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Edited by
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MERITORIOUS SERVICE AWARD

This award is presented to individuals who have distinguished themselves in administrative or technical service to mosquito control in Utah. The following four people were presented this award in 1999:

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Ralph Wyatt

Ed Yeates

Earl A. Jenne

AFRICANIZED HONEY BEES IN CLARK COUNTY, NEVADA

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The Africanized Honey Bee (AHB) first entered the United States in 1990 in Texas. Since then the AHB has continued to expand its range into the arid parts of Arizona, New Mexico, California, and Nevada. The AHB arrived in Clark County, Nevada. The AHB arrived in Clark County, Nevada in April 1998 in the extreme southern tip of the state in the town of Laughlin, along the Colorado River below Davis Dam. This area is across the river from Mohave County, Arizona where AHB had already been reported. The first confirmed AHB swarm in Las Vegas was found in July, 1998, in the downtown county government complex, in an outdoor covered parking area.

The movement of these bees has been tracked through the use of USDA-AHB traps that have been baited with pheromone lure. The traps have been placed in advance of the anticipated movement, especially along the Colorado River, Virgin River, and other water sources.

In the past 15 months AHB migrating swarms have been reported from all areas of the Las Vegas Valley and have extended into the northeast corner of Clark County to the town of Mesquite, adjacent to the Virgin River and close to the Arizona State line, which is approximately thirty miles from the southern Utah border. These bees have also moved in a northwesterly direction into Nye County and Armagosa Valley.

The Nevada State Department of Agriculture (NSDA) has examined numerous samples of bees that have been brought in by pest control companies, other agencies and residents. These bees have been identified by USDA-ID morphometric analysis, and up to the present there is an average of 50% Africanization. Some samples are 99% Africanized, while others are hybrids of European and Africanized bees.

According to Steve Thoenes of Bee Master, Inc. in Arizona, southern Nevada's Africanization will likely occur at a fast rate due to the fact that most of the European honey bees have been decimated by the Varroa mite over the past 5 years. This will allow the Africanized honey bee to colonize most of southern Nevada with little to no hybridization. Thoenes has also stated that AHB are not common in desert areas unless water is to be found near nesting sites. AHB are flourishing in and near the cities because of the abundance of year-round food and water.

The propensity of AHB to swarm is about ten times that of European honey bees. The AHB have swarmed frequently and in every month of the year in Clark County. Our European honey bees swarm mainly in the month of April, with some appearing in March and other extending into early May. Some AHB swarms in January froze during the night because of prolonged exposure on a tree branch. Most of the swarms of AHB have

occurred so far in September and October. During this time of year, the NSDA office receives 10-20 swarm calls per day. This count doesn't include calls that other agencies and pest control companies would receive about swarms.

The AHB swarms have typically been smaller than European bee swarms, with no unusual defensive behavior other than their being a little more flighty and easily disturbed. The smaller physical size of the AHB when compared to EHB is discernible after one has had experience dealing with both kinds of bees.

AHB swarms are typically found where EHB swarms have been known to occur, that is on branches of trees, on sides of buildings and on block walls and fences. They have also appeared in unusual locations such as on a small rock in the August heat, and spread thin on turfgrass on a hot day. Others have been found on palm trees on the Las Vegas Strip.

Location preference for established AHB colonies seems to be smaller cavities at ground level, especially utility boxes. They readily adapt to smaller spaces and unique locations, such as a birdhouse, a corrugated paper sack, and holes in the ground. Unused bee hives have attracted some of the swarms.

The defensive behavior of these bees has been variable and not always predictable. As mentioned, the swarms that have been found in trees, bushes, sides of buildings, etc. are generally docile, demonstrating no unusual defensive behavior, much like European honey bee swarms, except that the AHB swarms are typically smaller.

Once an AHB colony has been established for a few months, when the population has increased, brood is being reared and honey stored, then there has been more defensive behavior demonstrated. However, even then, the colony's reaction is not predictable, with some AHB colonies behaving in much the same way as European honey bee colonies. Due to the fact that many of the AHB colonies are occupying relatively small cavities, population size has not increased greatly before the space is full of bees and another swarm is issued.

Serious stinging incidents have not been a problem so far. Two dogs died from the stings of AHB that had established themselves in vacant bee hives in the backyards of former beekeepers. It has been reported from areas that have had AHB for several years that extreme defensive behavior has not been observed until 1 ½ - 2 ½ years after the discovery of the first swarm of Africanized honey bees (Dietz 1992).

What efforts are being made to control the AHB in Clark County? Generally, since the arrival of the AHB in southern Nevada, all honey bee swarms that are detected are exterminated. Swarms and colonies on private property are either eliminated by the property owner or a pest control operator. Bees found on the right-of-way and public land are controlled by the appropriate governmental agency. The pest control industry in southern Nevada has an Africanized honey bee 24 hour phone number available to the public, listing companies that will exterminate bees. Our agency and the Nevada State Department of Agriculture have this phone number on our recorded messages if residents call after business hours.

Local radio and TV stations have carried information about the AHB since their arrival 1 ½ years ago. Honey bee study materials, including a video and information sheets on AHB, have been

made available to schools. Emergency response sessions have been held with city and county fire units, school leaders, federal, state, county, and city land owners, hotel groups, and others so that everyone is informed as much as possible about this unwanted visitor to Clark County.

The Nevada State Department of Agriculture has added to their staff an Africanized Honey Bee Program Coordinator to help organize educational efforts and conduct training sessions for agencies and groups in how to deal with Africanized honey bees.

A pamphlet about AHB has been developed in cooperation with the Las Vegas Visitors Authority and other offices. Information for this publication has been gleaned in part from the states of Arizona and California. This publication has been made available to schools and the general public. There is also a Clark County web site about AHB at www.co.clark.nv.us/pubworks/ahb.htm.

Clark County residents are seeing more bee swarms because of the frequent movement of AHB. Since these swarms typically have not demonstrated any significant adverse defensive behavior, the residents are surprised that the bees are in fact Africanized. The AHB is considered established in Clark County, so essentially any swarms that are found are usually considered to be Africanized. Another year to two of living with established colonies of these bees should give us a much better understanding of how serious a threat their arrival in Clark County will become.

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THE *MOSQUITO MAGNET*® A NEW TOOL IN CONTROLLING TREE HOLE MOSQUITOES

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Introduction

The first tree hole mosquitoes, *Ae. sierrensis*, were collected in Salt Lake City in 1987. Since that time the problems with tree hole mosquitoes have drastically increased (Fig. 1). Tree hole mosquitoes lay their eggs in holes, and rotted areas of trees that hold water. Neighborhoods with older mature trees are most affected. Although programs are in place to control tree hole mosquito larvae, it is almost impossible to find all sources. For example, in densely forested areas such as along creek banks or where trees are wrapped with leafy vines, all sources cannot be found. For this reason there will always be adult tree hole mosquitoes. These mosquitoes are very aggressive which makes them a neighborhood nuisance. Fortunately, the tree hole mosquito stays fairly close to their source area, which makes trapping them a viable control method effective. The Mosquito Magnet®, a new type of mosquito trap, was used this year by the Salt Lake City Mosquito Abatement District. The purpose for using the Mosquito Magnet® was to find out how effective it was in temporarily reducing tree hole mosquitoes in selected areas.

Materials and Methods

The Mosquito Magnet® is a relatively new mosquito trap. It runs on liquid propane which is converted, through a catalytic reaction, into carbon dioxide and warm water vapor in similar proportions to that of human breath. The reaction also creates a small electrical charge that runs the traps fans. The trap uses a technology which is called a counter flow system (Fig. 2). The counter flow works by putting a smaller tube, that blows out the attractant, inside of a larger tube that sucks the mosquitoes up into the trap. Supposedly, mosquitoes have a tendency to reverse direction by flying up rather than down, this behavior brings them closer to the trap entrance.

The Mosquito Magnet® was brought to, and ran in several different locations over the course of the summer. Three main locations will be discussed in this paper.

1. 1166 Downington is the sight where the Mosquito Magnet® was used most. There were large numbers of tree hole mosquitoes at this location. The back yard bordered the banks of Emigration Creek. The back yard area, as well as the banks of the creek had many mature trees. To evaluate the effectiveness of the Mosquito Magnet® an ABC Pro® (American Biophysics Company) trap was also used at this location. The ABC Pro® trap is very similar in design to a CDC trap. It uses a thermal water jug filled with dry ice as its source of CO_2. Below the jug is the main body of the trap, which has some electronic components and a fan. Below the body is the net. It uses a 7 volt motorcycle battery as a power source.

The trap works by releasing CO_2 out the bottom of the jug. As the mosquitoes come close to the attractant they are sucked down by the fan into the net. It was set to run continuously day and night as the Mosquito Magnet® does.

After the Mosquito Magnet® was run for several days, it was removed and replaced with the ABC Pro® trap for one day and night. The ABC Pro® trap was then removed and the Mosquito Magnet® was operated for several more days. The two traps operated in the same location, but were never operating at the same time.

2. 1257 Gilmer Drive is in an older up scale neighborhood. There were a number of large mature trees in the area. Some of the trees are wrapped with leafy vines making it hard to find all of the tree holes. The mosquitoes at this house were numerous and the owner asked if the district could help.

3. 1709 Bryan Avenue was another location that bordered a creek. It was also populated with many trees. The tree hole mosquitoes were not nearly as abundant here as at the Downington location.

Results and Discussion

The Mosquito Magnet® was used more at 1166 Downington than at all other locations. This area had the biggest tree hole mosquito problem because of the large number of trees. Between June 11 and August 9 4,857 *Ae. sierrensis* were trapped at Downington. Over the course of the two month period, the mosquito population dropped from an average of 401 mosquitoes per night to about 11 mosquitoes per night (Table 1). A lot of this decrease is probably due to natural mortality over the summer, but it is also the result of heavy trapping in the area from the Mosquito Magnet®.

A comparison between the Mosquito Magnet® and the ABC Pro® trap was conducted at Downington (Table 2). From July 2-6 the Mosquito Magnet® trapped 198 *Ae. sierrensis* per night and zero *Cx. pipiens*. The ABC Pro® trap over a 24 hour day period from July 6-7 trapped only 13 *Ae. sierrensis*, but did trap 34 *Cx. pipiens*. The traps were run a second time, the Mosquito Magnet® from July 8-13 and the ABC Pro® trap during July 15-16. The Mosquito Magnet® again trapped many more *Ae. sierrensis* at 73 per night, than the ABC Pro® trap, which only trapped 7 in the 24 hour period. The ABC Pro® trap did catch 66 *Cx. pipiens.* The Mosquito Magnet® appears to be better suited for use with *Ae. sierrensis* than the ABC Pro® trap.

