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Edited By

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MERITORIOUS SERVICE AWARD

The Meritorious Service Award is presented to persons who have furthered mosquito abatement efforts in Utah in a manner far exceeding what was expected of them. The Utah Mosquito Abatement Association first presented this award in 1970. The 1993 awardee and 22nd recipient of this award is the late **Gerald Purdy.**

Gerald Purdy represented Kaysville on the Davis County Mosquito Abatement District Board of Trustees from 1970 to 1990. During these years he also served as a city councilman and as mayor of Kaysville. In 1991, he began a term as Davis County Commissioner and continued his service on the board of Trustees as the representative of the county commission, until his untimely death in 1993.

During those 23 years he demonstrated sound judgment and common sense, and became, by every measure, the accepted leader of the board. He gained a knowledge of mosquito control practices and policies over the years that made him a well-informed board member. He used that knowledge and leadership to help guide the Board of Trustees to make some changes in the district that have led to a stronger, more effective and environmentally sensitive mosquito control program.

Jerry enjoyed a good story. At the conclusion of every board meeting he would ask who had a story or joke to tell. Invariably everyone left a little more light-hearted than when they came.

Jerry had a sense of purpose. That purpose was to make his community a better place to live. He was devoted to serving and serving well. The Davis County Mosquito Abatement District and the citizens of Davis county were blessed to be the recipients of that service.

MOSQUITONET: A BETTER WAY TO COMMUNICATE

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INTRODUCTION

Since January 1, 1992, an experimental electronic information service for mosquito control workers in California has been in place. In the year and one-half it has been in existence we have learned much about electronic communication, and the system has steadily grown in terms of users and in terms of improved service. The system is called "MosquitoNet".

NEED FOR ELECTRONIC DATA SYSTEMS

MosquitoNet is based on the premise that electronic information systems can (1) save time; and (2) allow one to be informed with greater efficiency. For those of you who do not believe that electronic communication can save time, I ask you to consider the amount of time you spend every week responding to call-back slips and listening to answering machines, busy signals, voice mail ("if you have a touch-tone phone press '1', if you know the extension, press '2'...") and secretaries' promises to have the boss call back. The problem is that those are all forms of synchronous communication. Both the caller and the person called must be present simultaneously. E-mail, such as the system on MosquitoNet, is "asynchronous". You turn your computer on in the morning, read your messages, reply to them, and write any messages you wish to write, and you are finished, and in a fraction of the time it takes to listen to busy signals.

Timely access to information is probably the more important consideration. In the area of mosquito biology and control, as in all technology - based enterprises, information changes rapidly and constantly. Pesticide label information, vector-borne disease summaries, and endangered species lists are examples of constantly changing information. It is impractical to maintain data such as these using conventional print media.

TECHNICAL DESCRIPTION

MosquitoNet runs as an electronic bulletin board, using a commercial bulletin board software product known as the Major BBS (Gallacticom, Inc., Fort Lauderdale, Florida). The host computer is a Zeos 486-33 desktop computer with a 250 MB hard disk and 8 MB of memory. The system is configured to permit simultaneous access by 4 users. It includes a number of enhancement modules, some of which are described below.

ORGANIZATION OF MOSQUITONET

The system is operated jointly by the University of California, the California Mosquito and Vector Control Association, and the California Department of Health Services. The system has a part-time SYSOP (System Operator), John Gimping, who is also a graduate student in entomology at UC Davis. John oversees the day-to-day operation of the system. Policies are established by the CMVCA Computer Committee.

Functionally, the system is an enhanced E-mail system, with private E-mail (called E-mail) and public E-mail (called subject areas, or forums). The E-mail approach is unusual in that files can be attached to E-mail messages, and the files, which can be of any size, can be downloaded to a user's computer. Both the subject area (forum) messages and the attached files can be searched by key-word because of a search and retrieve capability of the system.

FORUMS

There are ten forums: Calendar, Chemical, Diseases, IGR's, Laws, Management, News, Research, Species, and Wetlands. The content of most of the forums are self-evident, but one or two require explanation. Species addresses the subject of endangered species. News is a general forum containing information about the system. Each forum has a forum operator, and in most instances that operator is a member of the CMVCA Computer Committee and also a member of another CMVCA Committee related to the subject of the forum. David Brown, for example, is a member of the Computer Committee and the Chemical Control Committee, and is the Forum Operator for the Chemical Control Forum. Within each forum are messages and attached files placed there by the Forum Operator. There are also public messages placed there by users.

The value of the forums is greatly enhanced by the search and retrieve capability mentioned previously. For example in the "Laws" forum, the CMVCA Legislative Analyst places weekly updates in the forum for all pending legislation of interest to mosquito workers. It is possible to search this large file by any keyword, such as a bill's sponsor, to find a particular piece of legislation.

ADDITIONAL FEATURES

MosquitoNet has a number of features which illustrate the advances that are being made in electronic communication. The Search and Retrieve capability has already been described. Full-screen editing of messages is also provided, as well as "hot keys" which enable the user to go directly to various parts of the system. Perhaps the most exciting new development is the availability of a new graphic interface for users having fast computers with color monitors and mice. The interface is available for downloading (free) and when it is installed the user can click on icons and various buttons to navigate through the system with the mouse and use pull-down menus. Users who like character-based systems will want to continue to use the existing interface, but those used to using Macs and Microsoft's Windows will like the new interface.

Two features of the system involve the ability to access other features and systems through MosquitoNet. Dialout allows access to systems such as University of California's Melvyl library catalog system.

Doors allows access to a separate computer attached to the host computer. We can run standard DOS programs such as dBaseIV, thus allowing users access to large and searchable databases. We plan to maintain records of the Pesticide Applicator Continuing Education program on this computer, so that one can dial up and find out the status of his or her training credits.

THE FUTURE

There are presently just over 100 registered users for MosquitoNet. About 90% of the users are from California. The system has a capability for handling many more users even with the present 4-user configuration. If needed, the system could be expanded to accommodate 64 simultaneous users. Eventually, the system will need to be linked into the Internet. Users outside the local calling area will not want to run up long-distance telephone charges, although at present that is the only cost to the user. The graphical interface is an improvement in the eyes of some people, but even that is in an early stage of development, and will be improved in the coming months.

If you would like to see a demonstration of MosquitoNet, give us a call (on your modem) at 916-752-5484. We are always on hand at 916-752-5833 to help with technical questions.

NEW REPELLENT COMPOUND SHOWS PROMISE AGAINST BITING MIDGES*

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ABSTRACT

Repellent field trials using human volunteers were conducted at Stansbury Island, Great Salt Lake, Utah, to compare the efficacy of four candidate repellent compounds against ceratopogonid midges of the genus *Leptoconops. Leptoconops* at Stansbury Island were very abundant, but their biting activity was closely related to weather conditions at the time of collections. In a direct comparison of efficacy of repellent candidates AI-37220 and DEET, the former outperformed the latter.

KEYWORDS: repellents, DEET, *Leptoconops.*

INTRODUCTION

Biting midges that most often attack humans fall into two genera, *Leptoconops* and *Culicoides.* These pests are not commonly associated with transmission of human pathogens, but they are nuisance biters and achieve such high populations that they can severely restrict efficient accomplishment of outdoor duties. The fact that soldiers have adopted a descriptive vocabulary for these biting flies (e.g., no-see-ums, screaming mimis, teeth with wings) reflects the severity of the problem. *Leptoconops* are abundant during the spring along the shores of the Great Salt Lake and elsewhere in the Salt Lake Valley (Rees and Winget, 1970, Rees et al., 1971). The larvae develop in vast areas of briny oolitic sand that border the lake. As a result, this area provides a convenient location for field testing repellents.

The Department of Entomology, Walter Reed Army Institute of Research, is specifically funded for advanced development of an improved repellent product that protects against biting midges and outperforms the 34%-DEET extended-duration repellent formulation (EDRF) currently in the Army inventory. To

* The views of the authors do not purport to represent the views of the Department of the Army or of the Department of Defense. For the protection of human subjects, the investigators adhered to policies of applicable Federal Law 4SCFR46.

that end, this field study was designed to compare the inherent repellency of four compounds against ceratopogonid midges of the genus *Leptoconops.*

METHODS AND MATERIALS

Prior to actual conduct of repellent trials, a two-day presurvey was conducted to find a suitable location and to determine the best way to expose volunteers to the *Leptoconops.* The western shore of Stansbury Island in the Great Salt Lake (Tooele County, 37 miles NW of Tooele Army Depot), was selected as the trial site based on abundant flies found there.

Our original plan was to place the repellent material on forearms, adjusting the quantity to the size of the arm in order to achieve 400 micrograms/cm^2 (Coleman et al. 1993). However, during the presurvey, it was found that most of the biting occurs on the ears, not on the arms. In order to modify the procedure to test the repellents on the ears, the long and short dimensions of the ear were measured on each volunteer and the product multiplied by 2 to approximate the ear surface area.

Four repellent products were tested (Coleman et al. 1993). Recent work by the U.S. Department of Agriculture, the U.S. Army Environmental Hygiene Agency, and by Coulston International Inc. resulted in the identification of three compounds with repellent activity that are approved for testing on human volunteers. Two of these compounds, AI-37220, and AI-32765, are structurally related to the standard Army repellent, DEET. The third is a proprietary product consisting of bicyclic lactones and is designated CIC-4. The fourth compound tested was DEET.

There were two levels of treatment: (1) the type of repellent, and (2) time between application and exposure to fly bites. Ethanol solutions of the four test repellents (12.5%) and ethanol alone were applied to the ear at a dosage equal to 400 micrograms/cm^2 (American Society for Testing and Materials 1983; Coleman et al. 1993). The head was then covered with a nylon stocking with the ears protruding from small holes. Biting rates on the ears were recorded at 0, 2, 4, 6, and 8 hours after application. It was suspected that populations would vary with time of day, hence applications of repellents were timed so that each delay after application occurred once at 1000, 1200, 1400, 1600 and 1800 hours. For example, on one day repellents were applied at 0200, then tested at 1000 following an 8-hour delay. Repellents could then be washed off with ethanol and new applications made for tests at 1200 (0 hr.), 1400 (2 hr), 1600 (4 hr), and 1800 (6 hr).

The five treatments were rotated through all volunteers in random order. Two volunteers were also designated as controls (untreated) for each day of the study;

the order of this assignment was also random. Control individuals made 15-minute collections on the hour and half hour from sunrise until sunset, with concurrent measurements of dry and wet bulb temperatures, wind speed, light level, and sky conditions. This procedure was repeated on 9 days of the study.

Flies in the process of biting (judged by pain and by posture of the fly) were collected from the ears for 15 minutes or until 20 flies had bitten, whichever came first. If 20 or more were collected before a full 15-minute period had elapsed, the time was recorded and the data normalized to the number of flies that would have bitten during the complete interval. Flies were collected by a second person whose head was protected by a net. They were collected with mouth aspirators, transferred to permethrin-treated cartons, which quickly immobilized the insects, then counted and preserved in 80% ethanol in an individual vial for each collection for later identification at the Walter Reed Biosystematics Unit. Great care was taken to insure accurate identification, since it was possible that more than one species was present. To support identification, male *Leptoconops* were collected from swarms and emerging from pupae in sand.

RESULTS

All *Leptoconops* collected during these trials were of one species, *Leptoconops americanus* Carter. *Leptoconops* at Stansbury Island were very abundant, but their biting activity was closely related to weather conditions at the time of collections. During our brief visit to the area, temperatures ranged widely from a day-time low of 5°C to a day-time high of 29°C. Few flies bit at temperatures below 12°C (54°F) and numbers decreased at temperatures above 25°C (77°F) (Figure 1). Wind also influenced the activity of the flies, the number of bites decreasing when wind gusted above 6 mph at lower temperatures. Cloudiness and rain at the time of collection inhibited activity, but especially during periods of lower temperature. On some days, there was evidence of a minor peak of biting activity in late morning and a major peak in late afternoon (Figure 2).

The trials of repellents in ethanol showed that AI-37220 maintained 95% effectiveness four hours after application which was better than the other three repellents. With the exception of CIC-4, all repellent candidates provided greater than 95% reduction in bites for at least two hours (Table 1). The effectiveness of both CIC-4 and AI-32765 diminished to 71% after 4 hours and to less than 50% after eight hours.

