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Edited by

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TABLE OF CONTENTS

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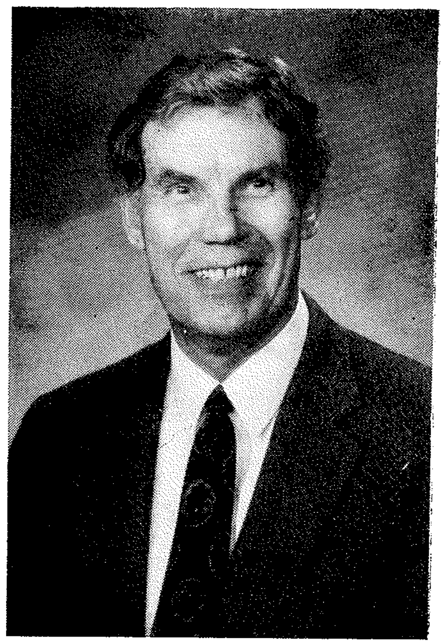

Dr. David Bruce Francy

DR. DON M. REES

MEMORIAL AWARD

This award was created in 1987 by the Utah Mosquito Abatement Association to acknowledge exceptional contributions to mosquito control in Utah. The award honors **Dr. Don M. Rees**, 1901-1976, who was often referred to as the "Father of Mosquito Abatement in Utah."

The 1990 Don M. Rees awardee, **David Bruce Francy**, received his MS degree in Medical Entomology at the University of Utah under the supervision of Dr. Don M. Rees. He later obtained a Masters of Public Health and a Ph.D. at the University of California at Berkeley where he worked closely with William Reeves. At present he is an Epidemiologist with Veterinary Services, U. S. Department of Agriculture. Prior to 1990 he served as Chief, Arbovirus Ecology Branch Division of Vector-borne Viral Diseases, CDC, Fort Collins, Colorado from 1982-1990 and from 1974-1982 as Chief, Vector Ecology Investigations Section, Vector-borne Diseases Branch, CDC, Fort Collins, Colorado.

Dr. Francy is an internationally known expert on the ecology and control of vector-borne viral diseases and has served as a consultant and researcher throughout the Americas and many foreign countries. He has presented inventational papers to agencies and associations throughout the United States and in Canada, Mexico and other foreign countries. He was instrumental in establishing an effective arbovirus surveillance program for the districts of the Utah Mosquito Abatement Association and has attended and presented papers at many of the annual meetings of this association.

Dr. Francy served as president of the American Mosquito Control Association, 1976-77, and the West Central Mosquito and Vector Control Association, 1977-78.

He has published more than 80 scientific papers on the epidemiology of vector-borne virus diseases. These publications have greatly advanced our knowledge of arboviruses and their arthropod vectors.

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. This award was first presented in 1970. **Lynn M. Thatcher**, in 1990, becomes the 19th individual to receive this award.

Lynn M. Thatcher is known by most of the members of the UMAA. Mr. Thatcher is well known for the quiet and unselfish way that he has fought for a strong mosquito abatement law and a high standard of mosquito control in Utah.

Mr. Thatcher served as a member of the Salt Lake City M.A.D. Board of Trustees from 1976 until 1991. His original appointment was made to fill the vacancy left by the passing of Dr. Don M. Rees. Prior to his appointment to the Board and the last several years, Mr. Thatcher has served on the UMAA legislative committee often lobbying on the behalf of mosquito control.

RELATIONSHIP BETWEEN JACKRABBIT POPULATIONS AND CALIFORNIA SEROGROUP VIRUSES IN WESTERN UTAH

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Recently, John S. Allan, U. S. Army Ecologist, sent us a manuscript by Eberhardt & Van Voris (1986) that was prepared under Dugway, Utah Environmental and Ecology Branch contract to the U. S. Department of Energy. They plotted Jackrabbit densities in western Utah from 1965-1985, the same time span as our mosquito-arbovirus studies (Elbel 1986, Elbel et al. 1989) which show that California serogroup (CAL) viruses in western Utah are not affected by climate, particularly at Blue Lake where CAL viruses and *Aedes dorsalis* are abundant in the flooded saltgrass at the lake margin. Blue Lake is a spring-fed marsh, 17 miles south of Wendover, Utah, on the western boundary of the Great Salt Lake Desert. Professor James L. Lords, University of Utah, asked if CAL virus abundance was correlated with Jackrabbit cycles. Our study is an attempt to answer that question.

Changes in Jackrabbit population densities were monitored on 119 permanent transects, each 1.6 km long in typical rabbit habitat in western Utah. During March and August of each year, a survey team of a truck driver and 2 observers drove over the transects during daylight hours when weather conditions were favorable. The surveys showed for March the number of Jackrabbits entering breeding and for August the productivity for the year. Mean values for the ratio of rabbits/transects/season were calculated as indices to Jackrabbit density which, for this paper, were averaged into one yearly index (Table 1). Statistical analyses using either the March or August index alone gave similar results. Mosquitoes were collected yearly during one or more of the months from May through September. CAL virus-*Ae. dorsalis* infection rates (isolations/mosquito x 10^3) were calculated as yearly totals for each of Blue Lake and the entire western Utah including Blue Lake (Table 1): In 1965 these infection rates included Western equine encephalitis and unidentified viruses. We used the Spearman rank correlation test to compare CAL virus-*Ae. dorsalis* infection rates and to examine associations between infection rates and indices to Jackrabbit densities for Blue Lake and western Utah.

The following data is illustrated in Figure 1 which was prepared by Kerry Matz, University of Utah. The peaks and lows in the CAL virus-*Ae dorsalis* infection rates were not significantly higher for Blue Lake then western Utah but the 1967 value for Blue Lake was almost 4 times that for western Utah. Both infection rate cycles were positively correlated (r_s = 0.71, $p < 0.05$) and both cycles are necessary to explain gaps in the mosquito-arbovirus survey. For instance, what happened at Blue Lake in 1966 when we surveyed only at Callao, a small farming community east of the Deep Creek Mountains in western Utah? Since the infection rate was low at Callao, it was probably low at Blue Lake. What happened in western Utah in 1983 when we surveyed only at Blue Lake? Since the infection rate was low at Blue Lake, it was likely low in western Utah. When the CAL virus-*Ae. dorsalis* infection rates were highest, 1967, 1976 and 1984, Jackrabbits were at the lowest part of the cycle but when the infection rates were lowest, 1970, Jackrabbits were approaching the highest part of the cycle, 1972. During the second and longest high of the Jackrabbit cycle, 1979-1982, there was no mosquito-arbovirus survey and at these meetings in 1985, Crane said that although we did not know what happened during the 6-year lapse, the sequence of virus isolations suggested an ascension of virus activity from 1 CAL isolate in 1983 to 66 CAL virus isolations in 1984 (Crane et al. 1985). Examination of the Jackrabbit cycle gives a good idea of what happened to CAL viruses during that 6-year lapse. Jackrabbits began to rise in 1977 so the infection rates probably started to decline from the 1976 peaks. In 1983 Jackrabbits were in the middle of a sharp crash but the index was still high so the infection rate at Blue Lake was still low. By 1984 Jackrabbits had reached the bottom of the cycle which explains the high infection rates but why did they decline in 1985? The CAL virus- *Ae. dorsalis* infection rates each rise and fall in a step rather than a straight line. The decline in 1985 is similar to the decline from the highs of 1974 to the lows in 1975 before the steps up to the 1976 peaks; Jackrabbits were low for these 3 years, 1974-1976. Therefore, lows in the infection rates in 1985 were likely just steps on the way to peaks in 1986 while Jackrabbits were still low. John S. Allan (personal communication) confirmed the low in 1986, the last year of the Jackrabbit survey. Similarly, the infection rate decline at Callao in 1966 was just a step on the way to the peak of 1967 when Jackrabbits were low. As Jackrabbits started to rise in 1968, the infection rates each declined with a step in 1969 on the way to the 1970 lows when Jackrabbits were high. Although CAL virus- *Ae. dorsalis* infection rates and Jackrabbit cycles appeared to be inversely associated, Spearman rank correlation tests were not significant.

According to Crane et al. (1983), precipitin tests indicated that most of 164 feedings by *Ae. dorsalis* were on rabbits at the marshes of Blue Lake and Fish Springs National Wildlife Refuge on the southern boundary of the Great Salt Lake Desert and cattle at Callao. Also, precipitin tests on an engorged abdomen removed from each of 2 CAL virus positive- *Ae. dorsalis* pools indicated prior feeding on rabbits at Blue Lake and cattle at Callao. If Jackrabbits are presumed hosts of both CAL viruses and *Ae. dorsalis*, why don't the peaks and lows in the CAL virus- *Ae. dorsalis* infection rates and the Jackrabbit cycle coincide? Crane et al. (1977) demonstrated transovarial transmission of California encephalitis subtype virus in *Ae. dorsalis* at Blue Lake and they suggested in 1983 that CAL viruses may be maintained in this manner regardless of climatic conditions or availability of hosts. Tesh & Shroyer (1980) maintained San Angelo (CAL) virus in *Ae. albopictus* by transovarial transmission and the virus was still lethal to newborn mice after 14 serial transovarial passages in *Ae. albopictus*. They suggested that arthropods may serve as both vectors and reservoirs of viruses. Reeves (1988) in his talk here stated that the reservoir of infection for CAL viruses was the vector because of transovarial transmission from female vectors to their progeny, a very effective mechanism to maintain virus infection. If the inverse trend in Figure 1 is real, transovarial transmission would seem to be more important than the host. Whether or not there is statistical concordance between CAL virus- *Ae. dorsalis* infection rates and Jackrabbit densities needs further study.

