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About the Cover: William Gorgas, tasked with reducing the spread of deadly mosquito-borne diseases during the US construction of the Panama Canal, relied heavily on the techniques of Rutgers professor John B Smith. Smith had also pioneered legislation for the creation of county mosquito control programs, which led to the creation of the New Jersey Mosquito Control Association 100 years ago. The original editorial cartoon by Peter B McCord depicted Uncle Sam standing in the Panamanian Isthmus shouting “Tell Jersey we need her mosquito man Smith!” The cover image was created by Ary Farajollahi and James Pulaski.

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Mosquitoes have been the scourge of mankind well before recorded history, and in the United States, New Jersey has long been considered the original “Skeeter State.” Perhaps it is our unique geography with five distinct physiographic provinces, starting with heavily glaciated valleys and ridges in the north to the outer coastal plain in the south, which provide ample larval habitats for over 60 species of mosquitoes. Or perhaps it is our vast human population density, close proximity to population centers in New York City and Philadelphia, large tourism needs, desire for comfort, or even sensational politics which have paved the way for New Jersey to claim the title of the Skeeter State.

Whatever the reason, New Jersey has paved the way to control mosquitoes effectively and efficiently. Most would agree that New Jersey is the birthplace of what we now know to be the modern mosquito control movement.

Mosquito control is a science, and has its roots in the field of medical entomology. We would not be in the position that we are in, if it were not for such giants as Sir Patrick Manson, Carlos Finlay, Albert Freeman Africanus King, Ronald Ross, Battista Grassi, Walter Reed, and William Crawford Gorgas. These men successfully incriminated mosquitoes as vectors of disease and threats to public health, which highlighted the need and importance for organized mosquito control. The great work of these men set the stage and responsibility for another group of entomologists, public health authorities, politicians, and reformists (primarily in New Jersey at that time) to launch the professional mosquito control movement.

The initial days of professional mosquito control in New Jersey were led by such individuals as: John B Smith, a Rutgers entomology professor who understood the importance of biology/ecology and the need for practical methods of control; Thomas Headlee, successor to Smith and a natural leader whose inventive approach and entomological/political skills were instrumental to the birth of modern mosquito control; and Tommy Mulhern, the assistant and protégé of Thomas Headlee whose relentless drive, ingenuity, and dedication transformed surveillance and control methodologies.

These men laid the foundation for the development of mosquito control in New Jersey. The movement was officially born in 1912, when Governor Woodrow Wilson signed the bill authorizing the creation of mosquito commissions, and the birth of the New Jersey Mosquito Extermination Association soon

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followed. This movement had soon expanded to other states such as California, Utah, Florida, and Illinois. A national agenda for mosquito control was forming and the leaders from the New Jersey Mosquito Extermination Association, along with representatives from other states, assembled in Trenton on 26 June 1935 to form a new organization called the Eastern Association of Mosquito Control Workers. It was this association that in 1944 was officially renamed the American Mosquito Control Association.

The stories of these men and mosquito control grace the pages of this special issue of Wing Beats dedicated to New Jersey. We are very grateful to have this opportunity to share a brief glimpse of what New Jersey has accomplished thus far, and what is to come in the future. This issue will not only provide information on the influential figures and the early days of mosquito control, but it will also highlight their legacy and what they have helped to create. New Jersey has been at the forefront of innovative control measures, open marsh water management, vector and disease surveillance, development of adulticides, larvicides, repellents, biological control, and public education. Some of these stories will be shared with you in this issue and in upcoming issues. We hope you enjoy our story, because our history is your history.

The New Jersey Mosquito Control Association is celebrating 100 years of organized mosquito control in 2013. Come celebrate with us at the AMCA Annual Meeting in Atlantic City, NJ!
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The Golden Age of American mosquito control started in 1896 when Rutgers Professor John B Smith turned his attention to mosquitoes; see Figure 1. It was Smith, perhaps more than anyone else, who kicked open the door of mosquito control in the United States. He declared in 1901 that “research must guide the mosquito movement.” Smith resembled Galileo and his telescope: wherever he looked he made a discovery. He conducted pioneering studies on larvicides, tested natural repellents, made the first powdered spray treatment, and was a leading figure in mosquito taxonomy. His extensive studies on mosquito fish made him an early advocate for biological control and open marsh water management. His source reduction program against the salt marsh mosquito, Aedes sollicitans, resulted in five million feet of hand-dug mosquito ditches by 1912. And he conducted educational programs to encourage the public to eliminate backyard mosquito habitats. It is not easy to find something that he did not study first. Yet it is Smith’s background as a lawyer that equipped him for his most important role: mosquito control crusader.

The New Jersey mosquito laws were a direct consequence of Smith’s basic research on mosquito dispersal. Smith’s seminal 1904 report to New Jersey policy makers, The Mosquitoes of New Jersey, established an evidence-based approach that mosquitoes are a state and not a local problem (Smith 1904). Because of Smith, New Jersey became a model for those who came after and aspired to build mosquito control programs.

We can only imagine what this man might have accomplished had he been granted a normal lifespan, rather than dying at age 53, when he was at the peak of his powers in
1912, just nine days before New Jersey Governor Woodrow Wilson signed the landmark mosquito laws that Smith had authored. Smith is richly deserving of the title Father of the American Mosquito Control Movement.

*Between the idea And the reality Between the motion And the act Falls the Shadow*

- TS Elliot

Elliot accurately notes that there often ‘falls a shadow’ between vision and creation. New ideas are only part of innovation. Someone capable of executing that vision is also required. Enter Thomas J Headlee; see Figure 2. Without Headlee, Smith might have been a mere footnote in the chronicles of the Mosquito Crusades (Patterson 2009).

Headlee was appointed head of the Rutgers Department of Entomology and leader of the mosquito program within months of Smith’s passing. He led the department and the program for the next 32 years. Headlee transformed New Jersey into a mosquito juggernaut. Using Smith’s template, Headlee implemented the concept of local mosquito control units, a concept subsequently widely emulated nationally and internationally. This is the most enduring legacy of these two titans of mosquito control.

Gifted with superb leadership abilities, Headlee established the New Jersey Mosquito Extermination Association in 1913, the forerunner for the American Mosquito Control Association. In 1921, Headlee founded the Associated Executives of Mosquito Control Workers, an association for New Jersey’s mosquito superintendents to share their experience and discuss problems of mutual interest. They have met monthly for 92 uninterrupted years. In 1935, Headlee laid the cornerstone for the AMCA when he called New Jersey’s leading mosquito control workers to meet in Trenton with their colleagues from nearby states to form the Eastern Association of Mosquito Control Workers (EAMCW). Of the 25 AMCA Charter Members, 15 founders were from New Jersey, including three from Rutgers: Headlee, Ginsburg and Mulhern. Elected as the first president, Headlee merits the accolade Father of the American Mosquito Control Association.

Among the talented faculty Headlee hired, Joseph M Ginsburg stands out; see Figure 3. Professor Ginsburg devised the first modern mosquito larvicide in the late 1920s, the “New Jersey Larvicide,” a pyrethrum-based larvicide. To learn more about FourStar SBG, contact ADAPCO toll free by phone at (800) 367-0659 by email at info@myadapco.com, or visit us at www.fourstarmicrobials.com.