Two separate statistical analyses indicated that AI-37220 outperformed the other repellent candidates. Analysis of variance of the number of bites for all trials resulted in a significant difference between repellents ($P=0.03$), with AI-37220 more effective than AI-32765 and CIC-4 (Table 2). In contrast, reduction in biting attributable to treatment with DEET was not significantly different from reductions attributable to the other repellents. Although the analysis of variance did not show a significant difference between DEET and AI-37220, in a direct comparison between these two repellent treatments with a paired t-test (paired by trial), AI-37220 outperformed DEET ($P=0.04$) (Figure 3).

DISCUSSION

Leptoconops biting midges at Stansbury Island were sufficiently numerous to create a serious operational threat to unprotected troops. Biting rates as high as 840 bites per hour were recorded on the ears alone. The bites of these flies are painful when inflicted and create an inflamed induration with a central petechia, which in 3 of 6 volunteers persisted with itching and swollen lymph nodes for several days. Furthermore, these flies have the habit of crawling about the skin before biting, which is also extremely annoying.

This study provided a clear demonstration of the value of understanding the biology of biting arthropods for support of military operations. Stansbury Island would be a very challenging environment for outdoor duties because of biting flies, yet a survey conducted at the wrong time would have suggested only a minor problem. Biting activity is heavily influenced by weather conditions at the time of collection, so that a survey during a cool, windy, or rainy day might leave the impression that biting pressure was low, even though hundreds of bites per hour could be expected the next day or even later on the same day.

Of the repellent candidates tested, AI-37220 performed the best, providing 95% protection for at least four hours. DEET and AI-32765 provided two hours less protection and CIC-4 was 95% effective only immediately after application. Based on the Stansbury Island study alone, we would recommend further development of AI-37220.

ACKNOWLEDGMENTS

The authors wish to thank Dr. Sammie Dickson and Mr. Bob Brand, managers of the Salt Lake City and Tooele Valley Mosquito Abatement Districts, respectively, for their cooperation and generous support. Both managers kept us informed as to weather conditions and earliest fly emergence, significantly facilitating accomplishment of our mission.

REFERENCES CITED

- Coleman, R. E., L. L. Robert, L. A. Roberts, J. A. Glass, D. C. Seeley, A. Laughinghouse, P.V. Perkins and R. A. Wirtz. 1993. Laboratory evaluation of repellents against four anopheline mosquitoes (Diptera: Culicidae) and two phlebotomine sand flies (Diptera: Psychodidae). J. Med. Entomol. 30:499-502.

- ASTMH (American Society for Testing and Materials). 1983. Standard E951-83, Annual book of ASTM standards, American Society for Testing and Materials, Philadelphia, PA.
- Rees, D. M., and R. N. Winget. 1970. Current investigations in Utah of the biting gnat *Leptoconops kerteszi.* Mosquito News 30:121-127.

Table 1. Reduction in the number of bites received by repellent-treated volunteers as a percentage of the mean number of bites received by untreated (control) volunteers. Based on four replicates at 0 hours and 5 replicates at 2, 4, 6, and 8 hours. The mean number of bites on ears of control individuals for each interval after application were 30 at 0 hours, 37 at 2 hours, 53 at 4 hours, 47 at 6 hours and 47 at 8 hours.

Repellent	0 hours	2 hours	4 hours	6 hours	8 hours
DEET	98	96	80	68	69
CIC-4	95	92	71	60	47
AI-37220	100	99	97	77	74
AI-32765	99	98	71	36	45

Table 2. Results of comparative analysis on the number of bites received by all treatments for all trials using the Student-Newman-Keul's test*. Means followed by different letters are significantly different.

Repellent	Mean	Std. Dev.	SNK*
CIC-4	16	27	a
AI-32765	15	23	a
DEET	10	18	ab
AI-37220	6	12	b

DF = 3/72; $F = 31$; $P = 0.03$

Figure 1. Biting activity of *Leptoconops americanus* in relation to dry-bulb temperature at Stansbury Island, Great Salt Lake, Utah.

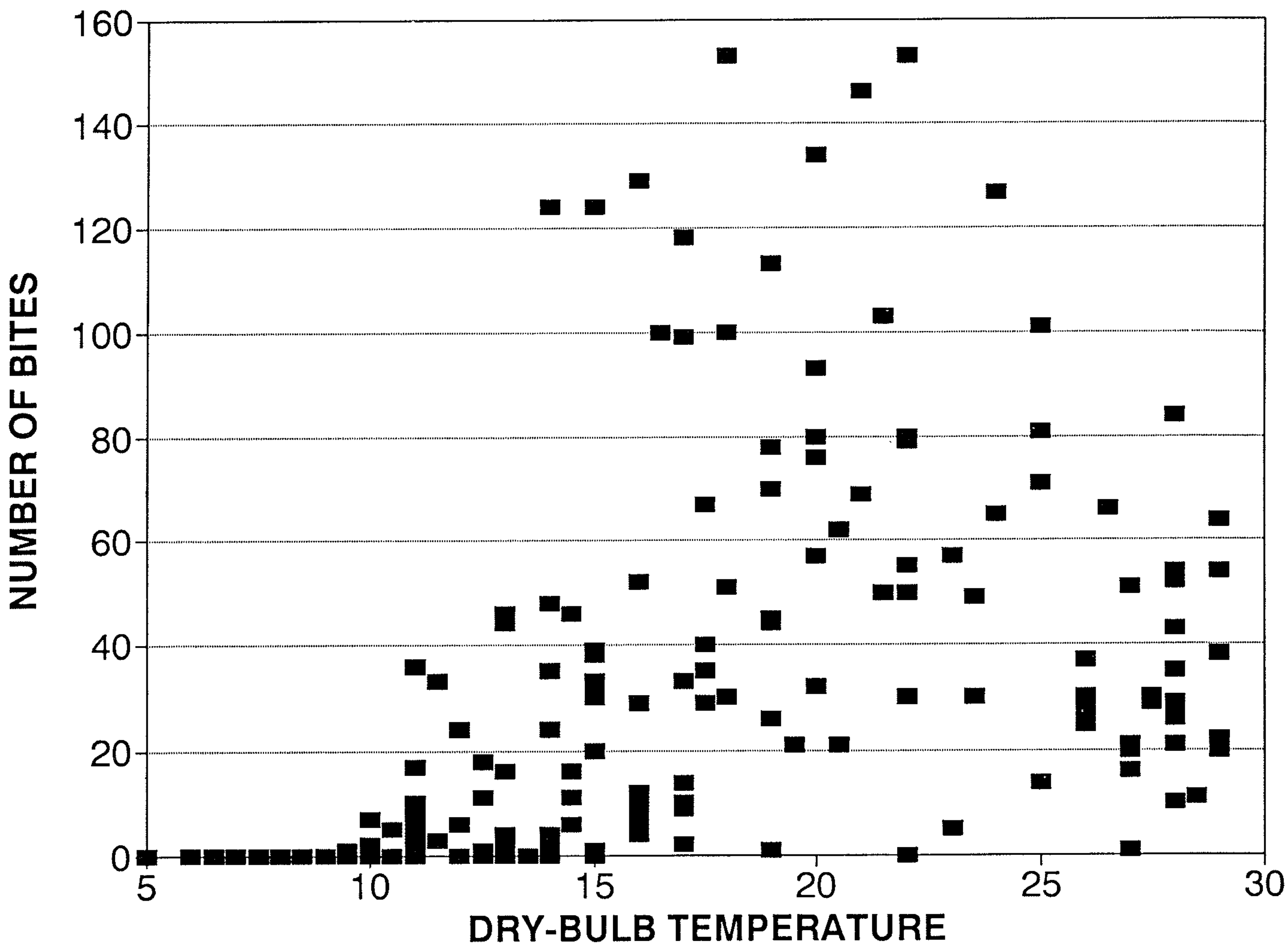


Figure 2. Temporal distribution of diurnal biting activity of *Leptoconops americanus* at Stansbury Island, Utah.

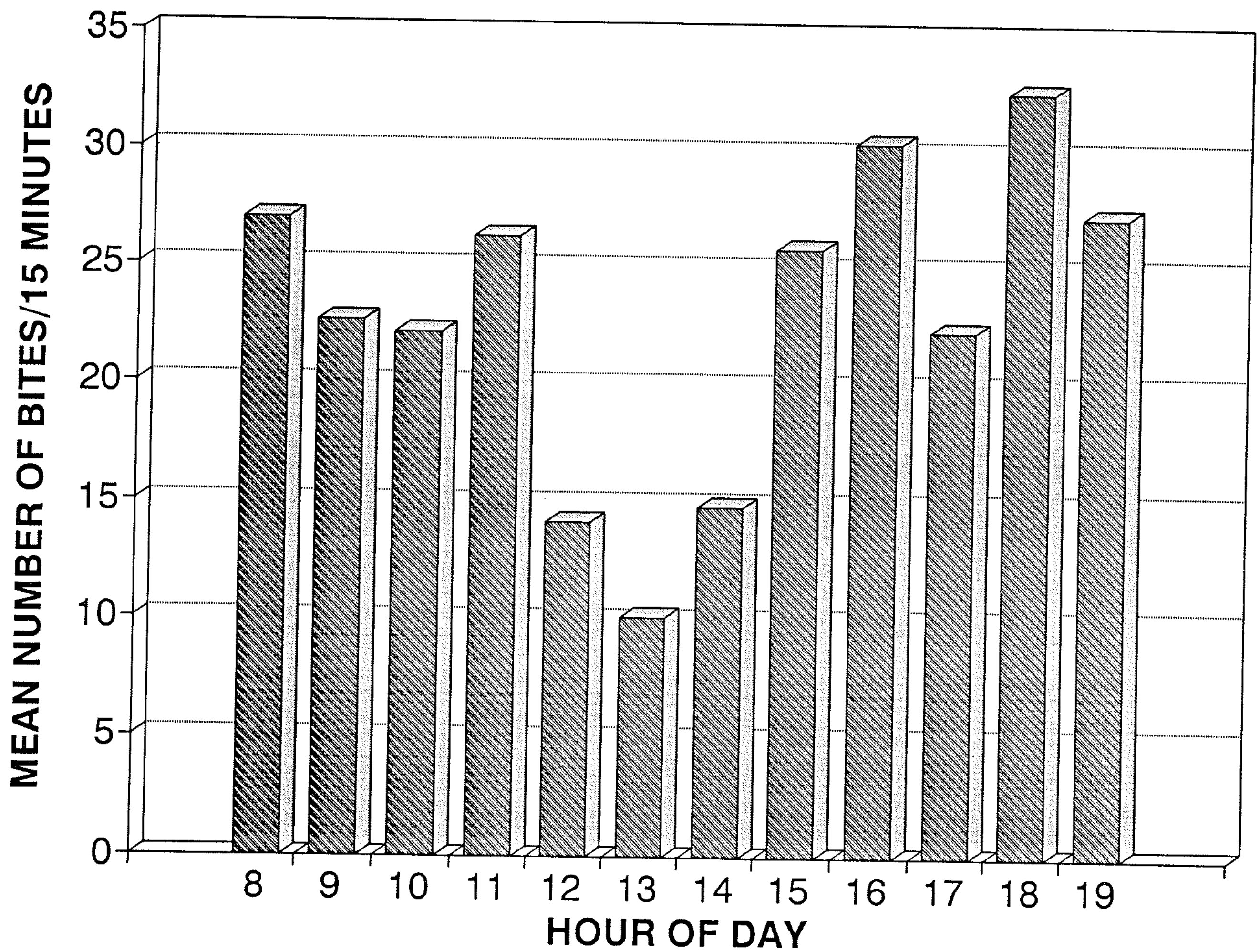
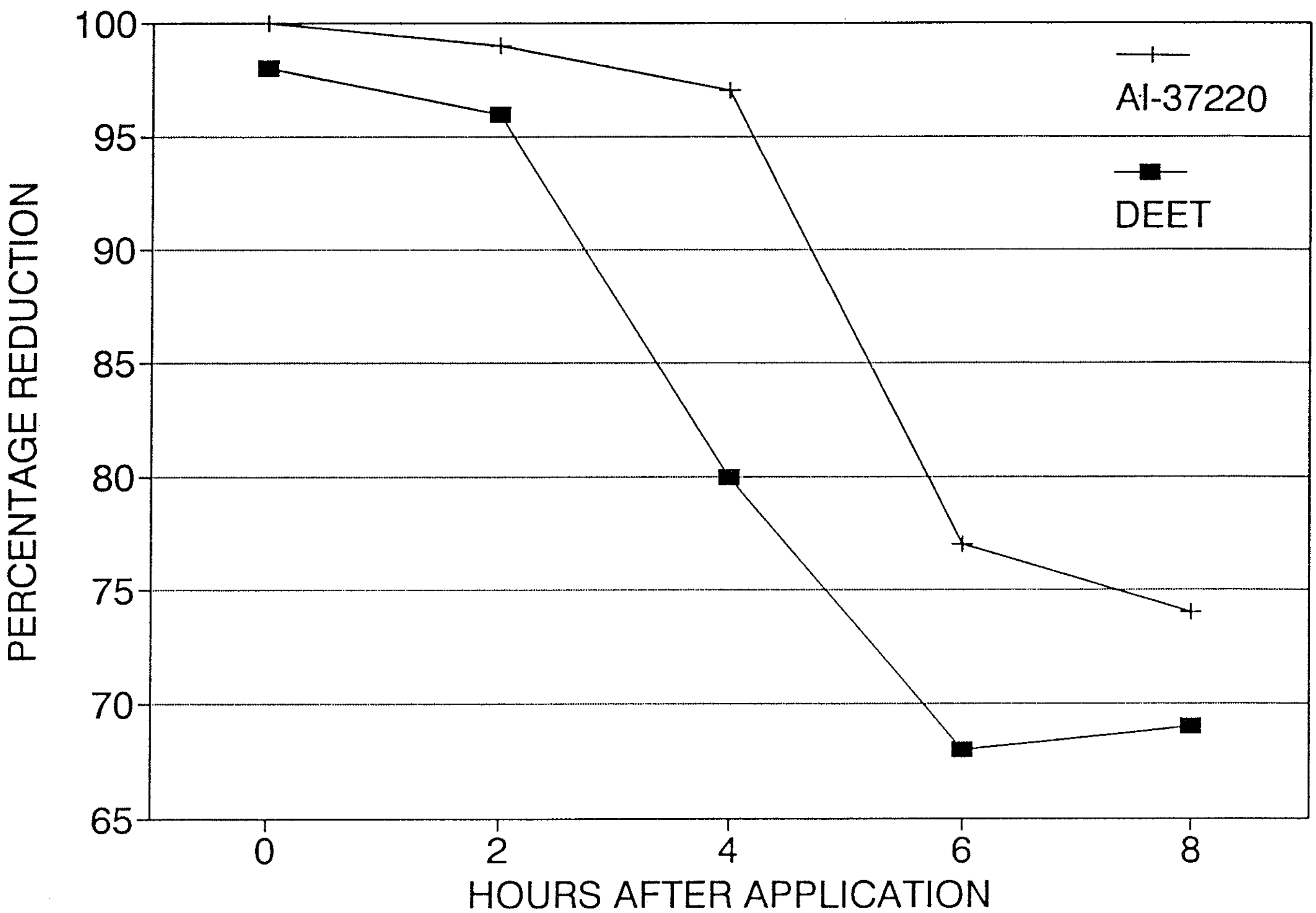