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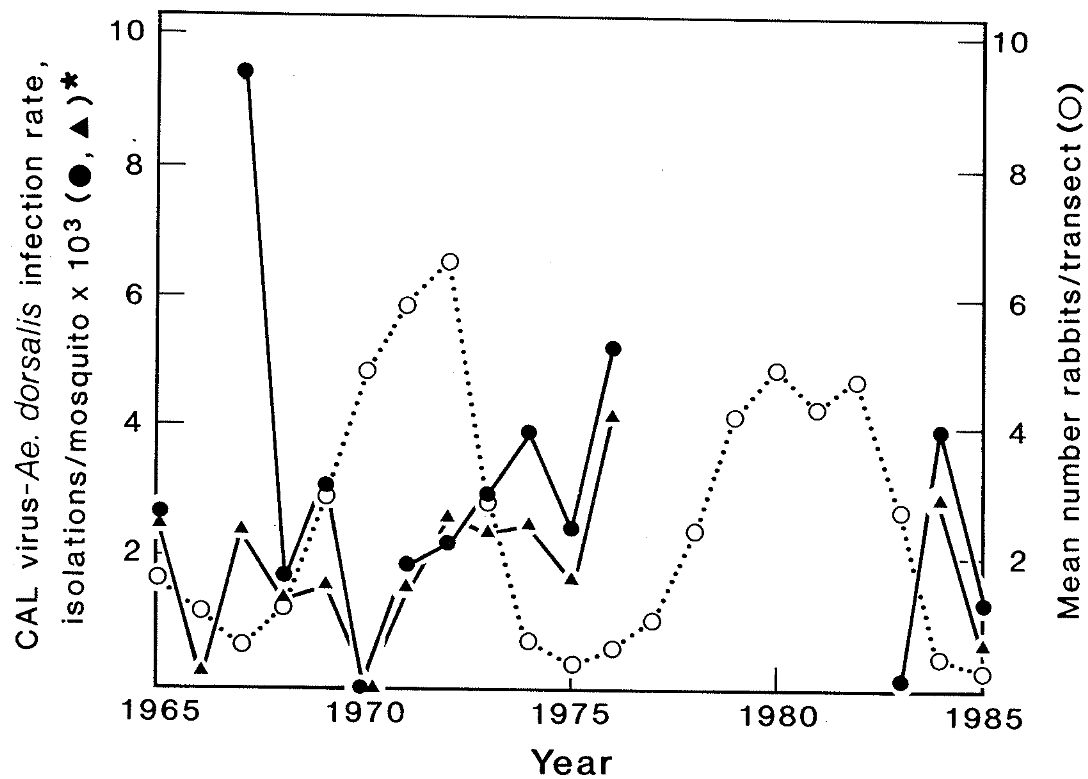
Table 1. California serogroup (CAL) virus- *Ae. dorsalis* infection rates and indices to Jackrabbit densities in western Utah from 1965-1985.

	Jackrabbit Population indices	CAL- *Ae. dorsalis* infection rate Blue Lake	W. Utah
1965	1.58	2.71	2.48
1966	1.15	-	0.21
1967	0.68	9.34	2.42
1968	1.20	1.72	1.32
1969	2.87	3.01	1.56
1970	4.81	0	0
1971	5.80	1.88	1.54
1972	6.43	2.16	2.62
1973	2.84	2.89	2.37
1974	0.71	3.89	2.51
1975	0.38	2.43	1.65
1976	0.60	5.18	4.13
1977	1.04		
1978	2.28		
1979	4.14		
1980	4.80		
1981	4.24		
1982	4.68		
1983	2.71	0.12	-
1984	0.50	3.93	2.88
1985	0.26	1.27	0.66

Figure 1. California serogroup (CAL) viruses in *Aedes dorsalis* compared with indices to Jackrabbit densities in western Utah from 1965–1985.



* ● Blue Lake, ▲ western Utah

FORTY-ONE YEARS OF YARD SPRAYING BY A MAD

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The Box Elder County Mosquito Abatement District began a yard spray program in Box Elder County over forty-one years ago, three years after mosquito control began. The main target for this program was flies in dairies, barns and private homes. However, over the past fifteen years, the district has been asked to treat for most bothersome insects around the outside of the home. The District does not conduct inside structural pest control, even though I am certified and licensed to do so.

During the first twenty-five years of this program, there were a few conflicts with the private pest control industry. Meetings were held, complaints, and even threats in some cases, were received over the years. However, a mutual understanding was finally realized after the executive board and I met with these people on several occasions. Since we don't conduct inside pest control and we don't advertise, the private sprayers didn't exactly agree with our program, but they finally accepted us, and we get along very well together.

There are more private pest control operators in the county now than ever before. I am sure they are doing okay.

This program pretty well pays its own way, and generally no tax monies have to be drawn upon to finance this operation. Several years ago, that was not the case. This program was going into the red several thousand dollars each year, and had to be subsidized. With some major changes in the program in 1982, and a very supportive executive board, we were able to turn this program around to where we end up in the black at the end of each season. The program is very popular in Box Elder County.

Up until just a few years ago, District yard spray crews spent approximately 70% of their time making door-to-door contacts with the public, and only 30% of the time was spent doing the actual spraying. They also spent a lot of time broken down, with old equipment. That has all changed with more modern equipment and a very efficient preventative maintenance program.

Door-to-door contacts are not a thing of the past, except in a very few instances. There is simply no time for this. Most spray requests now come to the office by phone, fifteen to twenty a day throughout the summer months. Crews do an average of twenty-five to thirty total jobs a day.

The crews are kept very busy handling the call-ins and have little time for door-to-door contacting. Before a yard is sprayed, the operator inspects the yard and surrounding fence lines making sure no beehives or small animals are present.

The property owner signs a release and the licensed operator sprays the yard with Diazinon, following strict quidelines set forth by the District, and of course, following label instructions. Training is extensive for these crew members.

The District treated 1,343 individual yards in twenty-one cities/towns during 1990, utilizing five power sprayer equipped trucks and a five man crew.

This program will continue in 1991; however, with the ever increasing complex environmental issues, only time will tell what the future holds. The high cost of liability insurance for this program is also a determining factor for the future.

EFFECTS OF THE BACTERIAL INSECTICIDE, Bacillus sphaericus, ON SOME AQUATIC NON-TARGET ORGANISMS

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ABSTRACT

Bacillus sphaericus is considered to be the most promising biological control agent for mosquito larval control and was expected to have no effect on aquatic non-target organisms associated with mosquito larvae. Therefore, an attempt was made to determine the toxicological effect on 4 species of aquatic non-target organisms, *Toxorhynchites splendens*, *Daphnia magna*, *Poecilia reticulata* and *Crothemis servilia*. There was no effect caused to the non-target species by *B. sphaericus* at the concentration of the 0.02 mg/l which is the level required to control mosquito larvae or at 300 times that concentration (6.25 mg/l). Each of the non-target species together with its prey was exposed to the same dose of *B. sphaericus*. Some mortalities were observed and varied with the exposure time. *B. sphaericus* seemed to have more adverse effect on *T. splendens*. A clearer understanding of the larval midgut physiology may show some mechanisms responsible for the increased mortality in this species. Infected larvae were offered to the non-target species and resulted in higher mortalities in all organisms except *T. splendens*. This seems feasible as the ingested larvae may have had a lethal amount of *B. sphaericus* or the amount in the larval midgut may have multiplied. However, it would appear that additional studies are needed to confirm the safety of *B. sphaericus* to non-target organisms in various conditions of simulated and field trial.

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CURRENT CONTROL PRACTICES AND RESULTS FOR 1990 IN BLACK FLY CONTROL IN SALT LAKE COUNTY

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The statement by Fredeen (1987) stating "our black-fly-management operating plans have never stabilized. Adjustments have been required every year to accommodate changes in ecological conditions in the river system, in species of black flies with new pest potentials, in monitoring and control strategies, in chemicals available for use as larvicides and adulticides, in licensing procedures for larviciding . . .," seems to be the premise that the South Salt Lake County Mosquito Abatement District has been trying to prove the last 10 years.

Recognizing the habitats of black flies as areas where water moves at sufficient speed to provide oxygen and suspended detritus for developing larvae attached to any available object, almost every moving source of water in the County has been observed to foster black fly populations. The obvious sources: the river, canals, streams and major irrigation systems are monitored and treated periodically and have been over the past several years. The concern now is the numerous lateral irrigation and drainage ditches that run continuously that haven't been located. The area of the Jordan River that flows from Utah Lake to the south of Salt Lake County to the County line and water sources along with several stretches of banks of known streams also provides populations of black flies that do not get treatment for several reasons.

