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TO: NATIONAL SCIENCE FOUNDATION
OFFICE OF INTERDISCIPLINARY RESEARCH

TYPE OF SUPPORT REQUESTED:	Research Grant
TITLE OF RESEARCH PROJECT:	"Social and Ecological Impact of Polychlorinated Biphenyls (PCB's) in the Environment"
PRINCIPAL INVESTIGATOR:	Eldon P. Savage Associate Professor Department of Microbiology Colorado State University Fort Collins, Colorado 80521 Telephone - (303) 491-6115 Social Security Number - 484-22-9681
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UNIVERSITY OFFICIAL TO BE CONTACTED REGARDING GRANT OR CONTRACT NEGOTIATION:	James F. Brown Contracts and Grants Administrator Colorado State University Fort Collins, Colorado 80521 Telephone - (303) 491-6355

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SPECIFIC PROBLEMS TO BE STUDIED:

Polychlorinated biphenyls (PCB's) will be traced through a watershed to determine major areas of concentration. Investigations will then be centered in high and low socio-economic areas of the communities of Greeley, Fort Collins, and Denver, Colorado to determine sources of PCB's in the environment. Environmental and biological substrates will be sampled to determine levels of PCB's in low and high socio-economic neighborhoods. During the third year of the study human tissue and/or bloods will also be collected to determine if there is a differential storage rate of PCB's by residents living in high and low socio economic areas.

ABSTRACT

SOCIAL AND ECOLOGICAL IMPACT OF POLYCHLORINATED BIPHENYLS (PCB's) IN THE ENVIRONMENT

Knowledge is increasing of the ecological and economic impact created by the use of certain man-made substances. The consequences of their continued use or curtailed use are being increasingly recognized as a problem with social ramifications.

PCB's used in a diversity of manufactured articles have become widespread in the environment and have been found in animal and human tissues. Investigations of the presence of PCB's in the environment will be followed to determine the major sources. The material will then be traced throughout a community to determine the importance of various environmental substrates in socio-economic areas.

IMPORTANCE OF RESEARCH:

With increasing technological advances in agriculture and the resulting increase in chemical pollution and ecological disruption, there has been a lack of understanding of the effects of many potential pollutants upon the ecosystem and upon human health.

The studies outlined in this proposal are urgently needed to help provide answers to many voids in our current knowledge about polychlorinated biphenyls. The results of these studies will help provide data that policy making bodies can use to make decisions on the continued use of polychlorinated biphenyls.

The current and immediate past experience of law makers dealing with the knotty problem of what to do with DDT and other pesticides demonstrates the urgency in finding out more about the prevalence of PCB's in the environment. PCB's have the same persistent characteristics as the

organo-chlorines; are widespread in use; have been found in many environmental substrates; are stored in animal and human tissues; are biologically magnified in the food chain; and may have been previously reported as DDT since they peak in the same general area as DDT on gas chromatograms when analyzed by gas-liquid chromatography. Decision makers who are responsible for deciding control measures necessary to prevent the environmental hazards from use of PCB's have very little evidence upon which to base decisions at this time. The proposed study will add to the depository of knowledge that is needed to make intelligent decisions in either restricting or curtailing use of certain compounds that may cause environmental and human hazards.

Determining the source and distribution of PCB's in the environment will help provide answers to the questions of how these materials are cycled through the environment, and to determine if PCB's have a greater prevalence in lower socio-economic areas.

The information gathered during this research will be developed into educational materials to be distributed through scientific journals; the extension service; and workshops conducted for ranchers, veterinarians, physicians, public health workers and the lay public.

BACKGROUND:

During the past 20 years man has added a variety of chemical materials to his environment. The report of the American Chemical Society in 1969 stated, "Emphasis on existing knowledge, should not be allowed to obscure the fact that extensive fundamental research is required to elevate man's understanding of the environmental system in all its myriad aspects

to a more nearly adequate level than exists today. The need is clear in ecology, in analytical chemistry, in the effects of pollutants, and a number of other areas. Such research must be started now if it is to provide the fundamental knowledge required for the new technology that will be needed in the not-too-distant future. It is critical, however, that this research be focused sharply on those areas where it will be truly effective." (1)

One of the products that should be more thoroughly studied is the polychlorinated biphenyl group of chemicals. Polychlorobiphenyls are made by substituting chlorine atoms for one or more of the hydrogen atoms at the numbered positions of the biphenyl structure. In this process a large number of substitution combinations arise. Gustafson (2) has noted that three monochlorobiphenyl isomers are possible, 12 dichlorobiphenyl isomers, 21 trichlorobiphenyl isomers, and so on until theoretically 210 compounds can be prepared in this substitution process. Monsanto, the only manufacturer of PCB's in the United States, produces them by a commercial process in which biphenyl is chlorinated with anhydrous chlorine in tall cylinders with either ferric chloride or iron filings acting as a catalyst. The process which takes from 12 to 36 hours to complete gives off a by-product of hydrogen chloride (a mixture of several PCB's). Monsanto markets their polychlorinated biphenyls under the trade name Aroclor. Each Aroclor is assigned a number in which the last two digits indicate the approximate weight percentage of chlorine in the product, and the first two digits indicate the type of material. For example, Aroclors 1242, 1254 and 1260 are all polychlorinated biphenyls containing 42%, 54% and 60% of chlorine respectively.

Although Monsanto is the sole U.S. producer, PCB's are also manufactured in Europe and Japan under trade names such as Phenoclor and Clophen.

The volume of PCB's marketed in the United States is not available, however, Table 1 gives some indication of the Aroclors' wide use by the size of containers in which the products are available. Note that seven of the Aroclors (1221, 1232, 1242, 1248, 1254, 1260 and 1262) are shipped by tank car lots. (3)

Reynolds (4) noted that the PCB's were studied as early as 1881. As early as 1936 Jones and Alden (5) reported that men employed in the production of PCB's developed Acne-type skin eruptions. Approximately three years later Greenburg and co-workers (6) reported that PCB's and polychlorinated napthalenes were responsible for deaths of three workers. Jensen (7) succeeded in identifying a series of peaks corresponding to polychlorobiphenyl compounds in 200 pike taken in different parts of Sweden, and in an eagle. Holmes, D.C. et al (8) detected polychlorinated biphenyl compounds in birds' livers, and eggs in Britain. The compounds occurring in British wildlife corresponded to the more highly chlorinated biphenyl compounds rather than the more lightly chlorinated types. These highly chlorinated biphenyls also occur to some extent in analogous polychloroterphenyl preparations which have commercial uses similar to those of polychlorobiphenyls. Risebrough and co-workers (9) detected PCB's in an unhatched abandoned egg of a Peregrine Falcon collected in the southwestern part of North America. They also found PCB's in a few other land birds and fresh water fish which indicated that PCB's are distributed among continental ecosystems in North America. They later

noted that concentrations of PCB's in fish and birds are highest in such industrial outfalls as San Francisco Bay and San Diego Bay and concentration gradients apparently exist from the sea areas to more remote areas. Lichtenstein et al (10) tested 11 plasticizers for their toxicological interaction with dieldrin and DDT. Since plasticizers are in the environment their potential effects on biological systems, especially in combination with other synthetic chemicals should not be disregarded.

TOXICITY:

A few toxicity studies have been conducted on PCB's, the first completed as early as 1931. In spite of these studies, knowledge of the general toxicity of the (PCB's) is poorly understood.

In 1931 Smyth (11) determined that a 4g/kg (degree of chlorination not stated) was nontoxic to guinea pigs and rabbits, but this appears to be due to the fact that material which was given as a paste passed through the intestine unabsorbed.

Seven years later in 1938 Bennett et al (12) concluded that experiments in which 0.05 g/rat of 65% chlorine biphenyl was given orally every other day led to 50% mortality.

