GOLDEN JUBILEE

1959- 50 YEARS -2009

The Virginia Tech
ENTOMOLOGIST

Virginia Tech Department of Entomology
50
1959-2009

Dedicated to the memory of our first Department Head
James McDonald Grayson

“Eulogy for Daddy” delivered by Nancy L. Grayson, March 10, 2008

On behalf of my sisters, our mother, and the rest of our family, I want to thank you – each of you – for being here with us today to celebrate the life of a man who was incredibly dear to us and, I suspect, most of you as well.

So many people have come up to us in recent years to tell us how much they admired and appreciated daddy. They’ve recounted wonderful stories that we’ve loved hearing. Almost invariably, what has come through most strongly in these stories and memories is his deep integrity, his fairness in dealing with people, and his lack of pretension. Daddy really did value people for their character and accomplishments, not for their looks or their money or their social standing. He didn’t have much truck with people who put on airs or thought overly well of themselves. He had a particularly fine sense of proportion regarding life’s values and priorities that stemmed in part, I think, from his upbringing in the mountains of Southwest Virginia.

Daddy grew up on a farm near Austinville in Wythe County and, for the first eight grades, went to school in a one-room schoolhouse. The schoolmaster, by the way, was Hobart Porter’s father (the grandfather of Diane Porter Goff and Beverly Porter Simpson, whom I’m sure a number of you know.). To attend high school, Daddy had to take the ferry across the New River to the tiny community of Ivanhoe. He graduated valedictorian of his high-school class of three.

The Grayson farm in Austinville was close to the banks of the New River. I’m delighted to tell you that two parcels of land near the Grayson farm are currently being brought under conservation easement, so at least some stretches of this land that Daddy loved will be preserved in much the way he remembered them. My father had a lifelong fascination with the New River. In a reflective moment several years ago, he remarked to me, “Sometimes I think the New River belongs to me”. And I said, “ Well, in a way it does, Daddy, because it’s been so much a part of your life”. He swam across the New River at the age of seven – to the great horror of his mother. He fished and canoed it throughout his life.

Daddy had a spiritual bond with the rivers and mountains of Southwest Virginia. He was the kind of naturalist that you don’t see too much anymore – one whose love for nature and broad knowledge of the natural world came from spending so much of his childhood in it. Later, of course, he studied biology and then entomology, but I’ve always thought that his ability to identify almost any plant or animal we’d see in the woods owed as much to his boyhood explorations as it did to his formal training. Hiking with him was a joy, because he knew so much and took pleasure in sharing his knowledge with us – unobtrusively, without lecturing. I have to say, though, that hiking with Daddy was no easy stroll. He had a long stride to begin with, and he’d grown so accustomed to navigating the brushy, hilly terrain here quail and grouse reside that it was hard to keep up with him. He was a bird hunter for most of his life – and a very skilled one. He was never interested in the tamer, more sedentary kinds of bird hunting – only the challenging kind through briary thickets on steep mountainsides, in search of what he called “the king of the upland game-birds”: the ruffed grouse. Mama tells the story about one of these hunting trips, when he invited someone fairly new to the entomology department to accompany him. (I’m not sure who it was.) His hunting partner was half Daddy’s age, but he returned exhausted. He looked at Mama and said, “That man doesn’t walk up those hills; he runs!”

My sisters and I were extremely fortunate to have a kind and loving father, one who always took great interest in our activities and loved us unconditionally. (Even through our less-than-attractive stages, he thought we were beautiful, and he made us feel that we were.) Many of our close friends when we were growing up called him “Uncle Jimmy”. He found time to talk and joke with them and was always ready for an excuse to take a group of us and our friends out for popsicles or milkshakes (Daddy loved milkshakes) or to Lakeside Amusement Park. He took us swimming regularly at Tech’s War Memorial pool, followed by trips to the “Dari Delight” for soft freeze; and we also made frequent trips to Claytor Lake. Daddy was a smooth, powerful swimmer, who always preferred lake swimming to the confinement (and the chlorine) of pools.

Even though Daddy had no sons (no biological sons), he was a mentor and a kind of surrogate father over the years to a number of young men who loved the out-of-doors. And this father of four daughters really enjoyed his five grandsons, who in a sense became the sons he never had. He took them canoeing and fishing and afterwards taught them how to clean fish and extract the roe. He took them to Tech ball games and also pitched balls to them in our backyard. (In his day, Daddy had been quite a good baseball player; he was a pitcher). My son remembers trips to Claytor Lake and Hungry Mother State Park with his grandparents. He says that some of his fondest memories are of times he spent with them.

Growing up, my sisters and I knew that our father was a “softer touch” than our mother. We’d approach Mama about something we really wanted, and often she’d say ‘no’ on the basis that it seemed unnecessary or extravagant. So when Daddy would get home, we’d try to do a “divide and conquer” routine. He would listen to our complaint, and then he’d talk privately with Mama. She told us years later that he’d say something like, “They’ve been good girls; don’t you think we could make an exception in this case?” After discussing it with him, Mama would usually agree. Then, instead of taking credit himself for the reverse decision, he would have Mama tell us. It was important to both of them, in matters such as this, to speak with a unified voice.

There’s simply no way that we can talk about James Grayson as a man and a father without paying tribute to the love of his life, our mother. They were married for 62 ½ years, and their love grew only stronger as the years progressed. Mama said to me several months ago, “I’ve had a wonderful life”. She then related it directly to Daddy; “He’d come home from a trip abroad”, she said, “to Europe or Australia, and say he wanted to go again, with me”. She talked about how supportive he’d been throughout their marriage. One day she told Janet Turner that regardless of how much time she and Daddy could have together, “it would never be long enough”.

In their last years together, they remained remarkably close. Margaret became “Margarita”, Daddy’s affectionate name for her; and whenever she walked in the room where he was sitting, he would motion for her to come over to him. He’d give her a kiss and then whisper to her, “You’re the best buddy I’ve ever had”. We witnessed this countless times, and it never failed to bring tears to our eyes. Daddy adored Mama, and she him. We never – not once – saw her lose patience with him. Our parents shared a deep and abiding love, and I feel certain that Daddy’s tenacious will to live was tied closely to his reluctance to leave his Margarita.

The one dimension of James Grayson’s life that I’ve not yet mentioned was his distinguished professional career. His pioneering work on insect resistance was nationally and internationally known. He was the guiding force behind the establishment of Virginia Tech’s Department of Entomology in 1959 (it had previously been part of Biology), and he led the department successfully through its first twenty years. His work as a research scientist, teacher, and administrator was enormously important to him. Judging from comments and stories we’ve heard, the integrity and fairness so evident in his personal relations carried over into his professional life as well. He cared deeply about the welfare of his department and its faculty and students. Just as he was “Uncle Jimmy” to his daughters’ friends, he was known affectionately as “Daddy G” to scores of graduate students, whom he took under his wing. Nor was this feeling confined to grad students. Michael Kosztarab wrote a lovely note to us a few days ago, saying that “Jim was, for many of us in this community and especially in his department for 25 years, our adoptive father, who helped us whenever we needed assistance”.

The main speaker at Daddy’s retirement banquet in 1979 noted that “you, Jim, have led this department through an exciting but complex time in the history of entomology … by your example of forthrightness and integrity, you have molded the faculty and staff into an integrated, harmonious team". (This is quite rare, give the infighting I've seen in so many academic departments). Bob Pienkowski remarked years later that "the Entomology Department stands as a living memorial to Jimmy Grayson".

Rather than list his professional accomplishments (a number of these are in the obituary), I want to share with you a part of a letter I found in one of Daddy's files as I was preparing to write this eulogy. It was written by William Van Dresser, Virginia Tech's Dean of Extension, on the occasion of Daddy's retirement in July 1979. It reads: "Jim, your contributions to the field of Entomology have meant much to this University. On a personal basis, your decision in the early 'Rachel Carson' years to phase out chlorinated hydrocarbons was an inspiration to me. With all the clamor of the chemical industry and many entomologists claiming that Carson was totally wrong, you in your quiet way, with intellectual honesty and insight into the problem, said 'yes, we have a problem' and 'yes, let's phase out chlorinated hydrocarbons'. Your stance in this difficult question I have recalled many times when I knew the truth of a situation would not be a popular side to present". He then goes on to say, "Jimmy Grayson has been more than a good department head, an expert on pesticide research, or a good person; he is academic integrity."

This letter took my breath away, because I'd never known my father's position on this critically important issue. (Like so many scientists, Daddy didn't talk very much about his work around his family). All I can say is that the work of few scientists in the world was more directly affected by the publication of Rachel Carson's Silent Spring than James Grayson's. His research at that time – and a good portion of his department's research – was on insect resistance to insecticides, most particularly DDT, which of course was the chief target of Carson's book. We now know that the publication of Silent Spring in 1962 was a watershed event in the history of the conservation movement. I am awed by the strength of character that my father showed in this moment of crisis.

In his great elegy In Memoriam, written upon the death of his friend Arthur Hallam, Alfred Lord Tennyson speaks of feeling "the footsteps of his life in mine". Footsteps indeed. I feel my father's footsteps nearly every day, and always in positive ways. I don't think there's any question that James Grayson's life was exceedingly well lived. It was in many respects an exemplary life, one worthy of emulation.

My father's last years were difficult ones, because he was quite ill. But he never made life difficult for those around him. He retained his dignity and his kindness to the end; and because of this, he aged with remarkable grace. My family wants especially to thank the marvelous caregivers who treated him with so much tenderness and compassion over the past few years: Traci, Charlene, Shirley, Debbie, Lori, Ashley, Rosie, Donna, Amy, Cheri, and Betty. You made it possible for our father to spend the last years of his life in his own home. That meant the world to him – and to our mother. We thank you from the bottom or our hearts.

And we thank you – all of you – again for being here with us today to celebrate the life of this wonderful, lovely man.

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A Historical Perspective of the Department of Entomology

L. T. Kok
Professor & Head

The History of the Department of Entomology at Virginia Tech Entomology falls into (a) pre-1959 phase when it was combined with or part of other departments, and (b) 50 years as an autonomous, independent department since 1959. Although Entomology has been taught for 120 years in Virginia Tech beginning in 1889, it had always been in conjugation with other disciplines prior to 1959. The following shows Entomology being in association with Botany, Horticulture, Mycology, Biology, Zoology and Animal Pathology prior to 1959:

1889 -1890	Department of Botany and Entomology
1891 -1902	Department of Horticulture, Entomology and Mycology
1902 -1904	Department of Mycology and Entomology
1904 -1925	Department of Biology
1925 -1935	Department of Zoology and Animal Pathology
1935 -1959	Department of Biology
1959 - present	Department of Entomology

It was only in 1959 that the Department of Entomology became an autonomous department, hence we celebrate our 50th anniversary in 2009.

Throughout its 50 year history, the entomology curriculum has not been static but has evolved with the changing emphasis of our discipline in response to the demands of a changing society. However, our basic mission has been consistent in providing professional expertise concerning insects and arthropods to the Commonwealth, the nation, and the world. This includes teaching and advising undergraduates, teaching and training graduate students, conducting basic and applied research on arthropods and disseminating the results. We also developed management strategies for arthropod pests in Virginia, providing information about management of arthropods and the usefulness of beneficial insects and other arthropods for pest control to clientele and the public, fostering development of entomological expertise at the national and international level.

The department offers two graduate degree programs of study: an M.S. degree in Life Sciences with specialization in Entomology, and a Ph.D. in Entomology. It does not offer a B.S. degree, but beginning of Spring 2008, has a minor in Entomology. We also participate in the College of Agriculture and Life Sciences online Masters' degree program.

During our 50 year history, there have been eight heads/interim heads (6 department heads and two interim heads) as follows:

Department Heads in Entomology:

1959 - 79	James M. Grayson
1979 - 85	Sidney L. Poe
1985 - 86	Donald G. Cochran
1986 - 87	Robert L. Pienkowski (Acting)
1987 - 92	Thomas L. Payne
1992 - 94	Donald E. Mullins (Acting)
1994 - 2003	Timothy P. Mack
2004 - present	L. T. Kok

When Entomology was first accorded autonomy, Dr. James M. Grayson was appointed Department Head, and he guided the department for 20 years until 1979. These first two decades were formation years for the department, when the number of faculty increased from three to 18 by 1972, the year when I joined the Department (under Dr. Grayson). Our department has since built on the momentum set forth by Dr. Grayson.

In the nineteen eighties, the number of faculty in our department increased to 27, and graduate students were in the mid-thirties. Succeeding budget cuts not only hindered but eroded the growth of the Department and the number of tenure track faculty fell to as low as 14 during the 2000 - 2003 period. However, the Department was able to slowly recover and we currently have 20 tenure-track faculty (15 on campus and 5 off campus), 1.25 non-tenure track faculty, and 10.5 staff positions on state funds. Several key positions that were lost during the faculty buy-out in the late nineties have not been replaced. One of these is the insect systematist position, a key position for the department. Our 2007 CSREES Review Panel recommended that the department be granted this position, but in view of the recent announcement of a budget short fall for the next biennium for Virginia, that recommendation will be placed on hold until the economy turns around.

For the past 37 years, the Department has experienced recurrent deficits. Despite the budget restrictions, we have continued to expand our graduate program. When I assumed the role of department head in January 2004, our graduate student enrollment was in the mid-twenties. My goal for graduate enrollment was to reach 40 with a Ph.D.:M.S. student ratio of 2:1 (27 Ph.D./13 M.S.) by the beginning of the academic year 2010/11. I am very pleased to say that as a result of the effort and hard work of our faculty we have already reached our target at the beginning of September 2008. Our faculty has also met the challenges of increasing research funding. Research expenditures for 2007 of about $2 million, was an increase of 13.7% over 2006, and an increase of 57% over 2004. Our extension programs address real needs of citizens and communities, and we continue to provide excellent instructions both in graduate courses, and in service courses for undergraduate students. During the past year we taught 38 courses to 2,089 students, about 50% were enrolled in our Insects and Human Society course. There were 10 students in our new minor in Entomology, approved for the Spring Semester of 2008.

Faculty and staff positions stabilized in recent years. During the past academic year, we graduated 5 Ph.D. and 3 M.S. students, and dropped two Ph.D. students. For replacement, we recruited 9 new Ph.D. and 5 new M.S. students. In 2008, we have 42 students (27 Ph.D., 15 M.S.), and three on-line M.S. students. This is the largest enrollment in our departmental history. Several of our faculty/staff received alumni and our college research and extension awards, and several students received awards at professional meetings. Although Price Hall is still the focus of our department, our campus faculty are now spread out and located in several other buildings on campus: Latham Hall, Fralin Biotechnology Center, the pesticide unit in Agnew Hall, Dodson Urban Laboratory on Glade Road, greenhouses and insectary at Washington Street, and the Quarantine Facility in Price's Fork. The off campus faculty are spread out in five Agricultural Research & Extension Centers: Eastern Shore-Painter (Kuhar), Virginia Beach-Hampton Roads (Schultz), Tidewater-Suffolk (Herbert), Southern Piedmont-Blackstone (Semtner), and Alson H. Smith-Winchester (Bergh). With the strong support from the Dean, our department has grown in strength. We are optimistic about our future, but are very concerned about the impact of the additional pending state budget reductions facing us.

A list of the faculty with current responsibilities is shown in the table below:

Faculty Tenure Track	Rank	Teaching %	Research %	Extension %	Expertise
Adelman	Asst. Prof.	10	90	0	Vector Biology
Bergh	Assoc. Prof.	0	75	25	Tree Fruits
Bloomquist	Prof.	25	75	0	Toxicology
Brewster	Assoc. Prof.	20	80	0	Quantitative Ecology
Fell	Prof.	0	75	25	Apiculture
Herbert	Prof.	0	35	65	Cotton / Peanut /Soybean IPM
Kok	Prof./Head	33	34	33	Biological Control
Kuhar	Assoc. Prof.	0	75	25	Vegetables/ Soybean IPM
Miller	Assoc. Prof.	10	20	70	Urban Entomology
Mullins	Prof.	60	40	0	Insect Physiology
Myles	Asst. Prof.	10	90	0	Molecular Entomology
Paulson	Assoc. Prof.	100	0	0	Medical &Veterinary Entomology
Pfeiffer	Prof.	40	35	25	Tree Fruits IPM
Salom	Prof.	25	75	0	Forest Entomology
Sharakhov	Asst. Prof.	10	90	0	Insect Bioinformatics /Genomics
Schultz	Prof.	15	45	40	Nursery/ Turf / Landscape
Semtner	Prof.	0	75	25	Tobacco IPM
Voshell	Prof.	70	30	0	Aquatic Entomology

Weaver	Prof.	0	5	95	Pesticide Safety & Education
Youngman	Prof.	10	15	75	Corn / Alfalfa / Turf IPM

Non-Tenure Track (*Soft funded %)
Hipkins - *50% Res. Assoc. 100 Pesticide safety
Roberts - *25% Res. Assoc. 100 GPS & Gypsy Moth

Goals and Future Focus Areas: The goals of the department are to build on its strengths and to develop and expand the Ph.D. program. Emphasis in the next five to six years will be to sustain our strong programs and generate new programs in alignment with the University and College plans as follows:

(1) Research (Biomedical and Natural/Agro Ecosystems)
(2) Teaching (Graduate and Undergraduates)
(3) Extension/Outreach (Pesticide Safety and Urban Entomology) and
(4) International Programs.

Specific projects in each focus area will undergo evolutionary changes according to funding opportunities, but the focal areas will remain. A summary of each focal area is as follows:

1. RESEARCH:
(a) Biomedical: The goal is to enhance the quality and quantity of research in the biomedical and public health sciences in the Department of Entomology and to develop innovative cross-disciplinary research efforts in this area that foster the development of new knowledge. This strategy is in alignment with program emphases of the Virginia Tech Institute for Biomedical and Public Health Sciences (IBPHS) and the NIH Roadmap (http://nihroadmap.nih.gov/), which describes major future funding to interdisciplinary research teams rather than single investigators examining a small portion of a problem. Research focuses on reducing and managing emerging and re-emerging infectious diseases, with particular emphasis in Human and Animal Disease, Urban Entomology and Public Health, and Mosquito Genomics and Molecular Biology.
(b) Natural/Agro Ecosystems: A major focus of our department involves insect-related research on wild and managed ecosystems that range from urban dwellings to unmanaged or managed forests to the full array of agricultural systems supported in the state. Our faculty will work on various aspects of integrated pest management (IPM) and environmental stewardship. Our overall goal is to help provide the mechanisms and information that enhance the management of Virginia's resources and maximize productivity of food and fiber with minimal impact on the environment.

2. TEACHING:
The overall goal of our teaching program is to provide students with a knowledge and understanding of entomology. Our teaching program involves instruction at both the undergraduate and graduate level. The undergraduate courses are directed at basic and applied entomology and serve the needs of students in many disciplines. The department does not offer an undergraduate degree, but provides courses for an Entomology Minor, courses for the Agricultural Technology Program, a course for the University Curriculum for Liberal Education (formerly called the Core Curriculum), and various service courses for majors in several departments and colleges. Entomology faculty will also teach courses specifically for curricula in the Department of Biological Sciences, and the College of Agricultural and Life Sciences.

(a) Graduate Program: The graduate program trains students pursuing Masters' and Doctoral degrees. Our emphasis is to advance the Ph.D. program and to preserve our M.S. program, while ensuring that students complete their degrees on schedule. Our graduate enrollment goal is to grow from the mid-twenties in 2003/2004 to an annual sustainable enrollment of 40 graduate students with a 2:1 ratio of Ph.D.:M.S. students by 2010/2011. We will provide relevant courses of instruction emphasizing critical thinking skills, and closely monitor student progress toward timely completion of their degrees. Formal courses are offered in several areas to help students meet the course requirements for their degrees. In addition, students may take advantage of experiential learning opportunities or participate in the Molecular Cell Biology Program. Students must also satisfy research requirements for the degree and prepare a written thesis or dissertation. A non-thesis M.S. degree is available for students seeking a terminal degree. Entomology faculty will also teach several courses for the on-line M.S. degree program offered by the College of Agriculture and Life Sciences.

(b) Undergraduate Program: The Entomology Department does not offer an undergraduate major leading to a Bachelor of Science degree, but has a minor in Entomology. Several faculty members in the Department offer a variety of service undergraduate courses. These courses can be used to earn a minor in Entomology. Service course offerings are coordinated with the needs of other departments both within and outside of the College of Agriculture, including Horticulture, Environmental Science, Fisheries and Wildlife, and Forestry. In addition, the department teaches a general course ENT 2004 “Insects & Human Society” that serves as part of the University Curriculum for Liberal Education (Area 7, Critical Issues in a Global Context). Basic courses are also provided as part of a cross-listed curriculum with the Department of Biological Sciences.

3. EXTENSION and OUTREACH:

(a) Faculty: Virginia Tech Entomology Extension is a highly adaptable group of programs that thrive on personal and cooperative interaction with stakeholders that include the agricultural community, pest management industry, and citizens of the Commonwealth. We provide both support and leadership to those stakeholders dealing with the invasion of exotic insect pests, both indoors and outdoors, pesticide safety education, and changes in agricultural practices from traditional row cropping to niche market crops or organic products. Invasive pests and changes in agricultural practices require the use of innovative pest management techniques and strategies. For example, replacing conventional insecticide applications with genetically-engineered crops that have built-in pest resistance or promoting the use of integrated pest management (IPM) in Virginia schools. Stakeholders look to Virginia Tech Entomology Extension as the principal provider of innovative pest management education and training.

(b) Graduate Students: The Alwood Society, comprised of graduate students in the department, has developed an insect tour that serves over a thousand K-12 students in the state of Virginia. Such tours to classes are very popular each spring and early summer. They serve as an excellent outreach and introduction of the various roles of insects to young citizens of the Commonwealth.

4. INTERNATIONAL PROGRAMS:
Entomology faculty are involved in a variety of international projects that span all three land grant missions: teaching, research and extension/outreach. Teaching activities include providing opportunities for undergraduate students in the biological/life sciences to travel to South Africa and Mali, West Africa to learn about agriculture and agricultural research in developing countries. Research activities include programs addressing African arthropod disease carriers, Integrated Pest Management (IPM) research in West Africa and Eastern Europe, collection and evaluation of potential biological control agents of the hemlock woolly adelgid from Asia. Extension activities include Geographical Information Systems (GIS) training workshops in support of IPM programs in East Africa and the Caribbean, and mentoring a pesticide residue laboratory and development of a pesticide safety education program in Mali, West Africa.

Summary:
As we celebrate our Golden Jubilee, we are buoyed up with optimism that our department will continue to energize and strengthen in the days ahead. While there will be challenges

to surmount, we are confident that we will be able to meet the primary missions of our department, and that our growing list of alumni and alumnae will make their mark in our discipline and play a significant and leadership role in promoting Entomology in the U.S.A.

The Department, October 2008

Entomology Faculty

This information was complliled from two sources: James McDonald Grayson 1984. *A Brief History of Teaching In Entomology at Virgina Tech*. Newman Library at Virginia Tech (LD5655.A522 E5 1984) and Entomology Department directories that were available dating from 1969-2006.

Name	Start	Finish
William A. Alwood	1888	1904
Ellison A. Smyth	1891	1925
W. R. Karr	1897	1898
W. M. Scott	1897	1898
J. L. Phillips	1899	1910
H. L. Price	1899	1900
W. J. Phillips	1903	1914
J. C. Stiles	1904	1909
W. J. Price, Jr.	1905	1918
E. A. Back	1910	1912
W. J. Schoen	1913	1956
M. T. Smulyan	1915	1916
L. A. Stearns	1918	1924
G. W. Underhill	1918	1953
C. R. Willey	1920	1926
W. S. Hough	1921	1963
L. R. Cagle	1924	1964
A. M. Woodside	1927	1970
Marvin L. Bobb	1933	1973
R. N. Jefferson	1934	1946
J. A. Cox	1936	1945
James McD. Grayson	1937	1979
L. A. Hetrick	1938	1945
C. B. Dominick	1939	1975
E. H. Glass	1940	1942
M. J. Janes	1944	1946
W. D. Fronk	1945	1948
John O. Rowell	1945	1970
Clarence H. Hill	1946	1980
Richard N. Hofmaster	1947	1974
John M. Amos	1949	1970
W. H. Howe	1951	1953
T. B. Davich	1953	1956
E. Craig Turner, Jr.	1953	1992
A. P. Morris	1954	1960
A. A. Muka	1954	1956
E. M. Raffensperger	1955	1961
W. G. Evans	1956	1958
G. M. Boush	1957	1965
Donald G. Cochran	1957	1995
J. L. Bishop	1958	1967
Mary H. Ross	1959	1997
W. A. Tarpley	1960	1965

Name	Start	Finish
Robert L. Pienkowski	1961	1995
Michael Kosztarab	1962	1993
H. M. Kulman	1962	1966
G. C. Rock	1963	1967
S. D. Carlson	1965	1969
O. W. Isakson	1965	1967
John C. Smith	1965	1989
H. Jack Heikkenen	1967	1991
Rodney D. Hendrick	1967	1972
John A. Weidhaas	1967	1990
William A. Allen	1968	1983
Ralph A. Alls	?	1969
John L. Eaton	1969	1998
James E. Roberts	1969	1989
C. I. Rose	1969	1969
William H. Robinson	1970	1998
Loke T. Kok	1972	Present
D. E. Mullins	1973	Present
Robert L. Horsburgh	1974	1994
Paul J. Semtner	1974	Present
J. Reese Voshell, Jr.	1976	Present
R. M. McPherson	1978	1987
Richard D. Fell	1979	Present
Sidney L. Poe	1979	1985
Peter B. Schultz	1979	Present
John M. Luna	1980	1992
Ed G. Rajotte	1980	1984
F. William Ravlin	1980	1997
Douglas G. Pfeiffer	1982	Present
D. Sharrod	1982	1984
Thomas L. Payne	1988	1992
Geoff Zehnder	1988	1991
Ames Herbert	1989	Present
Jesse A. Logan	1989	1992
Nicholas Stone	1989	2003
Roger Youngman	1989	Present
Jeffrey Bloomquist	1990	Present
Scott M. Salom	1990	Present
Timothy P. Mack	1994	2003
Sally Paulson	1995	Present
Michael Weaver	1996	Present
Brian Nault	1998	2000
Carlyle Brewster	1999	Present
Edwin Lewis	1999	2004
Dini Miller	1999	Present
Christopher J. Bergh	2000	Present
Thomas P. Kuhar	2001	Present
Igor Sharakhov	2005	Present

Name	Start	Finish
Zachary Adelman	2006	Present
Kevin Myles	2006	Present

Research Scientists and Associates

Larry Pappas	1976	1977
Stephen Bullington	1988	1991
Janet Delorme	1988	1989
Shelby Fleischer	1988	1991
Susan Rutherford	1988	1992
Michael Smith	1988	1989
Heather Wren	1988	1994
Ann Ascoli	1989	1990
Andy Roberts	1989	Present
Donald Grosman	1990	1991
Walid Kaakeh	1990	1991
Lukas P. Schaub	1990	1992
Rosalind D. Buick	1991	1992
Imre Folder	1992	1992
Curt Laub	1993	Present
Nachi Narayanan	1993	1994
Jacques Regniere	1993	1993
Alexei Sharov	1993	2002
Perian Dillon	1994	1994
David Gray	1994	1996
Belinda Carroll	1996	2002
Patricia A. Hipkins	1996	Present
Quintin McClellan	1996	1998
Judy Mollett	1997	2000
Alexandra Spring	1998	1998
Jeffrey Fidgen	2000	2005
Brinkley Benson	2001	2001
Mannin Dodd	2004	Present
Enrique Perez	2004	2005?
Theresa Dellinger	2006	Present
Maria Sharakhova	2008	Present
Dawn Wong	2009	Present

Entomology Graduates and Students

The following list contains some degrees awarded before Entomology was an independent department. The topics, however, were within the discipline.

Name	Year	Chair	Degree
Marvin Bobb	1935	Schoene	MS
James Grayson	1936	Schoene / Hough	MS
Roland Jefferson	1936	Schoene	MS
Edward Glass	1940	Schoene	MS
Edwin King	1947	Grayson	MS
Clarence Dominick	1948	Schoene	MS
Jessie Lancaster	1951	Schwardt	Ph.D.
Donald Cochran	1952	Grayson	MS
Floyd Jarvis, Jr.	1955	Levitan	Ph.D.
Phillip Harein	1956	Muka	MS
William Keeton	1956	Turner	MS
Averett Tombes	1956	Grayson	MS
John Barker	1957	Grayson	Ph.D.
Thomas Clarke	1958	Cochran	MS
Louie Hargett	1958	Turner	MS
John Harshbarger	1959	Raffensperger	MS
Guy Bush	1960	Boush	MS
Davy Crockett	1960	Bishop	MS
Benjamin Perkins, Jr.	1960	Grayson	MS
George Rock	1960	Hill	MS
Robert Peterson	1961	Raffensperger	MS
Charles Covell	1962	Kosztarab	MS
Owen Graham	1962	Price	Ph.D.
Antonio Guerra	1962	Bishop	MS
Donald Messersmith	1962	Raffensperger	Ph.D.
Richard Mills	1962	Cochran	MS
Neal Morgan	1962	Turner	Ph.D.
Nancy Wehrheim	1962	Turner	MS
Howard Townsend	1963	Cochran	MS
Bane Tyler	1963	Bishop	MS
James Wallace	1963	Turner	MS
Ching-Muh Wang	1963	Turner	MS
Stella Chen	1964	Grayson	MS
Rishiraj Mathur	1964	Pienkowski	Ph.D.
Richard Mills	1964	Cochran	Ph.D.
Alfonso Pamanes-Guerrero	1964	Pienkowski	MS
Michael Van den Heuvel	1964	Cochran	MS
William Campbell	1965	Cochran	MS
Charles Covell	1965	Kosztarab	Ph.D.
Reid Gerhardt	1965	Turner	MS
Antonio Guerra	1965	Cochran	Ph.D.
Charles Berisford	1966	Kulman	MS
Jakie Hair	1966	Turner	Ph.D.