Add to the above problem of several untreated water systems, the change over to a biological larvicide as the exclusive pesticide, the success of the program is still a frustration as the season nears the end.

Several factors have been addressed to try and modify the problems plaguing us from past years. The continuing problem of water with high amounts of suspended solids will always be with us. To kill black fly larvae, sufficient pesticide needs to be introduced into the water to provide enough particles of the insecticide to be selected along with all other indiscriminate suspended material the fly ingests. With high silt load, the black fly ingestion of silts, etc., is facilitated rapidly and then seems to shut down feeding for a short period of time (Colbo and Wotton, 1981). Kurtak (1978) suggests that individual black fly larvae catch only 1-10% by weight of the material passing over their fans. Though Kurtak further points out that high turbidity can increase the effects of an insecticide, he also points out the increased concentrations of particles on the fan surface beyond 200 particles/fan area/second for small particles reduces efficiency of ingestion. This problem of high concentrations of silt, etc., suspended in the water column may cause black fly larvae to feed sporadically (shut down due to overload for periods of time) reducing further the available pesticide with which to effect control.

Bacillus thuringiensis serovar. *israelensis* was tested in the heavy silt-laden environment of the South Jordan Canal in 1986 under the direction of Mitch Rohlfs, a Research Specialist with Abbott Laboratories. The South Salt Lake County Mosquito Abatement District conducted tests along a one and one half mile stretch of this canal using black plastic straps one half inch by 18 inches that were submerged 1 to 6 inches deep in the water (the depth varied as the canal fluctuated). The actual test was conducted when the monitors achieved 100-200 larvae/strap. The dosage rate of B.t.i. was 10 ppm trickled into the canal via a carboy for 10 minutes. Three monitors were located at one fourth mile intervals downstream from the treatment site. Monitors read 24 hours later indicated less than a 20% kill. Dr. Rohlfs concluded that the extremely high silt load was too heavy to permit larvae a sufficient chance at enough toxic crystals to effect a reasonable kill.

In spite of this evidence, B.t.i. needed to be the insecticide of choice for the Jordan River because of its fisheries potential. With water flows ranging from less than 5 cfs up to 100 cfs, the very rocky bottom of the river was exposed and provided excellent habitat for black fly larval attachment as did vegetation on the river bottom and along the banks that trailed into the water. Very gradually the river stairsteps its way to the north end of the valley. These "stairsteps" or trickle areas provide sufficient water velocity to encourage large numbers of black flies to lay their eggs along these sites. In between the trickle areas exist stretches of almost calm water (less than 1 fs) extending 100-200 yards long. These calm water areas seem to be the bane of the treatment program along with the heavy silt load in this area of the river.

Simulium vittatum, Zetterstedt, has been the only species found in the Jordan River in current collecting. Kurtak (1978) has pointed out that *S. vittatum* functions better in slower moving streams (30 cm/sec) as opposed to *Simulium pictipes*, Hagen which is a swift water inhabiter and is at 50 to 70 cm/sec level. *S. vittatum* also have short microtrichia (mount fans) of 7 microns compared to the longer heavier microtrichia of the *S. pictipes* which are 15 microns long. Slow water dweller fans are smaller and more delicate. With the very small amount of the catch (1-10% of particles by weight passing over their fans), *S. vittatum* larvae may need to be exposed to large quantities of crystals to effect sufficient control to satisfy the program and the taxpayers.

These observations led us to change two aspects of our treatment procedure. Last year concentrations at 30 ppm of B.t.i. was added to the heavily silted water with 10 ppm being used on the clear mountain streams entering the valley. During periods of high siltation of the Jordan River and side canals due to high winds agitating the shallow Utah Lake bed, 30 ppm provided from 0-80% control. Many stretches of canals had less than 20% control during these periods allowing large numbers of adult simuliids to emerge.

This year the dosage was increased where necessary to affect better control. Kurtak (personal communication) suggested going as high as necessary (100 ppm) to realize desirable control to satisfy the needs of an area. This can be justified, we feel, because there needs to be sufficient crystalline material to compete with the other suspended solids in the indiscriminate method of feeding utilized by the black fly larvae.

The second change was to cut down on the amount of pesticide used, for economic reasons. Since there doesn't appear to be any environmental impact using higher concentrations, a slug method of treatment was used to introduce the liquid quickly. Hopefully this provides sufficient insecticide in the water column passing the fly larvae that enough crystals should be ingested to produce a high mortality. The time saved, too, from having to drip the material over an extended period, has been beneficial.

Another concern addressed over the past 2 years is the drift phenomenon. Where sufficient concentrations of B.t.i. had been used to provide good control, monitors with large numbers of larvae would show excellent results (80-100% control) but would show 30-50% reinfection rates within 24 hours. This repeated observation led us to question how efficacious our original counts were regarding control. Was there drift reinfection immediately after release due to the chemical and if so how much? Was there enough drift to severely distort the post treatment data? Monitoring straps, 1 left with larvae attached prior to treatment and 1 placed 3 inches away on the same plane in the water indicated as high as 30% reattachment of drifting larvae. The problem to address now is did the chemical promote a catastrophic drift or was this just normal diurnal drift typical of the species? Further testing will be necessary to allow more accurate data collection.

A third factor causing considerable annoyance was the sudden appearance of large numbers of black fly adults after what appeared to be a successful larviciding season. Prior to 1979, when black fly control started officially, Dr. Bettina Rosay found black fly adults in the light trap catches continuously. These flies are not readily attracted to light traps so this could have been an indication of high numbers of black flies available for indiscriminate trapping. Subsequent light trap catches, after the full time program started in 1979, showed no appreciable numbers caught until July 14, 1988, when 5 of the 13 traps sampling caught 79 adult flies. The trap near the districts sentinel chicken flock in the southeast quadrant of the district caught 32 of that number. This trap seems to be significant because on July 16, 1988, over 1000 adult flies were trapped. On August 1, 1988, several hundred were counted (no specific numbers) in this trap and less than 10 in a trap approximately 14 miles to the northwest quadrant of the district.

In 1990, large numbers of black flies did not appear until the 20th of August, a delay of the problem for some 40 days. At that time the black fly adult populations increased dramatically.

The Salt Lake Valley has a unique feature due to the geology of the area being formed by a large prehistoric lake. The sand deposits (silt) from this large lake at the south end of the valley have formed hills which have created a funnel effect on the wind patterns. There is a natural flow of air from south to north along the valley floor and the Jordan River drainage. South of the "Narrows," as this region is called, lies the untreated portion of the Jordan River upstream to Utah Lake, its water source. Wind patterns at Brigham Young University weather station indicated winds gusting as high as 64 mph on August 19, 1990, with wind averaging over 35.3 mph for the days of August 18-20, 1990, not counting the gust high readings in the gusting periods. This caused high wind warnings to be issued for that part of the north Utah County and south Salt Lake County. The prevailing wind patterns for this area are a southerly flow in the 15-25 mph range. By the 19th and 20th of August, reports from those monitoring the adult fly populations started calling in reports indicating increasing numbers of black fly adults. Dubitskii (1978) reports the passive dispersal of simuliids is well known, winds carrying them long distances, as much as 50 km distant in 24 hours. He also states, however, that the nature of any given biotype has a bearing on the numbers of black fly concentrations, which vary appreciably even in closely adjacent locations.

This is definitely the case in Salt Lake Valley from neighborhood to neighborhood. One or two blocks distance between observers brings very differing reports.

Because there were relatively few adults over the entire valley floor prior to the wind storm and large numbers spread over the length and breadth of the County afterwards leads one to believe we'd been had by Mother Nature.

Subsequent sampling of the larva habitats did not show any noticeable change in pupal populations that would have accounted for such sudden, large concentrations of adult flies.

CONCLUSION:

Black flies continue to be a source of vexation in the Salt Lake Valley. The use of the biological larvicide B.t.i. has proven successful where applied at sufficient concentrations to be available to the nonselective feeding black fly larvae. Suspended particulate matter continues to be a serious deterrent to successful treatment procedures. Long stretches of inaccessible ditch banks probably add measurably to the adult population.

A continual effort to understand drift, both of larval and adult populations must be made in order to provide efficacious data pertinent to the long range control of black flies in Salt Lake County. Better use of available resources could be utilized if more accurate measurements of larval populations can be ascertained.

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HIGHLIGHTS OF CURRENT ENTOMOLOGICAL RESEARCH ON Culicoides IN THE USDA AGRICULTURAL RESEARCH SERVICE

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The USDA-ARS Arthropod-borne Animal Diseases Research Laboratory (ABADRL) represents a multidisciplinary effort on the part of entomologists, virologists and veterinarians to understand and eventually control arthropod-borne diseases in animals.

