(A-)

The

Seige of the Simazine

at the Parker House

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Independent Project

Environmental Studies 102

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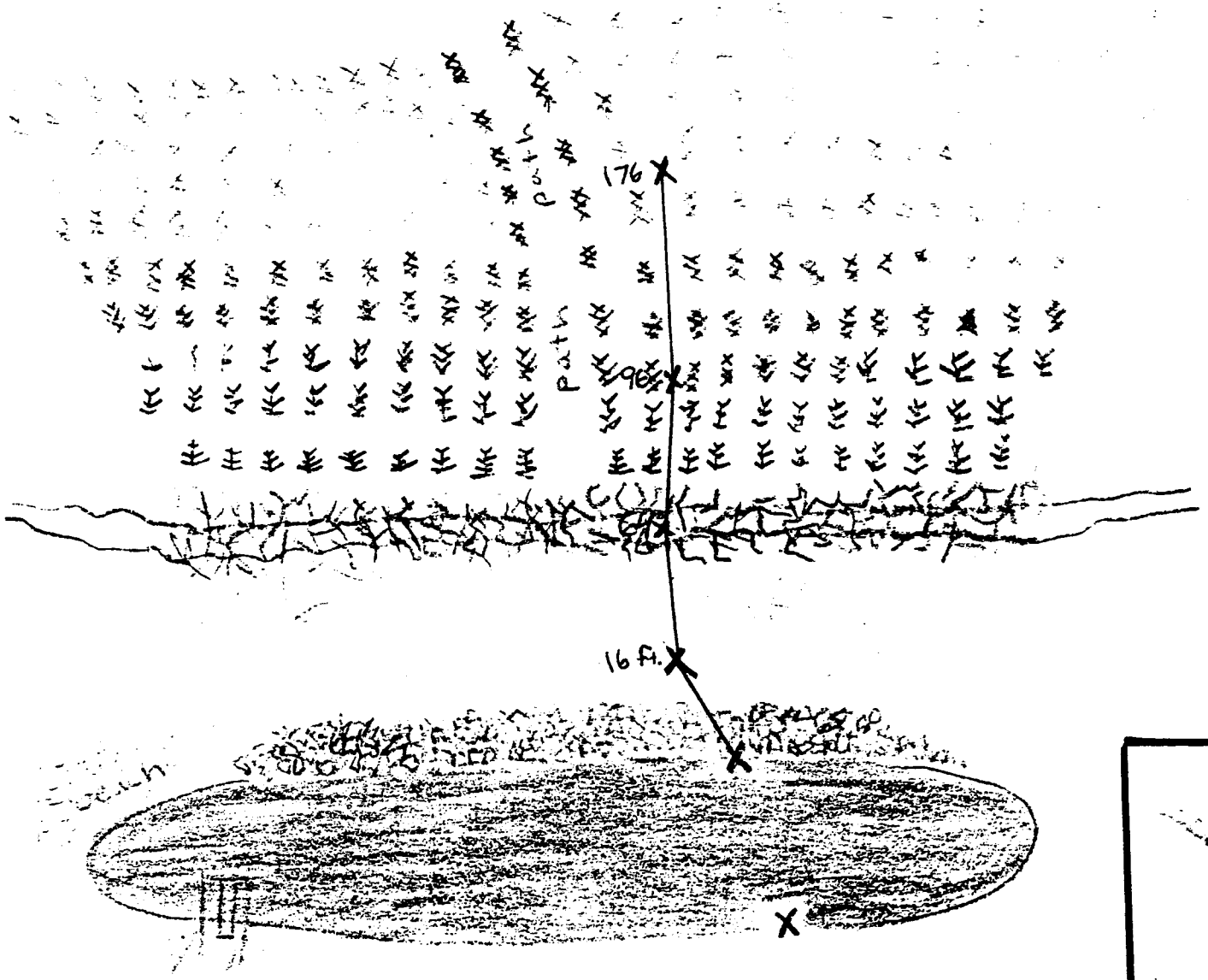
How it all began :

The idea just came to me. We were sitting in class discussing possible ideas for independent projects and BOOM! Suddenly I thought of the fact that my family, as part of the farming process, puts an herbicide, commercially called **Princep**, on our young Christmas-trees. As I thought, I remembered that a lot of these trees live on a slope that leads down to a pond we spend most of our summer in. A warning light came on. What if some of this, possibly quite toxic herbicide, was leaching through the soil down the hill and into the pond? I also remembered how we have always made a practice of inviting people to come over to swim and I realized we might in fact be endangering their livelihood, to say nothing of our own. Presented with the wonderful opportunity to use high-tech instruments, I decided to test both soil and water samples taken from the field and pond area to see if my fears were founded. I planned to take samples from the field soil, the pond sediment and one water sample from the pond. Professor Kegley enthusiastically agreed that this was a cool project idea and so we talked over good sampling procedures. After we decided on clean spoons and sterilized glass jars, I took off for spring break and some sampling.

