FRONTIERS of PLANT SCIENCE

FALL 1979

Saving Energy
see page 6

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION NEW HAVEN

Reducing populations of vector leafhoppers is a new approach to X-disease control

By George H. Lacy, Mark S. McClure, and Theodore G. Andreadis

In a survey of nearly 10,000 peach and nectarine trees throughout the state, we found 15% of the trees had symptoms of X-disease (Fig. 2). In central and western Connecticut 25% of 5659 trees had symptoms. Along the coast and in the eastern third of the state, however, only 0.7% of 4176 trees had symptoms.

In the past, X-disease was partially controlled by removal of chokecherry bushes within 500 feet of orchard blocks. Since 1969, however, a resurgence of X-disease in Connecticut has been observed coincident with the withdrawal of the persistent insecticide DDT from orchard use. This, and similar epidemics throughout the United States and Canada, suggests that control of insect vectors may reduce the frequency of X-disease. Therefore, we began research to determine if reducing leafhopper populations will lower incidence of X-disease in orchards.

Six leafhopper species are known to transmit XMLO in New York. These species are *Colladonus clitellarius*, *Fieberiella florii*, *Gyponana lamina*, *Norvellina seminuda*, *Paraphlepsius irroratus*, and *Scaphytopius acutus*. We had no information, however, on the ecology or biology of these species in Connecticut.

We studied the distribution and abundance of these species using yellow sticky traps that were attractive to adult leafhoppers. These traps were set out during the 1979 growing season in 16 individual peach blocks located in ten orchards throughout the state (Fig. 2). We found all six vector species. The highest numbers were trapped in western and central areas of the state. The most abundant species were *S. acutus* and *C. clitellarius*, which comprised 60 and 33%, respectively, of the leafhopper vectors caught.

Although we observed considerable variation, great-

What is X-disease?

Peach X-disease threatens the peach and nectarine industry in parts of Connecticut. This disease is caused by bacteria-like organisms called mycoplasma (XMLO) that grow within the phloem tissue of trees (See Fig. 1.) They restrict the transport of sugars formed by photosynthesis in the leaves to other parts of the plant. These organisms are believed to be spread to orchard trees by piercing and sucking insects called leafhoppers from XMLO-infected wild plants such as chokecherry.

The first symptoms of this malady are patches of yellow or red discoloration on some leaves. These areas become dry and brittle and the dead tissue falls out, giving the leaf a characteristic tattered look; affected leaves fall off and only the new terminal leaves remain. Over several years, affected branches die, one-at-a-time, until the whole tree is killed.

The disease causes losses in two ways: directly by reducing fruit yields on affected branches and indirectly through the cost of removing dead or severely affected trees. Replacement trees require 4 to 5 years before they come into full production.

In the past, control of X-disease has depended on removal of diseased orchard trees or their affected parts, eradication of chokecherry within

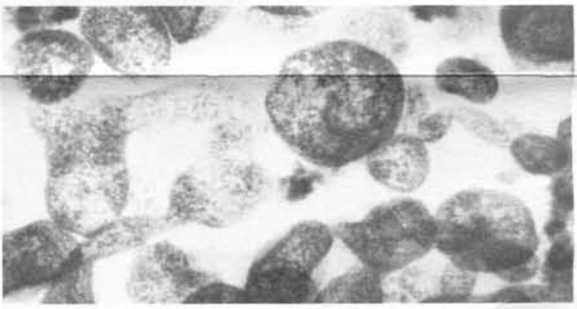

Fig. 1. Electron micrograph of mycoplasma-like bodies of the causal agent of X-disease (XMLO) magnified about 112,000 times. Photo-micrograph by R.E. Schlesinger-Bryant.

500 feet of orchards, and treatment of diseased trees by infusing the antibiotic oxytetracycline (OTC) through holes drilled in their trunks. These techniques have been disappointing.

Present controls for X-disease do not consider the insect vectors of XMLO. Although the first generation of leafhoppers in an orchard may be reduced somewhat by insecticides used to control other insects causing fruit damage, a second generation of leafhoppers feeds unmolested because insecticides are not usually applied after fruit harvest. The research reported in the accompanying article describes our attempts to learn more about the vectors so that the spread of X-disease may be lowered by controlling leafhoppers.