Name	Year	Chair	Degree
Dan Harman	1966	Kulman	Ph.D.
Ku Te-yeh	1966	Bishop	MS
Stella Yang	1966	Kosztarab	MS
William Gladney	1967	Turner	Ph.D.
Warren Mitchell	1967	Turner	MS
James Wallace	1967	Grayson	Ph.D.
John Witter	1967	Pienkowski	MS
Charles Berisford	1968	Heikkenen	Ph.D.
Ralph Burton	1968	Turner	Ph.D.
Hsieh Feng-kuo	1968	Pienkowski	MS
Jan Kankrlik	1968	Cochran	MS
George LeCato	1968	Pienkowski	MS
Kenneth Lewis	1968	Heikkenen	MS
Ian McDonald	1968	Cochran	Ph.D.
George Rolofson	1968	Cochran	Ph.D.
Stephen Springer	1968	Pienkowski	MS
Ku Te-yeh	1968	Cochran	Ph.D.
Jerry Vande Berg	1968	Cochran	Ph.D.
Ahmad Chawkat	1969	Pienkowski	MS
Douglass Frazier	1969	Heikkenen	MS
Curtis Hayes	1969	Turner	MS
James Howell	1969	Pienkowski	MS
Jan Humphreys	1969	Turner	Ph.D.
Srisan Loaharanu	1969	Cochran	MS
Rajandra Waghray	1969	Pienkowski	Ph.D.
Michael Williams	1969	Kosztarab	MS
Frank Battle	1970	Turner	Ph.D.
Gary Grant	1970	Eaton	Ph.D.
Oscar Isakson	1970	Pienkowski	Ph.D.
George LeCato	1970	Pienkowski	Ph.D.
Russell Brachman	1971	Kosztarab	Ph.D.
Alfredo D’Ascoli	1971	Kosztarab	Ph.D.
Joseph Dickens	1971	Eaton	MS
James Howell	1971	Kosztarab	Ph.D.
Kenneth Lewis	1971	Heikkenen	Ph.D.
John MacFarlane	1971	Eaton	Ph.D.
Donald Mullins	1971	Cochran	Ph.D.
Robert Rummel	1971	Turner	Ph.D.
Sandra Skrivseth	1971	Hendrick	MS
Gary Tanner	1971	Turner	Ph.D.
William Allen	1972	Pienkowski	Ph.D.
John Hines	1972	Heikkenen	MS
Paris Lambdin	1972	Kosztarab	MS
Dale Pollet	1972	Weidhaas	Ph.D.
Walter Surles	1972	Pienkowski	MS
Rodney Ward	1972	Pienkowski	MS
Michael Williams	1972	Kosztarab	Ph.D.
Peter Egan, Jr.	1973	Heikkenen	MS

Name	Year	Chair	Degree
Larry Alger	1974	Heikkenen	MS
Aphirat Arunin	1974	Pienkowski	Ph.D.
Robert Barlow	1974	Cochran	MS
James Beisler	1974	Pienkowski	MS
Mark Dow	1974	Turner	Ph.D.
Paris Lambdin	1974	Kosztarab	Ph.D.
Ralph Williams	1974	Turner	MS
Phyllis Willoughby	1974	Kosztarab	MS
Matthew Dow	1975	Eaton	MS
Alan Eaton	1975	Smith	MS
Robert Hall	1975	Turner	MS
Walter Knausenberger	1975	Turner	MS
Amos Showalter	1975	Pienkowski	MS
Donald Simonet	1975	Turner	MS
Lee Townsend	1975	Turner	MS
Gary Breeden	1976	Turner	Ph.D.
William Candler	1976	Robinson	MS
Avas Hamon	1976	Kosztarab	Ph.D.
Walter Surles	1976	Kok	Ph.D.
John Thomas	1976	Hill	MS
Rodney Ward	1976	Pienkowski	Ph.D.
Gary Cave	1977	Pienkowski	MS
Robert Hall	1977	Turner	Ph.D.
Jack Jenkins	1977	Smith	MS
Thomas McAvoy	1977	Smith	MS
Stuart McCausland	1977	Turner	MS
Michael Parrella	1977	Kok	MS
Richard Story	1977	Robinson	MS
Lee Townsend	1977	Turner	Ph.D.
John Trumble	1977	Kok	MS
Rodney Akers	1978	Robinson	MS
Ronald Baer	1978	Kosztarab	Ph.D.
Thomas Bailey	1978	Kok	MS
Stephen Bullington	1978	Kosztarab	MS
Peter Egan, Jr.	1978	Heikkenen	Ph.D.
Janice Knausenberger	1978	Allen	MS
Joseph McCaffrey	1978	Horsburgh	MS
Peter Schultz	1978	Kok	Ph.D.
Donald Simonet	1978	Pienkowski	Ph.D.
Larry Alger	1979	Heikkenen	Ph.D.
Arthur Buckman	1979	Roberts	MS
Kevin Cannon	1979	Robinson	MS
James Ferguson	1979	Heikkenen	MS
Robert Gorton	1979	Bell	Ph.D.
Clifford Keil	1979	Ross	MS
Boris Kondratieff	1979	Voshell	MS
Danilo Martinez	1979	Pienkowski	MS
Peggy Powell	1979	Robinson	MS

Name	Year	Chair	Degree
John Thomas	1979	Hill	Ph.D.
George Anderson	1980	Weidhaas	MS
Andrew Beck	1980	Turner	MS
Stephen Briggs	1980	Allen	MS
Patrick Dowd	1980	Kok	MS
John Fairservice, Jr.	1980	Heikkenen	MS
John Murphy	1980	Smith	MS
Charles Parker	1980	Voshell	Ph.D.
Michael Parrella	1980	Horsburgh	Ph.D.
John Trumble	1980	Kok	Ph.D.
Timothy Dickens	1981	Cochran	Ph.D.
Jo Anne Engebretson	1981	Mullins	Ph.D.
Shelby Fleischer	1981	Allen	MS
Joseph McCaffrey	1981	Horsburgh	Ph.D.
Deborah Rowe	1981	Kok	MS
Peggy Sieburth	1981	Kok	MS
Robert Zimmerman	1981	Turner	Ph.D.
Andrew Beck	1982	Turner	Ph.D.
Brian Bret	1982	Ross	MS
Kevin Cannon	1982	Robinson	Ph.D.
Frank Carle	1982	Turner	Ph.D.
Paul David	1982	Horsburgh	MS
Joseph Despins	1982	Roberts	MS
John Dukes	1982	Robinson	MS
Bobby Farmer	1982	Robinson	MS
Douglas Howell	1982	Voshell	MS
Clifford Keil	1982	Ross	Ph.D.
Boris Kondratieff	1982	Voshell	Ph.D.
Lorraine Los	1982	Allen	MS
Chapman Loyd	1982	Fell	MS
David Morris	1982	Smith	MS
Lane Smith II	1982	Kok	MS
Mike Tolley	1982	Robinson	MS
Jefferson Vaughan	1982	Turner	MS
Patricia Zungoli	1982	Robinson	Ph.D.
Bobby Cartwright	1983	Kok	Ph.D.
Joseph Chamberlin	1983	Kok	MS
John Deighan	1983	McPherson / Ravlin	MS
Edward Durbin	1983	Cochran	MS
Holly Ferguson	1983	McPherson	MS
Janet Goldblatt	1983	Fell	MS
Brett Highland	1983	Roberts	MS
Janet Knodel-Montz	1983	Poe	MS
Patrick Lummus	1983	Smith	Ph.D.
Sheila Andrus	1984	Pienkowski	Ph.D.
William Burkhardt	1984	Voshell	MS
Joseph Mares	1984	Robinson	MS
Peter Mehring	1984	Pienkowski	Ph.D.

Name	Year	Chair	Degree
John Williams	1984	Roberts	MS
Robert Bellinger	1985	Pienkowski	Ph.D.
Brian Bret	1985	Ross	Ph.D.
Paul David	1985	Horsburgh	Ph.D.
Daniel Donahue	1985	Poe	MS
Robert Hamilton	1985	Mullins	MS
Daniel Hilburn	1985	Pienkowski / Allen	Ph.D.
Joan Lasota	1985	Kok	Ph.D.
Raymond Layton	1985	Voshell	MS
Hannah Lembke	1985	Cochran	MS
Michelle Sprint	1985	Eaton	MS
Tracy Stoyer	1985	Kok	MS
Keith Tignor	1985	Eaton	MS
Jefferson Vaughan	1985	Turner	Ph.D.
Ren Wang	1985	Kok	Ph.D.
Thomas Boucher	1986	Pfeiffer	MS
Joseph Despins	1986	Turner	Ph.D.
Brett Highland	1986	Roberts	Ph.D.
Walter Knausenberger	1986	Turner	Ph.D.
John Luna	1986	Ravlin	Ph.D.
Peter Sherertz	1986	Mullins	Ph.D.
Ellen Thoms	1986	Robinson	Ph.D.
David Byron	1987	Robinson	Ph.D.
Bonny Dodson	1987	Robinson	MS
Michael Fletcher	1987	Turner	Ph.D.
Mohd Hamid	1987	Semtner	MS
James Harmon	1987	Ross	MS
Tong-Xian Liu	1987	Kosztarab	MS
T. David Reed	1987	Semtner	MS
John Rightor	1987	Robinson	MS
Merrill Varn	1987	Pfeiffer	Ph.D.
Heather Wren	1987	Cochran	Ph.D.
David Judge	1988	Mullins	MS
Anne Tisler	1988	Zehnder	MS
Karen Vail	1988	Kok	MS
Mark Wooster	1988	Ross	Ph.D.
Nonggang Bao	1989	Robinson	MS
Walid Kaakeh	1989	Pfeiffer	Ph.D.
Virginia Kirby	1989	Semtner	MS
Lorraine Koller	1989	Turner	MS
Raymond Layton	1989	Voshell	Ph.D.
Karen Yoder	1989	Robinson	MS
Reynaldo Abad	1990	Kok	Ph.D.
Martha Barnes	1990	Semtner	MS
Colleen Cannon	1990	Fell	MS
Deborah Davidson	1990	Eaton	Ph.D.
Curtis Laub	1990	Luna	MS
Richard McDonald	1990	Kok	Ph.D.

Name	Year	Chair	Degree
Peggy Powell	1990	Robinson	Ph.D.
Thomas Reed	1990	Semtner	Ph.D.
Antone Silvia	1990	Voshell	MS
Eric Snell	1990	Robinson	MS
Kenneth Stein	1990	Fell	Ph.D.
Preston Sullivan	1990	Parrish / Luna	Ph.D.
Barbara Bentz	1991	Logan	Ph.D.
Mark Carter	1991	Ravlin	Ph.D.
Van Christman	1991	Voshell	Ph.D.
Gema Guerra	1991	Kosztarab	Ph.D.
Anne Tisler	1991	Zehnder	Ph.D.
Jing Zhai	1991	Robinson	MS
Ban-Na Ang	1992	Kok	Ph.D.
Amie Birdwhistell	1992	Stone	MS
Jane Carter	1992	Ravlin	MS
Mark Coffelt	1992	Schultz	Ph.D.
Holly Ferguson	1992	Eaton	Ph.D.
David Gaines	1992	Kok	MS
David Midgarden	1992	Youngman	MS
Joelle Crouch	1993	Ross	MS
Harlan Hendricks	1993	Kosztarab	Ph.D.
Paul Taylor	1993	Shields	Ph.D.
Perian Dillon	1994	Turner	Ph.D.
David Gray	1994	Ravlin	Ph.D.
Erik Gronning	1994	Pfeiffer	MS
David Jefferson	1994	Schultz	MS
Brett Marshall	1994	Voshell	MS
Saripah Ulpah	1994	Kok	MS
Alesia Wright	1994	Bloomquist	MS
Jaime Acosta-Martinez	1995	Kok	Ph.D.
Surrendra Dara	1995	Semtner	Ph.D.
Byron Dowell	1995	Fell	MS
Raymond Ebbett	1995	Cochran	MS
Richard Hermann	1995	Fell	MS
Scott Ludwig	1995	Kok	MS
William Petka	1995	Herbert	MS
Alexandra Spring	1995	Kok	MS
Prabhakar Bhogaraju	1996	Stone	MS
Christopher Fettig	1996	Salom	MS
Donald Grosman	1996	Salom	Ph.D.
David Judge	1996	Mullins	Ph.D.
Thomas Kuhar	1996	Youngman	MS
Sean Malone	1996	Pfeiffer	MS
Tracy Negus	1996	Ross	MS
Shane Evans	1997	Voshell	Ph.D.
David Gaines	1997	Kok	Ph.D.
Sharon McDonald	1997	Ravlin	MS
Karen Walker	1997	Fell	Ph.D.

Name	Year	Chair	Degree
Xiao Yungxiang	1997	Mullins	Ph.D.
Colleen Cannon	1998	Fell	Ph.D.
Michael Kirby	1998	Bloomquist	Ph.D.
Kathy Knowles	1998	Pfeiffer	MS
Jarrod Leland	1998	Mullins	MS
Ethan Freeborn	1999	Bloomquist	MS
Anne Hillery	1999	Fell	MS
Jose Lopez-Collado	1999	Stone	Ph.D.
Lucas Mackasniel	1999	Fell	MS
Peter Warren	1999	Stone	MS
Sarah Engel	2000	Voshell	MS
Thomas Kuhar	2000	Youngman	Ph.D.
Christopher Barker	2001	Paulson	MS
Ken Cote	2001	Lewis	MS
Jarrod Leland	2001	Mullins	Ph.D.
Sean Malone	2001	Herbert	Ph.D.
Sharon McDonald	2001	Nault / Tolin	Ph.D.
Jessica Metzger	2001	Pfeiffer	MS
Gabriella Zilahi-Balogh	2001	Kok / Salom	Ph.D.
Corey Broeckling	2002	Salom	MS
Marjorie Browning	2002	Fell	MS
Erin Holden	2002	Brewster	MS
Michelle McClannan	2002	Pfeiffer	MS
Michael Moeykens	2002	Voshell	Ph.D.
Sarah Satterlee	2002	Stone	MSLS
Laura Barbani	2003	Fell	MSLS
Theresa Dellinger	2003	Youngman	Ph.D.
Stephen Hiner	2003	Voshell	MS
Rachael Perrott	2003	Miller	MSLS
Brent Short	2003	Bergh/Pfeiffer	MS
Youngsoo Son	2003	Lewis	Ph.D.
Ksenia Tcheslavskaia	2003	Brewster / Sharov	Ph.D.
Janet Ashley	2004	Herbert / Lewis	MS
Safiatou Dem	2004	Mullins	MSLS
William Dimock	2004	Lewis	Ph.D.
Bryan Jackson	2004	Paulson	MS
Joan Marie	2004	Semtner	MS
Lois Swoboda	2004	Miller	Ph.D.
Kimberly Tabor	2004	Fell / Brewster	Ph.D.
Roberto Alonso	2005	Kuhar	Ph.D.
Amy Braccia	2005	Voshell	Ph.D.
Roberto Cordero	2005	Kuhar	Ph.D.
Holly Gatton	2005	Salom / Kok	MSLS
Jinghong Kou	2005	Bloomquist	Ph.D.
Ashley Lamb	2005	Salom / Kok	Ph.D.
Vonny Barlow	2006	Kuhar	Ph.D.
Marc Fisher	2006	Miller	Ph.D.
Robbie Flowers	2006	Salom / Kok	Ph.D.

Name	Year	Chair	Degree
Devin Grim	2006	Paulson	MS
Charles Hannum	2006	Miller	MS
Scott Longing	2006	Voshell	Ph.D.
David Moore	2006	Miller	MS
Theresa Schooley	2006	Weaver	MS
Xing Zhang	2006	Pfeiffer	Ph.D.
Lisa Burley	2007	Fell	MS
Anna Chapman	2007	Kuhar	MS
Erin Hitchner	2007	Kuhar / Youngman	Ph.D.
Grace Lim	2007	Salom / Kok	Ph.D.
David Mausel	2007	Salom / Kok	Ph.D.
Rob Slaughter	2007	Pfeiffer	MSLS/Online
Siddharth Tiwari	2007	Youngman	Ph.D.
Dhana Raj Boina	2008	Bloomquist	Ph.D.
Helene Doughty	2008	Schultz	MSLS/Online
Brian Eisenback	2008	Salom / Kok	Ph.D.
Tim Jordan	2008	Pfeiffer	MS
Kathy Kamminga	2008	Herbert	Ph.D.
Michelle McKinney	2008	Paulson	MSLS/Online
Casey Palmer	2008	Paulson	MSLS/Online
Lakshmipathi Srigiriraju	2008	Semtner	Ph.D.
Ahmed Tawer	2008	Pfeiffer	MSLS/Online
Anna Wallingford	2008	Pfeiffer	MS
Katherine Willey	2008	Voshell	MS
Derek Monthei	2009	Fell	Ph.D.
Brenna Traver	2009	Adelman	MSLS
Nancy Adamson	current	Fell / Mullins	Ph.D.
Hamilton Allen	current	Miller	MSLS
Heather Andrews	current	Kuhar	MSLS
Damisi Bailey	current	Miller	MSLS
Shana Beirne	current	Fell	MSLS
Preston Brown	current	Miller	MSLS
Meredith Cassell	current	Kuhar	Ph.D.
Serena Ciparis	current	Voshell	Ph.D.
Gina Davis	current	Salom	MSLS
Daniel Frank	current	Bergh	Ph.D.
Philip George	current	Sharakhov	Ph.D.
Tiffany Gross	current	Adelman	Ph.D.
Nathan Herrick	current	Salom	Ph.D.
Bryan Jackson	current	Paulson	Ph.D.
Lacey Jenson	current	Bloomquist	MSLS
Ying Jiang	current	Bloomquist	Ph.D.
Timothy Jordan	current	Pfeiffer	Ph.D.
Maryam Kamali	current	Sharakhov	Ph.D.
Reina Koganemaru	current	Miller	Ph.D.
Amanda Koppel	current	Herbert	Ph.D.
William Kuhn	current	Youngman	MSLS
Laura Maxey	current	Pfeiffer	MSLS

Name	Year	Chair	Degree
Lisa Moore	current	Brewster	Ph.D.
Elaine Morazzani	current	Myles	Ph.D.
James Mutunga	current	Bloomquist	Ph.D.
Nicole Plaskon	current	Myles	MSLS
Andrea Polanco	current	Miller	MSLS
Matthew Reis	current	Miller	MSLS
Amy Snyder	current	Salom	MSLS
Heather Story	current	Salom	MSLS
Daniel Swale	current	Bloomquist	MSLS
Nancy Troyano	current	Paulson	Ph.D.
Ligia Vieira	current	Salom	Ph.D.
Justin Vitullo	current	Bergh	Ph.D.
Anna Wallingford	current	Kuhar	Ph.D.
Michael Wiley	current	Myles / Adelman	Ph.D.
James Wilson	current	Fell	MSLS
Meredith Worthen	current	Brewster	Ph.D.
Shaohui Wu	current	Youngman	Ph.D.
Ai Xia	current	Sharakhov	Ph.D.
Fan Yang	current	Sharakhov	MSLS

Research Histories

Department of Entomology Perspective

By Donald G. Cochran, Professor Emeritus

July, 2005

Preamble. In this document, I will try to set down my thoughts on how I saw the Department of Entomology develop during my tenure there. My plan is to outline my professional career at Virginia Tech as a vehicle for doing so, and to interweave appropriate comments along the way. A secondary goal is to provide a document that might serve as a historical reference to people and events from the past. Before I begin with the main task, however, I will present a brief statement of my early history for the record.

I was born on a family farm in Chickasaw County, Iowa in 1927. I attended and graduated from a one-room rural school and from New Hampton High School, the latter in 1945. At that time, WW II was drawing to a close. Because my older brother was already in the Army, and because food production was considered to be a high priority, I stayed at home for a year to help with the farm work. WW II ended in 1946, and my brother returned to resume farming. Because I had other plans, I left the farm and entered Iowa State College (now Iowa State University), Ames, IA in the fall of 1946. Although I majored in zoology, I soon became interested in entomology through some excellent coursework. At that time the entomology program at Iowa State was housed in the Zoology Department. However, the Department Head was the well-known Hemipterist Hal H. Harris, which explains the emphasis the entomology program received. I graduated in June 1950 with a B.S. degree in zoology.

My Early Contact with VPI. With the help of Dr. Harris, my cousin Dr. Norman Borlaug of the Rockefeller Foundation, and others, I became aware of the entomology program at VPI, as it was called at that time. I was offered financial aid to attend in the fall of 1950 as a Master's Degree candidate. I arrived in Blacksburg in September, and found myself in what was essentially a military institution. Nearly everyone, except graduate students and a few women, was in the Corps of Cadets, and when the Corps lined up for Retreat in the evening it occupied most of the oval around the Drill Field. I soon found that the instruction program was rigorous with some excellent teachers, especially in the Chemistry Department. The instruction program in entomology was housed in the Biology Department and the research program was called the Entomology Section of the Virginia Agricultural Experiment Station. The latter program was headed by Dr. William J. Schoene, who was one of the early pioneers in entomology at VPI. Other entomologists at the time were Grover W. Underhill, Leroy Cagle, and James M. Grayson, who became my major professor. There were also two extension entomologists; John O. Rowell and John M. Amos. Their work was in the Cooperative Extension Service. Several other entomologists were located at various outlying research stations. They were Drs. Walter Hough and Clarence Hill at Winchester, Dr. Marvin Bobb at Charlottesville, A. M. Woodside at Steeles Tavern, and C. B. Dominick at Chatham.

When I entered VPI, the problem of insect resistance to insecticides was just beginning to be recognized. Dr. Grayson had initiated a research project on resistance in the German cockroach. My thesis topic was to explore the inheritance mechanism of DDT resistance in that species. The topic was appropriate because I had a strong emphasis in genetics from my studies at Iowa State. The results of that research are still credible, but our interpretation of them was somewhat naïve. However, we were entering an unknown field, and no one was sure of its parameters. That work resulted in my M.S. thesis, a research publication, a presentation at the Eastern Branch, ESA meeting in New York, and an M.S. degree, the latter in June 1952. As will become clear later, the study of resistance was to become one of the main threads of research throughout my career.

In the summer of 1952, I left Blacksburg for the Department of Entomology at Rutgers University. At Rutgers my major professor was Dr. Andrew J. Forgash, and my dissertation was on the metabolism of DDT in the American Cockroach. While my major was in entomology, I also had a minor in biochemistry. I completed my Ph.D. degree in October 1954, and shortly thereafter entered the U. S. Army as a First Lieutenant Entomologist. I was assigned to the Entomology Department of the Medical Laboratories at the Army Chemical Center, Edgewood, MD for two years. While there, I worked with a famous biochemist named Dr. Bertram Sacktor. During this period we elucidated the alpha-glycerol phosphate shunt cycle through which insects are provided with the huge amounts of energy needed to carry out powered flight without incurring an oxygen debt. While I was a junior member of the research team, I consider that accomplishment to be a highlight of my career. The highlight publications are:

Sacktor, B. and D. G. Cochran. 1957. DPN-specific alpha-glycerophosphate dehydrogenase in insect flight muscle. Biochim. Biophys. Acta 25: 649.

Sacktor, B. and D. G. Cochran. 1957. Dihydroxyacetone phosphate, the product of alpha glycerophosphate oxidation in insect muscle mitochondria. Biochim. Biophys. Acta 26: 200-201.

I was mustered out of the Army in the spring of 1957 and returned to Blacksburg.

Appointment as Associate Professor – 1957-1964. I began my appointment as a faculty member in August 1957. At that time, Price Hall was a very crowded building. The two main occupants were the Department of Biology and the Department of Plant Pathology. In addition, the programs in Fisheries and Wildlife and Entomology were also assigned limited space. That space limitation problem was one that plagued entomology throughout most of the early years. By 1957 Dr. Grayson was in charge of the entomology program. Numerous faculty appointments had occurred since I left Blacksburg in 1952, and in 1959 the Department of Entomology was established with Dr. Grayson as its head. This was a major step on the part of the administration because there was opposition to what some saw as the demise of the Biology Department. Obviously, that did not occur. Even during that early time, Dr. Grayson made it clear that one of his goals was to develop a strong graduate program in the Department. As a part of that effort, we tried to provide financial support for incoming graduate students to the greatest extent possible.

As a part of the justification for my position, it was agreed that I would participate in a cooperative research project with Agricultural Engineering. The objective was to study flight activities in tobacco hornworm adults. The project was short lived because the engineer who was involved soon left campus and was not replaced. However, this project was an example of the cooperative spirit that existed on campus at the time, and that I found to be very refreshing. I then began to develop programs in insecticide resistance and insect biochemistry. My first graduate student was T. Hal Clarke who investigated cross-resistance in several strains of German cockroaches. Other work involved selecting for resistance to various insecticides in order to have appropriate strains for future research.

The insect biochemistry project was greatly enhanced by a cooperative agreement with the Department of Biochemistry and Nutrition, a part of which was housed on the fifth floor of Price Hall. This arrangement, established by Dr. Grayson, Dr. Charlie Engel, Head of Biochemistry, and Dean Wilson Bell, was of great help as I was given space on the fifth floor of Price and was allowed to use some of their equipment. Later, I was assigned a laboratory in the then new Biochemistry Building, now called Engel Hall. I began studies on the flight muscles of the American cockroach and was soon joined in that work by two new graduate students; Richard R. Mills and Charles F. Bruno. Mills concentrated on enzymes present in muscle mitochondria that are located on the pathway in the degradation of energy-yielding compounds, including adenosine triphosphate. Bruno examined enzymes involved in the degradation of pyrimidine compounds and in the synthesis of uric acid. Ultimately, Mills received an M.S. degree in Entomology, and Bruno a Ph.D. degree in Biochemistry for their work. That work was also greatly facilitated by a series of research grants I obtained from the National Institutes of Health. One of those grants allowed me to attend the XI International Congress of Entomology in Vienna, Austria in 1960, and present a research paper. From the very beginning, Dr. Grayson strongly encouraged participation in national and international meetings as a means of obtaining recognition for the Department. That philosophy was an important component of how the Department developed, and, I believe, has persisted to the present.

In 1959 Dr. Mary H. Ross joined the department, and we began a cooperative project designed to establish a formal genetics for the German cockroach. Our objective was to develop a series of mutant stocks that would eventually allow the identification of linkage groups in this insect. From earlier work we knew that insecticide resistance is genetically controlled, and that its further study would be enhanced by the availability of information about linkage groups. We hoped to place individual resistance traits in different linkage groups that would prove their separate identity. The work proceeded slowly in the beginning. A trait called Balloon-wing was the first morphological mutant we discovered. Over the next few years several other morphological traits were found and their inheritance mechanism was established. In an attempt to speed up the process of discovering new traits, we exposed nymphal German cockroaches to ionizing radiation in a Cobalt60 source owned by the University of Virginia at their Blandy Research Farm, Boyce, VA. Not only did we find new traits among the treated insects, we also gained valuable information about the effects of ionizing radiation on the German cockroach that resulted in a separate publication.

My initial appointment was 85% research and 15% teaching. My teaching responsibility consisted of the departmental course in Insect Physiology and directing my graduate students. I also gave occasional lectures in other courses, mainly dealing with the impact of cockroaches on the subject matter under discussion.

During the latter part of this period, VPI was on the brink of some major changes. Long time President Walter E. Newman retired and was replaced by T. Marshall Hahn. Leander B. Dietrick, Dean of the College of Agriculture, retired and was replaced by Wilson B. Bell. In a rather short time, a momentous decision was made to transform the institution from a military college into a major university. Many alumni and some faculty initially resented the change because it meant the Corps of Cadets was to become a minor part of the institution. Entering students were no longer required to become Cadets. Some name changing ultimately resulted in the addition of the phrase “and State University” to the institution’s official title. Closer to home, these changes initially had little effect on the Department, since our students were all graduate students. In addition, the Department of Entomology was in a favorable position because it had just been named as one of only two departments on campus to receive an excellent rating in a national report on the status of higher education in America.

Promotion to Full Professor – 1964. For the next several years my program continued with research being conducted in insect biochemistry, insecticide resistance, and cockroach genetics. Bruno finished his degree, and Mills entered the Ph.D. program. He conducted detailed studies on several enzymes from cockroach muscles involved in energy metabolism. My work was closely related, and the thrust of our program at that time was to compare the pathways found in cockroaches with what was known from other insects, mainly the housefly. My last graduate student in the more formal biochemistry program was Te Y. Ku. He did a comparative analysis of isocitrate dehydrogenase from housefly and cockroach thoracic-muscle mitochondria. From this point onward work in this general area assumed a more physiological nature, as will be detailed below.

Work on insecticide resistance continued and was facilitated by the involvement of Mary Ross and the arrival of graduate students Michael J. van den Heuvel, from England, and Ian C. McDonald. The work concentrated on establishing as many separate resistance traits as possible, and determining their inheritance mechanism. Through the work of graduate student George Rolofson we also attempted to look at how resistant strains metabolize insecticides. As before, this work was possible because of our continuing efforts to select for resistance to several different insecticides. As time progressed, the emphasis shifted to the pyrethroid insecticides. By intensively selecting for pyrethroid resistance and subsequently discontinuing selection, I was able to show that the development and loss of resistance to pyrethroids could be characterized in terms of gene frequency in a population as resistance developed or receded. Graduate student Ray H. Ebbett (deceased) contributed to these studies by determining the inheritance mechanism of several pyrethroids. The highlight publications are:

Cochran, D. G. 1994. Changes in insecticide resistance gene frequencies in field-collected populations of the German cockroach during extended periods of laboratory culture (Dictyoptera: Blattellidae). J. Econ. Entomol. 87: 1-6.

Cochran, D. G. 1994. Resistance to pyrethrins in the German cockroach: inheritance and gene frequency estimates in field-collected populations (Dictyoptera: Blattellidae). J. Econ. Entomol. 87: 280-284.

The studies on cockroach genetics were developing rapidly at this stage. We discovered numerous new morphological traits and determined their inheritance mechanism. By then there were enough known traits that we could begin to establish a linkage map for the German cockroach. This included the placement of resistance traits into appropriate linkage groups. Ross took the lead in this work, while I began a study aimed at the identification of the individual chromosomes of the German cockroach. Through detailed study, it was possible to recognize most of the chromosomes based on their appearance at meiotic metaphase in squash preparations of nymphal testes. This work progressed into a cytological examination of several reciprocal chromosomal translocations that we discovered in our stocks. By identifying the chromosomes involved and by tying an already established linkage group to the translocation we were able to make linkage group-chromosome correlations. The highlight publication is:

Cochran, D. G. and M. H. Ross. 1974. Cytology and genetics of T (9, 11) in the German cockroach, and its relationship to other chromosome 9 traits. Canad. J. Gen. Cytol. 16: 639-649.

Other studies demonstrated the existence of two distinct types of alternate disjunction at metaphase I. The second type had been postulated by others in the past, but had never been clearly demonstrated. The highlight publications are:

Cochran, D. G. 1976. Disjunction types and their frequencies in two heterozygous reciprocal translocations of *Blattella germanica* (L.). Chromosoma (Berl.) 59: 129-135.

Cochran, D. G. 1977. Patterns of disjunction frequencies in heterozygous translocations from the German cockroach. Chromosoma (Berl.) 62: 191-198.

As an offshoot of this work, graduate student Jon Kankrlik studied gametogenesis in the firebrat. On a broader note, this program also resulted in the establishment of The Genetic Stock Center for the German Cockroach, an entity that still exists in the Department. The establishment and maintenance of this Center was largely due to the efforts of Dr. Ross, with the assistance of technician Nancy Boles.

As mentioned, the biochemical theme of my program became more physiological in tone. Graduate student Tony A. Guerra studied respiration during the life cycle of the facefly. In addition, with the arrival of graduate student Donald E. Mullins we began an extensive program aimed at elucidating nitrogen metabolism and excretion in cockroaches. The first breakthrough in this study was the discovery that cockroaches do not excrete uric acid to the exterior as most insects do, and as had been erroneously claimed for cockroaches. The highlight publication is:

Mullins, D. E. and D. G. Cochran. 1972. Nitrogen excretion in cockroaches: Uric acid is not a major product. Science 177: 699-701.

This paper was followed by others in which we reported, among other things, that the American cockroach deals successfully with excess nitrogen in its diet by storing it as uric acid or urates in urate cells in its fat body. Even under conditions of being fed extremely high nitrogen-containing diets this insect does not excrete uric acid. Further studies led to a subsequent highlight publication on the cytology of urate storage as follows:

Cochran, D. G., D. E. Mullins, and K. J. Mullins. 1979. Cytological changes in the fat body of the American cockroach in relation to dietary nitrogen level. Ann. Entomol. Soc. Amer. 72: 197-205.

Through a series of detailed studies, Mullins examined nitrogen metabolism in the American cockroach under positive and negative dietary nitrogen balance. He also demonstrated that under certain conditions this insect excretes ammonia, something terrestrial insects are not supposed to do. As a result of this work, Mullins received the Ph.D. degree and published an important series of papers that illuminated nitrogen metabolism in cockroaches. At the same time, by looking at excretion in about 80 cockroach species, I demonstrated that most cockroaches do not excrete uric acid. The exceptions are cockroaches belonging to the genus Parcoblatta and a few other genera, all of which are members of the subfamily Blattellinae, family Blattellidae. They excrete uric acid as discrete formed pellets that are essentially pure uric acid. This process is also subject to regulation based on the amount of nitrogen present in the diet and appears to be a mechanism by which these few species can pass excess dietary nitrogen on to other members of a colony. We subsequently demonstrated that the urate pellets are consumed by members of a colony, provided there is also a dietary carbohydrate source available. Through the work of graduate student Hanna F. Lembke, we showed that these blattellid cockroaches void uric acid through the Malpighian tubules, as other insects typically do. As a result of our various publications, I was asked to prepare a number of book chapters on insect excretion and nitrogen metabolism. Two examples are as follows:

Cochran, D. G. 1975. Excretion in Insects. pp. 172-283. In: Insect Biochemistry and Function. D. J. Candy and B. A. Kilby (Eds.), Chapman and Hall, London.