The ABADRL entomology section is investigating the population biology, population genetics, systematics, vector ability and control of *Culicoides variipennis*. This species is the principal vector of bluetongue virus (BTV) in North America. BTV causes bluetongue disease in domestic ruminants resulting in economic losses to the U. S. livestock industry estimated at $120 million annually.

In order to understand arthropod-borne disease cycles like bluetongue disease, information concerning the arthropod vector, the pathogen and vertebrate host is required. Controlling arthropod vectors of disease has historically been, and remains, the most effective means to control epidemic disease. ABADRL's research on vector biology, systematics and genetics seeks to provide new insights about arthropod vectors which will offer novel means of insect control. Insect control will be efficient when it is directed only at those populations which are potentially dangerous, and this depends on both environmental and genetic factors. In addition, we seek to use insect genetics to devise novel insect control strategies. Consider controlling a dangerous vector population by releasing genetically engineered inefficient, less dangerous insects. Consider the possibility of releasing genetically engineered insects which would make natural populations of vectors more amenable to biological insect control strategies, such as being more susceptible to parasites and predators.

Current investigations of *C. variipennis* population biology have focused on the use of more efficient insect trapping techniques to provide efficient insect surveillance (Holbrook and Bobian, 1989). In order to understand the epidemiology of insect borne diseases, such as bluetongue, it is necessary to understand the movement of infected and non-infected insects. As a result ABADRL is using rare elements, such as rubidium, to mark individuals in field populations of *C. variipennis* to obtain information on migration (Holbrook et al. 1991). Biological control strategies using genetically engineered pathogens are being investigated, and management strategies are being designed, and tested, under varying geographic conditions.

ABADRL is utilizing several techniques to understand the population genetics and systematics of *C. variipennis*. Currently isozyme electrophoresis has been used to analyze genetic variation at 21 different enzyme including genetic loci (Tabachnick 1990) from more than 50 populations of *C. variipennis*. These populations were collected from different geographic locations in the U. S. Analyses of genetic differentiation at these loci have demonstrated the existence of at least three subspecies: *C. variipennis variipennis*, *C. v. sonorensis* and *C. v. occidentalis*. Several isozyme loci have been identified which completely discriminate between allopatric populations of the different subspecies. These loci are being analyzed in populations where it will be possible to determine the extent of gene flow between the subspecies. Preliminary laboratory and epidemiological evidence suggests that *C. v. sonorensis* is a much more efficient vector of BTV than the two other subspecies.

Analysis of *C. variipennis* are underway to determine environmental and genetic factors controlling different components of vector competence for BTV. ABADRL is primarily interested in understanding the genetic control of oral susceptibility to infection with BTV. Several selected lines of *C. variipennis* are maintained at ABADRL which are genetically homogeneous for either susceptibility or resistance to infection with BTV. Susceptible lines average 80% infection, while resistant lines are only 10% infected. Genetic crosses between these lines have demonstrated that this variation is controlled by a single genetic locus. Further studies of this locus and environmental effects are underway.

In order to isolate other genes important in *C. variipennis* vector competence ABADRL is constructing a genetic map of the species using DNA restriction fragment length polymorphisms (RFLPs) as markers. A genetic library of random *C. variipennis* DNA fragments has been constructed and these fragments are being used as DNA probes to screen *C. variipennis* individuals for RFLPs. Already several RFLPs have been identified. Such markers will be used to further study genetic variation in natural populations and will also be used to locate a variety of other genes important in vector ability.

Medical and veterinary entomologists have a great deal of work to do to develop the predictability of arthropod-borne disease cycles and sophisticated, efficient, environmentally sound control strategies which I have alluded to in this paper. However, recent and continuing advances in biological technology, genetics and entomology offer new avenues of research which will allow us to reach these goals. Genetic maps will become available for arthropod disease vectors and these maps will be used to isolate genes and environmental factors which are important for vector ability. Genes which are isolated in one species will be circulated among research groups to be screened in a variety of other species. The use of DNA probes no longer poses a species barrier to the exchange of information to other arthropod systems. Findings in species like *Culicoides* will be directly useful to speed work on species of *Aedes, Culex* and *Anopheles* and vice versa. Ultimately genetic and environmental factors will be used against arthropod disease carriers in a variety of new approaches. The future looks very bright for entomology and eventual control of vector-borne disease.

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A FIRST SEASON REPORT ON A VIRAL BLUETONGUE DISEASE VECTOR CONTROL PROGRAM IN UINTAH COUNTY, UTAH

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An extensive and in recent times unprecedented epizootic of vector-borne viral bluetongue disease in Uintah County, Utah sheep occurred in the late summer and autumn of 1989. The outbreak, as primarily centered in the eastern Uintah County farming community of Jensen, involved approximately 1,500 infected sheep, with mortality occurring in about 10% of the total infections. The initial onset of the disease was recorded in mid September, with the peak number of clinical manifestations occurring in early October. A localized epizootic of such intensity is, in recent times, unprecedented for the state of Utah as typically, viral bluetongue disease is widespread, but usually far more sporadic in its geographic occurrence and relative numbers of cases reported in any region per given season.

Bluetongue is a noncontagious, vector-borne viral disease of domestic sheep, cattle and goats, as well as wild ruminants. Locally, sheep have been most obviously impacted due to their inherent tendency to manifest severe clinical symptoms of the disease. Infections in cattle may be demonstrated via the real possibility of stillbirths and severe congenital deformities in newborn calves. There is some local concern for the potential impact of bluetongue upon deer and introduced Mountain Sheep populations.

Typically, the vector-borne infection cycle involves the spring or summertime acquisition of the virus by the primary biting gnat vector, *Culicoides variipennis* (Ceratopogonidae) by way of feeding upon reservoir cattle, some of which serve as the initial source of infection for vector populations in any given season. The virus is then amplified in the salivary glands of the vector which, through subsequent blood feedings transmits the disease to other cattle and highly vulnerable domestic sheep populations. The transovarial transmission of bluetongue virus in *Culicoides variipennis* is unknown, and has been considered as unlikely (Jones and Foster 1971). Secondary infections may also occur in cattle from generation to generation via reproductive routes, as transplacentally from cow to calf or from bull to cow, in semen (Luedke and Jones 1984). No vaccine is available for the Jensen, Utah viral strain (serotype 11).

In view of the uncommon severity and urgency of the Jensen, Utah bluetongue outbreak and the possibility of even greater incidence of the disease in the 1990 and future seasons, the Uintah County Mosquito Abatement District elected to integrate first-time bluetongue vector control measures into its 1990 mosquito and Mormon cricket control program. Operational, logistical and financial projections indicated that such a program, with initial emphasis placed upon the approximate 30 square kilometer area encompassing the existing epizootic might be successfully implemented without compromising the overall efficacy of the District's far greater, county-wide mosquito/vector control program. Essentially, the specialized vector control equipment, field personnel and supportive resources were already in place, as historically, the Jensen area in question was already subject to regular and intensive mosquito/vector control operations. The program as planned represented the first of its kind in the state of Utah, as specifically targeting the ceratopogonid bluetongue disease vector, *Culicoides variipennis*.

In cooperation with the Uintah County Mosquito Abatement District, the 1990 Jensen epizootic was closely monitored with the invaluable expertise and assistance of personnel representing the USDA Agricultural Research Service Arthropod-borne Animal Diseases Research Laboratories (Laramie, Wyoming). That cooperative work included initial and followup blood drawings from and serological analysis of sentinel sheep from the impacted Jensen area, production of laboratory reared Jensen, Utah strain adult *C. variipennis* at the Laramie facility for genetic and vector competence studies, and virus detection analysis of Jensen light trap collections of the vector, as regularly supplied by the Abatement District. Those Laramie researchers provided Abatement District personnel essential on-location instruction and assistance in specialized *Culicoides* field ecology, habitat recognition and current field sampling techniques.

Regular advisory contact was established and maintained with local veterinarians and the Utah State Veterinarian.

The Abatement District's primary objectives for the first season's (1990) *Culicoides variipennis* control program included:

1. A systematic biosurvey of the impacted area encompassing the Jensen epizootic for determinations of those *Culicoides* species present, and the relative abundance of the same.

2. Location and documentation commencing in February, 1990, of those critically important primary overwintering sites for larval *C. variipennis* populations.

3. Progressive and season-long location and mapping of those primary sources responsible for the continual production of successive broods of that extremely prolific and multibrooded vector.

4. Systematic destruction with subsequent regular maintenance control of those larval *C. variipennis* populations (hand and ATV dispersal of 1% Temephos sand granules) immediately following field and laboratory confirmation of the significant presence of the target organism.

5. Limited truck-mounted ULV adulticidal malathion applications in those regions known to bear significant adult *C. variipennis* populations as may occur in the course of necessary but infrequent adulticidal mosquito control operations within that identical area.

6. Limited hand larvicidal/pupicidal applications of approved suffocant oil to those infrequent sources which under very atypical circumstances may bear *C. variipennis* populations in association with target mosquito larvae/pupae, as confirmed to occur within the identical source.

7. Regular, season-long CDC light trap collections (baited with approximately 1 1/2 kilograms of dry ice) specifically deployed for Jensen *Culicoides* surveillance (4 CDC traps within the impacted area).