**Figure 3: Joseph M Ginsburg, pioneer in mosquito insecticide and spray technologies.**

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compound that quickly replaced the existing standards: kerosene and Paris Green (arsenic). He followed this success up with the first adulticide, ‘Flit,’ which became famous worldwide; see Figure 4. Standard Oil & others made a fortune from Flit. Rutgers and Ginsburg? Not so much. In 1930, Ginsburg and his colleagues designed an apparatus for delivering larvicides by airplane, culminating in the first aerial spray application for mosquito control. The research was derided by some as ‘pie-in-the-sky’ or impractical, but by 1947 more than a million acres of mosquito habitat a year were being sprayed from aircraft. Ginsburg was also an early innovator in formulation technology. He was responsible for multiple advances in the development of spreaders and other adjuvants. He delivered the first space spray at an outdoor evening concert in Newark in 1935 with 20,000 in attendance, an experiment extensively and favorably reported in the national media.

Ginsburg was among the first to study and call attention to the impact of chemical insecticides on aquatic nontargets. Then, as today, the world’s most respected scientific journal was Science. Ginsburg published an astonishing five papers in Science:


Joseph Ginsburg may well have been mosquito control’s chief innovator in the 1930s and 40s.

Another Rutgers innovator and a student of Ginsburg, Philip Granett, devised the earliest synthetic repellents in the 1930s, including ‘Stay-Way’ lotion; see Figure 5. This led to Rutgers 6-12 – which went into 150 million bottles of repellent distributed to troops in WWII and was still standard issue in the Vietnam War. Its composition and synthesis were a military secret. Granett contributed to saving countless deployed warfighters from vector-borne tropical diseases. Industry made millions from Rutgers 6-12. Rutgers and Granett? Not so much. Granett’s greatest contribution may have been elevating the study of repellents from an observational
to an experimental science; the methods he established still form the basis for repellent research and development. Granett’s research received significant national attention and he was featured in Life, a famous photographic magazine that chronicled the 20th Century.

Finally, Thomas Desmond Mulhern comes on the scene, a man whose extraordinary journey in mosquito control spanned seven decades and an entire continent; see Figure 6. His story began as a teenager in 1925, when he was a summertime inspector for the Monmouth County Mosquito Extermination Commission. He subsequently enrolled at Rutgers, where Headlee, in another in a series of brilliant hires, added Mulhern as a ‘Drainage Engineer.’ Mulhern soon became Headlee’s administrative assistant, which had an incalculable impact on the trajectory of young Tommy’s life. He was charged with designing and building new mosquito ditching technologies with an eye toward lighter, faster, cheaper ditchers, ditch cleaners, excavators, cranes, and anything that could dig or maintain mosquito ditches; see Figure 7. His contributions included several dike and gate innovations to reduce tidal flooding, most notably his novel self-cleaning ‘inverted siphon’ drainage outlet. Mulhern had a life-long interest in the development of novel spray technologies, including an early thermal fogging experiment in 1941 in which he strapped a spray tank to the front bumper of his state car, threading the insecticide out of the vehicle’s exhaust; see Figure 8.

Mulhern is best remembered for pioneering adult surveillance methodology, especially for inventing the New Jersey Light Trap which became the gold standard for surveillance for the rest of the century. Manufacturers of Mulhern’s trap made serious money selling thousands of units over the next 70 years. Rutgers and Mulhern? Not so much. Yet his genius is seen less in trap design than in his persistent advocacy for using traps to monitor adult populations, eventually overcoming strongly embedded resistance to the idea. It is uncertain who the Father of Mosquito Surveillance is, but a strong case could be made for Tommy Mulhern.

In 1939, an idea was proposed for the EAMCW to become a national organization. Three factions emerged: those like Headlee and Mulhern wanted a national organization, those wishing to merge with the Entomological Society of America, and those against any change that might dilute New Jersey’s dominant role. Mulhern, with a foot in both the academic and operational worlds, gradually reconciled the differences. In 1944, the EAMCW was re-named the American Mosquito Control Association, and the transition from a small regional organization with an in-house
Figure 8: Mulhern’s pioneering 1944 thermal fogging experiment. Mulhern strapped a spray tank to his state car bumper (inset) and ran the spray lines through the engine and out the exhaust, creating an aerosolized spray plume for adult mosquito control.

bulletin to an association and journal of international stature began. Mulhern continued his leadership role throughout the transition, devoting his career to the association and journal, and left a matchless legacy of service.

These five Jersey Giants were unrivaled innovators in public health insecticide development and spray technology, source reduction, open marsh management, surveillance, biological control, repellents, public education and more. They fashioned New Jersey into a virtual toolbox for mosquito control from 1896 until the end of the Golden Age – in 1949. Legends never die. The past is never gone. It is the foundation upon which we build today. The Golden age may have passed but mosquito control remains strong and resilient. May the past continue to provide inspiration for the next chapter in the on-going evolution of mosquito control science.

REFERENCES CITED


Smith, John B. 1904. Report of the New Jersey Agricultural Experiment Station upon the Mosquitoes Occurring within the State, their Habits, Life History, etc. 462 pp.

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How it all began can be summed up in a few words: “It was a real struggle, but one worth fighting for.” One hundred years is a long time to hold consecutive annual meetings. Maintaining that uninterrupted streak during two world wars and a great depression is quite impressive indeed. The New Jersey Mosquito Control Association has done this since its inception on February 21, 1914.

To help put things in perspective, the New Jersey Mosquito Extermination Association held its first annual meeting in the same year that a number of historic events took place: 1) the RMS Britannic, sister to the ill-fated Titanic, was launched in Belfast; 2) the US Post Office first used an automobile to deliver mail; 3) the first ship sailed through the Panama Canal; 4) Woodrow Wilson was inaugurated president; and 5) the assassination of Archduke Ferdinand initiated World War I.

The story leading up to the formation of organized mosquito control has been told quite well by a number of authors, and this article will borrow heavily from their work. The setting is the late 1800s and mosquitoes had long been a problem for the people of New Jersey. They were, in fact, a part of life and always had been, so people simply arranged their lives around them. Areas that were heavily infested were avoided when possible. The general sense was that extraordinary infestations took place at intervals and malaria was a fact of life. It should be noted that few people knew that mosquitoes transmitted disease. Health related plagues were a part of life at the turn of the 19th century and were accepted as something to be endured. Nuisance was the primary scourge attributed to mosquitoes, and through the years, strategies were developed to help lessen mosquito annoyance. As early as 1793 the use of oil on the surface of water was recommended to destroy mosquitoes around the home.

1901 book, “Mosquitoes: how they live; how they carry disease; how they are classified; how they may be destroyed,” reveals the extent of information known at that time; see Figure 1. Surprisingly, Howard outlines in considerable detail a variety of perfectly suitable means to alleviate the mosquito problem around the home and throughout a community. Very little has changed in non-chemical mosquito control after a hundred plus years.

As noted earlier, a handful of individuals believed that work to control mosquitoes could be done and local efforts to alleviate mosquito nuisance through elimination of standing water were underway in parts of New Jersey, but few towns had interest and the media frequently fostered public ridicule on a regular basis. Additional ridicule followed what was perceived as failed attempts when hordes of salt marsh mosquitoes came in from outside areas and took over towns. This often resulted in cutting off funds for upland projects. While basic mosquito biology was understood, the biology of specific pests had not been investigated and floodwater versus permanent water control strategies was unknown at the time.