Cochran, D. G. 1985. Nitrogen excretion in cockroaches. Annu. Rev. Entomol. 30: 29-49.

The last phase of this program was initiated by the arrival of graduate student Heather N. Wren. Because of her background in microbiology, we wanted to concentrate on the role played by the endosymbiotic bacteria housed in the mycetocytes of the cockroach fat body. It had been postulated for many years that these bacteria are involved in metabolic activities essential to the survival of cockroaches. Wren demonstrated that isolated preparations of these bacteria contain xanthine dehydrogenase activity, an enzyme on the pathway for the synthesis and/or degradation of uric acid. This finding provided an essential piece of evidence on how cockroaches degrade their fat body uric acid under conditions of nitrogen starvation. The highlight publication is:

Wren, H. N. and D. G. Cochran. 1987. Xanthine dehydrogenase activity in the cockroach endosymbiont *Blattabacterium cuenote* (Mercier 1906) Hollande and Favre 1931, and in the cockroach fat body. Comp. Biochem. Physiol. 88B: 1023-1026.

In further work, Wren demonstrated that DNA from endosymbiotic bacteria of several cockroach species is so similar that these bacteria can be considered to be one species, and that the minor differences that do occur appear to correlate with differences in nuclear DNA from the host cockroach species. This work was made possible through the cooperation of the Anaerobic Microbiology Laboratory, and is another example of the cooperative spirit that characterized this institution throughout most of my career. The highlight publication is:

Wren, H. N., J. L. Johnson, and D. G. Cochran. Evolutionary inferences from a comparison of cockroach nuclear DNA and DNA from their fat body and egg endosymbionts. Evolution 43: 276-281.

As an extension of this program, Dr. Wren subsequently developed a strategy for control of the German cockroach. It is based on a combination of two chemicals that, when fed to cockroaches, prevents the synthesis of uric acid. Because uric acid is vital to cockroaches, in its absence they fail to reproduce and eventually die. This product has been patented and is currently commercially available.

An additional theme in my research program revolved around reproduction in cockroaches. This work was initiated by using a genetic marker to demonstrate that female German cockroaches usually mate only once, but when they do occasionally mate a second time it is the sperm of the second male that takes precedence in the production of subsequent offspring. Graduate student Edward J. Durbin studied the effects of food and water deprivation on reproduction in female German cockroaches. I also compared the reproductive capacity of several species of Parcoblatta cockroaches. Lembke demonstrated that female *Parcoblatta fulvescens* exhibit different food preferences as they pass through a reproductive cycle. Much of this work derived from my earlier finding that female German cockroaches feed and drink voraciously as they prepare to form an egg case, but essentially stop eating and drinking while they carry the egg case. When the egg case is dropped at hatching, the female repeats the cycle. The highlight publication is:

Cochran, D. G. 1983. Food and water consumption during the reproductive cycle of female German cockroaches. Ent. Exp. Appl. 34: 51-57.

An early recognition afforded to the cockroach research program in the Entomology Department at VPI was an invitation from the World Health Organization to prepare a publication on the cockroach pest species of the world. This invitation was based largely on the reputation Dr. Grayson had already established. Because of the global nature of the project, we enlisted the aid of Ashley B. Gurney, a cockroach specialist at the Natural History Museum in Washington, D. C. The resulting publication is:

Cochran, D. G., J. M. Grayson, and A. B. Gurney. 1972. World Health Organization/Vector Biology and Control Series/72.354. V. Cockroaches-Biology and Control. pp. 1-45.

This publication was revised in 1975, 1982, and 1999.

From 1964 onward, I continued to teach the major portion of the Insect Physiology course. However, as time progressed other physiologists were appointed to the faculty; notably, Dr. John L. Eaton and Dr. Donald E. Mullins. This placed the Department in a favorable position because few other Entomology Departments had this luxury. Because the study of the physiology of insects was expanding so rapidly, it became necessary to share the teaching load in order to have the most up-to-date coverage. Eaton and Mullins assumed responsibility for parts of the course, as did Dr. Jeffrey R. Bloomquist when he arrived on campus. In 1968 I also assumed responsibility for the Insecticide Toxicology course. Again, as the subject matter expanded Bloomquist taught parts of the course. I also continued to give guest lectures in several other courses.

In order to involve the College of Agriculture and Life Sciences, as it became known, in the environmental movement that was at its height during the late 1960s and early 1970s, Dean James R. Martin asked me to develop and offer a course in this area that would attract students from all over campus. I developed a syllabus, got the course approved, arranged guest lecturers, and offered the course in four consecutive quarters, as we were still on the quarter system at that time. The course attracted more than one thousand students at a time when the College was struggling to justify its teaching faculty positions. After four quarters, I asked to be replaced. This course clearly demonstrated that agriculture, and more especially subject matter areas like entomology, have much to offer the University in terms of producing a well-rounded education. More recent efforts in the Department, as discussed below, have born out the correctness of that position, and will undoubtedly do so in the future.

Dr. Grayson continued as Department Head from 1959-1979. This was a period during which basic research received a high priority in the Department, and helped to advance our reputation at the national and international levels. Several faculty positions were added, which broadened the areas within entomology that were covered by the Department. At the same time our graduate program continued to expand, reaching a maximum of 30 plus students. This was also the period during which the University changed from the quarter to the semester system of instruction. That change had a profound effect on our teaching program. The course structure had been developed over many years based on the quarter system, and fit our needs quite well. It took several years and many changes in our courses to successfully adapt to the semester system. This was also the time that the Biology Department moved out of Price Hall. That move greatly relieved the space problem, as Entomology was assigned much of the vacated space.

With the retirement of Dr. Grayson in 1979, the Department had a series of new leaders. The first was Dr. Sidney L. Poe. During his tenure, the Department actually changed very little. I followed him, quickly discovered a lack of administrative ability on my part, and resigned. The next Department Head was Dr. Thomas L. Payne. His administration resulted in the first major shift in priorities that occurred during my time at Virginia Tech. His approach emphasized the computer-aided, mathematically oriented aspects of entomology. New faculty positions were added in this area. The traditional basic research programs in the Department were allowed to languish with little support or encouragement. The next Department Head was Dr. Timothy P. Mack. During his tenure, University officials began to emphasize the instructional program to the near exclusion of the other traditional roles of research and extension. Dr. Mack realized the vulnerability of the Department in this arena and initiated coursework designed to have wide appeal across the University. It proved to be a huge success and elevated the Department from a student-deficient to a student-surplus status in instruction. Its success was so great that it also elevated the entire College in this arena. Dr. Mack subsequently went on to develop a successful distance-learning program.

Retirement in 1995. I retired on March 1, 1995, and have made no attempt to discuss departmental events beyond that date. Shortly after my retirement, I was asked to serve as an expert witness in a lawsuit between The S. C. Johnson Company and The Clorox Chemical Company. The suit involved a claim of false advertising, and my testimony was based on my experience from previous work on resistance in the German cockroach. Subsequently, I have also become involved as an editor for the Annals of the Entomological Society of America. I was appointed as Associate Editor in 1997. I served as Co-Editor 1998-2003. When the Annals changed to an Editor-in-Chief system in 2003, I became and remain one of several Subject-Matter Editors.

In addition to revising the WHO cockroach brochure in 1999, I was asked to prepare a chapter on cockroaches for inclusion in the Encyclopedia of Insects, which was published in 2003 by Academic Press.

John Eaton's Entomological Career

I was introduced to entomology by my undergraduate professor, Dr. Clyde Dennis, at Millikin University, Decatur, Illinois. As a junior I transferred to the University of Illinois to major in entomology. In 1962 I received the B.S. degree in entomology. I continued graduate study at Illinois completing my Ph.D. in 1966 under the direction of James Sternburg and Clyde Kearns. My dissertation research concerned electrophysiological studies of the negative temperature coefficient of DDT action on cockroaches (1964). I first met Dr. James Grayson head of the VPI Entomology department at the 1965 ESA meeting while interviewing for insecticide toxicology positions upon completion of my degree.

My first faculty position was at Kalamazoo College, Michigan teaching undergraduate biology, physiology, and neurophysiology courses. Three years in this position helped me develop some rudimentary teaching skills that were previously lacking. It was during this time that I first developed an interest in insect physiology, particularly sensory physiology. Although I thoroughly enjoyed small college teaching, I began to feel that I could be more productive in a research position at a research university. In the fall of 1968, Entomology at VPI advertised a position for an insect physiologist to work on developing improved black light traps for control of lepidopterous pests. I applied for the position and through the good graces of Dr. Grayson and the faculty I was offered and accepted the position. I began my career at VPI in July of 1969.

The USDA cooperative agreement was for studies using light and pheromones alone or in combination for improved control of tobacco hornworms and cabbage loopers. The research group consisted of a team of two USDA agricultural engineers and three entomologists, two PhD students (Gary Grant and John MacFarlane) and me. It did not take me long to see that the cooperative agreement, while paying my salary, was a research dead end. If I intended to stay at VPI I needed to do something that would result in some publishable work. So while continuing on the cooperative agreement, I used micro dissection skills developed during my doctoral work to begin some morphological studies of the musculature of adult tobacco hornworm. While looking at musculature and nerves of adult Manduca sexta I observed many other interesting and heretofore undescribed structures. The most notable being the pair of internal ocelli emerging from the cerebral lobes of the adult moth. It was from this observation that I published a paper in Science (1971) and prepared an NSF proposal to study the physiology of ocelli. Funding of this proposal set the stage for a 15 year odyssey studying the structure and physiology of the ocellar system of moths. (An interesting sidebar is that the Science paper was initially rejected because of one reviewer's opinion that I was unlikely to pursue research on the internal oculus. I made a written appeal to Science editor Philip Abelson, who agreed to accept the paper.)

Funding of the NSF proposal opened the way to funding my first graduate student (Joe Dickens MS) and to additional ocellar publications, including one in Nature, describing a previously undescribed and likely rudimentary external ocellar cornea in Manduca (1973). This work led to further NSF funding and to the initiation of research on the structure and physiology of adult cabbage looper ocelli (Matt Dow, MS, Larry Pappas, Post Doc). Areas studied included electrophysiological studies of electroretinogram components and spectral sensitivity in *Trichoplusia ni* (1975) and Manduca, fine structure of ocellar photoreceptor cells and first order synapses, in *T. ni* and Manduca (1976) and cobalt infiltration studies of large and small ocellar interneuron structure in *T. ni* (1977).

The year 1977 marked the end of my efforts on the physiology of ocelli and the beginning of a period in which the function of ocelli in the flight behavior of moth became a focus my research. This research was aided by NSF and USDA grants. The research proved to be most daunting, but some valuable findings came from it. The most notable came from efforts to develop an anocellate moth to use for comparison to normal ocellate moths in flight actograph experiments (1980). I tried blocking adult ocelli by painting and by ablation using surgical and cauterization techniques. None of these worked. I then tried cauterization of ocellar primorida in the larvae of T. ni. By a systematic cauterization of areas of the cuticle of the larval head, this research resulted in the discovery that the ocellar primordial cells were located far from the antennal and optic primordial cells on the vertex of the larval head (1983). This fortuitous finding permitted the production of moths lacking ocellar photoreceptor cells yet possessing normal compound eyes and antennae. Here I won the battle but lost the war. We found that when experimental moths flight activity was compared to that of normal moths in a flight actograph the variability in flight activity of both the experimental and control groups prevented drawing statistically significantly conclusion about experimental hypotheses (Holly Ferguson, 1992).

There was a bright side to the discovery of the location of ocellar primordial cells. The anocellate insect model was and still would be useful as a research tool for other purposes. A discovery that came from it involved examination of the development of ocellar interneurons in moths that had unilaterally ablated ocelli. In such moths the interneurons of the ablated ocellus grow toward the remaining ocellus. This observation provided evidence for a guiding mechanism during pupal development which aids growing interneurons in making the correct neurological connections (1985).

Along the way I published several papers on moth morphology. One of which was a description of chemoreceptors in the cibario-pharyngeal pump of the adult cabbage looper (1979). My other morphology papers are referenced in the book I wrote titled Lepidopteran Anatomy (1988).

In 1988 I left the department to join the Virginia Tech Graduate School. In the Graduate School I was a part of the team which developed the electronic dissertation process (http://etd.vt.edu/) that made rapid access to the thesis and dissertation contents available to scholars worldwide.

I believe my contributions to the entomological basic research knowledge base are significant and lasting and I am quite proud of them. My advice to those who follow is keep alert for unexpected discoveries, change direction every five to seven years, and know when you should quit and move on.

Best wishes,

John L. Eaton

Professor of Entomology and Associate Graduate Dean Emeritus

October, 2005

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1963 Faculty

From first row, left: Amos, Ross, Grayson, Hill,
Tarpley, Turner, Bishop, Rowell,
Kosztarab, Kulman, Woodside, Bush,
Pienkowski, Cochran, Dominic

Insect Systematics and the Related Programs at Virginia Tech (1962-1992)

Michael Kosztarab

This was my path to Virginia Tech. In February 1962, after completion of my Ph.D. work at Ohio State University, I applied for an academic job to five universities. Four schools sent me questionnaires, and three universities invited me for interviews. In May, I visited the Southern and Eastern Illinois State Universities and soon I received their job offers. Next, I came to Virginia Tech and brought along my family.

It was a memorable job interview. Our six year old daughter Eva was sitting on Dean Dietrick's lap, who while playing with Eva interviewed me. Next day I was offered a position as an Associate Professor. The offer was with 15% less salary than that of the two Illinois universities however I accepted the offer on the spot because we liked the area. Blacksburg reminded me of my homeland in Transylvania with its hills and a similar climate, also as a multi-cultural community.

I jokingly told our Department Head, Dr. Grayson, after moving into Price Hall, that probably the reason why the Entomology Department offered me the position was because I was the only candidate who could fit into their available attic room (503B) with a 5'10" ceiling beam. At that time, I was 5'9". Back in 1962, four Departments were all crowded into Price Hall.

During the next summer, my low ceiling office directly under the roof became extremely hot, so I requested a window air-conditioner. I was surprised when it was declined. Soon afterwards I learned that air-conditioning was provided only for those rooms that had live insect colonies. I immediately started keeping lady beetles, who are predators of scale insects, in my office. Thus, I soon qualified and received my window air-conditioning unit.

My appointment was for full-time teaching on a 10 months basis, with a yearly salary of $7,200. I had to teach 2 graduate or undergraduate courses each quarter, and be in charge, as curator, of the departmental insect collections. I could also do research during the two unpaid summer months, especially if I could generate outside grants.

After receiving my first NSF research grant in 1963, I was reappointed to a 12 month position, with 25% research time. The following year, my Ph.D. dissertation was published as a 120-page research bulletin of the Ohio Biological Survey (Kosztarab 1964). During my first 20 years at Virginia Tech, I had ten different courses to teach (Table 1) including two in Insect Morphology, five in Insect Systematics (Principles of Systematic Entomology, Insects with Gradual Metamorphosis, and Insects with Complete Metamorphosis), Literature and History of Entomology (this course also included how to write and illustrate research papers and also the process of publishing), one in Entomological Methods, Coccidology, and one even in Insect Control, when its lecturer (Jack Bishop) resigned. By request of our Department Head, Dr. James McD. Grayson, I taught also one of his courses in Agricultural Entomology, which I turned into Horticultural Entomology, my original specialty in Hungary, because 82 of the 96 students taking the course were from Horticulture. Dr. Grayson, before his retirement, compiled a summary on the teaching of entomology at Virginia Tech (Grayson 1979).

In the late 1960s and early 1970s, we had a large number of students from the Horticulture Department, when the prevailing thinking was, "let's make a living off the land." My largest class in Horticultural Entomology included 96 undergraduate students.

The students liked my teaching methods and as a result submitted my name for the W. E. Wine Award for excellence in teaching. After receiving the Wine Award in 1967, my 10 year old daughter Eva asked me: "Dad, did you get the Wine Award for your wine making?"

In the 1960s we had no computers or Powerpoint capabilities, only 2x2 slides to use in connection with our lectures and laboratories. Therefore, I developed some extra teaching aids, including 76 large (40x30") color charts on the morphology and classification of insects, a large color slide series, and about 130 Riker mounts for laboratory demonstrations.

For the course in Coccidology in 1969 I prepared a 26-page brochure and for the course "Literature and History of Entomology", I prepared another brochure on the main sources of entomological literature. This brochure was expanded into 43 pages in co-authorship with Victoria Kok in 1978. Due to the lack of a specific text for my course on Principles of Systematic Entomology, I also compiled a 46-page brochure in 1989.

Because most of my entomology courses were in insect taxonomy/systematics and morphology, I faced the problem of how to present the relatively dry material in a palatable form, to the mostly non-taxonomically-minded undergraduate and graduate students who were often taking my courses because they were required. I also soon realized that not many students like to memorize a glossary of morphological terms or learn about the number of tibial spines on the hind legs of a cricket, not to mention learning the characteristics of more than 1,000 families of insects.

To achieve my teaching goals, I tried my best to transfer the enthusiasm I had for the subject to my students. I also wanted to sell them the material, but how? I decided to find out my students' areas of specialization and then I selected my examples from their fields of interest, and referred to these during my lectures.

How did I do this? During the first meeting of each course my students had to complete a questionnaire in which they had to state their interests, field of specialization, and the proposed title of their thesis or dissertation (if they were graduate students). For example, when I learned in one course that three of my students were interested in insects of forage crops, and two in parasites of pest insects, whenever I had a chance, I provided an example on the pertinent insects in my lectures. Also, once as a substitute instructor I had to teach agricultural entomology and I realized that all the graduate students enrolled were from tropical countries. So for their benefit I changed the course material into tropical agricultural entomology.

When I taught the morphology or classification of the insect families, I discussed the more interesting aspects of their biology, their economic importance, and the damage produced by some. In a few of my courses my students worked on individual projects in areas of their special interest for extra credit, allowing them to learn more than what I could provide through the class and lab. For example, when one of the students told me that his family owned a rose nursery, I asked him to prepare a paper on the pests of roses for extra credit. He did so.

I encouraged graduate students to present papers at national meetings and to publish their work. It created more interest and enthusiasm in them for their class projects, because of setting higher goals than merely preparing a class assignment. The professional experience for oral presentations and from publishing was valuable and provided an additional learning experience not usually included in most classes. I was fortunate to see some of the students from my classes presenting papers at professional meetings and publishing several papers as a result of research. Some of these originally started as class projects (e.g. Hall & Townsend 1977).

I usually treated undergraduate students the same way I treated graduate students which was something students appreciated. My office door, which adjoined the graduate lab, was always open for consultation. Some of the best research papers were edited in my office for presentation at one of the professional meetings. I helped to publish a number of these, and thus provided students with an opportunity to co-author their first research paper.

Students especially appreciated my laboratories in "horticultural entomology", when I held these in the Virginia Tech orchard or arboretum under an insect-infested tree. Here, I discussed the insects' life-cycle and showed the damage they produced.

To retain the students' attention and interest in the subjects covered, for years I collected jokes and humorous stories on insects and told some of these when pertinent to the subject matter covered in my lecture. I believe such humorous stories on insects told with my Hungarian accent gave some spice to my presentations.

I developed close working relationships with my graduate students by having their work area next to mine. Only one student, who liked to work during the nights, did not fully benefit from this arrangement. The latter, probably to save on rental expenses, started working after 5 pm. Before starting to work, he gave his girlfriend the key to her apartment. He worked all night in my laboratory, until his girlfriend showed up in the morning to give the apartment key to him for the day. This is just one of many examples on how some graduate students saved on their rent.

We often organized joint scale insect-collecting trips with out-of-state colleagues participating. I also went with my students to professional meetings where most of us presented papers. Both of these events gave an opportunity to graduate students to meet and exchange ideas with established colleagues in Coccidology.

Almost all of our predecessors in Coccidology had worked only on the taxonomy of the adult female scale insects, neglecting males and immature stages. So, we divided the work when revising most groups. One student worked on the adult females, another on the immature stages. But none wanted to work on the adult males, which are entirely different from all others. Therefore, in 1966 I invited an expert on male scale insects, Dr. Sherif Afifi from London as a Postdoctoral Fellow. He brought not only special knowledge for all of us, but he also exchanged ideas with our group on the training methods at the University of London.

I often ended up in my graduate classes with foreign students who were taking their first English language class in America. Because I had to study six languages, most of them phonetic, and have lived in foreign countries, where I learned to communicate with people speaking languages foreign to me, they had fewer problems understanding me than they did with professors who were from America.

One of my first foreign graduate students was having language problems. I tried to explain to her that for her research assistantship and for her thesis problem, she would need to work on the morphology and systematics of immature stages of the same group of scale insects where I had already started working on the adult females. She just shook her head unable to comprehend the information. Disappointed, but not giving up, I decided to simplify my explanation. I said, "You will have to work on the babies, while I will be working on their mothers". Her face brightened up, and with a smile, she said, "Now I understand."

Besides teaching almost full time, my other duties included curating, modernizing and expanding the departmental insect collections. Although the collection was started in 1888, it never had a permanent curator. By 1966 it contained about 81,000 specimens stored in 600 glass-topped Cornell drawers, housed in 15 large and four small steel storage cabinets (Covell & Kosztarab 1966). I fought for almost 30 years to receive appropriate funding and permanent housing for the insect collections. Fortunately, The National Science Foundation (NSF) recognized the need for upgrading our collections and in my grant request, provided $48,000 for new insect cabinets and new vial racks.

When I served as director of the Center for Systematics Collections at Virginia Tech between 1987-1989, I asked J. Reese Voshell to be in charge of the liquid collections, often used by him and his graduate students. Reese still has that collection under his control. It is stored at the US Forest Service (CATT Center) in a metal utility building. In

1990 I was named the Founding Director of the Virginia Tech Museum of Natural History. By the time of my retirement in 1992, the insect collection had expanded to include approximately 900,000 specimens and was housed until 2004 in the new Virginia Tech Museum of Natural History at 428 North Main Street (Kosztarab 1993). Unfortunately, due to lack of State and University funding, the museum was closed. The main part of the pinned/dry insect collection was "temporarily" transferred to the Price's Fork Research Facility, placing Eric Day in charge. The rest of the collection was taken to Martinsville (in the charge of Dr. Richard L. Hoffman) and incorporated into the State funded Virginia Museum of Natural History. To my delight, the scale insect collection was requested by Douglass R. Miller and taken to the Smithsonian Institution. Since no one worked on scale insects after my retirement, the Department gladly donated it for safe-keeping and future utilization.

After receiving my first NSF grant and getting 25% research time from the Department, my research work and graduate student training at Virginia Tech started in 1963. Only one student, Charles V. Covell "got away" with not working on scale insects. Charles' research was already well established on the systematics of moths, so he completed his Ph.D. work in 1965 on those. Charles is well known through a series of books on moths of Eastern North America (Covell 2005). All my other graduate students (Table 2), six for M.S. and nine for Ph.D. degrees worked with me on scale insect morphology, systematics, and biology projects, supported usually through NSF, Virginia State or other funding. I was fortunate to receive 11 research grants from the NSF, between 1963 and 1988, totaling $375,380. The results of our NSF-funded research were published, often in book-size research bulletins, at Virginia Tech (e.g. Lambdin & Kosztarab 1977).

Some of our research projects required collecting live scale insect samples from plants. I have been to many states collecting, so I could study species in several genera and families of scale insects with distribution across North America. I took my family on each of my four domestic collecting trips between 1964 and 1988. This way I had free help with the driving, and for collecting, labeling, preserving and shipping my samples. Because I only had partial funding for such trips, I usually combined these travels with some family vacation in the areas visited and I paid the difference for the extra expenses from personal funds.

During the first three trips, I also consulted with colleagues en-route, inventoried the scale insect collections of their institute (copies of the inventories were sent to the Smithsonian Institution, D.R. Miller). I also borrowed the pertinent material for our studies. I had to obtain ahead of time the necessary collecting permits for the state and federal parks to be visited. During my fourth trip in 1988, instead of flying to an international conference in Vancouver, Canada, I drove my car, so I could collect insect samples en-route and observe the effect of air pollution and acid rain in five of our National Parks.

My students and I benefited from the special knowledge of seven of our visiting scientists who were from six foreign countries (Table 3). While at Virginia Tech, I was invited for consultation and/or as a speaker to 17 foreign countries. Besides Central Europe, I did intensive 3 month long research and/or teaching in Costa Rica, Italy and Sri Lanka. I have greatly benefited from and enjoyed the multi-cultural experiences that my foreign trips provided.

Two of my graduate students (J. O. Howell and P. L. Lambdin) and I had completed a National Science Foundation supported study on a false pit-scale insect genus Lecanodiaspis with worldwide distribution. The results of our studies provided new proof for the theory of continental drift. We were excited about the discovery. It was suggested that we present the results in a talk at the 14th International Congress of Entomology (ICE) in Canberra, Australia, during August 22-30, 1972, instead of waiting until our findings were published. The presentation would give me the opportunity to attend for the first time an ICE. I also wanted to collect insects in the field and to select and borrow from the visited institutes some scale insects for our study. I asked our sponsor (NSF) for approval of the trip and received their support with partial funding. I was prepared to supplement the cost of this travel from personal funds.

Because I had to travel to Canberra, half-way around the world, I decided not to return on the same route, but continue eastward from Australia to go all the way around the world. I wanted to stop en-route and consult with as many colleagues as possible who were not going to attend the Congress. Also, I thought I should organize the first international gathering of scale insect specialists (coccidologists) from among those attending the Congress, which I accomplished with local help (Kosztarab 2004). I believed that knowing each other in person would promote cooperation and we could avoid duplicating each others work, if we knew who was doing what. As it turned out, this informal meeting was the starting of the International Symposium on Scale Insect Studies (ISSIS) series, and we have met every three years since then. Eleven such Symposia have been held to date.

It took almost a full year of preparation to re-schedule my official work-load, obtain permissions, arrange finances, shop for the best airline cost offers, get visas and shots, schedule meetings in institutes with scientists and make airline and housing reservations. Ultimately, I made arrangements to visit 21 entomological institutions and meet 27 coccidologists and a number of other entomologists in 10 countries and three states of Australia.

The least expensive airfare ($1,726.10) for my trip was offered by PanAm Airline as a package called: "Around the world in 80 days". To save money I stayed in guestrooms of visiting scientists at many institutions. The average cost of nightly housing on this trip was $6. A good example of how I saved on housing cost occurred at the Institute of Agricultural Entomology in Portici, Italy. Here I was offered free housing, provided that I would take what they had in the Silkworm Research Institute. It turned out to be a bed attached to the wall of their silkworm rearing room. The bed could be released from the wall at night for sleeping. A nearby bathroom was also available. So, I took the offer. I don't think my wife would have slept there; one could listen all night to the beautiful finger-sized silkworms chewing on mulberry leaves, and dropping their fecal pellets. I thought for an entomologist this was just a perfect bedroom!

Starting in 1970, I requested grants from the US Department of Agriculture (USDA) to prepare updated supplements to their earlier publications entitled: "A Selected Bibliography of the Coccoidea," and "An Annotated List of Generic Names of the Scale Insects" (Kosztarab & Russell 1974). My wife, Matilda, worked on the project for 16 years and co-authored three of the bulletins with me; the last one of book-size (Russell et al. 1974; Kosztarab et al. 1986; Kosztarab M. & M. P. Kosztarab 1988). For 36 years, we had someone on 50% payroll at Virginia Tech on this project until it was discontinued in 2006. My students' dissertation work and my own research benefited from the bibliography project in our lab by having reviews and translations prepared on the latest research articles for the USDA. Actually, over 23 years (1970-1992), with an average of $12,000 yearly allotment, the USDA grants totaled $276,000 for the project.

The US Academy and the Hungarian Academy of Sciences scientist-exchange program allowed me in 1975 to complete a book with a Hungarian colleague on the Scale Insects of Hungary (Kosztarab & Kozar 1978). We also published another book The Scale Insects of Central Europe (Kosztarab & Kozar 1988).

In 1975, while working in Hungary on the above listed books, on my own initiative, and without any grant support, with F. Kozar, we were able to collect scale predators, the fungus weevils, *Anthribus nebulosus*, and with permits, bring these to our Prices Fork Quarantine Lab for rearing (Kosztarab & Kozar 1983). I recall the exciting trip on a commercial airline, having the screened cage with about 3,000 live beetles in a cardboard box under my legs in a crowded seat. I did not reveal to my fellow passengers the contents of the box and why I had to keep it under my legs and occasionally had to sprinkle water into the box to cool the insects. The progeny of the beetles were released for biological control on spruce trees on our campus in 1978. After just three years some of the "hungry Hungarian beetles" as they were renamed by a newspaper reporter were captured by Cornell University entomologists in New York State. Occasionally I still find some beetles on our campus trees.

One of my priorities was that my students' publications were printed before they started applying for jobs. To facilitate early printing of their large research papers, and without extra expenses, I have initiated in 1967 a peer-reviewed research bulletin series entitled: "Studies on the Morphology and Systematics of Scale Insects." By 1992, there were 16 such bulletins printed which were listed in the last one (Perez-Guerra & Kosztarab 1992). After Virginia Tech discontinued publishing research bulletins, the last Ph.D. dissertation from our lab was printed free in Berlin, Germany in hard cover as a 213-page book (Hendricks & Kosztarab 1999).

After I realized that only one comprehensive study was published on Virginia insects before 1968 (Clark & Clark 1951), I have started another series of bulletins, "The Insects of Virginia" with co-editor/friend Richard L. Hoffman (Kosztarab 1969). There were l4 such bulletins printed, some of book-size (e.g. Bobb 1974, Williams & Kosztarab 1972). On my request, after my retirement, the Virginia Museum of Natural History still continues publishing this series. I have compiled in an article, the need for future studies on all invertebrates in Virginia (Kosztarab 1988a).

For some time I was interested in learning about the possible effects of acid rain on our biota. So after observing the decline of our trees in the Appalachian Mountains, I decided to study what was happening to our soil micro-invertebrates at different plant communities and under different acidification pressures. I applied for a three-year Miles C. Horton Research fund grant and received financial support for a graduate student (Ken Stein), without scholarship. After quantitative assessment, our samples were sent to specialists for qualitative analysis. Decidedly fewer insects and mites were found where higher acid (3.5 - 4.2 pH) was present in the soil samples. Actually acidification increased in our area after the oil embargo (1982-1983), when some oil furnaces were converted back to coal burning. I believe that scientists should study this phenomenon further. What is going to happen to our food crops if with acid rain we kill the microorganisms that help convert organic materials into essential nutrients for our plants? Also, more effective legislation should help to reduce present air pollution levels.

My goal after retirement was to complete my unfinished professional work. I was fortunate to have a small room in the Department for completion of my unfinished manuscripts and books. Even though I had to move my desk four times in six years I was still able to complete and publish the four books, as I intended, in my retirement.

After collecting and processing scale insect samples in the Eastern United States for 38 years, I began writing the first book "Scale Insects of Northeastern North America - Identification, Biology and Distribution" during my retirement. This 650-page book, with 263 figures and 32 color illustrations was published by the Virginia Museum of Natural History (Kosztarab 1996).

Some students have asked, "What is your life philosophy?" My answer is, "Live for your profession, not only make a living from it; but let's enjoy what we are doing, so that our work should become our hobby." After all we are not assembly-line workers. We have selected our professional work and it should be fun. However, we have to keep in mind that there are also social and community obligations, such as to our immediate environment, to our commonwealth, to our nation, but also to the world community. Therefore, we should avoid becoming narrow-minded specialists and not be afraid to take on "extra curricular activities" My work motto is also very simple, "do it, but now!"

