 mgs.

II. Agriculture's Responsibility

American agriculture has historically prided itself on the production, processing, and marketing of an ample supply of high quality foods, not only for use in this country, but in foreign countries as well. The successful development of American agriculture has been unparalleled in its continued application of science to achieve greater productivity and efficiency. This has included the widespread use of fertilizers, pesticides, antibiotics, hormones, and many other feed and food additives. The potential hazards associated with each of these have been generally recognized, and suitable control measures are in effect.

Considerable attention is being given to environmental pollution from pesticides and heavy metals by the Environmental Protection Agency, but little concern has been given to persistent industrial chemicals that slowly build up in the environment. Such is the case with the PCB's.

Agriculture, including the entire agribusiness community, from the producer to the consumer must be responsible for the production, processing, and distribution of wholesome food without polluting the environment. This involves the continued application of technology to solve or prevent problems. The PCB's should be no exception. Development and application of appropriate technology to meet new problems, requires directed efforts in research and education, most of which is done by land-grant institutions. The regulatory or legislative role falls on the Federal and State governments. State Boards of Agriculture

and the U. S. Department of Agriculture must provide technical guidance to their lawmakers and inspection agencies. The USDA not only is concerned with the support of research and extension activities to help agriculture develop and apply the technology needed for efficient production of high quality, wholesome foods, but it is also charged with the plant inspection of meat, poultry, and egg products.

The Wholesome Poultry Products Act of 1968, the Wholesome Meat Act of 1967, and the Egg Products Inspection Act of 1970, all require the responsible agencies within the USDA to prevent adulterated meat, poultry, or eggs from being traded in commerce. The definition of adulteration is similar in all three acts. Each act contains, as part of the adulteration definition, the following: "...if it (the respective products) bears or contains any poisonous or deleterious substance which may render it injurious to health; but in case the substance is not an added substance, such article shall not be considered adulterated under this clause, if the quantity of such substance in or on the article does not ordinarily render it injurious to health." In the case of an industrial chemical contamination as PCB's, the determination of the level which is injurious to health is a Food and Drug Administration responsibility. The USDA through monitoring, certification requirements, or testing must be certain these products are not adulterated when offered for sale.

Continued use of PCB's in transformers and capacitors should be permitted as no suitable substitutes are available. But, except for these uses, the Monsanto Chemical Company, the only PCB manufacturer in the U.S., indicates that they will not continue to provide these chemicals for uses in open-system and nonelectrical applications for which suitable substitutes are available. PCB's, however, are also widely manufactured in Japan, France, West Germany, Italy, and Russia and perhaps other countries. Without question, a number of products imported into the U.S. can be expected to contain PCB's. This leaves a major gap in the regulatory system to deal with PCB's and other industrial chemicals which may be potential hazards in the environment. There is no broad Federal authority at present to restrict use or distribution, to control imports, or to collect information. Such would be provided by the Toxic Substances Control Act now pending before the Congress.

According to the Interdepartmental Task Force Report, the Federal Government has taken several new actions to deal with the PCB problem. The Environmental Protection Agency will prohibit industrial effluents from contaminating water; and a standard of 0.01 ppb is being established for levels of PCB's in rivers and lakes. New regulations will be proposed by FDA with new and more stringent action levels for PCB's in food; steps to prevent PCB's in food-packaging materials; and measures to prevent accidental contamination of food, including animal feeds. The USDA has performed approximately 7000 assays on meat, poultry, and egg products for PCB's; and FDA has collected data on PCB content of foods, feeds, and food-packaging materials. The Environmental Protection Agency has

measured PCB's in sewage sludge and water, while the Departments of Interior and Commerce have followed the levels in fish and certain birds.

Although this vast effort appears to be reasonably comprehensive, it should be recognized that almost all of it was initiated after the problem existed, and that even now legislative authority is needed in certain areas of control. PCB's are but the first example of similar persistent industrial contaminants which can be expected. The phthalate esters, for example, may well be the next candidate. Concern about the levels of lead, cadmium, and mercury in selected areas also would appear to be justified. Since the agricultural community must continue to produce and process our foods so as to assure safety to the consumer, it would seem that the USDA should devise a better way to identify potential problems and develop solutions for implementation before such problems reach the proportion of the PCB's in the food chain. This would suggest the need for a surveillance system for hazardous substances as they relate to the technology of agricultural production. Such a system should include central laboratories, an information exchange system, and an evaluation and coordinating group.

This need by agriculture would build in information collected by other agencies and by the USDA meat, poultry, and egg products inspection programs; but more directed effort must be given to potential problems if we hope to prevent them through modified or improved technology. This is the broad responsibility of agriculture as it continues to meet the food and fiber needs of man without unnecessary pollution of the environment.

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Even now, it appears that a monitoring system for detection of the presence of PCB's in foods is needed. To establish such a surveillance system, accurate sampling procedures and analytical methods are required as well as meaningful guidelines and a knowledge of the routes of contamination. To accomplish these objectives a central scientific coordinating group is needed.

The USDA is the agency best qualified to carry out this mission since the Department already has the primary role for production, processing, and distribution of wholesome food and other agricultural products. In addition to a knowledge of good reliable analytical methods, detection and removal of sources of contamination of PCB's require a thorough knowledge of how each food commodity is produced and handled so that judgment can be used in collecting and interpreting results of incidents of PCB contamination and in removing the causes. To help fulfill this role, it may also be necessary to monitor potential industrial sources of PCB's and to recommend laws and regulations where existing statutes do not give sufficient authority.

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III. Inadvertent Contamination of Foods

The identified feed sources of PCB's has consistently been inadvertent or unintentional addition of a PCB mixture to one of the feed components or migration from a feed contact surface. The variety of possible sources of PCB's is apparent by reviewing past cases of PCB's residues in livestock and poultry for the original source of the PCB. These have been allegedly identified as plastic bakery wrappers, heat exchange fluid, hydraulic fluid and coating materials on silo walls. Generally, the PCB residue in the feed was lower than the residue found in the animal tissue.

PCB's are accumulated in the fatty tissue of an animal's body. Thus, birds and animals with a prolonged feeding period, such as laying hens, and dairy cows are more at risk.

A review of past occurrences is valuable as it allows the planning for future controls. In this instance, if the PCB problems had been carefully evaluated during the first two occurrences, later outbreaks would have been predicted and possibly prevented by proper corrective action.

The first occurrence of PCB was caused by transfer from silo wall coating to animal feed and then through milk cows in the late fall of 1969. PCB's in the silo lining material migrated into the silage. Cows fed this silage excreted the PCB's in their milk. Dairy herds in Ohio, West Virginia, and Tennessee were involved. The next farm animal incident did not occur until February 1971. Then laying hens and the eggs they produced were found to contain PCB levels judged to be hazardous to human health. This outbreak was confined to three New York counties. The suspected contaminated feed ingredient

was "bakery byproducts." The source of the PCB's was the plastic wrapping which had been ground with the baked goods. The ground bakery byproducts had been formulated into the laying mash.

In late summer, 1971, the largest of the PCB's incidents occurred. PCB-contaminated fish meal became an ingredient in chicken feed. The fish meal had become contaminated with heat exchange fluid during pasteurization to destroy Salmonella. This incident affected the entire southeastern United States poultry industry and required control efforts in eleven states. While this incident was occurring, a turkey flock in Minnesota was found contaminated with PCB's which required a special surveillance program. The suspected source was hydraulic fluid used to operate the hydraulic oil meal presses.

The cost of all these incidents to the agriculture community is difficult to assess. This is because of the difficulty in accurately assessing the intangible loss caused by a customer not buying a product. However, the more direct costs can be measured with a fair degree of reliability. The Poultry Division has spent $30,000 for specific tests on eggs and supervised the destruction of 123,750 pounds of product valued at $31,000. The Meat and Poultry Inspection Program has conducted 6,000 tests for an approximate cost of $200,000. In addition, it has supervised the destruction of 1,100,000 pounds of poultry with an estimated value of $275,000.

In addition to these estimated costs, the poultry industry estimates that it has had additional expenses amounting to millions of dollars to meet regulatory requirements from pretesting and birds destroyed on the farms or sold for less than market value.

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IV. Specific Concerns in Agriculture

PCB's must be considered as potential contaminants in several components of agricultural systems. They have found their way into animal feeds and animal food products through paints, heat transfer exchange fluids, fish meals, and cellophane. Since PCB's are fat soluble, they may be recycled in animal fats and byproducts. They are concentrated approximately $3\frac{1}{2}$ times in animal wastes. Paper and cardboard food-packaging materials also may be contaminated. PCB's have been found in milk, eggs, meats, fats, and oils, and cereal products. PCB's are known to be harmful to chickens, ducks, mink, fish, and wildlife. Synergistic effects of PCB's and certain pesticides also have been reported. Background levels being reported in remote areas suggest that these persistent chemicals will be of concern to agriculturists for many years to come. Some of these concerns are discussed below.