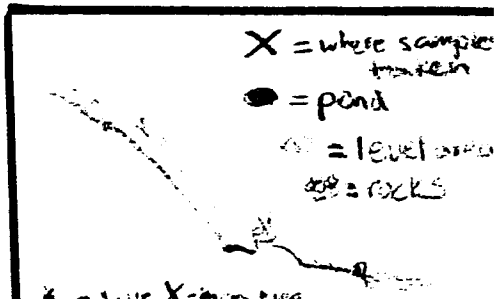
I conned my sister into helping me. With reluctance, she walked with me up the hill in the bitter cold in order to dig in the just-thawing ground. We took two soil samples (see the attached map) in the actual Christmas-tree field, two in the level area between the field and the pond and two sediment samples from the

The Parker Christmas-tree Farm



not to scale

Side View and Key



X = where samples taken

● = pond

= level area

= rocks

= live X-mas tree

= dead X-mas tree

= blackberry bushes

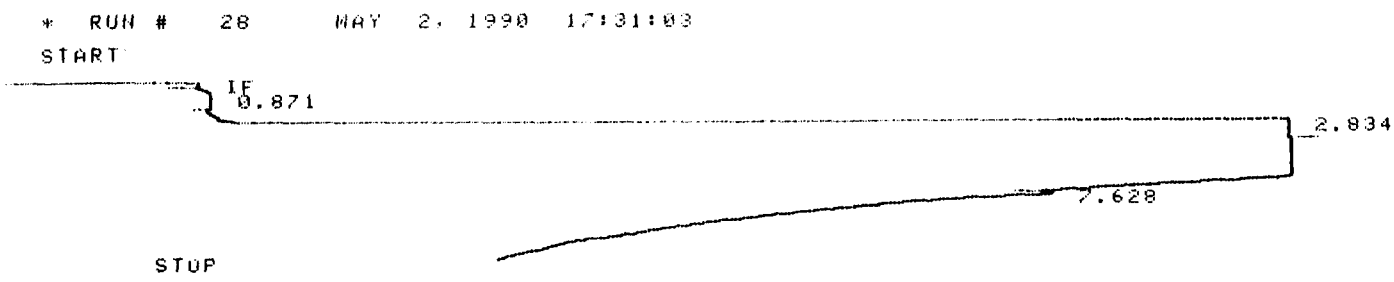
≈ = small paved dirt road

pond. Emily and I took turns breaking the ice and immersing our hands in verrrrrry cold water to dig around trying to find the elusive sediment buried under a layer of fist-sized rocks. We placed each of the samples, including a pond water sample, in small, screw-top glass containers and ambled back home. When I got back to school, I kept the samples cool until I could begin testing.

Procedure:

It all started when Professor Kegley ordered 100 milligrams of pure simazine from a company called Supelco. I had brought a sample of the herbicide we used at home but it contained only four percent pure simazine and it was easier to by pure simazine than try to extract it from my sample. As a side note, Professor Kegley and I worked as partners for parts of the project because of my lack of experience with lab procedure.

Because what would be found in the samples was unknown, the pure simazine was diluted into into a range of standards. The gas chromatograph, the instrument most qualified to answer our questions, used these standards as a frame of reference to estimate the concentration of injected samples. This process is explained in the section entitled The Gas Chromatograph. Originally five standards with a range of concentrations between 0 and 500 parts per billion were made up and injected. The results showed little or no sign of a simazine peak. This meant that in a graph such as the one below, no consistent peak appeared.



The next step was to try standards of higher concentrations, from 2 x 10^6 down to 3000 ppb. These were made up and injected. The result was a new peak that fluctuated with respect to the concentration of the standard.

To make these standards, we had to figure out how to make solutions with the desired concentrations. The equation $V_1C_1 = V_2C_2$ was used. In words, it states that the product of the first volume and the first concentration is equal to the product of the second volume and the second concentration. The known information included the value of the initial concentration, the value of the second volume (we decided on a second volume of 10 ml, the volume we wanted to end up with), and the value of the final concentration. Knowing these values simplified the calculation greatly. What still needed to be calculated was the amount of solution of known concentration needed to create a solution of lesser concentration. Below is an example of this calculation.

$V_1C_1 = V_2C_2$

$V_1 = \frac{10\ mL\ (200)\ ug/L}{5000\ ug/L}$

$= \frac{2000\ ug\ mL}{5000\ ug}$

$= 0.4\ mL$

$V_1 = 400\ uL$

After we determined the process of dilution that would enable us to create the standards, the standards had to be made. This entailed weighing out the 100 mg of simazine. First the bottle and simazine were weighed and after dilutions, just the bottle was weighed. The actual weight turned out to be 98.4 mg, give or take 0.5 mg lost during inaccurate pouring and transferring. The next step was to make the most concentrated solution by dumping all of the simazine into one container and diluting it to ~~10~~ 50 milliliters with ~~hexane~~ methanol. This created a solution of 2 x 10^6. The rest of the standards were made from this stock, using the dilution numbers determined above, starting with the simazine solution and diluting up to 10 ml with hexane.

The next step in determining the existence of simazine in the soil and water of my home was a process called extraction. What was done to the sediment was much more complicated than what was done to the water, so I will describe it first. I weighed out most of the sediment from each sample into a large beaker. The rest of the sample was put into crucibles to be dried out and used to determine the dry weight. The large beakers were brought over to the hood. To each beaker was added 100 ml (+ or - 10 ml) of methylene chloride and two tablespoons of sodium sulfate. Simazine is probably positively charged at neutral pH's and is therefore soluble in polar substances, including water. Because we needed to

have the simazine isolated in a substance other than water, we added a certain amount of sodium hydroxide to make the solution basic and ~~non-polar~~. Below is the mathematical process used to determine the amount of sodium hydroxide needed to make one liter of distilled water have a pH of 12. The known information included the weight of the sodium hydroxide (NaOH) which was 40 g/mole.

When want 1 Liter of H_2O w/ pH of 12

1st.