With these goals in mind in 1967 I volunteered to teach interested school children during the weekends as a 4-H Entomology Project Leader in our town. I also served several times as a judge for insect projects exhibited at science fairs in SW Virginia. Our graduate students selected me to serve as Faculty Advisor for the Entomology Club in 1967. During April of 1968, I conducted a 12-day insect collecting trip to Florida with five interested graduate students. On our return trip on Route US 301, our group saw a wild fire burning next to a gas service station and home in the Cary State Forest. We all leaped out of our car and helped to save both the gas station and home (Blacksburg Sun 1968).

To make entomology and our course offerings better known across campus, I set up an observation bee-hive inside a window of the Newman Library, close to the old entrance. Hundreds of students spent time watching the active bees and read my note (a hidden advertisement), which gave information on the courses and where they can learn more about these and other insects. I did the same with carpenter ant colonies behind glass inside the main entrances at Price Hall and also at Derring Hall to reach the biology students. As a result, our classes soon increased in size and the Department was able to hire three new faculty members (J.R. Voshell, D.E. Mullins, R.D. Fell) to take care of the expansion.

The Department and our courses became even more well known when in January 1976 I was able to co-direct, with colleagues Mullins and Robinson, the preparation of unique exhibits entitled: ”Insect Inspirations - Photography and Art” in the Squires Art Gallery. We borrowed a number of original paintings on insects from the Smithsonian and with the help of several faculty members we filled two large rooms with artistic paintings, photographs, postcards and stamps on insects. It was complemented by a continuous color slide show (by E.C. Turner). Over 3000 people visited our exhibits in less than one week (News Messenger 1976).

While I was serving as the Founding Director of the Virginia Tech Museum of Natural History, our curators' crew put together the first museum exhibit entitled: "Diversity Endangered", partly from borrowed material from the Smithsonian Institution. This was in 1990 for the Earth Week Celebration. It was a great success!!

In August 1994, after my retirement, along with two entomology staff members (T. McAvoy and W.T. Mays) we organized a "Butterfly Foray" in the Virginia Tech Horticultural Gardens for a large number of youngsters and their parents. Tom McAvoy still organizes, as a yearly event, the butterfly foray with much success.

By 1966, I developed an unusual collection for our Commonwealth of Virginia, a "Herbarium of Insect and Mite Damage". It was nicknamed the "fingerprint collection of the smallest criminals". I either dried plant samples between blotting paper, or in fine dry sand, or freeze dried plant parts that contained feeding damage, such as leaf skeletonization, leaf mining, characteristic discoloration, or malformations, including species-specific plant galls, etc. (Kosztarab 1966). Such a reference herbarium should help entomologists to identify the pest species, even after these are long gone, just by the evidence left behind. Thus, our specialists are able to assist growers and homeowners more effectively with the help of this reference collection. I was pleased when the Smithsonian Institution found it useful enough to ask for it and take over this unique collection when the Virginia Tech Museum of Natural History was closed.

A number of states have an official state insect. Some Alexandria school children in 1976 thought that we should also have one. With their Congressman's help they proposed a praying mantid for the state insect of Virginia. However, I realized that their proposed insect was the imported Chinese mantid. So I protested the choice when I was asked to comment on it. I counter-proposed the indigenous Tiger Swallowtail Butterfly as a more appropriate subject. This insect besides being native is the first insect ever described and named from North America by the famous biologist Linne, who named them from specimens sent to him from Virginia. The Virginia Senate agreed with me and voted for the butterfly but the House of Delegates voted for the mantid, thus creating a legislative deadlock. Therefore, no state insect was selected. In 1991, after 16 years, I teamed up with the members of the Virginia Federation of Garden Clubs. With the 10,000 + women behind our butterfly, the legislators listened and both houses passed the Tiger Swallowtail Butterfly for the official state insect (Kosztarab 1991). Today there are over 20,000 Virginia license plates displaying our beautiful insect.

In 2001 I co-edited the book "A History of the Virginia Academy of Sciences (1923-2001)". Also, by request I have written about a dozen chapters for books in our profession.

On invitation, I gave talks on "Beneficial Insects" in April 1988 and on "Good and Bad Insects in your Yard" in August 1991 at The Virginia Museum of Natural History. I also repeated the last title twice after retirement for organizations in our community.

My contributions of broader scope included the initiation of a national symposium series on scale insects, at Portland, Oregon in 1966, that met every three years (12 such symposia have been held since); the proposal and initiation of the Insect Fauna of North America Project (IFNA) from 1981-1984, which led later to the proposal of the National Biological Survey (NABIS) project, starting in 1984, eventually leading to the national implementation of the program by the US Department of Interior in 1993. It took me almost 10 years of hard work, with help, encouragement, and endorsement from numerous colleagues and from 39 scientific organizations to achieve this goal. It started with my editorial in Science (Kosztarab 1984), followed with the printing of numerous articles and four books dedicated to the proposed NABIS project, and by giving numerous talks (e.g. Kosztarab 1986, 1988b); including two national symposia (Kosztarab & Schaefer 1990, Schaefer & Kosztarab 1991). There were times of frustration too but I learned much through my lobbying efforts for NABIS, including turf fights between government agencies in Washington D.C. I had also learned, while living under two dictatorships, never to give up and to be consistent, and to apply my motto of “do it, but now.”

There were a number of other, probably less significant projects that I have worked on, but for the sake of space I have deleted these, as well as I have deleted listing the recognitions received from a number of organizations.

Overall, this summarizes the more significant projects I have worked on in 36 years while being associated with the Entomology Department at Virginia Tech.

To shorten my report, for more details on my professional and other activities, I am referring interested readers to chapters 15 through 21 (page 113-175) of my biographical sketch “Transylvanian Roots” (Kosztarab 1997).

I want to express my thanks to our College Administration, our Department, my colleagues, and former graduate students. I especially wanted to thank Matilda, my wife for 56 years, my daughter Eva, and to “my right hand” for 17 years, Mary Rhoades, for their support and assistance for helping to make my dreams in the profession come true.

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Lab Technicians and Lab Specialists at the Coccidology Laboratory

(Supported 50% or 100% on NSF funds)

Anna D. Kennedy (1967-69)

Mary Ellen Moses (1969-72)

Phyllis Ann Willoughby (1973-74)

Mary H. Rhoades (1976-92)

Table 1. Courses listed for Michael Kosztarab (with 75% teaching assignment) in the 1967 Entomology Department Newsletter

Undergraduate Level		
Ent. 401	Insect Morphology	(4 cr)
Ent. 402	Applied Entomology & Pest Control (taught jointly w/ Dr. Grayson)	(4 cr)
Ent. 411	Systematic Entomology	(3 cr)
Ent. 421	Systematic Entomology	(3 cr)
Graduate Level		
Ent. 502	Literature & History of Entomology	(2 cr)
Ent. 506	Entomological Methods	(3 cr)
Ent. 511	Advanced Systematic Entomology	(3 cr)
Ent. 521	Advanced Systematic Entomology	(3 cr)
Ent. 531	Advanced Systematic Entomology	(3 cr)
Ent. 601	Insect Morphology	(4 cr)

Note: Ent. 5970 (Coccidology) was taught as “Independent Study in Systematics” for six graduate students in 1969.

Table 2. Graduate Students Advised by Michael Kosztarab at Virginia Tech.

Degree Recipients:

1965	Charles VanOrden Covell, Jr. (Ph.D.)
1966	Stella Pau-hsuen Yang (M.S.)
1969	Michael Ledell Williams (M.S.)
1971	Alfredo D'Ascoli (Ph.D.), Russell Carlyle Brachman (Ph.D.), James Oliver Howell (Ph.D.)
1972	Paris Lee Lambdin (M.S.), Dale K. Pollet (Ph.D.) (co-advisor w/ J. A. Weidhaas), Michael Ledell Williams (Ph.D.)
1974	Paris Lee Lambdin (Ph.D.), Phyllis Ann Willoughby (M.S.)
1976	Avas Burdette Hamon (Ph.D.)
1979	Ronald George Baer (Ph.D.), Stephen William Bullington (M.S.)
1987	Tong-Xian Liu (M.S.)
1991	Gema Maria Perez Guerra (Ph.D.)
1992	Harlan Judson Hendricks (Ph.D.)

Table 3 – Visiting Scientists Who Worked in the Coccidology Laboratory (1967-1990)

Dr. Sherif Afifi, as Postdoctoral Scientist from University of London, England, 1967

Dr. Antonio Tranfaglia, Faculty Agr. Univ. Potenza, Italy, 1977

Dr. Yair Ben-Dov, The Volcani Center, Israel, 1982-1983

Dr. Frank L. Campbell, Professor Emeritus, Ohio State University, 1986 (Worked on the sensillae of Blattella germanica antennae in our laboratory)

Mr. Guang-zuao Jiang, Sichuan Acad. Agri. Sci, China, 1986

Dr. Ferenc Kozar, Plant Prot. Res. Inst. Budapest, Hungary, 1987

Dr. Imre Foldi, Nat.Mus. Nat. History, Paris, France, 1990

Note: In addition, 26 more scientists (including 15 coccidologists) visited our laboratory from nine foreign countries.

Recollections 1961 to 1996 for Entomology's 50th

R. L. Pienkowski

I have never regretted the decision to come to Blacksburg. Virginia Tech is a great University & getting better. Entomology is a great department, which has had more than its share of outstanding department heads, faculty, students and staff. And Blacksburg is a great place to live. This piece will stray from discussing only the Department and my activities, with some comments on my background prior to arriving in Blacksburg, plus thoughts on the University, the town and other ramblings.

I interviewed during June of 1961 and was not asked to give a seminar, it wasn't the pattern in those days. I also missed the requisite temperance lecture by the President, Walter Newman, since he had recently had a heart attack. There were slightly over 6000 students, almost all male, and most in the Corps of Cadets, since it was mandatory unless you were disabled, a vet, or a woman. During the interview I slept at the Lake Terrace Motel, which is soon to be torn down and is currently used primarily by indigents. My wife, Joni, and I arrived in Blacksburg September 6, 1961, which is also our anniversary. We left Madison, Wisconsin the day after my final oral exam, which seems highly presumptive. Though I now feel that a good major professor will never let one of his/her students go into a final exam which they do not expect the student to pass (though I have been on an advisory committee which voted no after a final exam). When we arrived in Blacksburg, we were grandly entertained by the whole Grayson family, even to the point of going swimming at the Country Club swimming pool, later the municipal pool, which seemed to us to be located on top of the world. From that spot, now a couple of hundred yards our home, one can see in all directions an area I estimate to be at least 300 square miles. Jimmy Grayson had found us a three room apartment at the Faculty Center, later the old part of Donaldson Brown Continuing Education Center, and now graduate student housing. We paid $50 a month, which included everything but the telephone, I wanted to stay there forever. Cheap, handy (I could walk to work), a beautiful pond in back (where I once found some *Anopheles* larvae, and where they later put the new & ugly part of the CEC), and free cockroaches when we had the wrong neighbors downstairs. The Kosztarabs lived upstairs. We had decided that we would stay in Blacksburg a couple of years and then head back to civilization, we soon changed our minds. When you've got a great boss, a great job, work with great people in a great place, why move?

My first office was in room 323, in the southwest corner of the building, which I shared with Don Cochran and Mary Ross. My starting salary in 1961 was $6960. At that time the salary range for assistant professor was $6600 to $8040, with 5 steps for annual merit increases. The salary range for associate professor was $7440 to $9840, with 6 steps for annual merit increases. This salary info is from Jimmy Grayson's letter to the Department Head at Wisconsin, which I was probably not supposed to see. The work week included Saturday mornings, and male faculty were expected to wear coats and ties.

Shortly after I arrived Craig Turner invited me to sit in on Neil Morgan's final oral examination for the Ph.D. This was a good learning experience, since obviously my only previous knowledge of oral exams were when I was supposed to answer the questions. I recommend this for all new faculty who have not previously supervised graduate students. At that time prelims were only oral exams, probably in the '80s we started using both written and oral. Craig was also one of the first that I recall using questions on diverse topics such as composers, literature, etc. These questions weren't crucial, but helped us know the student. For a while I asked the following type question on a number of written prelims: You have been stupid enough to play the lottery (which means you should be required to take or retake a freshman course in probability), but you have been lucky enough to win $200 K per year for the next 20 years. What would you do with it? How would it change your career goals? If you received notice of the award at the same time you received these questions, would you still (attempt to) answer them?

I continued to wear a coat and tie until I noticed Stu Neff, a professor in Biology, wore his field clothes all the time. Plus about that time I noticed some gray hair and figured that I didn't need a tie for students to know I wasn't one of them. When Biology moved from Price to Derring Hall, I inherited Stu Neff's office and lab, room 308, where Rod Youngman now hangs his hat. In 1961 we shared Price Hall with Plant Path, Biochemistry, Biology and Forestry and Wildlife Management. Coming in the back door from the parking lot one would occasionally hear one of Wildlife's rattlesnakes. And once in a while a biochemist on the 5th floor would leave a bunsen burner on too long, why the building never burned down I'll never know. Considering that most floors were wood which had for years been treated with linseed oil, plus the stairs were also wood at that time. Later they put in better stairs, floors and the huge metal fire escape, which looks as if it's designed to keep the building from falling down. Relations between departments in the same building are sometimes difficult. Entomology has suffered from floods from Plant Path on occasion. And I recall when Craig Turner had a lab in the basement directly under the Biology Department Head's office. With no air conditioning, windows were open, and Craig's lab, where he was engaged in cow pie entomology and reared flies, had an exhaust fan. The resulting air quality index was not good. I don't recall how, but they worked out a solution.

When we arrived in Blacksburg in September, 1961, the Lyric Theater was segregated, blacks entered and exited by a separate door, and had to sit in the balcony. Ironically, that's where I prefer to sit now. The theater was desegregated about six months later. We also encountered a whites only lunch counter in Roanoke. The President of the University, Walter Newman, for whom Newman Library is named, left Blacksburg Presbyterian Church, because Ellison A. Smyth Jr., then pastor, was actively pushing for integration (one reason we became Presbyterians). Smyth's father, Ellison A. Sr., who had a significant insect collection, was head of Biology from 1904 – 25, and Smyth Hall is named after him. Another note on segregation, in 1962 or 3, I had planned some field plots in Prince Edward County. Those were the days of Massive Resistance to integration, and Prince Edward County was the epicenter of Massive Resistance. Rather than integrate their schools the whites closed them and opened whites only private academies. It was a nasty, sad and scary situation. I was hesitant to even go there. But when I did go to set up my plots, I dealt with both white and black farmers, separately, of course, and I've seldom dealt with nicer folks. But then I wasn't telling them to integrate, though I wanted to. In the listing of faculty and staff in the University Catalog, Black extension agents were listed separately under Negro Staff until the 1965 – 66 Catalog. This inequality was finally corrected under Marshal Hahn, who followed Walter Newman as president of the University. Later, in the '80s & '90s Larry Moore, then Head of PPWS, and I worked with Martha Johnson, Assistant Dean of the Graduate School, to recruit more minorities, especially Blacks, into agriculture. I recall that we were offering paid summer intern programs for Black undergraduates. On one of our recruiting visits to Hampton University, a fine mostly Black school, I saw bulletin boards literally covered with posters offering internships. In Blacksburg, we had very few on our bulletin boards. After a while I came to have mixed feelings about affirmative action. When you're battling overt prejudice, OK, but long term it is bad for both the minority and the majority, affirmative recruiting, yes, affirmative admission, no, equal acceptance, absolutely. We've made progress since then.

Virginia Tech has also made considerable strides in accepting women during my time here. In his 1961 letter to Robert Dicke, Department Head at Wisconsin, seeking a replacement for Ed Raffensberger, who was going to Cornell, Jimmy Grayson stated "If you have any outstanding ***men*** nearing completion of their doctorate requirements…" (Emphasis is mine). Note also that Jimmy was the father of four very bright and capable daughters. He was a product of his time. If someone wonders if I am a feminist, they should note that I have a bright and talented wife, daughter, two daughters-in-law, and four granddaughters, and I want them all treated fairly, as did Jimmy. We recently found a copy of a brochure called "Tech Tips" an informal handbook for new students, dated Fall 1965 (because my wife produced the cover design). I mention it here because it includes a page titled: Some Unwritten Laws For Techmen, and each item starts with the pronoun HE. The first and the last in a list of 19 are: "He observes the honor system faithfully, in letter and spirit" and "He supports the annual Campus Chest Campaign". I mentioned that I shared an office with Mary Ross. She was a part-time instructor in 1961, and was not allowed to have a full-time position because her husband was a professor in the Biology Department. The University justified this based upon fears of nepotism. Later this changed and she moved up the professorial ladder quickly, but she earned and deserved everything she got. There were several other women in the University in a similar position. I have long felt that Janice Burt (she later married another grad student, Walter Knausenberger) was a pioneer for women doing field research in this department. In the mid '70s she proposed working on soybean susceptibility to corn earworm in eastern Virginia, but there was some concern about it being dangerous for a young woman working alone in that situation. Her committee decided to go along with the proposal, and, of course, she had no problems and produced an excellent thesis. Women are continuing to show that they are capable of doing almost anything they set out to do. One of the strengths of our current society is that we are beginning to utilize our full capabilities, not just the white male portion.

When I arrived the full professors were: Jim Grayson and Jack Rowell; associate professors were: John Amos, Don Cochran and Craig Turner; assistant professors were: Jack Bishop and Wally Tarpley according to the December 1961 VPI Bulletin. LeRoy Cagle was a part-time assistant professor and Mary Ross was a part-time instructor. The field station personnel were: Marvin Bobb at Charlottesville, A. M. (Mac) Woodside at Steeles Tavern, Walter Hough & Clarence Hill at Winchester, Clarence Dominick at Chatham, and Mal Bousch at Holland. This was the core from which Jimmy Grayson built an excellent department. Over the years we have had very few prima donnas, with few exceptions people worked hard and cooperated. If I had a grad student with a question in someone else's area of expertise, I had no qualms about sending the student to that professor for help.

Any comment on the history of the Entomology Department at Virginia Tech, then Virginia Polytechnic Institute, must include James McDonald Grayson. Born and raised in Wythe Country, Virginia near the New River, Jimmy was my optimal picture of a kind, southern gentleman. His wife and family were and are his equals in kindness and quiet class. He loved to fish and to hunt grouse. I learned a lot about administration and dealing with people from Jimmy. For example: if you want to tell your boss he or she should do something differently, first compliment them on what they are doing right, then oh, by the way, how about this idea. Tact frequently works, pounding on their desk doesn't. Administrators appreciate reports coming in on time, if you expect them to work for you, you must work for them. If you know of something that will truly benefit the organization (not you, but the organization), go ahead and do it, find out if you have bent the rules later. If you've done something outside of the rules, apologize, I'll never do it again, but the organization is better off. Jimmy was also one of the very few people I have known who had the personal self confidence to ask really stupid questions. The end result was that he did not remain stupid, the rest of us, who are to embarrassed to ask, remain stupid. Last, when we were looking for a replacement for Rod Hendrick to work in biological control, we were interviewing a fellow from Wisconsin named Kok. Loke Kok gave his seminar, in which it seemed to me that he expressed serious doubts as to whether biological control really worked very well. In our discussion later I said we should reject Loke and continue our search (I've told Loke this story). Jimmy said no, his recommendations are super, I want to hire him, and everyone knows who was right. I was fortunate to work closely with both Jimmy and Loke.

Obviously upper level administrators have varied, though among the very best were Neil Boyd, an Associate Dean, Warren Brandt, Vice President under Marshal Hahn in the '60s, and Marshal Hahn. Hahn, and Brandt (who was his hatchet man) transformed the University from a VMI look-alike into a rapidly growing, modern state university. Hahn's most remarkable achievements included making the Corps of Cadets voluntary in 1964 and his amazing ability to obtain funds from the legislature. I was surprised that Jimmy Grayson supported the proposal to make the Corps voluntary since he had gone to VPI and had been in the Corps of Cadets. But clearly Jimmy realized that this was in the best long term interests of the University. Had that not happened, VT enrollment would have stagnated, especially during the Vietnam War protests. Brandt and Boyd were among those administrators who were able to make tough decisions, but if they made a promise, you could count on it. Even in an informal setting such as a cocktail party, they would remember. Speaking of remembering, Marshall Hahn is one of two people I have known who had a photographic memory for names. He would also rattle off reams of statistics during a faculty meeting while using no notes.

Over the years every professor becomes involved with what Herb Kulman, forest entomologist 1962-66, called “administrivia.” On your annual brag sheet you were expected to have served on a committee or two. Some that I served on included a committee to consider whether Tech should switch from the quarter to the semester system. As I recall, I served on the second (1985-86), and we concluded, as did the first committee, that the cost and hassle of a change exceeded any advantages of the semester system. But you need to give administrators credit for persistence, they kept appointing new committees until they got one that gave them the recommendation they wanted. At one point I agreed to be the College representative on the University Commencement Committee. What could be better, I get points for serving on a University committee, and it requires virtually no effort. A word of advice, be cautious of no effort jobs. They don’t always stay that way. Shortly after I joined this group, they decided that the single University Undergraduate Commencement exercise was too large and too impersonal, each college would have its own. And guess who was in charge of the one for Agriculture? We were assigned the old war memorial gym space. You can’t have folding chairs and street shoes on a gym floor, covering it with paper was one of many time consuming chores. One of our ideas was good though, and has persisted, we gave each graduate a photo of them receiving their diploma. And that was before digital photography. I also served on the promotion and tenure committees at the department and college levels. I was always pleased that our department P&T committee worked with young faculty to help them earn tenure. When I became tenured about 1968, I received a letter from Vice president Warren Brandt, which contained a comment something like: oh, by the way, you now have tenure. It was not a major concern as it is now. I also recall when on the college P&T committee (in the 1980s), we reviewed the promotion recommendation of someone to full professor. This individual had great research and grantsmanship credentials, but poor teaching ratings. He did not receive a promotion, and this was well before the general furor over research being important and teaching was not. Through my time the University expected excellent performance in two of its three missions: teaching, research or extension. This, I feel was and is a poor policy, it has cost the University the services of some outstanding teachers and probably some great researchers. The following quip from Professor Jeff Bloomquist’s email signature block (obviously before he got tenure): “The juvenile sea squirt wanders through the sea searching for a suitable rock or hunk of coral to cling to and make its home for life. For this task it has a rudimentary nervous system. When it finds its spot and takes root, it doesn’t need its brain anymore, so it eats it. It’s rather like getting tenure.” Happily I never saw this in the Entomology Department, though I have seen it in other departments. Most of us tend to be hard on administrators, some deserve it, most don’t. I served as acting head twice, the second time before Tom Payne was appointed Head. That search seemed to take a while and I received some encouragement to throw my hat in the ring and become a candidate. I really appreciate the encouragement that I received from several faculty that I highly respected. In the end Dean Jim Nichols selected Tom Payne to be the next department head. Along with my letter of welcome to Tom in 1987, I enclosed a cartoon with the caption: “what do you think Tom is going to be like as the new Head… he’s going to be a real pain.” Since I had failed to get the head position I thought that I deserved a consolation prize. So I treated myself and my wife to an African photo safari. We had the trip to Kenya and Tanzania that I had dreamt about since I was about 10. So it was a win – win - win situation (and you don’t often get triple wins), as it turned out the University soon hit a fairly significant budget crunch, and it is never a lot of fun being an administrator without money, so that with the safari is two wins. The third was that Tom

Payne was an excellent Head. Referring to our departmental leader, many of us use the term boss. This does not include Professor Michael Kosztarab. Michael always uses the term chief. I asked him about this once, and he replied that the word boss sounds a lot like the term for penis in Hungarian, and Michael is both polite and kind (as well as being a very productive scientist).

For a number of years in late 70s & on, I was Graduate Coordinator - which means that I selected and assigned teaching assistants, advised new students who did not yet have a major professor, supervised the student loan funds and supervised graduate student recruiting. Early in this period I sent advertising posters with attached reply cards to most of the colleges east of the Mississippi. I had asked our efficient secretaries to retain all of the cards we received in reply. I later compared these against the applications we received, as it turned out none of the people who asked for application materials using a card from one of our posters ever actually applied for admission. Posters as a recruiting tool were obviously ineffective (at least ours were). About the only colleges which I didn't send material to were Liberty and Oral Roberts. I felt that a good background in biology involved an honest understanding of evolution, since evolution is a fundamental basis of much that we find in biology. And since these schools would only teach religious fundamentalist creation pseudoscience, their students could not be adequately prepared. This is unfortunate (for the students and for society), but true. An insistence on Biblical literalism is not intelligent or helpful from either a scientific or theological basis. And let's also leave "intelligent design" to a theology class. Any decent biologist should be able to cite several current examples where evolution is taking place.

A couple of years after I arrived "Silent Spring" by Rachael Carson was published. It has recently been the subject of a couple of review articles in American Entomologist, I assume because her 100th birthday was in May, 2007. I recall after reading her chapter on herbicides, I was shocked at the horrors of chemical weed control. Then I read the chapter on insecticides, there was little that I didn't know and a lot that she had left out. For instance, there was no mention of Stern, et al.'s seminal work on pest management, published in Hilgardia in 1959, three years earlier. So I classified her work as propaganda. She vilified DDT, and it certainly was devastating to raptors, but by then most crop pests were developing resistance to chlorinated hydrocarbons, so they weren't being used anymore for that reason. But DDT had and should have continued to save lives. I recall my father saying he sprinkled 10% DDT powder in his bedroll in Italy during World War II. It's also true that there were some entomologists who thought chemical sprays were the only cure to an insect pest problem, we referred to them as "nozzleheads." Recently I noticed in Wikipedia that Carson is considered the "mother " of the environmental movement, but it was healthy and strong before she came along. Nevertheless, she increased that pressure, and probably helped with Richard Nixon's decision to form the EPA and from this department's standpoint we were able to obtain funds to build the insectary which is a part of the greenhouse complex, and where several of us did a lot of our work.

I consider myself an average teacher at best. Though I think that I can make a few suggestions from what I learned over a number of years. First to allay butterflies when you first get up in front of a class, remember that first, you are in charge, and second, you almost certainly know the subject better than any of the students in front of you. Though as a teaching assistant in grad school I recall being asked to describe a statistical procedure to a graduate class in toxicology, and I can't claim to have significant knowledge in either area. I had gotten part way into the description of the statistical procedure, when I suddenly realized that I didn't really understand it. Somehow I blundered through and the students were either asleep or kind. There were obviously other occasions when I didn't know what I was talking about when I was in front of a class, but I learned better how to fake it. The lesson here is don't try to teach what you don't know. Another lesson that I learned before I got to Blacksburg, was to always keep a backup copy of your grades. I was teaching at a teacher's college and had returned the first midterm, when I realized that I had lost my grade book. What do you do beside look for it and panic? After a couple of days I found it, before I had to admit anything to the students. Another suggestion is something that my former students will tell you I learned way too late, the best teachers have a sense of drama. Teaching is a form of theater. Superb teachers like Rick Fell either know this or intuitively act on it to transfer their enthusiasm and hold their students' attention.

Over the years I taught, general entomology (a course known by various names), Insect Pest Management, and Insect Ecology. I took over Insect Ecology from Wally Tarpley when he went to East Tennessee State in 1965. When we went to the semester system, I taught 2/3 and Reese Voshell taught 1/3, combining terrestrial and aquatic ecology. This was one of those core courses that was on a lot of student's program of study. This also meant that I was asked to serve on a lot of graduate student advisory committees. I averaged being on about 12 –15 at any given time for quite a while. After one has taught a course covering a lot of profound principals for a while, one also sometimes learns from students. I met a former grad student, a young woman, at a professional meeting, she commented on one thing that she still remembered from my graduate course on Insect Ecology. I assumed that she remembered some vital principal of ecology. But no, she remembered one of the quips that I sometimes used to start a lecture: "Be like a duck, on the surface be calm and placid, but beneath the surface paddle like hell." A quip, but good advice, and perhaps was more valuable than the ecological principals. For several years I was involved in a team-taught course on environmental issues. My involvement with Insect Pest Management started when I inherited one section from Don Mullins, and a few years later took it over entirely. This course was for agriculture undergrads, but was used primarily by Horticulture students. I made use of a lot of guest lecturers from the department on the theory that they would have the most up-to-date information on their area of expertise (which was true, but also meant that I didn't need to prepare a lecture). Thus I personally listened to a significant number of our departmental faculty giving lectures. With few exceptions, they demonstrated an amazing diversity of style with an amazingly high quality. This department has been blessed with a bunch of outstanding teachers.

I also taught in foreign countries a couple of times. In 1979 I spent two months in Sri Lanka with a team from 3 universities organized by the UN Food & Agriculture Organization to help organize a post graduate program in agriculture. Virginia Tech had faculty from several departments, Michael Kosztarab and I represented Entomology. I taught a course in insect ecology and one in biocontrol. It's strange to teach a course to students who have no textbooks. As I recall, the cost in US dollars for the main text I used in biocontrol was about the same as the monthly income for middle class Sri Lankans. Their University library was also pitiful, seemingly a decent resource mostly for silverfish. Life in third-world countries is different, I recall thinking that I could frame an entire National Geographic article in about my first 10 minutes in the country. Upon meeting my wife, Joni, in Columbo after I had been there a month, within 2 hours of her arrival, she had held a king cobra, and petted baby elephants at an elephant orphanage. We often walked past women producing gravel by breaking larger rocks with hammers. Our driver "Peter" drove bare footed, and repeatedly used his horn to warn people and animals walking along the side of the road that he would miss them if only by a few inches, the adults and animals all seemed to understand this, though occasionally a kid would forget, but Peter was a good driver and carefully avoided the kids, he even managed to thread his way through a herd of cattle on the road while going about 50 mph. We were told that if your driver ever hit someone, you were to keep going and report it at the next police station, otherwise an angry crowd might kill you. A significant part of the program was for selected Sri Lankan students to come to the US, take courses and return to Sri Lanka to conduct their research. P. H. Somasundarum and his family came to Blacksburg, where he completed his course work. Then when he returned to conduct his research a bitter civil war erupted between the Tamil (Hindu) minority and the Sinhalese (Buddhist) majority. He barely escaped with his life. The war essentially destroyed the FAO program and Somasundarum's graduate program. And sadly this war continues today, more than a generation later.

I also taught a course in Insect Ecology in China in 1985. Joni and I were there over a month at the Northwest Agricultural College in Wugong, which is a small town about 40 miles west of Xian. This is the location of the Qin Terra Cotta Soldiers archeological site. Joni taught English. My cadre, or Communist Party supervisor, was also my interpreter, though we moved about the community without supervision. Most places were very clean, they swept the streets early every morning. This was not long after the Cultural

Revolution, 1966-77, during which intellectuals were attacked and often forced to work as peasants, separated from their families. The parents of some of our students committed suicide during this time. Prof. Wong, Head of the Plant Protection Department, with whom I worked, spent three years working as a peasant in the country, as did his wife. During a visit to his apartment, I asked to see a copy of Mao's "Little Red Book," Wong's response spoke volumes, "burned it." The difference between China in the mid '80s and now is remarkable. We could see the beginnings of capitalism there as we walked among farmers selling their produce in a central village market, using balance beams to weigh out what was purchased. In our small college town, there were only two automobiles, each with an assigned driver. I didn't tell them that at that time I personally owned three cars. Roads were used for walking, bicycles, a few motorbikes and fewer trucks. At night headlights were to be used only momentarily to avoid blinding pedestrians, scary for everyone.

Our Departmental staff has always been very competent and helpful. Some of the secretaries I dealt with included: Jo Proko, Barbara Waller, Bea Martin (who kept me out of trouble on numerous occasions when I was acting head), Helen Salmon, Linda Kramp Smith, Phoebe Webb Peterson, Cindy Schlossnagle, and Karen Guynn. They and others deserve much credit.

Regarding the technicians, I'll start with Frank Rock. Well named, he looked like the type who goes bear hunting with a switch. But he was gentle, kind and patient, especially with faculty and students who asked him to make a bizarre range of cages, equipment, you name it and he built it.

