Insect Farming of Food Waste to Produce an Alternative Protein Source

Faculty Mentor: M. Eric Benbow (benbow@msu.edu)

Department of Entomology, Department of Osteopathic Medical Specialties.

PROBLEM STATEMENT

As the global human population approaches nine billion, the associated demand for food products will double in the next 40 years (Tilman et al., 2011). However, increasing agricultural commodities to meet the demand for global food products exacerbates several issues of human concern. For example, there is concern about adequate, nutritious global food production (e.g., shortage in available protein) with continued population growth, due negative impacts from climate change, natural resources depletion, deceased livestock production, and conversation of land use from cultivation to residential areas. Presently, land use for livestock production directly or indirectly represents 70% of all agricultural land and 30% of the world's surface land area (FAO, 2006). Limitations of these social, economic, and natural resource will further manifest into amplified social pressures, such as, but not limited to, increased rates of disease and a lack of agricultural entrepreneurship in the following generations, which further weakens the global economy (FAO, 2014).

Insect-derived protein can, and often does, form a significant part of the local diet through direct or indirect (e.g., livestock feedstock for fish in aquaculture) consumption. It is very clear that limited protein intake leads to malnutrition in many parts of the world. Africa in general has the lowest annual protein intake per capita per day of all the major geographical regions in the world (WHO/FAO, 2013). When coupled with financial constraints on individuals, communities, and regions, the value of alternate sources of proteins, such as insects, becomes immediately apparent for poor rural communities in developing countries where inadequate intakes of energy and protein are common. Unlike in other countries, such as Thailand, where extensive work is performed on producing insects for human consumption, in Sub-Saharan Africa (SSA) there has been limited focus on the documentation, seasonality, processing, nutritive value, and acceptability of insects for human consumption or as a feedstock for livestock and aquaculture. Insects as food and feed is expected to be valued at $1 billion by 2020, not only for human consumption, but perhaps more importantly, as feed for livestock, such as aquaculture (e.g., fish and shrimp) and poultry. Therefore, any initiative that addresses this knowledge gap is critical to determine the implementation of insects for feed in SSA. Empirical data are key to inform the knowledge of how to sustainably farm insects in an economically feasible manner to strategically incorporate nutritional interventions (i.e., increased protein consumption), while providing a new source of jobs and revenue for women and youth across local communities in SSA.

The resulting need is to minimize these anthropogenic impacts through sustainable practices and produce alternative sources of protein for a wide range of human communities, in both the develop and developing areas of the world. This project will address this need by improving a widely available, economically viable alternative, insects, to enhance food security and enhance nutrition of livestock (including poultry and aquaculture). Geographically expanding insect production into Africa is an ambitious and tenable solution to a global challenge. While this need is global, uncertainty
remains in how regionally and locally available sources of organic food waste affects insect production. Understanding the variation in resource quality among a wide range of sources (e.g., market wastes, crop residues), and the associated effects on insect production, will allow researchers to optimize insect farming based on regionally and locally available sources.

One specific method is using the ubiquitous and huge volumes of post-consumer food waste (PCFW) as organic matter food sources for farming the Black Soldier Fly (BSF), *Hermetia illucens* (Diptera: Stratiomyidae). BSF has been optimized to compost PCFW for use as feed for livestock and aquaculture with leftover material serving as rich compost for other agricultural practices. Furthermore, BSF can be mass-produced (Sheppard et al., 2002); represents no known harm to the environment or people (Tomberlin et al., 2009); can convert organic wastes (Nguyen et al., 2013), such as food (FAO, 2011), to protein and fat (Myers et al., 2008); and is known to suppress bacterial pathogens in manure (Erickson et al., 2004; Liu et al., 2008). A new form of agriculture is particularly important in areas of the world, like SSA, where BSF farming has not been evaluated at household and small community scales of production. Improving and optimizing BSF bioconversion for use in small scale, but ubiquitous, farming operations will improve the livelihood of local communities in regions of the worlds such as SSA. *This project advances the AAP priority research areas of agri-food systems, nutrition and health and water, energy and environment, with long-term goals for improving youth empowerment.*

**OBJECTIVES AND HYPOTHESES**

Our *overall goal for this project* is to determine how variation in PCFW quality and quantity affects the production of BSF. We aim to better understand and predict the best local or regional sources of organic matter for this new form of agriculture in SSA. The *central hypothesis* is that the optimal PCFW diet for increased BSF yields will comprise lower relative contributions from high-fatty (e.g., meat waste) and high lignin (e.g., maize husks) organic matter. We also predict that BSF response to PCFW quality variation will be density dependent, with intermediate densities being most efficient at using lower quality PCFW. We propose the following *objectives to test this hypothesis:*

**Objective 1. Test PCFW quality effects on insect bioconversion.** Using mixed sources of PCFW, we will provide consistent organic matter at low, intermediate and high-quality organic matter to rear and produce BSF. The quality will be defined by the ratios of plant-based to animal-based organic matter provided to the BSF for consumption and growth. High-quality PCFW diets will have more plant-based components, while low-quality PCFW diets will contain more animal- and high lignin-based products. The measured responses will be BSF survivorship, larval growth rates, time to reach each development stage, post-feeding larval body size and collective biomass. The outcome will be results that determine the quality of PCFW diet that maximizes larval growth, production and yield, while minimizing mortality during the life cycle.

**Objective 2. Determine optimal BSF larval densities that maximize bioconversion of PCFW sources.** Using the same PCFW quality types developed for Objective 1, we will also determine the optimal BSF larval population density for converting each PCFW type into BSF larvae. The same insect responses will be measured for three larval densities (low, intermediate, high) against the three PCFW diets. The outcome will be results that determine how BSF larval density affects larval
growth, production and total yield, while minimizing mortality during the life cycle when presented with different quality PCFW resources.

EXPERIMENTAL DESIGN AND PROCEDURES

The project will begin 31 August 2019. A full factorial design will be used that includes three levels of PCFW quality diets by three larval densities. Each combination will be tested with N = 6 replicates (called biopods). Each replicate will consist of a 0.5 m x 0.5 m bin, with 1 kg of PCFW added as a food resource. Subsamples of the food resource will be taken and dried to constant mass for an estimate of dry mass that will be standardized among all replicates. Deionized water will be applied by a spray bottle at a consistent volume during the experiments to ensure a consistently moist food source. For all experiments BSF will be reared using methods of our collaborators (Tomberlin, 2002). Briefly, eggs will be collected from a colony of adults at Texas A&M University. Eggs will be added to each replicate corresponding to the projected larval density for that unit.