An interesting fact about *Ae. sierrensis* is that the male mosquitoes are attracted to CO_2 along with the females. They do this to find females for mating. The trap results showed this phenomenon at all three locations (Table 3). At Downington, only 45% of *Ae. sierrensis* were females. But, in the ABC Pro® trap, where mostly *Cx. pipiens* were trapped, 95% of all mosquitoes caught were female. At Gilmer Drive and Bryan Avenue only 59% of mosquitoes, mainly *Ae. sierrensis*, were females.

One of the main goals in using the Mosquito Magnet® was to give residences some relief from tree hole mosquitoes. At 1257 Gilmer Drive it seems that this goal was accomplished. This is a notorious tree hole area. The Mosquito Magnet® was placed in the yard. Over a three day period, from June 18-21, a total of 156 *Ae. sierrensis* were trapped. The trap was left another three days and caught 50 more, a big reduction from the previous three nights (Table 4). The

Mosquito Magnet® was then taken to a new location. Telephone calls were made to the owner of 1257 Gilmer Drive, one and two weeks after the last trap day. With both calls the owner indicated that the Mosquito Magnet® had really helped and that the mosquitoes were under control.

Conclusion

The trial of the Mosquito Magnet® by the Salt Lake City Mosquito Abatement District showed that it is an effective tool in helping control tree hole mosquitoes in Salt Lake City. It by no means got rid of all of the mosquitoes, but it did give people some relief and peace of mind that the mosquito abatement was trying to help. The trap is easy to use, and once in place requires no maintenance for up to 20 days. It is also environmentally friendly, it uses no pesticide, and it releases no harmful substances. The Salt Lake City Mosquito Abatement District was happy with the results of the Mosquito Magnet® in the use of trapping tree hole mosquitoes and will continue to use it as a control method.

Fig. 1. Percentage of complaints due to *Aedes sierrensis* from 1988-1999.

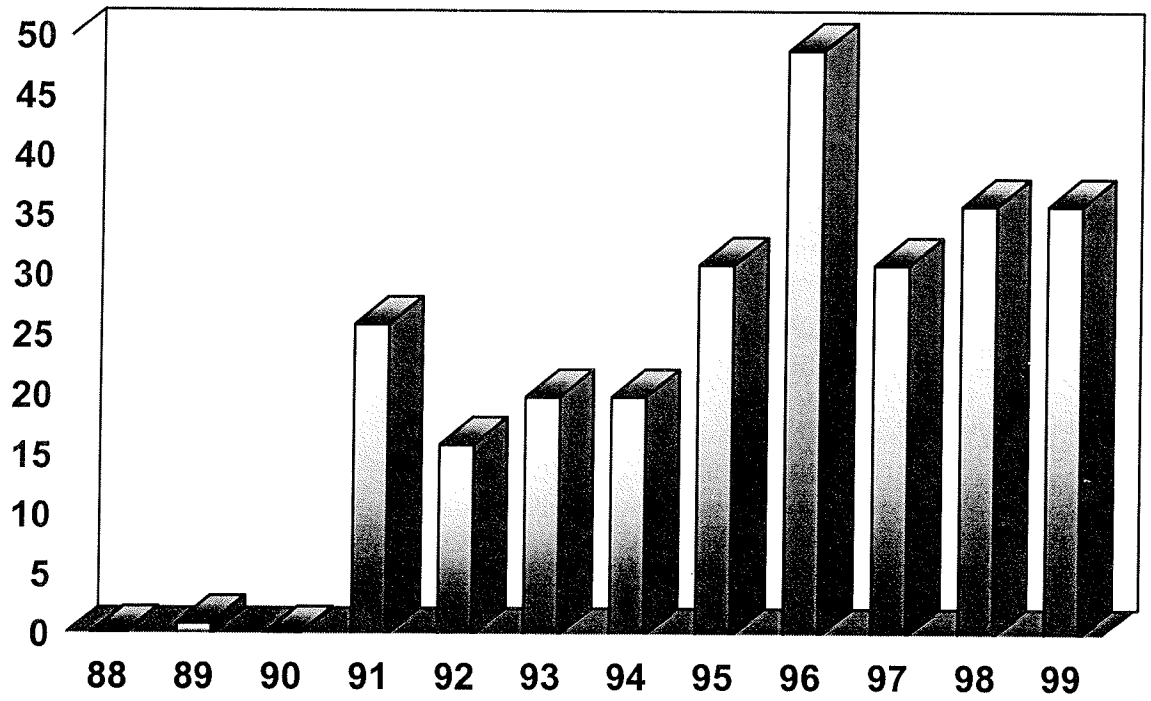

Fig. 2. Illustration of the counterflow geometry trap and counterflow movement of air through the trap.

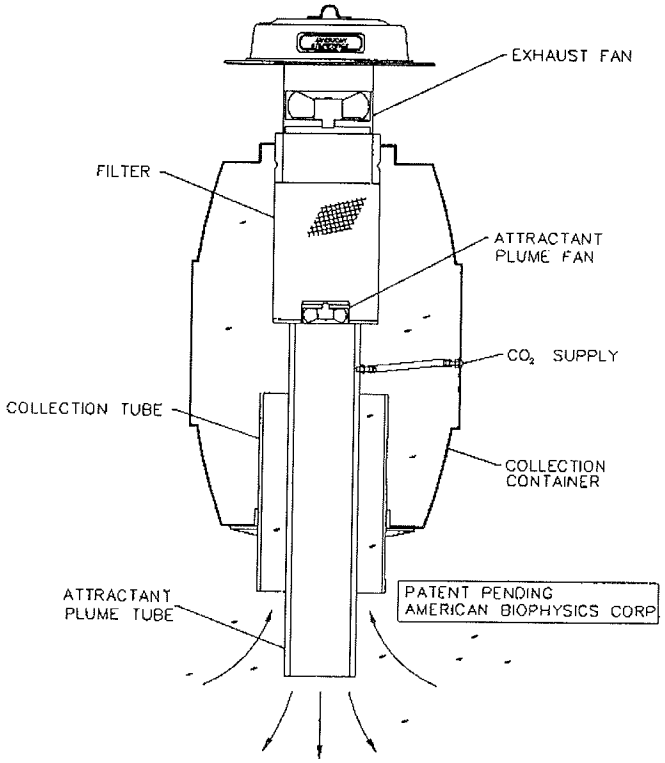

Table 1. Total number of mosquitoes and number of mosquitoes per day, caught at 1166 Downington street, off and on from June 11 to Aug. 9.

Dates	Total	#/Day
June 11-14	1,058	353
June 14-18	1,752	438
June 24-29	858	172
July 2-6	792	198
July 8-9	150	150
July 9-12	177	59
July 12-13	36	36
August 6-9	34	11

Table 2. Comparison between the Mosquito Magnet® and the ABC Pro® Trap.

	Mosquito Magnet®		**ABC Trap**		**Mosquito Magnet®**		**ABC Trap**	
	July 2-6		**July 6-7**		**July 8-13**		**July 15-16**	
	Aedes sierrensis	*Culex pipiens*	*Aedes sierrensis*	*Culex pipiens*	*Aedes sierrensis*	*Culex pipiens*	*Aedes sierrensis*	*Culex pipiens*
# Collected	792	0	13	34	363	0	7	66
Avg./Night	198	0	13	34	73	0	7	66

Table 3. Percentage of female mosquitoes trapped.

	Mosquito Magnet®	**ABC Pro® Trap**
1166 Downington	45%	95%
1257 Gilmer Drive	59%	
1709 Bryan Avenue	58%	

Table 4. Number of mosquitoes trapped at 1257 Gilmer Drive.

	Male	**Female**	**Total**
June 18-21	60	96	156
June 21-24	24	26	50
Total	84	122	206

THE EFFECT OF A PHOTODYNAMIC DYE, ROSE BENGAL, AND LIGHT ON FIRST STAGE LARVAE OF *CULEX TARSALIS*

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Abstract

First stage larvae *Culex tarsalis* were exposed to 20 mg/l of Rose Bengal and high light intensities for fifteen, thirty and sixty minutes. There was no mortality in dye alone and some mortality in all exposures of dye and light. Dye and one hour of light was 100% lethal.

Introduction

Photodynamic action is the destructive effect of visible light on biological systems when accompanied by exposure to certain photosensitive dyes (Blum 1941). This phenomenon has been known for many years although it's general occurrence may not have been adequately appreciated until recently. Photoradiation therapy for cancer has been being investigated for several years (see Giroth 1983 for an early review of the literature). In this research it was shown that certain hematoporphyrin derivatives in conjunction with light could have a localized and destructive effect on cancer tumors. Boyle and Dolphin (1996) have reviewed many of the successful chemicals used and Robinson (1998) has reviewed the potential problems and solutions under recent consideration. Photodynamic therapy has been shown to have an effect against macular disease, early stage lung cancer, and some skin cancers. Low heat diode emission, both light emitting and laser diodes, have recently been shown to be effective (Ignatius and Ignatius 1998).

Yoho, Weaver and Butler (1971) established that some common dyes used for marking organisms in ecological studies or as biological indicators had a photodynamic effect on some insects. These researchers went on to demonstrate photodynamic effects of numerous dyes and to quantify dose-response curves for many dyes in the order Diptera (1976a, 1976b, 1973). In this paper we show that a common fluorescent dye, Rose Bengal, has a photodynamic effect against first stage larvae of *Culex tarsalis*.

Methods and Materials

Ten specimens of first stage larvae of *Culex tarsalis* were placed separately in small glass vials, either in 10 mls. of water or 10 mls. of Rose Bengal, 20 mg/l. These were placed in a dark box consisting of a Styrofoam ice chest with a tight fitting lid and 15 mm holes bored into the bottom right corner and the top left corner for ventilation. One tube of larvae and water, and larvae and Rose Bengal, were each left in a light box for the duration of the experiment as controls.

The light box also consisted of a Styrofoam ice chest with a hole cut in the lid and covered with a double layer of plate glass separated by 5 mm spacers to vent heat from the light source. Light

was directed into the box from above using a 100W flood lamp on a ring stand and with a 1000 ml beaker of tap water between the light and the glass opening in the lid to act as a heat trap. In addition, a 15 mm hole was bored in the bottom right corner and the top left corner of each box for ventilation. A 20 mm x 30 mm mirror was placed in the bottom of the light box.