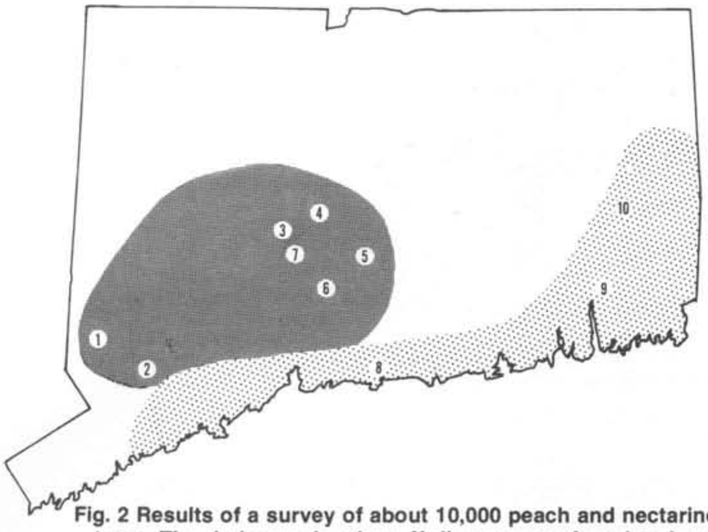

Fig. 2 Results of a survey of about 10,000 peach and nectarine trees. The dark area is where X-disease was found to have infected about 20% of the trees. The dotted area is where X-disease was found to have infected less than 10% of the trees.

er numbers were trapped in wooded areas adjacent to orchards than in orchards. The orchard blocks with the most leafhoppers generally had the most X-disease. Furthermore, the highest leafhopper populations occurred in parts of orchards where ground cover was a mixture of weed species, including members of the composite, grass, legume, rose, and vine families. Fewer leafhoppers were trapped where only grass grew or the ground was bare (See Table 1).

Leafhopper abundance may be related to incidence of X-disease. In western and central Connecticut 24.3% of 3846 orchard trees located near X-diseased chokecherries had symptoms, but in eastern Connecticut only 0.2% of 875 trees near diseased chokecherries had X-disease. Since the host (peach), the reservoir (chokecherry), and the pathogen (XMLO) are present in eastern Connecticut, this low incidence may be caused by the relatively low abundance of leafhopper vectors. (See Table 1).

Now, we are studying the importance of these leafhopper species in transmission of XMLO in the laboratory. Leafhoppers are either collected in orchards or they are caged on infected plants and allowed to acquire XMLO by feeding. They are then placed on celery plants. The leafhoppers feed, and if they transmit XMLO, the celery develops prominent symptoms of X-disease in 8-10 weeks. Over 10% of 146 plants developed symptoms after being fed on by 730 *S. acutus* adults captured in an orchard with a high incidence of X-disease.

To learn how to time leafhopper control measures to coincide with the greatest vector activity in the orchard, we are studying seasonal transmission capabilities of leafhoppers. These studies will indicate during which part of the growing season *S. acutus*, the most abundant and probably most important vector species, acquires and transmits XMLO.

To learn what host plants *S. acutus* preferred to feed on, we placed leaves of peach and other plants common from the orchard floor in cages containing adult leafhoppers. We counted the leafhoppers feeding or laying eggs on each leaf (Table 2). Adults strongly preferred to feed on red clover, a legume. Red clover, however, comprised only 1% of the ground cover. This suggests that more *S. acutus* might invade orchards if this attractive host were more common. Orchard grasses, although abundant in ground cover, were unsuitable host plants. This might explain why there are few leafhoppers in orchards whose ground cover was predominantly grass (Table 1).

Members of the rose family, which are predominant in ground covers with mixed weeds, were suitable hosts for feeding and laying eggs. Peach was

Table 1. Number of leafhoppers caught during June and July on sticky traps in peach blocks or bordering woods, % of peach trees with X-disease symptoms, composition of orchard ground cover and presence of X-diseased chokecherry.