A number of progressive people, who sought both relief from the tormenting hordes of summer and the possibility to generate additional revenue for their businesses, took up the cause in spite of antagonism by the media and attempted to organize community based mosquito abatement efforts.
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Spencer Miller is credited with initiating the New Jersey anti-mosquito movement by bringing LO Howard, the leading authority on mosquito control in the US, to New Jersey in 1901. After hearing Howard lecture on his recently published book, Miller, who had been having serious mosquito problems of his own, invited Howard to South Orange to speak in front of a group of influential business people. The event was publicized to attract attention and generate interest in the topic. Miller had picked up Howard at the train station in his horse drawn carriage and taken him for a tour around South Orange. The two were lamenting about the horrible mosquitoes on the wing while taking occasion to inspect potential breeding sites on the way to the meeting. When they finally arrived at the hall, turnout was better than expected and newspaper reporters were present. Howard’s lecture “Mosquitoes and the Possibility of their Extermination” went well. At the end of the presentation the South Orange residents organized themselves into a Village Improvement Association and called for mosquito control. The mosquitoes were bad that evening and articles in the local press soon followed, drawing public attention to the matter of mosquito extermination. What form that attention took is a matter of opinion, but it had the attention of a middle aged entomologist who was beginning his second professional career to solve New Jersey’s insect problems.

In April of 1889, John Bernard Smith, a lawyer by training, assumed the position as head of the Entomology Department at Rutgers and was the State Entomologist at the New Jersey Agricultural Experiment Station; see Figure 2. Smith, with only five years of entomological work under his belt, was industriously working on a variety insects of economic importance in New Jersey. He focused his attention on the problems farmers were having and sought practical solutions for the insects that were causing damage. Smith was the right man in the right place at the right time to solve New Jersey’s mosquito control problem.

Smith made good use of his training as a lawyer by drafting, and then moving, beneficial legislation through the state legislative process to make life better for New Jersey residents. The mosquito problem was just one of his projects, but fit his bill nicely. As attention to the mosquito question mounted, Smith conducted scientific investigations into the problem. In 1900 he received a small sum of money from the Experiment Station to begin preliminary investigations into the problem.

Smith knew Howard well from his days working in the US Department of Agriculture, a relationship he maintained throughout his professional career. Both men were well read and understood that mosquitoes could and ought to be controlled. They both understood that basic knowledge of the mosquitoes’ life history...
formed the foundation for responsible abatement. While we generally credit Smith for starting the New Jersey mosquito control movement, Smith in his own writings credits Howard’s “Little Book” for initiating the anti-mosquito movement in the US. Regardless of the beginnings, working together these friends made an unstoppable pair; see Figure 3.

Public support would be needed for their anti-mosquito efforts and Smith capitalized on publicity. He systematically went about attacking the New Jersey mosquito problem using sound science and gifted diplomatic ability. With solid scientific evidence in hand Smith presented a request for considerable state support and in 1902 was awarded a special appropriation from the New Jersey State Legislature “to investigate and report upon the mosquitoes occurring within the state, their habits, life history, breeding places, relation to malaria, and other diseases, the injury caused by them to agricultural, sanitary, and other interests of the state, their natural enemies, and the best methods of lessening, controlling or otherwise diminishing the numbers, injury or detrimental effect upon agricultural, sanitary, and other interests of the state.” What Smith had proposed was a daunting task in and of itself, but what he delivered, considering the challenges faced in just three field seasons, was simply incredible.

Smith’s report (Smith 1904) was destined to become a model for future mosquito control initiatives. He demonstrated conclusively that New Jersey had addressed the topic so completely that it formed the basis of what literally became an instruction manual to obtain successful mosquito control. In short, New Jersey had many more mosquito species than originally thought, but only a few of them were particularly troublesome. More importantly, Smith believed the solution to the mosquito problem presented by these few troublesome species was entirely within reach. Most people had believed that mosquitoes do not migrate far from the breeding grounds. His investigations revealed that some species are capable of extended migrations. This revolutionary new information meant that nearly two thirds of the state was within the flight range of the most pestiferous mosquito New Jersey produced in abundance on its salt marshes. As a result, local anti-mosquito campaigns could not address the source of the main problem. This new information also explained why diligent local efforts had sometimes failed to provide relief; see Figure 4.

In his report Smith declared: “I have spoken of mosquito control rather than extermination, because I do not believe actual extermination is possible in the case of an insect that develops so rapidly and in such a great variety of places. There will always be careless people and there will often be unusual seasons that will give mosquitoes a chance to maintain themselves; but it is quite within our power to deprive them of their larger breeding areas and to reduce them to a point where they will cease to be obnoxious.”

He continued: “It seems clear that the conditions are such as to demand State aid and, perhaps State supervision for the control of the marsh breeding species; but even if this involved the expenditure of a million dollars from the State Treasury, the benefits to be derived in increased value of the property, to say nothing of the increased comfort to the people,
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Smith’s message was clear. A workable plan based on sound science was possible. Winning state support was essential. Smith spent the next six years striving to secure funding for the work, organizing committees, collaborating with local boards of health, drafting and re-drafting legislation as the need arose fighting for and defending his mosquito control plan. The record is impressive. In 1904, the Duffield act was passed giving local boards of health authority to act against mosquitoes; in 1905, an act to provide for locating and destroying mosquito breeding places. In 1906 the state committed to a multi-year campaign to eliminate salt marsh mosquito breeding places under Experiment Station supervision. Smith was in great demand and spent his time persistently and diplomatically moving the New Jersey anti-mosquito movement in a positive direction. Smith led the New Jersey movement through organized coordinated efforts based on demonstrated scientific knowledge without ever knowing what his funding resources would actually be from year to year.

Though he made considerable progress, there were many setbacks and the personal suffering was becoming evident. Smith had Bright’s disease. He was burning the candle at both ends and time was running out. Tragic as the case may be, Smith would spend the rest of his life fighting for the plan he would not live to see enacted. It was evident for those involved that more work needed to be done in the legislature to advance the cause, but agreement on what direction this should take differed substantially. With Smith’s health failing and the final pieces of the endlessly evolving puzzle out of reach, he confided in friends that he was not happy with conditions as they stand (regarding the North Jersey Mosquito Extermination League fight for new legislation). In the closing months of 1911 there was nothing in the current commission proposals before him he particularly wanted to fight for or against. He felt it was unlikely he would see the matter through and urged that the work already accomplished be protected; he was however helpless to actively join in the fight. Smith died March 12, 1912, just 9 days before the final bill was signed by Governor Woodrow Wilson.

Figure 4: Three man team hand ditching the salt marsh, circa 1903. Pictured is a man with a marsh saw to cut the edges of the ditch, a man driving a shovel to remove sod and a third pulling the sod from the shovel to the side of the ditch.
This new law established county mosquito extermination commissions and placed the Director of the New Jersey Agricultural Experiment Station on each county commission with oversight authority. There was indeed much work still to be done and New Jersey’s leading mosquito control authority had passed. Essex, Union and Hudson counties were the first of New Jersey’s 21 counties to establish commissions under the new law and mosquito inspectors supported on public funds were actively engaged in suppression activities by June.