$pH + pOH = 14$

$pOH = 14 - pH$

$pOH = 14 - 12$

$pOH = 2$ (not in moles/Liter)

need to have 2 in moles/liter so

$\text{antilog}(p(OH^-)) = \text{antilog}(2)$

$[OH^-]\frac{\text{moles}}{\text{liter}} = \text{antilog}\ -2$

$= 1.0 \times 10^{-2}\ \frac{\text{moles}}{\text{liter}}$

2nd

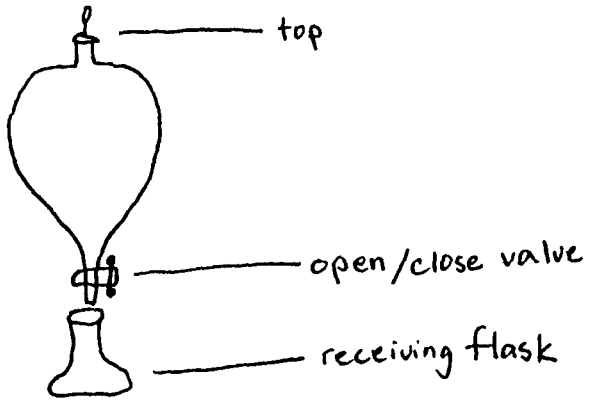
$4.0 \times 10^{1}\ \text{g/mole} \cdot 1\text{L} \cdot 1.0 \times 10^{-2}\ \frac{\text{moles}}{\text{liter}}$

$= 4.0 \times 10^{-1}\ \text{g}$

Methylene chloride (CH_2Cl_2), a non-polar ~~chemical~~ solvent, was used in this experiment to dilute the simazine. The sodium sulfate was added to get rid of excess water.

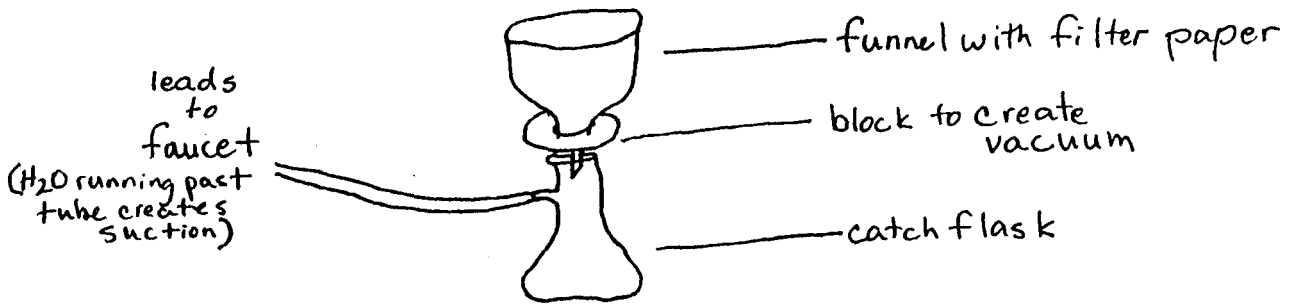
The next step included adding 50 ml of the sodium hydroxide-water solution to each beaker and sonicating them. The purpose of the sonicator, a machine that vibrates a bath of water very quickly but with little movement, was to separate out the simazine from the water and sediment into the methylene chloride.

After the beakers were sonicated, the top liquid layer was poured into what is called a separatory funnel, a diagram of which is below.



In this funnel, the water went to the top and the methylene chloride sunk to the bottom, taking the simazine with it. This happened because halogenated substances are always heavier than water. The bottom chloride solution was then drained off into a flask. Next, 50 more milliliters of the NaOH-water mixture was added to the sediment in each beaker along with 100 ml more of the methylene chloride to attract any simazine that had attached itself to the sediment. The entire beaker mixture was dumped into the separatory funnel and gently shaken up, with the air being vented periodically. After the bottom level was drained off again, 50 more ml of methylene chloride was added to the funnel and the whole mixture was shaken again. The layers separated out and the bottom methylene-chloride level was drained into the flask to join its predecessors. To each sample flask was added at least a tablespoon and at most two tablespoons of sodium sulfate to take out excess water before filtering.

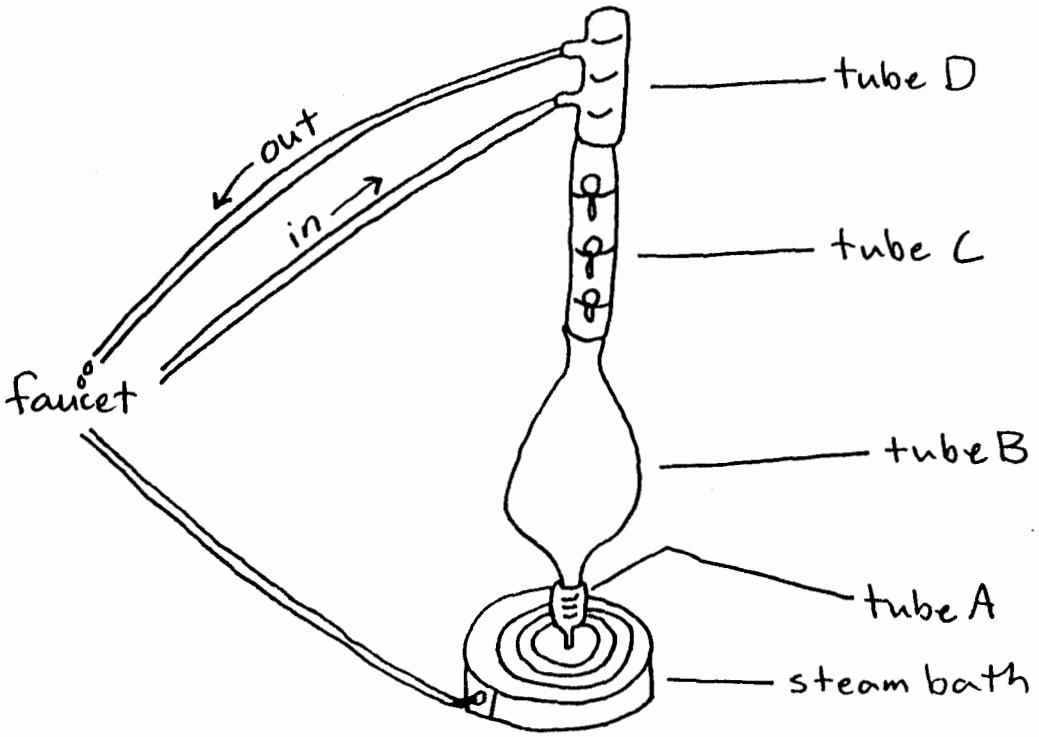
Filtering the solution was the next step. I used something called a Buchner filter, a diagram of which appears below.