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A. Contamination of Animal Feeds

The accidental contamination of animal feeds with PCB's has been responsible for most of the inadvertent contamination of foods just described. PCB contamination of animal feeds has been traced to heat transfer exchange fluids, hydraulic fluid, cellophane and plastic wrappers, paints and sealants used on silo walls and in feed troughs, and misused transformer fluid in a herbicide spray. A number of other PCB-containing substances which may be found in or near feed plants include lubricants, cutting oil, lacquers, varnish, polishes, dyes, rubber, asphalt, putties, printers ink, corrosion inhibitors, flame retardants, termite control compounds, etc. Presumably, the use of PCB's in all of these will be discontinued.

Quite apart from the accidental direct contamination of animal feed ingredients, the ubiquitous nature of PCB's also causes some concern about the biological magnification as they move through the food chain. For example, fish and aquatic invertebrates have been shown to accumulate PCB's to levels 75,000 times that present in water and frequently contain from 1 to 10 ppm. The levels which are reached also depend on the length of the exposure to PCB's. In rats fed a laboratory chow containing 0.05 to 0.1 ppm of PCB's, a 50-fold increase in level in the adipose tissue has been observed. Scott et al. (1971) reported a 4-to 6-fold increase in adipose as compared to diet levels in laying leghorn hens in only 8 weeks.

PCB's are fat soluble and are found in the lipid fractions of feed ingredients and food products. Animal products generally contain higher levels than do plant products when background levels alone are considered. Feed ingredients most likely to include significant levels of PCB's would [illegible]

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At present, the Food and Drug Administration is conducting a survey on the PCB content of animal feeds in cooperation with the American Feed Manufacturing Association, but this information is not yet available. The AFMA has observed a wide divergence of analytical results when different laboratories have checked the same sample, presumably due to the analyst's quantitation of the results. Despite this problem, levels of PCB's in feed ingredients and mixed feeds for animals appear to not normally exceed 0.5 ppm except when accidental contamination is involved. For low fat, non-marine, non-animal origin materials, the level will usually be substantially less. Limited information available to us suggests that the background PCB levels in feeds would be 0.2-0.4 ppm in cereals and legumes, 0.3 to 1.0 ppm in meat and fish products, 0.3 to 0.4 ppm in bakery products, and 0.5 to 1.5 ppm in feed-grade fats.

Discussion of some of the most likely accidental causes of PCB contamination of animal feeds follows:

1. PCB-Contaminated Silos

The problem was identified originally when the Ohio State Department of Agriculture detected PCB residues in milk samples from the Cincinnati milkshed. They traced the PCB's to the walls of concrete stave silos which had been painted with PCB-containing paint. PCB's have also been used in silo sealants. PCB-contaminated silos have since been reported in Kentucky, Tennessee, North Carolina, West Virginia, and Pennsylvania. It is probable that contaminated silos exist in some adjoining States. Enforcement activity has been confined to Ohio and Kentucky.

Information collected by the Ohio Department of Agriculture, field studies by the University of Kentucky, as well as field and laboratory studies by the Animal Science Research Division, ARS, provides some background on the significance of the problem when it occurs on individual farms. However, information is not sufficient to evaluate the significance of the problem on a nationwide basis.

Prior to 1968, one of the paints used to coat the interior of concrete-stave silos contained Aroclor 1254. Three silo builders have been identified as users of this paint. In two areas, centered in Ohio and Kentucky, the associated builders coated the entire interior walls of the silos. A third company, centered in Tennessee, used the material only to seal the joints between the staves.

Field studies by ASRD and the regulatory experience in Ohio and Kentucky suggest that if a dairyman has a silo with the entire wall coated, the residue levels of PCB will be in the range of 10-15 ppm in milk fat at the time silage is fed. The highest level observed was 28 ppm. The FDA guideline for PCB residues in milk is equivalent to 5 ppm in milk fat. Invariably, a dairyman with these silos will produce milk exceeding the guideline for at least part of the year.

Milk from four farms in Tennessee where only the joints were coated has been examined by ASRD. The residue levels were about 5 ppm in fat when silage was being fed. Thus, this situation is not as serious as the completely coated silos. In many cases, the residue levels may not exceed the guideline.

The total number of silos affected cannot be reliably estimated. There is, however, a reliable estimate of 300 affected silos within an area in Tennessee. The number of silos might be 1000 if it could be assumed that the other two companies are of similar size and that no other companies are involved. However, there is reason to believe that the other companies are larger and have built many more silos than the Tennessee company. If this is the case or if other companies are involved, the number of affected silos may be as great as 4,000 or 5,000.

Routine surveliance methods have not been adequate to detect the individual dairyman with PCB levels exceeding the guideline. The lower detection limit for PCB is about 1 ppm in milk fat. Thus, an individual dairyman with a contaminated silo, on the same pick-up route as ten other dairymen with no milk contamination, would not be detected. Unless farms are surveyed on an individual basis most PCB contamination will be undetected when surveyed in tank samples at the milk plant.

Based on the results of FDA surveys, the overall milk supply does not present a significant health hazard to the general public. There may be a possible hazard, however, to the individual farm family if they consume milk produced on the farm. Assuming consumption of one quart of milk per day with an average contamination of 7.5 ppm in the fat, an individual could consume as much as 10 mg of PCB per year. Over a 20 to 25 year period, this intake

would approach the intake of Japanese who exhibited acute symptoms from short term-high level intake. Whether this would present a significant health problem depends on several factors. Generally, a long term intake of a toxic substance is not as significant as a short term intake of equal magnitude. The Aroclor 1254 involved in the silos is different from the PCB involved in the Japanese problem. Thus, it may not contain the specific components that caused the most severe problems among the Japanese.

Field and laboratory studies by ASRD indicate that the rate of dynamics of Aroclor 1254 milk secretion is identical to the residue behavior of the DDT metabolite, DDE. Aroclor 1254 is resistant to metabolic degradation and it is transferred efficiently to milk fat or to body fat. It requires about 6 to 8 weeks to reduce milk residues by one half after the cow is placed on clean feed. No practical method has been found for speeding up the decontamination of the animal.

Cull dairy animals from farms with contaminated silos could be expected to have tissue residue levels of PCB exceeding 5 ppm in the fat. In general, the tissue residue levels would be similar in magnitude to the milk residue levels. Silage is not a significant feed for fattening cattle. Therefore, it is probable that no other class of meat would be contaminated from this source.

The Aroclor 1254 residues in silage occur mainly within 2 or 3 inches of the silo wall. As one progresses down the silo it is possible to detect small amounts of PCB several feet from the wall. However, because PCBs are non-polar and the silage medium is polar, the amount of migration is not significant.

Practical methods for handling the contaminated silos short of complete abandonment have not been developed. A practical method would have to be effective and cost significantly less than the price of a new silo.

Two temporary expedients have been attempted. Since most of the contamination is adjacent to the wall, some individuals have discarded the material within 3 or 4 inches of the wall. ASRD and the University of Kentucky have examined milk from several farms where this was attempted. Residue levels were reduced but did not consistently fall below the guideline. There are generally two problems with an approach of this sort. The first is that it is very difficult, if not impossible, to adapt this approach to mechanical silo unloaders. The second problem is that it does not remove the PCB from the silo and one cannot be certain that the same diligence would be exercised in succeeding years.

A plastic barrier installed as the silo is filled shows promise as an effective temporary expedient. Very little PCB penetrates through the barrier. However, as in the case of attempting to avoid the material next to the wall, this method is impractical with mechanical unloading and one cannot be certain that the barrier will be used in future years.

PCBs are quite soluble in a number of non-polar solvents. Thus, with the appropriate selection of solvent it should be possible to wash most of the PCB off the walls. Several silos in Kentucky have been washed with gasoline. This appeared to remove about 90% of the PCB from the walls near the top of the silos. However, it was apparent that a thorough job of washing was not done on the lower parts of the silos and some milk residue levels were nearly as high in these herds as in untreated herds. This method should be studied in a more thorough manner and its economics established.

Another method of removing the PCB from the silos would be sandblasting. However, the cost of sandblasting has been established at more than half the price of a new silo and in many cases would exceed the depreciated value of the existing silo. Sandblasting also creates a significant dust problem. Thus, it is possible that one would remove the PCB from the silo wall but spread it to other areas around the farm.

There are two general areas of information which are urgently required in regard to the PCB problem in silos. The number and location of the contaminated silos should be established. The second problem is to determine if it is possible to clean up the silos or whether it is necessary to totally abandon them.