After five months, Jacob G Lipman succeeded in recruiting the services of Thomas J Headlee, a young entomology professor from Kansas State Agricultural Experiment Station to take up where Smith had left off; see Figure 5. In October of 1912 Headlee found himself in a firestorm of New Jersey political activity. After a season of success in the suppression of pestiferous mosquitoes (in Essex and Union) the mosquito commission law that had just passed was already under fire. Homeowners concerned with access to private property, local boards of health running their own suppression programs and freeholders responsible for funding the county programs all had something to say on the matter. The latter proved to be the most significant challenge. The law mandated local freeholder boards appropriate funds approved by the Experiment Station Director. County commissions were responsible for submitting a mosquito control plan to the experiment station director, outlining the work to be undertaken in the ensuing year, along with cost estimates needed to perform the work. The experiment station director had the ability to modify these work plans, including the annual budget request. This approval was then forwarded to the county Freeholders who had to provide the funds out of the annual tax levy. The Freeholder’s amendment proposed to replace the word “shall” with the word “may,” with regard to the Experiment Station’s budget approval of the commission plans and estimates, thereby removing the mandatory clause altogether. This one change would amount to a repeal of the legislation should it be successful. A simple innocent amendment easy to slip through had Headlee been asleep at the wheel. Once again political savvy won the day; neither the Essex nor Union county freeholders supported the amendment to the bill during debate, the measure was defeated and the law saved. The mosquito inspectors in Essex and Union had done their jobs well.

The bold move to repeal the law from powerful politicians underscored the importance of Smith’s organizational fight to obtain it. With expanded reach now possible for anti-mosquito measures in the New Jersey, mosquito warriors needed to mobilize against future attacks and gain public support. Headlee acted immediately by jointly calling a meeting of the active mosquito control commissions. The topic in Trenton, on that November day in 1913, was to discuss the future of the mosquito control movement. Organization was at the

![Figure 5: Thomas J Headlee, circa 1912.](image)

![Figure 6: February 21th, 1914 group photo of some of the New Jersey’s Anti-mosquito men gathered in front of the Hotel Traymore.](image)
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center of the movement’s success and just as the Conference Committee on Mosquito Extermination and the North Jersey Mosquito Extermination League had aided Smith in his efforts to establish the mosquito laws, a new strong statewide working organization of mosquito fighters was needed to preserve them; and the New Jersey Mosquito Extermination Association was formed. In the proceedings of the 1914 meeting Headlee recalled the effort to repeal the law (Headlee 1914):

“When the question of repealing the law came up in the session of 1913, the legal representatives of Essex and Union Counties stood unanimously as against the repeal and for the continuance of the law. If the people of these two counties had not felt that they had been given adequate value for the money expended, it is hardly to be expected that their representatives at Trenton would have taken the stand which they did. I felt then and I feel now, that the effort to repeal the law was the critical point. From that time on the success of the movement was, and is, merely a matter of good, capable and faithful management.” These words ring true to this day!

At that first meeting, speakers reviewed the history of the anti-mosquito movement, shared their own experiences controlling mosquitoes, the problems encountered, the challenges faced, changes to the current law, funding, new scientific developments, public education, value of the work accomplished, promotion of services and expansion of land protected. In short, the sound advancement of the cause of mosquito extermination in New Jersey. The last order of business was a report of the committee on a permanent organization. We all know how that turned out!

A business meeting followed and the fight to defeat the most current bill in the legislature aimed at repealing the mandatory requirement in the law ensued. A measure carried, instructing the Executive Committee to use every honorable means to defeat the bill.

The next issue moved on to financing the mosquito control work of the State Experiment Station. Times were tight and expectations were low. Motion was made, that the Executive Committee be instructed to appear before the Finance Committee of the Legislature at the proper time and try to get an appropriation for this work; the motion was seconded and carried. The last order of business was a picture by photographer Harper Smith, of the Atlantic City “Press;” see Figure 6.

This tale closes. The New Jersey Mosquito Extermination Association, with a membership of about 42 participating in the first annual convention, exists as a permanent organization. These mosquito warriors set the stage for those who would go on to hold 99 consecutive annual conventions. The 100th meeting, in keeping with tradition, to be held jointly with the American Mosquito Control Association in February of 2013 on the boardwalk in an Atlantic City Hotel.

And after a hundred years of annual meetings exchanging information on how best to prosecute our mission, all New Jersey counties have active anti-mosquito programs. It is still a real struggle, but one worth fighting for. Especially when we are all working together for the common good!

ACKNOWLEDGMENTS

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REFERENCES CITED


Howard, LO. 1901. Mosquitoes: how they live; how they carry disease; how they are classified; how they may be destroyed. McClure, Phillips & Co. 272 pp.


Smith, John B. 1904. Report of the New Jersey Agricultural Experiment Station upon the Mosquitoes Occurring within the State, their Habits, Life History, etc. 462 pp.

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In an effort to control mosquitoes with less reliance on pesticides, the New Jersey mosquito control community uses several approaches. The NJ State Mosquito Control Commission supports several state-wide programs to supplement the network of county mosquito control agencies (Kent 1994). One part of the integrated pest control program is the use of biological control agents. An example of this for mosquito control is the use of the larvivorous mosquito fish, *Gambusia affinis*. When used correctly, it is an efficient, cost-effective, and environmentally sound method for the control of mosquito populations. This article describes the development of a statewide mosquitofish stocking program.

Often the most visible method of mosquito control is the application of an insecticide. Such applications for the control of larvae and adults are only temporary measures. It is the responsibility of New Jersey’s network of county mosquito control agencies to continually survey and to manage those sites which are documented as larval mosquito habitat.

Another control strategy is water management within the habitat. By eliminating stagnant, polluted or otherwise degraded conditions to restore a healthy ecosystem, mosquito control can be achieved.

In addition to the two aforementioned strategies (insecticides and water management), biological control agents are also employed as part of the state’s integrated control efforts. If mosquito fish are determined to be an appropriate biological control response, it is only as a result of an inspection and survey by the county mosquito control agency.

In New Jersey, as in most states, there exists a division of government dedicated to managing the state’s resources. The NJ Office of Mosquito Control Coordination (the administrative headquarters of the NJ State Mosquito Control Commission) is a component of the NJ Division of Fish and Wildlife. The Bureau of Freshwater Fisheries, also within the Division, conducts fisheries-related research, operates two fish hatcheries and annually stocks New Jersey streams, lakes and ponds with various species of game and forage fish. The Bureau has divided the state by drainage; with each area supervised by staff biologists. It was only natural that all the agencies coalesce to develop the New Jersey Bio-Control (mosquito fish) Program for mosquito control.

Step one involved the development of a policy around which the program would operate. Soon to follow was an estimation of cost, equipment needs, operational protocol, environmental concerns and the composition of a bulletin or booklet which would address the “how to” aspects of using the program.