During World War II in 1944 Miller (13) found that two oral doses of 69 mg of 42% chlorine biphenyl a week apart were fatal to guinea pigs.

Twelve years later in 1956 Treton et al (14) reported on the Toxicity of Vapors of Aroclor 1242 and Aroclor 1540. This work was supported financially by Monsanto Chemical Company. Several test animals including the cat, guinea pigs, mice, rabbits and rats were used in the experiment and several died. The authors concluded that all animals

survived a 24-day exposure to 0.83 ppm of Aroclor 1242 for 7 hours per day on 17 of the 24 days. Even after more prolonged tests, there were no severe effects from Aroclor 1242 (1.90 to 8.63 micrograms per liter) demonstrated no injury. However, prolonged exposure to comparable concentrations of Aroclor 1254 resulted in reversible degenerative changes in certain viscera.

In 1962 McCune et al (15) found their experimental chickens dying after they were placed in a feeding house that had certain parts freshly painted with epoxy paint. The toxic factor was found to be Aroclor 1242 used as a binder in the paint. Gross pathology included hydroperitonium, enlarged heart, liver and kidneys, and hemorrhage of internal organs. Microscopically the kidneys showed marked tubular dilation and numerous casts.

A few papers have been published during 1969 and 1970 about toxicity of PCB's. Among these Tucker and Crabtree (1970) (16) found that a single dose of 100 mg/kg Aroclor 1254 (stomach tubed in oil) was fatal to two out of three rats, while 500 mg/kg was not fatal to three rats. Aroclor 1268 killed one rat out of three at 500 mg/kg, 1000 mg/kg, 2000 mg/kg and 4000 mg/kg. They also found that neither Aroclor 1242, 1254, 1260 nor 1268 when given at doses of 2000 mg/kg were fatal to mallard ducks including four groups of three birds each.

Duke (17) reports 100% mortality of juvenile pink shrimp exposed to 0.10 ppm of Aroclor 1254 in water for 48 hours. This concentration of Aroclor 1254 will cause a 100% decrease in shell growth of oysters after 96 hours. To achieve the same effects with DDT in these experiments only 0.0006 ppm and 0.01 ppm, respectively, were required.

Similar studies on fish have been performed in several laboratories. Gustafson (2) reports that 96 hour-TL_{50} toxicities of the Aroclors to trout range from 1.17 to 60 ppm. Compared to DDT, whose 96 hour-TL_{50} toxicity is 0.002 to 0.009 ppm for trout, the PCB's have relatively low acute toxicity. With the more sensitive bluegill, the 96 hour-TL_{50} for Aroclor 1248 is 0.278 ppm, while that of DDT is 0.008 ppm. Aroclor toxicities appear to be directly proportional to the chlorine content of the mixture.

Recent work by Street, et al (18) has produced evidence to show that PCB's are similar to DDT in their activity. When PCB's accumulate in the liver, they induce microsomal enzyme activity by bringing about more rapid metabolism of drugs, insecticides, and other foreign compounds. Dr. Street fed rats a diet containing 50 ppm of Aroclor 1254 or Aroclor 1260. After being on this diet for 10 days the test animals were given hexobarbitol at a dose of 100 ppm to induce sleep. In comparison with a control group, the sleeping time for these rats was reduced by 65 to 80%. Aroclor, when fed at the same level reduced dieldrin storage in adipose tissue by 90 to 95%. He believes that the PCB's bring about steroid degradation, which can lead to altered endocrine relationships.

The chlorinated diphenyls have two distinct actions on man -- namely, a skin effect and a toxic action on the liver. The lesion produced in the liver is an acute yellow atrophy. This hepato-toxic action of the chlorinated diphenyls appears to be increased if there is exposure to carbon tetrachloride at the same time. The higher the chlorine content of the diphenyl compound, the more toxic it is liable to be.

In a paper entitled, "PCB's - Prevalent and Persistent" Gustafson (2) noted that in an investigation still in process that three groups of beagles were being fed Aroclor 1242, 1254 and 1260 respectively at a rate of 100 ppm in their diets. After three months no significant abnormalities have been noted in the beagles.

A very interesting piece of research was reported in the December 18, 1970 issue of Science by Friend and Trainer (19). They conducted a study to investigate possible antagonistic or synergistic interactions between organochlorine pollutants and infectious disease. They fed standard duck starter rations to groups of 10-day old mallard ducklings (Anas platyrhynchos). The three PCB diets contained Aroclor 1254 (in a corn oil premix) concentrations calculated to be 25, 50 and 100 parts per million. These diets were fed to five groups of 25 ducklings each, three principal and two control groups. On the 11th day each duckling was weighed and every fifth bird from each group was killed and tissues were collected for residue analyses, histological studies and weight determinations. During the 10 day feeding experiment none of the birds died or became clinically ill. All birds receiving the PCB's in their feed were significantly heavier at the end of the 10th day of the feeding experiment. The birds receiving 100 ppm PCB's in their feed registered the heaviest weight.

Five days after the 10 day PCB feeding experiment all of the birds except those untreated control groups (birds not receiving either PCB's or DHV) were inoculated intraperitoneally with 1.5 LD_{50} (50 percent effective lethal dose for ducks) of duck hepatitis virus (DHV) per bird.

The first ducklings died approximately 47 hours after inoculation. The results of the study indicated that PCB's may make a host more susceptible to certain types of infectious agents as the PCB concentrations appeared to influence mortality rates causing two to four fold increases (14 percent among those controls receiving only DHV versus 35 to 65 percent among groups receiving PCB's plus DHV). The ducklings fed PCB's when challenged with DHV also experienced a shorter incubation period and became ill at least 8 to 16 hours earlier than those in the control group treated with virus only. This research illustrates one of the potential effects of sublethal concentrations of chemical pollutants in the environment.

The limited toxicity data shown in Table 2 was taken from a Monsanto Chemical bulletin (3) and presents some data on the LD_{50} and skin MLD of the Aroclors.

Because of their similarities in structure and properties to the DDT pesticide group the PCB's if present, are carried through the usual pesticide residue analysis and PCB's chromatographic peaks have interferred with the peaks of some of the organo-chlorine pesticides. Reynolds (4) was unable to repeat Jensen's methodology in separating PCB's, apparently partly because of the nitration of some of the PCB's. The PCB laboratory analysis and confirmation problem has continued to be a major obstacle in detection of these materials from the environment. However, recently better methods have become available. Armour and Burke (20) of the FDA laboratories have developed an improved analytical methodology. Enos (21) of the FDA Perrine Laboratories has been able to adapt this methodology to other substrates.

Table 1

Size of containers used for shipping Aroclors (1)

Aroclor	Size of Container						
	25 lb.	50 lb.	200 lb.	450 lb.	500-550 lb.	600 lb.	Tank Car
1221		X			X		X
1232		X			X		X
1242		X				X	X
1248		X				X	X
1254		X				X	X
1260		X				X	X
1262		X				X	X
1268	X		X				
4465		X			X		
5442		X		X			
5460		X					

(1) From Monsanto Chemical Co., Bulletin No. O/PL-306A

X Indicates shipping container size

Table 2

Oral LD_{50} of the Aroclor Chlorinated Compounds

Skin MLD of the Aroclor Chlorinated Compounds

Aroclor	Oral LD_{50} (rats) (1) (mg/kg) (approx.)	Skin MLD - rabbits (mg/kg)	
1221	3980*	>2000	<3160*
1232	4470*	>1260*	<2000*
1242	8650*	> 794*	<1260*
1248	11000*	> 794*	<1260*
1254	11900*	>1260*	<2000*
1260	10000**	>1260*	<3160*
1262	11300**	>1260**	<3160**
1268	10900**	>2510###	
4465	16000**	>2000**	<3160**
5442	10600**	>1260**	<2000**
5460	19200#	>7940#	
2565	6310##	>2000##	<3160

* Given as undiluted material

** Administered as a 50% solution in corn oil

\# 33 1/3% solution in corn oil

20% solution in corn oil

10% solution in corn oil

Note: This is from a Monsanto publication (3). Sex of rats and rabbits used in this study was not indicated.