Orchard*	Number of leafhoppers trapped		% of peach trees with X-disease	Orchard ground cover	X-diseased chokecherry within 100 m
	Peach block	Woods			
5	484	1289	49	mixed weeds	Yes
2	183	263	58	mixed weeds	No
2	145	838	74	mixed weeds	Yes
1	45	61	0	grass	No
4	40	124	38	grass	No
5	35	387	14	grass	Yes
8	34	177	0	none	No
7	26	55	4	grass	Yes
4	21	180	32	grass	Yes
6	12	—	31	none	No
3	10	6	26	grass	Yes
8	8	17	0	none	No
6	7	166	28	none	Yes
1	5	15	84	none**	No
10	1	84	0	none	No
9	0	13	9	none	Yes

**See Fig. 2 for orchard location*

**In the last 3 years a mixed weedy ground cover has been removed with herbicides

Table 2. Percent of *Scaphytoplus acutus* feeding and laying eggs on plants found in the mixed weed ground cover of a peach orchard with a high incidence of X-disease

Host Plants		%	% leafhoppers	
Family	Common name	ground cover	Feeding	Laying eggs
Rose	peach*	—	24	5
Rose	blackberry, raspberry strawberry*	62	13	28
Grass	orchard grass	18	0	0
Composite	goldenrod, dandilion	5	8	5
Vine	Virginia creeper	2	5	11
Legume	red clover	1	50	51

*Known hosts for the mycoplasmalike organism causing X-disease.

preferred over other roseaceous plants for feeding, but less preferred for laying eggs. This suggests a possible cycle between peach and weeds that would create conditions ideal for XMLO transmission from reservoir plants in the ground cover to peach trees (See Fig. 3).

Practical control of X-disease will not be simple.

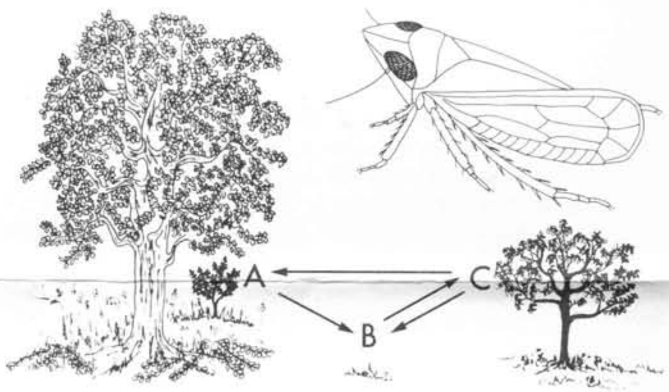

Fig. 3. Schematic representation of *Scaphytopius acutus* movement among hosts in the orchard and adjacent woods. A. Eggs hatch and nymphs develop on weeds at the edge of woods; some may feed on plant reservoirs of XMLO including chokecherry. B. Some adults migrate to favored feeding hosts on the orchard floor such as strawberry, plantain and wild carrot that may be additional reservoirs of XMLO. C. Adults readily move among the orchard ground cover, peach and woods to feed and lay eggs on preferred hosts. The inset at the top right shows what the vector leafhopper looks like (11x).

Several leafhoppers carry the XMLO and several wild and domestic host plants are capable of being reservoirs for the XMLO. Conceivably, control of the leafhoppers along with removal of reservoir hosts might suppress the number of new infections to a level where peaches and nectarines may be grown economically again in central and western Connecticut.

Many insecticides kill leafhoppers. Systematic use of chemicals for control of XMLO vectors has never been successful. In our experimental orchard, however, methoxychlor sprays reduced leafhopper populations, including those of X-disease vectors by 50 to 80%.

Cultural practices may also reduce populations of leafhopper vectors of XMLO in orchards. For instance, since leafhoppers and chokecherries are most abundant in woods at the edge of orchards (Table 1), it would seem unwise to plant peaches or nectarines in areas adjacent to woods. Furthermore, orchard ground cover type and quality might be manipulated to exclude host plants preferred by leafhoppers, such as legumes and roseaceous plants. Planting cover using less preferred plants such as grasses, would seem to be safer than planting legumes. Mowing or other measures that reduce common wild host species probably will reduce the food available for leafhoppers (Table 2).

In mathematics, the symbol X, after which X-disease was named, represents unknown quantities. Successful control of X-disease will be possible only when many of the unknowns of the ecology of the leafhopper vectors and XMLO are known

Recycling of clippings from lawns will save energy from nitrogen fertilizer

By H.C. DeRoo and J.L. Starr

Many homeowners remove the clippings from their lawns either by bagging them as they are cut or by raking them after cutting. This consumes some energy itself, but more importantly, our studies have shown that it also wastes valuable energy in the form of nitrogen fertilizer. The principal source of fertilizer nitrogen is anhydrous ammonia, which is synthesized at high temperatures and pressures using nitrogen from the air and hydrogen from natural gas or other hydrocarbons. Thus, a reduction in the large amounts of nitrogen used on home lawns could save substantial energy.