8. Incorporation of *C. variipennis* surveillance measures into the District's existing New Jersey light trap adult mosquito surveillance program on a full, county-wide basis (11 New Jersey traps).

9. Planning for, and possible implementation of any *C. variipennis* source reduction/physical prevention measures as may be feasibly addressed during the first season of operations.

10. Close and regular working contact with local farmers, ranchers and property owners for purposes of promoting local awareness of the existing problem, and communicating those farm/ranch *Culicoides* prevention techniques and procedures which might be independently implemented by those persons.

An estimated population of 4,000 - 8,000 Jensen sheep might conceivably be exposed to possible *C. variipennis*-borne bluetongue virus infection in any given season, as inclusive of permanent or long-time resident flocks, transient flocks and those very significant numbers of sheep which in the past have been reintroduced to the Jensen epizootic area in late summer and early autumn (with immediate exposure to the virus-laden vector), from mountain and other summer range.

The Jensen, Utah area, as initially impacted by the 1989 epizootic is best described as a somewhat sparsely populated rural farming community, the eastern boundary of which is established by the northeast-southwest flow of the Green River - a major Utah drainage system. Primary agricultural crops include alfalfa, corn and some assorted grains. Cattle and sheep are raised extensively throughout the area. Dominant non-agricultural vegetational types include great expanses of salt grass, dense stands of tamarisk and to a lesser extent, intermittent growths of cattail and willow. Flood irrigation practices for crop production are very extensive, and in combination with surface water sub-up common to water table fluctuations, is conducive to a mosquito/vector and other biting fly productive potential easily comparable to the greatest per given area in the Western U.S. The Abatement District's Jensen, Utah vector-borne encephalitis surveillance sentinel chicken flock yielded positive seroconversions for both Western Equine and St. Louis Encephalitis in 1986, and Western Equine Encephalitis in 1987 and 1990 as an obvious function of that region's productive capacity for the mosquito vector, *Culex tarsalis*.

The initial 1990 field location, documentation and mapping of larval *C. variipennis* sources impacting the epizootic area quickly proved very challenging, yet operationally rewarding. As anticipated, some obviously important aquatic developmental sites were located which demonstrated the classic *C. variipennis* habitat common to a highly exposed, finely particulate, heavily polluted and fully hydrated substrate (foul, soupy muck) as may often be associated with stockyards and livestock watering areas. Such typically important sources, though determined to be somewhat uncommon locally, demonstrated enormous vector productive potential per unit surface area presented. The largest well defined and most productive of such sources (encompassing an immediate area of approximately 0.1 hectare) bore estimated larval populations in some selected sample sites within that source which readily numbered in the tens of thousands of developing larvae per square meter. In view of the season-long and multibrooded reproductive capacity of the vector, such larval habitat could only be described as staggering in overall productive potential.

The systematic location and subsequent maintenance control of locally "atypical" larval sources proved far more challenging and operationally difficult. Intensive, season-long field surveys of likely *C. variipennis* larval habitat throughout the general area of the epizootic yielded numerous additional sources, all of which were of significance in producing the overall vector population common to that region. Many were small (a few square meters or less) but extremely productive "island" sources, as randomly spaced throughout vast areas (kilometers) demonstrating the reasoned potential for generating at least isolated and well hidden, but vitally important populations of vector larvae. Often, large multihectare areas yielded only small, sparsely populated pockets of larvae. Larval sampling techniques, sample frequencies and overall field survey procedures, though time consuming and tedious (from the culicidologist's perspective) were adapted to and considered appropriately thorough for the diverse field circumstances as encountered in the course of the initial *C. variipennis* survey/control work.

Complete species determinations of season-long 1990 carbon dioxide-baited CDC light trap surveillance collections from within the confines of the Jensen epizootic area yielded only two *Culicoides* species. A total of 76 trap nights yielded 29,085 *Culicoides*. Of that total collection, 99+% were the viral bluetongue disease vector, *C. variipennis*. The remaining species *Culicoides crepuscularis*, proved scarce and elusive, and was thus only sporadically represented. Other Ceratopogonidae common to the Jensen, Utah area include species of plant-feeding *Dasyhelea*, and extremely abundant populations of blood-feeding *Leptoconops*. Uintah County-wide New Jersey light trap Mosquito/*Culicoides* surveillance data indicate that with only one regional exception, the great bulk of *C. variipennis* vector production is occurring within, or in very close proximity to the Jensen epizootic area. This still very questionable supposition (inadequate sample sites for entire county) is based upon season-long unbaited New Jersey light trap collections from 11 sites representing 202 cumulative trap nights. Eight of those sites are located at least several kilometers from the Jensen epizootic area, while the remainder are placed in selected Jensen locations. Of a total county-wide seasonal collection of over 56,500 *C. variipennis*, only 3% of those vectors were collected from the 8 sites as located at great distance from the Jensen area. These very preliminary data can be generally correlated with the incidence of bluetongue disease in Uintah County, which currently is largely though not exclusively confined to the immediate Jensen area.

For the 1990 season, a total of 114 cumulative acres of enormously productive larval *C. variipennis* habitat were systematically treated (inclusive of repeat applications to the same sources as may have been required) with public health pesticides for purposes of bluetongue disease suppression. Maximally productive *C. variipennis* larval sources were, due to highly specialized physical and chemical requisites, far less common and usually much smaller in area than those larval mosquito sources as regularly occurred within the same general region.

The 1990 onset of viral bluetongue disease in Jensen sheep was first reported on August 15th. The reported and professionally confirmed incidence of the disease accelerated thereafter, with new cases being sustained through September of that season, to culminate in a total of at least 900 sheep having presented mild to severe clinical symptoms of the disease. Total mortality of those afflicted animals was estimated at about 3%, as compared with an approximate 10% mortality common to the 1,500+ Jensen sheep having contracted bluetongue disease during the first onset of the epizootic in 1989. Following onset of *C. variipennis*-borne disease in 1990, and with high numbers of Jensen sheep sustaining bluetongue infections, at least 2,000 lambs and yearlings were intentionally withheld from reintroduction to the Jensen area, as from distant summer range, until the cessation of *C. variipennis* activity in October. Had this action not been taken by some local ranchers, significantly higher total infection rates would have undoubtedly occurred.

The 1990 reoccurrence of very high numbers of bluetongue infections in Jensen sheep did not happen as a complete surprise for those Abatement District personnel involved in that first season's *C. variipennis* control program. Throughout the season, all larval vector sources were placed under immediate maintenance control following their initial discovery and documentation. Due to their very widespread (about 30 square kilometers), elusive and often highly cryptic disposition in the field, several probable overwintering, as well as seasonal *C. variipennis* sources were not located until the mid to latter part of the summer, and thus generated successive adult broods throughout a significant portion of the season. Numerous smaller, though very important sources are no doubt still at large. Monthly adult *C. variipennis* averages for all carbon dioxide-baited Jensen CDC light trap nights were 44, 318, 585, 486 and 281 for May, June, July, August and September, respectively. During the 4th week of July, and prior to the discovery of the contributing breeding source, one unbaited Jensen New Jersey light trap yielded over 14,000 *C. variipennis* females and males in a single trap night. Although very real and substantial technical and biological progress had been made in the course of the 1990 control program, adult vector populations had obviously survived those first season control procedures in numbers more than sufficient to result in a prohibitively large number of diseased Jensen sheep. No *C. variipennis* light trap data are available, for comparative purposes, for the 1989 epizootic season, as prior to the initiation of the vector control program in 1990.

The authors believe that there is good reason for optimism for the 1991 season, in that it represents the very first in which the Uintah County Mosquito Abatement District will enjoy the distinct operational advantage of having a prior season's cumulative knowledge of the geographic locations, local ecology and relative productive potential of numerous major *C. variipennis* sources. Those, as well as new sources will be addressed by personnel who will be well experienced in those highly specialized field techniques and procedures as essential for effective large scale control of the vector.

Culicoides variipennis
Control Objectives for 1991

1. Maintenance of the close, cooperative and essential working field/research relationship with USDA Agricultural Research Service Arthropod-borne Animal Diseases Research Laboratories (Laramie, Wyoming) personnel, as initially established in 1989.

2. Immediate larvicidal control (projected as commencing in early March) of those few, but extremely important larval sources as determined during the prior season to be highly probable larval overwintering sites. Control procedures to begin immediately following confirmation of overwintering status therein.

3. Immediate as well as maintenance larvicidal control, as indicated, of all currently known seasonal sources, as prior to any adult emergence.

4. Continued and ongoing field location, mapping and documentation of new, and as yet undiscovered larval *C. variipennis* overwintering and seasonal sources, with the theoretical goal of locating all significant aquatic sources within the general area of the epizootic, as followed by regular maintenance larval suppression via chemical or physical means.

5. Continued training/*Culicoides* field orientation of all Abatement District personnel, as previously designated - for combined mosquito/*C. variipennis* field surveillance and control.

6. Continued vector-specific regular season-long CDC light trap surveillance of *C. variipennis* populations, with immediate emphasis upon the Jensen epizootic.