Vials of larvae and water and larvae and Rose Bengal were removed at 15 minutes, thirty minutes, and one hour, and observed for one hour. Viability of larvae was evaluated based on activity and normal behavior. Each experiment was duplicated three times for a total of thirty larvae in each exposure protocol. The results shown here are average mortalities. Mosquitoes were obtained from the Carolina Biological Supply House as eggs and reared through larval stages.

Results

Table 1 shows the mean percent mortality of first stage larvae of *Culex tarsalis* exposed to 20 mg/l of Rose Bengal and four different lengths of light exposure. With as little as 15 minute exposure to light following exposure to Rose Bengal larvae began to behave in an erratic manner, some of them listing as they attempted to move up and down through the water column and sluggish in response to stimuli. Some appeared unresponsive and were presumed dead. The number of larvae showing abnormal behavior or giving no response increased steadily. After sixty minutes no larvae responded to normal stimuli.

Further observations have been made on later stages but the data is not sufficient at this time to draw conclusions. It appears that there may be interesting variations with fourth stage larvae and pupae, and the dye and light also appear to have some effect on adults.

Discussion

The theory behind the photodynamic effect is that certain chemicals react to the energy in light. In some chemicals, especially fluorescent dyes, light energy is sufficient enough to move an electron to an outer orbit. This is an unstable condition and the electron soon returns to it's previous orbit, thereby emitting the energy consumed when the electron was pushed outward. This usually is dependent upon the amount and quality of light be sufficient to provide the needed energy.

Given an excess of light energy the electrons may be bumped entirely free of the molecules and thus causing a chain reaction that will result in the destruction of the chemical itself. In fact, we discovered that if the dye used was left out in full sunlight during the day it lost it's ability to effect larval stages. If the energy provided to the molecule is somewhere in between these two states, apparently a third type of reaction can occur in which the electrons are bumped from their normal orbits, but the molecule is not destroyed. In this case singlet oxygen (a free oxygen radical) is often generated. Singlet oxygen is a highly reactive compound that will react with almost any other molecule available, most often in a destructive manner called combustion.

It is thought that some dyes react with light in this latter manner and have a destructive effect on the cells because the singlet oxygen reacts with whatever may be in close proximity, literally burning up molecules and organelles inside. Preliminary studies indicate that not all tissues absorb Rose Bengal and such tissues would presumably be

protected from photodynamic effect. One of the issues in cancer therapy is finding dyes that are selectively taken up by tumor cells, or in which tumor cells take on more, or hold the dye longer, than normal tissue since normal tissues can be harmed by this effect as well.

First stage larvae appeared pink for some time after being removed to fresh water suggesting that they did ingest the dye. There appears to be a strong lethal effect of Rose Bengal combined with light on this early stage *Culex* development, but there are a number of unanswered questions.

1. The effect of the dye on all other immature stage adults need to be completed. This testing is underway in our labs.

2. The effect of the dye on adults needs to be assessed.

2. The dye needs to be tested at several different concentrations to establish a dose response curve for the dye.

3. The dose response curve for light needs to be determined.

4. Other fluorescent and Photodynamic dyes needs to be tested.

5. The Photodynamic effect on other parasitic organisms needs to be determined.

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Table 1. The mean mortality rates for first stage larvae of *Culex tarsalis* with, and without, exposure to Rose Bengal and light.

Rose Bengal Exposure	Light Exposure			
	Dark (60)	15 Minutes	30 Minutes	60 Minutes
20 mg/l	0	64	90	100
0 mg/l	0	0	3	0

CONTINUED IMPLEMENTATION OF GIS IN THE UTAH COUNTY MOSQUITO ABATEMENT PROGRAM: REPEAT OFFENDERS IN PROVO CITY 1995-98

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Background

In 1994, Stacey Petersen, Lewis Marrott, Xin Lu and Don Nay began integrating GIS (Geographic Information Systems) into the work of the Utah County Mosquito Abatement Division. GIS can be viewed as the link between field data such as dip counts, species, instar, etc. which can be stored in tables and the map or geographic location. This software link was initially provided by ARC/INFO and now by ArcView, both products of Environmental Systems Research Institute, Inc. These early workers had magnificent early success overhauling the mapping system used by the field inspectors and sprayers. The change was twofold: first, inspectors located breeding spots using maps with current roads and property lines instead of 10-year old aerial photos, and second, inspectors collected field data about single breeding spots instead of large geographic areas which might contain hundreds of breeding spots. As original personnel have moved on to other jobs, Lewis Marrott stayed the course and finally persuaded me to stay full-time and finish a great start.

A Specific Application

All of this early work produced more information, more readable maps and greater efficiency in the field. However, GIS was not the only newcomer to mosquito control. In the 1998 field season, the inspector assigned to monitor the Provo City gutters began using Agnique MMF which is a mosquito larvicide/pupated produced by Henkel Corporation and distributed through Van Waters & Rogers. We became interested in the impact of this new product on his work. His perception was that the time between treatments increased, allowing him to spend more time elsewhere. We decided to test his perception using the information and maps provided by GIS. Collected field data and the number of days between treatments for individual breeding spots located in the Provo City gutters were compared for 1995 to 1998.

Table 1 has been gleaned from database files and maps contained in the GIS. Repeat offenders refer to City gutters that harbor mosquito larva and have to be treated at least twice during the season. The table divides information by season (year) while some field data remained constant over the four seasons.

What conditions remained essentially the same?

1. Irrigation was recorded as the water source for 98% of the Provo City breeding spots. Seepage followed at 1.3% and precipitation at 0.7%.

2. Two mosquito species are found in

the Provo City gutters: *Culex pipiens* and *Culiseta inornata*. *Culex pipiens* make up the overwhelming majority found.

3. Almost always, no vegetation was found with mosquito larva. However, when gutters are neglected, plants can and do grow. When vegetation was found, the two most common recorded by field inspectors are algal masses and discarded grass clippings.

4. Finally, the water level in the breeding spot changed very little over the length of the season. Either the water remained during the season or dried slowly. Yet, the inspector recorded water depths up to 12+ inches. This increased water column can affect some control products such as Dursban and Altosid, but not Agnique MMF which works on the surface.

And what changed?

1. The total number of Provo gutter breeding spots treated and the total number of repeat offenders increased from 1995 to 1997 and then decreased slightly in 1998.

2. The mean number of days between treatments for Provo gutter breeding spots were the same for 1995 and 1996, but then gained 4 days in 1997 and 4 days again in 1998.

3. Though the minimum number of days between treatments stayed relatively the same, the maximum number of days increased two-fold. Also, the range, variance and standard deviation increased from 1995 to 1998 indicating an increasing dispersion in the treatment intervals. (See Distribution of Treatment Intervals for 1995 to 1998).

4. Control products used were the same for 1995 and 1997, but changed in 1996 and in 1998 when Agnique MMF was introduced.

What did we learn?

1. The use of BTI sand and Altosid Briquets in addition to Dursban granules and pupa oil during 1996 did not impact the treatment interval as compared to 1995 when Dursban granules and pupa oil were used exclusively. Yet, the treatment interval increased four days from 1995 to 1997 despite using the same control products.

2. Average number of days of control increased 8 days from 1995 to 1998. However, the number of repeat offenders increased as well.

3. Provo gutters in the south end of town harbored mosquito larva all four years while the east side of town posed a large problem in 1996 and then eased off a bit in 1997 and 1998. As expected, gutters along major roads posed less of a problem than minor residential roads. (See Provo City Gutters Treated maps 1995 to 1998).

4. Specific field conditions affected the mosquito larva population in the Provo City gutters all four seasons:

   a. Water delivery schedule.
   b. How often gutters are cleared by Provo City government.
   c. How often citizens discard grass clippings and garbage in the gutters.
   d. Weather conditions, temperature and amount of precipitation received.

We started this GIS problem with a

perception. The perception was tested and information gathered and results found. Do the results back up the inspector's perception? Yes, we believe that Agnique MMF lengthened the time between treatments in the Provo City gutters, keeping in mind that a new control product was not the only changing condition to affect the results. These results from the GIS provide data to help us complete our work more efficiently and also communicate more effectively with the public we serve.

Table 1.

	1995	1996	1997	1998
Total Gutter Spots Treated	62	125	122	116
Total Repeat Offenders	28 (2 - 8 treatments)	84 (2 - 8 treatments)	74 (2 - 7 treatments)	61 (2 - 5 treatments)
Mean # Days Between Treatments	**16**	**16**	**20**	**24**
Maximum # days	43	55	62	90
Minimum # days	6	3	5	3
Range	37	52	57	87
Variance	81	115	149	244
Standard Deviation	9	11	12	16
Insecticide used in treatment (% of total # of treatments for the Provo gutters for that season)	▪ 100% pupa oil & Dursban granules	▪ 74% pupa oil & Dursban granules ▪ 26% BTI sand ▪ Altosid Briquet trial in SW Provo blocks	▪ 100% pupa oil & Dursban granules	▪ 89% Agnique MMF & Dursban granules ▪ 11% pupa oil & Dursban granules
Water Temperature **(Note: Temperature data was not collected for each treatment)**	▪ Lowest: 55 F on 6/20, 6/21 ▪ Highest: 80 F on 7/17, 7/20	▪ Lowest: 55 F on 6/12 ▪ Highest: 83 F on 7/29	▪ Lowest: 60 F on 6/2, 6/4, 6/5, 6/9, 6/12, 6/18, 6/26 ▪ Highest: 77 F on 7/23, 7/29	▪ Lowest: 56 F on 6/4 ▪ Highest: 78 F on 8/10

Figure 1. Provo City Gutters: Mosquito Breeding Spots.