As for my technicians, I'll start with Tim Blakesslee. He had done a lot of things, a couple of years of engineering, managed a restaurant, flew a plane pulling advertising banners, etc. He was always full of ideas, such as determining the terminal velocity of a potato leafhopper. One of our adventures which I remember best is renting a small plane from the Hokie Flying Club for about $50/hr so he could pilot it and I could take infrared photos of alfalfa fields with my Exacta to see if we could relate the photos to infestation levels. So there I was, the one who is uncomfortable on a ferris wheel, leaning out of the propped open plane window at 500 or so feet taking pictures, and having a great time. The project didn't result in anything very useful, but it was worth a try. When Tim left, he went back to school, with my encouragement, and finished his degree in engineering. Since then he's been developing high tech computer stuff for the navy, going all over the world, and spending lots of time at sea. Now he's retired and still spends time at sea, but on his own sail boat. I recall a quote from Tim: "An elephant is a mouse built to government specifications," I wonder how many government specs he prepared. Another technician was Aubry Neas who later worked for Lynchburg College and the Forest Service. Next Tupper Garden worked for me. He had started a Ph.D. in PPWS, and decided to take a break, fortunately for me. He soon fell under the influence of Ellison Smyth, the Presbyterian minister whom I have already mentioned, and left in 1984 to attend Union Theological Seminary in Richmond. Tupper has been the senior pastor at Raleigh Court Presbyterian Church in Roanoke since 1991. Later Steve Bullington helped with our work on insect pests of cocoa beans at Norfolk International Terminals. My last technician was Mary Rhoades. Mary has worked in a variety of positions in the Department, probably longest for Michael Kosztarab. With me she helped with our studies of coccinellids in alfalfa, and actually published a paper after I retired. Mary is one of those folks who, if the cards had been stacked right, would have been a professor, not a technician. I was fortunate to spend some time learning from each of these folks.

Research wise, perhaps some background as to how I came to be working on insect pests of forage crops. I grew up in a suburb of Cleveland, I was not a farm kid. As an undergrad at Ohio State I majored in Entomology and Zoology, my advisor was Ralph Davidson (who took over authorship of "Insect Pests of Farm, Garden & Orchard"). He got me a summer job with B. A. App at the USDA Forage Research Station near Columbus, Ohio. It was there that I learned to use a sweep net, and counted thousands of meadow spittlebugs. Later Bernie App was influential in my going to the University of Wisconsin for my graduate work. There I worked with John Medler on potato leafhopper migration into alfalfa, and frequently used a sweep net. In Virginia my first research area was also forage crops where I also frequently sampled populations using a sweep net. I have on occasion wondered why I never caused any automobile accidents, as normal people drive by on a rural highway wondering why an apparently grown man was out in that field waving a butterfly net back and forth. A large proportion of my research has been conducted by graduate students, which has then comprised their theses and dissertations. I seldom asked students to do research which they could not also call their own. I felt that if a student felt ownership, they would work harder and be more creative. In my experience this has been true. I have left the forage crop area several times when I picked up the supervision of someone left behind by a departed faculty member, when a student had independent support, or when I was involved with a grant. Toward the end of my stay I started an additional area, stored product pests.

Alfalfa is an interesting crop because it is a long term perennial with a short term harvest cycle. In addition with the newer salts available it can be used for grazing by cattle without danger of bloat. Thus different harvest practices can be used to assist in pest management. The alfalfa fauna has been shown to include an extremely high number of arthropod species, over 750 in New York and ca. 1000 in California. Jim Howell identified 112 species of spiders in alfalfa near Blacksburg. Its high protein content and being a perennial may contribute to the species diversity. In spite of the high faunal diversity, or perhaps because of it, there are only two major insect pests, the alfalfa weevil and the potato leafhopper. Another reason for the low number of pests is that aesthetic injury is not a problem, the cows just aren't that fussy. Other insects, such as the meadow spittlebug, pea aphid and more recently (in 1992) the blue alfalfa aphid, can be numerous and serve as important prey, but seldom cause crop injury.

When I arrived, the alfalfa weevil, a fairly recent introduction, was commonly eliminating the first harvest, slowing the second and thinning stands. Jack Bishop had helped develop the use of a dormant granular application of heptachlor along with fertilizer. This gave growers an impetus to fertilize along with effective weevil control. This came to a halt when residues of heptachlor were detected in milk. We then relied on sprays when tips became infested in the spring. At this time the USDA was searching for parasites and the first of several which became established, *Bathyplectes curculionis*, we first released in a field where the Blacksburg Middle School now stands.

In an effort to reduce the weevil populations during the winter, and thus the earliest larvae which attack when the plant is most susceptible, we tried several insecticides and burning the field to make it an unsuitable habitat. During the late '60s we tried burning fields using LP gas burners. This was when the price of oil was about $13/barrel vs. over $60 today; the first peak in oil prices due to an Arab oil embargo and government mishandling of the problem occurred in the early '70s. It actually worked to greatly reduce the number of eggs overwintering and the number laid during the winter, the spring laid eggs tend to hatch when the alfalfa is larger and better able to tolerate feeding. One of the earlier insecticides approved for use on alfalfa, Diazinon, was effective against the alfalfa weevil, but with Dale Wolf, we showed it to be phytotoxic to alfalfa. It did not cause obvious visible symptoms, but reduced plant growth rate. When screening insecticides to control insects which attack crop plants, we must be aware of this possibility. We also looked at the sublethal effects of certain insecticides on alfalfa weevil feeding rates.

Much of our early work on the alfalfa weevil was intended to help us better understand its biology and to look for patterns which could be exploited to control it. Al Pamanes, one of my first students, studied the movement of tagged adult alfalfa weevils to learn more about their movement out of alfalfa fields prior to their aestival diapause, and their later return. During diapause the adult alfalfa weevil prefers a dark, dry habitat, which leaves them hidden, but less susceptible to fungal disease. When it seemed that chemosterilants might be useful, Frank (Feng-kuo) Hsieh found that apholate, reduced egg viability when applied to adult males. Lenny LeCato started out looking for an alfalfa weevil sex pheromone, and conducted a thorough study of their mating and reproduction. He didn't find a pheromone nor was sound a factor. Temperature and density influence reproduction and the presence of sperm stimulated oviposition. Steve Springer looked at humidity preference of adult alfalfa weevils as a factor explaining their diurnal habitat preferences. Raj Waghray found that certain extracts of alfalfa, red clover and ladino clover elicited a positive anemotaxis and in the absence of air movement a combination of klino- and orthokinesis. And Zbigniev Golik, a non-thesis student from Poland, studied the effect of temperature on the kinetic host orientation movements of mature adult alfalfa weevils. Amos Showalter determined the preferred feeding site on the alfalfa plant for newly emerged 1st and 2nd instar alfalfa weevil larvae. He also looked at the impact of this feeding on the plant, the influence of low versus high temperatures, and the impact of crowding on larval development.

The fact that alfalfa weevils laid more eggs during the winter and spring at lower elevations resulted in increased crop damage and led to control recommendations differing as to altitude. Aphirat Arunin evaluated a variety of sampling methods for larval and adult alfalfa weevils. A preliminary life table indicated that the primary population regulating mortality occurs during the egg and larval stages. Later, Dan Hilburn (who had Bill Allen and myself as cochairmen) compared the impact of winters at higher elevations with those of lower elevations on the alfalfa weevil, considering temperature, parasites, and fall regrowth management. He developed sampling methods to determine absolute density. Fewer adults were found in fields where the fall regrowth had been removed. Adult dissections showed a maximum parasitization rate, by three species of parasite, of 16%. Dissections also showed that females contained fully developed eggs shortly after returning to alfalfa in the fall. Field deposited egg density was similar at high and low elevations in February, but much higher at low elevations in March. A simulation model was developed to help describe the effects of the variables studied on overwintering life stages. The 7-spotted lady beetle was shown to readily kill and feed on weevil larvae. Thus this accidentally introduced, and now dominant, lady beetle is helping reduce alfalfa weevil populations. The alfalfa weevil, at least at higher elevations, has now been largely controlled by a complex of wasp parasites, a lady beetle predator, and fungal disease.

Raj Mathur, another of my first students, looked at the impact of spittle bug adults, pea aphids and potato leafhoppers on forage quality of alfalfa, red clover & birdsfoot trefoil in the greenhouse. In the early ‘90s a new aphid species, the blue alfalfa aphid, was found on alfalfa in Virginia in 1992. It moved here from states to the west. We did not see high populations but they were heavily parasitized.

Don Simonet developed absolute sampling methods for all three stages of the potato leafhopper. This included a method of clearing alfalfa stems so that eggs deposited inside the stems could be counted. He also came up with a small cardboard fumigation chamber to help determine the density of nymphs, a stage which is also difficult to sample. Shelby Fleisher determined that sticky traps gave useful information on potato leafhopper activity, but did not yield useful density information. He developed a relationship between sweep net counts and density and determined optimal sample size curves. The harvesting of a portion of a field altered adult spatial distribution. Simonet also determined temperature dependent developmental and oviposition rates. These rates were used in a study of the effect of harvest on leafhopper populations. Clean harvest is important in reducing leafhopper populations and the later impact of leafhoppers on early regrowth of the next cutting. Potato leafhopper sex ratios from regular surveys are predominately female, an indication of a migrant population. The first arrivals in the spring are all female. Thus alfalfa which is harvested at relatively short intervals and is harvested cleanly is probably not a major source of potato leafhoppers. Warmer winters in the later years were associated with early arrival of potato leafhoppers and with somewhat higher problems later in the season.

Regarding our studies on predators in alfalfa, Jim Howell studied the spider fauna in this part of Virginia. Using both D-Vac and sweep net he found 14 families, 75 genera and 112 identifiable species. He looked at diurnal impact on sampling, impact of harvest on spider populations, and conducted feeding studies using ten species. He studied the biology and a parasite of one of the more common species, *Tetragnatha laboriosa*. Danny Martinez observed that Nabis and Orius feed on leafhopper eggs, nymphs and adults, while coccinellids and chrysopids feed on nymphs and adults. He determined the relative toxicity between predators and potato leafhoppers for several insecticides. In the late ‘70’s the dominant coccinellids were *Hippodamia convergens* and *Coccinella* *novemnotata*. Sheila Andrus studied predation by the nabid, *Reduviolus americoferus*, on pea aphids and potato leafhoppers in the field and in the lab. She determined field densities of all three, and determined which nabids had fed on which pest prey species using three serological procedures. While pea aphids are the preferred prey, nabids were more important in preventing potato leafhoppers from exceeding economic thresholds. Peter Mehring looked at the sublethal impact of two insecticides on the nabid, *Reduviolus americoferus*. There was not a consistent pattern for either nymphs or adults. He described an apparent behavior by males of flicking with the hind leg to disperse a pheromone. He observed nabid parasitization rates by a tachinid of up to 40%, and by a braconid up to 4%. A sublethal repellent effect of insecticides was hypothesized as a method of conserving natural enemies. Initial laboratory tests involved the screening of insecticides approved for use on alflalfa using the convergent lady beetle. These tests indicated that chlorpyriphos may be somewhat more repellent than the others tested. In a field test in which 20 ft strips sprayed with chlorpyriphos were alternated with unsprayed strips, within 4 days posttreatment potato leafhopper populations in the untreated strips were reduced. Lady beetle adults appeared to remain in the untreated strips, even though aphid populations were similar in both treated and untreated strips. This could mean coccinellid repellence, and that leafhopper trivial movement brought them into contact with lethal doses of the insecticide.

In the late 1980s the sevenspotted lady beetle become common in Virginia alfalfa fields. This insect predator was accidentally introduced into the USA. Adult lady beetles are common in alfalfa early in the spring when alfalfa weevil larvae are also numerous. This is the only insect predator which is common at that time. The sevenspotted lady beetle has largely displaced both the convergent lady beetle, previously the dominant lady beetle in alfalfa and has reduced populations of *Hippodamia parenthesis*. The ninespotted lady beetle, previously second most common coccinellid in alfalfa no longer exists in this area. Populations of the other lady beetles in alfalfa are relatively unchanged. The reason for this displacement by an ecological homologue or partial homologue is not known. Prey, especially the pea aphid, were probably not limiting. The sevenspotted lady beetle is most common in spring, early summer and late fall. The spotted lady beetle, *Coleomegilla maculate*, which can complete its life cycle using pollen as an alternative food, is most common in late summer. Nabids, primarily *Reduviolus americoferus*, do not become numerous until late June, but are common until frost. The most numerous predator, mid-June to fall, is *Orius insidiosus*. *Geocoris* was present throughout the season, but was most numerous in late summer. In 1993 a second accidentally introduced coccillelid, *Hamonia axiridis*, was first observed, it became numerous by late summer and partially displaced the sevenspotted lady beetle in the next few years.

I became involved with the weed biocontrol program when Rod Hendrick left and Wayne Surles finished his M.S. under my direction. Wayne studied the biology and impact of the thistle head weevil, *Rhinocyllus conicus*. This was the first insect released to control Carduus thistles. Rod Ward (for his M.S.) conducted studies of host specificity for the thistle rosette weevil, *Ceuthorrhynchidius horridus*, which are required prior to the release of an exotic insect for biological control of a weed. He also worked on rearing techniques, specifically methods of terminating aestival diapause. Later Kok and I received a grant to look at the indigenous insect fauna attacking several important weeds. Mark Beisler surveyed the insects attacking yellow nutsedge and three weedy grasses, Johnson grass, fall panicum and large crabgrass, and suggested several which might have future biocontrol potential. Richard Storey studied the biology of one of these, a buprestid which attacks yellow nutsedge. Gary Cave studied the biology of a native seed-feeding gelechiid which attacks giant ragweed. Finally, Rod Ward (for his Ph.D.) studied the accidentally introduced shield beetle, *Cassida rubuginosa*, a thistle herbivore. He looked at beetle biology, parasites and impact on the host plant.

My work with stored product insects began in the late ‘60s when Ahmad Chawkat, with his own funding, wanted to work on the cigarette beetle. He found that humidity influenced cigarette beetle hatch, stadial length, oviposition, adult weight and survival of all stages. In general humidities as low as 20% were deleterious and those over 60% slowed larval development.

In the early ‘90s I submitted a project on stored product insects and soon after became involved in looking at the insect problems of cocoa beans stored at Norfolk International Terminals. This, of course was a natural for a chocoholic. Over $200 million worth of cocoa beans are annually shipped through the port of Norfolk. Much of this is stored in dockside warehouses for periods of months or years. Bags of beans arriving from tropical ports are often infested with a variety of insects even though they are technically inspected or fumigated prior to shipment. We made a preliminary survey of infestations and the effectiveness of the normal prophylactic control method. The most severe pests are the rice moth, the tobacco moth, the cigarette beetle, the foreign grain beetle, and the rusty grain beetle. The use of dichlorvos as a space treatment had little effect. The foreign grain beetle was largely influenced by the moisture level inside the bags. Plastic drapes designed to increase the dichlorvos impact, resulted in increased humidity and higher beetle populations. The moisture content of the beans was related to both the presence of drapes and dichlorvos.

In studies of other stored product insects, the standard stored-product moth pheromone supplied for traps to survey for pest problems, will not attract rice moth males. Since the rice moth is becoming an important pest world-wide, serious infestations could be missed by relying on the pheromone traps alone. Farmers who store grain over the winter months should take extra precautions when the winter weather is warmer than usual. Samples taken in stored grain and meal in western Virginia have revealed an uneven distribution of insect pest natural enemies, including five hymenopterous parasites and one hemipterous predator. *Bracon hebetor* and *Venturia canescens* will readily reproduce on the Mediterranean flour moth, but will not complete development on the rice moth. Biocontrol in stored grain has its limitations since the Federal Grain Standards equate an insect parasite or predator with a pest species when found in grain about to be processed.

In the early ‘80s, Virginia was experiencing severe problems with grasshopper outbreaks. As a result, Jim Roberts, Paul Semtner and I had a proposal funded to study grasshopper population dynamics. My portion funded Bob Bellinger. Bob primarily studied the red-legged grasshopper. He found that temperature influenced the number of nymphal instars, which was correlated with adult size and population number. He was able to determine the number of egg pods deposited and the number of eggs per pod by observing the ovarioles of dissected females. Females from larger eggs had more ovarioles. Number of egg pods laid was related to rainfall in September, and pod size was related to body size and rainfall in October. Thus we had some pretty good predictive tools with which to consider future outbreaks.

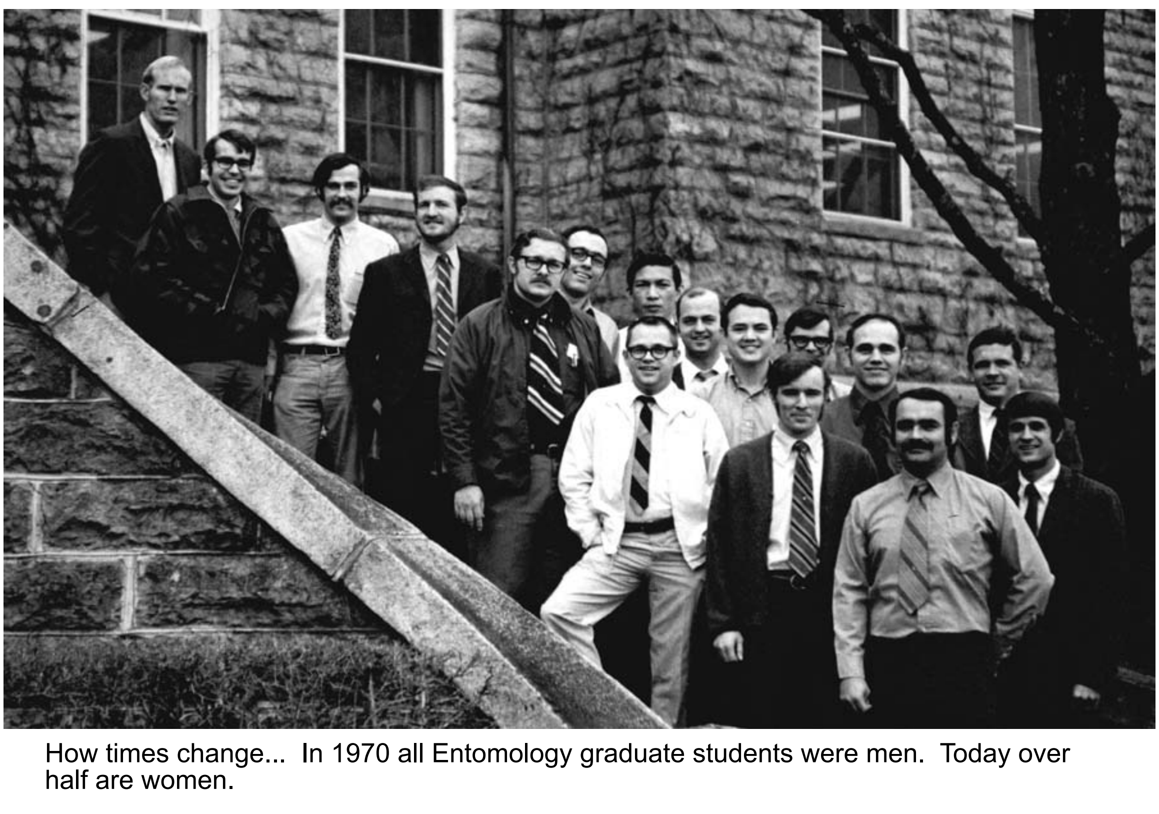
In the late ‘60s Bill Isakson, who had his own funding, wanted to study the transmission of peanut stunt virus. He found that it is transmitted by two species of aphids. In these aphids the virus is non-persistent, and is mechanically transmitted without a latent period. White clover was shown to be the overwintering host of the virus. Shortly after this Bill Allen decided to pursue a Ph.D. and since he didn’t need funding, he selected a study of the frit fly. The frit fly is a pest of bentgrass golf greens and forage grasses such as reed canarygrass. He described the biology, mating behavior and parasites. The life tables Bill developed showed that frequency of rain during the egg laying period was a key factor. Bill went on to have a remarkable career, President of the ESA and head of extension at Virginia Tech. He said that a goal was to retire before I did, but he missed by a few months.

When Sid Poe departed, he left behind a joint Israel-US grant for work on leafminers attacking ornamentals, which I inherited, and a good post doc, Pat Parkman, who was doing the work. Of course I also inherited Sid’s administrative duties when I became acting head. Pat did a lot of work including: the influence of cultural practices on the biology of *Liriomyza trifolii*, the efficacy of certain control practices, and the variability in insecticide resistance among geographic strains. Populations from Maryland were found to be much more resistant to pyrethroids than those from Florida or California. Neem, a plant derived insecticide, had little direct effect on adult flies, but when used as a soil treatment reduced both the production and viability of pupae.

Finally I served temporarily as major professor for Herb Kulman's students after he left. John Witter studied a coccinellid introduced to help control the balsam wooly aphid and Wayne Berisford studied the hymenopterous parasites of Ips bark beetles.

In June 1995, I took special leave (as part of a buy-out), and officially retired Sept. 1, 1996. On April 21, 1996 I was appointed Professor Emeritus. Not many faculty are granted Emeritus status before they are retired.

In closing, I want to thank all involved, it was great. Also to close this properly, not long ago my wife found some scrap paper, on the back was a routing slip for Current Contents, Life Sciences, a journal we formerly used to try to keep up with the literature. In the left column listed under Circulate Rapidly, were Cochran, Eaton, Kok, Mullins, and Ross, while in the right column listed under At Leisure, was Pienkowski. It seemed to confirm what she had long suspected.



How times change... In 1970 all Entomology graduate students were men. Today over half are women.

Genetic Studies on Cockroaches at Virginia Tech, 1959 – 1995

Mary H. Ross

The Department of Entomology at Virginia Tech became known for research on cockroaches. Research began with pioneer studies by Dr. James M. Grayson, head of the newly-established Department of Entomology in 1959. He discovered the presence of insecticide resistance in the German cockroach, *Blattella germanica*. Dr. Donald G. Cochran joined Dr. Grayson in this early research. I was hired in 1959 to assist in the resistance research. The program was enhanced by Dr. Donald E. Mullins' research on cockroach physiology and biochemistry. Don M. joined the department in 1973.

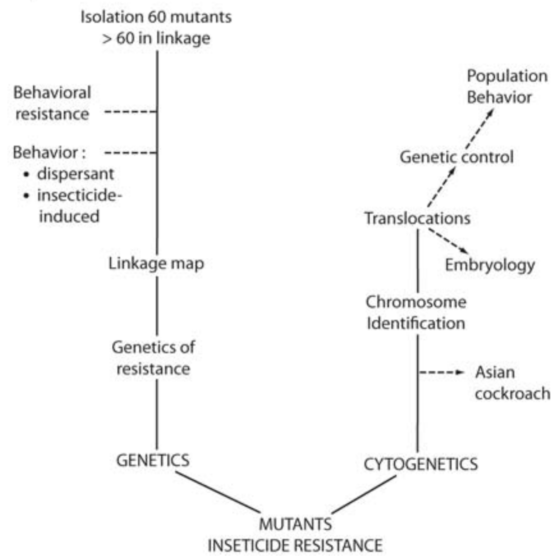
During the 1960s, evidence that insecticide resistance is genetically controlled stimulated a growing interest in genetics of insects of public health importance. Don C. discovered a male German cockroach with bubbles on the wings. I attempted to isolate and, if possible, establish the inheritance pattern of the trait. It indeed proved to be a mutant. Would it be possible to establish a genetics for the German cockroach? My search for heritable traits in *B. germanica* was hampered by a sparcity of morphologic mutants. Nevertheless, with inbreeding, examination of numerous stocks, use of ionizing radiation, and persistence, stocks were gradually accumulated. Thus began an endeavor that took much of my time for the next 35 years.

The following paragraphs touch on results from research on *B. germanica*. However, first I would like to recognize several outstanding technicians who contributed greatly to the success of the program. Foremost among these were Nancy Boles and Elizabeth Watson. Nancy started in 1970, and remained until my retirement in 1995. She was expert in making chromosome slides, photography, whole embryo mounts, and in overseeing care of the mutant stocks. Elizabeth came on board in the mid-1970s and, except for several years in the early 1980s, stayed into the 1990s. Her artistic talent was very valuable, not to mention her color photos of each mutant and major contribution to a webpage on cockroach genetics. Two part-time technicians, each of whom was with me for several years, also contributed to the program. One, Keith Tignor, conducted experiments on a dispersal pheromone; the other, Nguyen-tan, modified a feulgen stain technique for study of cockroach embryos.

A description of several mutants and data on their linkage relationships was published as a preliminary report in the Annals of the Entomological Society of America in 1965. Subsequently, a series of reports on "Genetic Variability in the German Cockroach" was published in the Journal of Heredity. Genetic Variability I appeared in 1967. The first linkage of a mutant with an insecticide resistance trait was discovered by a Ph.D. candidate, Ian McDonald. The 1960s also saw discovery of two mutants of evolutionary interest. One, prowing, (*Pw*), is characterized by wing buds on the pronotum that are reminiscent of those of some early fossil insects. The other mutant, notched sternite (*st*), shifts development of abdominal segments in a primitive direction. Embryos carry rudimentary limbs on all abdominal segments. The appendage on the 8th segment is retained postembryonically in females.

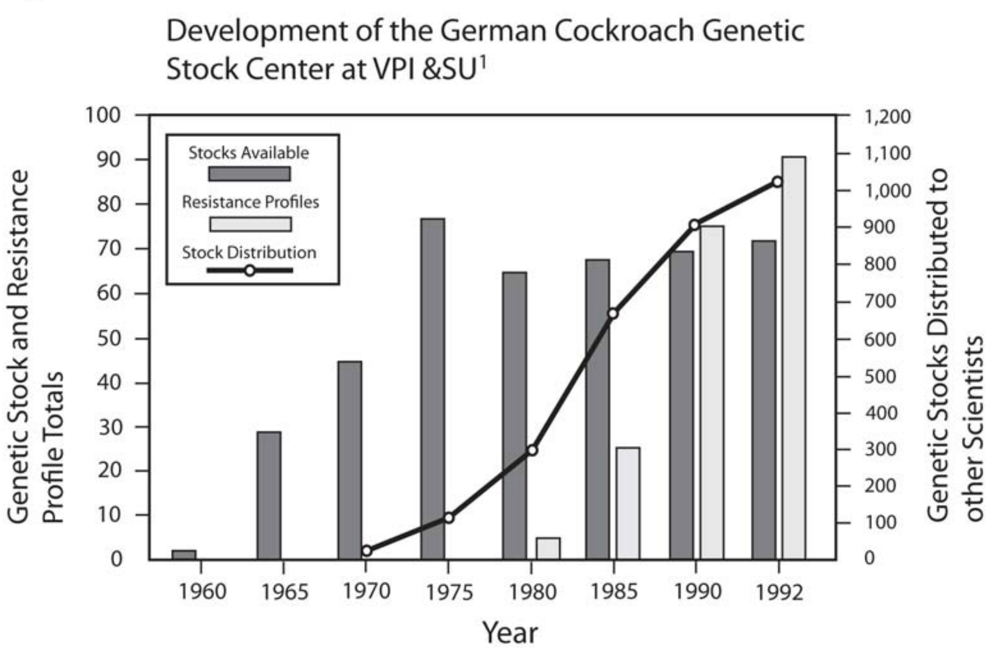
Figure 1 illustrates growth and expansion of the research program, often into areas that could not be anticipated at the start. Nevertheless, genetic and resistance studies remained at the core of the program until retirements in the 1990s. Don C. and I worked together on investigations of inheritance and linkage of genes imparting insecticide resistance. During the 1970s, support of the stock center and resistance research included grants from NSF and the National Communicable Disease Center, respectively. The laboratory became increasingly well known. The availability of mutant stocks, resistant strains, and a variety of cockroach species other than the German cockroach provided a rich and unique resource. Figure 2 illustrates growth and usage of the stock center until 1992, when I was close to retirement. Visitors to the lab ranged from photographers for National Geographic to grade school children. Some of the latter asked questions concerning cockroach "mommies and daddies" that were a bit hard to answer!

Figure 1.



Chromosome studies became a major component of the program. Therefore Fig. 1 is separated into two parts, genetics and cytogenetics. It would be difficult to separate contributions to the cytogenetics research made by Don C. and myself. We identified meiotic chromosomes by length measurements and staining patterns. Experiments with ionizing irradiation resulted in the discovery and isolation of heritable chromosome mutations known as reciprocal translocations. Translocations are interchanges between two non-homologous chromosomes. Chromosome identification made it possible to identify specific chromosomes involved in the translocations.

Figure 2.



[1]Stock distribution and resistance profile data, cumulative totals. Stocks available fluctuate over time.

The cytology and linkage relationships of individual translocations were analyzed. I utilized close linkage with mutant markers to establish mass backcross systems for maintenance of individual translocations. In these systems, nearly all morphologically wild type individuals were translocation heterozygotes. In the late 70s - early 80s, an outstanding graduate student, Clifford Keil, contributed significantly to the cytogenetics program. He conducted a basic study of chiasma frequency and developed a C-band technique for study of chromosome structure.

Turning to genetics (Fig. 1), studies on isolation, inheritance patterns, and linkage relationships of mutants begun in the 1960s were continued, especially during the 1970s. By 1975, the 12 linkage groups were tentatively identified. Most markers fell into one of four groups; other groups were marked by one or two traits only. Gradually, linkage groups were correlated with specific chromosomes. Studies on individual mutants included cooperative research with Dr. Frank L. Campbell. We used an antennal mutant to enhance our understanding of antennal growth and development.

Continued experiments with translocations involved the development of double translocation heterozygotes. High lethalities in matings of double translocation heterozygotes resulted in the reduction of viable embryos in the egg case to a point where they were unable to force open the egg case at the time of hatch. I called this unique sterility mechanism “embryonic trapping”. Cliff Keil analyzed reduction in hatch in relation to specific lethalities. I experimented with the use of single and double translocations in laboratory experiments on population suppression. The Office of Naval Research (ONR) began support for this work in 1976 - support that was continued well into the 1980s. An offshoot of the translocation studies was the discovery of gross effects of aneuploid gametes (unbalanced chromosome complements) from matings of translocation heterozygotes on embryonic development (Fig. 1, embryology). Perhaps this approach might be used to determine the location of genes controlling early development. The zygotic genome apparently acts earlier in control of embryonic development in *B. germanica*, and possibly other primitive hemimetabolans, than in holometabolous insects.

Laboratory experiments on population suppression and synthesis of a particular double translocation culminated in a first “field” experiment on genetic control. The experiment was done on two Navy ships in the early 1980s. Cliff took part in the experiment. Lethalities in matings of certain double translocation-carrying males with wild-type females were so high that sterility from embryonic trapping was complete. Double translocation-carrying males were released near known infestations on each ship. One of the ships left before the experiment was completed. On the other ship, males were successfully introduced into groups near points of release. Sterility in such groups was high. Nevertheless, growth of previously undiscovered groups was unchecked. It was clear that a greater understanding of wild type population growth and behavior was needed. This led to a number of studies during the 1980s that are indicated as an offshoot of genetics (Fig. 1, behavior).

It is difficult to define a cockroach “population”. Presumably a population consists of mixed age groups that occur in hidden spots (harborages) within a given structure. Behavior within such groups and also the amount of mixing between groups are mediated by the combined effects of female density and reproductive state (Brian Bret, M.S. and Ph.D. projects). Aggregation increased with density of gravid females within groups. The increase was attributable to emission of aggregation pheromone by gravid females (ootheca-bearing). In contrast, density decreased with increase of non-gravid females. The lower density associated with non-gravid females suggested that females might emit a repellent. This was subsequently verified by work on a dispersal pheromone. However, a follow-up experiment showed that 7-day-old non-gravid females may emit aggregation pheromone. This occurred when female density was much lower than that required to stimulate emission of the dispersant. Other experiments revealed that age classes differed in their response to aggregation pheromone. The response of middle instars was lower than that of other age classes. The lower response possibly accounts for a greater movement away from groups within individual harborages by middle instars than by other age classes (experiment on an inactive ship; see below).