7. Continued New Jersey light trap surveillance (as previously incorporated into the District's existing mosquito/vector surveillance program) on a county-wide basis. Larvicidal measures for *C. variipennis* to be implemented in other regions of Uintah County as may be indicated by adult vector surveillance and/or incidence of significant clinical manifestations of bluetongue disease.

8. Maintenance of regular advisory and working contact with local veterinarians and the Utah State Veterinarian.

9. Continued public education and working contact with local farmers, ranchers and other property owners as operationally indicated, with emphasis upon those independent or cooperative *C. variipennis* source reduction/physical prevention measures which might be implemented.

ACKNOWLEDGEMENTS

Grateful appreciation is extended to F. R. Holbrook Ph.D., and research, laboratory and field personnel representing the USDA Agricultural Research Services Arthropod-borne Animal Diseases Research Laboratories (Laramie, Wyoming) for their invaluable counsel and assistance during the implementation of the first season, 1990 *Culicoides variipenis* control program.

The authors wish to thank Ed W. Oscarson, DVM, Vernal, Utah, for his expertise, professional counsel and regular assistance throughout the course of those field and research procedures as addressing the 1989-90 Uintah County, Utah vector-borne viral disease epizootic.

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CANINE HEARTWORM INFECTION

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Heartworm in dogs is a disease complex caused by the filarial worm, *Dirofilaria immitis*. The adults occur primarily in the right ventricle of the heart, and the pulmonary artery. Adult females are about 27 cm long and they discharge microfilariae into the bloodstream of the animal.

The microfilariae develop further only when ingested by various mosquito species. The most common species in our area is *Culex pipiens*, which is very active along the Wasatch Front. Within the mosquito, development from the microfilariae to the infective larvae is completed in about 2 weeks. The infective larvae then migrate to the mouth parts and gain entrance into the dog when the mosquito feeds again.

The immature stages develop and grow in the intramuscular fascia or subcataneous tissue for approximately 2 months and then begin migration to the right ventricle, for the worms to reach maturity. Thus, microfilariae first appear in the peripheral circulation about 6 months after infection. Adults may live and continue to produce microfilariae for several years.

In the USA, it occurs frequently in all mosquito-infested areas. Previously, it appeared to be endemic mainly in the southeastern states, with the prevalence in mature dogs kept outdoors reaching as high as 50%. It is now nearly as common in wide areas of the Atlantic states, the Midwest, and Canada where high mosquito densities occur.

CLINICAL FINDINGS:

Physical examination and a thorough history usually will indicate gradual weight loss, decreased exercise tolerance and cough aggravated by exercise. In advanced cases, dyspnea, increased temperature, abdominal fluid, cyanotic mucous membranes and periodic collapse may occur. Dirofilariasis may be complicated by various cardiac problems.

In the acute hepatic syndrome, the adult worms obstruct the posterior venacava causing sudden onset of critical signs, hemoglobinuria, and death with 24-72 hours due to hepatic and renal failure.

DIAGNOSIS:

Identification of *D. immitis* microfilariae in blood samples confirms the provisional diagnosis based on history and clinical signs. Heartworm microfilariae are differentiated from microfilariae of *D. reconditum* by size, shape, and movement (Table 1).

To complicate diagnosis some dogs (15 - 20%) do not exhibit circulating microfilariae, thus the term "occult infection." The diagnosis is then based on history, clinical examination, thoracic radiographs, and serological test.

TREATMENT AND CONTROL:

Because of the serious sequelae that may be associated with treatment, prevention is preferable. Unfortunately, protection from mosquitoes involves mosquito control and confinement of dogs, which may not be possible and daily administration of diethylcarbamazine orally.

TREATMENT FOR PREVENTION:

1. Diethylcarbamazine orally. Daily administration beginning prior to and continued for two months after the mosquito season, which kills the infective larvae on their migration to the heart.

2. Ivermectin. Given at 30-day intervals. It should be noted that it is very necessary to perform tests for microfilariae in the blood before either one of these tests is begun.

TREATMENT FOR ADULTS:

Arsenamide is the drug of choice for adult worms. The drug is potentially nephrotoxic and hepatotoxic. This requires pretreatment evaluation of liver and renal functions.

TREATMENT FOR MICROFILARIAE:

1. Dithiazanine iodide. Microfilaricidal treatment should follow adulticidal treatment within 3-6 weeks.

2. Levamisole has been reported to be an effective microfilaricide but may have central nervous system side effects.

SUMMARY:

1. Heartworm infection in local dogs has occurred in the past 3 years in two defined areas of Utah. Number one area, 8 dogs located from Layton to Hooper (Table 2).

2. One dog in Payson, Utah.

This infection appears to be associated with the warmer areas along the shores of the Great Salt Lake and Utah Lake. Also I think there is a connection between the transient population in the Hill Field area. It is very common for families to move in and out of the air force base frequently.

Table 1. Differentiating characters of microfilariae.

	D. immitis	*D. reconditum*
Anterior end	Tapered head	Blunt head
Posterior end	Straight	Sometimes hook-shaped
Movement in blood	Wriggling in place	Forward movement
Size	315 x 6-8	270 x 5-6

Table 2. ***Dirofilaria immitis*** infections diagnosed from canines in Utah.

Date of Diagnosis	Probable Area Acquired	Veterinarian
7-01-87	Clearfield	Richard Winward
3-15-89	HAFB out of state	Richard Winward
7-27-89	Payson	James Barton
8-12-89	Syracuse	Richard Winward
3-17-90	Layton	Richard Winward
3-24-90	Layton	Calvin Richards
4-27-90	Layton	Evan Gubler
5-07-90	West Point	Richard Winward
6-21-90	Layton	Kathy Ford
8-06-90	S. Carolina	Richard White
9-06-90	Clinton	Denzel Taylor
9-18-90	Texas	Barton

STRAW ITCH MITE (*Pyemotes*) INFESTATION OF FARM WORKERS IN IDAHO

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As you can see from the title, my topic has nothing to do with mosquito biology and control. However, some of our mosquito control people in southern Idaho are receiving calls about this problem, so I offer this information for whatever use it may be.

We have recently experienced a number of cases of dermatitis caused by the straw itch mite, *Pyemotes ventricosis*. Since the calls we were getting involved people in the alfalfa seed and leafcutting bee industry important in our area, we made it a point to follow up on some of the reports.

First - a little background review on the straw itch mite. It is not a new problem and seems to occur sporadically in many locations. It is fairly well documented in the text books where it is associated with insect infestations and with stored grain insects in particular. It is also associated with farm handling of hay and straw, hence the names of "hay itch" and "straw itch." The mites attack insect larvae whereupon they feed and ultimately destroy the insect host. Man and animals are also subject to attack when in contact with insect infested grain or straw products. The mites, Family Pyemotidae, are extremely small, from .1 to .2 mm in length and very difficult to see with the naked eye.

The recent infestations in Idaho started coming to our attention in 1987 with most of them in 1989. Several individuals indicated they had experienced the problem in 1985. This mite was responsible for a moderate to severe dermatitis. In all cases that we investigated, the dermatitis was experienced by farmers and hired workers associated with management of leafcutting bees.

Alfalfa leafcutting bees, Family Megachilidae, are intensively managed and used for pollinating alfalfa grown for seed throughout the northwestern states of Washington, Oregon, Nevada, Montana, Idaho and the west most provinces of Canada. It is only half the size of a common honey bee. Since its accidental introduction into the U. S. in the 1950's and the realization of its value as a pollinator, this bee has become the focus of a multi-million dollar industry.

Some quick background on the biology of this bee: The bees are active from June through August when they cut leafpieces to form individual cells which are provisioned with pollen and nectar. One egg is laid in each cell before it is sealed and the next one begun. After the nesting and pollinating season, the bees diapause and overwinter as larvae in the leafpiece cells. There is one generation per year. In nature, the bees utilize holes of approximately 1/4 inch diameter in wood posts, trees, etc. for their nest sites. Commercially, they are provided with wood boards drilled with thousands of 1/4" holes for nesting purposes. More recently, the industry has moved to using drilled polystyrene foam blocks and other materials for bee nesting sites in commercial fields. Bee boards are placed in field shelters of various types and designs for the summer pollinating season.

Many growers use movable bee shelters designed to be transported from field to field as the need arises. The shelters contain 20 to 50 bee boards or nesting materials. During the active season, there may be several hundred thousand bees active around each field shelter.

A quick summary of bee management and how this fits into the straw itch mite problem: Bees are placed in the field shelters for the pollinating season. After the season, the bee boards with newly made and provisioned bee cells inside are removed from the field and stored in a sheltered and secure location. We strongly recommend winter storage at near freezing temperatures of 35-38 degrees F. to reduce pest insect problems. In the spring the bee boards are allowed to incubate naturally until adult bee emergence, or more commonly they are incubated in enclosed buildings at 85 degrees for 21 days to synchronize bee emergence all at one time when the alfalfa field is in bloom. During these late spring and early summer time periods is when the intensive handling of bee materials and management practices by farm workers takes place. Also, this is when the recent straw itch mite cases have been noted.