Figure 3. Results of a direct comparison of AI-37220 and DEET, using a paired t-test (paired by trial; n =25; p = 0.04).



KNOWING THE TRUTH ABOUT THE DROPLET SIZE KILL RANGE AND YOUR SPRAYER'S OUTPUT WILL REVOLUTIONIZE YOUR ADULTICIDE PROGRAM

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ABSTRACT

A Malvern laser diffraction particle sizer was used to obtain droplet size distributions of malathion (95%) and Biomist™ 4+12 for an airblast and a rotary atomizer. The rotary atomizer produced a narrower distribution with far fewer "fines" (droplets with diameters smaller than 6 *μm*). The implications of these results are discussed.

INTRODUCTION

As professionals we are after the most efficient and cost effective method of controlling mosquitoes while protecting people and the environment. John Beidler, director of the Indian River Mosquito Control District, said it this way: "A successful program will achieve at least 90% control 90% or more of the time." This goal leads us to consider three factors that we must know and understand regarding the spray cloud for an effective adulticide program.

1. <u>Droplet Size Kill Range</u> - based upon extensive field trials and laboratory tests, this range is 6 - 30*μm* (Mount et al, 1968; Himmel, 1969; Mount, 1970; Lofgren et al, 1973; Haile et al, 1982; Linley and Jordan, 1992; Swartzell, 1991). These are the most likely reasons for the effectiveness of this range: Droplets larger than 30 *μm* do not readily remain airborne. Droplets smaller than 6 *μm*, which we call "fines", are easily dispersed by air currents. Thus a cloud composed of a large portion of fines easily fragments. Even if the fines reach the target areas, they may simply follow the air flow around the mosquitoes rather than impinge upon them. Here is why: The direction of moving air is changed by objects in its path. If the air carries droplets of different sizes, the small droplets follow the air stream around the object. Larger droplets, because of their greater momentum, do not respond so easily to the change in direction of the air flow. The net effect is for smaller droplets to follow the air stream around the object while larger ones hit it.

2. <u>Droplet Size Distribution (DSD)</u> - this gives the amount of material in each droplet size "bin". The meaningful range of droplet sizes in a distribution comprises all the bins, from the smallest size to the

largest, that contain at least one percent of the total volume of the spray cloud. (We consider less than one percent "noise".) The desired DSD should match the droplet size kill range as closely as possible for maximum effectiveness of the spray.

3. Mass Median Diameter (MMD) - is the droplet size of the distribution that divides the volume of the spray into two equal amounts. One-half of the volume consists of droplets larger than the MMD and the other half of droplets smaller than the MMD. MMD is an imprecise parameter for characterizing a spray because disparate DSDs can have the same MMD. In our opinion, therefore, the emphasis should be upon DSD rather than upon MMD. Yet most labels state an allowed MMD range; they say nothing regarding too small a droplet which renders the insecticide ineffective. Yes! Droplets can be too small such that they are ineffective and even detrimental to your program. We feel that too small an MMD or too large a percentage of fines is the greatest reason for ineffective and over-application of ground adulticides.

To produce droplets in compliance with point 1 is the goal of a sprayer. Points 2 and 3 are a "report card" on its actual performance. Some sprayers have better report cards than others, as will be shown below.

We wanted to know the difference in the distributions produced by two completely different atomization methods - airblast and rotary - to see which one produced a more effective spray. Airblast machines and rotary atomizers generate droplets by different methods. An airblast machine employs a twin-fluid nozzle in which liquid insecticide pumped through one or more ports is intercepted by a high speed air column. The column tears the liquid apart and atomizes it. At a constant flow rate, one controls the droplet size by adjusting the air pressure. Greater pressure reduces the MMD and shifts the DSD to smaller sizes. For higher flow rates, higher air pressure is required to maintain the same mean droplet size.

Rotary atomizers utilize a rotating, porous, cylindrical sleeve. The insecticide is injected into the sleeve's interior. The centrifugal force drives it thru the sleeve and droplets form on its surface. A blower then turns the droplets 90° to exit the sprayer. Droplet size is controlled by the rotation speed of the sleeve. The faster the sleeve rotates, the smaller the mean droplet size.

MATERIALS AND METHODS

We compared a Leco model HD twin-fluid nozzle sprayer with a Beecomist Pro-Mist model 25HD rotary atomizer. We used a Malvern laser drop size analyzer, one of the most technically advanced and accurate sizing instruments available (Swithenbank et al, 1976; Felton, 1990; Phillips, 1993). The Malvern uses light to analyze the spray's characteristics, so there is no interference that can change the nature of the spray. Thus the entire range of droplet sizes can be accurately determined since droplets of all sizes are detected - not just those that are large enough to impinge upon a collector. Before the measurements we checked the Malvern with an optical reticle to insure it was functioning correctly.

RESULTS

Measurements were taken for a number of combinations of pressures and flow rates. We present the results for malathion (95%) at a pressure of 4.5 psi and a flow rate of 4.3 oz/min, and for Biomist™ 4+12 at 4.5 psi and 6.0 oz/min (Figs. 1 & 2). We found that the airblast unit generated a much broader distribution than the rotary, and that it produced a substantial volume of fines. Other combinations of pressures and flow rates produced similar results.

The consequences of producing such small droplets will be discussed later, but first we need to examine why the number distributions have a different appearance from their corresponding volume distributions. As an example, suppose we have a hypothetical bimodal distribution with an equal volume of spray in droplets with diameters of 2 and 20 *µm* (Fig. 3). The spray's volume distribution would display two equally sized peaks at these two diameters. Equally sized volume peaks, however, do not transform into equally sized number peaks. The reason is that the volume of a droplet depends upon the cube of its diameter. A 20 *µm* droplet is ten times larger than a 2 *µm* droplet, but its volume is $20^3/2^3 = 1000$ times greater. This means that one thousand 2 *µm* droplets contain the same volume as one 20 *µm* droplet. A number distribution of our hypothetical spray, therefore, would show a peak at 2 *µm* that would be 1000 times larger than the peak at 20 *µm*.

The comments relating to our hypothetical distribution carry over to our measured distributions. Although the volume distributions are spread out with two peaks at roughly 2 and 20 *µm*, the corresponding number distributions contain one large peak around 2 *µm* and very little elsewhere.

The situation differs for the Beecomist sprayer. In this case the volume distributions peak around 10 and 20 *µm*. The diameters of the droplets producing these peaks differ by a factor of two, so the volumes of the droplets differ by a factor of $2^3 = 8$. Thus there are eight times more 10 *µm* droplets than 20 *µm* droplets, and an eightfold - rather than a thousandfold - difference exists in the corresponding peaks of the number distribution. Hence, there exists a closer correspondence between the volume and the number distributions for the rotary sprayer than for the airblast machine.

DISCUSSION

The implications of our results are twofold. First, airblast machines produce a large fraction of ineffectual spray. Although we tested one airblast machine, we strongly suspect our results to be common to others since they incorporate the same principle of atomization.

Second, we recognize that for some workers swung 1"x3" glass microscope slides furnish the only technique available to determine the droplet size distribution of insecticide sprays. Nevertheless, we caution those who employ this method that it does not provide an accurate picture of the spray's distribution. The primary reason for this is that small droplets follow the airstream around the slide; they do not impinge upon it as efficiently as larger droplets. Hence, the distribution measured by a slide is unpredictably biased towards larger droplets. In fact, for droplet diameters smaller than 5 *μm* the collection efficiency is so low that most of them do not hit the slide (Fig. 4). The net result is that the droplets in the 2 μm range produced by the airblast machine would hardly be observed *even though the overwhelming number of the droplets are this size!* Thus a slide would inevitably skew the distribution towards larger droplet sizes (Fig. 5).[1]

In short, our results show that a significant volume of the spray from an airblast unit is in droplet sizes that are ineffective. Thus a considerable amount of insecticide is wasted. For those who use thousands of dollars of insecticide each year, the cost of an inefficient sprayer is substantial. Many gallons of insecticide are also needlessly injected into the environment.

CONCLUSIONS

Measurements of the size distribution of ULV sprays of malathion (95%) and Biomist™ 4+12 show that the airblast machine produced a large volume of fines. The rotary sprayer atomized most of the insecticide in the desired 6 - 30 μm range. Very few fines were produced.

Fines are not useful for general adulticiding. Clouds composed of a large volume of fines easily fragment. Even if these small droplets reach the target areas, they may follow the airstream around the target rather than impinge upon it.

Since fines are not detected by swung slides, a great deal of uncertainty should exist in the minds of users of airblast machines as to the true makeup of the spray. Is more insecticide being used than necessary? Only accurate knowledge of the spray's size distribution can answer this question. And this kind of accuracy comes from instruments like the Malvern, not by swinging slides. At present the Malvern is limited as an indoor laboratory instrument. Insitec Measurement Systems of San Ramon, CA, however, has a portable laser unit, but it is very expensive. We hope that soon these instruments will be affordable and used by those in mosquito control.