In addition to paints and sealants for silos, PCB-containing paints, putties, and water-proofing compounds have been used on animal feed troughs and other surfaces. In one instance where a feed trough for swine was coated with a sealant containing Aroclor 1254, chips from the bottom contained 8000 ppm PCB's. Similarly finished feed transported in a newly painted hopper car contained 6.5 ppm of Aroclor 1248.

2. Plastic and Paper Products

The PCB contamination of eggs from laying hens in New York State, which led to the incrimination of a bakery byproducts meal used in the laying mash, is an example of PCB contamination from cellophane and plastic wrappings. It appears that the amounts of these materials ground up with the bakery byproducts were sufficient to explain the PCB contamination.

The use of PCB as a plasticizer has been almost completely replaced by the phthalate esters.

The presence of PCB in paper products was described at a recent meeting sponsored by the Grocery Manufacturers of America, Inc. The primary source of PCB was found to be carbonless paper which was present in certain grades of paperstock being recycled in the paper industry. The PCB's were used as a component of the dye carrier in the carbonless carbon paper. In many cases, the recycled paper was used for packaging food, thus resulting in a contamination of the food.

Presumably, PCB's are no longer used in carbonless carbon paper, and recycled paper is no longer used to package food; thus, exposure from this source should no longer occur. It should be pointed out, however, that PCB's have been found in paper and paperboards that did not contain carbonless carbon paper. The American Paper Institute is currently sponsoring a study to determine levels of PCB in United States pulp, paper, and paperboard and to investigate the migration of PCB from paperboards to foods.

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3. Heat Transfer Exchanger Fluids

PCB's have been used extensively as heat transfer exchanger fluids due to their inflammable nature or high flash points. Leaks on a hot surface or into a furnace present a fire hazard with flammable heat transfer fluids. Where PCB's have been used, this danger has been avoided in the past. This accounts for the widespread use of PCB's in heating systems used to process or sterilize feed and food ingredients.

The largest of the PCB incidents which occurred was caused by chicken feed containing imported fish meal that had become contaminated with heat exchange fluid during pasteurization to assure Salmonella control.

Restrictions have been proposed by FDA on the use of PCB's in food or feed processing facilities, so as to prevent any further chance of accidental leaks causing contamination.

In some instances, water can be used as a satisfactory substitute at moderately high temperatures. Some hydrocarbons are now being used as heat exchanger transfer fluids, but these do present fire hazards in high temperature systems.

In replacing PCB's with another material, caution should be exercised to avoid spillage and contamination of the environment where food or feed is processed. Spillage can result in heavy contamination of grease-trap fat, which sometimes is used in feed-grade animal fats. All PCB's removed from such systems should be buried or returned to the Monsanto Chemical Company where they can be burned in a special high temperature furnace which will degrade these compounds.

4. Hydraulic Fluids

PCB's also have been widely used as hydraulic fluids since they have a high flash point. It is anticipated that satisfactory substitutes will replace PCB's for this use, but one should always suspect their presence in present equipment.

Hydraulic systems are frequently used on farms, in processing plants, in feed mills, and throughout the entire agribusiness complex. Leaks from hydraulic lifts on feed trucks have contaminated feed. Other leaks into the environment could find their way into the food chain in a less direct way.

5. Recycled Animal Products

A number of feed ingredients are made from byproduct and waste materials which accrue during processing of animals for human food. These include feed grade poultry and animal fats, poultry byproducts meal, hydrolized feather meal, meat scraps, meat and bone scraps, tankage, and blood meal. In theory, each recycling of such products through another generation of food animals will result in a slight increase in the concentration of PCB's in the food fat. This occurs since the animal accumulates a higher level in its body fat than was present in the diet. Expressed on the basis of dietary fat vs. body fat, however, there may be no increase in concentration of PCB's. Recycling of animal byproducts is not likely to result in a measurable PCB buildup in such products unless diets containing high levels of dietary fat are used. For example, carcass fat of broilers might be 12%, while the amount of fat in a commercial broiler feed containing 5% added feed-grade fat, would range from 7%. If feed conversion averaged 2.0 and 30% of the PCB's consumed were retained in the carcass, the resulting level of the PCB's in the adipose tissue in the bird would be only one-third that in the feed expressed on the basis of feed fat, even though the concentration in the body fat would be eight times higher than that of the total feed.

Though higher levels of PCB's would be expected in turkey roosters kept to 24 weeks, this still should not result in an increase in PCB content of body fat vs. feed fat since they would consume only about twice as much feed per pound of gain as would broilers. Hens kept for commercial egg production and as broiler breeders would consume from 60 to 120 pounds

of feed per pound of body weight before marketing and could develop four to ten times higher levels in the body fat as in the feed fat. However, animal byproduct wastes from such sources would not constitute a significant proportion of the total supply. Moreover, most of the feed-grade fat is used in broiler feeds. No buildup of PCB's would be expected in beef, lamb, or swine production.

When high levels of PCB's are found in animal products, consideration should be given to the prevention of recycling contaminated animal byproduct feeds, especially those high in fat. Moreover, a system of surveillance to detect residues of PCB's or other fat-soluble materials should include careful monitoring of recycled animal byproduct feeds and feed-grade fats at the feed ingredient production level.

B. Effect of PCBs on Animals and Transfer to Animal Food Products

Poultry

McCune et al. (1962) observed that an epoxy-resin paint containing Aroclor 1242 caused symptoms of "chick edema" when chicks were placed in a freshly painted battery brooder. Subsequent studies with levels from 100 to 800 ppm showed that this compound produced labored respiration, accumulation of abdominal fluids, enlarged heart, hydropericardium, swollen kidneys, and hemorrhage of internal organs. Mortality was severe and weight gains reduced.

Further studies by Flick et al. (1965) suggested that 400 ppm were required to produce serious symptoms. They observed cream-colored pancreas, enlarged adrenals, small spleen, dermatitis, loss of feathers, low hemoglobin, low hematocrit, and reduced blood glucose.

Rehfeld et al. (1971) have recently reported that the maximum tolerance of the chick to PCBs, containing 48% chlorine, is approximately 50 ppm in the diet. Symptoms observed in chicks fed PCBs included depressed weight gain, edema, gasping for breath, hyperpericardial fluid, internal hemorrhaging, depression of secondary sexual characteristics, and an increase in liver as a percent of body weight. Several of these symptoms were present when levels of more than 20 ppm of PCBs were fed.

Scott et al. (1971) fed four levels (0.5 to 20 ppm) of Aroclor 1248 to White Leghorn hens for 8 weeks and measured the effect on egg production, egg breaking strength, fertility, hatchability of fertile eggs, feed consumption, and PCB content of eggs,

adipose and other tissues. No effect was observed on feed intake, breaking strength of eggs or fertility while egg production was reduced only 10 and 13% after 8 weeks when 10 and 20 ppm of PCBs, respectively, were fed. The levels of PCBs found in adipose tissue and eggs after different lengths of time on diet are given in Table I.

The two lowest levels of dietary supplemental PCBs, 0.5 and 1.0 ppm, did not increase the PCB content of the eggs above 0.45 ppm. With the 0.5 ppm dietary level the PCB in the eggs plateaued at about 0.2 ppm, and with the dietary level of 1.0 ppm, the amount in the eggs plateaued at approximately 0.45 ppm. The ratio of PCB in the eggs in comparison to that in the fat of the hens after 8 weeks on the experiment was almost exactly 1:15 for both of the lowest levels of dietary PCBs. With the 10 and 20 ppm dietary levels of PCB, the ration of PCB in the eggs to that in the fat of the hens was approximately 1:12.

The effect upon hatchability was more dramatic than egg production (Table II). The lower levels of 0.5 and 1.0 ppm of PCB produced no effect but the 10 percent level of PCB reduced hatchability in 4 weeks by 28 percent and 20 ppm level almost completely eliminated hatchability of the eggs. At this higher level, the embryos in eggs died during the 21st day of incubation. Egg production is reduced by about 10 percent when the PCB level of eggs approaches 3 ppm of PCB and further reduction occurs when PCB level of eggs reaches 7 ppm. The hatchability of eggs was only about 56 percent of normal when the PCB level reached 3 ppm in the eggs, while a level of 4.5 ppm or more of PCB in the eggs almost eliminated hatchabili

TABLE I. TRANSFER OF PCBs (AROCLOR 1248)
FROM THE LAYING DIET TO THE ADIPOSE TISSUES AND EGGS

PCB in diet	PCB in adipose tissue			PCB in eggs				
	1 wk	4 wks	8 wks	1 wk	4 wks	6 wks	7 wks	8 wks
ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
0	0	0	0	0	0	0	0	0
0.5	1.54	2.16	3.10	0.10	0.16	0.21	0.20	0.22
1.0	2.21	4.41	6.62	0.19	0.33	0.42	0.45	0.41
10.0	10.4	22.7	37.1	1.05	2.21	2.83	3.11	3.06
20.0	16.3	54.7	82.7	2.19	4.51	5.37	5.72	7.04

Data of Scott et al. (1971)

TABLE II. EFFECT OF PCBs (AROCLOR 1248) ON HATCHABILITY [1]

PPM PCBs In Diet	Weeks on Diet 4	6
	Percentage of Fertile Eggs	
0	89.8	90.5
0.5	91.3	91.6
1	88.2	93.7
10	65.4	50.0
20	3.9	2.4

[1] No effect was observed on fertility or breaking strength of egg shells.