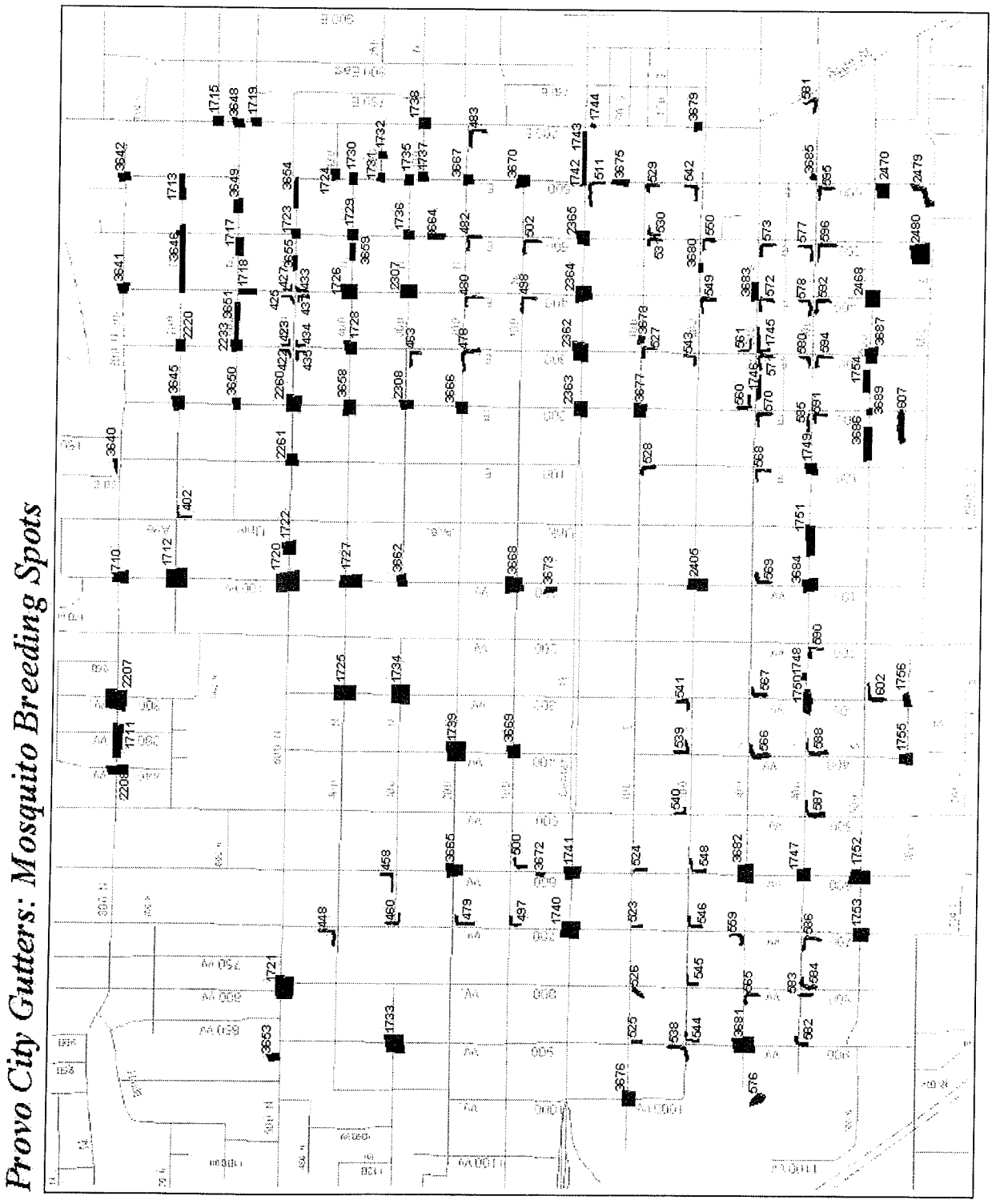


Figure 2. Distribution of Treatment Intervals for 1995 to 1998.

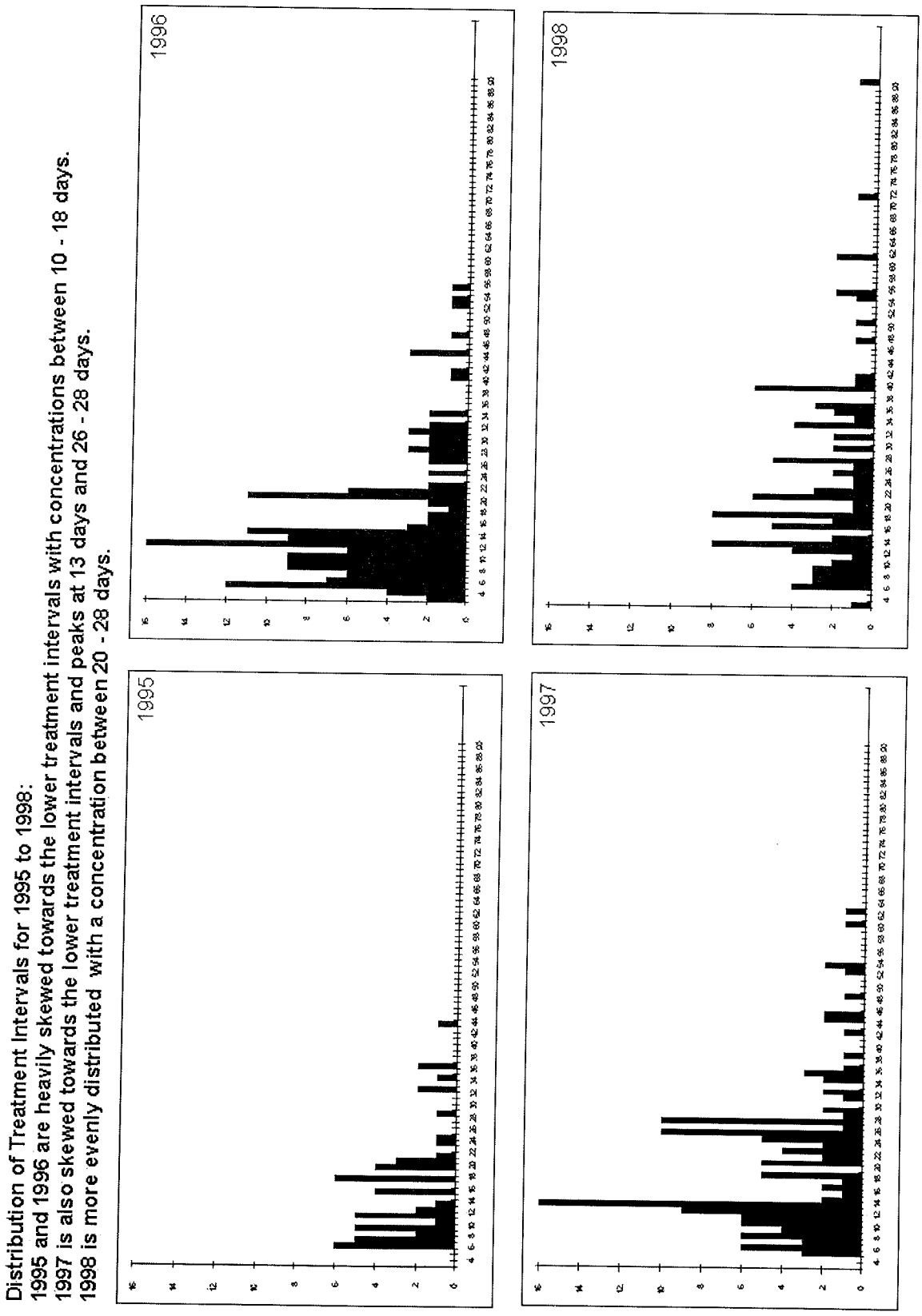
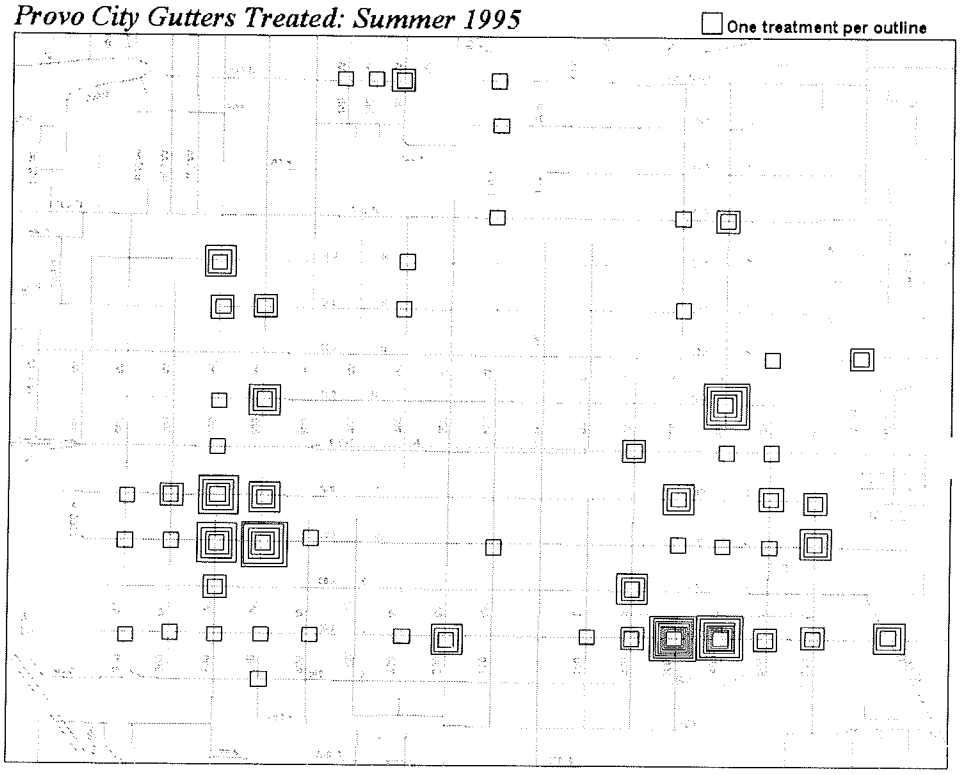
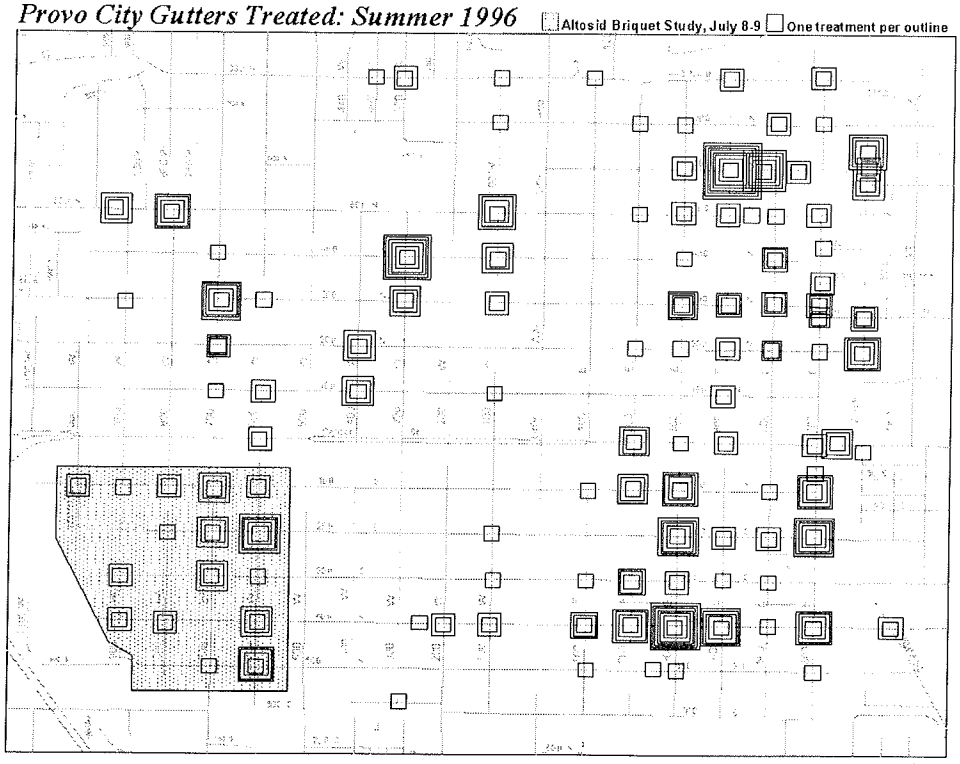
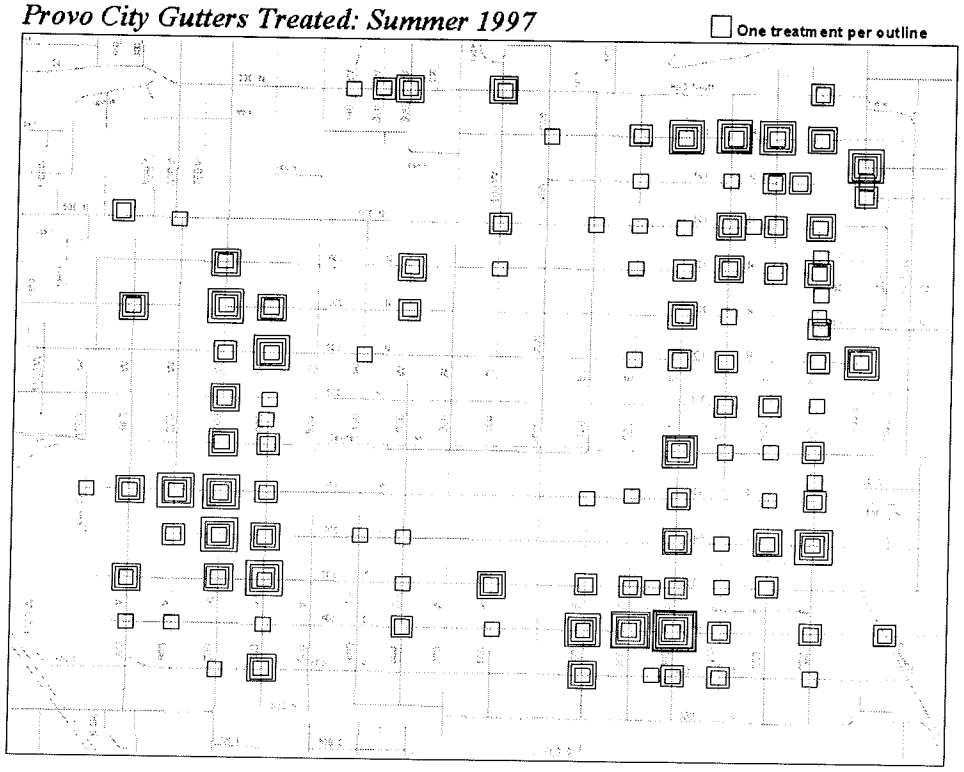