SPECIFIC PROBLEMS:

Among the synthetic pollutants which are accumulated by wildlife the chlorinated hydrocarbons used in pesticides appear to be the most abundant. Environmental pollutants which share some of the same properties as the chlorinated hydrocarbons might be expected to be distributed in the global ecosystem in much the same way. PCB's like DDT are used in many different manufactured products and are produced in large volume. Their chemical stability is such that they are resistant to degradation by many of the usual detoxification mechanisms and are fairly non-biological degradable. They are insoluble in water. They may be of importance through entering the atmosphere. Incineration of PCB's would also significantly increase the rates of vaporization of these compounds.

OVERALL PLAN:

The proposed research effort on PCB's would proceed over a three year period. The research would develop in five phases as shown in the flow chart in Figure 1. Early efforts would focus on the tracing of PCB's through a watershed by collection of water and biological samples at several sampling points; collection of precipitation samples, and collection of air and water samples near waste disposal sites. Later efforts would consist of tracing the PCB's back into socio-economic neighborhoods and identifying industrial sources of these pollutants in the neighborhoods. Other activities would concentrate on the presence of PCB's in food samples, dust samples, and related environmental substrates. The communities being studied would be divided into areas of high and low socio-economic class. Human and animal samples will

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also be collected to determine the levels of PCB's in these substrates and to determine if PCB's are stored more readily by people living in low socio-economic areas.

The sources of PCB's in the environment have not been studied in any great detail in this area, however, recently PCB's have been recovered from sewage sludge taken from the Fort Collins Municipal Sewage Plant, and in pelicans collected in Weld County, Colorado. Since the Cache La Poudre River flows through both Larimer and Weld Counties, we propose to collect samples at selected points along its route to determine the major sources of PCB's.

The proposal includes determining the source of PCB's in the environment by studying their occurrence in the Cache La Poudre River as it flows from its headwaters at Clark Peak, elevation 12,965, to its connection with the South Platte River below Greeley, Colorado. Initially, water samples will be collected at the following sites: the sewage treatment plants outfalls at Fort Collins, Colorado; the sewage treatment plant outfall at Greeley, Colorado; at sites near Windsor, Colorado; LaPorte, Colorado; Timnath, Colorado; at the stream headwaters at Clark Peak; and at its jointure with the South Platte River. Samples will also be collected at the South Platte River above and below Denver. Samples from these sites will be collected on a schedule as shown in Table 3.

A central hypothesis of the study is that differentials in exposure and perhaps storage rates of PCB's in humans will be found that cannot be accounted for in terms of variable intensity of such general environmental sources of contamination as atmosphere and water supply. Specifically, the study will look for differential rates in environmental samples on

Table 3

Schedule for Collection of Samples (H_2O and Biological)

	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Headwaters	2	2	2	2	2	2	2	2	2	2	2	2
LaPorte	2	2	2	2	2	2	2	2	2	2	2	2
Fort Collins	2	2	2	2	2	2	2	2	2	2	2	2
Windsor	2	2	2	2	2	2	2	2	2	2	2	2
Timnath	2	2	2	2	2	2	2	2	2	2	2	2
Greeley	2	2	2	2	2	2	2	2	2	2	2	2
Denver	2	2	2	2	2	2	2	2	2	2	2	2
Jointure with South Platte	2	2	2	2	2	2	2	2	2	2	2	2
TOTAL	18	18	18	18	18	18	18	18	18	18	18	18

TOTAL SAMPLES = 216

Rain and snowfall samples will also be collected and analyzed to determine their role in dispersing PCB's as contaminants.

The precipitation samples will be collected six times annually at Fort Collins, Greeley, Clark Peak, LaPorte, Windsor, Denver and the jointure of the Poudre and South Platte Rivers. The schedule of samples to be collected are as follows:

	Jan-Feb	Mar-Apr	May-June	July-Aug	Sept-Oct	Nov-Dec	
Fort Collins	1	1	1	1	1	1	6
Greeley	1	1	1	1	1	1	6
Clark Peak	1	1	1	1	1	1	6
Denver	1	1	1	1	1	1	6
LaPorte	1	1	1	1	1	1	6
Windsor	1	1	1	1	1	1	6
Jointure with South Platte	1	1	1	1	1	1	6
Total Precipitation Samples	7	7	7	7	7	7	42

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the basis of city of residence, residential location within cities and socio-economic status of the population sample.

Sampling of water sources (the Poudre and South Platte Rivers), of precipitation, and of the atmosphere will be utilized to determine contaminant levels of general environmental sources. Variable incidence of PCB's in these sources will then be correlated with environmental samples and perhaps storage rates of PCB's in the human population sample. Should status and residential variations be found that are unexplained by the general contaminant sources, a further study will be designed to explore possible sources of such variation. Such a study would necessarily deal with dietary and perhaps other behavioral variables logically related to differential exposure to selected PCB's.

The communities of Greeley, Fort Collins and areas in Denver will be divided into high and low socio-economic areas based on criteria established by the Hollingshead index (22).

The Hollingshead index was originally used by Hollingshead and Redlich in social class studies conducted in selected New England communities. More recently it has been used with selected environmental data by the U.S. Public Health Service in correlating levels of immunizations in communities with socio-economic areas. The Hollingshead index has also been found quite useful in other epidemiological studies. This index requires collection of information on factors of education and occupation. We plan to add factors on housing, and related environmental standards to divide the communities into high and low socio-economic areas. This method is similar to the one currently in use by the Center for Disease Control of the U.S. Public Health Service in their Disease Control Demonstration Projects.

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During this phase of the study levels of PCB's in high and low socio-economic areas of the communities will be assessed by collecting samples at the junction points of the trunk sewers and following them back into high and low socio-economic neighborhoods. During the same period of time a source survey will be conducted to determine major industrial sources of PCB's. This study will be patterned after the pesticides use studies conducted by the Community Studies on Pesticides Research Projects. The industrial sources will be mapped to depict their location in the high and low socio-economic study areas. Potential commercial sources of PCB's such as dry cleaning plants, brake repair businesses, and related industries will be located and samples collected at locations below their sewer connection discharge points.

Air samples will also be collected at Fort Collins, Denver and Greeley from the areas suspected of having the greatest PCB concentrations. This will be done in accordance with the results of the socio-economic survey of the neighborhood areas to determine if there is any possibility that respiratory exposure to PCB's may be a problem in these areas. These will be conducted on a seasonal basis and samples will be collected at all of the sites. Air sampling will be increased during the summer at all of the industrial sites.

AIR SAMPLING TECHNIQUES:

Three accepted methods of sampling air for organo-chlorines will be evaluated during the first phase of this research. These sampling methods are the modified Greenburg-Smith Impinger, nylon cloth screen impaction method, and the high volume air sampler. The modified Greenburg-Smith Impinger air sampling unit is capable of taking up to

four samples in 24 hours at a flow rate of 29 lm^{-1}, giving an air sample of about 40 m^3 in 24 hours. The sampling train consists of an unimpregnated glass cloth filter, a modified Greenburg-Smith Impinger and an adsorbent tube (23).

The nylon chiffon screen consists of a piece of nylon material 1/2 m^2 suspended between a wooden frame. The screen is left in place for a five day period. The screen has been used successfully to detect organo-chlorine pesticides in air by the Greeley Community Study on Pesticides.