Data of Scott et al. (1971)

In this study attempts were made to deplete the tissue of the hens of PCB (See Table III). They used high-and low-energy diets; but with either, the rate of depletion of the body stores of PCB was slow.

After the 8-week feeding test, the skin, muscle, liver, and gizzard of the hens were assayed for PCBs after depletion periods of 2 and 4 weeks (Table IV). The skin, apparently because of its high fat content, had the highest amount of PCBs. The PCB content of the whole fresh muscle was not very high and was quickly depleted to levels below 1.0 ppm. Values for organ and tissue levels of PCB are shown in Table IV.

Shutze et al. (1971), collected data on three commercial farm flocks where Single Comb White Leghorn breeders had consumed a feed containing 27 ppm of PCBs from fish meal accidentally contaminated with Aroclor 1242 used in a heat transfer exchange fluid. Hatchability of eggs was less than 0.5 percent when the eggs contained more than 2.3 ppm of PCBs. When the PCB concentration in the eggs from flock A decreased to 1.6 ppm, a 20 percent hatch was obtained. Flock B was subjected to 14 days of starvation to determine the influence of forced molting on depletion rate of PCBs. During this period, the concentration actually increased in the adipose tissue from 20.4 to 38.4 ppm.

A third flock was maintained on an uncontaminated breeder ration and PCB content of eggs and hatchability of fertile eggs were monitored weekly. After 2 weeks, the level of PCBs in the eggs dropped to 1.3 ppm and hatchability was 85%. After one more week, the

TABLE III. EFFECT OF 4-WK. DEPLETION PERIOD ON LEVELS OF PCBs (AROCLOR 1248) IN BODY FAT AND EGGS OF LAYING HENS

Level PCBs in Diet During 8-Wk. Period PPM	Wks. Depletion After 8 Wks. on PCB-Containing Diets 1/		
	0 Wks.	2 Wks.	4 Wks.
	PPM in Body Fat		
10	37.1	40.2	21.2
20	82.7	67.0	43.0
	PPM in Eggs		
10	3.1	2.11	1.62
20	7.0	4.8	3.40

1/ Low-energy diet fed first 2 wks., then high-energy diet fed 2 wks. Other data failed to show that dietary energy level had any effect.

Data of Scott et al. (1971)

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TABLE IV. PCB (AROCLOR 1248) CONTENT OF EDIBLE PORTIONS OF THE HEN

Depletion diet no.	Initial lot no.	PCB content of tissues, 4 wks depletion			
		Skin	Muscle	Liver	Gizzard
		ppm	ppm	ppm	ppm
1	4	12.0(22)*	0.42(24)	5.0 (18)	2.0(21)
	5	28 (46)	0.67(44)	6.0 (37)	4.2(45)
2	4	13.7(27)	0.42(27)	1.16(24)	2.1(27)
	5	21 (63)	0.35(58)	1.7 (46)	2.0(56)
2 & 3	4	16 (26)	0.42(30)	5.0 (21)	3.0(25)
	5	18 (47)	0.56(45)	12 (37)	2.0(39)

* Figures in parentheses show PCB in parts per million of the extractable fat of the tissue.

Data of Scott et al. (1971)

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level in eggs dropped to 1.1 ppm and hatchability was 92 percent. After 10 weeks of depletion on the uncontaminated diet, the level of PCBs in eggs had dropped from 2.5 to 0.72 ppm and in adipose tissue from 20.4 to 8.6 ppm.

The level of PCBs required to affect hatchability in chickens is much greater than is needed to interfere with the reproduction in ranch mink. Coho salmon containing 15 ppm PCBs caused reproductive failure when fed to ranch mink (Auerlich et al., 1971).

In still another flock of 10-week old pullets, PCB levels dropped from 11.2 ppm to 2.8 ppm at 19 weeks of age. Mortality, growth rate, and appearance seemed to be normal.

Dahlgren and Linder (1971) reported that (Aroclor 1254) PCBs fed to pheasants at 25 mg per week for 17 weeks significantly depressed egg production and increased the number of pips. Even though weekly weight changes of hens, fertility and hatchability of eggs, mortality of adults, and egg shell thickness did not appear to be affected by PCBs, total reproductive success was depressed. Mortality of chicks from hatching to 6 weeks of age was significantly greater in the offspring from hens fed 50 mg PCBs weekly. (Shutze et al. 1971).

Tucker and Crabtree (1970) observed that the acute oral LD50's for Aroclor 1242, 1254, 1260, and 1268 in the Mallard duck were around 2000 mg/kg or greater. Similarly, Flatanow and Funnell (1971) found the LD50 to be about 200 to 400 ppm in chicks when fed from day-old for 4 to 13 weeks.

In chickens, Japanese quail, and rats, PCB poisoning causes a rise in porphyrin in the liver, bile, small intestine, and bone which leads to increased excretion of fecal coproporphyrin and protoporphyrin. The porphyrin formation may be due to induction of ALA synthetase (Vos and Koeman, 1970).

Dairy

Fries (1971) has studied the transfer of PCB (Aroclor 1254) from paints used on silo walls. This is discussed above. The levels found in silage have ranged from 3.4 to 31 ppm within 4 inches and from 0.1 to 0.27 ppm from 6 to 24 inches from the wall (Skrentny et al. 1971). Although highly variable, the level in contaminated silage will average about 0.8 ppm of PCBs. Cows fed such silage produce milk containing from 5 to 11 ppm of PCBs in the milk fat. The level of PCBs in the milk declined about 50% within 3 weeks after removal of the silage. After this, the rate of decline was 1.3% per day. Milk from cows not fed contaminated silage may contain 1 to 2 ppm of PCBs in the milk fat from background levels.

Fries (1971) has found that cows fed 200 mgs of Aroclor 1254 daily for 60 days produced milk containing 50 ppm of PCBs in the fat. When PCB feeding was stopped, the level in the milk fat dropped from 50 to 24 ppm in 10 days. Thereafter, the concentration decline was approximately 1% per day. Concentration of PCBs in the milk fat was not related to stage of lactation or level of milk production.

If one assumes an average fluid milk consumption of 450 gms, including cheese, ice cream, and butter, intakes of 1.1 mgs per day could be obtained if all the milk fat contained 11 ppm of PCBs.

A report by Saschenbrecker et al. (1972) suggests that a higher percentage of PCBs is excreted in the milk than through either urine or feces in the study with two dairy cows. They administered 10 and 100 mg of PCBs per kg. of body weight and obtained levels of 6.3 and 74.5 ppm, respectively, in the milk one day later. Total collections of urine and feces for 7 days accounted for only 2.0 and 1.4% of the total dose, while 7.4 and 4.8% was recovered in the milk over the same period. Urinary excretion was insignificant, being less than 1% in both animals.

Charcoal appears to be somewhat effective in the prevention of absorption when fed with PCB-containing silage but has no value in removing body stores.

D. Waste Disposal

Animal Waste

The safe economic disposal of animal wastes is rapidly becoming a priority concern. The increased size of agricultural units needed for most efficient production has rendered land recycling less adequate and the possibility of recycling of certain types of animal wastes in feeds for animals is receiving considerable attention. Although much more information is needed to properly appraise the feeding value of different types of animal wastes (poultry manure, feedlot wastes, etc.), present information clearly indicates that such wastes can provide a significant proportion of the nutrient needs of ruminant animals. Any animal waste would require some type of processing to insure that it is pathogen-free prior to use in animal feeds, and such wastes must not contain [illegible] such as the PCBs which are potentially harmful to men or animals.

Studies by Yoshimura et al. (1971), involving radiolabeled Kanechlor given to rats, showed that urinary excretion was limited; but 70% of the dose was in the feces, some of which had been changed to phenolic metabolites. Depletion studies with rats (Curley et al. 1971) confirm the much greater excretion of PCBs in the feces as compared with the urine.