The experiments will be performed at room temperature (~23°C). Each replicate will be evaluated daily for larval survivorship and to make observations of timing of life stage (i.e., instars) transitions. At the end of larval development (i.e., post-feeding stage) the larvae will be collected, weighed, and counted to assess survivorship. A subsample of the post-feeding larvae will be dried to constant mass for dry mass and then combusted at 550°C to measure ash-free dry mass (AFDM) of each individual to extrapolate the collective biomass of each replicate: AFDM provides a measure of the organic tissue mass of the insect less the inorganics associated with the exoskeleton and is a better measure of nutrient and energy assimilation.

PROPOSAL IMPACT ACTIVITIES

Upon the completion of this project, it is our expectation that we will have determined how PCFW diet quality affects BSF production, in addition to understanding better how larval densities may impact PCFW resource use with population level fitness effects that impact potential insect product quantity and quality. The postdoctoral associate will be responsible for giving scientific presentations at meetings, writing and submitting a manuscript for publication and collaborating on joint grant applications if/when they become available. As part of their training, they will also participate in the Department of Entomology courses and workshops associated with responsible conduct of research, that will also involve weekly laboratory meetings with student and other faculty. Additionally, the postdoctoral associate involved with this project will be asked to develop a small-scale BSF rearing container based on the biopod design and results of this project that will be constructed using local materials and PCFW in their home country. This last aspect of the project is intended to begin to field test BSF production at a local, individual household scale in a way that could potentially be adopted by other members of the local community. Importantly, the postdoctoral researcher will be co-mentored by an early career female assistant professor (Dr. Jennifer Pechal, PhD) over the course of the project. The proposed mentoring activity and research would also align well with the broader impact aspects of an initiative that my colleagues and I would like to develop.
called 'Insects-4-Africa-By-Africa' that would encompass capacity and livelihood development for using insects as food and feed in Africa.
LITERATURE CITED


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Website: http://www.benbowlab.ent.msu.edu/
Google Scholar: Benbow Publications

EDUCATION

Doctor of Philosophy, Biology, Aquatic Biology, 1999
UNIVERSITY OF DAYTON, Dayton, Ohio

Bachelor of Science, Biology, Psychology Minor, cum laude 1994
UNIVERSITY OF DAYTON, Dayton, Ohio

PROFESSIONAL APPOINTMENTS

2015 - Present: Associate Professor, Dept. of Entomology and Dept. of Osteopathic Medical Specialties, Michigan State University, E. Lansing, MI
2013 - Present: Adjunct Professor, Dept. of Entomology, Texas A&M University, College Station, TX
2014 - 2015: Assistant Professor, Dept. of Entomology and Dept. of Osteopathic Medical Specialties, Michigan State University, E. Lansing, MI
2008 - 2013: Assistant Professor, Dept. of Biology, University of Dayton, Dayton, OH
2008 - 2013: Adjunct Professor, Dept. of Entomology, Michigan State University, E. Lansing, MI
2008 - 2009: Adjunct Professor, Dept. of Entomology, Ohio State University, Columbus, OH
2006 - 2008: Assistant Professor (fixed-term), Dept. of Entomology, Michigan State University, E. Lansing, MI
2005 - 2006: Assistant Professor, Dept. of Biology, DePauw University, Greencastle, IN
2003 - 2005: Visiting Assistant Professor, Dept. of Entomology, Michigan State University, E. Lansing, MI
2001 - 2003: Visiting Research Associate, Dept. of Entomology, Michigan State University, E. Lansing, MI
1999 - 2008: Adjunct Research Assistant Professor, Dept. of Biology, University of Dayton, Dayton, OH
1994 - 1999: Graduate Research and Teaching Assistant, Dept. of Biology, University of Dayton, Dayton, OH
1992 - 1994: Undergraduate Research Assistant, Dept. of Biology, University of Dayton, Dayton, OH

RESEARCH INTERESTS — aquatic entomology/ecosystems; microbial-insect community interactions; disease and carrion decomposition ecology

Research interests involve basic and applied multiscale and multidisciplinary studies of insect-microbial community interactions. Major efforts have been in the following areas: 1) aquatic entomology, ecology and energetics; 2) insect and microbial community ecology of aquatic ecosystems; 3) insect microbiomes; 4) ecology of Buruli ulcer disease; and, 4) carrion decomposition and forensic ecology.

HONORS AND AWARDS

• Fellow of the American Academy of Forensic Sciences, February 2019
• Invited Keynote Speaker – 6th Annual Meeting of Laboratoire d’Excellence Centre d’étude de la Biodiversité Amazonienne, Cayenne, French Guiana, 5 October 2017
• Fellow of the Academy for Global Engagement Program, Michigan State University, MI — 2016
• Invited Keynote Speaker – 60th Annual Meeting of the Michigan Entomological Society, Saginaw, MI, 15 June 2014
• Invited Plenary Speaker – Global Conference on Entomology, Chiang Mai, Thailand, 5-9 March 2011
• Invited Keynote Speaker – First Annual Meeting of the Malaysia Association of Forensic Entomology, Kuala Lumpur, Malaysia, 6 July 2011
• Invited Keynote Speaker – One Day Seminar on Forensic Entomology and It’s Implications in Medicine, Kuala Lumpur, Malaysia, 5 July 2011
• Beta Beta Beta Biological Honor Society Honorary Member, Theta Kappa, University of Dayton — 2010
• Platinum Award for DVD entitled "Forensic entomology: collection and preservation of entomological evidence for court". Ava Awards — 2008
• Telly Award for DVD entitled "Forensic entomology: collection and preservation of entomological evidence for court" — 2007
• NSF Travel Grant Award through the Entomological Society of America for the 2004 International Congress of Entomology, Brisbane, Australia — 2004
• Invited Research Director for JASON Foundation Online Expedition — 2001
• Sigma Xi Graduate Research Award, University of Dayton Chapter — 1998
• University of Dayton Teaching Assistant Scholarship — 1995 - 1999
• University of Dayton Graduate Teaching Award — 1996
• Society of Sigma Xi Membership, University of Dayton Chapter — 1996
• University of Dayton Scholars Program — 1992 - 1994
• University of Dayton Special Achievement Award — 1992 - 1993
• Wittenberg University Alumni Scholarship — 1990 - 1991