Implementation of the program began with an initial stock of *Gambusia affinis*. These fish were used as brood stock at the state’s Charles O Hayford Fish Hatchery in Hackettstown, in order to develop an almost unlimited amount of fish for mosquito control. Next, the State Mosquito Control Commission agreed to annually provide dedicated funds to the Division of Fish and Wildlife to cover expenditures of the Bureau of Freshwater Fisheries. Then, several oxygen bottle-equipped fish transport tanks were purchased, the size of which allowed for their transfer from pick-up truck to pick-up truck. This enabled community servicing from county-to-county mosquito control districts.

The composed booklet about the program describes how New Jersey’s county mosquito control agencies may, by following established policy and protocol, obtain a truck-tank full of healthy...
mosquito fish and stock larval mosquito habitat with them. There is no cost to the counties for these fish as part of the State Mosquito Control Commissions state-aid to counties program. Since 1990, the program has offered over 150,000 fish annually. Fish are distributed throughout the mosquito season. An indoor over-wintering facility at the hatchery allows for early spring stocking taking place by April. The hatchery’s outdoor brood rearing ponds and raceways are used as needs expand in summer. Fisheries biologists are readily available to deal with diseases, habitat limitations and applicability of other larvivorous fish species as they become more and more familiar with the needs of the mosquito control community. On the other hand, the New Jersey mosquito control community is also learning more and more about mosquito-eating fish as their use increases. As the program developed, four other fish species were added to the inventory of those available for stocking based on habitat and mosquito species. They are: the fathead minnow, *Pimephales promelas*; bluegill sunfish, *Leopomis macrochirus*; the freshwater killifish, *Fundulus diaphanus*; and the Pumpkinseed sunfish, *Leopomis gibbosus*. The fathead minnow has become quite useful as a mosquito control agent in place of *Gambusia* in bodies of water which may be associated with a natural watershed.

In addition to input from the staff of the State DEP, the Research and Development Committee of the New Jersey Mosquito Control Association, Inc is composed of staff biologists from various county mosquito control agencies around the state. The committee offers valuable input to improve the program. For example, the committee spent several mosquito seasons studying the use of these fish in the field, and as a result, useful information about the stocking rates of mosquitofish has been obtained and published (Duryea et al 1996).

While the use and distribution of mosquitofish is not recommended to the general public, they may gain the benefit of this biological control agent by way of their county mosquito control.
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agency. Following a request to, and approval by, the NJ Office of Mosquito Control Coordination, deliveries or stockings of fish are made via the New Jersey Division of Fish and Wildlife’s Charles O Hayford Fish Hatchery.

Not all bodies of water require introduction of mosquito fish, such as lakes, ponds and streams, as these sites don’t generally produce many mosquitoes. Likewise, not all mosquitoes are pestiferous to humans, or transmit disease and so require no control. Some examples of mosquito habitats where fish may be introduced, include: 1) Stormwater management facilities; 2) Woodland, or snowmelt created pools; 3) Long standing sheet-water; 4) Ditches and swales; 5) Freshwater marshes; 6) Dredge-spoil impoundments; 7) Wildlife production impoundments; 8) Artificial containers (ie, ornamental ponds, abandoned swimming pools, foundations); 9) Excavated sites; 10) Trash sites; and 11) Sewage lagoons and/or wastewater facilities.

Potential stocking sites of an environmentally sensitive nature should be reviewed by state biologists from the Division of Fish and Wildlife’s Bureau of Freshwater Fisheries, and from the NJ Office of Mosquito Control Coordination.

Mosquito fish stocking does not take place without first performing the important program of surveillance. Before any insecticide application or water management project is undertaken, one must be assured of the presence, density and species of mosquitoes there. This need applies no less significantly with regard to the stocking of mosquito fish.

Sites that have been documented as mosquito producers and are considered to be favorable for stocking with mosquito fish may include: 1) Areas that are environmentally sensitive to, or inaccessible for, pesticide applications; 2) Sites that cannot be managed via Freshwater Best Management Practices or Open (salt) Marsh Water Management; and 3) Sites that do not support native or resident fish populations.

It is the policy of the New Jersey Bureau of Freshwater Fisheries to permit the stocking of Gambusia affinis in certain state waters for the purpose of mosquito control. Permission will be granted only for those waters in which no indigenous fish population exists and from where the mosquitofish can be reasonably expected not to escape. Additionally, the above mentioned waters must harbor sufficient numbers of mosquito larvae or pupae to become a nuisance or health concern for the surrounding human or animal population, as determined by the state or a county mosquito commission or agency.

Stocking of mosquito fish will not be permitted in areas identified as endangered or threatened (plant or animal) species sites, exceptional resource wetlands, or adjacent to such sites or in identified state “Natural Areas.”

As part of an ongoing program, a mosquito control agency should index sites and periodically record mosquito production. Early spring fish stocking is the most efficient for season-long control. However, mid-season stocking may be appropriate for areas which periodically dry back and re-flood as a result of seasonal weather.

The continued presence of adequate numbers of mosquito fish has generally resulted in the reduction of the mosquito population and any associated pesticide applications. Mosquito control inspectors and biologists should continue to periodically survey sites after stocking in order to evaluate the overall efficacy of mosquitofish as control agents.

Figure 4: Some of the many mosquitofish transport tanks available after being cleaned and sanitized, stored outdoors at the hatchery.
Fish are shipped by one of the following two methods depending on the number of fish needed and the urgency of the request.

County agencies may choose to pick up fish at the hatchery. This method is preferred if between 1,000 and 25,000 fish are needed. The NJ State Mosquito Commission has purchased several oxygen-bottle equipped transport tanks for this purpose. If more than 25,000 fish are requested, the hatchery will deliver the fish to a central point in a county or region. The county agency will then transfer the fish directly to the site or into one of the transport tanks where the fish can then be distributed as needed. This method works best if several counties coordinate delivery of large numbers of fish. Requests for mosquito fish by this method and subsequent deliveries will be coordinated with other county agencies.

Fish are conditioned if the temperature difference between the receiving water and the transport tank water is greater than 5°F. Temperature differences between the hatchery truck and the transport tanks are also checked before transferring fish. Conditioning can be accomplished by adding water to the transport tank by pump or bucket until the desired temperature is reached. The fish can be transferred by net into the receiving water. During times of extreme temperatures, caution is exercised with regard to the ambient temperature of the receiving water.

New Jersey’s state health statutes provide for each county and the state government to establish a county mosquito commission or agency. These agencies work together to operate surveillance and control programs to keep our state as mosquito free as possible while protecting, and even enhancing, the environment that may support mosquito development. Even with all the previous tools provided, this ongoing effort has been greatly improved in an environmentally, economically and efficient way, with the help of the Division of Fish and Wildlife’s Bureau of Freshwater Fisheries staff, facilities and the hundreds of thousands of fish that they provide. Since its inception, over 3 million fish have been distributed to county mosquito control agencies by the NJ State Mosquito Control Commission’s Bio-Control Program.

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REFERENCES CITED


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When mosquito control efforts began in New Jersey, John B Smith of the Rutgers Entomology Department realized that the most effective approach to reducing mosquito populations required scientific understanding of mosquitoes. This included knowledge of where mosquitoes occurred, what species were present and how many mosquitoes were there. At that time, the most prolific trap available was the human, where collectors would use a net to catch mosquitoes attracted to them. Thomas Headlee (1922) cited the difficulties of using human collectors, such as differences in attractiveness to mosquitoes and abilities to use a net successfully. Because of these difficulties, population characteristics would be difficult to establish in a meaningful way and the search for a "mechanical trap" that would eliminate nonrandom variability began.