Based on the work of Scott et al. (1971) where laying hens were fed diets containing 0.5, 1.0, 10, and 20 ppm of PCBs, the proportion retained in body fat, excreted in eggs, and voided in the droppings has been estimated. These calculations, which involved estimates for feed consumption, body size, egg size, percent egg production, and body composition, suggest that, expressed on the basis of total PCBs consumed, from 12 to 15% was excreted in eggs; 18 to 30% was retained in the adipose; leaving from 55 to 70% to be voided in the droppings. A higher proportion was retained in adipose and in eggs when the lower levels were fed. These calculations would suggest that the observations with rats may be reasonably correct for food animals with respect to PCB excretion and that animal wastes could contain up to 70% of the PCBs consumed.

In most cases, digestibility of animal feeds will approach 60% the grain and concentrate portion of the ration; therefore, if as much as 70% of the dietary PCBs is excreted in the feces which would approximate 20% of the solids in the diet, there could be as much as a 3½-fold increase in concentration of PCBs in fecal wastes on a solids basis. At low levels of intake, the increase in concentration in the feces would be somewhat less.

This increase in PCB concentration in animal wastes is not likely to consistute a problem in practical recycling for animal feeds where only background levels of contamination are involved, and relatively low levels are included in the total ration.

With ruminants where higher dietary levels of processed animal waste products can be effectively used and where longer periods of feeding are involved, one could expect the concentrations in the adipose to be increased. Accordingly, attention to PCB content of such animal wastes must be considered in determining its suitability for recycling in rations of food-producing animals. In this connection, one would anticipate greater concentration in animal wastes than in such byproduct ingredients as meat scraps, poultry byproducts meal, etc. except where the byproducts are made from breeding animals fed PCB-containing diets over a long period.

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Processing Wastes

PCB's have been traced to industrial effluents both in the United States and in Western Europe. Sewage outfalls and effluent ditches from industrial plants have been identified as PCB sources, but there is little or no documentation as to the actual source of PCB within the plants. PCB contamination of the Escambia River was traced to an effluent stream from the Monsanto Chemical Company and the presumed source was a leak in the heat exchange system of the plant. Aside from the well-publicized episodes of leaking heat exchangers in feed mills, PCB's have been found in trace amounts in the by-products from two potato processing plants, one located in the Denver area and the other in Seattle, according to a FDA report. These appear to be the only instances so far where the agricultural processing industry has been the source of contamination.

From the known solubility properties of the PCB's, the refining of crude vegetable oils and animal fats should eliminate them but they would probably be found in the deodorizer distillates. The by-products from meat packing, poultry processing and rendering operations also probably accumulate PCB's. Feed lot waste fractions and corn-milled products from sludge-treated soil are also possible sources of contamination arising from agriculture product processing industries.

Uses of Sewage Sludge

Analysis of sewage sludge at Fort Collins, Colorado indicated that PCB content ranges from less than 1 to 12 ppm based on air dry weight. The sewage sludge samples were taken from the drying beds after anerobic digestion. Aroclor 1254 was the primary constituent with lower amounts of Aroclors 1248 and 1232. Water analyses sampled above and below the sewage plant showed PCB's in the samples taken primarily from below the sewage plant. The PCB's were found on suspended particulate matter.

Dried sewage sludge is frequently used on lawns and golf courses.

Sewage sludge analyses could possibly be used as an indicator of PCB load entering the environment. If the uses of PCB's in open systems are indeed curtailed, one could expect a marked decrease of PCB content in sewer sludge.

Wildlife Preservation

PCB's, like many of the organochlorine insecticides, are stored in the lipids of animals. They resist metabolic changes, and tend to be concentrated at succeedingly higher levels in animals higher in the food chain. The higher chlorine PCB's are the more stable.

Existing data suggest that the principal route of PCB's through the environment is from waste streams into receiving waters, downstream movement in the waterways in the water and on sediment, accumulation from the water by aquatic organisms and transfer to birds and mammals through residues in fish that are eaten.

PCB's are lethally toxic to fish and aquatic invertebrates in concentrations of parts per billion or less. However, in simple food chains, fish to eagles or fish and mussels to seals, concentrations increase to thousands of times from prey to predator.

The toxicity of PCB's in birds is similar to DDE. Residues of PCB's in brains of chickens killed by PCB dosage range from 40 ppm to 700 ppm. The toxicity of PCB's is greatly increased by the presence of chlorinated dibenzofuran and chlorinated naphthalene impurities, apperent in foreign manufacture of PCB's.

The toxicity of PCB's increases when the organism is under stress. In addition, PCB exposure will stress an animal to increase the susceptability to other mortality factors. For example, mallard ducklings exposed for 10 days to a dietary dosage of 25, 50 or 100 ppm of Arochlor 1254 showed 35 to 44 percent mortality upon subsequent exposure to duck hepatitis virus, whereas mortality among birds exposed only to virus was 14 percent, significantly lower. In addition, reproductive failures are evident in some known instances when exposed to PCB's in the diet as in ranch mink. PCB's induce microsomal enzyme activity in birds and mammals and the lower chlorinated mixtures have estrogenic activity in rats.

Egg shell thickness of ducks, quail and doves are unaffected by low or moderate dietary doses of Arochlor 1254. In brown pelicans DDE residues correlate with thinning eggshells better than residues of PCB's. On the other hand, chicken eggshell thickness is thinned by high doses of Arochlor 1254 and by low doses of Arochlor 1242.

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Behavorial differences have also been observed with high dosages of PCB's as in poor choices of visual cliff tests in pheasants. Migratory restlessness was increased in English robins exposed to PCB's.

In conclusion, it is apparent that the evaluation of PCB's actual or potential effects in the environment is hampered by the complex nature of the PCB mixtures, by the inclusion of contaminants in the mixtures and by the interactions with other stress factors. In addition, experimental studies have been conducted with the unaltered products and the results may not properly reflect the effects of the components as they exist in the environment. The evidence available, however, indicates that PCB's must be viewed as potential problems to wildlife.

Synergistic Effects With Certain Pesticides.

Limited information is available concerning the synergistic effects of PCB's with pesticides. However, what information that is available should not be disregarded.

Sublethal dosages of several Aroclors increased the toxicity of dieldrin and DDT to Drosophila and house flies. (Lichtenstein et al. 1969). In another investigation Arochlor 1254 increased the toxicity of carbaryl to house flies by factors of 11-to-62 fold. The mechanism of synergism is unknown, but probably does not involve the inhibition of microsomal oxidase which is usually responsible for insecticide synergism (Plapp - unpublished).

Aroclor 1248--although nontoxic by itself to houseflies at dosages of 10 micrograms per fly--significantly increased the toxicity of the oxygen analogs of five organophosphorus insecticides after simultaneous topical application to houseflies. PCBs applied simultaneously with parathion, however, decreased the toxicity of parathion to houseflies, but increased mortalities when applied to flies one-half hour after the application of the insecticide. The PCBs apparently inhibited the conversion of parathion to its toxic activation product, paraoxon, and the breakdown of paraoxon into nontoxic compounds. (Lichtenstein 1971)

If synergism related to PCB's occur with other insecticides and with mammals as well as with insects, then unintentional exposure to PCB's due to environmental contamination may have significant implications to non-target organisms exposed to combinations of PCB's and pesticides.

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Problems of Monitoring the Wholesomeness of the Food Supply

The total food bill (excluding alcoholic beverages) paid by the American consumer reached a high of some $128 billion in 1971. This figure includes purchases for home preparation as well as away-from-home meals. Food purchases represent about one-third of total product purchases, making it by far the largest single category in the product purchase budget.

Another way to look at the importance of food is to note that the average person consumes about 1,450 pounds of food each year. Based on the current U.S. population, this represents a total annual consumption of almost 300 billion pounds of food.

While the number of food manufacturers has declined greatly since World War II--from 40,000+ in 1947 to 32,000+ in 1963--it nevertheless requires a very sizeable and diverse industry to satisfy the needs of the consuming public. While up-to-date figures are not readily available on the number of companies involved in food production, one can estimate that the number is perhaps in the area of 25,000 at the present time. Another factor that has a bearing on the overall problem of food surveillance programs is the imports which represent about 10 percent of our total food supply. Looking at the total food supply and the need to maintain quality at levels and tolerances acceptable to the consumer and at the same time provide maximum assurance of a wholesome product, one can see that an inspection program is certainly confronted with challenge.