**PUBLICATIONS**

(^ = Benbow as a corresponding author on that paper)
[IF = Impact factor for previous year or 5-year average]

**Submitted Papers, Chapters, and Books**

1. Merritt, RW, KW Cummins, ^ME Benbow. Sampling benthic macroinvertebrates for bioassessment studies: effects of within-reach variability in population, diversity and tolerance indices. (*in revisions at Rivers, Research and Applications*)
3. Stiegler, J, C von Hoermann, J Müller, ME Benbow, M Heurich. Carcass introduction for scavenger conservation in a temperate forest ecosystem. (*submitted to Ecological Applications*)
8. Lang, JM, RW McEwan, **ME Benbow**. Coupled roles of bottom-up and top-down effects throughout stream microbial biofilm succession. (*submitted to ISME J*)


**Peer-reviewed Publications**

2019


2017


25. Moore, HE, JL Pechal, ME Benbow, FP Drijfhout. 2017. The potential use of cuticular hydrocarbons analysis to age the puparial cases of *Calliphora vicina* and *Lucilia sericata*. *Nature Scientific Reports* 7:1933. doi.10.1038/s41598-017-01667-7 [IF = 5.53]


2016


36. Yuan, Y, Y Zhang, S Fu, T Cripen, D Visi, ME Benbow, M Allen, JK Tomberlin, S-H Sze, AM Tarone. 2016. Genome sequence of a *Proteus mirabilis* strain, isolated from the salivary glands of larval *Lucilia sericata*. *Genome Announcements* 4(4), e00672-16 [IF = 1.18]


2013


69. Williams, SJ, M Kaufman, RW Merritt, HR Williamson, ME Benbow. 2013. Fish and amphibians as potential reservoirs of Mycobacterium ulcerans, the causative agent of Buruli ulcer disease. Infection Ecology and Epidemiology 3: 10.3402/iee.v3i0.19946. PMCID: PMC3580280 [IF = 2.87]


2011


2010


2009


2008


2007


2004


2003


2002


2001


2000


1997


Books

2015 - Present


Book chapters (* = peer-reviewed)

2018


2017


2016


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**2015**


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**2013**


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**2012**


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**2011**


2010


2009


2005


**The National Academies of Sciences, Medicine and Engineering Reports (peer-reviewed)**

2018


2017


Technical Reports

2013


2011


2010


2007


2004


PEER-REVIEWED PUBLISHED PROCEEDINGS


**PROFESSIONAL PUBLICATIONS – BOOK REVIEWS, MANUALS, DVDs**


**GRANTS, CONTRACTS AND FELLOWSHIPS**

**Successful Funding**

1. The Avielle Foundation (Neuroscience and Clinical Research Grant to Prevent Violence and Build Compassion) — 2019. ($100,000) AJ Robison (PI), C Kwiatkowski (co-PI), A Zeoloi (co-PI), ME Benbow (co-PI), A Moeser (co-PI). Aggression and the gut-brain axis.
3. MSU CANR Professional Development Microgrant — 2018 ($3,000) ME Benbow (PI). Travel funding to improve international collaborative NSF proposal.

5. CDC (Centers for Disease Control and Prevention: National Center for Emerging and Zoonotic Infectious Diseases) — 12/31/2016 – 12/30/2021. ($1,213,224) (Benbow budget = $0) E Walker (PI), M Kaufman (co-PI), J Tsao (co-PI), Z Xi (co-PI), J Owen (co-PI), ME Benbow (co-PI): The Upper Midwest Regional Center of Excellence in Vector-borne Disease.

6. MSU CANR Professional Development Microgrant — 2016 ($3,000) ME Benbow (PI). Travel funding to French Guiana for new research partnerships.


10. MSU VISTAS Program (Visiting Scholars to Advance Science Grants) — 2015 ($4,852) ME Benbow (PI). VISTAS Grant to host visiting scholars from Penn State University, Texas A&M University and Mississippi State University.


17. Hamilton County Park District — 2011. ($2,000) (Benbow sub-award of $1100) MD McIntosh (PI) and ME Benbow (co-PI). A temporal assessment of invertebrate structure and function within vernal pools of Southwestern Ohio.

18. Hamilton County Park District — 2010. ($2,000) (Benbow sub-award of $1000) MD McIntosh (PI) and ME Benbow (co-PI), G Farnsworth (co-PI). A temporal assessment of invertebrate structure and function within vernal pools of Southwestern Ohio.

20. Research Council SEED Grant: Summer Research Fellowship, Grant-In-Aid-Award and Equipment (University of Dayton) — 2011. ($6,500) ME Benbow (PI). Effects of an antimicrobial agent on microbial-insect interactions: implications for potential pathogen dispersal by flies. University of Dayton, Dayton, OH.

21. Research Council SEED Grant: Summer Research Fellowship, Grant-In-Aid-Award and Equipment (University of Dayton) — 2010. ($11,000) ME Benbow (PI). Microbial succession and potential pathogen dispersal by flies. University of Dayton, Dayton, OH.

22. Research Council SEED Grant: Summer Research Fellowship and Grant-In-Aid-Award (University of Dayton) — 2009. ($6000) ME Benbow (PI). Ecology of carrion decomposition and application to forensic and medical entomology. University of Dayton, Dayton, OH.


27. USGS — 2007 ($20,000 contract): ME Benbow (PI). Baseline studies of benthic macroinvertebrate communities in diverted streams of West Maui, Hawaii.


29. USDA-CSREES (2006-35101-16566) — 2006-2008 ($497,041; $70,000 subcontract): GA Lamberti (PI), JL Tank (co-PI), DT Chaloner (co-PI), RW Merritt (co-PI), ME Benbow (co-PI), RT Edwards (co-PI), DV D’Amore (co-PI), and SD Bridgham (co-PI). The role of salmon-derived nutrients in managed U.S. forests.

30. NSF Travel Grant Award — 2004 ($2,300): ME Benbow (PI). Competitive award for postdoctoral associates through the Entomological Society of America for travel to the International Conference of Entomology, Brisbane, Australia.


32. Michigan Department of Transportation — 2001 – 2004 ($200,000): RW Merritt (PI) and ME Benbow (co-PI). Road salt impact on marsh invertebrates.


strategies for life in a harsh environment.