The solution was poured into the funnel, leaving being as much of the sodium sulfate residue in the original flask as possible. The faucet was then turned on so that the solution was sucked through to a catch-flask below because of the suction force caused by the movement of water past the open tube. The purpose of the filtering step was to separate any large sediment particles from the methylene chloride-simazine solution.

As I said before, extracting the water sample was a much simpler process. The same methylene chloride and NaOH additions and separations were done with the separatory funnel but no filtration was done. The water sample went from the funnel process straight to the steam bath.

After the sediment solutions had been cleaned up by means of filtration and the water solution had been separated, each sample was given a steam bath. The steam bath, identical to the one used for the PCB lab, was used to get rid of the liquid diluting the substance being looked for. In this case, I wanted to get rid of the methylene chloride and leave the simazine. Following the boiling off of the solvent was a process called a solvent exchange, from methylene chloride to hexane. This process was necessary because the GC much prefers hexane over methylene chloride. But first, the steam bath. I used what is eloquently called the Kuderna-Danish concentrator. A diagram of this mechanism has been drawn below.



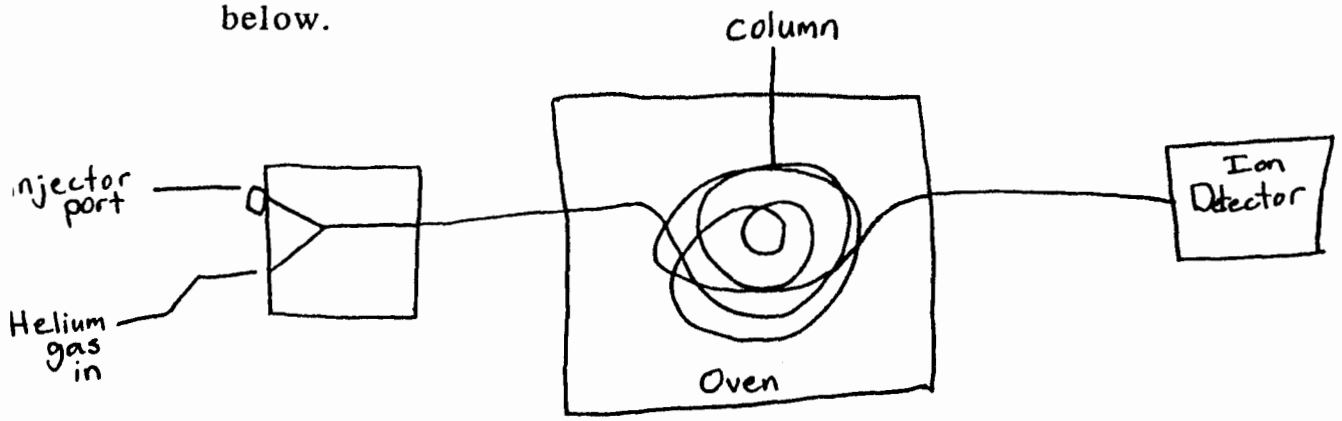
The way this instrument worked is as follows. The solution to be concentrated rests in tube A and is boiled by hot steam created when water from the faucet enters the steam bath. The solution in tube a rises through tube B into tube C where it is cooled. This cooling happens because another stream of cold faucet water circulates through tube D for the sole purpose of cooling the solution originally in tube A. When the steam bath is turned off, the remaining solution runs from tube C back down to tube A and is collected there. The next step was the solvent exchange.

The solvent exchange was a very simple procedure. After the remaining solution, at a volume of at the most 10 ml, had collected in tube A, about 50 ml of hexane was poured into tube B. The whole solution was given another steam bath. Then the hexane addition process was repeated. After most of the solution had boiled off, tube A was removed. The solution was diluted up to 10 ml (in some cases a little more by mistake) with hexane and poured into a small labelled bottle. This whole extraction process took about eight

hours but there sat my samples, transformed from dirt to a substance the GC could understand.

The Gas Chromatograph (GC):

A diagram of this wonderful instrument has been drawn below.



The basic procedure used with the gas chromatograph included injecting into the port 10 microliters of each of the solutions to be tested, both the standards and the samples. Each sample was vaporized in the injector tube and the gas was sent through the tiny but extensive glass column. From the column, the vapor met up with an ion detection site and the information gathered was transferred to a printer. A printout of a graph of ions present along with their retention times resulted.

The next step was to use the following process, photocopied from the GC folder. next two pages →
This process enabled the GC to use information gathered about the standards, namely their concentration and their peak area, to

How to Make a Calibration Table for Use with an External Standard

1) Prepare a series of standards that cover the range of interest.

2) Be sure all instrument parameters are set properly, including any temperature programming, baseline corrections, run times, and other timetable events.

3) Clear all previous calibrations by pressing [DEL] [CALIB] [ENTER]. Respond yes (Y) to the computer's question.

4) Inject a known volume of the lowest concentration standard and let it run. **This same volume should be used for all other standards and any samples using this calibration file.