The high volume air sampler consists of a filter pad through which air is pulled at an approximate rate of 1.70 m^3 per minute. An advantage of this sampling method is that the volume of air passing through the filter can be quantitated. The Colorado State Department of Health has used high volume air samplers to monitor selected air pollutants.

Meteorological data including temperature, humidity, wind velocity and related information will be collected at each air sampling site. Dr. Myron L. Corrin, Professor of Atmospheric Science at Colorado State University will provide consultation on this phase of the project.

LABORATORY ANALYSIS:

When biphenyls are chlorinated the product is a mixture of compounds including isomers. It is difficult to separate biphenyls into the specific Aroclors. Current methodology will not separate the various Aroclors of one series from each other. Initially quantitation will be based upon Aroclors in the 1200 series. The G.L.C. sensitivity for the Aroclor 1200 series is approximately ten times greater than the G.L.C. sensitivity for the 2500, 4400 and 5400 Aroclor series.

All samples collected in the study of PCB's will be examined at the Institute of Rural Environmental Health Analytical Laboratory housed at the Greeley Community Pesticide Study. The Institute of Rural Environmental Health Laboratory is equipped with G.L.C. capability utilizing two Nickel-63 Electron Capture Detectors and a Coulson Conductivity Detector. The Nickel-63 detectors are designed to operate up to 300°C for extended periods, thus causing less down-time for detector clean-up. The Coulson detector is a sensitive and specific detector for organic halogens, sulfur, and nitrogen and will be used as a confirmatory tool for organic halogens. This type of detector is being used by other investigators with success in some of the current research performed on PCB's (24).

The analysis and confirmation will be done in accordance with the best analytical procedures. The chemical techniques preliminary to quantitation of residues in samples containing both PCB's and chlorinated hydrocarbons pesticides fall into two groups - those necessitating the destruction or alteration of one or more of the compounds, and those which do not. Included in analyses of the first group is nitration with sulfuric and nitric acids. A more rigorous nitration was described by Erro et al (25). Risebrough et al reported that this nitration also removed the chromatographic peaks of PCB's (9). Reynolds (4) reported that his attempts to nitrate samples were not fully successful in that there appeared to be loss of some of the more volatile PCB's. Armour and Burke (20) reported that complex chromatograms resulted after nitration which could not be related to the unreacted DDT-PCB mixture, therefore nitration will not be pursued as a practical means of separating DDT and PCB's.

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Saponification with alcoholic NaOH or KOH was reported by some investigators (26,27), but the method breaks down most of the organochlorides and therefore it is not a realistic procedure.

The second, and more desirable group of analytical techniques allows the separation of many chlorinated hydrocarbon pesticides from PCB's (4, 28, and 20). All of the methods in this group of procedures accomplishes separation by column chromatography. At the present time the best method to achieve separation seems to be the method described by Armour and Burke (20).

The methodology for the environmental substrates, after separation will follow the current accepted analytical procedures for the organochlorine pesticides. Confirmation of all PCB's will be accomplished by two and three column GC, and one or more other methods such as Coulson detection, microcoulometric detection, thin layer chromatography, infrared analysis and mass spectrometry.

1. Air

Sampling the air for PCB's will be carried out with the best method as previously discussed. After sampling with the nylon chiffon and high volume air sampler the filter pads will be extracted using the soxhlet extraction apparatus and the extract carried through the clean-up procedures. After clean-up the PCB's will be separated from the DDT and its analogs, followed by the appropriate concentration adjustments and gas chromatographic analysis.

Analyses of air samples collected with the modified Smith-Greenburg Impinger will follow a modification of those described in the report entitled, "Measurement of the Atmospheric Contamination of Pesticides" (23).

2. Biological Substrates

Whole animal and individual tissue samples will be extracted according to the procedure of Mills et al (29), with the modification of the separation procedure after florisil column clean-up. Based on the assumption that fat or fatty organs generally yield the lowest recoveries a series of recovery experiments will be conducted with hexane solutions of fat samples fortified with known amounts of PCB's. The spiked fat samples will be carried through the entire procedure and the percent recovery calculated.

3. Soil and Household Dusts

A limited number of soil samples and stream bottom muds will be taken in areas near industrial sources of PCB's. Household dust samples will also be collected in a limited number of residences in the high and low socio-economic areas in Denver, Greeley and Fort Collins, Colorado.

Soils and vacuum cleaner bag dusts will be analyzed in the air-dry state. If a soil sample is obviously damp, it will be allowed to equilibrate its moisture content with room air before handling. Most house dusts contain approximately 0.1% moisture. Vacuum cleaner bag contents will be sieved on U.S. Standard #10 and #60 sieves to remove hair, fibers and large particles. The resulting "fines" will be separated into paper bags until analyzed. Soils will be sifted on a U.S. Standard #18 sieve to remove stones and other foreign material. The sieved soil will be stored in paper bags until analyzed (30).

Organochlorine compounds and other lipid-soluble substances will be extracted by continuous Soxhlet extraction with acetone-hexane. Interfering lipid-soluble materials will then be partially removed from the extracts by successive clean-up on aluminum oxide and florisil columns. Residual extracts will be made up to standard volume prior to assay by gas chromatography.

4. Water

Water samples will be collected utilizing both grab and nylon cloth sampling procedures. Grab samples will be done by collecting one liter of water at random. "Cloth samples" consist of four individual pieces of a nylon chiffon cloth sewed together. The (1 m^3) cloth is placed in the water at the sampling site for approximately one week duration. Water runs through the cloth continuously. Samples are collected and returned to the laboratory for analyses. The water "grab samples" are extracted into an organic solvent. Interfering components are then removed from the extracts by chemical treatment and column absorption chromatography. The sample is carried through the separation procedure and appropriate concentrations made for GC analysis.

The "cloth samples" are extracted similar to air and soil samples using the soxhlet apparatus. The organic solvent and water mixture will then be dried over anhydrous sodium sulfate, followed by clean-up steps, the separation procedure and final concentration for GC analysis.

5. Human Samples (Blood and urine)

Blood and serum samples will be extracted according to the modified Dale et al procedure (31), along with the separation procedure for DDT and its analogs from PCB's incorporated in the extraction.

Urine samples will be extracted similar to the water "grab samples". A suitable size sample will be extracted into an organic solvent. Interfering components are then removed from the extracts by chemical treatment and column adsorption chromatography, followed by concentration for GC analysis.

5. Food

Both fatty and nonfatty foodstuffs will be examined using the procedures outlined in the Analysis of Pesticide Residues Manual as prepared by H. P. Burchfield, et al (32). In general, it can be stated that the best available methods for the extraction of pesticides and PCB's from fatty foods are based on isolation of the lipid fraction by the combined action of an alcohol and fat solvent or of a fat solvent alone. The pesticides and PCB's are then separated from the lipids by a partitioning step, which is then followed by the separation procedure for the DDT analogs from the PCB's.

In determining PCB's in materials by electron capture gas chromatography, there are many sources of contamination, which could create a major problem. The samples and extracts will not be allowed to come in contact with materials other than glass or teflon. Laboratory glassware will be thoroughly washed with hot, soapy water, rinsed with distilled water, acetone and hexane. All equipment will be rinsed again with hexane just prior to use and blanks will be frequently carried through all steps of the procedures to insure against the possibility of contamination.

The laboratory will continue to conduct a vigorous internal control program. Known standards and unknowns will be run periodically. All PCB's found will be confirmed. In addition the laboratory will participate in the quality control program conducted by the Community Study on Pesticides.

During the third phase of the program, arrangements will be made with pathologists at the Weld County General Hospital and at the Poudre Valley Memorial Hospital and a hospital in Denver for human milk, tissue and blood samples. Samples will be collected from each hospital and these will be run to determine the levels of PCB's in the general population. Since the three communities will be divided by socio-economic area, great care will be taken to try to get an equivalent number of samples from these areas. Concurrently food samples and selected biological organisms will be collected from the two socio-economic neighborhoods in each area and the samples will be analyzed at the laboratory in Greeley. The analyses will then be used in an attempt to determine if there is a difference in the amount of these materials stored by residents in neighborhoods by socio-economic class.