Pending Proposals

1. **Swedish Research Council, 2019** – L Chiwona-Karltn (PI), R Musundire (co-PI), M. Langton (co-PI)
   ME Benbow (co-PI), M Matanda (co-PI), J Jackson (co-PI). *Demand driven evolution of traditional insect foods to branding and marketing* (Submitted April 2019) .................................................. ~$433,000 ($103,983)

2. **NIJ - National Institute of Justice (Research and Development in Forensic Science for Criminal Justice Purposes), 2019** – HR Jordan (PI), ME Benbow (co-PI), JL Pechal (co-PI). *Microbial biomarker validation for early postmortem interval detection across the US* (Submitted April 2019) ....~$XX XXXXX

3. **NIJ - National Institute of Justice (Research and Development in Forensic Science for Criminal Justice Purposes), 2019** – Brinkac (PI), ME Benbow (co-PI), JL Pechal (co-PI). *Geosourcing potential of postmortem microbiota* (Submitted April 2019) ........................................~~~$ XXXXXX

4. **NIH - National Institutes of Health (NIAID), (9/1/2019-8/31/2021)** — ME Benbow (PI), H Jordan (co-PI). *The Role of Mosquitoes and Microbial Communities in the Poorly Understood Transmission and Environmental Dispersal of Mycobacterium ulcerans.* $415,532 (Submitted February 2019)

5. **MacArthur 100 & Change Competition White Paper to Michigan State University Competition for Proposal Preparation** — ME Benbow (PI), JL Pechal (co-PI), W Liao, (co-PI), S Cho (co-PI), D Weatherspoon (co-PI), J Jackson-Malete (co-PI), C Effiong (co-PI), L Weatherspoon (co-PI). *IN4FOSE – Commercializing insects for food and feed to support a global African bioeconomy.* (Submitted March 2019)

6. **NSF - National Science Foundation (Ecology and Evolution of Infectious Diseases, 16-592), (7/1/2019-6/30/2023)** — ME Benbow (PI), JF Guegan (co-PI), JL Pechal (co-PI), H Jordan (co-PI), and M Sandel (co-PI). *Novel weapon evolution in mycobacterial pathogenesis, dispersal and ecological persistence.* $2,499,999 (**Benbow budget = $946,696**) (Submitted November 2018)

7. **NSF - National Science Foundation INFEWS/T2** — JK Tomberlin (PI), ME Benbow (co-PI), JL Pechal (co-PI), S Marquart-Pyatt (co-PI) HR Jordan (co-PI), S Khanal (co-PI), S Swiger (co-PI), T Crippen (co-PI), MT Holtzapple (co-PI), AH Knap (co-PI), G Murthy (co-PI): *INFEWS/T3: Sustainable insect farming contributing to food, water and energy security,* $2,500,000 (**Benbow budget = $615,132**) (Submitted August 2018)

Grant Efforts Not Funded in 2018


**International Development Research Centre of Canada (1/1/2019-12/31/2022)** — R Musundire (PI), K Masamba (co-PI), L Chiwona-Karltn, J Pechal (co-PI) ME Benbow (PI), (co-PI). *Insects as a sustainable food and income source: community and market-led expansion of captive rearing of edible insects.* (submitted March 2018). $2,312,679 (**Benbow budget = $397,603**)
NIH - National Institute of Health (R03, PA-18-488), 2018 – JL Pechal (PI), ME Benbow (co-PI), HR Jordan (collaborator), CJ Schmidt (collaborator). Potential Microbial Biomarkers of Infant Development through a Postmortem Survey (Submitted June 2018) .................. $100,000 (Direct Costs)

NIJ - National Institute of Justice (Research and Development in Forensic Science for Criminal Justice Purposes, NIJ-2018-13600), 2018 – JL Pechal (PI), ME Benbow (co-PI), AM Tarone (co-PI), and SH Sze (co-PI). Microbes and Machine Learning: Identifying and Evaluating Microbial Model Accuracy for Death Investigation (Submitted April 2018) ................................. $975,000 (~$665,000)

NIJ - National Institute of Justice (Research and Development in Forensic Science for Criminal Justice Purposes, NIJ-2018-13600), 2018 – HR Jordan (PI), ME Benbow (co-PI), JL Pechal (co-PI), CJ Schmidt (Collaborator). Refining of Potential Microbial Biomarkers as Indicators for Post-Mortem Interval (Submitted April 2018) ............................................................... $940,00 (~$320,000)

Forensic Sciences Foundation, American Academy of Forensic Science Acorn Grant — 2018. ($6,000) SF Kaszubinski (PI), JL Pechal (co-PI), CJ Schmidt (co-PI), ME Benbow (co-PI). Identifying microbial biomarkers of infant death during autopsy.

National Institute of Justice (Research and Development in Forensic Science for Criminal Justice Purposes, NIJ-2018-13600), 2018 – ME Benbow (PI), JL Pechal (co-PI), J Wankmiller (co-PI), and M Van Grinsven (co-PI). Establishing bio-ecological baseline metrics for a new forensic research facility to understand human decomposition in a northern latitude environment (Submitted April 2018) $900,000 (Benbow budget = $625,000)

National Science Foundation (Ecology and Evolution of Infectious Diseases, 16-592), (7/1/2018-6/30/2022) — ME Benbow (PI), JF Guegan (co-PI), JL Pechal (co-PI), H Jordan, and M Sandel (co-PI). Novel weapon evolution in mycobacterial pathogenesis, dispersal and ecological persistence. (submitted November 2017) $2,499,999 (Benbow budget = $881,632)


PROFESSIONAL EXPERIENCE & SERVICE

The National Academies of Sciences, Engineering and Medicine (formerly the National Research Council) Review Committee Member (2017-2019) — Appointed Member of the Review of the Edwards Aquifer Conservation Program – Phase III.

The National Academies of Sciences, Engineering and Medicine (formerly the National Research Council) Review Committee Member (2015-2016) — Appointed Member of the Review of the Edwards Aquifer Conservation Program – Phase II.