REFERENCES CITED

- Felton, P. G. 1990. Review of the Fraunhofer diffraction particle - sizing technique. Liquid Particle Size Measurement Techniques: 2nd volume, pp. 47-59, Hirleman, E. D., W. D. Bachalo and P. G. Felton, eds., ASTM STP 1083. American Society For Testing and Materials, Philadelphia.
- Haile, D. G., G. A. Mount and N. W. Pierce. 1982. Effect of droplet size of malathion aerosols on kill of caged adult mosquitoes. Mosquito News 42(4):576-582.
- Himmel, C. M. The optimum size for insecticide spray droplets. 1969. J. Econ. Entomol. 62:919-925.
- Linley, J. R. and S. Jordan. 1992. Effects of ultra-low volume and thermal fog malathion, scourge and naled applied against caged adult *Culicoides furens* and *Culex quinquefasciatus* in open and vegetated terrain. J. Am. Mosq. Contr. Assoc. 8(1):69-76.
- Lofgren, C. S., D. W. Anthony and G. A. Mount. 1973. Size of aerosol droplets impinging on mosquitoes as determined with a scanning electron microscope. J. Econ. Entomol. 66(5):1085-1088.
- May, K. R., R. Clifford. 1967. The impaction of aerosol particles on cylinders, spheres, ribbons and discs. Ann. Occup. Hyg. 110:83-95.
- Mount, G. A. 1970. Optimum droplet size for adult mosquito control with space sprays or aerosols of insecticides. Mosquito News 30:70-75.
- Mount, G. A., C. S. Lofgren, N. W. Pierce and C. N. Husman. 1968. Ultra-low volume nonthermal aerosols of malathion and naled for adult mosquito control. Mosquito News 28(1):99-103.
- Phillips, P. G. 1993. How do forward scattering laser diffraction instruments measure droplet sizes? J. Fl. Mosq. Cont. Assoc. 64:(1): 35-39.
- Rathburn, C. B., Jr. 1970. Methods of assessing droplet size of insecticidal sprays and fogs. Mosquito News 30:501-513.
- Spillman, J. 1984. Spray impaction, retention and adhesion: an introduction to basic characteristics. J. Pest. Sci. 15:97-106.

- Swartzell, R. P. 1991. Use of the army insecticide measuring system (AIMS) at the district level. Proc. Calif. Mosq. Vector Control Assoc. 59:97-99.

- Swithenbank, J., J. M. Beer, D. S. Taylor, D. Abbott and C. G. McCreath. 1976. A laser diagnostic technique for the measurement of droplet and particle size distribution. Experimental Diagnostics In Gas Phase Combusion Systems, Progress In Astronautics and Aeronautics. AIAA 53:421-47.

- Yeomans, A. H. 1949. Directions for determining particle size of aerosols and fine sprays. USDA Bur. Entomol. Pl. Quar. ET-267.

- __________ 1955. A method of determining particle size of liquefied-gas aerosols. USDA, ARS. 33-35.

FOOTNOTE

We are aware of the method used to correct for the dependence of collection efficiency on droplet size. It is stated that the collection efficiency of droplets by a slide increases directly with the square of the droplet diameter D^2 (Yeomans 1949, 1955; Rathburn 1970). The VMD, however, is computed on the basis of the volume of the droplets, which depends upon the cube of the diameter D^3. To compensate for these two weightings, the number of droplets in each size bin is multiplied by the ratio $D^3/D^2 = D$.

The problem with this method is that the collection efficiency drops off much more rapidly than D^2. It is the *impaction parameter* - not the collection efficiency - that decreases with D^2 (Spillman 1984). The collection efficiency drops off exponentially as the impaction parameter decreases (May and Clifford 1967), thereby leading to an exponential, rather than a linear, decrease in collection efficiency. The efficiency curve in Fig. 5 illustrates this phenomenon. Notice the sharp cutoff below which a slide collects no droplets.

Rathburn's admonition (1970:510) applies here: "This weighting of the droplets to compensate for the reduction in efficiency of deposit of the smaller droplets is satisfactory only if all droplet sizes produced are included in the sample, *and may lead to serious errors* [emphasis ours] in sprays containing significant numbers of droplets not included in the sample by reason of their low efficiency of deposit." For droplets as small as we observed, serious error is the rule rather than the exception.

Figure 1. Comparison between rotary and airblast sprayer for malathion (95%) for the settings given in the graph.

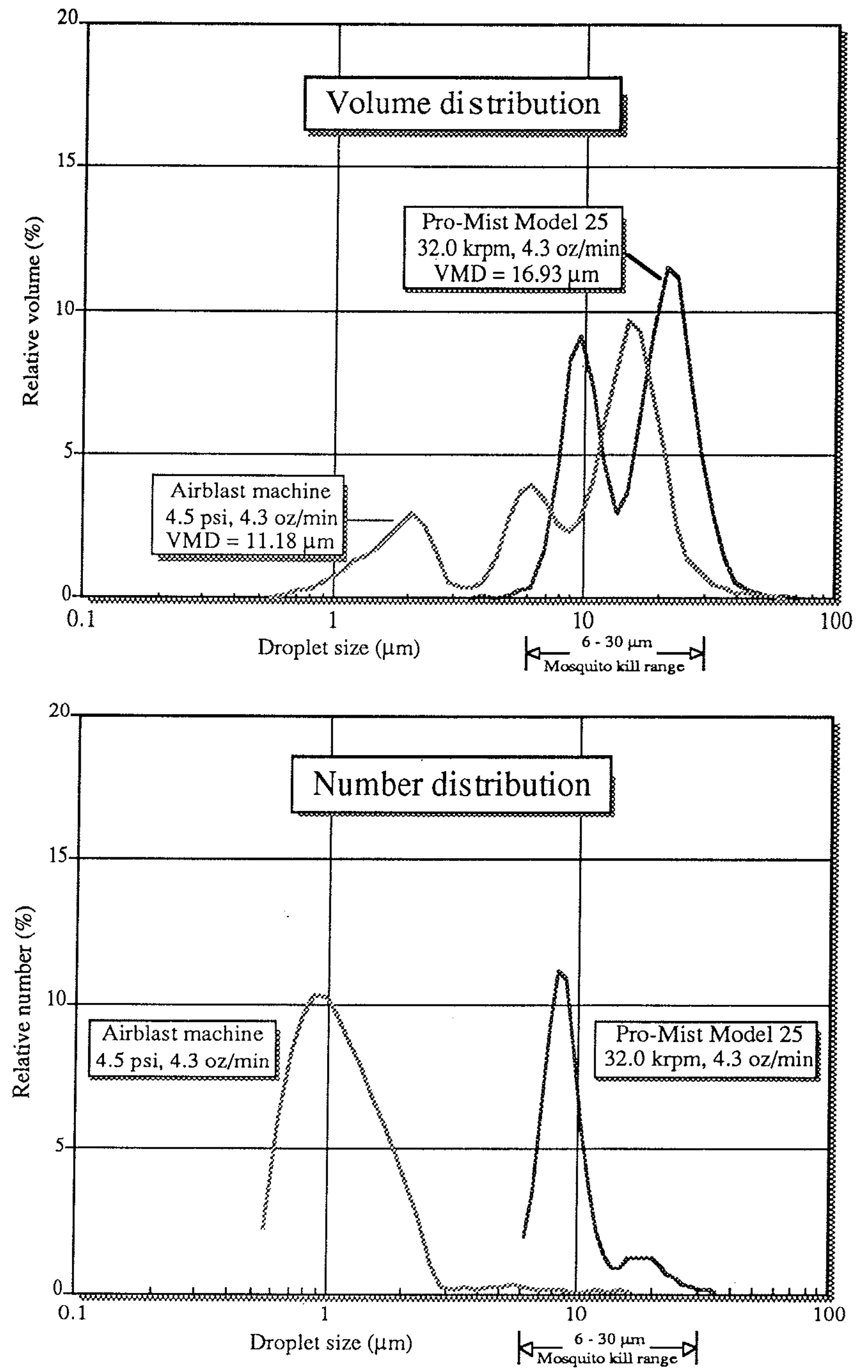
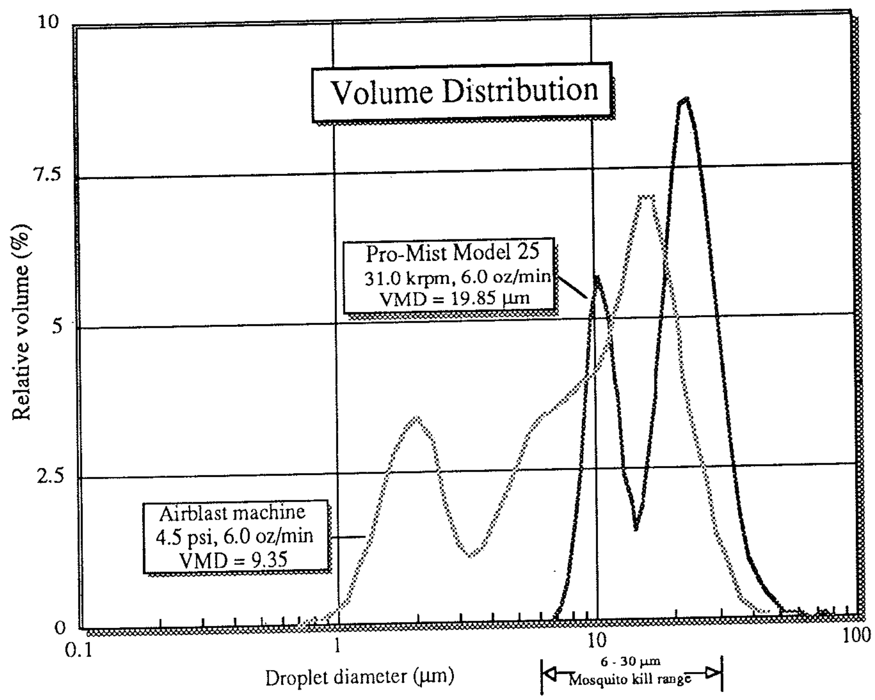


Figure 2. Comparison between rotary and airblast sprayer for Biomist™ 4+12 for the settings given in the graph.



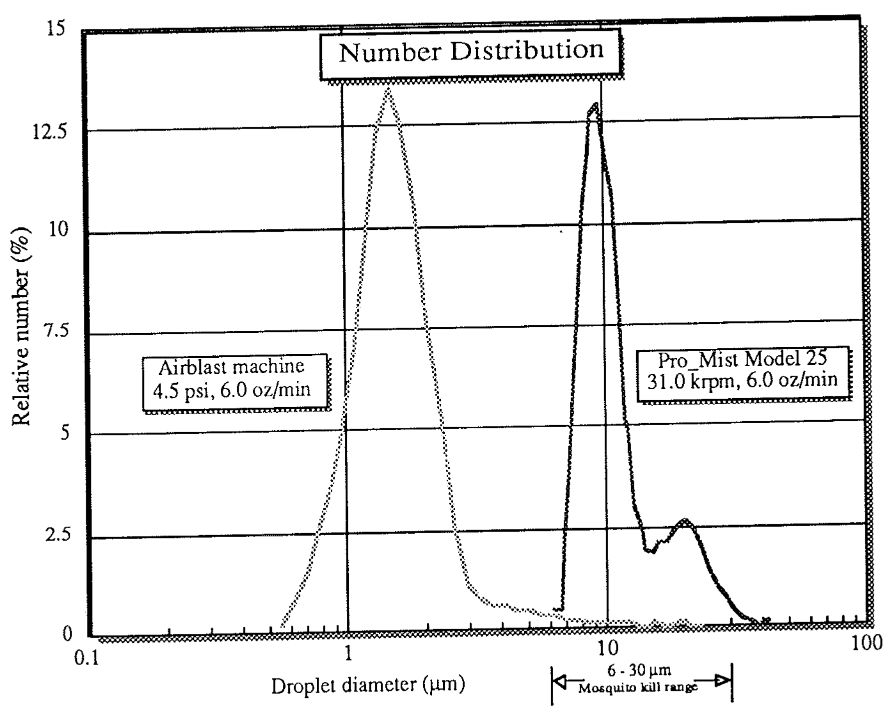
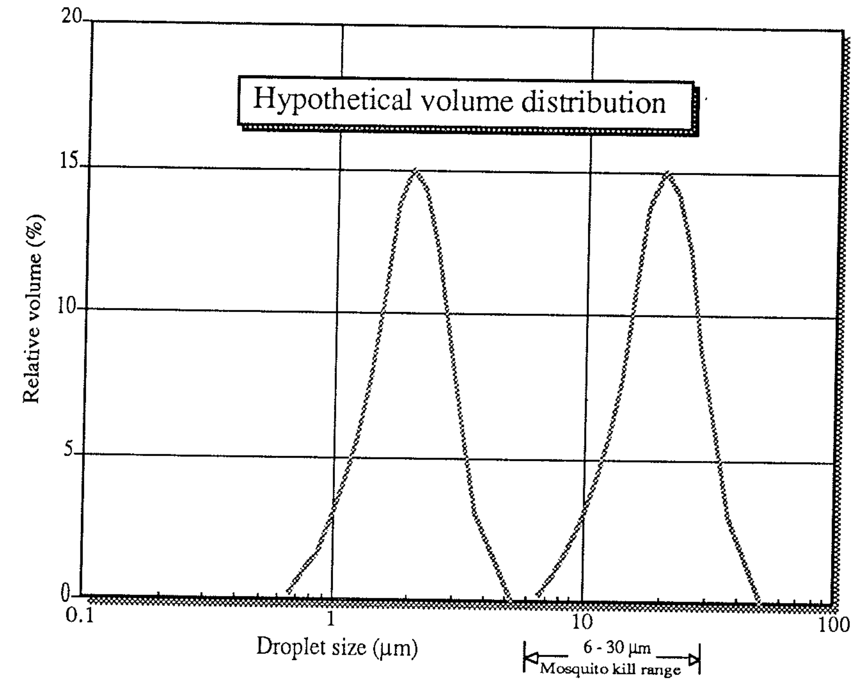


Figure 3. Hypothetical volume and number distributions. See text for explanation.