In the fall of 1975, we established four turf plots at our Valley Laboratory at Windsor. Each plot was instrumented with tensiometers to measure soil moisture at various depths, with suction probes to remove samples of soil water at similar depths, and with wells to sample the groundwater beneath each plot. The primary purpose of this installation was to study the leaching of nitrate nitrogen to groundwater. This is important because nitrate nitrogen at concentrations greater than 10 ppm in drinking water can be harmful to infants and ruminant animals. To date, our studies on these turf plots have shown little loss of nitrogen by leaching.

After the instruments were installed, the turf plots were limed, tilled, fertilized, and seeded with a conventional mixture of Kentucky bluegrass and fescue grass. After establishment, the plots were fertilized once in the spring and once in the fall of 1976 and 1977 with a standard lawn fertilizer (10-6-4) containing 50% organic nitrogen. Each application corresponded to a typical turf fertilization of about 2 lbs of N per 1000 ft^2 (or 0.98 kg N per 100 m^2). In 1978, the fertilizer nitrogen was changed to inorganic ammonium sulfate and enriched with the heavy isotope of nitrogen on two plots. This isotope (mass 15) is not radioactive, but can be distinguished from normal nitrogen, which is 99.6337% mass 14, with an instrument known as a mass spectrometer. The determination consists of measuring the ratio of the two isotopes and comparing the ratio in the sample to the ratio in normal nitrogen.

The grass was mowed weekly in spring and fall and about every two weeks in summer. The clippings from each of the four plots were collected, weighed, and then subsampled for analysis for moisture, total nitrogen, and in 1978, for the isotope N^{15}. Following subsampling, clippings were returned to two of the four plots. In 1978, we revised the experiment so that clippings from one plot fertilized with N^{15} were exchanged with the clippings from the plot receiving no labeled fertilizer. In this way, we could measure how rapidly N from clippings was released by decomposition and utilized by the new growth. Clippings from the two remaining plots were discarded as before.

The response of the two plots receiving the clippings was obvious: the grass was greener and growth was more vigorous than where the clippings were removed. Although objective assessment of turf quality is difficult, the turf was acceptable where the clippings were removed. Thus, if the clippings are returned, less fertilizer nitrogen is required to maintain the same appearance.

On an annual basis the difference between the yields and N content of the clippings was substantial, particularly after the first year of establishment (Fig. 1). In 1976 and 1977, about 1.8 lbs N per 1000 ft^2 (0.87 kg N per 100 m^2) were removed when the clippings were removed from the plot. This amounts to fully 45% of the total amount of N applied. In 1976, the amount returned in the clippings was 56%, so that nitrogen equivalent to over half the fertilizer was added to the plots by the end of the season. This agrees with studies

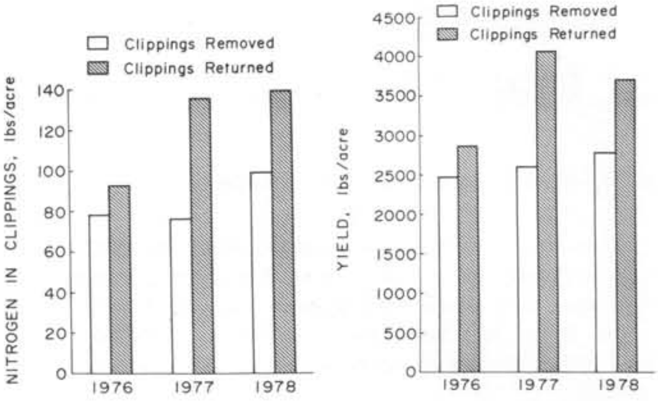

Fig. 1 Nitrogen in clippings (left) and yield of grass (right).

in Michigan of removal of clippings from Merion Kentucky bluegrass where an additional 2 lbs of N per 1000 ft^2 was required to maintain turf quality comparable to that where clippings were returned.