Federal Reviews as Ad hoc or on Panels:

*French National Research Agency– Review Panel Committee Member* (Health-Environment: Environment, pathogenic agents and emerging and re-emerging infectious diseases, adaptation and resistance to antimicrobials, 2018-2019)


*Biotechnology and Biological Sciences Research Council of the United Kingdom, Ad Hoc Proposal Reviewer* (2017)

*National Geographic Society, Ad Hoc Proposal Reviewer* (2017)

*United State Department of Agriculture – NIFA, Ad Hoc Proposal Reviewer* (2016)

*Romanian – USA Fulbright Commission, Ad Hoc Proposal Reviewer* (2016)


*Department of Energy - SCGF (Office of Science Graduate Fellowship, 2010)*

**Invited Speaker** — *World Health Organization* (6), *Michigan State University* (4), *Ohio State University* (2), *University of California Berkeley*, *University of Notre Dame*, *Purdue University*, *Texas A&M University*, *University of Texas El Paso*, *Emory University*, *University of Surrey (United Kingdom)*, *University of Wüzburg (Germany)*, *Waldgeschichtliche Museum at the Nationalparkverwaltung Bayerischer Wald (Bavarian National Forest) (Germany)*, *University of Malawi*, *Malawi University of Science and Technology*, *Bowling Green State University*, *Wright State University*, *Indiana University-Purdue University (Ft. Wayne)*, *DePauw University* (2), *University of Dayton* (3), *Central Michigan University* (2), *Oakland University*, *West Virginia University*, *Hope College*, *University of Toledo*, *Millersville University*, *Kellogg Biological Station*, *Lorain County Community College*, *The Freshwater Society*, *Burapha University (Thailand)* (6), *Ubon Ratchathani University (Thailand)*, *Texas State University*(Forensic Anthropology Center), *Kettering College*, *Indiana University-Purdue University*(Indianapolis), *Huazhong Agricultural University*(China), *Zhejiang University*(China), *Zhuahai Agricultural Center*(China), *Universiti Teknologi Mara*(Malaysia), *Guangdong Police College*(China), *Northwest Agricultural and Forestry University*(China), *Pacific Whale Foundation*, *National Research Council of the Republic of Palau*, *Christopher Hills Foundation*, *Maui Watershed Awareness Involvement Forum,*

**Invited Keynote Speaker** – *6th Annual Meeting of Laboratoire d’Excellence Centre d’étude de la Biodiversité Amazonienne, Cayenne, French Guiana, 5 October 2017*

**Invited Keynote Speaker** – *60th Annual Meeting of the Michigan Entomological Society, Saginaw, MI, 13-15 June 2014*

**Invited Plenary Speaker** – *Global Conference on Entomology, Chiang Mai, Thailand, 5-9 March 2011*
Invited Keynote Speaker – First Annual Meeting of the Malaysia Association of Forensic Entomology, Kuala Lumpur, Malaysia, 6 July 2011

Invited Keynote Speaker – One Day Seminar on Forensic Entomology and It’s Implications in Medicine, Kuala Lumpur, Malaysia, 5 July 2011

Past President — North American Forensic Entomology Association, Executive Committee (2013 - 2014)

President — North American Forensic Entomology Association, Executive Committee (2012 - 2013)

President-Elect — North American Forensic Entomology Association, Executive Committee (2011 - 2012)

Associate Guest Editor — Frontiers in Ecology and Evolution, Death and Decomposition in Aquatic Ecosystems Special Issue

Editorial Board, Subject Editor — World Journal of Clinical Infectious Diseases (2011 - 2015)

Editorial Board, Subject Editor — Lepcey – Bulletin on Entomological Studies of Tropical Asia (2011 - present)

Editorial Board, Subject Editor — Pan-Pacific Entomologist (2008 - 2013)

Editorial Board, Subject Editor — Entomology Digital Library of the AAAS - Medical and Veterinary Entomology/Forensics Section (2006 - 2009)

Editorial Board, Section Editor (Invertebrates) — Encyclopedia of Inland Waters. Elsevier Press. GE Likens (Editor-In-Chief) (2006-2008)

Associate Subject Editor — Journal of Medical Entomology (2003 - 2006)


Expert Reviewer — Proposed Rule of Critical Habitat for U.S. Fish and Wildlife Service, Honolulu, HI

Invited Workshop Member — the Na Wai Eha Stream Biology Working Group, Maui, HI (2006)

Invited Workshop Member — Texas State University Forensic Entomology Workshop, San Marcos, TX (2011)


Research Director — Earthwatch Institute Hawaii’s Mountain Streams Project 1999-2001 (110 volunteers). JASON Foundation 2001 Online Expedition (Hawaii’s Mountain Streams); included mentoring 6 middle school students in field research, data analysis and conference presentation
Michigan State University International Research and Teaching Delegation — one of three scientists that visited Can Tho University, Vietnam to evaluate/facilitate potential research and teaching opportunities for Michigan State University - 2006

Scientific Advisor (Watershed Ecology) — Watershed biomonitoring program for the Republic of Palau; Christopher Hills Foundation, Maui, HI (2002-Present)

Scientific Advisor (Forensic Entomology) — New Jersey Forensic Science Commission, Forensic Anthropology and Associated Forensic Specialties Sub-Committee (2005 – 2011)


International Advisory Board — Global Conference on Entomology, Chiang Mai, Thailand, 5-9 March 2011


Professional Service Committees — North American Forensic Entomology Association (NAFEA): Membership Survey Committee; Annual Conference Organization Committee Chair (2013); American Academy of Forensic Science, Awards Committee (2018-2019), Program Committee (2018-2019);

NSF HBCU-UP Advisory Committee — committee for Historically Black Colleges and Universities Undergraduate Program grant award to G. Javan, Alabama State University (2014-2016)

Visiting Scholar — Belau National Museum, Republic of Palau (2009-2012); Burapha University, Thailand (2010, 2011); Ubon Ratchatani University, Thailand (2010); Faculty of Medicine, Universiti Teknologi Mara, Malaysia (2011); Huazhong Agricultural University, China (2011); University of Surrey, United Kingdom (2012)

Ad hoc Reviewer (# of reviews) —

Funding Agencies

NSF (4) • USGS (3) • USDA-NIFA • US Forest Service • The French National Research Agency (ANR)(2) •
National Geographic Society (2) • BBSRC (Biotechnology and Biological Research Council [UK] • Fulbright Commission • National Sciences and Research Council (NSERC) of Canada • National Institute of Justice • The Leverhulme Trust (UK)