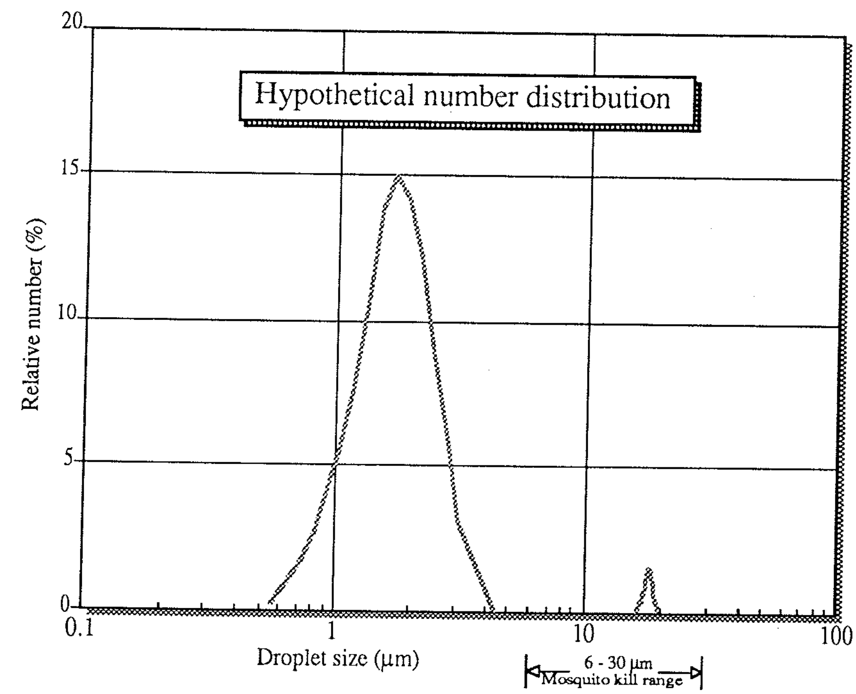
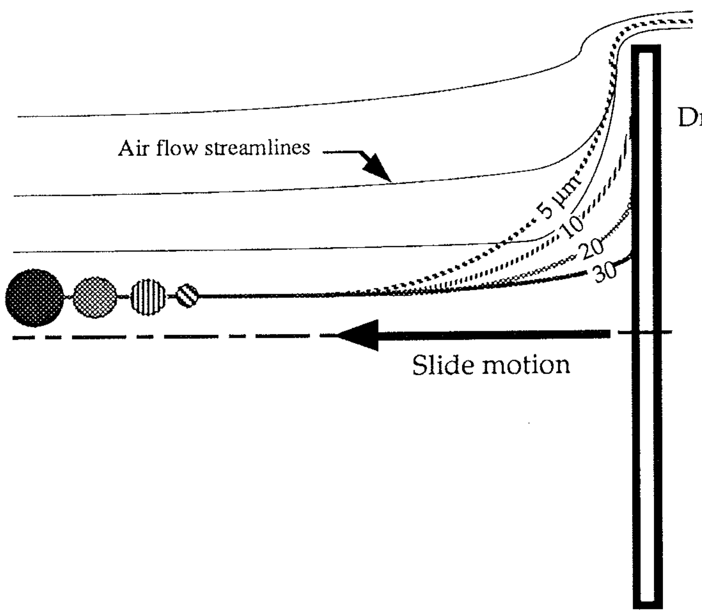
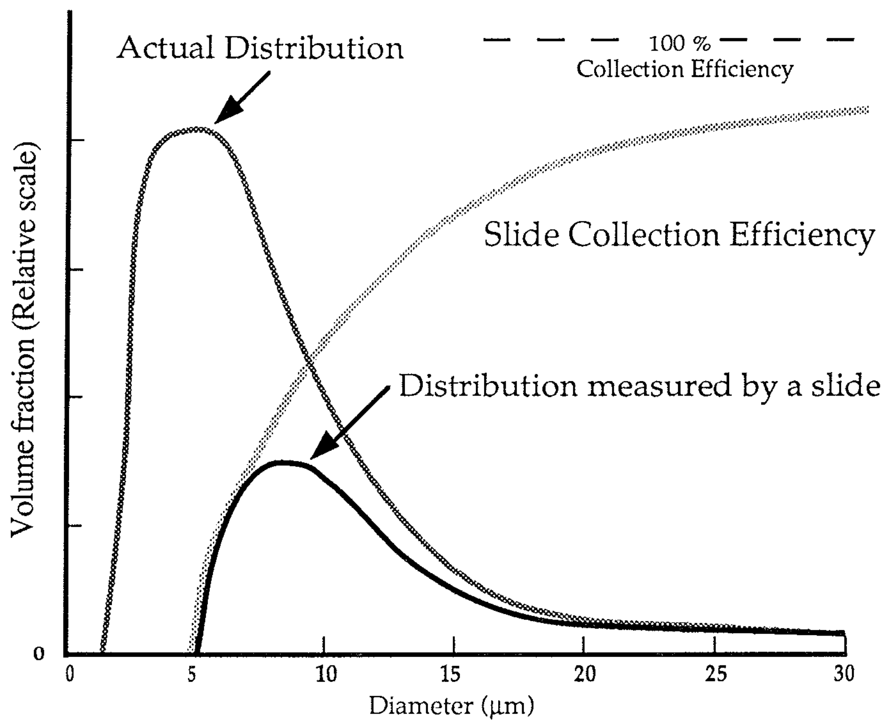


Figure 4. Illustration of air and droplet motions around a 40 mph (18m/s) moving microscope slide. The numbers on the right show the calculated collection efficiencies for water droplets.



Droplet size	Collection efficiency
5 (µm)	2 (%)
10	30
20	70
30	80

Figure 5. Illustration of the modification of a distribution by a moving microscope slide. The peak of the distribution shifts to larger droplet sizes because the smaller droplets are not collected.



UPDATE ON THE AGGRESSIVE HOUSE SPIDER, (HOBO SPIDER)

TEGENARIA AGRESTIS, IN UTAH AND SOUTHERN IDAHO 1992-1993
(Arachnida: Araneae: Agelenidae)

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INTRODUCTION

The aggressive house spider, *Tegenaria agrestis,* is native to Europe where it is a common spider of homes and buildings. *T. agrestis* is a member of the funnel weaving spiders, Family Agelenidae. It was first found in the United States in 1930 in the Seattle area and by the 1960's had been found in many areas of the Pacific Northwest including the Pullman/Moscow area where it had become common (Fig. 1). Reports of necrotic spider bite have been numerous through the years and have been attributed to the brown recluse spider (*Loxosceles reclusa*) which does not occur in the Pacific Northwest. Vest (1987) attributed these bites to *Tegenaria agrestis* which were common in the same localities where bites had occurred. Collections of the aggressive house spider during the last few years and the increasing number of necrotic spider bite cases indicate a widening distribution of this spider into areas adjacent to Washington, Oregon, and Idaho.

IDAHO

The aggressive house spider has been known in the Moscow and surrounding areas for many years and was reported to be common in Idaho Falls and Boise by Vest (1987). Specimens were identified from Twin Falls and Caldwell during 1989 - 1991 and from Soda Springs, Boise, and Idaho Falls during 1992. During 1993 additional specimens have been identified from the following counties in southern and eastern Idaho: Canyon, Ada, Valley, Gooding, Jerome, Twin Falls, Cassia, Minidoka, Oneida, Franklin, Power, Bannock, Caribou, Bingham, Bonneville, Madison, Jefferson, and Bear Lake (Fig. 2). Spider bite cases have been difficult to attribute to the actual cause because the spider is usually long gone when the bite is discovered and treated. Wand (1972) attributed a serious necrotic bite to the brown recluse but no *Loxosceles* spiders were found in the Boise area. With current knowledge of the ability of the aggressive house spider to cause such bites and its likely presence in southwestern Idaho at that time, we feel the bite was caused by *T. agrestis* and not *Loxosceles* sp. The work by Vest (1987, 1989) further indicates the primary cause of necrotic spider bite in Idaho to be *T. agrestis.* Several cases of necrotic spider bite during 1992 and 1993 have been associated with presence of *T. agrestis* in the home or premises where *Loxosceles* and *Chiracanthium* spiders were absent.

UTAH

The first known records of aggressive house spiders in Utah were specimens from Cache County (Logan) and Wasatch County (Heber) in 1992 identified by Utah State University entomologists, Jay Karren and Alan Roe, and confirmed by the author. Publicity in the media has resulted in hundreds of aggressive house spiders being sent in for identification by USU entomologists during August and September 1993 (Fig. 3). Currently the spider is known to occur in Box Elder, Cache, Weber, Davis, Salt Lake, Utah, Wasatch, Sanpete, and Summit Counties with most spider collections coming from sites along the Wasatch Front.

Much of the interest in Utah was stimulated by a Reader's Digest (Morris, 1993) article condensed from Good Housekeeping (April 1993) concerning a life threatening bite resulting in necrotic and systemic symptoms in a Salt Lake woman. The bite was attributed to *Loxosceles* (brown recluse) which is not known to occur in Utah. Evidence indicates the bite was actually caused by *T. agrestis.* All three national TV networks plus CNN carried news features on the spider and local newspapers also covered the "Invasion". In fact the spiders have probably been present for many years since necrotic bites have been reported many times in the last 20 years. Current publicity and excitement has resulted in many more spiders for identification and the increased knowledge of its distribution and activity. Interestingly, no *T. agrestis* spiders were found in the collections at Utah State University in Logan nor at Brigham Young University in Provo.

MONTANA

The most recent new locality collections were in three counties in Montana where at least one recent necrotic bite case is known. Aggressive house spiders have been collected from Lincoln, Missoula, and Gallatin Counties with unconfirmed reports from Thompson Falls, Great Falls, Billings, and Havre (Fig. 4). Apparently the spider has been present in many areas for many years but only recently identified.

SUMMARY

The male aggressive house spider is much more common in homes because of its habit of leaving its web during mid to late summer in search of females for mating. It is therefore a wanderer and comes in contact or proximity to humans much more frequently than other spiders. The name, aggressive house spider, and the publicity are a bit unfortunate since it causes unjustified fear among the populace. It is not aggressive in the sense that it hunts down humans to bite them as you may have seen in the movie "Arachniphobia" but when cornered or caught in clothing or bedding, it does bite more readily than other spiders. Its wandering behavior and apparent lack of fear of humans and household pets adds to the perception that it is aggressive. It deserves appropriate attention as a venomous spider to be aware of but not the unjustified fear or attention it has received recently.

The aggressive house spider is now recognized as a serious venomous spider in the Pacific Northwest and adjacent areas including Idaho, Utah, and Montana. Increased collecting results in more spiders being found and an increasing known geographical range. Necrotic bites are not new to the Pacific Northwest but strong evidence indicates the aggressive house spider is the primary cause.