Searching historical patents shows that mechanical traps have been a concept since at least the mid 1800s, but many of these traps were designed to kill, or were impractical to make or use. However, one trap, the "Sugar Can" trap of 1927 began the serious development of the New Jersey light trap at Rutgers and the New Jersey Agricultural Experiment Station (Rutgers/NJAES); see Figure 1. The Sugar Can trap used only a 2-candle-power electric lamp to attract mosquitoes. There was no fan and the trap was battery-operated. Nighttime collections were said to be about what a good human collector "could secure in a 15-minute collection" if mosquitoes were abundant (Headlee 1932), but the trap was inadequate when mosquitoes were less abundant. The trap design was modified over the next several years, changing shape, orientation and use of a fan until the Model 50 trap was introduced in 1934; see Figures 2 & 3. The now vertical Model 50 included a timer to turn on the fan and light bulb (Mulhern 1934). Because the goal was to collect a significant number of mosquitoes, testing of various features, particularly the color and luminosity of the light...
source occurred resulting in the standard use of a 25-watt white incandescent bulb that is still in use today.

In 1934, Rutgers/NJAES placed some 40 traps throughout the state and the results of the mosquito season were reported at the 1935 New Jersey Mosquito Extermination Association annual meeting. This summary of seasonal mosquito abundance continued to be reported over the years, including raw data for several years; see Figure 4. The use of traps was also mentioned in reports from other agencies, such as Utah and Delaware, indicating that mosquito control and research agencies had been using traps since 1932. Records from Hauscherr Machine Works, which made the New Jersey light trap early on, show trap orders from the 1940s coming from mosquito control agencies, governments and universities worldwide, as well as the US War Department.

Over time, the pros and cons of the NJ light trap became apparent. While the variation in the use of the human collector was eliminated, the low diversity of mosquito species caught was still problematical. Pestiferous species such as *Culex pipiens*, *Aedes sollicitans*, *Ae vexans* and *Coquillettidia perturbans* are attracted to the traps. But while light traps catch a wider range of species than most other traps (Williams and Gingrich 2007), there are still some species that are not particularly attracted to them and they therefore do not give a true indication of their population density. Because the traps run on electrical power, their location is limited to areas of human habitation or industry. The traps need not only to be maintained, but also to be calibrated (Mulhern 1948, 1953).

It is this calibration that gives New Jersey light traps an advantage over other traps, in that comparisons through time and space can be made without generating significant error from trap effects.

Mulhern reported on mosquito populations at the annual New Jersey mosquito meetings until his departure for California in 1949. After that, statewide mosquito populations reports were few, although the use of light traps by mosquito control agencies in New Jersey grew. In 1973, the Entomology Department at Cook College and NJAES began anew the statewide surveillance, using light traps in a program funded by the New Jersey State
Mosquito Control Commission (SMCC). Traps were operated by both Rutgers/NJAES and county mosquito control commissions, with samples being identified at Rutgers. The data were compiled for weekly regional reports on mosquito averages in New Jersey (http://www.rci.rutgers.edu/~vbcenter/reports/mospop/1973vol1no1.pdf) and faxed or mailed to interested parties. This program ran for about a dozen years.

In 2003, following the emergence of West Nile virus, SMCC provided funds to NJAES through Mosquito Research and Control (which became the Center for Vector Biology), renewing the statewide adult mosquito surveillance program in cooperation with county mosquito control agencies. Currently, around 80 county-run traps throughout the state contribute to the weekly reports, covering population trends for *Aedes vexans*, *Culex* spp., *Ae sollicitans*, *Culiseta melanura* and *Coquillettidia perturbans* with other species trends reported when activity is high. Summaries for more than 25 species are provided in the end of year reports. The program includes training on trap calibration and results are posted to the Center’s public website: http://vectorbio.rutgers.edu/surveillance.php. Reports from the first surveillance program are now being posted to the website for historical perspective.

Light traps have provided information, not only on mosquito population trends, but also first reports of species in New Jersey. These include *Culiseta minnesotae* 1956, *Aedes dorsalis* 1957, *Aedes intrudens* 1964, *Aedes albopictus* 1995, and *Aedes japonicus* 1998. The last two are of particular interest, given their rapid spread and potential involvement in arboviral transmission.

Light traps have proven to be a dependable method of mosquito population evaluation, but future technologies could provide new and interesting ways of monitoring culicids. In the past decades, remote sensing has been used to determine habitats and urban usage. Currently, using remote sensing to monitor the environment and then apply models to predict mosquito populations from current conditions (Chuang 2012) is a possibility. But direct assessment will likely be the goal. Traps have been designed for orchard pests using pheromones, entrance scanners and wireless networking to attract, count and automatically report oriental fruit flies (Tseng 2008). Similar devices have been used to count mosquitoes, but without identifying species (Hoffman 2010). Use of wingbeat frequencies to identify male and female mosquitoes has been used to varying degrees of success (Li et al 2005). In time, trap development using these various characteristics may lead to the ability to automatically identify, count and transmit information back to mosquito control agencies. In the meantime, the New Jersey light trap and other traps continue to monitor mosquito populations throughout the world.

**REFERENCES CITED**


Headlee T. 1922. The problem of evaluating mosquito density and the advantages to be realized from its solution. Proc NJ Ext Assoc. 9:48-56.
Figure 4: Top ten species reported in New Jersey from 1932-1936 during the development of the New Jersey light trap. From Table 1 of Headlee 1938.


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Jim David, Director of St. Lucie County Mosquito Control District, Fort Pierce, Florida
Eastern Equine Encephalitis (EEE) virus is a member of the family Togaviridae, genus *Alphavirus*, and is closely related to western equine encephalitis virus and Venezuelan equine encephalitis virus. Its transmission is most common around freshwater hardwood swamps along the Eastern seaboard, Gulf Coast states, and the Great Lakes region. Typically, the largest numbers of cases are found in Florida, Georgia, Massachusetts and New Jersey (CDC Fact Sheet 2010).

The EEE cycle is maintained between *Culiseta melanura* mosquitoes and avian hosts, but it can be transmitted to mammalian hosts through several bridge vector mosquito species. Persons younger than age 15 and older than age 50 are most at risk for severe infection, and about one-third of those who develop the disease die (CDC Fact Sheet 2010).

Besides humans, this virus can also be devastating for horses and some species of birds. The case fatality rate for horses can be as high as 90% and for birds such as pheasants, emus, whooping cranes, glossy ibises, and partridges, the case fatality rate ranges from 5–87%. In fact, only in birds has this virus been known to be spread through non-arthropod-borne routes, mainly through feather picking and cannibalism (usually this behavior is exhibited in flocks of game birds). Whole farm flocks can succumb to this disease in a very short period of time (Iowa State University CFSPH, 2008).

In New Jersey, EEEV first appeared in the 1930s, and has continued to cause problems ever since. The first major outbreak occurred in 1959, with 33 confirmed human cases occurring in the eastern and southern portions of Atlantic, Burlington, Cape May, Cumberland, Ocean, and Salem counties. Of these, there were 21 deaths, and most of those who survived had severe brain damage (Kandle 1960).