Figure 3. Provo City Gutters.

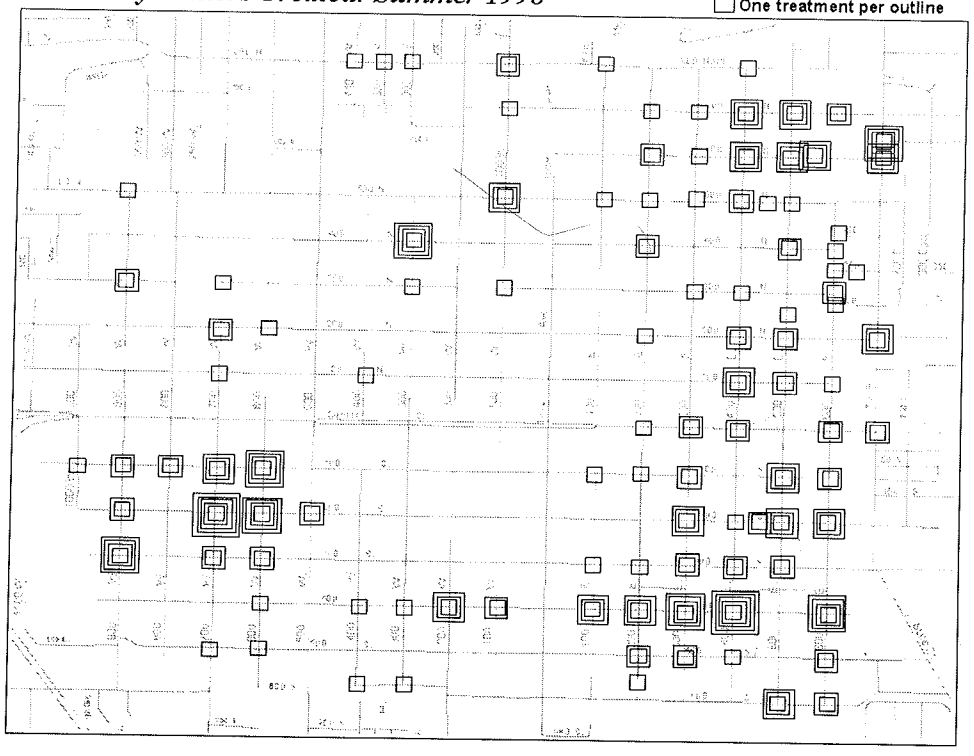




Provo City Gutters Treated: Summer 1997



Provo City Gutters Treated: Summer 1998



THE EVOLUTION OF A MOSQUITO CONTROL PROGRAM

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Abstract

The Benton County Mosquito Control District became operational in 1970. Its formation was in response to numerous cases of WEE and SLE, both equine and human. The District has undergone many changes during its 30 year existence including, managerial, operational funding, boundaries, equipment use and product selection. On an operational level, the most significant change in the program was the increased emphasis on larviciding while de-emphasizing the adulticiding portion of the program. Fogging in urban areas is now accomplished by quiet (Beecomist) fogging machines and low odor products such as Anvil, Biomist and natural pyrethrins. An increased labor force and the introduction of Altosid and Bti formulations into the program have made a marked improvement in the level of control. Bti or duplex mixtures of Bti and Altosid are used in temporary ponds, while the more permanent water bodies are treated with Altosid solid formulations. Altosid XRG and Pellets offer the residual effect that has been absent since the Washington State Department of Ecology forbid organic phosphate applications to surface waters in the state. The District continues to evolve just as any program must in order to survive. In this way, the District is able to offer the tax paying residents the best results with the available resources.

A COMPUTER MODEL OF HOST SEEKING BEHAVIOR

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Abstract

A model of parasite host seeking behavior was constructed in the Logo programming language and using subsumption architecture. In subsumption architecture no central decision making program is provided, but only a series of simple behavior programs, which then operate on top of one another and decide movement to movement who is in charge and what to do next. In this model the two behaviors are moved, which generates random motion, and smell, which checks distance and direction to the host. The "parasite" can move towards a "host", find and circumvent barriers, leave a tracing of it's path for analysis, count the number of moves required for each host search and stop when the host in contacted. The behavior appears lifelike, including surprising behaviors not specifically assigned such as finding ways through barriers, not just around them.

Introduction

How a mosquito finds a blood or nectar meal is not well understood. Certain basics have been known for many years, such as preferences for feeding at certain times of the day and arousal by carbon dioxide. It is likely that the process is a complex variety of behaviors, each with it's own triggers and responses. What arouses the adult female mosquito to move from hiding to seek a host may not be the same stimuli that prompts her to actually land on a host. For example, carbon dioxide has been shown to be excitatory, but does not necessarily induce landing or biting.

There appears to be at least four separate steps involved in obtaining a blood meal: arousal, seeking, selecting, and biting. The basic responses to a given stimulus for each of these behaviors may well be species specific. Given the number of species of mosquito, the number of separate stimuli and behaviors, and the small amount of research devoted to basic biology over control issues, it is not surprising that more is not known concerning mosquito host finding, selection and biting for any given species.

In studies done on other host seeking organisms such as entomopathogenic nematodes or trematode cercariae, there appears to be two basic strategies (Womersley, 1993): ambush behavior where the nematode lies in wait until the host happens by, and hunting behavior where the nematode actively seeks their host. It may be that these strategies are also utilized by some mosquitoes, but I am unaware of any work that verifies these generalizations in any given species of mosquito.

What is of greater interest is how mosquitoes can even carry out such complex actions in a dynamic and shifting

environment with limited neurological capabilities. Tracking down a host in a confusing world would seem to call for a sequence of decision making activities that is beyond the simplified nervous systems of invertebrates such as mosquitoes. Carbon dioxide arrives in plumes and swirls, not as a steady consistent stream of data. Motion comes and goes with activities of the host, colors appear differently in different lights, lactic acid or other chemical cues drift and are mixed by wind current, and even temperature and humidity can vary over a relatively wide range in a short time. Yet, mosquitoes and other parasites seem to successfully find adequate hosts much of the time.

The number of neurons in the entire nervous system cannot be of a sufficient number to facilitate decision making. It is well established by numerous researchers that insects operate at a preprogrammed level. What exactly does that mean? What is the program that is written into their DNA that allows them to successfully make complex decisions in a dynamic world?