ACKNOWLEDGMENTS

I wish to thank Mr. Alan Roe and Jay Karren of Utah State University for providing information and records from Utah (Roe, 1993). Drs. Robert Stoltz and Larry Sandvol and Ms Nancy Matteson provided specimens from southern and eastern Idaho. Dr. Will Lazier provided information and specimens from Montana. I also wish to recognize the assistance of Dr. Roger Akre and Ms Elizabeth Myhre, Washington State University for providing information (Akre and Myhre, 1991) and confirming identifications and for showing all of us how to identify these spiders and understanding their importance.

CONTROL: Rational Control Measures

1. Spiders are beneficial, even this one, and should not be routinely or totally wiped out as a result of fear.

2. Physical control: swatting, squashing, vacuuming individual spiders.

3. Exclusion from homes: screening, caulking, closing up, tighten up

4. Sanitation: around the yard, eliminate habitat, junk, debris, wood piles, grass where the spiders live.

5. Sanitation in the home: avoid clothing being left on the floor, laundry rooms, basements where they could get into clothing and cause a bite.

6. Last resort: Pesticide use. Probably of little value against this spider because they move so rapidly and seldom stay in one place for long. Direct spray onto a spider will certainly kill one, but even residual sprays applied to openings, door frames, etc., are of limited value because of their searching, wandering habits. Nonetheless, I recommend an outdoor barrier spray around foundations, steps, basement windows, etc. for controlling most unwanted insect and spider vagrants at this time of year. They are all trying to get in for the winter. I suspect it helps some with these spiders but it is not a cure all and should not be relied upon as the primary control.

REFERENCES

- Akre, R. D. and E. A. Myhre. 1991. Biology and medical importance of the aggressive house spider, *Tegenaria agrestis,* in the Pacific Northwest (Arachnida: Araneae: Agelenidae). Melanderia 47:1-30.
- Morris, D. 1993. Along came a spider ... and almost killed her. Reader's Digest, July 1993, pp. 165-172.
- Roe, A. H. 1993. The aggressive house spider (hobo spider). Fact Sheet #86. Utah State University, Department of Biology, Logan, Utah.

- Vest, D. K. 1987. Necrotic arachnidism in the Northwest United States and its probable relationship to *Tegenaria agrestis* (Walckenaer) spiders. Toxicon 25:175-184.
- Vest, D. K. 1989. Emergent patterns in the occurrence and severity of probable hobo spider (*Tegenaria agrestis*) envenomation in humans. Toxicon 27:84.
- Wand, M. 1972. Necrotic arachnidism: A new entity in the Northwest. Northwest Medicine 72:292-295.

Figure 1. Range expansion of *Tegenaria agrestis* in the Pacific Northwest.

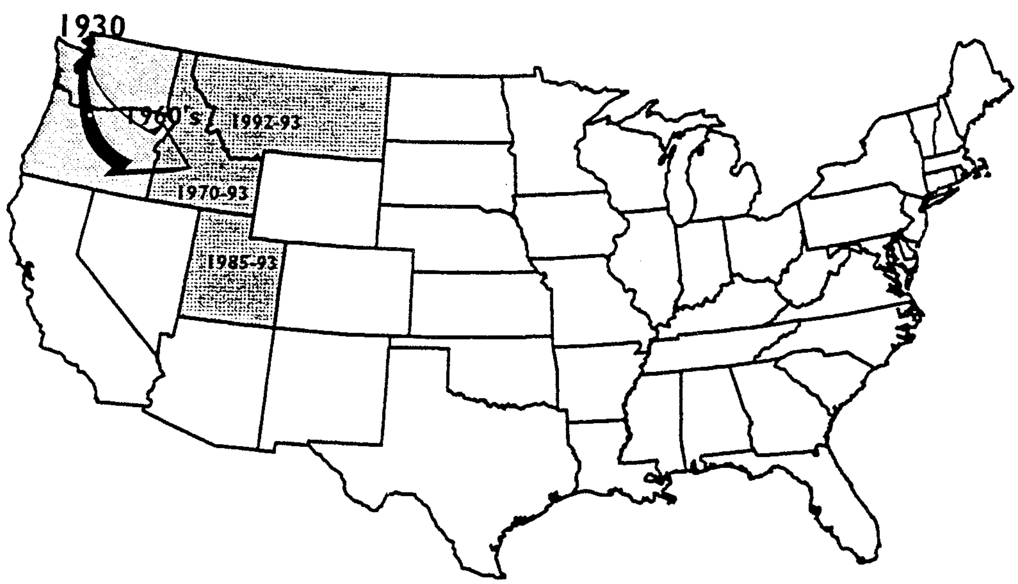


Figure 2. Idaho *Tegenaria agrestis* collections.

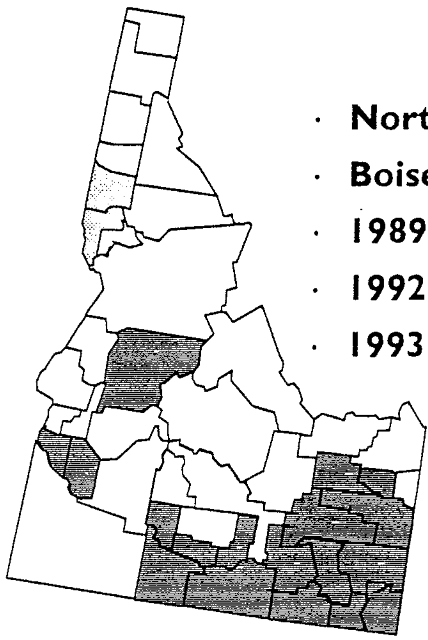


Figure 3. Utah *Tegenaria agrestis* collections.

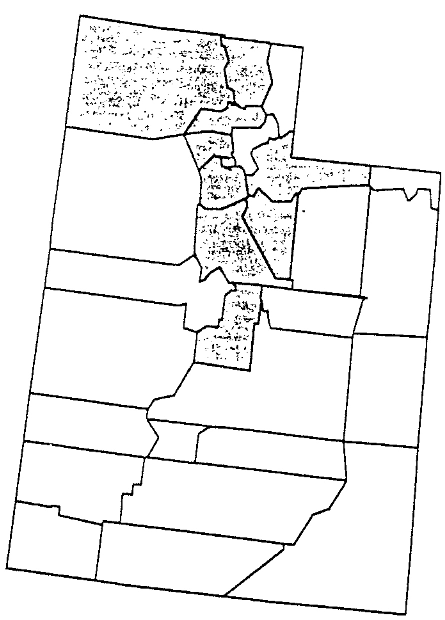
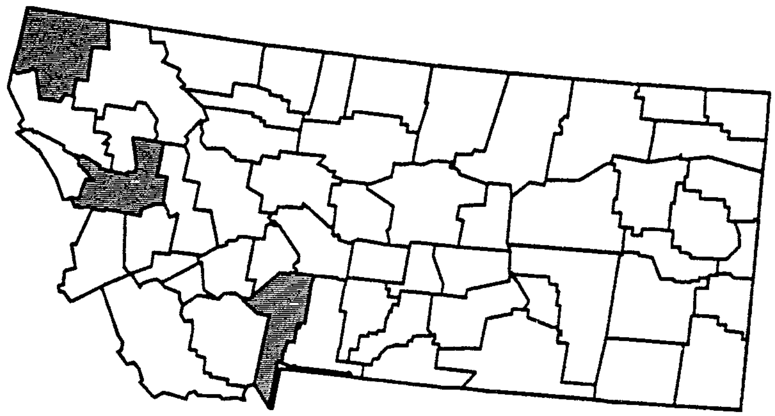


Figure 4. Montana *Tegenaria agrestis* collections.



- **Libby (Lincoln Co.) ****
- **Missoula (Missoula Co.)**
- **Bozeman (Gallatin Co.)**

USE OF BATS IN INSECT CONTROL

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"Bats", wrote Howard et al. (1912) "are important mosquito-destroying animals" and noted a common brown bat (*Eptesicus fuscus*) had been "found with its stomach full of mosquitoes". The first structures built for bats were in France around the turn of the century (Stebbings & Walsh 1988).

Campbell (1925) constructed roosts for bats to control mosquitoes and malaria in 1901. Campbell's claims of successful control were not confirmed by subsequent observers (Howard 1920, Goldman 1926, Nelson 1926 and Storer 1926). Howard wrote "rigid scientific experimentation must still be carried out before any of his conclusions are accepted, and frankly, the field is not sufficiently promising to induce the government entomological service to spend money in this direction which can be used for more pressing needs." Of the many mosquito predators which Howard considered, only mosquito fish (*Gambusia affinis* and other top-minnows) are used by mosquito abatements (Bruce-Chwatt 1981).

In a laboratory, bats captured 10 mosquitoes per minute (Griffin et al. 1960). Davis et al. (1962) estimated Brazilian free-tailed bats (*Tadarida brasilliensis*) ate many tons of insects per year. Belton & Kempster (1962) broadcast ultrasonics similar to bat echolocation noises over fields and found moths repelled and crop damage halved.

Constantine, in his 1970 review, felt "it is probable that bats do control populations of species on which they regularly prey", though the evidence he cites of competition implied by cranial differentiation in skulls of co-occurring bats and increases in foraging distance through the season is circumstantial. He concluded, "funds have been available to investigate problems like diseases in bats, but studies of the food of insectivorous bats have unwisely not received equal encouragement."

Malin & Mendelssohn (1985, cited in Tuttle 1988) reported the first evidence that destruction of bats apparently caused an increase in moths and crop damage. Tuttle (1988) reviewed support for the effectiveness of bats in controlling insects, but none of the evidence is from controlled field experiments using bats. Mitchell (1992, 1993) noted that "insect populations easily make good the bat depredations" and that lab studies do not necessarily represent situations in nature. He concluded that bats "will consume mosquitoes and should be considered part of an integrated management program". The Nature Conservancy is setting bat houses out for mosquito control in Moab, Utah.

Controlled field experiments on using bats for insect control have not been conducted. I propose setting up bat roosts in an area and monitoring insects and plants potentially affected by bats. Monitoring a similar area without bats roosts would provide a control. Artificial bat roosts range in size from that of a bird house to 16 m towers (Stebbings 1988). They usually feature open bottoms which prevent entry of birds and squirrels and roughened crevices on which bats cling. Clawson (1990) found 20.5% of roosts surveyed were used by bats and Tuttle and Hensley (1993) found 52% occupancy. Relocating unoccupied roosts may cause occupancy. Bat roosts retail around $30.00 or more by mail or in garden shops but can be constructed from scrap wood. Occupancy of roosts and flight activity would be noted visually and with ultrasonic detectors (Kunz 1988). Insects would be collected with light traps arrayed around the roosts with bite counts and complaint rates providing additional data.

Vegetation would be monitored for damage. The Brazilian free-tailed bat, for example, eats Gelechiid microlepidopterans (Ross 1961) whose larvae cause galls and other damage in a variety of plants including sagebrush, goldenrod and conifer (Borror et al. 1981). It would be important to check roost areas before and after bats occupied them.

Bats eat a variety of insects, many of which are agriculturally or medically significant. Though bats feed opportunistically, certain species tend to eat more of certain types of insects (Black 1974) due to their flying abilities, echolocation behavior (Ransome 1990) and dentition (Freeman 1979). Of Utah bats (Hasenyager 1980), *E. fuscus* and *Myotis evotis* eat many beetles; *T. brasiliensis, Plecotus* sp. and *Lasiurus* sp. tend to eat moths; and smaller bats like *M. lucifugus* and *M. yumanensis* eat chironomids, midges and presumably other nematocerans, including mosquitoes. In agricultural areas, moth-eating bats might prevent damage caused by moth larvae and adults (Whitaker 1993a), but in urban areas where mosquitoes were a problem, getting smaller bats to roost might be advantageous.