Where clippings were returned, the yield of dry matter was greater by 15 to 55%, depending on the year and the source of nitrogen fertilizer. Since the yields were greater, the amounts of N contained in the clippings were also greater. Indeed, in the third year, nitrogen equivalent to nearly 80% of the total fertilizer nitrogen applied had been returned to the plot in the clippings.

Two objections to leaving the clippings on a lawn might be mentioned. One is simply the appearance of brown, dead clippings which may spoil the looks of the lawn. With frequent mowing to heights of 1½ to 1¾ inches as in our experiments, appearance was not a problem.

A second objection is that failure to remove clippings may contribute to the accumulation of thatch. However, studies have shown that clipping debris does not form a major component of thatch. Grass clippings decompose relatively readily, especially when cut at such a size that they fall through the turf close to the soil.

This rapid decomposition is verified by our measurements of the appearance of the nitrogen isotope tracer in plots receiving clippings containing N^{15}. Within one week after a cutting, the tracer had begun to appear in the new growth of grass. We followed the accumulation of tracer nitrogen in the new growth throughout the year in order to estimate the amounts of nitrogen in the crop derived from all sources. We estimate from these data that, at the end of the third year, about one-third of the nitrogen harvested in the lawn grass came from soil organic nitrogen, one-third from the fertilizer applied, and one-third from the cumulative effect of returning the clippings to the plot. Thus, the increase in yield by an average of one-third can be attributed to the one-third increase in the total nitrogen made available to the crop from the clippings. Conversely, reduction of fertilizer nitrogen additions by one-third and returning the clippings should produce an acceptable lawn and save valuable energy.

Plants can grow well in a greenhouse at lower nighttime temperatures

By Martin Gent and John Thorne

Commercial growers who make their living growing plants during the winter, must heat their greenhouses. Because fuel costs and greenhouse heat losses are high, there has been much interest in finding ways to conserve energy used in greenhouses during the winter.

A New Haven grower, William Loefstedt, reasoned that plants may not require a warm environment for an entire night; therefore, he suggested that considerable fuel could be saved by maintaining a greenhouse at the usual 60° F for part of the night and lowering the temperature for the rest of the night.

This split-night regime rests on the hypothesis that most of the translocation and use of sugars produced in the leaves of the plant during a winter day would be completed early in the night, and the plant would be relatively inactive for the remainder of the night.

The Experiment Station observed an informal experiment that Loefstedt began using chrysanthemums and lilies in a New Haven Park Dept. greenhouse during Winter, 1977-78. Although the results were encouraging, there were too many variables to conclusively prove that the split-night regime would work. Therefore, we, with the help of Donald Aylor, designed a controlled experiment.

We decided to use tomato plants because tomatoes are important greenhouse crops in some areas, are frequently produced in greenhouses by bedding plant growers for sale to home gardeners in the spring, and because much is known about their physiology.

The tomatoes (var. Patio hybrid) were grown from seed and placed in the experimental greenhouse as 21-day-old seedlings on January 8, 1979. The greenhouse was divided by a glass partition. On one side of the partition a timeclock on the thermostat maintained the temperature at 60° during the first part of the night and then at 10 p.m., lowered it to 45° so that the temperature would be reduced for 8 hours during the night. On the other side of the partition, the temperature was maintained at 60° throughout the night, which is a standard practice.

The fuel savings of the split-night regime was calculated from weather records for 5 years at the Lockwood Farm in Mt. Carmel, CT. For an 8-hour split-night regime, a fuel savings of 20% during the months from January to April was predicted. Since the savings is a percentage of the amount spent without the regime for a greenhouse in any condition, the dollar savings would be more in a drafty greenhouse and would be more in the colder months than in the warmer months.

Each morning at 6 a.m., the plants received 70° water automatically. The water warmed the soil, and therefore the roots, before the day's growth. Because only a small amount of water could be used, however, it usually took until 10 a.m. for the soil on the split-night side to reach the same temperature as soil on the other side.

The height of the plants was used as a measure of growth before the fruit set. The plants on the split-night side of the greenhouse grew a little more slowly, lagging 4 to 5 days; however, they reached the same final height as the plants on the other side of the partition. The final vegetative size was relatively unaffected; therefore, it appears that the system could be used by bedding plant growers to start plants that will be sold for later transplanting.

Although flowering on the split-night side was delayed by about 4 days, plants on both sides of the partition produced the same number of flowers and fruit.