Experiments using filter paper conditioned by crowding adult females, especially non-gravid females, indicated that a dispersal pheromone is indeed secreted by females. Dispersant secretion was limited to adult females, at least in our stocks. Greater repellency was associated with non-gravid than gravid females, as suggested by behavior of mixed age groups. A more detailed look at non-gravid females indicated a more intense level of crowding of 3-day-old than 7-day-old females was needed to stimulate secretion of the dispersant. More information was added from work on antennal ablation and the effect of starvation. Starvation inhibited secretion of the dispersant. This was not surprising because Don C. had shown that the female reproductive cycle is related to food availability.

Experiments on behavior were largely limited to the laboratory. A unique opportunity to study growth and behavior of a free population was made possible by permission to use an inactive Navy ship for our experiments (Portsmouth Inactive Ship Facility). Groups of cockroaches were established in known locations throughout one area of the ship. The total from sequential trapping data and a final cleanout documented that a cockroach population is capable of exponential growth. Underlying changes in age class structure distinguished the development of large from that of small groups. Limits on size of harborages apparently resulted in dispersal of middle and late instars. Most movement was from small to large groups, at least until the latter reached the carrying capacity of the harborage. Cockroaches avoided open spaces.

During the 1990s, the primary source funding of the research program was from various industries involved in cockroach control. NSF had dropped support for many small stock centers, ours included; the Army took over Naval research. Of special interest because of our background in genetic research and industry-related concerns was the possibility that continued use of insecticides had resulted in behavioral changes - changes about which virtually nothing was known. Therefore, a number of experiments were conducted that hopefully added to our understanding of cockroach behavior and, simultaneously, raised many new questions.

Although much of our research was on industry-supported projects, two happenings significantly advanced the basic genetic studies. The first was an invitation from Florida entomologists to collect specimens for study of *Blattella asahinai (B. a.)*, a recently-introduced close relative of *B. germanica (B. g.)*. I was a bit startled when insects, closely resembling German cockroaches, up and flew away when I tried to catch them. Subsequent laboratory studies were on morphological differences, hybridization, transfer of insecticide resistance to hybrids and potential through hybridization to transfer resistance from *B. g*. into Asian cockroach populations (Fig. 1, Asian cockroach). The discovery of a cytological difference between the species was of particular interest (at least to me). A section of the X chromosome carrying the nucleolus-organizing region of *B. g*. was shifted to an autosome in *B. a*. Consideration of all lines of evidence, including hybridization studies, strongly suggests that the chromosome mutation generated a complex of mechanisms that, acting together, resulted in divergence of the two species. There are arguments in the literature concerning the role of chromosome mutations in speciation.

The second happening that advanced basic genetic research stemmed from the interest of Dr. Akira Tanaka (Nara Women's University, Nara, Japan) in the genetics program. Dr. Tanaka had long been interested in growth and development of the German cockroach. He spent eight summers in our laboratory, during which we expanded his studies of wild type to mutants that alter growth and development. A few examples are: mottled body, in which determination of color patterns apparently occurs before dorsal closure during embryogenesis; fused tarsi, in which experiments on regeneration indicated that regeneration is actually an abbreviated process of normal development; and stumpy, with femur/tibia length ratios suggesting the mutant has primitive legs, not yet fully differentiated from an archetypal leg type. The location of stumpy was of particular interest because of close linkage with three other mutants, *Pw, st*, and *mpe* (maxillary palp elongate). I had long thought that the occurrence of the latter mutants on one out of eleven autosomes is of evolutionary significance. Each mutant causes a greater-than-normal identity of body segments, as expected if each is an expression of a primitive developmental pathway. Insects are thought to have evolved from a multi-legged ancestor that had a high identity of body segments.

Turning to work involving insecticides, a variety of strain differences were investigated (Fig. 1, behavior). Strain differences included a higher frequency of premature drop of egg cases following insecticide exposure by susceptible than by insecticide resistant females (Jim Harmon, M.S.). Another behavioral difference was that susceptible strain cockroaches avoided residues of pyrethroids on filter papers. Pyrethroid resistant cockroaches settled on the papers. Non-avoidance was inherited as a partially dominant trait that was attributable to a single major gene. Partial dominance suggests that non-avoidance would likely persist in future generations. Field strains also responded differently when exposed to pyrethroid vapors (Don C. and myself). We also found strain differences in response to insect growth regulators and emulsifiable concentrates. Yet another change that accompanied the development of resistance was a loss of fitness in two highly-resistant field strains.

Experiments by Mark Wooster (Ph.D.) showed that dispersal can be induced by very small amounts of pesticide in air. Volatilization of a propoxur formulation resulted in redistribution of propoxur onto previously uncontaminated surfaces. Amounts were small, yet they could be sufficient to repel cockroaches and thus allow them to avoid lethal exposure.

Last, but hardly least, is the work with toxic baits. Scientists at Clorox Co. found two strains with resistance to their hydramethylnon bait. My experiments indicated behavioral resistance to the bait base. Subsequently, Jules Silverman (Clorox, Co.) identified glucose as the component of the bait base that cockroaches avoided. Jules cooperated in genetic studies that revealed glucose aversion is an autosomal semi-dominant trait. Altering the bait base (no glucose) increased attractiveness of the bait. Selection for decreased efficacy of the non-glucose bait favored cockroaches that ate less of the bait. Clearly, food consumption has a genetic basis and appears to be recessive.

Tracy Negus (M.S.) began selections for development of behavioral resistance with a variety of toxic baits. I continued the experiments. Variations due to active ingredients, formulations and strain were too extensive to be covered here. Suffice it to say that, as toxic baits continue to exert selection pressure on field populations, there is a strong possibility decreased efficacy will be due to altered behavior rather than an increase in physiological resistance.

Overall, I enjoyed working with the German cockroach. The opportunity to follow mutant characteristics through each of the 6-7 instars separates these observations from those on holometabolans. Identification of the presence and stage of embryonic lethals in oothecae prior to hatch was another plus. If I had another lifetime (obviously I don't), I'd look into embryology. I've seen cell divisions that look amitotic. Perhaps I should mention that, as much as I find rewarding in laboratory studies, I would not want cockroaches in my kitchen!

Research and Teaching, 1953-1992

E. Craig Turner Jr.

Research (85%)

Introduction

In 1953, I was appointed Associate Professor of Entomology in charge of research on biology and control of pests of forage crops, replacing G.W. Underhill. These crops were principally alfalfa and red clover. The pests included the clover root curculio, the three cornered leafhopper, the spittle-bug and the clover root borer. The alfalfa weevil was important in the Western part of the U.S. but had not been discovered in Virginia. At that time, the clover root curculio was the principal pest of alfalfa causing major damage to the roots and a decline in the stands which were supposed to last at least five years before expensive reseeding. Our major emphasis was to study the biology of this insect and also to evaluate the effectiveness of various insecticides applied to the soil. This project led to four publications (Underhill et al. 1955, Turner 1955, Woodside & Turner 1956, Turner 1957). In 1956, another staff member was put in charge of this project.

Medical and Veterinary Entomology

In 1956, at my request, I was put in charge of research on Biology and Control of Insects affecting Man and Animals. I remained in charge of this project until I retired in 1992. About 90% of the total operating funds for all research, including support for graduate students were generated by Commercial grants, the United States Department of Agriculture (USDA), the National Institute of Health (NIH), the Animal & Plant Health Inspection Service (APHIS), and private foundations.

Horn Fly, *Haematobia* (=*Siphona*) *irritans*

The horn fly was imported into this country from Europe, in the late 19th century, probably on infested cattle. They were blood suckers feeding several times a day in swarms of up to hundreds on the sides and backs of cattle. Since spraying cattle was time consuming and labor intensive, our initial research on horn flies was to test the effectiveness of self-application devices (back rubbers). They had been reported to be effective on horn flies in other states. They were simply strands of barbed wire mounted on posts and thickly wrapped with burlap bags which were then soaked in a 5% oil solution of insecticides. We set them up in areas where the cattle loafed. This took advantage of a natural tendency for cattle to rub against fence posts, trees and other natural objects in attempts to rid themselves of these flies. These results were effective, practical and acceptable to cattle owners (Rowell & Turner 1969). A variation of this method involved wrapping these back rubbers with burlap bags partially filled with a dilute insecticide dust. Results were also satisfactory (Hargett & Turner 1958). At that time, the application of insecticides in dairy barns for control of house flies was not as stringent as they are at present. We observed that horn flies were also controlled on dairy cattle entering milking barns that had been previously sprayed for house flies (Turner & Hargett 1958).

Morgan (1964) studied the effect of temperature and humidity on the position and behavior these flies. He showed that they rested on the cattle most of the time leaving only to lay eggs on fresh cattle manure. In day-light hours, they generally preferred dark colored areas of bi-colored cattle depending on the ambient temperature. They preferred a micro environment (within the ½ inch of the skin area) of 85 degrees and a relative humidity of 65%

Cattle Grubs, *Hypoderma lineatum , H. bovis*

The most important pests of cattle in 1956 were two species of flies called the heel fly and bomb fly. Both species were called cattle grubs in the larval stage. Cattle ran wildly in the pastures being chased by these big hairy flies the size of bumble bees that were attempting to lay eggs on their host's flanks and legs. They had no mouth parts; their sole purpose was to lay eggs attached to hairs. The eggs hatched and larvae migrated into the body. By January through March, maggots the size of a thumb appeared on the backs of infected cattle causing large open wounds and scabs. This not only reduced the quality of meat on the back but scars left on animals being slaughtered made the hides less valuable as leather. Early attempts had been made to control these grubs by sprays with limited success. In 1956, Dow Chemical Company formulated an organophosphate systemic insecticide (called Dow ET-57 or Ronnel) when applied orally to cattle in the fall, would kill the grubs in its early stages before they appeared in the backs of the animals. This break-though was followed by the development of other insecticides, Co-ral and Ruelene, which did not have to be applied orally but simply sprayed or poured on cattle in the fall. We tested these and other systemic insecticides (all organophosphates) with similar satisfactory results (Turner 1962). We also tested the effect of these systemic insecticides on anthelmintic activity (Turner & Watson 1962). A single dose of Ruelene applied in the fall, not only reduced cattle grub larvae, but reduced the number of stomach nematodes over a period of 96 to 114 days.

It was not known if infestations of these grubs affected the weight gains of feeder beef cattle. Now that insecticides were available that could effectively control these grubs, researchers in the USDA and various states evaluated the weights gains of treated and untreated cattle. Their results were inconclusive. I believed that their research had not taken in factors, such as diet, in cattle weight gain and loss. In 1958, we treated two groups of feeder cattle on separate diets. One group was fed a full feed diet to maximize weight gains. The other group was fed a general maintenance diet. Grub treatment was effective in both treated groups. The results, however, showed that untreated feeders on full feed diet gained significantly less weight than treated feeders on full feed diet. The grubs affected the weight of animals only on a full feed diet. There was no significant difference between treated and untreated animals on the general maintenance diet. Since there was greater stress to animals on full feed, any factors, such as cattle grubs, would affect weight gains (Turner & Gaines 1958).

These systemic insecticides were so effective that they have been accepted nationwide. Cattle grubs, while not eradicated, are no longer a major pest of cattle.

Face Fly, *Musca autumnalis*

This pest, also a native of Europe, was discovered in Eastern North America in 1956. It was probably again brought over by infested cattle or horses. This fly was non-bloodsucking but swarmed about the faces of cattle causing severe irritation especially to the eyes. It was suspected also to transmit the pathogen of pinkeye, *Moraxella bovis* to cattle. By 1958, it was reported in Northern Virginia. We began research on the biology and control of this pest (Wallace & Turner 1962, Wang 1964, Turner & Gerhardt 1965, Turner 1965). We established a laboratory colony of face flies that allowed us to evaluate more closely the toxicity of insecticides (Turner & Wang 1964, Hair and Turner 1966a) and the effects of temperature and diet on fecundity and egg development (Turner and Hair 1966, Turner & Hair 1967). From these studies we concluded that female face flies needed a high protein diet for egg development, hence the need to feed on the lachrymal ducts of the faces of cattle and horses. The flies were also highly attracted to blood from wounds.

Several commonly used insecticides were tried in the field both as sprays and dusts with little success. These flies, unlike the horn fly, did not stay permanently on a single animal, but moved frequently from animal to animal and pasture to pasture. They rested on fences, shrubs and grass at night. Knowing that these flies laid their eggs in cattle manure, we tried another approach. A test was initiated using low level feeding of Ronnel, a systemic insecticide, added to the mineral salt. A large percentage of the insecticide ingested by the cattle was excreted in the manure. The objective of this test was to control face fly larvae breeding in cattle droppings. Larval counts from manure collected in the treated fields resulted in 58 to 96% reduction, but, there was still no significant reduction of flies on the faces of cattle in treated fields. It was obvious that flies were moving from untreated to treated fields. These results were confirmed in large scale trials on 23 adjacent pastures and supported by a grant from Mooreman Chemical Co. (Wallace & Turner 1964). We later tried using insecticides on these 23 pastures using dust bags, filled with insecticide, covering the mineral salt boxes. The animal was dusted in the face whenever it used the salt box. Although complete control was not obtained there was substantial reduction in the number of flies per animal compared to animals in untreated pastures. Considerable relief was noted (Turner 1965).

We hoped that native parasites that attacked other manure breeding larvae such as horn flies and house flies might also attack face fly larvae. We began a survey of natural parasites of face fly larvae present in manure droppings. Larvae and pupae samples of horn flies, house flies and face flies were brought in the laboratory. Parasites emerged readily from house fly and horn fly pupae, which were brown. Only a small percentage of parasites emerged from white face fly pupae. We noted that large numbers of parasites emerged if the face fly pupae were slightly cracked. It was concluded that the heavily calcified white face fly pupae shells were generally too hard for the native adult parasites to chew themselves free (Turner et al. 1968, Burton & Turner 1968, 1970, Hayes & Turner 1971). Thus, native parasitism of face fly larvae would be only a partial source of biological control.

In later studies from 1987 to 1990, (Fletcher et al. 1989) we evaluated the use of plastic ear tags impregnated with permethrin, a synthetic pyrethroid, and other insecticides. The results showed reduction of face flies for up to 4-6 weeks and horn flies for the entire season. Unfortunately, this widespread use of insecticide treated ear tags has led to development of horn flies resistant to insecticides in other parts of the country. Probably the same thing will happen in Virginia.

Culicoides spp. (Diptera: Ceratopogonidae)

These small bloodsucking midges, sometimes called “no-see-ums”, belonged to the family Ceratopogonidae. Little was known of the biology of individual species other than that they were mostly aquatic in the larval stage. At the time of these investigations, there were approximately 37 species of Culicoides described in Virginia.

In 1960, an NIH grant on the transmission of Infectious Synovitis disease in poultry by bloodsucking insects was funded in this department to E. M. Raffensperger. It was suspected that this disease might be transmitted by one of the species of bloodsucking *Culicoides* attacking poultry (Messersmith 1965). These researchers began a survey of *Culicoides* spp. in poultry houses (Messersmith 1966).

With the departure of Dr. Raffensperger in 1962, I was put in charge of this project. We continued light trapping of Culicoides adults. We also began laboratory studies on transmission of the Infectious Synovitis organism in chickens, using adults reared from collected larvae of *Culicoides variipennis*, a known vector of Blue Tongue in sheep (Turner et al. 1963). We were only able to transmit successfully the disease organism from diseased birds to healthy birds by inoculating the healthy birds with infected macerated blood engorged adults. No active bird to bird transmission by bite of these insects was demonstrated. We concluded that the organism was destroyed in the digestive tract of the suspected vector. Possibly another species of this genus might be the vector. Further field studies of the 37 species were needed.

We expanded our investigation of this genus since so little was known of the life history, distribution and habits of various species. We collected species using live animal traps containing large and small birds and mammals, and even ourselves (Hair & Turner 1968, Turner 1972, Humphreys & Turner 1973). Tanner & Turner (1974) also placed animal traps on the ground and in tall trees. *C. obsoletus*, & *C. sanguisuga* preferred large mammals on the ground but *C. arboricola* preferred birds over mammals in the trees. They also recorded the seasonal distribution of species using three different trapping methods (Tanner & Turner 1975). Using a light meter, Humphreys & Turner (1971) noted that light intensity had a significant effect on *Culicoides* feeding activity. This confirmed earlier field observations that feeding took place during crepuscular hours (dawn and dusk).

Distribution, laboratory and field studies on the biology of *Culicoides* spp continued (Hair et al. 1966, Hair & Turner 1966, Battle & Turner 1969, 1970a, 1970b, 1972, Knausenberger & Turner 1976). At this point, all investigations and transmission studies were made from larvae, particularly *C. variipennis*, collected in the field. We thus attempted to rear other species in the laboratory. A sustained laboratory colony of *C. guttipennis*, a tree-hole breeder, was established in our laboratory (Hair & Turner 1966, Williams & Turner 1976). The only other known sustained colony of this genus was *C. varipennis* at the USDA laboratory in Boulder, Colorado.

The above results were presented at the International Congress of Entomology XIII in 1968 at Moscow. We continued surveys of these biting midges in Virginia. These studies resulted in a systematic monograph and catalog of the 37 known Virginia species of the genus *Culicoides* (Diptera: Ceratopogonidae) (Battle & Turner 1971).

This group of insects attracted world wide attention. In the summer of 1976, we hosted an international conference, “World Ceratopogonidae Group” at the Mountain Lake Biological Station (Linley et al. 1977)

The disease Bluetongue in sheep and cattle was known to be transmitted by *Culicoides variipennis*. To determine if other species attacked these animals and supported by a grant from APHIS, we surveyed *Culicoides* feeding on sheep and cattle in three geographic areas of Virginia (Zimmerman & Turner 1983a, 1983b). The most common species collected were *C. biguttatus, C. stellifer, C. variipennis* and *C. venustus*. At the Piedmont site, parous rates (those that had oviposited previous to trapping) were higher in *C. stellifer* collected from cattle than from sheep. Parous rates in the coastal plains were higher in *C. variipennis* collected in cattle than from sheep. Based on these and previous studies it appeared that the larger the animal, the more attractive it was to all *Culicoides spp*. on the ground.

The town of Saltville, Virginia contained several natural salt marsh ponds where *Culicoides variipennis* were breeding by the millions. This was an ideal spot for field studies of the dispersal and behavior of these biting gnats. (Zimmerman et al. 1982a, 1982b, Zimmerman & Turner 1982, 1984).

Also from this study it was noted that a number of species of salt marsh mosquitoes, *Aedes sollicitans* and *Ae. vexans* were breeding in marshes containing a chloride tolerance of 1,000-30,000 and 500-11,500 ppm respectively. *Anopheles punctipennis*, a fresh water breeder, was also collected in pools containing chloride concentrations of 0-3,000 ppm. (Zimmerman & Turner 1982). Just how these salt marsh species got to this mountainous region so far away from seashore marshes is unknown.

We later examined the development and seasonal micro-distribution of immature *C. variipennis* at Saltville. Spatial distribution showed that pupae and early instars were localized above the shoreline in the top centimeter of mud. Most movement of later instars was horizontal rather than vertical, remaining in the top cm of mud. Late instars moved to the water during the day but migrated up above the shoreline at night. Larvae moved progressively downward into the mud during the autumn. During the winter, when the site became frozen, they occupied the narrow interface between the ice cover and the frozen mud beneath (Vaughan & Turner 1985, 1987a, 1987b,1989).

Black Flies on Horses

During this period, an interesting bit of research was conducted on black flies infesting the ears of horses. Townsend et al. (1977) reported that simultaneous feeding by 14 or more black flies caused scabbing in the ears and also caused adverse behavior of the animal (they became bridal shy). Townsend & Turner (1976) evaluated a number of selected insecticides mixed with petroleum jelly as a smear. Petroleum jelly without an insecticide was used as a standard. All of the treatments, including the standard, afforded up to 3 days protection to the ears. The addition of insecticides did not enhance the effectiveness of the smear. Therefore, it was recommended that the horses be treated only with petroleum jelly.

Northern Fowl Mite, *Ornithonyssus sylviarum*

This blood sucking mite was becoming increasingly important on Virginia poultry, especially on caged layers. It was suspected that they came in on wild birds and even rodents (Hall & Turner 1976). They attacked hens around the anal area in large numbers causing severe irritation, reduction of egg laying and even death by exsanguination in severe infestations. We evaluated various insecticides on infested caged layers. Most of these insecticides, applied as sprays directly to the birds, were quite effective (Hall et al. 1975, 1978).

Most cages contained 3 to 4 birds, but mortality would result in a reduction in the number of birds per cage. In the tests when we were counting mites on chickens, we noticed a significantly higher infestation of mites in single caged birds than birds having two or more cage mates (Hall et al. 1978). We suspected that reduced stress of single birds per cage resulted in this heavier infestation. In cooperation with W. B. Gross of the Veterinary Science department, we began an investigation of the hormones caused by stress levels in chickens. It was found that increased stress caused by multiple cage mates increased the corticosterone level resulting in reduced levels of mite infestations (Hall et al. 1978a, 1978b, 1978c, 1979).

Mosquitoes, Family Culicidae

Mosquito breeding has long been associated with lakes and man-made impoundments. In 1965, a new impoundment in Virginia, Smith Mountain Reservoir, and a smaller lower impoundment, Leesville dam, were being completed. It employed a unique system of water level management called pumped storage. Power was generated by turbines from the upper lake, and steam power from coal furnaces during peak daylight electricity use. Then when the demand for power was low (at night), the turbines were reversed and using this steam power, the water was pumped from the lower lake back into the upper lake to be used again. It was cheaper to maintain the steam furnaces 24 hours than to restart them every day. It was believed that this unique system of water level management would result in reducing mosquito breeding in both lakes.

I was approached by representatives of Appalachian Power Company to conduct a survey of mosquitoes breeding in both lakes. A new graduate student William J. Gladney was given a research assistantship to conduct this survey. We used a number of standard trapping methods (Turner & Earp, 1968) collecting both adults and larvae from fixed and temporary locations around both lakes. Results indicated that the mosquito population was lowest during the pumped storage cyclic fluctuation of water level. An adjacent water area not under the influence of pumped storage water level management was used as a control area. Thus, this water level variation was a major factor in mosquito suppression. (Gladney & Turner 1969, 1970)

During this time a broader study of Virginia mosquitoes was made leading to a monograph "Mosquitoes of Virginia" (Diptera: Culicidae) (Gladney & Turner 1969)

Aquatic Insects as Indicators of Pollution in Streams

In 1970, a grant to the Virginia Water Resources Research Center was submitted and approved. This involved the use of multiple plate samplers above and below three sources of pollution outfalls. They were "organic wastes" (the Green Hill meat packing plant), "heavy metal output" (Federal Mogul Corp) and the "release of heated wastes" at a power plant on New River. Results were published by Knausenberger and Turner in Occasional Papers from the Department of Entomology. Samples taken below the sources of pollution contained mostly species of Chironomidae whereas samples taken above the sources of pollution contained a diverse number of aquatic species. This finding indicated toxic stress on the aquatic fauna below the sources of pollution.

Measurement of negative photo-static response of *Aedes aegypti* had been tried earlier by others to determine the toxicity of insecticides. This species was easily reared in the laboratory. Eggs of this mosquito could be stored long term and when immersed in water, the 1st instars would emerge within minutes allowing for a uniformly aged population to be available for testing. A simple 4 chambered photo-migration apparatus was designed to evaluate heavy metal toxicity to these insects. (Knausenberger & Turner 1975, Simonet & Turner 1976).

First instars were exposed for 8 hr and then placed in the chambers. Those unable to migrate 30 cm away from the light source within one minute were recorded. LC 50 values (lethal concentrations toxic to 50% of the larvae) were 1.3 ppm for copper (the standard), 0.6 ppm for cadmium, and 8.9 ppm for chromium. Analysis of the tests indicated that this procedure could be implemented as a rapid bioassay for heavy metal toxicity (Simonet et al. 1978).

Lesser Mealworm (*Alphitobius diaperinus*)

The lesser mealworm has long been associated with the nests and guano of various species of wild birds. With the advent of large scale poultry production, it became abundant in litter and manure of both broiler and egg houses (Turner 1986). We also noted that the lesser mealworm was a predator of the house fly (Despins et al. 1987)

Most of the newer chicken houses used polystyrene as insulation panels in the upper walls of these houses. These panels became ideal oviposition and pupation sites for the mealworm. The damage from the tunneling activity of the larvae was such that insulation was destroyed within 2 or 3 years. This loss of insulation resulted in increase in heating cost during colder months and heat stress on birds in warmer months. It also caused increased cost in replacing the insulation, loss while the house was out of production and depreciation of the buildings. (Vaughan et al. 1984, Despins et al. 1987) Toxicity tests on various panel surfaces in infested houses indicated that wettable powder formulations were more effective on polystyrene surfaces than emulsifiable concentrate formulations. In other tests, dimethoate, carbaryl, tetrachlorvinphos, and propoxur were effective on late instars and malathion was most effective on adults (Vaughan & Turner 1984).

Despins et al. (1989) observed that larvae preferred to remain in manure habitats of 30-40% moisture. Dispersal from the manure increased significantly when manure moisture increased to 50-60%. They also observed that larvae could climb a greater distance up vertical wooden surfaces than concrete block surfaces, thus houses built with concrete block foundations in the lower pits were less predisposed to insulation damage than houses with wooden walls in the lower pits.

Potomac Fever in Horses

Potomac horse fever was a severe disease in horses caused by the Rickettsia *Ehrlichia risticii*. First identified in 1979, initial research demonstrated that it was not contagious and most infections occurred in July and August. This suggested an arthropod vector. In 1984, supported by a private foundation grant, and in cooperation with researchers from the college of veterinary medicine, we began a survey of arthropods attacking horses using horse baited traps and a mobile insect sorting table to identify, sort and quickly store in liquid nitrogen arthropods collected from these traps. The survey was conducted in the Northern Virginia and Southern Maryland endemic area of the disease. Light traps were also operated in these same areas (Fletcher et al. 1988, Perry et al. 1989). The disease organism was not found in any of the collected insects.

Ticks have been known to be vectors of Rickettsia organisms. We collected large numbers of *Dermacenter variabilis* from fields in the endemic area. We then reared them in the laboratory. Transmissions tests using these ticks as vectors on horses and mice failed to demonstrate any association with potomac horse fever (Fletcher 1987). Tests with other species of ticks were also tried with similar results (Hahn et al. 1990) Tests using blackflies (Simuliidae) also failed to show transmission (Hahn et al. 1989). To date, no natural arthropod vector of the disease organism has been found.

House Flies (*Musca domestica*) in Commercial Poultry Houses

Probably the most worrisome pest in poultry houses is the house fly, particularly in commercial caged layer houses. These houses produce large quantities of manure leading to the breeding of huge numbers of house flies. These flies not only are annoying around the poultry houses but they spread to neighboring residences and cause widespread complaints as well as public health concerns.

Our research on control of house flies involved a combination of manure management, chemical control, and biological control. Monitoring house fly numbers in caged layer houses was essential in pest management programs against house flies. Beck (1985) evaluated five house fly population monitoring techniques however none of these methods were consistently correlated with either absolute fly numbers or a visual index of fly numbers. Turner & Ruszler (1989) finally came up with a simple quantitative method (a moving sticky tape) of monitoring house fly numbers in caged layer houses. This method was quicker and less tedious. It was used satisfactorily by service managers in integrated pest management operations.

Chemical control of house flies had been tried with varying success. House sprays were initially effective but labor intensive. Also, the flies developed resistance to most of the insecticides that were approved for use in poultry houses. We began evaluating, in laboratory and field tests, various insect growth regulators and a synthetic pyrethroid (methoprene) as feed additives to prevent house fly breeding in manure. (Breeden et al. 1975, 1981, Townsend & Turner 1980, Beck et al. 1983). Methoprene, trade name Ectiban, was adapted by most egg producers with good fly control. Workers in South Carolina noted that application of this insecticide in feed at the rate of 1.5 ppm in high rise caged layer houses not only reduced house fly emergence but resulted in the dominance of a facultative predator *Ophyra aenescens* which then prevented an increase in house fly emergence when the insecticide treatment was withdrawn. Even after population dominance was obtained, this small fly was not a pest in the houses or the surrounding area. We obtained a starter colony from South Carolina, and began mass rearing this fly to use as a bio-control agent of the house fly. In preliminary trials, Turner & Carter (1990) released mass-reared *O. aenescens* into the pits of high rise poultry houses in Virginia. Not only were house fly populations reduced but the predator remained almost exclusively in the pits and did not become a pest. Thus, it was concluded that mass rearing and release of the predator could be included in an integrated pest management program (IPM) to control house flies.

Turner et al. (1992) published a four year study describing a five phase integrated pest management program to control house flies in high rise poultry houses. In 1986, a standard control program using synergized pyrethrin sprays, fly baits and cyromizine feed additives were applied in four houses. This was compared with the IPM program implemented in all six houses from April 1987 to September 1990. The phases of the IPM program were: (1) monitoring house flies in each house to determine when the house fly population exceeded a “Fly Nuisance Threshold (FNT)”; (2) manure management, removing only part of the manure from a house at a time; (3) release of on-site mass reared *O. aenescens*; (4) use of insecticide bait panels containing 1% methomyl; and (5) treatment of feed with cyromazine if the FNT was exceeded The cost of the standard insecticide program was $15,689.63 per year. The cost of the IPM program was $3,082.10 per year for all six houses. It was concluded that on-site mass rearing of *O. aenescens* was a feasible and economical program to control house flies in commercial high rise poultry houses. It was subsequently recommended in an extension service publication by Youngman et al. (1991).

In 1992, I was honored by receiving the prestigious Cooper Award by the Livestock Insect Workers Conference for outstanding contributions to the field of livestock entomology. I was also elected an honorary member of the Entomological Society of America.

TEACHING (15%)

My regular teaching schedule involved an undergraduate course, Medical and Veterinary Entomology, 4 credits, taught every other year mainly to pre-medical and pre-veterinary students from the Biology Department. I also taught every other year a graduate course, Arthropod Disease Carriers, 4 credits. This included graduate students from the Entomology and Biology departments. Other graduate courses I taught, when no teacher was available, included Immature Insects and Aquatic Entomology. In the early years of the department I also taught Systematic Entomology and Literature and History of Entomology.

In the 39 years in the department my greatest enjoyment in teaching was the supervision of graduate students I supported. There were 18 M.S. degrees and 21 Ph.D. degrees awarded under my direction. It was a two way process. I learned as much from them as they did from me.

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The Insect Collections at Virginia Tech Department of Entomology

Michael Kosztarab

The collection has been in existence for over 120 years. It was started in 1888 by William B. Alwood, the first botanist and entomologist of the Virginia Agricultural Experiment Station. The Insect Collection has been used for teaching and research, also by extension workers, as reference material for identifying pest and beneficial insects sent by home owners, farmers and county extension agents.

The collection was kept in several ways. Most of the specimens were dry-preserved and mounted on insect pins with appropriate labels and kept in air-tight glass-topped Cornell insect drawers. In addition, brittle Odonata with folded wings, are kept in cellophane envelopes. The alcohol-preserved, usually soft-bodied insects, adults and immature forms are kept in ethyl alcohol, in 4-dram vials with polyethylene corks, on vial racks; but some in labeled shell vials filling tightly closed 12 or 16 oz jars. Small soft-bodied insects and mites are permanently mounted in Canada balsam on microscope slides stored on aluminum trays in 3,000-slide capacity wood cabinets.