As results from this proposed research concerning PCB's becomes available these data will be closely scrutinized to determine their significance. Each of the environmental substrates will be evaluated to determine their levels in the environment. This evaluation will be followed by evaluating the total environmental levels of PCB's from all the substrates examined. The significance of PCB's in the environment will be extremely difficult to evaluate, but they can be correlated with levels of the chlorinated hydrocarbon pesticides and corrective action can be taken accordingly. The recent findings of the synergistic effects of PCB's on duck hepatitis virus raises the most important question of the effect of PCB's on human health. If high levels of PCB's are found to be stored in human tissues and milk, it may point out the need for

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additional studies to determine the effect of PCB's on the incidence and severity of selected human diseases -- especially those diseases that have an adverse effect on the liver.

RELATION TO INTERESTS OF OTHER FEDERAL AGENCIES:

The current research proposal is of vital interest to several of the action federal agencies. For example, the Department of Interior held a national meeting on PCB's in Duluth, Minnesota during the spring of 1970. The Federal Subcommittee on Pesticides conducted an all day meeting on PCB's on May 22, 1970. In developing our current proposal we have discussed all or parts of the proposal with several people from action agencies. In general they have endorsed the concept and ideas. Representatives from action agencies contacted regarding this proposal include:

1. Dr. Henry Enos, Chief Analytical Laboratory, Food and Drug Administration, Perrine, Florida.

2. Dr. S. W. Simmons, Chief, Community Study on Pesticides, Food and Drug Administration, Chamblee, Georgia.

3. Dr. A. Yobs, Chief State Services Branch and Director National Human Monitoring Study, Food and Drug Administration, Chamblee, Georgia.

4. Dr. Bill Stevenson, Chief Field Training and Consultation, Food and Drug Administration, Chamblee, Georgia.

5. Dr. Henry Fischback, Director Office of Pesticides and Product Safety, Food and Drug Administration, Washington, D.C..

6. Dr. Dale Lindsey, Associate Commissioner for Science, Food and Drug Administration.

7. Dr. William Upholt, Staff Director Secretary's Pesticide Advisory Committee.

8. Mr. Reo Duggan, Deputy Associate Commissioner for Compliance, Food and Drug Administration, Washington, D.C.

9. Dr. Page Nicholson, Chief, Industrial and Agriculture Pollution Control Research Program, Department of Interior, Athens, Georgia.

10. Dr. Carl Gustafson, Professor, Kings College, New York (on leave and working with Dr. Nicholson at Athens).

11. Mr. Kenneth Walker, Assistant to Commissioner for Research and Development, Department of Agriculture, Washington, D.C.

12. Dr. F. Kingma, Deputy Director of the Bureau of Veterinary Medicine, Washington, D.C.

13. Dale B. Parke, Sanitary Engineer, U.S. Department of the Interior, FWPCA, Missouri Basin Region.

14. Carl M. Walter, Sanitary Engineer, U.S. Department of the Interior, FWPCA, Missouri Basin Region.

15. Dr. Cipriano Cueto, U.S. Department of Agriculture, Washington, D.C.

RELATED EDUCATIONAL EFFORT:

Colorado State University supported by a founding grant from the W.K. Kellogg Foundation has established an Institute of Rural Environmental Health (IREH) in the College of Veterinary Medicine and Biomedical Sciences in recognition of the health effects inherent in certain inter-relationships between man and his environment.

The Institute coordinates research services in environmental health and provides a multi-disciplinary approach to the solution of environmental problems. Programs of research, education and service are currently being developed.

Future plans include developing a graduate training program in environmental health; conducting seminars for physicians, veterinarians, public health personnel, agricultural or industrial groups; holding workshops and training courses of longer duration for specific interest groups including the lay public; development and dissemination of leaflets, bulletins and audiovisual materials on rural environmental health problems and their prevention.

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Sections on "chemical epidemiology" and "comparative medicine and ecology" have been established in the Institute.

The chemical epidemiology section provides a nucleus for study of chemical substances in the environment that pose hazards to human health. Attention is given to the role of chemical environmental pollutants as they relate to human health both from the standpoint of acute toxicity and for possible chronic effects.

Unexplained illnesses, isolated or epidemic, in human and animal populations are sought for study as possible indicators of exposures to chemical products.

An analytical laboratory is being developed at this time to support field investigations and to provide diagnostic services.

As potentially harmful chemical pollutants are discovered, they are studied in relation to the total ecology of the region.

A comparative medicine and ecology section has been developed to investigate the risk of animal diseases to rural residents and other high-risk groups and ot conduct appropriate research on the natural history and control of such diseases.

This section will establish a diagnostic laboratory for identification of viruses, bacteria and molds which cause disease in man and animals, to support the field studies.

The current proposal will allow the Institute to broaden its capability and the research effort will provide new teaching materials as well as experience for students at the University.

ARRANGEMENTS WITH COLLABORATING GROUPS:

Arrangements have been made with the Colorado State Department of Public Health, Food and Drug Administration, Greeley City Manager and others for support of the proposed study. Significant letters in this regard are found in attachment A. Therefore, some sampling problems that could arise in collection of environmental substrates have been avoided.

INTERDISCIPLINARY CHARACTER OF THE RESEARCH GROUP:

The team is composed of an interdisciplinary research group from Colorado State University with assistance from the Colorado University Medical Center and the Colorado State Department of Public Health. The team members are from the Departments of Microbiology, Sociology and Statistics. Complete curricula vitae of each researcher are attached to this proposal.

The coordinator of the project has recently joined the CSU staff. He has a broad background in Public Health and was formerly a Scientist Director in the Commissioned Corps of the United States Public Health Service. He has held a variety of positions in health fields with the National Communicable Disease Center and the Food and Drug Administration. He has served as coordinator of Community Demonstration projects, has a wide experience in conducting field surveys and research projects. His last position was with the Division of Community Studies on Pesticides in Atlanta as Chief of State Services Section.

The sociologist on the team has a broad experience in teaching and research. He has expertise in the study of rural sociology and he has published extensively on this subject.

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The statistician has worked for a number of years on biomedical projects. He is also well trained and has a broad knowledge of research design and analysis.

One of the key features of this proposal is the analytical laboratory. Arrangements have been made with the Colorado State Department of Public Health and the Food and Drug Administration whereby the analytical chemistry unit will be housed at the laboratory of the Community Study on Pesticides at Greeley, Colorado. Mr. John Tessari, an analytical chemist who is on our staff, is currently housed at the laboratory. The pesticides laboratory is equipped with a capability in liquid gas chromatography and back-up analytical instrumentation. The laboratory is one of 16 in the U.S. that participate in the quality control program of the U.S. Public Health Service, and has consistently scored high on its quality control work. The laboratory is currently capable of detecting PCB's in several environmental substrates including animal tissues, milk, air, soil, plants, sewage, water and other media.

The Director of the Institute and Chiefs of the two sections have had academic training and many years of experience as epidemiologists. In addition, the Institute has a budgeted vacancy for a physician-epidemiologist and active recruiting efforts are being made to fill that position. All of these people will be available to assist with the PCB study through consultation and other active participation.

RELATED PROGRAMS AT COLORADO STATE UNIVERSITY:

BUDGET AND OPERATION PLAN:

The study will be conducted in five phases. Portions of each phase may be conducted concurrently. As presently conceived the first phase will be utilized to determine the scope of the problem, complete a

socio-economic stratification of Greeley and Fort Collins, select sampling sites, initiate field sampling and laboratory analyses, select staff, and initiate activity in all areas of the proposal. During the third phase of the study collection of field data and laboratory analyses will be intensified, the analytical laboratory quality control program will be in full operation. During the fourth and fifth phases training aids will be developed and arrangements for seminars will be completed. During the final phase reports will be developed, seminars will be conducted, field work completed and final reports will be prepared.