1. Problems of Inspection and Control

The objective of an inspection program is to provide a system of defining and controlling quality at levels acceptable to the consumer or buyer at a cost that is reasonable. At the same time, materials that are toxic or otherwise present a hazard to health must be identified and eliminated to the maximum extent possible. The extent to which these objectives can be attained depends to some extent upon the authority of the inspection agency to perform the necessary functions of food inspection and also the availability of funds and people to carry out an effective monitoring system. There are, of course, many interrelated areas of concern that must be considered in the total program such as:

a. Identifying that a hazard exists

b. Locating source of contamination

c. Corrective action

d. Developing an appropriate sampling procedure

e. Methodology

f. Disposition of contaminated product

It has been suggested that the attributes of food quality fall into two general categories; namely, those that are sensory and are normally detected by appearance, taste, odor, etc., and those that are hidden and would most likely escape detection by the consumer's senses. This latter category is of increasing importance as far as the consumer's health is concerned since so many toxic substances fall into this class. Fortunately, many of the potentially dangerous substances, such as pesticides, are relatively

The same is true of authorized food additives, some of which are known hazards and must be controlled. The most critical problem is detecting those contaminants that creep into the food supply through accidental contamination from environmental sources. Our current knowledge of PCBs indicates that the principal route to man through the food supply is restricted for the most part to fish, poultry, eggs, and milk. The problem associated with carbonless paper and recycled packaging materisl is being corrected. This then identifies certain specific food sources that warrant monitoring to protect thepublic health.

The type of sampling scheme utilized in the inspection program depends to a large extent upon the purpose for which the inspection is made. In setting up a sampling plan, it is often customary to classify defects in product characteristics as minor, major, and critical--a minor defect is one that might affect the economic value of the product but not its wholesomeness; a major defect is one that is not injurious to health but could make the food unsuitable because of aesthetic considerations; and a critical defect is one that presents a hazard to health. Since the risks to the consumer must be minimized in the case of "critical defects," sampling procedures must be tailored to this objective. Obviously, routine market sampling would not offer sufficient protection. The most effective approach in the case of substances such as PCBs is to concentrate on the known or suspect sources and perform

near 100% sampling to assure detention of contaminated products. This type of sampling is illustrated by a recent FDA order to sample all fluid milk in the 50 States at the "farm pickup point" for PCB testing.

Historically, the inspection services have been confronted with problems of methodology whenever a contaminant appears unexpectedly in the food supply. When dealing with these highly toxic materials, the method must be sensitive to levels in the order of parts per million and even in some cases parts per billion. Generally, chemical or instrumentation procedures are required as they are faster than bioassays and can be handled in many laboratories. Fortunately, the newer, more sophisticated analytical procedures together with the input and expertise of the scientific community have done much to improve the analytical capabilities associated with a good control program.

The matter of disposition of suspect or known contaminated lots merits consideration. Those products exceeding action levels of contamination must, of course, be removed from the food supply. In many cases, this requires detention of the food pending a segregation of "good" and "bad" lots when such action is feasible and disposition of affected portions according to guidelines prescribed by the regulatory agency.

In any inspection program dealing with contaminated foods, the objective is, of course, to protect thehealth of the consumer by removing contaminated products from the market. A further

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objective is to attack the source of contamination and eliminate it completely or invoke an appropriate surveillance program. This can best be accomplished by placing the control responsibility to the fullest extent on the industry concerned. An example of a very successful industry-monitoring program is the pretesting for aflatoxin of all peanuts that are used in edible food products. Industry is bearing practically all of the cost and input of this program.

Two regulatory agencies, namely the Meat and Poultry Inspection Program and the Food and Drug Administration are charged with maintaining a wholesome food supply in the United States. The officials in these Agencies and Congress recognized that it would offer more protection to control ingredients going into the food supply than to depend on the finished product testing to control toxic ingredients. This is tacit recognition that the very voluminous and diverse sources of the food supply to the United States or any other nation limits finished product testing to an assurance program. The short time lapse from raw product to the table also dictates that toxic components must be kept out of the our food supply with surveillance to assure that no toxic materials are included.

To meet their responsibilities in the non-visible toxic substance area, both USDA and FDA use the same basic approach. This is prior approach of food additives and materials used in direct contact with food and laboratory surveillance programs to detect toxic residues which may be in the raw agricultural product prior to processing. To minimize the danger of the raw agricultural products containing a harmful residue, any man-made compound used to produce agricultural products is also subject to limitations as to amount used or residue remaining in or on the raw agricultural product.

These laws on which the agencies' actions are based have been proved capable of allowing many man-made compounds to be used safely in the production of food and fiber. However, they have not provided much protection, prior to the discovery of environmental contaminants and unintentional inclusion of

industrial-type chemicals in the food supply. The last two sources of toxic agents must be suspected and then detected before controls at the source can be instigated.

This creates a special problem because the analytical methods often must be developed before tests can be performed; a toxicological evaluation made if the toxic compound is present; a determination made of the source; and finally, practical control measures must be evoked. These actions take time, especially when an essential industrial use may be affected. A judgment factor is always inherent, therefore, in the final decision as to the how-and-when of a regulatory action for controlling these inadvertent residues.

Need for Continuing Surveillance of Feeds and Raw Food Products for Potential Hazards

The need for surveillance of agricultural commodities and feeds depends on the precise threat PCB s, as toxic substances, pose to human health and the environment. The discussion given here assumes that the PCB's are a potential and not an immediate health hazard but that the hazard is serious enough to require continued surveillance.

A major thrust should be the identification of the major points at which PCB enter the food chain so that surveillance procedures can be developed to back up control methods and regulations designed to break the cycling of PCB in the food chain. If, as seems likely, PCB's in the food chain originate mainly from animal, poultry and fish sources, surveillance procedures should obviously be concentrated on animal feeds and, more particularly, on the specific ingredients of such feeds. Because of the tendency of PCB's to deposit in adipose tissue, feed ingredients derived from meat packing, poultry processing and rendering processes are likely to be the major sources of contamination. Adequate analytical methods will be needed for monitoring for these ingredients.

Surveillance of the mixed feed itself will not suffice because traces of PCB could be rendered non-detectable by dilution in the feed. Biological magnification resulting from PCB deposition in the animal lipids nullifies any attempt to solve the problem by dilution.

Fish and crustacean sources of PCB's in the food chain, unless the fish are produced in controlled aquaculture, can offer some problems in a surveillance program because of the difficulty of affecting any control. Currently the only solution would be to prohibit the use of those marine animals that characteristically magnify PCB levels by tremendous orders of magnitude.

Beside the direct ingestion route, the entrance of PCB s in the food chain must mainly arise from contact of the food product with equipment or packages and containers incorporating or coated with PCB in which there can be diffusion of the PCB's into the food product. Surveillance may be needed in this area until currently used equipment is withdrawn from use and stricter standards are developed for containers and packaging materials.

MONS 042991

Analytical Methodology

PCB's can be detected in the environment and all foods by the same basic analytical method used to detect the chlorinated hydrocarbons. Confirmatory procedures require the chemical alteration of the pesticide compounds, usually by alkalization which does not affect the PCB's present. These highly stable compounds escaped detection in food and environmental samples for a long time because they were mixtures, present in low concentration, and many of the individual compounds contained in the mixtures were have the same retention time on GLC columns as commonly found chlorinated pesticides. However, as PCB's increased in the environment and more sensitive detectors became available an unknown contaminant was suspected and proven by Jensen in 1967 to be PCB's.

Identification of the PCBs has proven difficult since the chemical standards are not pure compounds but commerical chemical mixtures. In addition, PCB's are partially metabolized by animals and birds, therefore, tissue residues normally differ from the provided standards. Chemical analysts have to be able to resolve analytical problems so that qualitative identification of PCB's may be made. Problems in quantitation have not been fully resolved.

Traditionally, multiple peak residues have been difficult to accurately quantitate on GLC. Basically, it is a question of how to measure the recorder response when more than one peak is involved. Some chemists prefer to measure the area under individual peaks and other chemists prefer to measure the area under all the peaks. It has been proven that analytical results

can be in reasonable agreement between laboratories if analysis in both laboratories use the same extraction procedure and method of quantifying the residues detected. This allows regulatory control measures to adequately protect the consumer.

MONS 042993

Background Levels in Foods and Feeds

PCB s are now found in all parts of the biosphere, in the tissues of birds, fish, and humans in quantities and distribution similar to the pesticide DDE. They are metabolized and excreted very slowly by these organisms. Concentrations in tissues of wildlife and fish are higher nearer industrial communities than in sparsely populated regions. Animals and fish vary greatly in their ability to concentrate these substances. These observations indicate that PCB s have become a ubiquitous contaminant in the world ecosystem with background levels that will vary in different regions of the world. Nevertheless, there is no place for them in the Nation's food supply.