5) At the end of the run, press [PREP] [CALIB] [ENTER]. Answer the computer's questions as indicated below:

Computer prints out	You respond	What it means
E = EXTERNAL STANDARD I = INTERNAL STANDARD N = NORMALIZATION CALIBR PROCEDURE (E*/I/N):	E or [ENTER]	external standard being used
REF % RTW [5.000]:	[ENTER]	retention time window for reference peaks (in %)
NON-REF % RTW [5.000]:	[ENTER]	retention time window for non-reference peaks (in %)
RF BASED ON AREA OR HEIGHT [A*/H]	A or [ENTER]	calibration will be based on peak area
CAL # RT AMT NAME 1 :	Input the retention times of the reference peaks, prefaced by a minus sign, followed by [ENTER]. Then type in the concentration of the standard, and a name if desired. Repeat this procedure for each peak you wish to calibrate. When all desired peaks have been listed, press [ENTER].	
GROUP PEAKS [Y/N*] :	N or [ENTER]	for looking at individual peaks
CALIBRATION OPTIONS		
RF of uncalibrated options [0.000 E+00]	[ENTER]	related to response factors (ask your instructor if you want to know)
Replace calibration fit [Y/N*]	Y	necessary for a calibration involving more than one standard
P = point-to-point L = linear N = non-linear (quadratic) Calibration fit [N/L/P*]	P	gives a point-to-point fit for the calibration curve
Disable post-run RT update [Y/N*]	N or [ENTER]	updates retention time changes at the end of each run
SAMPLE AMT	enter the amount of sample injected in µl	
MUL FACTOR	~~1.000~~ 0.10	parameter to correct for dilution, unit conversions, etc.

6) You are now ready to inject your second standard, so do so and let it run.

7) At the end of the run, press [PREP] [CALIB] 2 [ENTER]. The computer responds with the retention times of the chosen peaks. All you have to do is fill in the amount contained in the second standard for each peak. The 2 tells the computer that this is your second level of calibration.

8) Repeat steps 6) and 7) for all standards, incrementing the level number after each run, i.e., for the third standard, press [PREP] [CALIB] 3 [ENTER].

9) After all standards have been run and entered into the calibration table, store your calibration file by typing [STORE] [CALIB] filename [ENTER].

10) Insert the filename in the method by pressing [EDIT] [METH]. The computer gives you a list of things to edit. Chose 3, the calibration file. The computer responds:

REPLACE CURRENT CALIBRATION [Y/N*]:	type Y [ENTER]
CALIBRATION FILENAME :	enter the filename of the calibration file just created, followed by [ENTER]
SECTION TO BE EDITED:	[ENTER] (This gets you out of the EDIT mode)

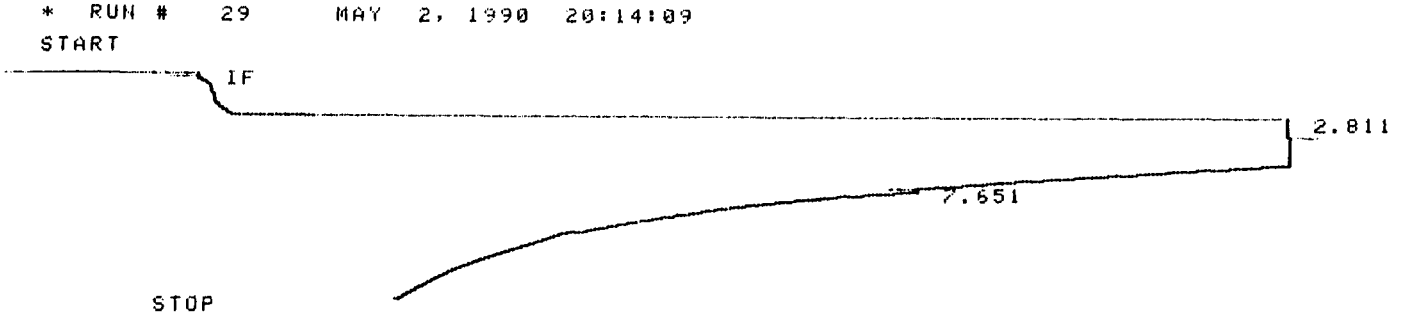
11) If desired, check the calibration by pressing [LIST] [CALIB] [ENTER].

12) Store the modified method file by pressing [STORE] [METH] filename.

estimate the unknown concentration of a random sample. Below is the printout of this function.

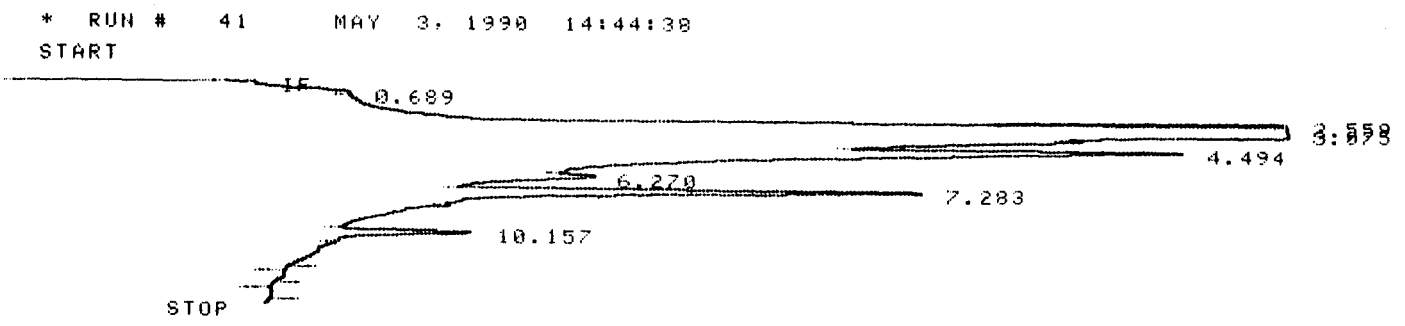
Collected Data:

As I said in the procedure section, the original standards did not work. The graphs created were unsatisfactory because of the fact that they dipped below the zero limit and ran too much of the time at the highest level. Below is an example of one of these ugly graphs.