Journals

Ecology Letters (2) • Ecology (4) • Biological Reviews • ISME J (Nature) • Scientific Reports (Nature) • Scientific Data (Nature) (2) • Oikos • PLoS ONE (2) • PLoS Neg Trop Dis (15) • Ecosphere (2) • JN Am Benthol Soc/Freshwat Sci (5) • Freshwater Biology • Appl Environ Microbiol • Emerg Infect Dis • J Animal Ecology • Environ Microbiol • Peer J (2) • Ecological Processes • Front Microbiol • Environ Entomol (3) • EcoHealth (3) • J Environ Qual • J Am Wat Res Assoc (6) • Mar Freshwat Res • J Trop Ecol • Ecol Entomol (4) • J Am Mos Cont Assoc • Great Lakes Entomol • J Med Entomol (13) • Landscape Ecol. • Ann Limnol — Int J Lim (2) • Caribb J. Sci. (2) • J Vect Ecol (2) • J Insect • Aquat Sci • Pertanika J Trop Agric Sci • Wetlands (2) • Applied Herp (2) • Trans Am Fish Soc • Acta Oecol (2) • Hydrobiologia (4) • Environ Biol Fish • Aquat Sci • Environmental Pollution • Pan-Pac Entomol (3) • J Insect Sci • J East Afri Nat His • Entomologia Experimentalis et Applicata • BMC Public Health (2) • J Forensic Sci (15) • Forensic Sci Internat (7) • J Wat Sanit Develop • African J Agric Res • J Microbiol Methods • EcoHealth • Conservation Biology • Entomological News • BMC Research Notes • Waste Management (2) • The Canadian Field-Naturalist • Ulcers • J Mar Sci: Res and Develop • Aquatic Insects • Int J Legal Med (4) • J Insect Conserv • Acta Tropica • Appl Microbiol Biotechnol • J Mollusc Studies • Int J Health Geographics (2) • J Hydrol Reg Stud (2) • Bull Southern Calif Acad Sci • Rev Brasileira Entmol • Am J Trop Med Hyg • J Great Lakes Res • Pacific Science • J Insect Behav • Curr Opinion Insect Sci • Canadian J Infect Dis & Med Microbiol • Microbes and Environments • Behav • Southeast Nat • Southwest Entomol • Micronesica (2)

Publishers

Elsevier • Harvard University Press

MEMBERSHIPS

American Association for the Advancement of Science • Ecological Society of America • Society for Freshwater Science (formerly the North American Benthological Society) • Entomological Society of America • American Academy of Forensic Science • North American Forensic Entomology Association • Ohio Academy of Science • Xerces Society • The Association for Tropical Biology • Malaysia Association of Forensic Entomology • European Association of Forensic Entomology

INVITED SEMINARS AND ADDRESSES

Bridging Ecology and Applications Through High Throughput Sequencing Technology. Invited Seminar at University of Turin, Italy, 14 March 2019. International Invitation


Using High Throughput Sequencing Technologies to Advance Insect Science. Invited Seminar at Burapha University, Thailand, 7 February 2019. International Invitation

The Dark Side of the Necrobiome: The Role of Carrion in Ecosystems. Invited Seminar at Waldgeschichtliche Museum at the Nationalparkverwaltung Bayerischer Wald (Bavarian National Forest), Germany, 11 October 2018. International Invitation
The Ecological Importance of Carrion and the Necrobiome in Human and Natural Systems. Invited Seminar at University of Würzburg, Würzburg, Germany, 10 October 2018. **International Invitation**

Exploring Lake Midge Emergences to Determine Natural Aquatic Insect Colony Feasibility in Malawi. Next Generation of Food Security in Malawi Symposium, Salima, Malawi, 18-19 July 2018. **International Invitation**

The necrobiome and forensic science: understanding death and decomposition for societal good. Invited seminar at Northern Michigan University, Marquette, MI, 16 May 2018.

The human postmortem microbiome: past, present and future. Invited Seminar at University of Salzburg, Salzburg, Austria, 4 May 2018. **International Invitation**


Bugs, bacteria and bodies: potential applications of the necrobiome in forensic investigation. Invited seminar at Sam Houston State University, Huntsville, TX, 20 October 2016.

The human postmortem microbiome: potential applications in forensics and novel translations for investigating human health and disease. Invited seminar at College of Medicine, University of Malawi, Blantyre, Malawi, 8 June, 2016. **International Invitation**

The human postmortem microbiome: potential applications in forensics. Invited seminar at Malawi Institute of Technology, Malawi University of Science and Technology, Blantyre, Malawi, 7 June, 2016. **International Invitation**

The human postmortem microbiome and potential forensic applications. Invited address at Advances in Forensic Medicine & Pathology, Department of Pathology, University of Michigan, Ann Arbor, MI, 11-12 May, 2016.


Insect-microbe interactions of decomposition and forensics: a next-generation approach to integrating basic and applied science. Invited seminar in the Department of Biological Sciences, Burapha University, Thailand, December 16, 2015. **International Invitation**

Carrion decomposition, forensics and disease: tales of microbes and insects from death scenes to scenic streams. Invited Seminar at University of Notre Dame, South Bend, IN, November 25, 2015.

Riparian invader ripple effects in headwater stream ecosystems. Invited Seminar at Bowling Green State University, Bowling Green, OH, October 10, 2015.
Insights from the living dead: what flies and microbes can reveal about death, decomposition and incarceration. Invited Seminar at Central Michigan University Biological Research Station on Beaver Island, MI, June 3, 2015.

Salmon carcass effects on stream-riparian forest networks: bottom up effects from microbes and insects. Invited Seminar at Central Michigan University Biological Research Station on Beaver Island, MI, June 2, 2015.

So what, who cares? Why insects, microbes and their interactions are important in forensics and medicine. Invited Seminar for Future Forensic Scientists Club, Michigan State University, April 27, 2015.

Exotic plant invasions and salmon decomposition mediate insect-microbe interactions. Invited Seminar in the Department of Biological Sciences, University of Windsor, Canada, October 3, 2014. International Invitation

Insects and Microbiomes: An (un)likely intersection of ecology, disease and forensics. Invited Seminar in the Department of Entomology, Michigan State University, September 12, 2014.