Not much was known about EEEV then, but health officials did observe that horse and pheasant cases preceded human ones. In fact, 56 horses in 12 different counties fell victim to the virus that year, with the majority of these cases concentrated in the southern counties. Only four recovered. Additionally, outbreaks were reported among 16 pheasant flocks on farms located in 10 counties. The actual numbers of cases were not known, but it was estimated that mortality reached 30% in some of these flocks, many of which contained several hundred birds (Kandle 1960).

The loss of horses and game birds certainly had a negative effect on the economy, but even more importantly, hysteria and panic gripped the public as a result of the human deaths. This fear resulted in a severe economic impact on the late fall and winter resort business. Further impact was felt in the building industry, the real estate industry, and the banks (Kandle, 1960). Additionally, Garden State Parkway officials closed the picnic areas along the Parkway from Ocean County south. It is estimated this caused business on the highway to drop by about $60,000 (Bontempo 1960).

Subsequent to this initial, severe outbreak, EEEV cases were reported again in New Jersey three more times over a three year period. In 1965 there was one human case, in 1967 there was one human case and 32 equine cases, and in 1968 there were 12 human cases and 126 equine cases (Crans 1977).

In response to these outbreaks, massive air sprays were conducted; however, it became necessary to search for a more effective solution. In 1975, an inter-agency vector surveillance program was developed, with the New Jersey Agricultural Experiment Station, the New Jersey State Department of Health, the New Jersey State Department of Agriculture, the New Jersey Department of Environmental Protection, and seven county mosquito control agencies all involved. The program monitored EEEV and its mosquito vectors at a number of study sites with yearly funding provided by the New Jersey State Mosquito Control Commission. These study sites were chosen based on historical human or equine cases, and
Culiseta melanura was used as the main indicator of virus activity (Crans and McCuiston 1993). Fifty resting boxes, placed at each site June through October are serviced on a weekly basis. This program continues today and is the primary method used to monitor EEEV in mosquitoes in New Jersey.

Culiseta melanura population levels are closely monitored. Deviations from long-term means and Minimum Field Infection Rates (MFIR) are calculated and updated weekly. For many years, sentinel chicken surveillance was also used to monitor EEEV, but this method has been abandoned in favor of mosquito testing. Additionally, equine cases were used to determine necessary control measures for Coquillettidia perturbans and associated vectors in upland areas (Crans and McCuiston 1993).

Another standard of measure introduced to this program was the calculation of the physiological age of Aedes sollicitans populations, important bridge vectors. These data helped mosquito control agencies determine the risk of transmission of EEEV to humans. When periods of risk were determined, adulticides were applied, targeting physiologically “old” Ae sollicitans populations. Since the launch of this program, confirmed human cases have drastically declined and are not been necessary (Crans and McCuiston 1993).

With the arrival of West Nile virus (WNV), the vector surveillance program expanded in 2001 to include all 21 counties and the monitoring of that virus as well. It has since grown to include St Louis encephalitis (SLE) and La Crosse encephalitis (LAC). Moreover, eight southern and coastal counties have added even more sites to monitor EEEV, handling the collection and preparation of specimens themselves (the historical EEEV sites are monitored by Rutgers University staff). Furthermore, the field work portion of the WNV, SLE, and LAC surveillance program is solely managed by county mosquito control staff, and the data collected are entered into a web-based program and passed on to the New Jersey Department of Health (NJDH) in Trenton and to Rutgers University. County staff collects the mosquitoes, counts them, identifies them to species, and prepares them for transport to the NJDH. A courier, paid for by the New Jersey State Mosquito Control Commission, transports the specimens to Trenton to be tested for each virus. A weekly report is prepared by Rutgers University staff and sent to all county agencies.

These reports are prepared by Dr Lisa Reed, Scott Crans, and Dr Mark Robson from the Center for Vector Biology, Rutgers University. They are invaluable in helping county staff not only see what is occurring in their area, but what is occurring throughout the state. The vector surveillance program has come a long way since it began in 1975, and it continues to be a crucial tool in helping to protect the residents of New Jersey.

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REFERENCES CITED


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Celebrating the New Jersey Mosquito Control Association’s 100th Anniversary
The Mid-Atlantic Mosquito Control Association's 38th Annual Meeting will be held March 13-15, 2013 in Columbia, SC at the Courtyard Columbia Downtown, 630 Assembly Street. For more information, including hotel, registration and local contacts, please visit MAMCA’s website at www.mamca.org.

The Michigan Mosquito Control Association’s 2013 Annual Meeting will be held February 6-7, 2013 at the DoubleTree by Hilton, 1 Wenonah Park Place, Bay City, MI 48708. Contact Planning Chair Rebecca Brandt 989-894-4555 or visit our website at www.mimosq.org for further details.

The 10th Arbovirus Surveillance and Mosquito Control Workshop will be held at Anastasia Mosquito Control District, St Augustine, FL, March 26-28, 2013. Visit AMCD’s website at www.amcdsjc.org or contact Jessica Phillips at 904-471-3107 or jessicaamcd@bellsouth.net for more information.

The 3rd International Forum for Surveillance and Control of Mosquitoes and Mosquito-borne Diseases will be held at Suzhou, Jiangsu Province, China, May 27-31, 2013, sponsored by the Asian Society of Vector Ecology and Mosquito Control, Entomological Society of China, Beijing Institute of Microbiology and Epidemiology, and Jiangsu CDC. Contact Dr Tong-Yan Zhao at aedes@263.net and Dr Rui-De (Rudy) Xue at xueamcd@gmail.com or call 904-471-3107 for more information.

The Manatee County Mosquito Control District is looking to expand the Entomology Department through the hiring of an additional Entomologist. We are looking for a recent BS or MS graduate in the field of Entomology, Biology or related scientific discipline that may have some background in insect taxonomy, mosquito borne diseases, and/or mosquito surveillance. We are also willing to train an ideal candidate who may otherwise be lacking in formal training within a specific area. We are looking for a motivated and intelligent individual to fill this newly created position.

The Entomology Department is supervised by a Senior-level Entomologist. This is a full-time position (40 hrs/week), 12-months/year with hourly-based salary ranging from $32,000 to $37,000/year. Currently, the District offers paid family health insurance for all full-time employees.

Interested and qualified candidates should contact Christopher.Lesser@manateemosquito.com with a resume and letter of interest. Interviews will take place in early 2013.

Christopher Lesser, Assistant Director
Manatee County MCD, 2317 2nd Avenue West, Palmetto, FL 34211
941-722-3720
From Where I Sit: Notes from the AMCA
Technical Advisor by Joe Conlon

Well, it certainly has been an interesting year hasn’t it? West Nile virus has reappeared on the media radar screen with the Dallas outbreak and has offered a number of lessons for which we should take note:

- West Nile has not gone away as some in the public had surmised.
- The extent of the severity and scope of the outbreak caught most by surprise.
- Anti-pesticide activists remain impervious to scientific fact.
- National Pollutant Discharge Elimination System (NPDES) compliance costs have had profound negative impacts on our mosquito control capabilities.