The fact that a bat will eat an insect of medical or agricultural significance does not imply that the bat is controlling a pest problem. Hence the need for experiments to demonstrate control. The estimated percentage of insect mass eaten by bats is very low. Assuming a maximum flight distance for a small bat of 1.8 km from the roost (Ransome 1990) in a colony of 30 bats (Tuttle & Hensley 1993) foraging 365 nights a year and every bat eating 1 gram of secondary production per day (Gould 1955, Davis et al. 1962, Ransome 1990), and a maximum annual secondary productivity for the foraging area of

50 grams per meter squared per year (Benke 1984), then:

Insect biomass eaten per year per bat = (nights/yr.)(amt. eaten/bat night)

= 365 days/year X 1 gr./night

= 365 grams/year

Potential insect biomass produced in foraging area per year = (Area of forage) x (possible biomass/unit)

$= (\pi)(1800\ m)^2(50\ gr/m^2)$

$= (3.142)(3{,}240{,}000)(50)$

= 509,004,000 grams

It would take approximately 1,394,532 bats per 2,000 acres (or 693 bats/acre) to eat the entire insect biomass potential. This of course assumes that the insect biomass is available in equal amounts every day of the year and that the bats eat at least 1 gr./night. This estimate may be unrealistically high because annual secondary productivity is usually lower than the 50 grams per meter squared found in some aquatic areas (Benke 1984) and a bat may eat more than 1 gram per night (Schmidley 1991).

Predation on insects could be higher in the vicinity of the roosts. Species composition and size changes of insects might occur. Gould (1955) found certain sized insects to be preyed upon. Since predators continually eat insects over wide areas before a pest problem develops, unlike conventional pesticides which are usually short-term and localized, the effect of predators may have novel effects on insect populations.

Bat ultrasonics interfere with moth dispersal which would decrease herbivory (Belton and Kempster 1962) even though the insects were not consumed. Bat interference with mosquito flight was noted by Campbell (1925).

Indirect damage caused by insects as vectors (Sylvester 1984, Whitaker 1993a) is often high. Critical thresholds where small changes in pests numbers cause large changes in damage are possible (MacDonald 1957) so mass consumption rates alone can be misleading.

Bats present a number of health, sanitation and environmental problems. Few bats have rabies (Constantine 1970, 1988; Schmidly 1991), but rabid bats may be more likely to encounter people than uninfected bats. Rabies is deadly without vaccination.

Bat guano may overload structures and can harbor fungi causing histoplasmosis, a respiratory illness. Most parasites do not stray from bats though mites from roosts can bite humans (Constantine 1970). Since bats can host mosquitoes, (Gillett 1972) bat colonies could attract more mosquitoes than the bats consume!

Augmenting natural bat populations has unknown environmental effects. If day insects do not overlap with night insects, bats would be unlikely to diminish food supplies for insect-eating birds but the data are lacking. Species of bats inhabiting artificial roosts could lower food supplies of or interfere with (Rydell 1986, Ransome 1990) species of naturally occurring bats or increase disease incidence. Ethical considerations prevail in using bats for any purpose.

Bats should be preserved. If eviction becomes necessary bats should not be killed and alternate roosts should be provided (Schober & Grimmberger 1989, Whitaker 1993b). Research is needed on the extent to which pesticides and habitat destruction create pest problems by killing predators on insects as well as research on how free-ranging predators can be integrated into control programs.

As a biological control agent, bats have not been sufficiently evaluated to know how effective they are in controlling insects. Experiments allow more definite answers.

REFERENCES CITED

- Belton, P. and R.H. Kempster. 1962. Field test on the use of sound to repel the european corn borer. Ent. Exp. Appl., 5:281-288.
- Benke, A. C. 1984. Secondary production of aquatic insects. The Ecology of Aquatic Insects, Ch. 10. V. H. Resh & D. M. Rosenberg (eds.), pp. 289-322, Praeger Publ., New York.
- Black, H.L. 1974. A north temperate bat community: structure and prey populations. J. Mamm. 55: 138-57.
- Borror, D.J., D.M. Delong & C.A. Triplehorn. 1981. An Introduction to the Study of Insects, 5th ed. Saunders College Publ., Philadelphia.
- Bruce-Chwatt, L.J. 1981. Leland Ossian Howard (1857-1950) and malaria control: then and now. Mosquito News 41:215-225.
- Campbell, C.A.R. 1925. Bats, Mosquitoes, and Dollars. Stratford Co., Boston.
- Clawson, R.L. 1990. Bat houses: construction and success by the general public. Bat research news, Winter:62.
- Constantine, D.G. 1970. Bats in relation to the health, welfare, and economy of man. Biology of Bats, Vol. 2, Ch. 7, Wimsatt, W. (ed). Academic Press, New York.
- Constantine, D.G. 1988. Health precautions for bat researchers. Ecological and Behavior and Behavioral Methods for the Study of Bats, Ch. 29. T. H. Kunz. Smithsonian Inst. Press, Washington.
- Davis, R.B., C.F. Herreid II & H.L. Short. 1962. Mexican freetailed bats in Texas. Ecol. Monog. 32:311-346.

- Freeman, P.W. 1979. Specialized insectivory: beetle eating and moth eating molossid bats. J. Mamm. 60:467-79.
- Gillett, J.D. 1972. The Mosquito: its Life, Activities and Impact on Human Affairs. Doubleday, Garden City, New York.
- Goldman, E.A. 1926. Bats, mosquitoes and dollars (review). J. Mamm. 7(2):136-138.
- Gould, E. 1955. The feeding efficiency of insectivorous bats. J. Mamm. 36:399-407.
- Griffin, D.G., R.A. Webster & C.R. Michael. 1960. The echolocation of flying insects by bats. Animal Behavior, 8:141-154.
- Hasenyager, R.N. 1980. Bats of Utah. Div. of Wildlife Resources Publ. #80, p. 15.
- Howard, L.O. 1920. Mosquitoes and bats. Public Health Reports, 35(31):1789-1795.
- Howard L.O., H. G. Dyar & F. Knab. 1912. Mosquitoes of North and Central America and the West Indies. Carnegie Inst. of Washington Publ. 159, Vol. 1. Lord Baltimore Press.
- Kunz, T.H. 1988. Ecological and Behavioral Methods for the Study of Bats. Smithsonian Inst. Press, Washington.
- MacDonald, G. 1957. The Epidemiology and Control of malaria. Oxford Univ., London.
- Malin, D. & H. Mendelssohn. 1985. Insectivorous bats, victims of Israeli campaign. Bats 2:1-2, 4 cited in Tuttle 1988.
- Mitchell, L. 1992. Mythical mosquito control. Wing Beats 3(2):18-20.
- Mitchell, L. 1993. Myths about mosquito control (bats, birds and bug zappers). Vector Control Bull. North /Central States 2(1):35-40.
- Nelson, E.W. 1926. Bats in relation to the production of guano and the destruction of insects. USDA Bull. 1395.
- Ransome, R.D. 1990. The Natural History of Hibernating Bats. Christopher Helm, London.
- Ross, A.J. 1961. Notes on the food habits of bats. J. Mamm. 42:66-71.
- Rydell, J. 1986. Feeding territoriality in female northern bats, *Eptesicus nilsonni.* Ethology 72:329-337.
- Schmidly, D.J. 1991. The Bats of Texas. Texas A & M University Press, College Station.
- Schober, W. and E. Grimmberger. 1989. A Guide to Bats of Britain and Europe. Hamlyn Publ., London.

- Stebbings, R.E. 1988. Conservation of European bats. Christopher Helm Publ., London.

- Stebbings, R.E. and S.T. Walsh. 1988. Bat boxes; a guide to their history, function, construction and use in the conservation of bats. 2nd Ed. Fauna and Flora Preservation Society, London.

- Storer, T.I. 1926. Bats, bat towers and mosquitoes. J. Mamm. 7(2):85-91.

- Sylvester, E.S. 1984. Insect disseminators of other organisms, especially as vectors. Ecological Entomology, Ch. 21, C. B. Huffaker and R.L. Rabb (eds.), John Wiley Press, New York, pg. 633-658.

- Tuttle, M.D. 1988. America's Neighborhood Bats. Univ. Texas Press, Austin 1st ed.

- Tuttle, M.D. & D. Hensley. 1993. Bat houses: the secrets of success. Bats 11(1):3-15.

- Whitaker, J.O., Jr. 1993a. Bats, beetles and bugs. Bats 11:23.

- Whitaker, J.O., Jr. 1993b. Bats: benefits and alternatives to control. Vector Control Bull. North Central States 2:104-109.

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PAST PRACTICES AND UNFORESEEN ENVIRONMENTAL CONCERNS

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Mosquito Control has had many changes in the past 50 years. Nevertheless, many things have remained the same. The quest to control mosquitoes has always been through an 'integrated pest management' approach even before the phrase was coined. The primary focus is and has been to eliminate standing water to prevent mosquito production. For many years this was accomplished through the drainage of water from low lying areas. Today, with the completion of innumerable ditches, and a better understanding of wetland ecology, water control is accomplished through control structures, public relations and education of water users.

The failure or inability to control the flow of water inevitably results in the possibility of mosquito production. The primary means of monitoring for mosquito larvae is to visit areas of stagnant water and make a visual inspection. A dipper, although the shape and handle-length have changed has always been the standard monitoring tool for larval surveillance. Upon finding mosquito larvae the choices are either to let the mosquitoes hatch, if they pose no health or pest problem or to kill them with an application of a biological or chemical agent. Mosquito fish, *Gambusia affinis,* have long been a standard biological control practice for a variety of mosquito larval habitats. Some researchers now believe that mosquito fish directly compete with native fish species for some limited resources and may have contributed to the threatened or endangered status of some species. Thus, the placement of *Gambusia* are being closely monitored or eliminated by some state fish and game programs.

The next option available to stop mosquito production is the application of chemicals to the larval habitat. The appearance of the application equipment has changed dramatically over the years while actual techniques have changed very little. Areas that at one time required tanker-trucks with long hoses carried by several men to the site, is now treated by a single person using an all-terrain-vehicle. Aircraft applications have become much more efficient and precise due to improved navigational systems and spray nozzle innovations.

The failure to control mosquitoes in the larval stage results in the last and least preferred method of control, adulticiding. The application of adulticiding chemicals has evolved from the use of thermal fogs, created by the combustion of petroleum products with an adulticide, to the blowing of dusts, to the use of ultra low volume (ULV) technique. ULV application requires specialized equipment that can deliver small amounts of chemical in a uniform droplet spectrum over large areas.

The most dramatic change in mosquito control in the past 50 years has not been in the fundamental philosophy, technique or equipment but rather in the type of chemical used. Following World War II until the mid-1960's mosquito control agencies used chlorinated hydrocarbons (CH's), such as DDT, almost exclusively as the preferred larvicides. The development of resistance to CH's and a new generation of pesticides, organophosphates (OP's), resulted in the elimination of CH's as mosquito control larvicides. This change occurred several years before public concerns emerged and the eventual banning of CH's. Malathion, parathion, fenthion, chlopyrifos and similar OP's dominated the list of chemicals used to control mosquitoes from the mid-1960's until the late 1980's. As with CH's, the use of OP's started to decline as resistance in mosquito populations were observed. OP's are now being replaced by biological and synthetic chemicals, which are much more specific in control of the target organism.

While the chemicals used in mosquito control have evolved from CH's to OP's to biological /synthetic products, the way in which they were handled and stored remained unchanged. Mosquito control across the country has traditionally been accomplished with modest funding. Facilities for mosquito control have typically been housed in surplus governmental buildings or similar type property that was never designed for the needs of mosquito control activities. As control agencies have begun to renovate or design new facilities, their **'past practices have raised unforeseen environmental concerns'**. In order to remove old underground storage tanks or to sell property that has been used to store or mix pesticides, it is now standard procedure to perform an environmental audit. The audits consist of two parts: Phase (1) the determination of any and all possible sources of contamination from a historical perspective, and if warranted; Phase (2) the actual sampling of potential contamination and recommendations for any remediation.

Phase (1) studies focus on obvious areas of contamination, such as, where chemicals have been handled in loading and unloading, stored and mixed; where empty containers are stored, rinsed or disposed; and underground storage tanks. Although there may be no record or memory of any spill or leak ever occurring a Phase (2) environmental audit should not be ruled out. Most older facilities no matter how well managed will encounter some levels of CH's contamination, whereas, OP's and biological /synthetic products rapidly break down and do not persist in the environment. Analytical methods routinely detect traces of CH's in concentrations in parts per billion. Even though the effects, if any, that these minute amounts of chemicals may have on the environment or human health, they are deemed to be hazardous waste in any detectable amounts. CH's, such as DDT, in concentrations of less than 1,000 ppm can be disposed of in hazardous waste landfills, if the contamination is determined to have occurred as a result of the pesticides use in its intended manner. The critical question becomes 'how did the contamination occur'? Were minor drips in loading and mixing, or a mechanic rinsing off a sprayer before repair considered a part of intended use? If contamination cannot be shown to be within the scope of intended use the methods of remediation are limited to incineration at an approved hazardous waste incinerator or various unproven methods. The cost of incineration may be beyond the financial resources of a mosquito control agency.