DISSEMINATION OF RESEARCH EFFORTS:

The proposed research on polychlorinated biphenyls is of an applied nature to find solutions to a specific problem. Therefore the findings deserve a better fate than to become buried in some obscure scientific journal. Colorado State University is in a unique position to disseminate information on findings to both the scientific and lay communities. Important scientific findings as a result of this research effort will be published in appropriate scientific journals. In addition to this outlet selected findings will be put in a form that the lay public can understand and will be disseminated through the Colorado State University Extension Service Network. This will be done primarily through leaflets and the mass media. The Institute of Environmental Health is also pledged to service and at least one seminar will be held annually at CSU to inform veterinarians, health workers, ranchers and other interested parties of important findings resulting from these studies.

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The research proposal, "Social and Ecological Impact of Polychlorinated Biphenyls (PCB's) in the Environment", describes the establishment of an interdisciplinary team and is submitted by the College of Veterinary Medicine and Biomedical Sciences. Professors from three colleges and three departments of Colorado State University are named as investigators. The departments are Microbiology, Sociology and Statistics. The grant application names Dr. E. P. Savage, Associate Professor, Institute of Rural Environmental Health, Department of Microbiology as Program Co-ordinator.

The research group is organized to function as an interdisciplinary team. Although the team represents different departments within Colorado State University, a plan has been developed to insure co-ordinated efforts within the Institute of Rural Environmental Health. The team leader will encourage free exchange of expression and thought.

All research efforts will be co-ordinated to insure no duplication of effort. Periodic discussions will be held to discuss problems encountered and progress made. Each team member will be expected to develop his portion of required reports and to participate in seminars conducted to disseminate information.

The projected annual budgets for this study are based on the fact that an analytical laboratory is already in operation. The travel budget of $5,000.00 per year is necessary to collect the samples and to conduct the environmental source studies as outlined in the proposal. The new personnel needed to do this study could be added to the staff quite rapidly and several qualified applicants have already applied.

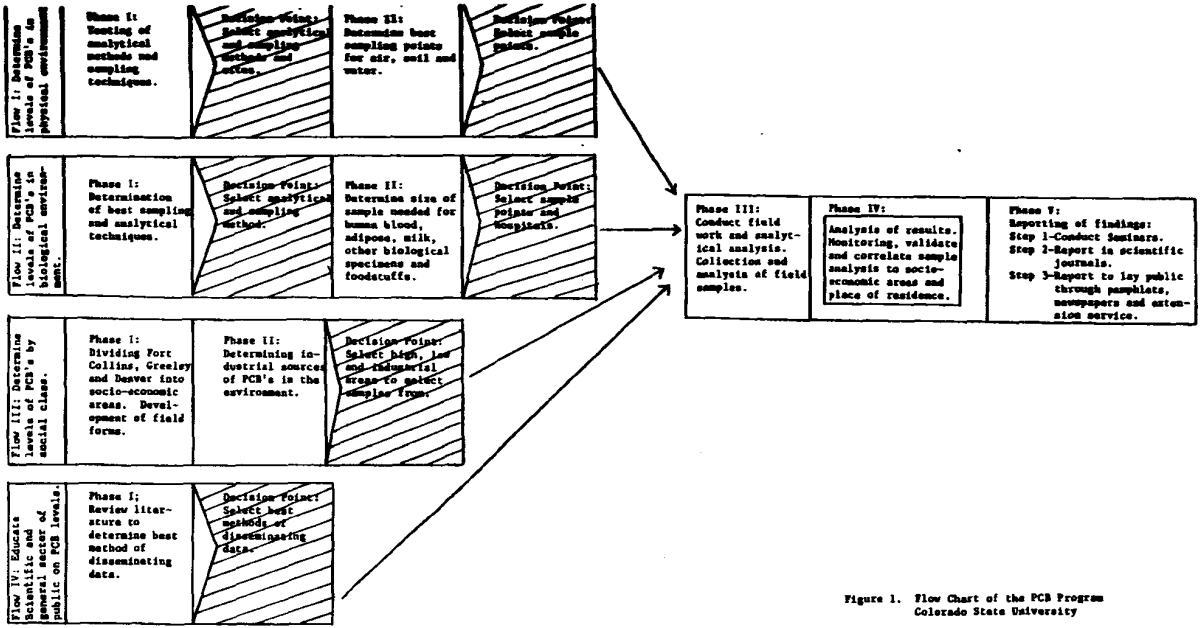

Figure 1. Flow Chart of the PCB Program
Colorado State University

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Investigator:

Emmit Sharp
Professor of Sociology
Colorado State University

Education:

B.S., Sociology, Oklahoma State University, 1948
M.S., Rural Sociology, Oklahoma State University, 1951
Ph.D., Rural Sociology, University of Wisconsin, 1961.

Major Research Interest:

Demography, Methodology, Stratification

Employment:

1967 - present: Professor, Department of Sociology and Anthropology, Colorado State University. 1966-67: Research Consultant, Industrial Relations Center, University of Chicago. 1963-64: Research Consultant, Department of Agriculture and Conservation, Province of Manitoba, Canada. 1962-67: Associate Professor, Department of Sociology, Northern Illinois University. 1957-62: Assistant Professor, Department of Rural Sociology, Cornell University. 1954-57: Project Assistant, Department of Rural Sociology, University of Wisconsin. 1951-54: Research Assistant, Department of Rural Sociology, University of Wisconsin. 1948-51: Research Assistant, Department of Rural Sociology, Oklahoma State University.

Publications:

"Rural Sociological Research in the Wheat Belt," Rural Sociology, Vol. 15, No. 4, December, 1950.

Rural-Urban Migration in Wisconsin, 1940-1950. Wisconsin Agricultural Experiment Station Research Bulletin 196, August 1951.

A Short Scale for Measuring Farm Family Level of Living: A Modification of Sewall's Socio-Economic Scale, Oklahoma Agricultural Experiment Station Technical Bulletin No. T-46, September, 1952.

"Migratory Farm Workers in New York State" published in Report of New York State Joint Legislative Committee on Migrant Labor, 1958.

"Migratory Farm Workers in New York State" published in Report of New York State Joint Legislative Committee on Migrant Labor, 1959.

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"Characteristics of Migrants in New York Agriculture," Health News, (New York State Department of Health), April, 1959.

Migratory Farm Workers in New York: Changes 1953, 1957, and 1958. United States Department of Agriculture, ARS 43-105.

Migratory Farm Workers in the Atlantic Coast Stream I: Changes in New York, 1953-1957. Cornell Agricultural Experiment Station Bulletin 948, May, 1960.

"Migratory Farm Workers in New York State, 1959, and Comparisons with 1953, 1957 and 1958," published in Report of the New York State Joint Legislative Committee on Migrant Labor, 1960.

Migratory Farm Workers in the Atlantic Coast Stream II: Education of New York Workers and Their Children, 1953-57. Cornell Agricultural Experiment Station Bulletin 949, May, 1960.

Migratory Farm Workers in New York State, 1959, with Comparison with 1953, 1957, and 1958. United States Department of Agriculture, ARS 43-121.

"Some Thoughts on Population Change in New York State, The Labor Force and Regional Planning," in Barclay Jones and Burnham Kelley (eds.). Long Range Needs and Opportunities in New York State, College of Architecture, Cornell University, Ithaca, New York, 1962.

"Criteria of Item Selection in Level of Living Scales," Rural Sociology, Vol. 28,1963.