Our solution was to just keep trying, injecting standard after standard, changing the levels of concentration and amounts injected. The solution was to inject 10 microliters of each standard with each standard have a concentration between 2 $x10^6$ and 3000 ppb. The graphs suddenly stopped dipping and a verifiable peak came out at ten minutes, give or take 0.5 minutes. The time varied with respect to how fast or slow I pushed the start button after injecting the solution. An example of one of the perfect graphs produced after the adjustments is below.

Level 64'



What I expected to find:

My knowledge of the process of the leaching of substances through soil made me think that I would probably find simazine somewhere around the pond, either in the sediment or in the water. If there was in fact simazine in the pond, I would have expected to find it or more of it in the sediment. I expected this to be true because there was a flow of water through the pond and water was constantly leaving and being replaced. If there was simazine around the pond, I knew there had to be quite a bit in the field, as the field was the only place simazine was put above the pond. An important point is that the simazine herbicide we put on the trees is in granular form and "moisture is needed to move it into the root zone (3, CIBA-GEIGY)". The herbicide needs water to get into the soil and therefore the process of leaching is more likely to occur.

simazine probably adsorbs to soil particles

With respect to the concentrations of the simazine I expected to find, I expected to see increasing levels from the first level (land) sample to the highest field sample. I thought I might see

some simazine in the pond sediment, but not levels higher than in the field because there has been no direct application of herbicide on the pond. I didn't expect to see much, if any, in the actual pond water because of the flow-through.

What I did find:

The first step was to inject the standards to determine whether the estimated concentration mechanism discussed before actually worked. When the sample of known concentration 7000 ppb was injected, an estimated concentration of 9567 ppb was given by the GC. This was declared a good estimate.

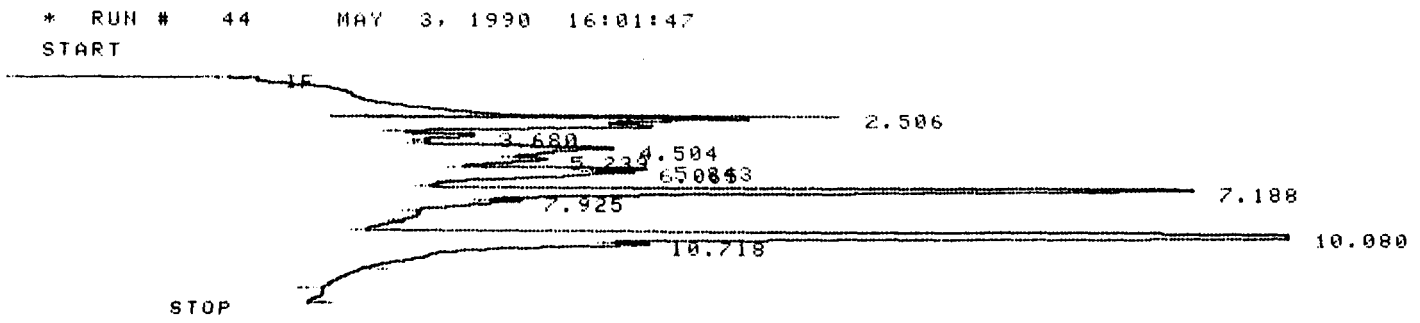
The next step was to inject the samples. Below is a compilation of the data produced by the GC about my samples, starting with the sample taken at the farthest pond edge.

Sample (feet)	Retention time (minutes)	Estimated concentration (ppb)
pond swing	10.81	622
pond beach	none	none
level 16	10.50	1836
level 64	10.07	2469
field 96	10.16	2061
field 176	10.08	34,437 (5500 mine)

These should be labeled on your map more clearly

The results came out slightly differently than predicted. The incredibly high 34,437 is the result of the gas chromatograph

reading the wrong ten minute peak. As you can see below, there were two peaks that came out with in the (+)0.4 (-)0.4 minute time limit.



The 10.72 peak should have been the one analyzed. By measuring the height of the later peak and comparing the measurement to the standards, one can come up with a reasonably good estimate of the concentration. The estimated concentration found this way is 5500 ppb. Entered back into this chart, this value makes much more sense than the original.

Looking at the adjusted chart, a relatively smooth increase in concentration from the lowest placed sample to the highest is evident. But the curve is not so smooth as to be perfect. The sample for the beach side of the pond showed no simazine peak. The possible reasons for this discrepancy follow. The sampling technique used may have somehow differed for this sample than for the others. For example, I may have only taken surface/near-surface sediment because of the frozen ground conditions. The simazine may only leach through deeper in the ground. Another possibility is that the process of extraction was not done as effectively for this sample. The sample may not have been sonicated

thoroughly or not enough methylene chloride was used to attract the simazine. Maybe sand particles don't hold as much as the organic-rich soils in the field

Other minor points about discrepancies in concentration data are the following. The concentration level for sample level 64 is slightly higher than the level of sample field 96. As we saw above in the first paragraph of this sub-section, the estimated concentration for the known concentration of 7000 ppb was 9567 ppb and the discrepancy of 2567 ppb was not considered a large one. This allowance can account for the slightly higher concentration of sample level 64. Another interesting difference is that simazine showed up on the side of the pond farthest from the field (sample pond swing) and did not show up on the side directly at the bottom of the field (sample pond beach). This discrepancy is best explained by the arguments presented in the above paragraph.

All in all, the collected data formed a picture much like one one would expect. The concentration of simazine is highest where it has been directly applied, lowest where water (which is polar) is present, and decreases at a fairly constant rate.

Toxicity:

Simazine belongs to the s-triazine family. The chart below shows simazine, its distinguishing parts and a few of its family members.