Chemicals used in the past were at the time thought to be the safest and most effective form of control. Decades later our knowledge of community ecology of the aquatic environment has greatly increased. Biological and synthetic chemicals take advantage of this new knowledge and are believed to be the safest ever used. However, will we one day find that these chemicals are also damaging in some unforeseen manner? Mosquito control is a necessity if we are to maintain the quality of life and health we enjoy. It is improbable that chemicals will not be needed as integral parts of integrated mosquito control programs in the foreseeable future. Therefore, in any chemical storage and handling we must stress containment. Usage must be strictly monitored, always seeking to use the least possible effective application rate.

REVISED CONSTITUTION OF THE UTAH MOSQUITO ABATEMENT ASSOCIATION

Adopted at the 8th Annual Meeting of the Association - 1955
Revised at the 13th Annual Meeting - 1960
Revised at the 25th Annual Meeting - 1972
Revised at the 28th Annual Meeting - 1975
Revised at the 30th Annual Meeting - 1977
Revised at the 34th Annual Meeting - 1981
Revised at the 41st Annual Meeting - 1988
Revised at the 46th Annual Meeting - 1993

ARTICLE I. NAME

The name of the organization, an unincorporated association, shall be "UTAH MOSQUITO ABATEMENT ASSOCIATION", also known as "UMAA."

ARTICLE II. OBJECTIVES

The objectives and purposes of the Association shall be to promote close cooperation among those concerned with, or interested in, mosquito control and related work, to increase the knowledge and advance the cause of mosquito abatement in an efficient and effective manner compatible with the goals of a sound environment. The Association may also encourage and undertake such other insect problems as the Association may determine.

ARTICLE III. MEMBERSHIP

Section A. The membership of the Association shall consist of three classes: Members, Contributing Members, and Honorary Members.

Section B. Members shall consist of two categories: Agency Members and Individual Members.

(1) Agency members shall be any active mosquito abatement program supported with an annual budget from public funds.

(2) Individual members shall be any person interested in or concerned with mosquito abatement who desires affiliation with the Association.

Section C. Contributing Members shall be any commercial or other organization which desires affiliation with the Association.

Section D. Honorary Members shall be any individual who has performed outstanding service in the interest of mosquito abatement and who has been elected to honorary membership for life by two-thirds majority vote of voting members present at the time of voting.

Section E. Approval of Membership. All applications for membership shall be subject to approval by a majority of the Board of Directors at which a quorum is present.

Section F. Voting. All trustees, commissioners and designated permanent employees of agency members shall have one vote at Association meetings. All individual and honorary members shall have one vote. Contributing members shall have no vote.

ARTICLE IV. REVENUES

Section A. The revenue of the Association will be derived from dues paid by members, from the sale of publications, from donations and contributions, and from such other sources as may be approved by the board of Directors.

Section B. The dues for members and date of payment shall be established annually by the Board of Directors of the Association. All mosquito abatement districts and organizations sponsoring members shall be notified by November 15th following the annual meeting of any changes in the amount of dues from those assessed the previous year and approved by the Board of Directors.

ARTICLE V. OFFICERS

Section A. The elective officers of the Association shall be President, President-elect, Vice President, and a Secretary-Treasurer. The Officers shall be elected at the annual business meeting by a majority vote, except for the president-elect who automatically ascends to the office of President. A director shall be appointed by the governing body of each unit in Utah engaged in mosquito control and which is a member of the Association. The elective officers and the duly appointed directors shall constitute the Board of Directors.

Section B. The Board of Directors, at their discretion, shall appoint an Executive Director who will sit as a voting member of the Board. The Executive Director's salary will be established by the Board of Directors.

ARTICLE VI. DUTIES OF OFFICERS

Section A. The President shall preside at all meetings of the Association, annual and special, and at all meetings of the Board of Directors. He shall maintain and exercise general supervision over the affairs of the Association, subject to the authority of the Board of Directors, and shall discharge such other duties as usually pertain to the office of President. He shall name members of the committees with consent and approval of the Board of Directors at their first meeting during his term of office. In the absence of the Secretary-Treasurer, the President may sign checks to pay for bills approved by the Board of Directors.

Section B. The president-elect shall exercise the powers and perform the duties of the President in the absence or disability of the President. In case of a vacancy in the office of the President, the President-elect becomes President for the balance of the term of the office. He shall function as Program Chairman for the Annual Meeting held during his term of office. The Board of Directors shall appoint by a majority vote an acting President-elect, when the office becomes vacant, to serve until the next election of officers by the Association.

Section C. The Vice President shall assist the President and the President-elect with the duties of these offices as directed.

Section D. The Secretary-Treasurer shall keep full and correct minutes of all meetings of the Association and of the Board of Directors. He shall be responsible for the maintenance of all membership records, conduct the correspondence of the Association, and issue all notices of meetings. He shall collect and receipt for all dues, assessments and other income. He shall deposit promptly all funds of the Association in such depositories as shall be approved and designated by the Board of Directors. Checks in payment of obligations of the Association shall be signed by the Secretary-Treasurer. He shall, under the direction of the Board of Directors, pay all bills of the Association and make such other disbursements as are necessary and incidental to the operations of the Association. He shall, at the annual meeting of the Association, and if directed by the Board of Directors at special meetings, make full and true report of the financial condition of the Association. He shall perform such other duties as are usually incident to the office of Secretary-Treasurer and as may be assigned to him by the Board of Directors. The Secretary-Treasurer with the approval of the Board of Directors and with the assistance of the Publications Committee, shall publish and distribute the proceedings and other publications of the association. In the absence or disability of the Secretary-Treasurer, the Board of Directors shall appoint a member of the Association to serve in this capacity as required or until the next election of officers by the Association.

Section E. The Executive Director shall serve the association by duties which include:

(1) Coordinating the Annual Conference with the Program Chairman.

(2) Serving with the Local Arangements Committee to facilitate hotel requirements, exhibit space, etc., associated with the Annual Conference.

(3) Aiding in the promotion of Annual Conference and obtaining commercial exhibitor participation.

(4) Serving with Officers and Directors to promote the UMAA to various Local, State and Federal agencies regarding environmental concerns and issues.

(5) Monitoring and working with the Legislative Committee on

matters that impact mosquito control which come before the State Legislature.

(6) Coordinating bidding for chemicals for the Association.

(7) Representing the Association at the Meeting of the American Mosquito Control Association and at any other meetings which the Board of Directors may deem necessary.

(8) Assisting in the development and coordination of the annual Workshop.

(9) Publishing an Association Newsletter on a bimonthly basis from April through October.

(10) Submitting an Annual Report during the Annual Conference Business meeting.

(11) Other such duties as the Board may direct.

Section F. The Board of Directors shall meet upon the call of the President, or upon the request of three (3) or more members of the Board of Directors directed in writing to the Secretary-Treasurer. At least five (5) days prior notice in writing shall be given by the Secretary-Treasurer to all members of the Board of Directors: the time and place of such meetings shall be designated by the president. A majority of the members of the Board of Directors shall constitute a quorum for the transaction of business, and action by the Board of Directors shall be upon the vote of a majority of those members present at any meeting of the Board of Directors at which a quorum is present. The Board of Directors shall manage the affairs of the Association and shall have power:

(1) to fill any vacancy among the elected officers of the Association,

(2) to appoint the following standing committees each to consist of not less than three (3) members: Publications, Auditing, Program, and Nominating. Special procedures for the Nominating Committee are included in Article VII. The Secretary-Treasurer shall be an ex officio member of all committees.

(3) to appoint such other committees as it may deem to be necessary or useful in conucting the business of the Association.

(4) to prescribe the duties of officers of the Association not otherwise prescribed in the Bylaws of the Association.

(5) to prescribe rules and reguations for the conduct of the affairs of the Association, as are not inconsistent with the provisions of the Constitution of the Association,

(6) to determine the number and price of each publication which shall be distributed to the

various members of the association, and to others; to approve lists of non-members who may receive publications without charge, and

(7) to accept or reject applications for memberships in the Association, prescribe rules and procedure in relation thereto.

ARTICLE VII. NOMINATION AND ELECTION OF OFFICERS

Section A. At least 15 days prior to the annual meeting of the Association, the President shall appoint, subject to approval of the board of Directors, a nominating committee consisting of five (5) members of the Association naming one of the five to serve as Chairman.

Section B. The Nominating Committee shall determine its nominees for elective officers of the Association. It shall present the names of the nominees selected in the opening session of the annual meeting of the Association. It shall also present at this time, on request, any nominations made in writing and signed by three or more members of the Association. Election of officers will be conducted in a business meeting where nomination for officers may be made from the floor.

Section C. Officers of the Association shall be elected by majority vote at the annual meeting of the Association, and shall serve until the next annual meeting.

Section D. The Executive Director shall be appointed at the discretion of the UMAA Board of Directors by a simple majority vote. Term of office shall be one year subject to reappointment, at the annual conference meeting.

ARTICLE VIII. MEETINGS

Section A. There shall be an annual meeting of the Association, for the election of officers, the presentation of papers and discussions on mosquito abatement and related subjects, and such other business as may be properly considered. Such meetings shall be held at such times and places as the Board of Directors shall prescribe. At least 7 days prior notice shall be given to all members as to the time and place of the annual meeting.

Section B. Special meeting of the Association may be held whenever the Board of Directors deems such meetings necessary, or whenever ten or more Members shall make a written request thereof, presented to the Secretary-Treasurer. Such request shall be presented to the Board of Directors, which shall designate a time and place for such special meeting. The Secretary-Treasurer shall give written notice of all special meetings of the Association to all members at least seven (7) days prior to the date of such special meeting.

Section C. A simple majority of Members of this Association shall constitute a quorum for the transaction of business at any annual or special meeting and any actions taken at such meetings shall be by majority vote.

ARTICLE IX. AWARDS

Section A. Don M. Rees Memorial Award. This award is presented to individuals who:

(1) Have made significant contributions to mosquito control in Utah and the Utah Mosquito Abatement Associ-tion.

(2) Have significantly contributed to our knowledge of mosquitoes in ways which have improved control procedures and reduced the threat to human health.

Section B. Meritorious Service Award.

(1) This award is presented to individuals who have distinguished themselves in administrative or technical service to mosquito control in Utah.

Section C. Nominations

(1) Nominations for these awards may be made by any member of the UMAA. Nominations will be reviewed by the Awards Committee who will make recommendations to the Board of Directors. Candidates must then receive a majority vote of approval by the Board.

(2) Awards will be made when suitable candidates exist. Presentations will be made at the Annual Meeting of the Association.

(3) The Awards Committee will be appointed by the incoming president of the UMAA and will consist of three members in good standing. The chairperson each year will be the immediate past president. The Awards Committee must make their recommendations at a monthly board meeting at least 2 months prior to the annual meeting.

ARTICLE X. REPORTS AND PUBLICATIONS

Section A. The Association shall publish an annual report. The report may contain the proceedings, papers, and business transacted at the annual meeting. It may also include any other matter deemed by the Board of Directors to be essential to the general welfare of the UMAA.

ARTICLE XI. PARLIAMENTARY PROCEDURES

In the absence of rules in this Constitution of the Association, the proceedings of the Board of Directors' meetings, as well as the Association meetings shall be conducted in accordance with established parliamentary procedure.

ARTICLE XII. AMENDMENTS

This Constitution may be amended at any regular business meeting of the Association at which there is a quorum, by a two-thirds vote of the members present, provided the Board of Directors has previously considered the merits of the amendment.

ARTICLE XIII. FINANCIAL RESPONSIBILITY

Except by the specific direction of the Board of Directors under their personal individual financial responsibility, no debt or other financial obligation of this Association shall be incurred by this Association beyond the amount of the funds (over and above all liabilities) then in the hands of the Secretary-Treasurer.