Recent human involvement with the straw itch mite in Idaho has in all known cases been associated with handling or management of leafcutting bee boards or other nesting materials or equipment. The problem varies depending on the source of the bees. Bee boards filled with developing bee larvae are a valuable commodity in the Northwest and are bought and sold on a large scale basis. Bee transactions of several hundred thousand dollars or larger are common. So there is a lot of interstate and international (from Canada) transport of bees in the Pacific Northwest. Most of itch mite problems came from bees managed and handled locally. The source is probably not as important as the practices utilized by individual farmers.

In our 1989 survey of farmers reporting dermatitis, we were able to interview 22 individuals. Eight of these had been sufficiently severe that they had sought medical attention. The two cases that were hospitalized were misdiagnosed as scabies. Several others were tested and were negative for Lyme Disease and released. We feel there were many other dermatitis cases of varying severity that were not reported to us. Typically the symptoms were single to multiple bites on the covered areas of the body, especially around the belt-line and around the wrists of those wearing long sleeved shirts. Also on the legs from the knees down. All interviewees reported very intense itching which often resulted in a heavily scabbed dermatitis and secondary infection. This lasted 2 to 3 weeks. Most affected workers discontinued working with bees and improved quickly. Not all workers in a location were bothered by the mites. Some workers in a group were affected while others doing the same work were not.

One fellow had been severely affected with the mite during the early summer of 1989 and would not allow us any photos at that time. A photo of the same individual taken during the 1990 season indicated a less severe infestation. He indicated that while these bites itched, it was nowhere near as bad as he had experienced in 1989.

We feel the itch mite problem is one of proper bee management and bee sanitation. The root of the problem is that there are 30 plus insect parasites and predators associated with leafcutting bee boards including many of the classical stored product pests such as grain moths, flour beetles, etc., which are the classical hosts of straw itch mites. In spite of continued recommendations to the contrary, many bee producers do not exercise proper bee management sanitation by destroying old nesting materials and keeping the pollen and leafpiece debris cleaned up in the field shelters and work areas. Most large scale bee producers and farmers refrigerate the bee boards over winter. Where this practice is not done, various bee parasites and predators are very prevalent. In addition to bee losses, this situation provides a ready source of insects for itch mites when other conditions are favorable.

We feel it is important for many reasons to destroy old bee boards such as this to prevent bee losses due to pest insects and diseases. The itch mite associated with the pest insects is added reason to manage better. Another management problem is the leafpiece and pollen debris that accumulates in field shelters. This is attractive to stored product insects which in turn may be a ready source of itch mites. Some seed producers and bee managers clean field shelters religiously. Others do not.

We feel the itch mite problem is preventable with proper bee management and attention to bee sanitation.

1. Susceptible individuals should avoid working near leafcutting bees during the early season.

2. Bee board handlers and associated farm workers should wear loose fitting clothing.

3. We have made an attempt to promote awareness in the leafcutting bee industry by way of newsletter and paper information.

Our conclusions are that this is not a new problem although itch mite involvement with leafcutting bees and associated pests is unique and not well reported in the literature. We feel there are no long-term effects and that the problem is preventable with proper bee management.

AGGRESSIVE HOUSE SPIDER (*Tegenaria agrestis*) A REVIEW OF SPIDER BITE CASES AND OCCURRENCE IN THE PACIFIC NORTHWEST INCLUDING A RECENT CASE IN BOISE, IDAHO

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The aggressive house spider, *Tegenaria agrestis*, is increasingly being recognized as a major case of necrotic arachnidism or necrotic spider bite, a situation in which a necrosis or sloughing of skin around a spider bite occurs. Dr. Roger Akre of Washington State University is the individual in the Pacific Northwest (PNW) who has done most of the work with this spider and with whom we have cooperated to gather information for Idaho.

This spider belongs to the very common spider family, *Agelenidae*, the funnel weavers or funnel web spiders. There are a number of genera in this family but the one we are concerned with here is the genus *Tegenaria*, the so-called "house spiders." In the United States there are 7 species, only 1 of which is native, the others being of European origin.

Three species of *Tegenaria* are found in the Pacific Northwest. The domestic house spider is the most common and is probably distributed far beyond the PNW. The gigantic house spider is much more limited being found only around the Seattle area so far. The bites of these species have not been found to be important in any way. Either the bites are extremely infrequent or innocuous or both.

The aggressive house spider *Tegenaria agrestis*, is so named because of its great tendency to bite when trapped in clothing or when pressed against the skin. In caged tests, it has been shown to be somewhat more aggressive and willing to bite than the other members of the genus. In the literature it is also referred to as the "Hobo Spider," indicating the belief that it has migrated along rail routes and readily enters homes. The markings are quite distinctive and allow a person familiar with spider classification keys to key them out fairly readily.

This spider was first recorded in the United States near Seattle in the 1930's, then at these other locations by the mid 1960's. It is now found in many homes in Washington, Oregon and Idaho, and in fact is considered the most common spider in homes in the Moscow-Pullman area.

A female *Tegenaria agrestis* remains in a funnel shaped web characteristic of the family. Like other members of the family, they capture and feed on insects and other arthropods that wander into their web. In this respect they are definitely beneficial.

Wandering males seeking females during the late summer and early fall seem to be the most important in terms of bites. Whereas females tend to stay in the web, wandering males may inadvertently get into clothing or bedding and be brought into contact with human skin more readily. Firewood with an unseen spider being hand carried into a home has been indicated in a few cases as the method of contact.

This brings us to the reason for concern, the fact that the bites of some species of spiders result in a condition of necrotic sloughing of the skin around the bite over a period of several weeks or months of very slow healing. These symptoms are typically attributed to the brown recluse spider which does not occur in the PNW or anywhere nearby. The only positive record of brown recluse is from central Washington in packing boxes recently brought from the Southeastern U. S. In spite of several instances of presumed spider bite with classical necrotic symptoms reported by physicians insisting the cause to be brown recluse, we have felt it not to be the offending spider. Other than the bite symptoms, which may be caused by several spider species, a good case cannot be made for the brown recluse being the cause. *Chiracanthium* (Family Clubionidae) another spider capable of producing the necrotic symptomology is present throughout the northwest but is more rare. Since preparing this talk I have learned this spider is much more prevalent in southern Idaho than previously thought. Although found around homes, its contact with humans is much less frequent. With Dr. Akre's work at Pullman, and recent papers by Dr. Darwin Vest reporting on southern Idaho bite cases, *Tegenaria agrestis* is the most likely culprit. It is a rather common spider, especially when the homes of bite victims are examined.

The bite symptoms are as noted. In most cases the victim does not notice the bite, at most a pin prick sensation. Within 30 minutes, an enlarging red area around a small "pimple," followed by blistering within 15 to 30 hours. After 24 hours the wound tends to ooze fluid. Over time the lesion tends to slough necrotic tissue and scab with difficulty.

In the cases examined by Drs. Akre and Vest, there is a lot of variation in symptoms as one would expect in different people. Consistently though, the lesion reaches a size of one-half to one-inch in diameter and tends to be oval in shape. In almost all cases investigated, the wound did not completely heal for 3 to 6 months.

Systemic illness may or may not accompany the bite. However, the most common symptom is a severe headache occurring usually within 10 hours that does not respond to the usual headache remedies. The headache may persist for several days and may be accompanied by weakness, nausea, and temporary vision impairment. Symptoms resemble those of migraine headaches. Bites by this spider have not caused any deaths. It is interesting to note that in Europe, their area of origin, there are few records of bites by these spiders causing any medical problems.

In the case in Boise in 1987, we did not recover a spider as the woman did not notice symptoms for a couple of days until she discovered the small lesion while bathing. She recalled having seen a brown spider on the bedding but did not kill it. Without prompting, she recalled a very slight pin prick bite but thought nothing of it for a couple of days. When the bite began to blister, she consulted her physician who treated the wound for bacterial infection. She was ill with flu-like symptoms for several days. Based on the typical symptomology, this bite is attributed to *Tegenaria agrestis*. In the recent case in Boise, the bite lesion formed a scab approximately 3/4 inch long and 1/2 inch wide and finally healed in about 4 months.

The problem we have been having in the Boise area is one of misinformation. At least one pest control operator (PCO) perhaps more, has been waging a scare campaign to sell his pest control services. We have had several articles in the local paper and media explaining the actual situation which should not be alarming to the public.

Our position has been this: We know this spider to be a fairly common one in the area. It tends to prefer structures for its nesting and living. Although it is disposed to bite more readily than others, it certainly is not aggressive in that it seeks out humans to bite (as had been suggested by the pest control person). Only a small number of people are bitten by this spider and fewer yet develop clinical symptoms. Bite situations are actually quite rare.

As one of the county extension people in Boise has said: "Getting bitten is about as likely as getting struck by lightning." This is probably fairly accurate.

Another problem is one of identification. All funnel weaving spiders or all brownish grey spiders become the "aggressive house spider." No amount of evidence convinces some PCO's that a given spider is not the aggressive house spider but rather some innocuous funnel weaver.