Triazines

X	Y	name
ethyl	ethyl	simazine
ethyl	isopropyl	atrazine
isopropyl	isopropyl	propazine
isopropyl	cyclopropyl	cyprazine
ethyl	sec.butyl	sebuthylazine
ethyl	tert.butyl	tertbuthylazine
ethyl	1-cyano-1-methylethyl	cyanazine
ethyl	diethyl	trietazine
isopropyl	diethyl	ipazine
diethyl	diethyl	chlorazine
diisopropyl	diisopropyl	siprazine
cyclopropyl	1-cyano-1-methylethyl	procyazine

The toxicity of a chemical partly depends on the chemical's ability to decompose. Simazine, like other triazines, breaks down in water because simazine is polar. This means that simazine can break down both in the soil and in plants. Below are two diagrams from pages 255-256 of a book called Organic Pesticides in the Environment. The first is of the way simazine breaks down in soil and the second in a plant, namely corn.

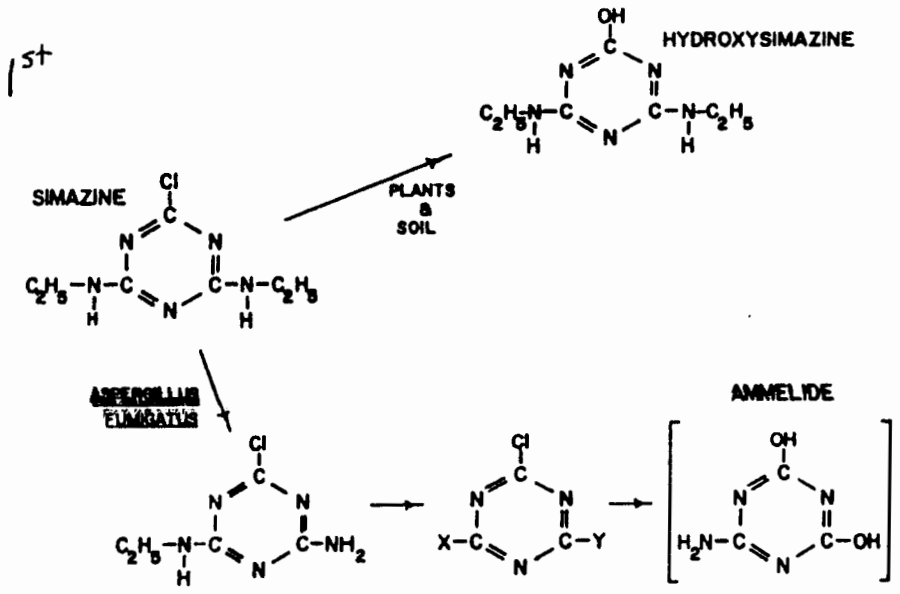


Figure 7. Proposed metabolic pathway for simazine decomposition in soils [from Kearney et al. (26)]

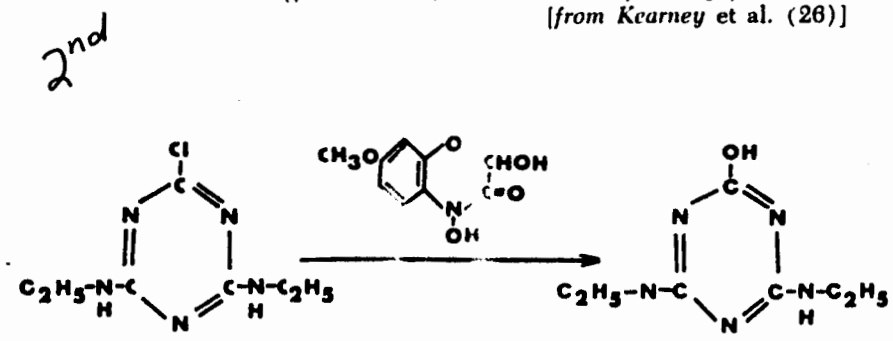


Figure 8. Proposed reaction for the conversion of simazine to hydroxysimazine as catalyzed by the cyclic hydroxamate in corn

The toxicity also depends on the rate of decomposition. The Complete Ecology Fact Book of 1972 states that simazine is a moderately persistent pesticide and has "a lifetime of from one to eighteen months, and [is] measurably more dangerous [than non-persistent pesticides] (Deedy, 294)". Already knowing this fact, my family only applies the herbicide once every three or four years.

Toxicity of herbicides also depends on the amount of time and to what extent one is exposed. The booklet that accompanies each bag of **Princep** warns that its product "causes eye irritation. Harmful if swallowed, inhaled, or absorbed through the skin. Avoid breathing dust. Avoid contact with skin, eyes, or clothing. Wash thoroughly with soap and water after handling. Remove and wash contaminated clothing before reuse (Princep, 10)". The booklet also warns the user to avoid contaminating "domestic or irrigation water supplies, or lakes, streams or ponds (Princep, 9)". The following chart, from a book entitled Safe Use of Pesticides published in 1967, shows where simazine stands with respect to other pesticides when the harm caused to the applier is compared. These tests were performed on "experimental animals" over an unstated amount of time.