The only detailed information currently available on background levels in food and feeds appears to be the results of surveys conducted by FDA since November 1969 when FDA began to analyze all raw agricultural commodities sampled under the pesticide surveillance program for PCB's as well as pesticide residues. Six hundred eighty-four samples of fish, cheese, milk, shell eggs and fish by-products, out of 3,505 samples of these commodities, have been found positive for PCB's. The following report of results is taken from a talk given by Dr. Virgil Vodicka, Director, Bureau of Foods, FDA.

"PCB's were encountered most frequently in fish in 363 of the 670 samples ranging from trace levels to 35.29 ppm. PCB s were detected in fresh water fish including catfish, chubs, and smelt and also salt water species including porgies, sea trout, bluefish, bonita and sardines.

PCB's have only been detectable in the shellfish at trace levels. The results of the pesticide program for PCB s are as follows:

PCB IN SELECTED FOOD COMMODITIES - 7/1/70 to 9/30/71

Commodity	No. of samples examined	No. of samples positive	Percent positive	PCB Levels (ppm) Low	High	Average
Fish	670	363	54	T	35.29	1.87
Cheese	1344	91	6	T	1.0	.25
Milk	941	69	7	T	27.8	2.27
Shell Eggs	550	161	29	T	3.74	.55
Fish By-Product	-	13	-	T	5.0	1.17
TOTAL (Excluding Fish By-Product)	3505	684	19			1.14

Above results reflect both surveillance and compliance samples. Average residue levels do not include values indicated as "trace." T indicates "trace," which in normal analyses would be less than approximately 0.1 ppm fish; 1-1.5 ppm milk or cheese fat; 0.2 ppm eggs.

"The FDA total diet studies representing a total of 900 composite samples analyzed for the past 2½ years show 54 composite samples to contain PCB residues ranging from a trace to 0.36 ppm. These

positive findings were found in the meat, fish, poultry, dairy, and the grain and cereal composites. The 0.36 ppm PCB value reported in the total diet study was found to be caused by migration of PCB from the grayboard container and dividers to packaged shredded wheat. "Subsequent information gathered on the occurrence seemed to point to the use of reclaimed, or recycled, paper in the manufacture of the cardboard packaging material used for these food packages."

FDA conducted a national survey of PCB contamination of foods from packaging materials. The results revealed that even though 67% of the complete food packaging tested contained PCBs at levels as high as 338 ppm, only 19% of the foods in these packages contained PCBs. The average PCB concentration in food was 0.1 ppm, and the maximum PCB level found was 5 ppm. In packaged infant cereal samples, 75% of the food product contained PCBs. The average PCB concentration in the cereal was 0.3 ppm, and the maximum PCB level found was 1 ppm.

The survey shows a continuing and substantial reduction in the PCB concentrations of paper-packaging materials. Currently, 95% of recycled paperboard samples examined contained less than 5 ppm PCB; data on the same type of material manufactured during 1970 and 1971 show that only 18% of the samples examined contained less than 5 ppm.

No PCBs have thus far been reported in fresh fruits and vegetables.

The data available to date from an FDA program now in progress to determine levels of PCBs in animal feeds show that of 1,274 samples of feed manufactured for various livestock and poultry species, only 4.4% were positive for PCBs (Feedstuffs, March 20, 1972). Levels range from

no detectable contamination to a maximum PCB level of 0.6 ppm. It appears that complete animal feeds are not a significant source of PCBs for food-producing animals and that PCB contamination of feeds for food-producing animals can generally be attributed to avoidable industrial accidents and practices (Federal Register 37(34) March 18, 1972).

The proposed temporary tolerance for specific feed ingredients, such as fish meal and meat scraps, is 5 ppm. If PCB residues in finished feeds are no higher than 0.5 ppm, residues in poultry meat should be well below the proposed tolerance of 5 ppm in the fat.

FDA has proposed temporary tolerances for foods and feeds as follows:

	PPM
Milk (fat basis)	2.5
Dairy products (fat basis)	2.5
Poultry (fat basis)	5.0
Eggs	0.5
Finished animal feed	0.5
Animal feed components (including fishmeal)	5.0
Fish (edible portion)	5.0
Infant and junior foods	0.1
Food-packaging material	5.0

At the conclusion of the PCB-in-feed program, FDA plans a nationwide study of PCBs in milk by collecting milk for both bottling and manufacturing use.

A study is planned to follow this which will give specific attention to PCBs in shell eggs.

Substitutes

The principal uses for the PCB's are dielectric fluids for transformers and capacitors, heat exchange fluids, industrial fluids for hydraulic and vacuum pump uses, plasticizers and other miscellaneous uses. The PCB's are not being sold by Monsanto Chemical Co. for any of the miscellaneous uses and apparently, adequate substitutes for these uses are available.

The best substitute for PCB when being used for dielectric fluids is mineral oil, but the flash point of mineral oil is sufficiently low to create a fire hazard, therefore, mineral oil as a substitute can only be used when fire does not create a hazard. Solid state circuits greatly reduce the need for capacitors and dry transformers can be used but are much larger and more expensive. The fluorocarbon liquids can be used but the transformers require a special design. Few fluids have a comparably high dielectric constant and lend themselves as suitable substitutes.

The function of PCB's in the heat exchange fluids and hydraulic fluid is to reduce the fire hazard. Substitutes for hydraulic fluids are a chlorinated biphenyl - phosphate ester - petroleum hydrocarbon blend, a mineral hydraulic oil, and aromatic chlorides. The mineral hydraulic oil increases flammability and also results in formation of emulsion. The aromatic chlorides are poor substitutes for the PCB and could also result in an undesirable effect upon the environment. The PCB mixture would appear to be the best compromise and a much smaller quantity of PCB's would be used.

PCBs as plasticizers have been replaced largely by the phthalate esters. These compounds appear to be very good substitutes and are destroyed upon burning; whereas, the PCB will result in environmental contamination unless the temperature exceeds 980°F. One report was given at a recent meeting in St. Louis indicating that the phthalates are somewhat poisonous to fish but at a much higher level than PCBs.

V. Research Needs in Agriculture

In order to identify laboratories involved in PCB research and approximate the extent of PCB research activities in USDA, a questionnaire was prepared and sent to directors of State Agricultural Experiment Stations, forestry school technical representatives, members of the Technical Committee of Pesticide Residue Regional Projects, and to ARS. There are approximately 10 scientist man-years and 12 support man-years in the 30 research programs reported. Most of the programs are concerned with residue and analytical methodology. Less than half are related to field studies and 24 of the 30 are involved in laboratory research. Approximately 20% of the research programs are supported by ARS. The results of this survey are appended to this status report.

Additional Research Needs in Agriculture

1. Better information on PCB content of animal feeds and animal wastes.
2. Better information on quantitative transfer from feeds to animal foods and identification of factors which may affect it.

MONS 042999

3. Methods for detoxification or removal of PCBs from feeds and from food animals.

4. Practical methods of removal of PCB-containing paints and sealants from silo walls and other feed-bearing surfaces.

5. Development of standard methodology for laboratory extraction and quantifying the PCB residues detected in order to obtain more nearly comparable results from different laboratories.

6. A surveillance and monitoring program should be initiated to identify and prevent problems of environmental contamination in the future. This will require a coordinated State-Federal-industry effort with appropriate sampling and assay procedures directed to the detection of potential routes of contamination.

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APPENDIX I

SURVEY OF RESEARCH IN AGRICULTURE *

	AIR	WATER	SEWAGE	SOIL	BIOLOGICAL	MOVEMENT	TOXICOLOGY	RESIDUE	ANALYTICAL METHODOLOGY	BIOLOGICAL MAGNIFICATION	FIELD STUDIES	LABORATORY STUDIES	TWX	SUPPORT MAN-YEARS
R. S. Adams, Jr. Univ. of Minnesota	x							x			x			
Walter Aue University of Missouri		x							x			x		
Arthur Bevenue University of Hawaii		x	x					x	x		x	x		
M. C. Bowman Georgia, USDA-Ent-PCRB									x			x	0.1	
Walter M. Britton Univ. of Georgia					x		x	x	x		x	x	0.2	0.5
H. C. Cox Ent-ARS									x				0.0	
D. J. Crosby University of California											x	x	0.1	0.2
Paul A. Dahm Iowa State University								x			x		0.1	
H. W. Dorough University of Kentucky									x			x		
R. C. Fish ARS-Kerrville, Tex.					x		x	x	x	x		x	.25	2.0
R. D. Geer Montana State University									x			x	0.2	0.7
F. A. Gunther University of California								x	x			x	0.5	1.5
R. C. Hall Purdue									x			x	1	
K. R. Hill Entomology, USDA		x		x	x			x	x		x	x	0.5	
R. E. Johnsen Colorado State University		x	x	x				x	x		x		.3	.3
P. C. Kearney ARS-USDA, Beltsville												x	.5	.5
Paul Lichtenstein University of Wisconsin						x	x			x		x	1.5	2
P. J. Lisk Cornell University							x	x				x	1	1
T. Nakatsugama State University, Syracuse, N.Y.														