New research in microbe-insect interactions. Invited Seminar at College of Plant Protection, Shandong Agricultural University, Shanghai, China, June 12, 2014. International Invitation

The insect microbiome within a biogeographic context. Invited Seminar at the Institute of Entomology, Northwest Agricultural and Forestry University, Yangling, Shaanxi, China, June 9, 2014. International Invitation

Microbe-insect partnerships: the importance of biogeographic variation. Invited Seminar at the State Key Laboratory of Agricultural Microbiology, Huazhong Agricultural University, Wuhan, China, June 7, 2014. International Invitation

Diverse applications in carrion decomposition ecology research. Invited Seminar at the State Key Laboratory of Agricultural Microbiology, Huazhong Agricultural University, Wuhan, China, June 6, 2014. International Invitation

Diverse applications in carrion decomposition ecology research. Invited Seminar at the College of Agricultural and Biotechnology, Zhejiang University, Hangzhou City, China, June 3, 2014. International Invitation

Emerging multidisciplinary research efforts in carrion ecology and forensic entomology. Invited Seminar in the Department of Entomology, Purdue University, March 6, 2014.

Aquatic community responses to riparian invaders. Invited Seminar in the Department of Entomology, Michigan State University, July 23, 2013.

Bugs and bodies: new frontiers and dimensions of forensic entomology. Invited Presentation for the 32nd Annual Empire State Association of Two Year College Biologists, Albany, New York, April 20, 2013.

Carrion ecology, evolution and their applications: new insights into microbe-insect interactions of ephemeral resources. Invited Graduate Luncheon Seminar in the Department of Integrative Biology, University of California Berkeley, April 15, 2013.

Insects and incarceration - maggots, medicine and microbes, oh my! Invited Seminar in the Division of Arts...
and Sciences, Kettering College, February 14, 2013.


*The mysteries of Mycobacterium ulcerans infection (Buruli ulcer) - a neglected tropical disease.* Invited Seminar in the Department of Biology, Indiana University-Purdue University, Oct 5, 2012.

*Ecological eavesdropping: implications for forensic science.* Invited Seminar in the Department of Microbial and Molecular Science, University of Surrey, United Kingdom, May 31, 2012. *International Invitation*

*A mysterious infectious disease system and a complex systems approach to understanding transmission of Mycobacterium ulcerans infection.* Invited Seminar in the Faculty of Medicine, Universiti Teknologi Mara, Kuala Lumpur, Malaysia, July 5-6, 2011. *International Invitation*

Understanding the mechanistic role of blow flies in the microbial ecology of carrion decomposition: implications to food borne disease spread. Invited Keynote Speaker for “Forensic Entomology and It’s Implications in Medicine” at the Faculty of Medicine, Universiti Teknologi Mara, Kuala Lumpur, Malaysia, July 5, 2011. *International Invitation*

New approaches for understanding the mechanistic role of microbial community-blow fly interactions during carrion decomposition: applications to forensic science. Invited Seminar for the Department of Forensic Science and Technology, Guangdong Police College, Guangzhou, China, June 28, 2011. *International Invitation*

Understanding the mechanistic role of blow flies in the microbial ecology of carrion decomposition: implications to food borne disease spread. Invited Seminar at Zhuhai Agricultural Center, Zhuhai, China, June 27, 2011. *International Invitation*

Understanding the mechanistic role of blow flies in the microbial ecology of carrion decomposition: implications to food borne disease spread. Invited Seminar at the State Key Laboratory of Agricultural Microbiology, Huazhong Agricultural University, Wuhan, China, June 24, 2011. *International Invitation*

*A mysterious infectious disease system and a complex systems approach to understanding transmission of Mycobacterium ulcerans infection.* Invited Seminar at the State Key Laboratory of Agricultural Microbiology, Huazhong Agricultural University, Wuhan, China, June 23, 2011. *International Invitation*


A new approach to the mechanistic role of microbial community-blow fly interactions during carrion decomposition: applications to forensic science. Invited seminar in the Department of Biological Sciences, Burapha University, Thailand, January 10, 2011. *International Invitation*

Understanding the role of ecology in infectious disease systems: complex environmental interactions beyond medical entomology. Invited seminar in the Department of Biological Sciences, Ubon Ratchathani University, Thailand, July 24, 2010. *International Invitation*

Understanding carrion decomposition ecology for application to forensic science. Invited seminar in the Department of Biological Sciences, Burapha University, Thailand, January 2, 2009. *International Invitation*
Forensic Entomology: the collection and preservation of insect evidence from crime scenes. Invited seminar in the Department of Biological Sciences, Burapha University, Thailand, January 3, 2009. *International Invitation*

*Mycobacterium ulcerans infection: the ecology of a neglected tropical disease.* Invited seminar in the Department of Microbiology, The Ohio State University, January 21, 2009.

*Large scale patterns of land use and aquatic invertebrate community structure as part of a West African disease system.* Invited seminar in the Department of Entomology, Texas A&M University, April 23, 2009.

*Multiple-scale and multi-disciplinary ecological studies on a mysterious emerging disease in West Africa.* Invited seminar in the Department of Biology, West Virginia University, October 26, 2009.

*The ecology of worldwide emerging diseases: how and why do infectious agents emerge from the environment.* Invited seminar in the Department of Biological Sciences, Burapha University, Thailand, December 29, 2008. *International Invitation*

*Complexities of studying a neglected tropical disease: Mycobacterium ulcerans infection.* Invited seminar in the Department of Biological Sciences, Burapha University, Thailand, December 30, 2008. *International Invitation*


*The role of biting hemipterans in the emergence of a mysterious infectious disease in West Africa.* Invited seminar in the Department of Entomology, Ohio State University, February 19, 2008.

*Starting from ground zero: the first ecological studies of a worldwide emerging infectious disease.* Invited seminar in the Department of Biological Sciences, Wright State University, October 20, 2008.

*Deciphering a disease system by integrating ecosystem ecology and molecular biology.* Invited seminar in the Department of Biological Sciences, Oakland University, November 25, 2008.

*From satellites to gene probes: understanding the ecology of an emerging mycobacterial disease in tropical West Africa.* Invited seminar in the Department of Biology, University of Texas El Paso, El Paso, TX. April 14, 2006.

*Ecology of Mycobacterium ulcerans Infection: evaluating landscape relationships with freshwater food webs and disease occurrence.* Invited seminar in the Department of Biology, DePauw University, Greencastle, IN. March 31, 2005.

*Human impacts on freshwater ecosystems: the case study of Mycobacterium ulcerans Infection.* Invited seminar in the Department of Biological Sciences, University of Toledo, Toledo, OH. March 1, 2005.


*Water flow reduction effects on Hawaiian stream communities.* Invited seminar in the Department of Biology, Hope College, Holland, MI. May 1999.