Table I—Estimated relative acute toxic hazard of pesticides to pesticide appliers [1]

Most Dangerous	*Dangerous*	*Less Dangerous* [2]	*Least Dangerous*
Demeton (Systox) (OP)[3]	Aldrin (CH)	BHC (CH)	Aramite (M)
Di Syston (OP)	Bidrin (OP)	Binapacryl (Morocide) (N)	Captan (M)
Mevinphos (Phosdrin) (OP)	Carbophenothion (Trithion) (OP)	Chlordane (CH)	Carbaryl (Sevin) (C)
	DDVP (OP)	Co-Ral (OP)	Chlorobenzilate (CH)
			2, 4-D (CH)

Parathion (OP)	Delnav (OP)	Diazinon (OP)	Diquat (M)
Schradan (OMPA) (OP)	Dieldrin (CH)	Dicapthon (OP)	DDD (TDE) (CH)
TEPP (OP)	DNOC (N)	Dichloroethyl ether (M)	DDT (CH)
Phorate (Thimet) (OP)	DNOSBP (N)	Dimethoate (OP)	Dilan (CH, N)
Zinophos (Cynem) (OP)	Endrin (CH)	Dipterex (Dylox) (OP)	2, 4, 5-T (CH)
	EPN (OP)	Endosulfan (Thiodan) (CH)	IPC (M)
	Ethion (OP)	Fenthion (Baytex) (OP)	Karathane (N)
	Methyl demeton (Meta-Systox) (OP)	Guthion (OP)	Kelthane (CH)
	Methyl parathion (OP)	Heptachlor (CH)	Malathion (OP)
	Nicotine (M)	Lead arsenate (M)	Maneb (M)
	Pentachlorophenol (M)	Lindane (CH)	Methoxychlor (CH)
	Phosphamidon (OP)	Naled (Dibrom) (OP)	Mirex (CH)
	Sodium arsenite (M)	Ruelene (OP)	Morestan (M)
	Zectran (C)	Toxaphene (CH)	NAA (M)
		VC-13 (OP)	Perthane (CH)
		Vapam (M)	Phostex (OP)
			Piperonyl Butoxide (M)
			Ronnel (Korlan) (OP)
			Rotenone (M)
			Simazine (M)
			Sulphenone (M)
			Tetradifon (Tedion) (CH)
			Thiram (M)
			Zineb (M)
			Ziram (M)

SOURCE: U. S. Public Health Service, Communicable Disease Center, Toxicology Laboratory.

[1] The estimates of hazard in this table are based primarily on the observed acute dermal, and to a lesser extent oral, toxicity of these compounds to experimental animals. Where it is available, use experience has also been considered. It should be noted that the classification into toxicity groups is both approximate and relative.

[2] The fumigant compounds acrylonitrile, D-D, and Telone have systemic toxicities that would indicate their placement in the "Less Dangerous" category. However, special note should be taken of the fact that the volatility of these compounds and their capacity to produce irritation of skin, eyes, and other tissues indicate that appropriate caution should be exercised in their use.

[3] The chemical class to which the pesticide belongs is designated as follows: C, carbamate; CH, chlorinated hydrocarbon; M, miscellaneous; N, nitro; and OP, organic phosphorus.

When all of these different factors have been weighed and taken into account, simazine looks fairly evil. The final value on which the toxicity of simazine depends is the lowest actual amount that will cause harm. As we saw in the data section of the report, the lowest concentration was around 600 ppb (in the pond sediment) and the highest was around 5500 ppb (in the highest field sample). Below is a chart from a book entitled Pesticides in the Soil Environment, published in 1980, that gives a fairly accurate estimate of the lowest value of simazine that will be toxic to humans as tested on rats.

different units

Pesticide	Physical state	M.P. (°C)	B.P. (°C)	Vapour pressure mm Hg (°C)	Solubility in water, ppm (°C)	LD50 mg/kg
Parathion Methyl	S	35-36		0.97×10^{-5} (20)	60 (25)	14
PCP	S	191		0.12 (100)	30 (50)	27-80
PCNB	S	146				12000
Pebulate	L	142.5		6.8×10^{-2} (30)	60 (20)	1120
Phenthoate	S	17.5			11 (24)	300-400
Phenylmercury acetate	S	149-153		9×10^{-6} (35)	4370	
Phorate	L		118-120	8.4×10^{-4} (20)	50	3.7
Phosalone	S	48			10	120
Phosfolan	S	37-45			sol	8.9
Picloram	S			6.16×10^{-7} (35)	430 (25)	8200

Pirimicarb	S	90.5		$3x10^{-5}$ (30)	$27x10^{2}$ (25)	147
Profenofos	L		110			400
Profluralin	S	27-28			0.1 (25)	10000
Prometone	S	91-92		$2.3x10^{-6}$ (20)	750 (20)	2980
Prometryn	S	118-120		$1.0x10^{-6}$ (20)	48 (20)	3750
Pronamide	S	154-156		$8.5x10^{-5}$ (25)	15 (15)	8350
Propachlor	S	67-76		0.03 (110)	700 (20)	710
Propanil	S	92-93		$9x10^{-5}$ (60)	225	1300-1500
Propazine	S	212-214		$2.9x10^{-8}$ (20)	8.6 (20)	>5000
Propham	S	87-88				
Pyrazon	S	207		0.074 (40)	300 (20)	3000
Pyrichlor						80
Quintozene	S	146		$133x10^{-4}$ (25)	Insol	>12000
Ronnel	P	40-42		$8x10^{-4}$ (25)	40 (22)	1740
Sesone	S	245			$26.5x10^{4}$ (25)	1400
Siduron	S	133-138		$<8x10^{-4}$ (100)	18 (25)	>5000
Simazine	S	225-227		$6.1x10^{-9}$ (20)	5 (20)	>5000
Sodium Arsenite	S				sol	10-50
Solan	S	82-86			Insol	>10000
Swep	S	112-114			Insol	522

This chart means that as long as my family members, our guests, and I don't swim in, inhale, absorb or ingest the soil in the Christmas-tree field above 96 feet from the pond, we should be quite safe.

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Addendum

This has been an enormously fun project. I must thank you, Susan Kegley, for spending those crazy and numerous hours in the lab, and for all your help as an ace instructor. I value our friendship and I hope you have a wonderful summer. I have learned a lot about all kinds of things doing this project and it has made the subject of chemistry much more appealing. My parents will be greatly impressed, as I am, with the fact that I actually found out about a subject that directly relates to our lives and our health. I was able to do an experiment and get conclusive results. Thank you tons and tons.