People of Manitoba, 1951-1961, ARDA Research Report, No. R-2, Department of Forestry, Ottawa, Canada, 1966. (also published in French - La Population Du Manitoba, 1951-1961).

Manitoba High School Students and Drop Outs, Published by Manitoba Department of Agriculture and Conservation, Manitoba, Canada, 1967.

Multi-County Rural Development Areas in Colorado, 1969. (in process of being published by Colorado State University Experiment Station.)

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Investigator:

Paul W. Mielke, Jr.
Associate Professor
Mathematical Statistics
Colorado State University

Education:

B.A., University of Minnesota, 1953.
M.S.,University of Arizona, 1958.
Ph.D.,University of Minnesota, 1963.

Major Research Interest:

Development and application of non-parametric statistics and estimation.

Employment:

1964-present: Colorado State University, Assistant Professor of Mathematical Statistics. Intern Research Consultant and Supervisor of Statistical and Computing Services, Biostatistics Division, School of Public Health, University of Minnesota.

Publications:

Cowan, Donald W., Hugh J. Thompson, Harold J. Paulus and Paul W. Mielke, Jr. Bronchial asthma associated with air pollutants from the grain industry, Journal of the Air Pollution Control Association, Vol. 13, November 1963, pp. 546-552.

Kennedy, B.J., Paul W. Mielke, Jr., Ignacio E. Fortuny. Therapeutic castration versus prophylactic castration in breast cancer, Surgery, Gynecology and Obstetrics, Vol. 18, March, 1964, pp. 524-540.

Kennedy, B.J. and Paul W. Mielke, Jr. and Ignacio E. Fortuny. Therapeutic versus prophylactic castration in breast cancer, Post Graduate Medicine, Vol. 36, October 1964, pp. 310-314.

Mielke, Paul W., Jr. and Richard B. McHugh. Non-orthogonality in the two-way classification for the mixed effects finite population model, Biometrics, Vol. 21, June, 1965, pp. 308-323.

Mielke, Paul W., Jr. and M.M.Siddiqui. A combinatorial test for independence of dichotomous responses, Journal of the American Statistical Association, Vol. 60, June 1965, pp. 437-441.

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Grant, Lewis O. and Paul W. Mielke, Jr. A randomized cloud seeding experiment at Climax, Colorado 1960-1965. Proceedings of the Fifth Berkeley Symposium in Mathematical Statistics and Probability, Vol. 5, 1967, pp. 115-131.

Mielke, Paul W., Jr. Note on some squared rank test with existing ties, Technometrics, Vol. 9, May 1967, pp. 312-314.

Duran, Benjamin S. and Paul W. Mielke, Jr. Robustness of sum of squared ranks test, Journal of the American Statistical Association, Vol. 63, March 1968.

Mielke, Paul W., Jr. Statistical design and weather modification. Proceedings: Skywater Conference II, Design and Evaluation of Weather Modification Experiments. October 11-13, 1967. United States Department of the Interior, pp. 259-273.

Grant, Lewis O., Charles F. Chappell and Paul W. Mielke, Jr. The recognition of cloud seeding opportunity. Proceedings of the First National Conference on Weather Modification, April 28-May 1, 1968, Albany, New York. pp. 372-385. Sponsored by the American Meteorological Society.

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Mielke, Paul W., P.J. Eicker and M.M.Siggiqui. A matrix occupancy problem. Submitted to The Annals of Mathematical Statistics, 1969.

Mielke, Paul W., L.O. Grant and C.F.Chappell. Elevation and spatial variation effects of wintertime orographic cloud seeding. Submitted to Journal of Applied Meteorology, 1969.

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Mielke, P.W. and H.W.Mielke. Distribution dependence of three toad species, Bufo Americanus, B. Cognatus and B.Hemiophrys, on temperature and moisture. Submitted to Ecology, 1970.

Mielke, P.W., L.O. Grant and C.F.Chappell. An independent replication of the Climax wintertime orographic cloud seeding experiment. Submitted to Journal of Applied Meteorology, 1970.

Professional Societies:

Mathematics Association of America
American Statistical Association
Institute of Mathematical Statistics
Sigma Xi
Biometric Society
American Meteorological Society

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Program Co-ordinator and Investigator:	Eldon P. Savage Associate Professor, Dept. of Microbiology Institute of Rural Environmental Health Chemical Epidemiology Section Colorado State University
Education:	A.B., University of Kansas, 1950 M.P.H., Tulane University, 1958 Ph.D., University of Oklahoma, 1967
Major Research Interest:	Chemical Epidemiology
Employment:	1970-present: Associate Professor, Institute of Rural Environmental Health, Colorado State University. 1967-70: Chief State Services, Pesticides Program, FDA. 1964-66: Assistant Chief State Aids Section, CDC, USPHS. 1958-64: Director Environmental Health Demonstration Project, Lebanon, Pennsylvania. 1954-57: Co-ordinator Vector Control Demonstrations Kansas City, Kansas; Cedar Rapids, Iowa. 1950-54: Staff Research Fly-Polio Projects Atlanta, Georgia; Charleston, West Virginia; Topeka, Kansas.
Publications:	Schoof, H.F. and Savage, E.P.: Comparative Studies of Urban Fly Populations in Arizona, Kansas, Michigan, New York and West Virginia. Entomological Society of America, Vol. 48, Nos. 1-2, January-March 1955. Schoof, H.F., Mail, G.A. and Savage, E.P.: Fly Production Sources in Urban Communities. Journal Economic Entomology Vol. 47, No. 2, April 1954. Schoof, H.F., Dodge, H.R. and Savage, E.P.: Comparative Studies of Urban Fly Populations in Arizona, Kansas, Michigan, New York, and West Virginia II. Seasonal Abundance of Minor Species. Entomological Society of America, Vol. 49, No. 1, January 1956. Savage, E.P., and Schoof, H.F.: The Species Composition of Fly Populations at Several Types of Problem Sites in Urban Areas. Entomological Society of America, Vol. 48, 1955. Savage, E.P.: Techniques for Evaluating Vector Control Measures. Journal of Milk and Food Technology, Vol. 26, No. 8, August 1963.

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Savage, E.P. and Bucciarelli, W.,: Economical Pamphlets on Refuse. Journal of Environmental Health, Vol. 25, 1962.

Savage, E.P.: The Lebanon Sanitation Demonstration Project, Pennsylvania League of Cities, January 1959.

Savage, E.P.: The Formation of a Metropolitan Refuse Authority. The Sanitarian, Col. 22, No. 4, January-February, 1960.

Savage, E.P.: Ear-Invading Beetles Active Again at Boy Scout Jamboree, Valley Forge, Pennsylvania. United States Navy Medical News Letter, Vol. 45, No. 2, January 1965.

Savage, E.P.: The Epidemiology of Rat Bites. Master Thesis, Tulane University, 1958.

Lisella, F.F., Mullen R.L., and Savage, E.P.: A Review of the Rat Bite Problem in Tampa, Florida. Journal of Environmental Health, Vol. 29, No. 4, January-February 1967.

Savage, E.P., Simmons, S.W.: The Price for Pesticide Safety: Constant Vigilance, 1968. DHEW, PHS, CDC, Atlanta, Georgia. Pest Control Magazine, Vol. 36, No. 1, January 1968.

Savage, E.P.: An Ecological Study of a Low Socio-economic Neighborhood. Ph.D. Thesis, University of Oklahoma, 1967.

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Savage, Bogue, M.D., and Brown, W.C.: A Study of Rodent Control Problems in Boston,Mass. February 1963. DHEW, PHS, CDC, Atlanta, Georgia.