Rodney Brooks (1998) has proposed a mechanism for creating robotic intelligence that he calls subsumption architecture. He develops simple electronic systems to operate autonomous mobile robots. He does not try to program in intelligence in the respect of complex decision making capabilities. Instead, the programs call up simple behaviors and then stacks them onto the robot in sequence. The basic program may tell the robot to move randomly while other programs tell the robot to move towards certain things. There is no command center or central decision making set of rules. The robot is left to sort out the demands of conflicting programs simultaneously. The behavior of the robots has proven to be robust and surprisingly lifelike. It was decided to create a computer program to model parasite behavior using the ideas of subsumption architecture to see if it was possible to model host seeking behavior.

Methods and Materials

The program was created in Logo, specifically in the recent iteration of the language called Microworlds. Two objects had to be created on the screen and differentiated to represent parasite and host. In my original version I used color, but geometric shapes or even photographs of a parasite and host could be used. In the figures accompanying this paper I have labeled the agents. The two behaviors identified as essential to finding a host were movement and some way for the designated parasite to determine approximate distance and direction. These were built into the program as two separate programs, each of which could be run separately. **MOVE** caused the parasite to arouse and begin a random motion that consisted of moving one step forward of a random distance and then turning a random number of degrees.

Some other abilities are included in the **MOVE** program, but they are all for the convenience of the research and have nothing to do with this basic random motion behavior just described. One of these was a wait command so that there was slight pause between each move. This was done simply because the movement of the parasite occurred to rapidly for observation without it. The parasite was also instructed to leave a tracing of it's path so the pattern of motion could be visualized and analyzed. Finally, a counter was added so the number of moves to find a parasite could be determined easily and quickly for statistical analysis if desired. Lastly, a barrier was created that could be moved

about on the screen and through which the parasite could not penetrate. This was done to explore the problem solving abilities of the program such as, what would happen if the mosquito hit a barrier such as a window screen.

The second program created was called **SMELL**. **SMELL** simply had the parasite check the distance from the host after each move and report that distance back to the screen. **SMELL** contained an "if...else" command such that, if...the distance was less than the previous distance it would move randomly, or, if the distance were greater than the previous position, the next turn would be "toward" the host in a general and still random amount. The parasite could be moved around on the screen by hand and after each movement it would report the distance to the host. If the distance were greater and you started motion, the first move would be towards the host, etc. Again, one extra command was put into facilitate observation, but does not change the basic behavior. A second "if...else" statement was added that stated if the parasite was within 10 units of the host all programs would cease. Since the host was only 10 units wide this basically represented a "hit".

Finally, a third program was constructed called **FIND** consisting of only two commands or procedures: **MOVE** and **SMELL**. To operate this program the parasite had to first move, then seek, then move again in an endless loop. This description of the program should allow such a program to be constructed in almost any language. Figure 1 is an English version of the programs. I do not include the actual code in this paper since it is language specific.

Results

Figure 2 illustrates the initial screen and one successful find operation. The parasite and host are labeled. The slider in the top right shows the number of moves. The buttons on the bottom left are for ease of use. CG clears the screen for the next trial. Setup repositions the counter to zero. Parasite activity is initiated by the find button. All **FIND** operations are successful, only the time required for the number of moves to be successful changes. Figure 3 illustrates a successful **FIND** operation with a barrier in place but with room around the barrier to negotiate. Part B of figure 3 demonstrates the ability of the parasite to wrap around the screen and penetrate the barrier. Note in these last two illustrations the phenomenon of bouncing off the barrier. This is shown by the lines tracing the parasites path.

When seen in real time, bouncing or penetration happens very quickly as the parasite is repelled or penetrates, and looks extremely like mosquitoes bouncing off the screen. (Am I the only one who has gleefully sat and watched mosquitoes bounce against the screen in their frustrated efforts to reach me, their favorite blood meal?) A surprising observation is the penetration <u>through</u> the screen. After a series of bounces the parasite can sometimes seemingly discover a hole in the screen and suddenly penetrates.

Discussion

Logo is a list processing language created over thirty years ago at MIT for the use of children to give them easy access to computing power. The people involved in it's creation were also pioneers in artificial intelligence work and Logo turns out to be a user friendly version of LISP, a language commonly used in the artificial intelligence community. This language was selected because of it's ease of entry, powerful

extensibility, and the fact that it could be used in more than one capacity. (It is taught in the local public schools for use in science education. The author is involved in this science education project as well.) The Microworlds version of the language was used because of familiarity from the public school project, but also due to it's rich visual interface that makes creating objects on the screen and buttons, sliders and other such accessories extremely easy and fast.

Moving at random maximizes surface area contacted and therefore the opportunity to contact hosts. Many parasites appear to utilize this method of searching, although they do so in a three dimensional world rather than the two dimensions represented here. In this program, distance becomes somewhat analogous to stimulus intensity. It doesn't matter how close the parasite is (how strong the stimulus). The parasite behavior remains the same regardless how close it gets to the host. But, it does require that the stimulus vary in intensity. That is if the stimulus grows weaker (greater distance from the host), the parasite reacts by turning back toward it's previous direction. If the stimulus is the same or stronger (closer to the host), the parasite continues moving at random.

The parasite overcomes barriers with simple persistence combined with random movement. Given enough time and changing direction and distance constantly, a way around the barrier will always be found. The phenomenon of punching through the barrier as if there were a hole requires some explanation. It was a surprise of the program when first observed and is not built into the program intentionally. In fact there is no hole. But if the random number generated for the forward movement is larger than the width of the barrier, the computer identity we call the parasite actually moves to the new position instantly. It does not actually move across the screen dragging a marker behind that leaves a line as it appears, but jumps to it's new position inside the computer. The line is drawn after the fact, although it happens so quickly one can't see it on the screen. If the new position is within the barrier region, the move is disallowed and the "parasite" jumps immediately back. This gives a surprisingly lifelike appearance to the behavior and activity, similar to a parasite being repelled. In the instance when the distance is greater than the barrier the parasite appears to jump through the screen as if finding a hole.

Models and simulations are not organisms, and what is observed may not happen in nature. However, they can test hypothesis that are too difficult, or expensive, to test in other ways, and they may suggest new ideas and explanations for follow up experimentation. In this case, it appears that the mosquito does not need a large set of neurons to negotiate the complex dynamic world of host seeking. Perhaps two preprogrammed behaviors would be sufficient to account for seemingly complex responses to a continuous and constantly changing data flow.

Of course, these two behaviors need not be represented by specific neurons since behavior is usually a function of how neurons are connected, not built into the specific neuron. Thus one neuron can represent many behaviors. Further work is underway to use this model to explore host selection when choices are available, infection rates, swarming behavior, dispersal from central locations, and other phenomenon.

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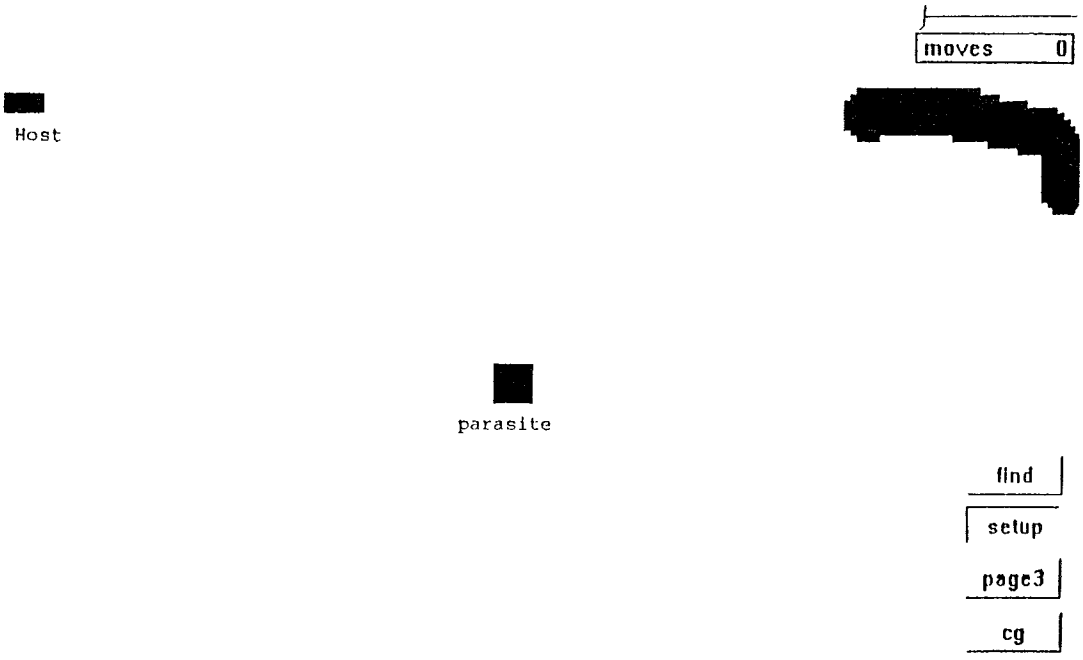
Figure 1. The steps of the three programs, **MOVE**, **SMELL**, and **FIND** written in English.

```
To MOVE
        put the pen down and draw a line when you move
        forward a random number between 1 and 50
        check for barrier
                if barrier go back
                or else continue program
        turn right a random amount between 1 and 359 degrees
        record one movement in the counter
        wait 5
End

To SMELL
        check distance to host
                if same as, or smaller, than previous reading, continue checking
                distance
                or else turn toward host a random amount
        print distance to host
                if less than 10 units from host stop all
                or else continue checking distance
End

To FIND
        MOVE
        SMELL
End
```

Figure 2. A. Illustrates the blank screen before any activity is initiated.