There had been reports that tomato plants do not set fruit well after cold nights, perhaps because the following days are also cold and pollinating insects are absent. Because there were no breezes or pollinating insects in the greenhouse, the flowers were pollinated by vibrating them with an electric toothbrush. The final yield of tomatoes, however, was about 12% less on the split-night side, which was the cumulative effect of small differences in fruit growth.

On a more basic level, we were curious what effect the reduced temperature had on physiological processes. First, we found no detectable difference in net photosynthesis between the two treatments. However, we did find a difference in the transport of the sugars produced by photosynthesis. The plants growing on the split-night side of the partition moved sugars to the fruit and other parts of the plant quickly during the day; there was little sugar movement after the temperature was reduced. Plants in the warm portion of the greenhouse, on the other hand, required the entire night to complete this process.

The regular daily trend in the amount of starch (a storage form of sugar) in the plants was shifted by about eight hours on the split-night side, which apparently was the way the plants adapted to the cooler temperatures.

The experiments show that the split-night regime is practical. This method of lowering the greenhouse temperature for part of the night is now being referred to as the Connecticut system in some reports. Experiments will be run to learn if the soil temperature in the split-night side can be altered to help the plants yield more, and there will be more experiments to determine the optimum temperature setback that balances fuel savings against effects on growth and yield.

PCBs in the Housatonic River are bound to the fine sediments

By C. R. Frink, B. L. Sawhney and W. Glowa

In the spring of 1977 the Connecticut Department of Health posted the Housatonic River with signs advising fishermen not to eat their catch because PCBs were found in fish from the river. Also, because of PCBs in the river, the Connecticut Department of Environmental Protection reduced its stocking of trout in 1978, and the Connecticut Academy of Science and Engineering established an Advisory Committee to study PCBs. C. R. Frink of the Station was vice-chairman of the Committee.

The Committee found that little was known about the distribution of PCBs in sediments of rivers. Therefore, The Connecticut Agricultural Experiment Station in New Haven began an extensive investigation of the distribution of PCBs in sediments in Lake Lillinonah.

Lake Lillinonah, the largest impoundment on the Housatonic River, was selected because it is the logical place to look for PCBs if they are being carried on sediments. There were two objectives: (1) to establish the nature of the PCBs in the lake sediments and (2) to learn the relation between properties of the sediments, such as particle size, and the distribution of PCBs.

The analytical task is complex, for there are 210 possible PCB compounds, although only 100 are likely to occur in commercial products. A particular Aroclor generally contains substantial amounts of 15 to 20 individual compounds with traces of other chemicals, including polychlorinated dibenzofurans or PCDFs. Although PCDFs are thought to be more toxic, they cannot be separated chemically from PCBs.

We used gas chromatography coupled with mass spectrometry to analyze for PCBs. In gas chromatography, the gaseous sample is passed through a column containing a solvent on an inert surface. The various compounds move at different speeds through the column depending upon their solubility in the solvent. A record showing the time a compound is retained in the column identifies the compound. The height of the peaks on this record measures the concentration of the compound.

To determine the amounts of each Aroclor mixed in a sample of sediment we used the mathematical technique of multiple linear regression. As the name implies, we assumed that the peaks present could be represented as the linear sum of the appropriate peaks of the individual Aroclors. The mathematics of regression then allowed us to calculate the amounts of each Aroclor that would provide the best fit to the chromatogram of the mixture. As an example of the ability of the method to distinguish varying known amounts of the Aroclors in synthetic mixtures, we present the data in Table 1. While the agreement between amounts known and calculated is not perfect, we believe that this method is satisfactory for determining Aroclors in sediment samples.

Table 1. Test of Analytical Method for Mixtures of PCB Aroclor, ppm

	1248	1254	1260
Known	0.1	0.1	0
Calculated	0.1	0.1	−0.01
Known	0.1	0	0.1
Calculated	0.12	0.002	0.09
Known	0	0.1	0.1
Calculated	−0.001	0.11	0.1
Known	0.1	0.1	0.1
Calculated	0.09	0.10	0.07

Polychlorinated biphenyls (PCBs)