* Summaries of active PCB research in Agriculture as of November 1971

MONS 043004

SURVEY OF RESEARCH

IN AGRICULTURE

	AIR	WATER	SEWAGE	SOIL	BIOLOGICAL	PESTICIDE	TOXICOLOGY	RESIDUE	ANALYTICAL METHODOLOGY	BIOLOGICAL IDENTIFICATION	FIELD STUDIES	LABORATORY STUDIES	SUPPORT MATERIALS
L. D. Newsom Louisiana State University					X	X			X		X	6.1	
Charles Clagy Univ. of Rhode Island					X			X	X	X		6.1	5.0
O. E. Olson S. Dakota State University								X	X	X	X	6.1	5.0
D. B. Peakall Cornell University							X				X	6.1	
F. W. Plapp, Jr. Texas A&M					X		X				X	6.1	
T. J. Sheets N.C. State					X			X	X		X	6.1	
J. C. Stut Utah State University								X	X		X	6.1	5.0
Van Middelem University of Florida				X	X				X	X			
G. W. Ware University of Arizona								X	X	X			
E. J. Warwick ARS, Beltsville							X	X	X	X	X	6.1	1.0
L. B. Willett Ohio State, Wooster					X	X	X	X			X	6.1	1.0
R. W. Young VPI, Virginia					X			X	X		X	6.1	1.0

MONS 043005

SURVEY OF RESEARCH IN AGRICULTURE

Adams - University of Minnesota

Looking for EDT, chlorinated hydrocarbons, and PCBs in rainwater.

No concrete results at this time.

Bevenue - University of Hawaii

Working on analytical method to determine residues in water and sewage.

Bowman (ARS) - Tifton, Ga.

Working on method to separate from DDT and DDE

Britton - University of Georgia

Studies are being conducted to determine the levels of several of the PCBs which influence hatchability when added directly to the egg or when added to the diets of laying hens. Tissue and egg residues are being analyzed.

Cox (Entomology, ARS) - Beltsville

(1) Devoloped a method using chromous chloride reagent to distinguish toxaphene from PCBs, singly or in mixtures, in any substrate but primarily in H_2O.

(2) Tables of "p-valves" in several solvent pairs were determined for all visible GC peaks from 5 commercial Aroclors in order to provide an additional confirmation procedure for distinguishing pesticides from PCBs. Although different "p-valves" were obtained for p,p,-DDE and and the PCB peak having the same GC retention time, the standard deviation of the method permitted too much overlap for reliable confirm.

(3) During the analysis of 111 egg product samples thought to be contaminated with PCBs, it was found that a simple hexane solution from a Florisil column would separate PCBs from naturally occurring interfering substances in the eggs.

Crosby - University of California, Davis

Study the effects of sunlight on PCB when suspended in water and hydrocarbons. Found that there is a breakdown of PCBs.

Dahm - Iowa State University

Several mink have been collected in the Iowa area and analysis of fat, brain, and liver for PCBs and chlorinated hydrocarbons will be made. Levels will be correlated with age.

Dorough - University of Kentucky

Found PCB (Aroclor 1254) in sealant in silos. The milk from cows eating this silage contained levels of PCBs in excess of that considered safe by FDA.

Fish (ARS) - Kerrville, Texas

Research is in progress on farm animals consisting of 2-year-old sheep (male and female) and 7- to 11-week-old chickens (male and female) at dosages of 10 to 100 mg./kg/ daily for 21 days for chickens and dosages of 25 mg./kg. daily for 71, 95, and 100 days for sheep. Three different types of Aroclors were used for sheep and three different types for chickens. No results to date.

Geer - Montana State University

Synthesized 30 PCB isomers and they are developing a voltametric method for directly individual PCB isomers and chlorinated compounds.

Gunther - University of California, Riverside

Studying the persistence of PCBs in various soil types which are incubated at constant environmental condidtions. Also working on analytical methodology.

Hill (USDA) - Beltsville

Working on methodology to separate PCBs from DDT, DDE, and toxaphene

Kearney - Beltsville

Isolate microorganisms capable of metabolizing biphenyl and determine the effect of chlorine substitution on the rate of metabolism.

Lichtenstein - University of Wisconsin

Investigated toxicity of dieldrin and DDT with and without 11 different PCBs. As the chlorine content of PCB decreased there was an increase in toxicity. When the PCBs were added to the organochlorine insecticides, there was a synergistic action.

Lisk - Cornell University

Analyses of PCBs in newspaper and cardboard which may be used to feed cattle as a source of cellulose. Plans are to look at milk from cows which are fed recycled paper containers.

Nakatsugawa -

Study the phenomenon of biological magnification analytically. PCB will be used as one of the test compounds. No conclusions at this time.

Newsom - Louisiana State University

Ducks and chickens were fed a diet containing 100 ppm of PCB (Aroclor 1221) or a diet containing an organochlorine pesticide. When fed to chickens, PCB had no statistically significant effect upon eggshell thickness or strength, number of deformed eggs, egg production, or carbonic anhydrase activity of uterine tissue. PCB at 100 ppm had no effect on shell thickness and hatchability when fed to mallard ducks, but did cause a decrease in shell weight (-8%), calcium content of shell (-9.6%), and egg production (-0.05 egg/day).

Olney - University of Rhode Island

Surface waters of Narragansett Bay have shown residues of PCB at the level of 4 ppb or less. To date there is little evidence of any specific Aroclor in fish, sediment-water samples from streams and ponds of Rhode Island.

Olson - South Dakota State University

Studies have been carried on concerning the PCB levels in tissues and eggs of wild cormorants and pelicans and their foods and environment. Attempts were made to assess the effects of these compounds, mercury and chlorinated hydrocarbons, on the nesting failures of these birds. The storage and deposition of PCBs by pheasants has also been looked at and eggs were found to be an important way of excretion.

Peakall - Cornell University

Determined the physiological effect on birds at 10 ppm of Aroclor 1254. No mortality was found in the first generation but heavy mortality in second (embryonic). No eggshell thinning or shell breakage.

Plapp, Jr. - Texas A&M

Using houseflies, he demonstrated that the polychlorinated biphenyl mixture, Aroclor 1254, acts as a synergist with carbaryl. The mechanism of synergistic action is unknown but he speculated that it involves the inhibition of microsomal oxidase which is usually responsible for insecticide synergism.

T.J. Sheets - North Carlina

Routine analyses of eggs from hens receiving Aroclor 1242 in feed at dosages ranging from 0.3 to 2.5 ppm. Have not been successful at this time in separating PCB from DDT and degradation products.

Stut - Utah State University

Hepatic microsomal enzyme induction in rats was evaluated using the entire Aroclor series 1221 through 1268 with 4465 and 5442. The materials were fed to female rats in concentrations from 25-100 ppm for 15 days. Induction potency of enzymes was highly correlated with the percentage chlorination of the biphenyl. All the materials, except 1221, caused marked liver enlargement.

Van Middelem - University of Florida

Looking at levels in brown pelicans and the fish consumed by pelicans. No results or conclusions at this time.

Ware - University of Arizona

Working on methodology. Attempting to codistill PCBs with water.

Warwick (ARS) - Beltsville

Eleven PCB and PCT materials were tested to determine their estrogenic activity in rats. All of the compounds containing up to 50% Cl were found to be active, while compounds containing higher amounts of Cl were inactive.

PCB 1242 was extensively investigated in rats and Japanese quail and caused an increase in liver weight and liver lipids and lowered liver vitamin A concentration and content.

Aroclor 1254 has been used in silo coatings. ...In a detailed study of one herd, the rate of elimination of PCB residues from milk followed approximately the same kinetics as DDE. Treatment with activated carbon and/or phenobarbital did not enhance the rate of PCB elimination from cows.

Willett - Ohio State University, Wooster

Research objective is to eliminate PCB residues from a contaminated dairy herd by (1) covering PCB coating in silo; (2) elimination of fat pools in dairy animals; and (3) centrifuging milk to remove fat-soluble PCB contaminants. No data available.

Young - Virginia Polytechnic Institute

Analyzed PCB levels in diets, feces, and urine samples of preadolescent girls fed diets typical of low-income families. Also checked levels in paper bags, marking tags, turkey fat, heavy fowls, eggs, and poultry feeds. PCBs were found in all but two samples and the concentrations ranged from 0.063 ppm to 4.56 ppm.

MONS 043012