B. Illustrates one successful **FIND** operation with no barriers.

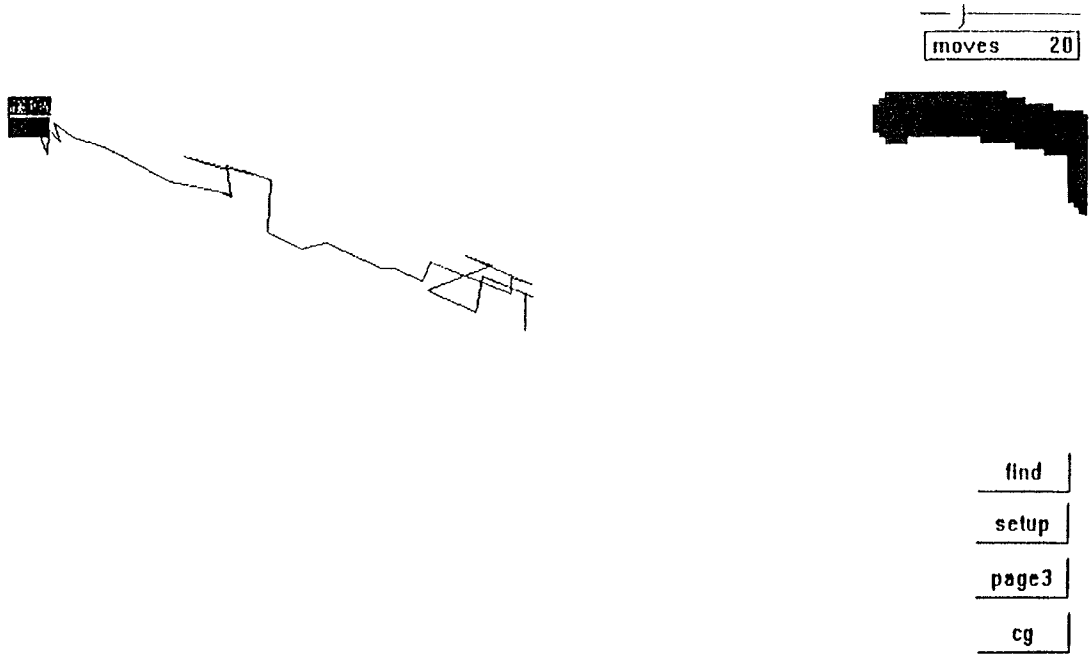
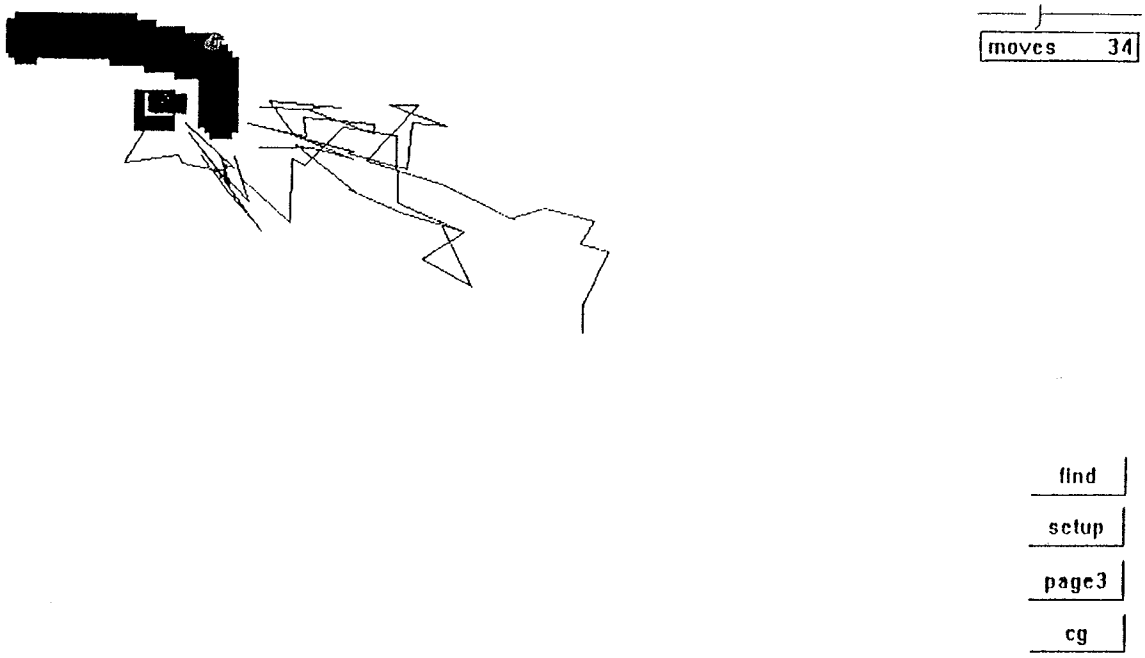
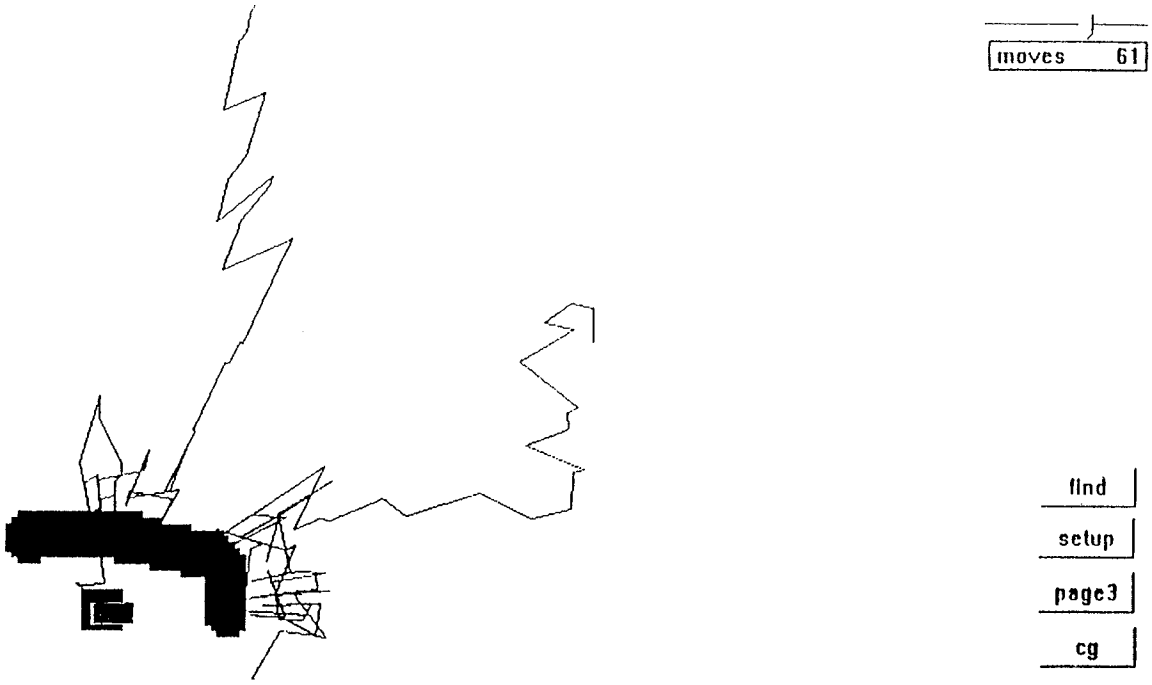


Figure 3. A. Illustrates a successful **FIND** operation by the parasite skirting the edge of the barrier.



B. Illustrates a successful **FIND** operation by the parasite first wrapping around the screen from top to bottom, and finally penetrating the barrier after many probes.



ACARINE PARASITES OF MOSQUITOES IN WEST CENTRAL COLORADO

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Abstract

Over three thousand adult female mosquitoes were surveyed in 1996, and 6000 in 1999, for acarine parasites. In 1996 two genera of mites were identified (*Arrenurus* and *Thyas*) on four species of host (*Culex, Culiseta, Aedes vexans* and *A. idahoensis*) with infestation rates between one and seven mites per mosquito. Overall 0.005% of the mosquitoes harbored mites in 1996 and 0.004% in 1999. Black flies were also reported infested in 1999 but data from this year is not yet tabulated. This is the first report of mosquito mites in Colorado and the first report of *Thyas* on *Aedes idahoensis.*

The first record of a mite occurring on a mosquito as a parasite was by DeGeer in 1778. He named the mite *Trombidium culicis.* The host mosquito was not identified in this early report, as mosquitoes were mostly ignored taxonomically until the 1900's when they were shown to be involved in disease transmission (Mullin 1975). In the early part of this century there were numerous reports of mites on Anopheline mosquitoes in various regions of Africa. Over the last century other research has shown that while mites probably do effect fecundity and longevity of the host they do not appear to be a significant pathogen. They are almost surely an indicator of nulliparity in females since the mites are immature stages of aquatic mites, probably picked up during ova position. However, the whole relationship is poorly documented and understood.

In the United States recent work has been done by Gary Mullin (1974, 1975, 1976, 1977). According to his research the following species have been reported as harboring acarine parasites: *Aedes, Anopheles, Coquillettidia, Culex, Culiseta, Ficalbia, Hodgesia, Mansonia, Psorophora, Toxorhynchites, Uranotaenia,* and *Wyoemyia.* Geographically, there have been 241 reports of mites on mosquitoes; 103 from North America, 16 from South America, 50 from Europe, 22 from Asia, 2 from the Middle East and 48 from Africa. There have been 87 from the United States alone, but the distribution of this association has not been well studied.

In 1996, 3,089 adult female mosquitoes were trapped in carbon dioxide baited, CDC light traps, identified and examined for mites using a Bausch and Lomb dissecting microscope. Infected individuals were preserved in alcohol with the host and sent to Dr. Gary Mullins of Auburn University for identification. These mites were collected along the Colorado River in the area of Grand Junction, Colorado, just west of the confluence of the Colorado and Gunnison Rivers. This area is incorporated into the Redlands Mosquito Control District and includes a few small

farms, numerous residential subdivisions, empty canyons receiving irrigation runoff, and flood plain wet lands with wild animals and plants typical of the region such as cottonwoods. The elevation is approximately 4,500 feet above sea level and it is approximately 39 degrees north latitude.

Two genera were identified, *Thyas* and *Arrenurus.* All mites were immature stages of free-living aquatic mites and some could not be identified to species for that reason. Two *Culex tarsalis* were found infested with *Arrenurus*, one harboring 5 mites and the other 4. This was 0.29% of the total *Culex tarsalis* population. One *Culiseta inornata* carried 1 *Arrenurus* mite. Five *Aedes vexans* had between 1 and 2 mites each of *Thyas barbigera* (0.23% of the *Aedes vexans* population). Six *Aedes idahoensis* had mites of the genus *Thyas barbigera*, ranging from one to four specimens per host. This was 0.37% of the *Aedes idahoensis* population. In total, 14 mosquitoes were parasitized, for a total of 0.005% of the adult female population sampled.

In 1999, another study was done which sampled over 6,000 adult female mosquitoes trapped in carbon dioxide baited CDC light traps from the same area as sampled in 1996, and an additional area of about the same size just west of the original study site. These specimens are still being processed and identified. But, there were 21 mosquitoes with mites, or 0.004% of the 6,000 mosquitoes examined. In 1999, it was also noted that an extremely large number of black flies caught in the traps were harboring mites as well. These are also being mounted, identified and counted and will be the subject of a later report.