In order to be able to determine a pest species, even after the culprit has been long gone, a herbarium of insect and mite damage was developed on the evidence left behind on plants by the pest species (Kosztarab 1966). Many insects have distinctive feeding habits and therefore leave a sort of "fingerprint" behind; there are chewers, leaf miners, gall makers, borers, leaf rollers, cutters, folders, skeletonizers, tyers, webbers, sucking insects, and others. On request, this collection was sent to the Smithsonian Institution when the Virginia Tech Museum of Natural History was closed, and it has been in their possession since 2004. At the same time, the scale insect research collection numbering 69,000 microscope-slide mounted specimens stored in 10 wood cabinets, and 262,000 dry specimens in envelopes with 72,000 alcohol-preserved specimens was requested and donated to the Smithsonian (Curator D.R. Miller).

Many pest species with their preserved damage were mounted into over 140 Riker mounts for teaching demonstration in classes and laboratories in our department.

The collection, without a full-time curator, benefited from the care and work of a number of enthusiastic volunteers, including Ellison A. Smyth, Jr. (Mitchell & Kosztarab 1998), Richard L. Hoffman, E. Craig Turner, Charles V. Covell, J. Reese Voshell, Jr., Boris Kondratieff, David A. West, and many others. Only in 1962 was a curator (Michael Kosztarab) officially designated as part of his work, in addition to his 100% teaching assignment.

By 1966 the collection included 81,000 specimens in 600 glass-topped Cornell insect drawers, housed in 15 large 4 small steel cabinets (Covell & Kosztarab 1966). By 1991 when the insect collection was part of the Virginia Tech Museum of Natural History, the detailed inventory (Table 1) included ca. 817,517 specimens (Kosztarab 1993b).

I fought for almost 30 years to receive funding and permanent housing for the insect collections. Fortunately, the National Science Foundation (NSF) recognized the need for upgrading our collection and in my grant request, provided $48,000 for new insect cabinets and new vial racks in 1983.

I served as director of the Center for Systematics Collections at Virginia Tech between 1987 and 1989, and became the Founding Director of the Virginia Tech Museum of Natural History in 1990. By the time of my retirement in 1992 the insect collection was expanded to over 1,000,000 specimens and was housed until 2004 in the new Virginia Tech Museum of Natural History at 428 N. Main Street. Unfortunately, due to lack of State and University funding the branch museum at Virginia Tech was closed. Therefore the insect collection was divided between the Virginia Museum of Natural History in Martinsville (curated by Richard L. Hoffman) and our Department in 2004. Since that time, the remaining part of the collection, with about a half million dry preserved specimens is "temporarily" housed in a storage room at the Price's Fork Research Facility, under the curatorship of Eric Day, who is also the Manager of the departmental Insect Identification Lab. The alcohol-preserved collection, under the curatorship of J. Reese Voshell, Jr., is stored at the US Forest Service facility on Rt. 460, west of Blacksburg, VA.

To make the Virginia public aware of the beauty, but also the endangered status of some useful insects, after 16 years of work (1976-1991) with our Legislators (Kosztarab 1991,1993a) the Tiger Swallowtail Butterfly was adopted as our official Virginia State Insect. At last count, over 20,000 Virginia automobile license plates displayed our beautiful insect.

Major Donations to the Insect Collections. It would take several pages to list the retired and active entomologist colleagues and former graduate students in the Department and at the Ag. Experiment Stations, who donated preserved insects. Also many voucher specimens were deposited from a variety of research projects. More detailed listings are available from "Insect Collection" reports (Kosztarab 1976, 1979 and 1984) included in the Virginia Tech Entomologist for those years. Some additional major donations are listed below:

Roberto J. Cordero, 194 unique insects from Honduras; Mrs. Joyce T. Hopkins of Roanoke, donated a large number of mostly Lepidoptera, from her late husband's collection; Romeo Erdie of West Virginia, ca. 300 tropical insects in display boxes; Michael & Matilda Kosztarab 28,474 mostly tropical insects, most slide-mounted, from Central and South America, also California and Ohio; Robert L. Pienkowski, 298 African and Sri Lankan insects; Sidney Poe, 19,760 slide-mounted mites; Ellison & Linda Smyth, 6,000 insects, mostly Lepidoptera in a cabinet with 24 drawers; University of Richmond, Department of Biology, 22,000 pinned insects from Central Virginia in glass-topped drawers in wood cabinets; David A. West, 2,360 Lepidoptera spread and 1,480 papered in 12 Cornell drawers and 13 Schmitt boxes.

Specimens from our insect collections frequently have been requested on loan for study by scientists from a number of research institutions and by individuals in the United States and from abroad. Since 1963, many research workers visited our insect collections to study the specimens at Virginia Tech, and often to select and borrow insects for further studies at their own institutions. Thirty-two visiting scientists from the USA and thirteen foreign countries, often spent three to twelve months in our insect collections (Kosztarab 2009).

The insect collection provided researchers with needed information to complete manuscripts for a number of research papers, monographs, books, and book-chapters on certain insect groups. Two research bulletin series at Virginia Tech were mainly based on our collections. One was the "The Insects of Virginia" series which published 15 bulletins between 1969-2006. The second series "Studies on the Morphology and Systematics of Scale Insects" had 16 research bulletins printed between 1967-1992; some of book-size. The monograph, entitled "Scale Insects of Northeastern North America" was also based on our insect collection (Kosztarab 1996).

The labels associated with the preserved insects, giving localities and dates with the type of host plant provide needed information on distribution, host-preferences, life cycle, and number of yearly generations for many species. Such records are needed when selecting the appropriate type and time for initiating management of many pest species.

Although I retired in 1992 I kept working on publishing 4 books (Elswick 1998). Because of diminishing funding for graduate research in systematics, I requested no retirement gift, but suggested that donations could be made to the scholarship fund that my family established for graduate students doing outstanding research in systematics, and I would match them. Since my retirement, 15 such scholarship awards have been given out to deserving graduate students.

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The tiger swallowtail butterfly, *Papilio glaucus* is Virginia's official state insect

Department Heads

James M. Grayson

Sidney L. Poe

Donald G. Cochran

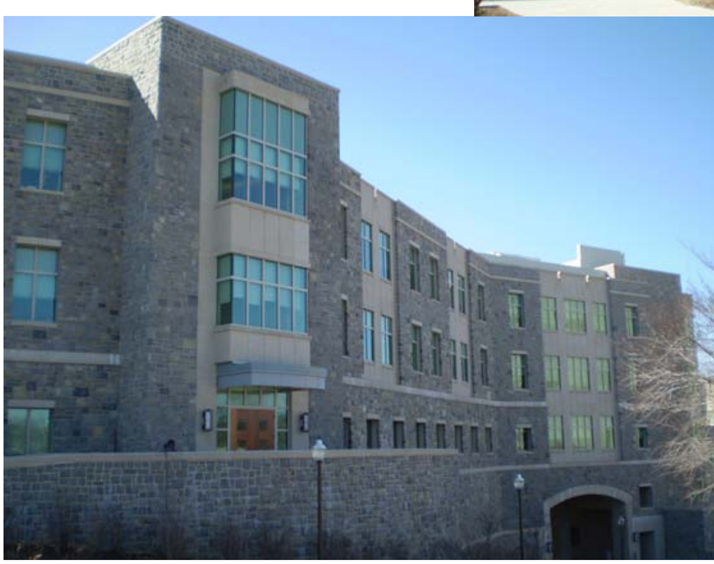
Thomas L. Payne

Timothy P. Mack

Loke T. Kok

Price Hall

Fralin Hall



Latham Hall

Agricultural Research and Extension Centers

Alson H. Smith, Jr.

Eastern Shore

Hampton Roads

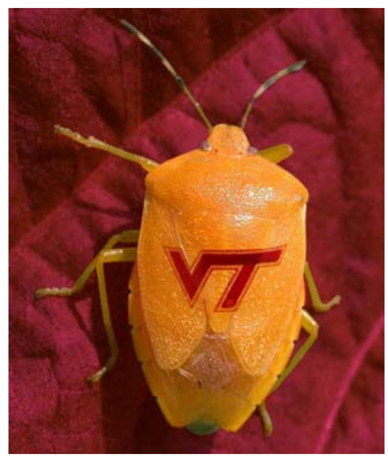
Southern Piedmont

Tidewater

Truckload of lettuce, early 1900s at what is now Hampton Roads AREC

Myles, Plaskon, Morazzani, Wiley, Murreddu
Autumn 2008

Eric Day at an outreach event at Kentland Farm



“Hokie” stinkbug

2003 Eastern Shore AREC field crew

Current Programs

Zach Adelman

Research in my laboratory is concerned with developing genetic control strategies to supplement the currently available methods of containing and eradicating vector-borne diseases such as source reduction, vaccination, insecticides and anti-pathogen drug development. Research projects are based in the molecular virology of arboviruses (dengue viruses, Sindbis) as well as the molecular biology and genetic manipulation of the vector mosquito, *Aedes aegypti*.

Generation of pathogen-resistant mosquitoes

Previous work has demonstrated the feasibility of generating genetically-modified pathogen-resistant mosquitoes using RNA interference. Two of the large open questions remaining include: How can such genes be driven to fixation in a natural mosquito population in a relatively short amount of time?, and what is the potential for the targeted pathogen to escape from interference?

Gene Drive

Gene drive refers to the inheritance of a gene at super-Mendelian rates, which should cause a given allele to increase in frequency within a population every generation, with the eventual result being fixation of said gene in the target population. Work in my lab centers around two potential gene drive mechanisms: homing endonucleases and transposable elements.

Homing endonucleases are selfish DNA elements encoding a site-specific endonuclease. The recognition sequence for a given homing endonuclease can range from 14-40bp, meaning they can be expected to generate very few double-stranded DNA breaks in a particular genome. Following DNA cleavage, host-mediated repair using gene conversion results in a duplication of the homing endonuclease gene. Research projects in my lab aim to determine the ability of homing endonucleases to function in *Ae. aegypti*; and evaluate whether the repair of germline-specific homing endonuclease-generated dsDNA breaks can result in heritable gene conversion.

Transposable elements are also a potential gene drive mechanism. Class II transposable elements also encode a single gene, the transposase, which as opposed to recognizing a single sequence, recognizes inverted repeat sequences flanking the ORF. The transposae mediates both an excision and re-insertion to a new chromosomal location. Like homing endonucleases, repair of the double-stranded break results in gene duplication. Work in my lab investigates the design an autonomous transposable element (controlled by nanos or other germline-specific regulatory elements) as a possible method of driving virus/parasite-resistance genes into naïve mosquito populations.

Mosquito-transgene/ Mosquito-pathogen interactions

Current work aims to understand the potential for pathogens such as dengue viruses to escape from RNAi. This requires a full understanding of the components and regulation of the RNAi pathway in mosquitoes. With the complete genome sequence of the mosquitoes *Anopheles gambiae* and *Aedes aegypti* now available, a comprehensive strategy for identifying genes involved in the RNAi pathway is underway.

In a similar fashion, we know very little about how mosquitoes defend themselves against foreign DNA elements. What are the effects of transgene insertions on chromosome structure? Will the mosquito recognize and shut down a transgene over time? And what effect will this have on the potential for genetic control? The answers to these questions are of vital importance to the implementation of a successful genetic control strategy.

Public Outreach

A key component of my work is to raise public awareness of the potential benefits and limitations of genetically-modified organisms related to the control of disease: within the local community; among elected representatives; and, most importantly, in areas where these strategies could be implemented.

The ultimate goal of this research is to introduce one or more anti-pathogen effector genes into a natural, pathogen-transmitting mosquito population via a transposable element- or homing endonuclease-derived gene drive system in an ethical, legal and fully disclosed fashion, with the result being complete pathogen resistance among the target mosquitoes, and abrogation of disease transmission.

Teaching

In collaboration with other Virginia Tech faculty members, I am currently teaching three courses. The first course is Field & Laboratory Methods In Vector-Borne Disease Research (ENT 5224). This course provides an in-depth examination of techniques currently employed to study vectors of human disease, as well as the pathogens they transmit. The second course is Molecular Virology (BMVS/ENT 5624). This course covers the basic mechanisms of virus replication and pathogenesis for several medically important virus families. The third course is Topics in Virology (ENT 6654). In this course students read and present current primary research articles in specific areas of virology. Students then have an opportunity to discuss the articles with experts in that area of virology.

Chris Bergh

My program (75% research: 25% extension) at the Alson H. Smith Jr., AREC, Winchester, focuses primarily on the discovery, development and validation of new or improved tactics for monitoring and managing arthropod pests of horticultural crops, based largely on insect behavior and chemical ecology. While my assignment mandates emphasis on tree fruit IPM, my projects also include a pest of wine grapes and an invasive pest of tropical ornamentals and, where possible (e.g. dogwood borer), span more than one commodity group. In tree fruits, considerable effort is devoted to applied research and extension projects that assist growers with the transition from conventional pest management practices to the adoption of new approaches involving the use of reduced-risk products and IPM tactics, including mating disruption, ecologically and physiologically selective pesticides and increased reliance on information regarding pest monitoring and biology in their decision-making.

Current projects, including those of my two doctoral students, are:

- Multi-state Risk Avoidance and Mitigation Program (RAMP) for eastern tree fruit production regions, involving large-scale demonstration trials of reduced-risk programs in commercial apple orchards
- Natural Resources Conservation Service (NRCS) Environmental Quality Incentives Program (EQIP), involving incentive payments to tree fruit producers to adopt IPM practices in apples and peaches
- Development of an effective mating disruption formulation for dogwood borer
- The horticultural impacts of dogwood borer infestation of young apple trees
- Insect-plant relations between dogwood borer and its hosts
- Factors influencing the abundance and distribution of grape root borer within and among commercial vineyard blocks
- Biological control of woolly apple aphid, with emphasis on a guild of specialist and generalist hover fly predators
- Risk assessment of pink hibiscus mealybug in south Florida
- Pesticide efficacy trials in experimental orchards at the AREC

My current projects are supported by awards from the USDA (RAMP, PMAP, S-RIPM), the Virginia Wine Board, the State Horticultural Association of Pennsylvania, the Virginia

Apple Research Program and various agrichemical companies.

My international activities involve an upcoming sabbatical in New Zealand, toward exploring the potential for introduction of a specialized hover fly predator to supplement biological control of woolly apple aphid in New Zealand apple orchards.

Jeff Bloomquist

My research program is broad in scope and in the past year included work in four topic areas. The most significant (primary) research topic is a large, collaborative project (Grand Challenges in Global Health-FNIH) begun 9/1/05 that is focused on new anticholinesterases for control of malaria-spreading mosquitoes. This project, funded by the FNIH/Grand Challenges in Global Health program, is producing interesting lead compounds for insecticide development. A collaborating molecular modeling group at Molsoft (San Diego, CA) is turning out a number of excellent predictions of activity from in silico screening of virtual chemical libraries. The group has identified three good lead compounds with about 100-fold selectivity for the mosquito vs. human enzyme, and one with over 1000-fold selectivity, all acting at the catalytic site like conventional carbamate anticholinesterases. In addition, they have identified a compound acting at another site of the enzyme that has 40-fold selectivity for mosquito vs. human enzyme. Typical selectivity ratios for established anticholinesterases are about 4-fold.

Another research area for Dr. Bloomquist is on the role of toxicant exposure in the etiology of neurodegeneration. His laboratory is studying the effects of insecticides and the metal manganese along with the diabetic drug glibenclamide on mouse behavior and dopaminergic brain pathways. This project is being conducted in collaboration with Dr. Brad Klein, Dept. of Biomedical Science and Pathobiology, Virginia-Maryland Regional College of Veterinary Medicine (VMRCVM). A previous doctoral student, Jinghong Kou (2005), found that the effects of mitochondrial complex 1 inhibitors are enhanced both in vitro and in vivo by the antidiabetic drug, glibenclamide. These results suggest that patients taking this drug might be at greater risk for developing Parkinsonism.

A third area of research is on the development of continuously cultured insect neuronal cell lines derived from undifferentiated Lepidopteran ovarian cells, conducted with Dr. Sally Paulson. Sally and Jeff have shown that undifferentiated ovarian cells can be induced to grow elongated processes and form presumptive synapses reminiscent of nervous tissue, and that these cells express voltage-sensitive sodium channels that are particular to neurons. A simple technique for producing large amounts of insect neuronal tissue would be a boon to insecticide discovery research, because it would obviate the need to dissect large numbers of insects, or to clone every target site of interest and express it in a cell line, which is expensive. This project has been picked up as the M.S. project of a new graduate student, Lacey Jenson. She has confirmed and extended previous work, showing that insulin mimics and caffeine is an inhibitor of ecdysone’s effects.

Carlyle Brewster

I have an 80/20 % research and teaching appointment. The goal of my program is to integrate ecological approaches and information technologies to improve agricultural science education and the way we study and practice agriculture and integrated pest management (IPM). The nature of the two disciplines (ecology and IT) makes mine an inter-disciplinary program that utilizes tools and approaches from different areas of ecology (quantitative, spatial, and landscape), geo-information technology (remote sensing, geographic information systems, and geostatistics), mathematical modeling, and the Internet. Because of the rapid analytical and technological advances in these fields, my program must constantly evolve. In addition, because my program is not commodity-specific, it requires a level of collaboration with others across a broad range of commodity profiles and disciplines.

Research

A main focus of my research is to understand the spatial and temporal dynamics of arthropod populations of agricultural, medical, urban, and environmental importance. As such, one area of my research has involved an understanding of pest dynamics in agricultural fields (e.g., the twospotted spider mite) and development of technology for managing these pests using a Precision Agriculture approach. My research has also focused on the dynamics of gypsy moth populations in forest systems and, specifically, on the mechanisms of mating disruption. The results of this research have shown that the dosage of pheromone used for mating disruption could be reduced significantly from previous application rates without loss of treatment efficacy. Forensic Entomology is another area of research in which my contribution has been the development of quantitative methods for analyzing the dynamics of forensically-important species. With respect to urban pests, I have worked on a project to characterize the species composition of the termite gut flora and have attempted to correlate changes in the gut flora with changes in the social behavior of the termite. Current projects include a study of the ecology of macroinvertebrates in stream ecosystems in which the role of eastern hemlock in stream ecosystems is being studied, with special emphasis on the impact of hemlock woolly adelgid. Because of the recent focus on vector-borne diseases, I am also currently studying the spatiotemporal dynamics of mosquito vectors of the La Crosse virus and the potential of using canine seroprevalence as a monitoring tool for the virus. I am involved in a USAID project to develop an IPM CRSP Regional Consortium of Excellence in West Africa. My role is to develop a regional pest management system for whitefly pests and to train a Ph.D.- level student.

Teaching

I teach several courses that closely reflect the nature of my research program. The graduate-level course, Information Technology in Agriculture, which is taught in the spring of odd years, targets upper-level students within the College of Agriculture. Because of the rapidly changing nature of technology, the course syllabus is designed to be flexible so that students can select topics of relevance to their research. Closely aligned to the IT course are two courses in research methods for incoming graduate students. These are Research and Information Systems in the Life Sciences, a face-to-face course offered each fall semester, and an on-line counterpart, Information Systems and Research in the Life Sciences that is offered for graduate credit as a core requirement of a new online Masters of Science degree program (Professional Studies in Agricultural and Life Sciences). Instruction on insect ecology has been lacking in the Department of Entomology for a number of years. Therefore, we have revised the course in Insect Behavior to include a section on insect ecology, which I teach. I have a strong interest in teaching methodologies and assessment of student learning. To this end, I have obtained grant support from USDA to develop a Web-based Concept Mapping Tool (CMT) that will be used to understand how students process information as a precursor to developing new ways of delivering that information. Finally, because of the recent focus on vector-borne diseases, the course, Field and Laboratory Methods in Vector-borne Disease Research, was developed that will be taught for the first time in fall 2007. My role in this course will be to provide instruction in quantitative methods and IT technologies as these apply to the management of vector populations and vector-borne diseases.

Rick Fell

My primary responsibilities are in teaching and extension (75%/25%). I teach undergraduate and graduate courses in entomology, as well as study abroad courses in entomology and biology. My major efforts in extension are directed toward the apiculture industry and I have worked to develop a coordinated program that provides education and training to Virginia beekeepers. I also assist fruit and vegetable growers with programs on pollination, and the pest management industry with problems on stinging insects and carpenter ants. My research program currently focuses on the biology and management of honey bees, but also includes pollination biology and forensic entomology.

Research

The main focus of my research is on the biology, behavior and management of honey bees. In recent years my major efforts have been directed to the problems associated with the control of parasitic mites and the impacts that they have had on colonies within the state. Since the mid 1980’s when the first parasitic mites were introduced into the U.S., the number of managed colonies in Virginia has declined by over 50%. Annual winter losses of colonies in Virginia exceed 30%. We are working with beekeepers to try and improve management practices and reduce the negative impacts of both mites and mite control practices. We have received EPA and state funding to develop and evaluate IPM practices that beekeepers can incorporate into their management schemes. We have also initiated a study to determine if miticide residues are present in the honey and beeswax of treated colonies. The over-reliance on miticides has led to other potential problems, a major concern of which is the impact of miticides on the bees themselves. For the past several years we have been investigating the impacts of various miticides on the reproductive physiology of honey bee queens and drones. We have shown that commonly used miticides can affect sperm production and viability in drones, as well as the viability of sperm stored in the queen’s spermatheca. These findings may help explain why so many beekeepers have had problems with failing queens. In addition to our work with honey bees we have an on-going study looking at the pollination of the Tree of Heaven, *Ailanthus altissima*. This tree is a problem in many areas of the state, especially along roadsides. This project involves a study of the pollinator complex of Ailanthus, the relative attractancy of the flowers, and the effects of a fungal disease on attractancy and seed production. My last area of research involves forensic entomology and the use of insects for post mortem interval (PMI) determinations. This research has involved the study of insect successional fauna on carcasses, the effects of ante mortem alcohol ingestion on fly development and PMI determinations, and the effects of maggot activity on gunpowder residue retention. Our current studies are concerned with the dispersal of OxyContin in the body and its effects on maggot development and PMI determinations.

Teaching

My primary responsibilities are in teaching, and I teach basic lecture and laboratory courses in Entomology, as well as several graduate courses. I serve as the advisor for the entomology minor and as a major advisor or co-advisor for graduate students (3 M.S., 3 Ph.D. at the present time). At the undergraduate level I teach Insect Biology (2 credit lecture course) and the Insect Biology Laboratory (2 credit lecture/lab). I also teach the Bees and Beekeeping lecture (2 credit) and laboratory (1 credit) courses. At the graduate level I teach an Insect Biology and Systematics course (4 credits) for incoming graduate students, and co-teach Insect Behavior and Ecology (with Carlyle Brewster). In the recent years I have also directed a portion of my efforts to the development of study abroad courses and to increasing student exposure to international programs. In the past 5 years I have co-taught 9 study abroad courses which have involved travel to Mali, South Africa and Ecuador. As part of the preparation to take students abroad, I also co-teach a 2 credit course each semester before the study abroad to help prepare the students for their international travel.

Extension

Virginia has a bee industry consisting of 2000 - 3000 beekeepers and approximately 40,000 colonies of honey bees. The industry consists of commercial honey producers, hobby beekeepers, and provides pollination services for a number of horticultural crops (such as apples, melons and cucumbers). My primary extension efforts are directed at providing education and training to Virginia beekeepers and fruit growers. I take an active role in working with extension agents and beekeepers, and provide training sessions and programs for both local groups and the state organization. I also participate in in-service training programs, and have developed a short course program that has provided non-credit instruction to anyone interested in keeping honey bees. In 2000, I initiated a program in forensic entomology after receiving a request for assistance from the Chief Medical Examiners Office in Roanoke. Since that time, I have provided assistance to the medical examiner in the determination of post mortem intervals for human cases, and provided training programs for police investigators.

Ames Herbert

I am stationed at the Virginia Tech Tidewater Agricultural Research and Extension Center (TAREC) in Suffolk, Virginia and have statewide responsibility for insect pests of peanut, soybean, cotton and small grains. A diverse group of insect pests attack these crops and can cause significant losses requiring extensive action by producers. My overall program objective is to develop insect pest management practices that provide producers with a means to lower input costs and maintain crop yields and quality while reducing pesticide load to the environment. New program tactics have included development of economic thresholds, risk indices, pest advisories, and basic information on pest biology and host plant interactions.

I received a B.S. in biology at Johnson State College in Vermont in 1971 then earned an M.S. in Entomology in 1975 and a Ph.D. in the same discipline in 1985 from Auburn University. I joined the faculty at Virginia Tech in 1988. Since 1995 I have been an adjunct faculty member of North Carolina State University's Department of Entomology. I have served as the Extension Project Leader for the department since 1994, served as the State Integrated Pest Management Coordinator since 1997, and have been on the Southern Region IPM Center (Raleigh, NC) Advisory Council and Steering Committee since 2002. I have served as a member and/or in a position of leadership in SERA-IEG 7 Regional Information Exchange Group-Peanut Entomology, S-1039 Regional Project-Soybean Insects, and SERA-IEG 3 Regional Information Exchange Group-Integrated Pest Management. I have served two terms on the CALS Promotion and Tenure Committee, and on various CALS, VCE, TAREC and departmental committees. I am active in ESA, the American Peanut Research and Education Society, and the National Cotton Council Beltwide Cotton Conferences. A few program highlights include:

Virginia Tech/NC State advisory for improved management of the southern corn rootworm in peanut http://www.ext.vt.edu/pubs/entomology/444-351/444-351.html.

Evaluating the susceptibility of virginia-type peanut varieties and advanced breeding lines to tomato spotted wilt virus and tobacco thrips.

The Corn Earworm Advisory and Economic Threshold Calculator for soybean http://www.ipm.vt.edu/cew/

Biology and management of cereal leaf beetle in wheat http://www.ext.vt.edu/pubs/entomology/444-350/444-350.html

Aphids in Virginia small grains: life cycles, damage and control http://www.ext.vt.edu/pubs/entomology/444-018/444-018.html

Evaluation of Plant Termination Rule Strategies for Determining Last Effective Insecticide Sprays for Bt Cotton.

The Virginia AG Pest Advisory, a weekly email delivered pest advisory http://sripmc.org/virginia

Pest Management Guide for Field Crops (insect control recommendations for small grains, peanut, cotton, soybean, and stored products) http://www.ext.vt.edu/pubs/pmg/index.html

Loke Kok

Provides leadership in development of departmental programs, and recruitment of graduate students.

Research

The goal is to develop a strong, nationally or internationally recognized, research program in biological control, with specific emphasis on the biological control of weeds and arthropod pests. The biological control program focuses on the development of effective, economical, and environmentally sound approaches for management of noxious weeds and arthropod pests. This includes selection, host specificity testing, and evaluation of natural enemies as potential biological control agents of pests that are of importance to Virginia and the USA. Both native and exotic beneficial organisms are evaluated for potential use in the target ecosystem. Where applicable, research findings are published in reviewed journals as well as extension or popular journals.

Teaching

Contribute to the instructional mission of the department by helping to develop courses and be guest lecturer in biological control and pest management. Instruction incorporates multimedia techniques and focuses on recent published information in the respective fields. Responsibilities include serving as major advisor for graduate students and as committee member in graduate advisory committees.

Extension

Identify leaders for branded programs in extension. Promote construction of websites by extension specialists that have detailed and current information that are instructive and useful for the clientele, and encourage cooperation between specialists and extension agents.

Tom Kuhar

The overall goal of my program is to develop, evaluate, and help implement sound integrated pest management practices on vegetable crops, which can enhance the profitability and sustainability of vegetable production in Virginia as well as improve food and environmental quality by minimizing the use of toxic pesticides. I have a 75% Research: 25% Extension appointment at the Eastern Shore Agricultural Research and Extension Center, where I investigate the biology and control of arthropod pests and use this knowledge to develop and deliver useful pest management information to agricultural clientele and the scientific community. I strive for my research to be well received by my peers including publication in scientific journals, yet also be directly applicable and deliverable to agricultural clientele.

Some specific research areas over the past 5 years include:

- Biological control of European corn borer in potato and vegetables using augmentative releases of the parasitic wasp, *Trichogramma ostriniae*. Specific studies have included dispersal behavior, effects of plant architecture, overwintering survival, efficacy of inundative releases in peppers, and compatibility with insecticides.
- Wireworm ecology and management in potatoes
- Insecticide resistance management of Colorado potato beetle
- Use of synthetic chemical attractants for IPM of Colorado potato beetle
- Host plant studies of Colorado potato beetle
- Integrated pest management in bell peppers
- Ecology and IPM of diamondback moth on collards in Virginia
- Thrips populations and management in tomatoes
- Bean leaf beetle economic injury levels and management in green beans
- Bean leaf beetle transmission of bean pod mottle virus
- Evaluation of *Metarhizium anisopliae* biopesticide for insect management in vegetable crops
- Insecticide resistance monitoring of Colorado potato beetle, beet armyworm, and corn earworm
- Evaluations of novel approaches and insecticide chemistries for the control of insect pests of tomato, potato, pepper, sweet corn, cucurbit crops, brassica crops, and green beans.

Dini Miller

My combined research and extension program is very diverse, focusing on a number of urban pest that are of concern in Virginia and other regions of the United States. I am currently conducting research on bed bugs, cockroaches, several ant species, subterranean termites and carpenter bees. The discoveries made by this research have been, and will continue to be, transferred to the public and pest management industry through a series of extension programs and electronic delivery methods. My program has been supported since 1999 by many sources of funding, including $80,000 in competitive research grants; $20,000 in industry contracts, $537,000 of industry research funding and $113,000 in competitive grants for extension programming. As part of my research program I have been the major advisor for two Ph.D. students and four M.S. students. My students have been largely responsible for the productivity of our laboratory including a total of 11 refereed journal publications since 2004.

Research

Research projects 2007-2010: Evaluation of cockroach bait formulations for control of German and American cockroaches; Mechanisms of bed bug resistance; Odorous house ant response to gel bait formulations of indoxacarb; Fumigation as a control measure for bed bugs in multi-unit housing; Succession of pest ant species in Puerto Rican housing developments; Managing the Red Imported Fire ant in Virginia.

Teaching

Courses for 2007-2010 (even years): Urban and Public Health Entomology. I am responsible for the urban portion of the curriculum. My teaching philosophy has been to provide students with hands-on experiences in pest management training. Therefore, all of the students are subjected to real world situations where they have to design an

IPM program for a sensitive environment, they have to crawl under a home to inspect for termites, and they must interview people suffering from multiple chemical sensitivity.

Extension

Extension programming for 2007-2010: Project Director for the Pre-construction termiticide application training; Virginia School IPM program; Project leader for Red Imported Fire ant working group; Bed bug inspection and management training; IPM for German cockroach control in public housing including efficacy and the assessment of residents' willingness to pay for IPM.

Don Mullins

Career publication summary: Author/Co-author: 50 refereed publications, 5 book chapters, 15 published symposia proceedings. Career University Service: Membership in 5 University standing committees, 21 College and 11 Departmental standing committees, and 16 Departmental 7 College and 3 University ad hoc committees. Served as a member of 27 M.S. and 29 Ph.D. committees, and Major/Co-Major Professor for 6 M.S. and 6 Ph.D. students.

Research

Research interests and activities include three general areas: 1. Addressing and researching IPM/Quality Assurance issues in developing countries (West Africa), 2. Developing new approaches to formulation of insecticidal baits and biopesticides, and 3. Conducting basic research in insect physiology and biochemistry, including the areas of nitrogen metabolism and excretion, maternal and paternal investment of nutrients, insect cold hardiness, lipid and carbohydrate metabolism and water balance in insects.

Teaching

Teaching responsibilities include instruction in undergraduate and graduate courses and undergraduate and graduate student advising. Undergraduate courses include: Life Sciences in the 21st Century, Pesticide Usage and Independent Study. Graduate courses include: Research and Information Systems in the Life Sciences, Insect Physiology , and Information Systems and Research in the Life Sciences (online course). Undergraduate student advising includes students who are pursuing an Entomology Concentration. Graduate student advising includes serving as a major advisor in areas of expertise, as a M.S. or Ph.D. committee member as requested by students and serving as the Entomology Department Graduate Student Coordinator. Priorities associated with the instructional activities include meeting and administering courses in a well- prepared and professionally competent manner, efforts in providing students with up-to-date information associated with appropriate topical areas and the development of new and novel instructional tools designed to enhance the learning process. Awarded a Certificate of Teaching Excellence (1981) and the Distinguished Achievement Award in Teaching (Eastern Branch of the Entomological Society of America) and a nominee for the National Distinguished Achievement Award in Teaching for the Entomological Society of America, both in 1984.