The latest flap in Boise has resulted in some beneficial side effects. It has raised the public awareness of spiders and provides us the opportunity to warn them about some things, but to also instruct as to the beneficial value of most spiders.

Our recommendations are to use rational controls. Do not spray indiscriminately to eliminate all spiders. Use mechanical controls where possible to eliminate specific offending spiders. Inspect homes for entry points. Repair openings where spiders and insects may enter. Inspect firewood for spiders or egg sacs before bringing into the house. Use a vacuum cleaner to remove spiders and webbing from crawl spaces beneath homes and other areas. And where persistent problems occur with numerous spiders or constant entry into living areas, household insecticides are warranted. Dursban, Baygon, and some of the pyrethroids are commonly used by PCO's with varying success.

AROSURF, AN ALTERNATIVE LARVICIDE

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Midwest Spraying & Supply, Inc. (MSSI) is a distributor of insecticides and is located in Long Lake, just outside of Minneapolis, Minnesota. MSSI is the national distributor of Arosurf, MSF Larvicide/Pupicide. Sherex, the manufacturer of Arosurf MSF, is located in Dublin, Ohio, and is a subsidiary of Schering Berlin A.G., a West German pharmaceutical company.

Arosurf is an exciting new tool for use as a larvicide/pupicide in integrated mosquito control programs. What may surprise you is that this product has essentially been on the market for over 20 years, typically sold as personal care emollients in products such as bath oils, skin lotions, and other cosmetics.

It is a non-petroleum, bio-degradable, non-polluting surface active film. It was not until 1976 that Arosurf MSF was discovered as a mosquito control agent, by the U. S. Navy. This came as a spin off of using mono-molecular surface films for the containment of oil spills. During their work, the Navy noticed a significant reduction in the volume of adult mosquitoes. In an oil spill, oil is already on the water, which some of you would consider a good larvicide; however, when they used Arosurf, they noted a reduction in mosquitoes. Using extensive laboratory and field tests, Arosurf MSF was found to be a very effective non-chemical agent for controlling a broad spectrum of mosquitoes. This led to a 1977 patent now held by the U. S. Navy.

When applied to a mosquito habitat, Arosurf spreads spontaneously and rapidly over the surface of the water to form an ultra-thin film that is one molecule thick. That is why it is called a mono-molecular film. The spread rate is about 28 ft/minute on 90 degree water--16 ft/minute on 33 degree water. This can be easily viewed by placing a few grams of baby powder on the water surface and then adding a couple drops of Arosurf in the center of the powder. The Arosurf will quickly spread, pushing the powder away.

Unlike some other larvicides, Arosurf is not a chemical and does not kill by a toxic reaction. Arosurf slightly changes the surface tension of the water. This change is from about 72 dynes to about 28 dynes/cm. Larvae and pupae cannot attach themselves to the surface, their breathing tubes become wetted and they drown. Since the kill mechanism is strictly physical, i.e., drowning, resistance of any kind is not expected to develop. In addition, floating egg rafts and adult mosquitoes that oviposit or rest on the water surface will sink and drown.

This statement that adults landing or eggs deposited on Arosurf treated water will sink is an interesting statement. In a test using *Culex quinquefasciatus* (*pipens* to some of us northerners) adults died while alighting on water samples treated with Arosurf more than with GB-1111 or GB-1356. The control had five males, 0 females that drown, at 1 ul/cm^2; Arosurf drown 69 males, 72 females, GB-1111, 0 and 0, and GB-1356 2 and 0.

But there is something very unusual with this information that was not even mentioned in this research article. There also appeared to be an extremely high attraction to the Arosurf treated sample, away from the other samples. Whether it was due to the fact that Arosurf is invisible, and non-petroleum, or that there were certain odors involved, no one knows. I do feel the researchers doing this discovered a unique phenomenon but didn't follow up on it. Regardless, it does prove that Arosurf sinks adults and egg rafts.

When I first started studying Arosurf a couple of years ago, I had many of the same questions you have; most basic was, "did it work?" Here are some of the effects I've discovered.

1. A stiff breeze will move the Arosurf to one side of a lake or pond. It will rapidly respread once the wind calms but, obviously, a steady wind for many days can be a problem.

2. Cleanliness of equipment is very important. Because the base product is similar to a skin cleanser, any contact with contaminants may form a mayonnaise looking product that is a job to clean up. Arosurf tends to clean your equipment of rust and dirt--so use clean equipment.

3. The third effect I noted was both a detriment and a bonus. The material once applied is completely invisible. Unlike petroleum products that create a sheen on the surface, Arosurf cannot be seen. To check for the presence of Arosurf, place a drop or two of indicator oil

from a plastic eye dropper bottle onto the water surface. If the indicator oil spreads, then there is no Arosurf present. If the indicator oil forms a tight bead and does not spread, then you know that the Arosurf is present and there is no need to retreat that area.

4. Arosurf is an excellent pupicide and pupae will usually fall to the bottom in just a matter of hours. In the 4th instar and pupal stages where the larvae have stopped feeding and chemical larvicides are ineffective, Arosurf works excellently. On the other hand, I've found 1st to 3rd instar usually take 24-72 hours to be completely controlled. If you are used to dipping a few hours after treatment and finding dead larvae, you'll have to exercise your patience a little.

5. Many districts have found that the combination of a slow release larvicide such as 30 day B.t.i. briquets and Arosurf give results that are better than the individual sums. That is, if product A will kill 5 larvae and produce B would kill 5 larvae, the two in combination instead might kill 14 larvae. Levy et al. (1982) state that results of tests of the combinations, at application rates that were at or below label recommendations for each product, indicated that formulations of Arosurf MSF and commercial B.t.i. would produce significantly better control of mixed developmental stages of mosquitoes than either of the formulation components.

I have talked to many districts and generally have found that no product currently available is the answer to every mosquito control problem. These same districts, many of whom had not tried Arosurf, told me that when things were getting out of hand, they were able to quickly regain control by applying Arosurf right through the pupal stage. Once convinced, they quickly added Arosurf to their regular program, many times in combination with a slow release B.t.i.

I would recommend that if you have not previously used Arosurf, you consider adding it at least on a testing basis to your program. In the next few years, it may turn out that environmentally speaking, Arosurf may be one of the few remaining products you will have available in your arsenal. You should be familiar with it.

Let me close by stepping back into the salesman role and tell you a quick little story of why I like to offer Arosurf. In Minnesota, I have many unorganized customers, such as cities and towns, golf courses, recreation areas, etc. I don't have the time to teach them, and they don't have the time to learn the biology and entomology of mosquito control. However, because Arosurf lasts up to 10 days, I can tell them that any time they get any significant rainfall that might produce larvae, two days later, just go out and apply Arosurf. If they are a day or two early or a day or two late makes no difference; they have a long window and they'll get the control. The same philosophy might apply to your operations. If you can't be everywhere at once, you can apply Arosurf early and control larvae & pupae, and you can apply Arosurf late and still control pupae. It would also be an excellent product for you to hand out to home owners, etc.

Let me volunteer 3 or 4 questions that are asked over and over again--which must mean they are of fairly general interest.

A. Can Arosurf be used on fish bearing waters? Yes. Fish hatcheries find Arosurf about the only product they can use. Fish testing was done at 10 times maximum label strength with many fresh and salt water species. Five of the control group died, but none of the treated samples showed any sign of stress.

B. Can Arosurf be used on waste water effluents, where pH and oxygen levels must be maintained? Yes. Arosurf does not affect the pH or oxygen content of water.

C. What effect does Arosurf have on non-target species? The only non-target species that it is possible to affect are those that operate at the water/air interface, such as water skippers, spiders, etc. However, most of these are much bigger than the mosquito and displace much more water. Thus, they usually are not affected by Arosurf. In essence, Arosurf has literally no ill effects.

D. How does water temperature affect Arosurf's effectiveness? The effects of temperature on Arosurf requires a more detailed explanation--you also have to constantly keep in mind that we are working with a product that deprives the larvae of oxygen. Therefore, any other factors that affect the oxygen availability will also affect the results; for instance:

   1. As larvae progress through the 4 instar and pupal stages, their oxygen requirements rise considerably. Arosurf will be most effective when oxygen requirements are greatest.

   2. A 30 degree rise in water temperature will double the oxygen rate uptake of larvae. Therefore, if you are using a product that denies oxygen, it will work twice as fast.

3. Surface tension of water is inversely related to temperature. The hotter the temperature, the less surface tension already present on the water. Therefore, if Arosurf lessens surface tension, there will automatically be still less surface tension in hotter weather.

4. Salinity is inversely related to dissolved oxygen. Increase salinity-decrease oxygen. Therefore, there is less dissolved oxygen available in salty water, so again larvae may be more susceptible to oxygen depriving products.

5. Photosynthesis (plant growth) produces an increase in pH; as pH increases, dissolved oxygen, especially as CO_2 decreases. Therefore, the high level of photosynthesis will assist an oxygen depriving product.

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