Polychlorinated biphenyls (PCBs) are stable organic compounds that are virtually insoluble in water. They are non-volatile, nonflammable, and have a low electrical conductivity and a high heat capacity. These properties make them ideal for various applications in the electrical industry, where they have been widely used in capacitors and transformers. They have also been used as heat-transfer and hydraulic fluids, and in rubbers, synthetic resins, carbonless paper, and other chemical applications. At least nine different commercial preparations of PCBs were manufactured. These vary principally in their degree of chlorination, which regulates their physial properties such as viscosity and melting and boiling points. Monsanto Chemical Co., the sole U.S. manufacturer, formerly marketed these under the trade name of Aroclor. Mounting evidence of the possible toxicity of PCBs prompted the FDA in 1973 to establish a tolerance level of 5 ppm for fish and some other foodstuffs sold in interstate commerce. PCBs are no longer manufactured, although they are still in use in many different locations. Their persistence in fish and other foods has recently caused the FDA to propose lowering the tolerance level to 2 ppm.

Having established a technique for measuring PCBs, we next examined the sediments in Lake Lillinonah. The samples were collected from the surface 6 inches of sediment in the center of the former river channel at increasing distances from the dam.

We found that sediment from Lake Lillinonah contained Aroclors 1248, 1254, and 1260. The last two digits represent the percentage of chlorine in the compound. Aroclor 1254, used by General Electric in Pittsfield, MA in the manufacture of transformers, was replaced by Aroclor 1260 in 1974. PCBs were apparently never directly discharged to the Housatonic River, but it seems inevitable that some leaks and spills would find their way to the river. General Electric stopped using PCBs in March, 1977. The presence of Aroclor 1248 in sediments, however, suggests that there are other sources of PCBs to the river. Indeed, preliminary analyses of sediments from the Still River at elevations well above the flood level of the Housatonic have revealed significant amounts of Aroclor 1248 and lesser amounts of 1254 and 1260. Thus, we shall have to examine all tributaries carefully and search for more sources.

One sample was divided into four particle sizes by non-destructive methods and each fraction analyzed for total PCB with the following results:

Particle Size	Amount, %	PCB, ppm
Fine Clay, $< 0.2\mu$	2.9	9.7
Clay, $2\text{-}0.2\mu$	50.8	4.6
Silt, $50\text{-}2\mu$	44.6	0.5
Sand, $> 50\mu$	1.7	—

Since PCBs are clearly associated with the fine silt and clay, we tested this relationship by measuring the PCBs in a sediment sample and by analyzing a separate sample for particle size by rapid but destructive methods. Regression analysis showed a positive correlation between clay and total PCB content for 19 samples from Lake Lillinonah as shown in Fig. 1. The fraction of the variability in the data accounted for by the regression line is given by the coefficient of determination of $r^2 = 0.74$. In these 19 samples, Aroclors 1248, 1254 and 1260 were found in the proportions of 1.0 to 0.6 to 1.6.

Finally, we tested whether the affinity of PCBs for fine sediment can be used to predict the location of PCBs within an impoundment. Since fine sediment tends to settle out near the dam where the water moves slowly in the wider and deeper areas, we estimated the PCB content as a function of distance from the dam. For these same 19 samples, taken over a distance of about 12 miles, the coefficient of determination between PCBs and distance from the dam was $r^2 = 0.50$.

Thus, it appears that the distribution of PCBs is controlled by the distribution of clay in the sediment. We are working with the Department of Environmental Protection and the U.S. Geological Survey to locate the PCBs in the remaining impoundments on the Housatonic River from Pittsfield, MA to Long Island Sound and to predict the rate of transport of PCBs down the river.

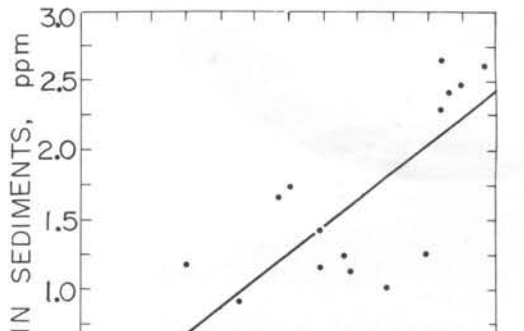

Fig. 1. Relation between PCBs and clay in sediments of Lake Lillinonah.

Frontiers of Plant Science published in May and November, is a report on research of The Connecticut Agricultural Experiment Station. Available to Connecticut citizens upon request.
Vol. 32 No. 1 Fall, 1979 ISSN 0016-2167 Paul Gough, *Editor*