Kevin Myles

A member of the Vector-Borne Disease Research Group at Virginia Tech, Myles' research focus is the virus-vector interactions occurring in the mosquito. Current research seeks to identify genetic factors influencing mosquito innate immune responses to arboviral pathogens. Understanding how arboviruses establish persistent infections in mosquitoes could have applications in controlling the impact of vector-borne viral diseases on public health. Myles intends to use the information obtained from these studies to improve the ability to predict and prevent arboviral disease epidemics. In addition, a strategy that would replace natural populations of mosquitoes with genetically modified mosquitoes is currently being investigated for controlling arboviruses.

Homepage http://web.ento.vt.edu/ento/personalPage.jsp?uuid=1308628

Vector-Borne Disease Research Group: http://www.vectorborne.biochem.vt.edu/

News Release: University researchers discover how mosquitoes avoid succumbing to viruses they transmit: http://www.vtnews.vt.edu/story.php?relyear=2008&itemno=775

Scientific American - 'Bug vs. bug: How do mosquitoes survive deadly viruses unscathed?"

http://www.sciam.com/blog/60-second-science/post.cfm?id=bug-vs-bug-how-do-mosquitoes-surviv-2008-12-01

Teaching

In collaboration with other Virginia Tech faculty members, I am currently teaching three courses. The first course is Field & Laboratory Methods In Vector-Borne Disease Research (ENT 5224). This course provides an in-depth examination of techniques currently employed to study vectors of human disease, as well as the pathogens they transmit. The second course is Molecular Virology (BMVS/ENT 5624). This course covers the basic mechanisms of virus replication and pathogenesis for several medically important virus families. The third course is Topics in Virology (ENT 6654). In this course students read and present current primary research articles in specific areas of virology. Students then have an opportunity to discuss the articles with experts in that area of virology.

Sally Paulson

My area is medical and veterinary entomology and my 9-month appointment is 100% teaching. I teach Medical and Veterinary Entomology (lecture and lab) and Virology for upper level undergraduates. I also supervise 2 to 3 undergraduates in research projects each year. My graduate teaching responsibilities include teaching Urban and Public Health Entomology (50%), Field and Laboratory Methods in Vector-borne Disease Research (20%) directing M.S. and Ph.D. student research, and serving on graduate student committees. In addition, I teach Animal and Plant Biosafety and Biosecurity (50%) as part of the on-line Master's of Agriculture and Life Sciences.

The most significant role played by mosquitoes in public health is as vectors of various pathogenic organisms. Understanding the biology of the vector is crucial to understanding the epidemiology of the diseases transmitted by these insects. A major focus of my lab research is La Crosse (LAC) encephalitis virus, the most common and important endemic mosquito-borne disease of children in the USA. LAC encephalitis virus has been on the move, expanding its range from the traditional upper Midwest distribution into the Southeast. To investigate the apparent emergence of LAC virus into areas of southwestern Virginia we are looking at various factors such as the role of newly introduced mosquito species in the transmission of disease and developing better methods to measure the rate of virus transmission in a location. Another research area is the development of novel insecticides. Insecticides are a major tool for controlling vector populations and reducing the transmission of pathogens. However, the incidence of mosquito-borne diseases is increasing globally in part due to the development of resistance in the vector to the insecticides being used. I am part of a research group that is using a state-of-the-art experimental approach called "in situ click chemistry" to develop a selective insecticide with low toxicity to humans. The resulting product(s) would then be tools in the antimosquito arsenal, providing viable alternatives to existing insecticides as part of a resistance management scheme.

Doug Pfeiffer

My appointment is 40% teaching/35% research/25% extension. My main interest area is integrated pest management in tree fruit, vineyard and small fruit systems. I am the Director of the College's on-line Masters of Agriculture and Life Sciences curriculum, and have an international research component in my research/extension programs, primarily in Eastern Europe. Career publication summary: Author/Co-author: 39 refereed publications, 5 books/manuals, and 7 book chapters. I have served as Major/Co-Major Professor for 4 Ph.D. and 9 M.S. students, and as a member of 29 Ph.D. and 28 M.S. committees.

Research

In recent years, important areas of of my research have included mating disruption for lepidopteran pests, biogeography of plum curculio, and the sharpshooter vectors of Pierce's disease of grapevines. In orchards, mating disruption has been used against codling moth, oriental fruit moth, the leafroller complex, dogwood borer, and lesser peachtree borer. In vineyards, this approach has been used for grape berry moth and grape root borer. A recent research project has focused on biogeography of the strains of plum curculio and their strains of Wolbachia symbionts. During our examination of sharpshooter vectors of Pierce's disease, we expanded the known range of this important disease using ELISA sampling for *Xylella fastidiosa*. I am the site chair for the Eastern European regional project of the IPM CRSP, a USAID-supported project exploring IPM in several sites around the world. This project includes IPM of high-value horticultural crops in Albania, Moldova and Ukraine.

Teaching

I teach "Insect Structure and Function", an entomology course required of most of our graduate students, and is a prerequisite for Insect Physiology. My goal is to illustrate how various organ systems have become modified during insect evolution, how functional morphology adapts an insect to its environment, and how organ systems have been adopted into secondary functions. I first taught the course in Fall 1995. In 2004, I was assigned the undergraduate and graduate pest management courses. "Insect Pest Management" is mainly a service course for other applied departments, routinely reaching its cap of 40, and "Arthropod Pest Management" provides a more in-depth examination for entomology graduate students. I am developing "Managing Insect Pests" as an on-line course, part of the new Master's of Agriculture and Life Sciences curriculum.

Extension

I maintain an active extension program in tree and small fruits, and in winegrape vineyards. My extension philosophy has been to use a blend of new information dissemination tools (web and e-mail based delivery), as well as traditional means (grower meetings, extension publications). The former is efficient for our most progressive growers; the latter reaches all growers including those needing extension guidance the most. I serve as coordinator for the spray bulletin for commercial tree fruit growers, a multi-disciplinary publication (involving 15 specialists in entomology, plant pathology, horticulture, weed science, wildlife management and pesticide safety from Virginia Tech, West Virginia University and University of Maryland). I am the lead author of our grape and small fruit recommendations, and a co-author of our home fruit recommendations. I developed and maintain the Virginia Fruit web site (www.virginiafruit.ento.vt.edu) in support of the fruit industries in the mid-Atlantic region. This web site provides information on IPM and horticultural aspects and control recommendations for apple, peach, pear, grape, blueberry, strawberry and caneberries. The pages in this site received 801,973 visits in 2006, a maximum since the site went on-line in 1997, and a 42% increase from the previous year. I have initiated a series of fruit entomological updates by e-mail for orchardists, vineyardists, caneberry growers and agents in the main fruit counties, including updated status of degree-day accumulation and population development, pest and beneficial insect biology, and regulatory developments. In 2005, I converted these simple e-mail lists into listservs. This will allow development of greater two-way interaction between growers, agents and faculty involved in fruit production.

Scott Salom

Research

Research is conducted to solve forest and shade tree insect pest problems. The current major area of work emphasizes the biological control of important forest pests, such as the hemlock woolly adelgid, the tree of heaven, and most recently, the mahogany shoot borer in Malaysia. These are collaborative efforts with our department's biological control specialist and Department Head, Dr. Loke Kok. The numerous studies that support this work encompass the full spectrum of classical biological control activities, including foreign exploration, quarantine evaluation, development of mass rearing procedures, followed by release, establishment, and impact assessment of the agents. Additionally, in recent years he has become more actively involved in the testing of systemic insecticides on subcortical feeding and sucking insects. Research from the past involved the development of a semiochemical-based suppression tactic for the southern pine beetle, and various lab and field studies were conducted to improve our understanding and management of the pine reproduction pest, the pales weevil.

Teaching

From 1990 to 2005 Dr. Salom team taught Forest Protection (FOR 4514) and from 1995 to 2004 the team taught Pest and Stress Management of Trees (ENT 4524). Both courses have been combined and taught for the first time as Forest and Tree Pest Management (FOR 4514) in fall 2005. He has taught Advanced Topics in Forest Entomology (ENT 6004) in 2001 and 2004, and in fall 2005, taught for the first time Biological Control of Arthropods and Weeds (ENT 5264).

Extension

Dr. Salom has used information technology to improve the availability and flow of forest entomology resources to scientists, educators, and resource management professionals. Examples include the development of a dynamic comprehensive website for southern pine beetle in collaboration with Dr. Nick Stone and ISIS, and searchable online databases for hemlock woolly adelgid (bibliography), southern pine beetle (bibliography, expertise, and research projects), and forest and shade tree insect sampling procedures (bibliography with abridged descriptions).

Pete Schultz

I was hired as the Entomologist at the Virginia Truck and Ornamentals Research Station (now the Hampton Roads Agricultural Research and Extension Center [AREC]), Virginia Beach, in 1978 to develop an applied research and extension program that would address new strategies to manage insect pests impacting the commercial nursery industry of Virginia. The Research Station merged with Virginia Tech in 1985, at which time I transferred into a faculty position. The goals of my program were and remain to lower production costs for commercial nurseries and landscape managers, and reduce degradation of water quality in the Chesapeake Bay watershed through improved pest management. Program objectives are to: 1) develop knowledge that leads to reduced pesticide usage, and 2) evaluate reduced risk and non-chemical alternatives. Since 1992, my duties include administrative leadership of the AREC.

Current research examines the seasonal biology of ambrosia beetles and strategies that minimize risk of tree losses to producers of shade and fruit trees from these pests. Reduction of losses has been documented. New collaborations with ARS and others focus on new management strategies. Research on the biology and ecology of orangestriped oakworm identified strategies that significantly reduced pesticide usage and resulted in documented savings of 85% to the municipality. Follow-up evaluations indicated that the recommended strategies continue to be effective after 15 years.

Extension responsibilities are to develop educational programs that provide the latest IPM information for insect pests of horticultural crops. Degree day models have been developed for several pests and programs utilizing the information presented. Recent efforts have incorporated the use of internet-based degree day data available to the public. In addition, demonstration projects evaluate new biorational pesticides for national registration or label expansion. Recent effort has centered around educational programs on management of the red imported fire ant in Virginia, particularly using eXtension as a resource data base.

Paul Semtner

I came to the Virginia Tech Southern Piedmont AREC in September 1974 to establish research and Extension programs in tobacco insect pest management. I grew up in Oklahoma and obtained his Ph.D. in Entomology from Oklahoma State University in 1972. My Ph.D. research was on the ecology and behavior of the lone star tick, *Amblyomma americanum*. I also studied the biology of the gulf coast tick, *A. maculatum*, and taught at a junior college before coming to Virginia Tech.

The objectives of my research program are to:

1. Investigate insecticide resistance in the tobacco-adapted form of the green peach aphid,
2. Determine the impact of the tobacco budworm, tobacco flea beetle, green peach aphid, and tobacco splitworm and timing of insecticide applications on tobacco yield and quality,
3. Assess cultural practices and biological controls for managing insect pests on tobacco,
4. Evaluate new insecticides to improve insect control and reduce environmental impacts.

My field trials with new insecticides have helped increase the number of safe, effective compounds registered on tobacco in Virginia. Working in resistance management, My Ph.D. student, Lakshmipathi Srigiriraju found that the tobacco-adapted form of the green peach aphid (*Myzus persicae*) has moderate levels of resistance to imidacloprid. He also found that an orange-colored form is more insensitive to organophosphate and carbamate insecticides than other color forms. My earlier research has established economic thresholds for the tobacco budworm (*Heliothis virescens*), the green peach aphid, and the tobacco flea beetle (*Epitrix hirtipennis*) on flue-cured tobacco. I also investigated the influence of white-fringed beetles (*Naupactus spp.*) on the yield of burley tobacco. Research is underway to determine the impact of the tobacco splitworm (*Phthorimaea operculella*) on burley tobacco production in Virginia. I am assessing various cultural practices to reduce splitworm injury to burley tobacco. This research also includes a multistate project to find sources of infestations and to assess pheromone traps and weather conditions for predicting splitworm infestations on tobacco. I assessed the influence of cover crops, cultivation practices, and insecticide treatments on pest and beneficial insects on tobacco. I found that conservation tillage reduces early-season aphid and flea beetle populations and promotes beneficial insects. I also studied the impact of early-season tobacco flea beetle infestations on the incidence of the soil-borne tobacco black shank. My research on the tobacco-adapted form of the green peach aphid included studies on its biology and taxonomy and cultural and biological controls. I investigated the development of the aphid on various host plants, the influence beneficial insects and a fungal pathogen on aphid populations on tobacco.

My outreach and extension responsibilities include service to the public and to tobacco farmers in Virginia. I use my applied data to develop information and teach farmers about IPM practices including cultural practices, enhancing beneficial organisms, and timely insecticide applications based on field scouting to reduce pest infestations. This program promotes maximum profitability with minimum impact on the environment.

Igor Sharakhov

The goal of my program is to produce and disseminate new knowledge at the interface between genomics (the study of all of the DNA sequences of an organism), bioinformatics (computational analysis of genomic data), and vector biology (the study of the transmission of human, animal, and plant disease pathogens by Arthropods). My primary responsibility is to develop a nationally recognized, extramurally funded research program in genomics with emphasis on insects of medical importance. I have published 27 research papers in peer-reviewed journals. Currently, I am advising one PhD student, one VT-PREP student, and one undergraduate. My research has been supported in part by the Institute for Biomedical and Public Health Sciences (IBPHS) Mini-Grant Program. I am a Co-Training faculty for NIH/NIGMS R25GM072767 training grant "VT Initiative for Maximizing Student Diversity." 2007-2010. PI: Edward Smith, the Department of Animal and Poultry Sciences, Virginia Tech. My role is to review applications and advise selected students.

Research

My research interests are in Molecular and Medical Entomology, Genomics, and Bioinformatics. The long-term goal is to produce new knowledge that can be used to develop innovative approaches for vector control. My specific research interests include: 1. Development of genomic tools for studying evolution of disease vectors. 2. Identification of the genetic mechanism of the mosquito ability to adapt to diverse environments. 3. Studying associations between genome rearrangements and the ability of mosquitoes to transmit a pathogen. My laboratory collaborates with the Imperial College London on a grant from The Biotechnology and Biological Sciences Research Council (BBSRC). The goal of this three-year project is to identify the mechanisms of sex determination in mosquitoes.

Teaching

My teaching interests are aligned closely with my research and also focus on Genomics, Bioinformatics, and Vector Biology (the study of the transmission of human, animal, and plant disease pathogens by Arthropods). In 2006 and 2007 I taught BCHM 4052/GBCB 5984 Genomics, the part 2—functional genomics (3H, 3C). The objective of this course was to familiarize students with the modern concepts of functional organization of the genome. The part 1—structural genomics was offered by Edward Smith, the Department of Animal and Poultry Sciences, Virginia Tech. Currently, I am developing a graduate level course ENT 5024: Genomics of Disease Vectors (1H, 1C). The objective of this course is an in-depth examination of the modern approaches and techniques currently employed to study genomes of arthropod vectors of human, animal, and plant diseases. Topics include: genome organization, regulation, and evolution; preparation and analysis of chromosomes; genome mapping, sequencing and assembly; principles of taxonomy and systematics; adaptation and evolution of arthropod vectors; genetics of vector competence; comparative genomics and bioinformatics.

Reese Voshell

I have been in charge of the aquatic entomology program for 32 years. Mr. Stephen Hiner, Laboratory Specialist Senior, has played a key role in the program for 27 years. The aquatic entomology program consists of teaching and research. I am involved with graduate training by serving as major advisor for graduate students in my laboratory and as a committee member for graduate students in several other departments, mostly biology and fisheries. Undergraduates acquire experience in aquatic entomology by working as part-time employees in my laboratory and conducting independent, undergraduate research projects under my supervision.

Ent/Biol 4354 Aquatic Entomology is taught annually to about 40 students. This is a 4-credit lecture/lab course that covers the biology and taxonomy of the insects and their invertebrate relatives that live in all types of freshwater environments. Students are primarily from the departments of biology, fisheries and wildlife, and environmental science. Ent/Biol/FiW 4484 Biological Monitoring and undergraduate research are taught sporadically as needed. We regularly teach several short courses for the U. S. Fish and Wildlife Service at the National Conservation Training Center in Shepherdstown, WV. These include introductory and advanced courses on freshwater invertebrates and biomonitoring. Students in these short courses are professional aquatic biologists who work for various federal and state agencies and private consulting companies involved with natural resource management or environmental protection. In addition, we teach Ent 2004 Insects and Human Society, which is a very broad course that is included in the Global Issues component of the University Curriculum for Liberal Education. This course is taught in two versions, classroom in fall semester and on-line/distance learning in spring semester, and attracts more than 1200 students from departments throughout the university.

The aquatic entomology research program emphasizes the application of ecological knowledge of aquatic insects and other freshwater invertebrates to solving problems in environmental protection and natural resource management. The overall goal of the research program is to understand the determinants of biological integrity in streams. This is being done by establishing quantitative links between benthic macroinvertebrate assemblages and environmental variables, especially stressors resulting from human activities in watersheds. This knowledge will facilitate restoring streams to a healthy condition, as required by the Clean Water Act. Benthic macroinvertebrates are the organisms used most often in environmental assessments of surface waters, so there are good opportunities to interact with a diverse clientele of state and federal agencies as well as citizen groups. Current research projects involve the effects of cattle grazing and the causes of fish kills in large rivers of Virginia. Previous research by the aquatic entomology program has included a wide range of environmentally related topics: river impoundment, an oil spill, commercial navigation, black fly larviciding, developing long-term monitoring programs, experimental pond mesocosms, gypsy moth defoliation, multimetric indices, volunteer monitoring, and sedimentation.

Mike Weaver

Dr. Weaver's position (95% extension, 5% research) involves primarily Extension pesticide safety education and regulatory IPM programs. His Extension program is almost entirely supported with contracts and grants with the US Environmental Protection Agency, USDA Agricultural Marketing Service, Pesticide Recordkeeping Branch, Virginia Department of Agriculture and Consumer Services, Virginia Pesticide Control Board, Penn State University, North Carolina State University (NCSU), and the Southern Region IPM Center (NCSU and USDA (CSREES)).

Research

Weaver's research time is minimal. He has responsibility for supporting and reporting research activities associated with the IR-4 Minor Use Pest Control Clearance Program (for the past 27 years). He has also conducted research (most recently) to determine the extent of lead arsenate residues in Virginia soils from the use of this chemical from 1880 to 1947. That work is continuing but the research is not funded (formally) as a project.

Teaching

Although Dr. Weaver has no assigned teaching time, he has taught AT0554 Chemical Application in the two year Virginia Tech Agricultural Technology program for the past 16 years. He is the lead instructor of this course. This course is partially online (for the past 12 years) and involves weekly student centered assignments. Weekly meetings involve laboratory activities and student hands-on functions.

Extension

Weaver's Extension program involves significant support by external sponsors and in-kind support from Virginia Cooperative Extension. There are 9.5 FTE's dedicated to this program statewide. This involves 85 Extension agents and seven specialists. In addition, Weaver's program employs six support staff. Pesticide safety education (PSE) is a mandatory assigned responsibility for agents statewide. There are over 21,000 certified applicators in Virginia. This program supports all of them through training and the development of program media including 23 different training manuals. The program also supports five online training courses for trainers (agents and specialists), master gardeners and pesticide regulatory inspectors. One course is hosted for USDA and has over 400 inspectors enrolled in the course. Weaver and his colleagues have developed extensive electronic media resources that are available to the public and pesticide safety educators. The program supports both Internet (eight) and Intranet (two) websites. In addition the program hosts websites for the American Association of Pesticide Safety Educators and the electronic Journal of Pesticide Safety Education. Weaver is the editor-in-chief of the journal. "Regulatory IPM" activities involve serving as the state contact to the Southern IPM Center (for pesticide regulatory issues). One of the most important roles of the IPM Center State Contact is to provide timely feedback to critical pesticide regulatory inquiries to the Center as they are requested by EPA and USDA. The program has developed and published over 30 crop pest profile and pest management strategic planning (IPM) documents. These are critical documents to Virginia agriculture since they are used extensively by EPA and USDA to determine their priorities for pesticide registration decision making. The program is the first to develop an online IPM Priorities database - developed with the input of an established IPM stakeholders network. The driving force behind these activities is to provide regulators and pest managers a mechanism of transition so that they can sustain viable pest management tools throughout the regulatory process initiated by the Food Quality Protection Act.

Rod Youngman

I have a 75% extension, 15% research, and 10% teaching appointment in the Department of Entomology. My areas of responsibility include field corn, alfalfa, grass hay and pasture, and commercial turfgrass IPM. A major focus of my extension and research program is to develop and disseminate research-based pest management information for each of these commodities. I largely achieve this through research that compliments my ongoing extension programs.

Research

Examples of recent research activities include studies on insect resistant transgenic corn hybrids and glandular-haired alfalfa cultivars; efficacy and role of novel insecticidal seed treatments against secondary corn insects; cultural and biological control of corn and alfalfa insects; and regional surveys of grower IPM practices and pest injury on forage crops. In March 2006, I picked up commercial turfgrass IPM research and extension responsibilities. Turfgrass is a billion dollar industry in Virginia with over 1.7 million acres of maintained turf in the state. My turfgrass research to date consists of working with the Virginia Turfgrass Council and industry representatives on efficacy and timing of new and novel insecticides for managing white grubs and cutworms. I fully expect to expand my involvement in turfgrass research over the next several years. Grass hay production is another area I expect to expand my research and extension activities. The appearance of hunting billbug in orchardgrass hayfields in northern Virginia in 2005 has caused much concern among hay growers. Our damage surveys indicate that hunting billbug rivals bluegrass billbug in economic importance.

Teaching

I serve as instructor for one-third of AT 0434 (Pest Control: Insects, Diseases, and Weeds; 4 credits) every fall. I place a strong emphasis on having my students gain an appreciation of the entomological principles of insect identification, biology, and insect ecology as related to agricultural and turfgrass systems. Additional topics of discussion include genetically-engineered crops, resistance management, and IPM. My section of AT 0434 has been available online since 1997. My course web site contains over 50 web pages of lecture notes and related handouts in addition to approximately 250 slides and other visual aids. The laboratory handouts and insect identification keys were revised and added to the course web site in 2003. In addition, graduate students are critical to the success of my research and extension programs. I work to ensure that my students are thoroughly grounded in the principles of entomology, IPM, quantitative ecology, and statistics. In addition, my students are exposed to the many challenges unique to field research programs. Currently, I serve as major advisor to one MSLFS student and co-major advisor to one Ph.D. student.

Extension

An IPM extension emphasis for my program since 2003 has involved developing economic thresholds for secondary corn insects such as annual white grubs and wireworms, and efficacy trials on the relatively new seed-applied insecticides that target these insects. Specific findings indicate that two insecticides consistently provide superior control of these insects and may ultimately save growers $15-$20 per acre in reduced insecticide costs. In addition, fall soil sampling methods and economic thresholds for predicting cornfields at risk to secondary soil insects are necessary to provide growers sufficient time to include a seed-applied insecticide treatment with their order. A related extension emphasis for my program since 2004 has been to develop economic thresholds for European corn borer stalk tunneling on corn harvested for silage and grain. These findings have been used to annually update extension agents, growers, and agribusiness professionals. I also have ongoing extension IPM programs on alfalfa and grass hay production systems. One extension highlight of the alfalfa program is the Virginia Alfalfa IPM Source web site that was completed in 2005 and addresses the needs of anyone interested in better managing insect pests on alfalfa. The website contains eighty-eight separate pages in addition to numerous photos and illustrations. The web site has been submitted for formal peer review. Commercial turfgrass IPM is my newest program area. As society becomes more urbanized, the need for expanded educational opportunities emphasizing environmental stewardship in turfgrass management are being realized. In 2006, the Virginia Tech Turf Team (of which I am a member) working with the Virginia Turfgrass Council has begun to address these educational opportunities through workshops, field days, and the annual short course.

Pat Hipkins

As Assistant Coordinator of Virginia Tech Pesticide Programs, with a 100% Extension appointment, my primary responsibility is to support the VA Pesticide Safety Education Program (PSEP) and the Extension Educators who participate in it.

Pesticides are one of many tools in most pest management programs. Used correctly, they improve the quality of our lives. However, if used improperly, they pose a risk to human health and the environment. In addition, in many instances, misuse will result in economic losses. Thus, effective risk mitigation—for people and the environment—involves developing the knowledge and skills necessary for safe pesticide use and handling. People who handle pesticides must be competent in both pest and pesticide management. When considering an application to register a pesticide for use in the United States, EPA weighs the benefits vs. the risks involved. EPA considers pesticide safety education; specifically, the occupational applicator certification program, to be a risk mitigation tactic. In Virginia, state laws and regulations require most occupational pesticide users to be certified. Applicator certification involves both passing a competency exam and participating in a continuing education program. Virginia Tech Pesticide Programs supports the educational component of Virginia's certification regulation.

Activities include:

- instructional/curriculum design,
- writing and field-testing lesson plans for activities and demonstrations,
- acquiring and/or producing program support materials,
- reviewing new and/or revised certification manuals,
- writing and/or updating certification exams,
- coordinating and teaching pesticide safety education courses and programs,
- reviewing and assigning credits to Private Applicator recertification programs and managing an on-line database of approved PAR programs.

Teaching highlights:

- an Agricultural Technology course, Chemical Applications (AT0554), provides an opportunity to teach basic pesticide safety instruction to VT students who are prospective certified applicators in a practical and useful way via a variety of methods, including on-line instruction and hands-on activities in real-world settings.
- the Northeast Region Pesticide Safety Education Center is an opportunity to interact with colleagues from other parts of the country; being one of the members of the invited teaching team is an honor and a privilege.

In addition to pesticide safety education activities, I support the Virginia Tech Pesticide Programs' mission of serving as a clearinghouse for information about pesticides. In that role, I handle inquiries about pesticides from Virginia Cooperative Extension agents, specialists, and the general public.

Andy Roberts

I am director of the information systems group for the National Gypsy Moth Slow the Spread (STS) Project, a large scale (11 states) IPM project directed at gypsy moth. My group is responsible for information management in the project as well as maintenance and development of the STS decision support system. In addition to work with databases and geographic information systems (GIS) in STS, I fund and supervise one post doctoral associate who performs research on the use of mating disruption in gypsy moth management, and I fund and oversee a project on the development and deployment of location-intelligent customized data collection devices for gypsy moth survey. In addition to work with gypsy moth, I am currently working with other members of the department on a project to develop information systems components of a hemlock woolly adelgid predator release and recovery project.

My current teaching responsibilities are limited to co-teaching (with Dr. Carlyle Brewster) Information Technology in Agriculture. This class meets in alternate years in the spring semester. My role is development and presentation of lectures and labs in GIS and global positioning systems (GPS). In addition, I regularly give guest labs and lectures in GIS and GPS.

My work with gypsy moth in Virginia has a direct link to extension and outreach through information distribution via a number of avenues such as web sites, formal meetings, and informal personal communications. We are the repository of the largest amount of current and historical gypsy moth data in the state and one of (if not the) largest in the nation. Consequently, we often contribute this information, as well as our expertise, to other agencies. Providing electronic access to information continues to be a theme with our group. As gypsy moth moves southward into previously noninfested areas, this information will be more and more valuable to counties faced with managing this pest.

I currently am involved in a long-term IPM CRSP project in East Africa where I am responsible for development and implementation of GIS and GPS technology to assist in management of tomato and coffee pests.

Homecoming 2000
VW bug decorated for parade

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Individual Contributions:

Dr. Chris Bergh

Dr. Jeffrey Bloomquist

Mr. Eric Day, Insect ID Lab

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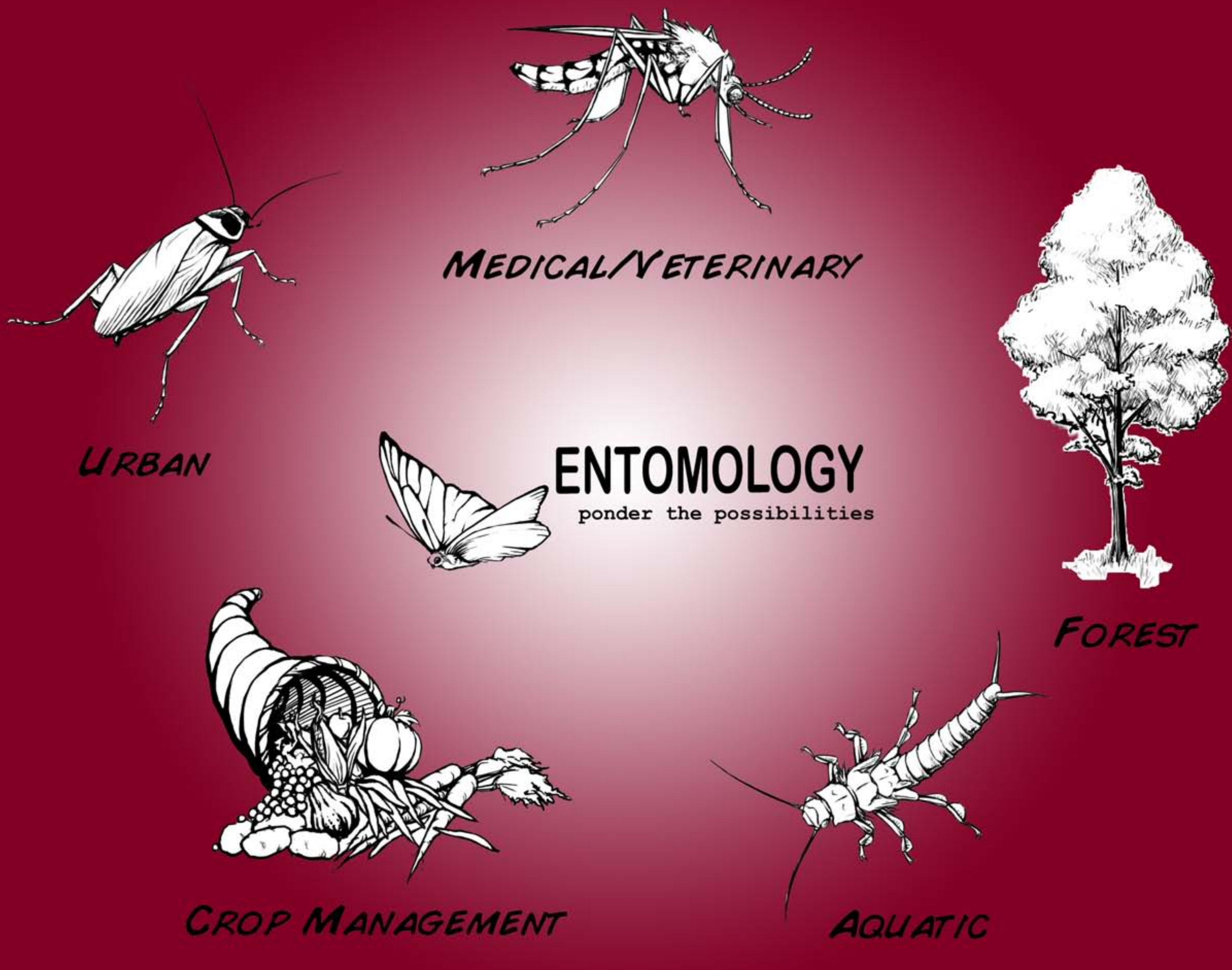
Dr. Rod Youngman

This publication was compiled and edited by:
Denise Dodd
Chris Bergh
Michael Kosztarab

Thanks to June Mullins for the front cover design
and the W.B. Alwood Society for the back cover.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