**West Nile has not gone away as some in the public had surmised.** In recent years, cases of West Nile have fallen – in some regions, precipitously. Coupled with pressures from agencies seeking ways to shrink budgets, there has been a noticeable push to reduce mosquito control budgets, remove special-taxing status or consolidate mosquito control activities into various other county/municipal programs. For the most part, these initiatives have been defeated, with cooler heads prevailing. However, if West Nile returns to quiescence, the political will to maintain a robust mosquito control infrastructure will be again tested.

In my opinion, the 2012 outbreak should serve to remind us all that a properly funded and fully equipped and trained public health infrastructure is critical and must be both functioning and maintained even in the absence of demonstrable disease. A forward-thinking public health system must be prepared to meet new and emerging threats at our shores and not after they’ve become firmly established to the point that they can no longer be ignored. Playing catch-up is inimical to the preventive role upon which public health is based. To be sure, it is politically difficult to argue for resources without visible evidence of a threat. Nevertheless, we are an 8-hour flight from some of the most devastating mosquito-borne diseases on the planet and spin-up response times will become less and less if we are to avoid potentially disastrous emergence and spread of any number of vector-borne diseases of humans and animals.

The extent of the severity and scope of the outbreak caught most by surprise. The most persistent question from the media during my interviews to date this year has been, “To what do you attribute the resurgence of West Nile this year?” – or something to that effect. It’s nearly impossible, when representing the profession, for me to come out and flatly state, “We don’t know.” Yet, that’s probably as close as I could get to the correct answer. A great deal of conjecture has been proffered to explain the severity of the outbreak – usually involving an unusually warm winter, coupled with intense springtime rains. That may or may not be true – it’s nearly impossible to tell. An immunologically naive avian and human cohort in the areas of the outbreak probably contributed as well, but that again, is conjecture. The real point is (and one I make sure is stated as a take-away message) is that West Nile is a relatively recent epidemiological phenomenon in North America and there is much we have yet to learn about how it overwinters, what sets of conditions favor outbreaks, etc. This underscores the need for...
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fully resourced monitoring and control programs to track and contain outbreaks regardless of conditions meeting predetermined criteria indicative of an imminent outbreak. On a more sober note, this capability must be ready to meet the challenges of a potential terrorist attack utilizing vector-borne diseases – it’s been done before.

Anti-pesticide activists remain impervious to scientific fact. One of the more difficult and frustrating duties I have as AMCA technical advisor is addressing the myriad of misinformation, inaccurate and misleading propaganda, as well as the erstwhile banalities used by activists to discredit our activities, while advancing their own agenda. I’m keenly aware that there are a number of my compatriots as exasperated as I at presenting validated scientific data in public forums, only to have it summarily dismissed by those either scientifically ignorant or willfully obtuse. What is particularly annoying is the lack of time usually afforded us to make a compelling case that a simple statement such as “mosquito control is ineffective at controlling West Nile according to this journal article I read” is misleading and inaccurate. There is generally little time to effectively refute this in a truly convincing manner to those not inclined to lend us credence. Alas, even when we’re allowed a full measure of time to make our case, it often falls on deaf ears. In the words of Sir Winston Churchill, “Men occasionally stumble over the truth, but most of them pick themselves up and hurry off as if nothing ever happened.” This is the lobstersmen’s case against methoprene in a nutshell. No matter how much evidence is produced by a plethora of state and national agencies that indict eutrophication, low dissolved oxygen levels, warming waters, etc in Long Island Sound, methoprene is always targeted by politicians as the real culprit. Politics is akin to playing Wack-a-Mole: When one specious argument is successfully rebutted, another rises up to take its place.

I spent an entire afternoon as a member of a Huffington Post podcast roundtable featuring Judge Clay Jenkins (the Dallas County judge who authorized the aerial spraying of the county in response to the 2012 West Nile outbreak), a citizen (who was a bit skeptical of the process, but supportive) and 2 anti-pesticide activists. It was one of the most infuriating afternoons of my life. Literally EVERY statement from the activists was factually incorrect. I could have spent weeks
cataloguing and contesting their assertions that “pesticides are hazardous toxins that kill dragonflies – not mosquitoes;” “the aerial spray will make the mosquitoes immune;” and other choice activist boilerplate. I specifically rebutted each assertion but could only address 4 before cut off by the moderator due to time constraints. While I made an impression on the citizen (who informed me as such after the podcast, and the Judge, who had used one of my earlier rebuttal papers as a basis for his spray decision), it was clear that I had made no headway with the activists who are “frequently in error – but never in doubt.” This has convinced me to target our message to those willing to listen. I would advise you to do the same, while keeping your powder dry for rebutting activist claims you gain traction with the public.

National Pollutant Discharge Elimination System (NPDES) compliance costs have had profound negative impacts on our mosquito control capabilities. One of the many narratives arising this year from the collision of West Nile with NPDES permitting requirements, is that mosquito control districts, for all their caterwauling about how they would no longer be able to render effective services if NPDES went into effect, have somehow managed to sustain their operations. Environmental groups, in particular, have made this a principal argument against a legislative fix, citing a perceived lack of demonstrable impacts upon mosquito control operations. That is why I asked, via blast e-mail, for specific instances in which mosquito control services were either curtailed or ceased entirely as a result of NPDES costs and liability concerns. I compiled the responses I received into a list of message points that I then sent to senators and congresspersons on key committees so they would have list of impact data that was no longer alleged, but demonstrable.

The adverse impacts present excellent message points that we need to keep in mind when speaking with legislative staffs who want verifiable information with which to work on a legislative solution to the problem. The negative impacts I noted were:

- NPDES regulatory requirements are forcing programs to redirect control resources to comply with the increased costs resulting from their imposition. Every dollar or man-hour needed to meet CWA requirements is a dollar not being put toward protecting the citizen’s health.
- Commercial applicators historically serving rural communities and small municipalities are increasingly opting to cancel their programs out of fear of increased liability. This represents a profound social injustice to those rural poor most in need of these services.
- In some states, preventive mosquito control strategies such as comprehensive larviciding are being curtailed in order to redirect resources toward increased administrative and water monitoring costs. This pushes districts toward more extensive use of adulticides to provide the same measure of control.
- Liability fears from adulticide applications are effectively pushing them farther down the control algorithm or eliminating them entirely. Liability fears are fueling pressures to forego consideration of preventive adulticiding until human cases have presented, allowing for transmission to take place while diseases are incubating in the human population. This effectively makes humans disease sentinels.
- Water monitoring costs now being levied from California districts, if writ nationwide, would close many districts in other states. In the absence of a public health exception to NPDES, there will eventually be increased pressure for other states to adopt California’s monitoring policies.
- Federal and State agencies are expending vital funds to initiate and maintain NPDES programs governing mosquito control applications. There is no longer slack in government budgets at any level to absorb NPDES program maintenance costs.

We shall see in the coming months whether these impacts will provide the wherewithal to help engender an exemption for mosquito control from superfluous Clean Water Act jurisdiction. In the meantime, I’d advise everyone to continue documenting the ways in which NPDES compromises execution of your public health mission. We’ll need as much valid data as possible to compel legislators to acknowledge that there is a problem and that its solution lies in a statutory resolution that is clearly a political positive.
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