Obviously, there are differences in host specificity between the two genera of mites; *Arrenurus* found exclusively on *Culex* and *Culiseta* while *Thyas barbigera* was found only on *Aedes.* It seems that this is most likely due to the different types of breeding sites favored by the different genera of host. It is known that *Arrenurus* prefers warm, organic water which is also favored by *Culex. Thyas* has been reported to favor springs, fresh ponds and seepage areas with cold, clear water. This might be similar to the flooded fields that *Aedes* favors in the west. We believe this is the first report of mites parasitic on mosquitoes from the state of Colorado. Also, this is the first report of *Aedes idahoensis* being parasitized by *Thyas barbigera.*

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G. J. SPENCER ON INSECTOPHOBIA

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In 1957, Professor G. J. Spencer, University of British Columbia, Vancouver, British Columbia, Canada, said that insectophobia starts from an actual serious infestation or a series of attacks by insects, generally blood-sucking insects (Spencer 1957). The horror and disgust of the infestation persists long after the insects have disappeared. Some people are afraid of crawling things like spiders, scorpions, centipedes and snakes and the fear intensifies into a phobia. I want to cite some of Spencer's examples and some of mine.

A junk dealer complained of invisible flying insects biting at night causing bumps and itching all over his body. As he talked, he whacked his face, "See, one is biting me now!" He opened his shirt to show bite marks on his chest which was unblemished but coated heavily with a yellow ointment that stained his undershirt. Spencer showed him under the stereoscope that the specimens he brought were all trash: small particles of coal, seeds and hairs from his chest. The hallucinations started some months ago when he removed a junk pile from some woods and was attacked by black flies or biting midges.

Spencer received a box of "no-see-ums" which are biting midges but the box was empty.

A lady had ointment on her skin to keep mites away. She sent some trash which she called mites but Spencer found no trace of mites. She boiled clothes that were in contact with her body, bathed regularly and disinfected her house to no avail. She said her neighbor who was similarly infested was treated by a dermatologist for 6 weeks with no results.

Conversely, I get frequent calls and letters from ladies who complain that doctors and dermatologists think they are crazy. I have to convince them that they are not crazy, that the constant itching and black streaks on their skin are due to scabies. If it's dog scabies, it will be gone in 10 days but if it's human scabies, wash bedding daily, bathe daily with sulfur soap or antibacterial soap, use rubbing alcohol, followed by baby oil and when the skin is dry, use a pyrethrum powder. Don't ever use Lindane which forces the mites to burrow deeper into the skin. Some dermatologists will recommend Lindane once but when itching continues, patients often suggest I tell their dermatologist to increase the dose so I call and tell them not to use Lindane at all since it is toxic to humans. One insistent secretary obtained pure Lindane from a Nursery and mixed it into a salve for her use. She told me to tell others so troubled that she would give them some but I refused and told her not to use it. She quit work and I never heard why or what happened to her.

An elderly man said he was infested with mites but all the specimens he brought were dried serum. He said he had already done everything I recommended above for scabies but was still infested. He stated that his wife was also infested. He claimed the mites burrowed so deep into his balding scalp that the only way he could recover them was to scrape hard with a wire comb. He did and produced only particles of dried blood. His scalp was streaked with scars and scabs from the wire comb. I told him to get rid of the wire comb which was causing the injury, that he did not have a problem with mites. He asked where he could go for help so I suggested the University Hospital but said that if he had an insect or mite problem, they would send him back to me. He asked if anyone could help him and I said a psychiatrist might help since it was all in his mind. I suggested he could continue to bathe with sulfur soap or antibacterial soap and use rubbing alcohol and baby oil but he did not need pyrethrum as he did not have mites.

Most callers since the hobo spider abundance in 1993 have asked, "What's this spider and is it poisonous?" There are only 2 venomous spiders in Utah: 1. The black widow for which the venomous female is black with a ventral red hour-glass but males and immatures are tan with longitudinal white stripes. 2. The hobo spider for which the venomous male has a thorax with 2 dark longitudinal stripes with an intervening clear area containing a fine pencil mark and the gray abdomen has 3 faint white crescent-shaped marks; the female is similarly marked but has a reddish tinge. If you are concerned, sprinkle pyrethrum powder along the base of walls and doors and where you see funnel-shaped webs or rubbish on floors. Hobo spiders do not climb.

A University of Utah workman had a black and blue mark on his arm the size of a baseball. He said he was cleaning his garage and was bitten by a hobo spider that was under some rubbish. He did not save the spider but the bite mark was typical so the University Hospital said they would treat him. I saw him about 2 weeks later and asked what the hospital did. He said that he did not go; his wife reminded him that they did not have insurance so it was cheaper to die. He was pretty sick but recovered.

A lawyer said that he represented a truck driver from Texas who was suing the State of Utah because he was bitten by a brown recluse spider while driving through Utah. Would I testify? Yes, that the brown recluse is not found in Utah so the truck driver was bitten in New Mexico or Texas and the lawyer had no case. I did not tell him that the bite of the hobo spider is very similar to that of the brown recluse and most bites that have been blamed on the brown recluse in the last 20 years have actually been due to the hobo spider (Roe 1993). Why volunteer information to a lawyer?

An elderly lady called and said that she was blind and deaf but every time she sat in her favorite chair, she was covered with spiders; she could not see them but she knew they were there. Dr. Lewis T. Nielsen passed by the laboratory and said, "Send her to a psychiatrist!" I answered, "No, we have to treat imaginary as well as real infestation and pyrethrum does both." I told her to sprinkle her chair with pyrethrum powder prior to sitting down each time; it would not harm her or her cats and she would have no more trouble.

I received some "frozen spiders" that a lady found in her garden one cold morning but I sent them back with a note

to give these rubber spiders to her child or grandchild.

The local director of a discount drug store brought in some canned Thai shrimp containing bugs. He was afraid of being sued for poisoning people with Thai bugs. Since the shrimp were recanned in California, he hoped the bugs were local ones. They looked like Thai water bugs and they were confirmed as such by Dan Polemus, graduate student of bugs so there was a possibility of a law suit. There are 2 species of Thai water bugs which differ in size; one is extremely delicious cooked in soy sauce and the other is deadly poisonous. I don't know which size is the good one so I always trusted the villagers but nearly every week, there is a story in the Thai papers about a villager who ate the wrong species of water bug and died a horrible death.

A lady brought in a vacuum bag of sweepings containing bird lice that a veterinarian suggested were from her cat. She said that lice were all over the house and were biting her constantly but the bag contained no lice, fleas or mites. I told her to sprinkle pyrethrum powder on her cat and on the floor and chairs.

A 70-year old pensioner suffered insect attacks for many years. He claimed he was bitten at night, all over his body, but mainly on the head, neck and ears causing red blotches and irritation. He pointed to red marks on his face but there was not a single mark and the skin was smooth. He pleaded for help so Spencer sent him to a psychiatrist.

A young lady who modeled furs with 22 other girls in Hotel Vancouver, British Columbia, Canada gave Spencer some insects which she said burrowed into her skin but her insects were minute fragments of fur and rolls of epithelium scratched by long fingernails. She produced a big bag of specimens so Spencer went down the hall to get the stereoscope and when he returned, she had removed all her clothes. She was sitting in a chair rubbing her back where she said there were bumps, about an inch long, that itched. Spencer said, "My God women" and hastily shut the door so students would not misunderstand. He suggested that she tell the fur dealer to brush the furs very thoroughly before they were modeled by the girls because tiny bits of fur got into their skin.

Morrill (1994) noted that nudists have a significantly lower rate of Lyme disease than the general population because ticks do not like sunlight. They get on the nudes but leave quickly, so for protection from ticks and Lyme disease, go nude and stay in sunlight.

Spencer's first case was of book lice. A lady was talking and laughing, "Lice are all over the house; they come out of the basement and are everywhere." Spencer was laughing with her so his supervisor took over and said later, "Don't you know what hysterics are? These things have to be taken extremely seriously." Spencer had 8 more cases of acute distress from book lice ranging from hysteria to painful hallucinations. One case was from a farmhouse and 2 were from upholstered furniture. One case came from a damp wall in a kitchen and another from an insurance office where 22 women clerks threatened to go on strike because lice were pouring out of moldy insurance records kept in a dark, damp room. The sixth case was from books in a doctor's study from which lice were spreading to the rest of the house so Spencer said, "You will have to take this seriously and reassure your wife because otherwise she

will have hysterics" and the doctor replied, "My God man, it's me!" The seventh case was reported by a pest control operator who could find no insects after he treated the house for a few Book Lice. The owner was obsessed with the idea that all bits of trash in the house such as sand, dust and cotton fibers were alive when he examined them under his microscope and that these minute objects were biting everybody. He smeared his 2 children with benzoate ointment to control scabies. To please the owner, Spencer suggested spraying everything with an aromatic solution which the operator did and pocketed his fee without giving Spencer a percentage. The eighth case was an elderly couple who moved into a new house in which a heavy rain soon percolated through the new roof soaking everything and producing a musty smell. They were infested with several imaginary insects ranging from fleas, mites, moths to silver fish. They had the house fumigated but still believed the house to be infested. They sent specimens to Spencer which were all trash with no trace of insects. The problem probably started with book lice in the damp house.

Spencer sent many cases to psychiatrists but I prefer to treat all with pyrethrum: powder for crawling insects and spiders, aerosol for flying insects and water soluble mixed into a paste and painted on wood for carpenter ants, termites and powder post beetles. Pyrethrum does not harm adults, children or pets and if you think it works, it does.

Insecticides for dog and cat fleas work perfectly in Utah since the fleas cannot survive here. Dog and cat fleas are cosmopolitan except in arid areas like Utah. When people ask what to do about dog and cat fleas, I tell them they just arrived from California or the Eastern U.S. so wait for 10 days. Timing is everything! One summer the Insect Control Officer at Dugway said people were complaining about mosquitoes so he wondered if spraying the next day would be a good idea! I said, "Why? The mosquitoes are only *Aedes nigromaculis* and *Psorophora signipennis*, temporary breeders that emerge only after several days of rain have submerged eggs along normally dry stream beds. They feed, mate, lay eggs in drying mud and are gone in 10 days. Tomorrow makes 10 days and they will be gone whether you spray or not ." He said, "Perfect , I'll fog the area thoroughly early tomorrow so when people come to work, there will not be any mosquitoes and everyone will pat me on the back for doing such a good job!"

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