Savage, E.P.: Study of Vector Problems and Recommendations for Improvement on the Island Of Guam. January 1966. DHEW, PHS, CDC Atlanta, Georgia

Savage, E.P.: A Study of Refuse Handling Practices in Bedford, Mass. - with Recommendations for Development of a Comprehensive Refuse Handling System. (1962)

Savage, E.P. and Schindler, R.: Community Environmental Health Report,Hudson, N.Y.(1962)

Savage, E.P.: "Disease Vectors" to be included in book entitled, "Environmental Health ans Science" edited by Dr. P.W.Purdom (1969)

Professional Societies:

Commissioned Officer's Association of U.S.Public Health Service
Research Society of America
National Environmental Health Association
American Mosquito Control Association,
Royal Society of Health
Who's-Who in Science

John D. Tessari

Education: B.A. Chemistry, 1967, Colorado State College
1968, 30 quarter hours towards masters in chemistry at Colorado State College

Employment: May, 1968 - September, 1970, Public Health Chemist, Colorado State Department of Health, Community Study on Pesticides

Short Courses: September-November, 1969, Principles and Practice of Analytical Chemistry of Pesticides, FDA Laboratories, Perrine, Florida

February, 1970, Operational Trouble-shooting of Gas Chromatographic Systems, FDA Laboratories, Perrine, Florida

Publications: Tessari, John and Spencer, Dave, "Air Sampling for Pesticides in The Human Environment", submitted to Journal of The Association of Official Analytical Chemists.

Professional Societies: American Chemical Society

Rocky Mountain Gas Chromatography Discussion Group

BUDGET	1st year	2nd year	3rd year	Totals
A. Salaries and wages				
1. Senior Personnel				
a. Program Coordinator Savage, E.P.(4 mos. 1st yr.) 1.33 mos. 2nd & 3rd yr.	-0-	2,200	2,420	4,620
b. Investigators:				
Sharp, E. F. (1 mo. summer /year)	2,000	2,200	2,420	6,620
*Tessari, J.D. (3 mos.1st yr) (6 mos. 2-3 year)	3,000	7,700	8,470	19,170
Mielke, P. (1 mo./year)	2,000	2,200	2,420	6,620
Subtotal	7,000	14,300	15,730	37,030
2. Other Personnel				
a. Chemist field coordinator (12 months)	12,000	13,200	14,520	39,720
b. *1 laboratory technician (12 months)	6,000	6,600	7,260	19,860
c. 2 graduate research assistants (Ph.D.) 9 mo. academic year, 3 mo. summer	8,000	8,800	9,680	26,480
d. *1 chemist (12 months)	9,000	9,900	10,890	29,790
e. 1 secretary and clerical, 12 mos.	5,100	5,600	6,160	16,860
f. labor (2500 hrs. @ $2)	5,000	5,500	6,050	16,550
Subtotal	45,100	49,600	54,560	149,260
Total Salaries & Wages	52,100	63,900	70,290	186,290

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BUDGET cont.	1st year	2nd year	3rd year	Totals
B. Fringe Benefits				
PERA (retirement)	3,324	4,216	4,638	12,178
Total Salaries, Wages and Fringe Benefits, A and B	55,424	68,116	74,928	198,468
C. Permanent Equipment				
1. Gas chromatographs instrumentation	11,000	11,000	-0-	22,000
2. Air samplers (3)	2,400	-0-	-0-	2,400
3. Miscellaneous equipment	4,000	1,000	1,000	6,000
Total Permanent Equipment	17,400	12,000	1,000	30,400
D. Expendable Supplies & Equipment				
1. Glassware	1,000	1,000	1,000	3,000
2. Chemical reagents	2,000	2,000	2,000	6,000
3. Electronic parts and supplies	3,500	3,300	3,500	10,300
4. Gases	1,000	1,000	1,200	3,200
5. Standards	600	600	600	1,800
6. Solvents	400	400	400	1,200
7. Miscellaneous parts and supplies	1,700	1,700	1,700	5,100
Total expendable supplies, etc.	10,200	10,000	10,400	30,600
E. Travel				
1. Domestic	5,000	5,000	5,500	15,500
2. International	-0-	-0-	-0-	
Total Travel	5,000	5,000	5,500	15,500
F. Publication Cost				
1. Pamphlets	200	200	400	800
2. Reports	600	600	600	1,800
3. Other	250	250	250	750
Total publications cost	1,050	1,050	1,250	3,350

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BUDGET cont.	1st year	2nd year	3rd year	Totals
G. Other Costs				
1. Consultants	1,000	1,000	1,000	3,000
2. Seminars	800	800	800	2,400
3. Computer rental	1,000	1,000	1,000	3,000
4. Electronic shop	1,000	1,000	1,000	3,000
5. Instrument rental	800	800	800	2,400
Total Other Costs	4,600	4,600	4,600	13,800
H. Total Direct Costs (A through G)	93,674	100,766	97,678	292,118
I. Indirect Costs				
On Campus, 55% of salaries, wages and fringe benefits	19,742	23,022	25,325	68,089
*Off Campus, 25% of salaries, wages and fringe benefits	4,883	6,564	7,221	18,668
Total Indirect Costs	24,625	29,586	32,546	86,757
J. Total Costs (H and I)	118,299	130,352	130,224	378,875
K. Amount of this Award	118,299			

Colorado State University will cost-share in accordance with Foundation policy as set forth in Notice No. 31, Dated September 3, 1970.

Colorado State University's overhead rate on proposals is 59% of salaries, wages, annuities, sick leave, holidays and vacation except NSF which is, by agreement, 55%. Audit was performed and the above proposal rate approved by the Denver Branch of the Defense Contract Audit Agency (Room 585, New Customhouse Building, 19th and Stout Streets, Denver, Colorado 80202) for the period 7/1/67 to 6/30/68/

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Budget explanation of item C (1):

The Institute of Rural Environmental Health currently has a gas chromatograph. This was purchased in 1970. This instrument will be available for use on PCB project 3/4 of its operating time. Due to the sample load, additional gas chromatographs will be needed to analyze the samples collected during the course of the study. The addition of these two pieces of equipment will enable the laboratory to do analyses on all of the samples collected during the course of the project.

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7. Jensen, S., New Scientist, 1966.

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Current Support and Pending Applications

E. P. Savage -

None

E. F. Sharp -

None

J. D. Tessari -

None

P. Mielke -

Bureau of Reclamation, ¼ of year
Division of Design Criteria and Statistical Analyses
Project 1779, Department 1877

MONS 044494

INFORMATION CONCERNING INSTITUTION SUBMITTING PROPOSAL

A. This proposal is submitted by COLORADO STATE UNIVERSITY. Contracts and grants that result from this proposal should be made in the name of COLORADO STATE UNIVERSITY.

B. The officials authorized to sign and to submit proposals are: (1) Rue Jensen, Vice President for Research, or (2) James F. Brown, Contracts and Grants Administrator.

C. The official authorized to negotiate contracts is the Contracts and Grants Administrator.

D. Correspondence should be addressed to: Colorado State University, Fort Collins, Colorado; Attention: Contracts and Grants Administrator; Telephone 491-6355. Area Code (303).

E. The VICE-PRESIDENT FOR RESEARCH OF COLORADO STATE UNIVERSITY is authorized to sign contracts or to acknowledge grants.

F. Colorado State University is an agency of the STATE OF COLORADO and enjoys exemption from tort liability.

STATEMENT ON SOLICITING

We hereby certify that we have not employed or retained a company or person (other than a full-time employee) to solicit or secure this contract (grant) and agree to furnish information relating thereto as requested by the Sponsor's cognizant officer.

We certify that the distribution of costs between the direct and indirect categories as shown in the proposal conforms to the usual accounting practices of the institution and to the distribution used by the cognizant federal audit agency.

Date 1/26/71

Eldon P. Savage
Principal Investigator

James E. Ogg
James E. Ogg, Head
Department of Microbiology

James F. Brown
James F. Brown
Contracts and Grants Administrator

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