**INVITED WORKSHOP SPEAKER/LEADER**
**Benbow, ME.** Bridging Ecology and Applications Through High Throughput Sequencing Technology. Invited workshop at University of Turin, Italy, 14 March 2019.


Benbow, ME. 2011. The role of aquatic organisms in forensic investigations. Invited Speaker. Forensic Entomology Workshop. Forensic Anthropology Center at Texas State – Grady Early Forensic Anthropology Research Laboratory, Texas State University, San Marcos, TX, November 6, 2011.

**SCHOLARLY PRESENTATIONS**

*Please see full list of presentation citations at the end of the CV.*

**TEACHING**

**Courses taught at Michigan State University:**

- Forensic Entomology (ENT 401) — Fall 2018
- Forensic Entomology (ENT 812) — Spring 2017
- Forensic Applications of the Necrobiome (ENT 812) — Spring 2016
- Aquatic Entomology with Lab (ENT 422) — Fall 2015, 2017
- Insects, Disease and Natural Resources Management (ENT 812) — Fall 2014
- Graduate Independent Study (ENT 890) — Fall 2017
- Honors Capstone Project (MMG 499H) — Fall 2017, Spring 2018
- Guest Lecture in Environmental Health – Spring 2015
- Guest Lectures in Introduction to Forensic Science – Fall 2014, 2015, 2016, 2017
- Earth Systems Science (Honors Course – co-taught with other faculty) — 2007
- Forensic Entomology (Freshman Seminar Course – co-developed) — 2005
- Online Forensic Entomology (co-developed) — 2005
- Aquatic Entomology, Tropical Biology, & Insect Ecology (Multiple Guest Lectures) — 2001 – 2006
- Insect Production and Energetics (Graduate Seminar Course) — 2003

**Guest Lectures at Other Universities/Institutions**

- Guest Lecture in Health Science - Northern Virginia Community College (virtual lecture via video conference) — Fall 2014

**Lecture Courses taught at DePauw University and the University of Dayton:**

- Disease Ecology (BIO 465) — 2010-2013
- Guest Lecture in Restoration Ecology – Multiple Semesters from 2009-2013
- Guest Lecture in Ecology – Multiple Semesters from 2009-2013
- Ecological Methods and Instrumentation (BIO 552 P2) — 2010
- Introduction to Biology — Ecology and Evolution (BIO 152) — 2008-2013
- Invertebrate Sampling and Identification (BIO 596) — 2010
Island Environmental Biology (BIO 360) - (co-developed) (Study Abroad) — 2002-2005, 2009
Culture, Biodiversity and Resources Management (BIO 340) (co-developed) (Study Abroad) —2005, 2010
Undergraduate Independent Study (BIO 421) — 2009-2013
Comparative Animal Physiology (BIO 465) — 1998 (5 weeks) & 2000
Science 230 Introductory Biology for non-majors (SCI 230) — 2000
General Biology (BIO 101, majors and non-majors)— 1998
Invertebrate Zoology — 1997 (5 weeks)
Introduction to Ecology and Evolution — 2005, 2006 (DePauw)
Senior Seminar — 2005 (DePauw)

Laboratory Courses taught at the University of Dayton:


Lab Development at the University of Dayton:

Island Environmental Biology (co-developed with AJ Burky) — 2001-2002; 2008-2011
Culture, Biodiversity and Resources Management (co-developed with AJ Burky)— 2004-2005; 2010

LECTURE/LABORATORY/WORKSHOP MANUALS & SUPPLEMENTAL TEACHING MATERIALS


MENTORING & NON-COURSE TEACHING

Faculty Mentoring at MSU

Faculty Mentor Committees:

Peter White, PhD (Assistant Professor in Lyman Briggs and the Department of Entomology) (2014 – 2018)
Jennifer Pechal, PhD (Assistant Professor, fixed-term, Department of Entomology) (2015 – present)

Graduate and Post-Graduate Major Advisor or Co-Advisor

Postdoctoral Advisor or Co-Advisor: M. McIntosh, PhD (2008-2010); J. Pechal, PhD (2012-2014)
Graduate Advisor or Co-Advisor – Graduation Year:

Sanchai Naree (PhD) – present – major co-advisor, Burapha University, Thailand
Breanna Wydra (MS) – present – major advisor
Sierra Kaszubinski (MS) – present – major co-advisor
Joseph Receveur (PhD) – present – major advisor
Courtney Larson (PhD) – present – major advisor
Nicholas Babcock (MS) (2018) – major advisor
Courtney Weatherbee (MS) (2016) – major advisor
Gerald Nowak (MS) – (2016) – major advisor
Samrit Maksong (PhD) (2015) – major co-advisor, Burapha University, Thailand
Jennifer Lang (PhD) (2015) – major advisor at University of Dayton until move to MSU
Rachel Barker-McNeish (MS - 2011 and PhD - 2016) – major co-advisor
Kathleen Jennings-Gorbach (PhD) – (2012) – major co-advisor
Andrew Lewis (MS) – (2011) – major advisor
Megan Shoda (MS) – (2010) – major co-advisor

Graduate Committee Member:

Rex Mbewe (MS) – 2017 - present
Patrick Stillson (MS) – 2018 - present
Christine Kwiatkowski (MS) – 2017 - present
Joel Betts (MS) – 2017 – present
Samantha Tank (MS) – 2017 - present
Patrick Engelken (MS) – 2015 - present
Jason Matlock (PhD) – 2015 - 2018
Rebecca Vinit (MS) – 2015 - 2017
Ellen Jesmok (MS) – 2015

Service on Graduate Committees at Other Institutions and prior to 2014 at MSU (graduation year)

Jana Englmeier (PhD) – University of Würzburg (2019-present)
Alberto Doretto (PhD) – University of Turin, Italy (outside examiner) (2018-2019)
Tharindu Bambaradeniya (M.Phil) – University of Peradeniya, Sri Lanka (outside examiner) (2018-2019)
Zanthe Kotze (PhD) – Texas A&M University (2017-present)
Lindsay Harrison (PhD) – Mississippi State University (2017-2018)
Laxmi Dhungel (PhD) – Mississippi State University (2016-present)
Zachary Burcham (PhD) – Mississippi State University (2015-2019)
Supine Away Chankong (MS) – Burapha University, Thailand (2015-present)
Aumaporn Pongura (MS) – Burapha University, Thailand (2015-present)
Joseph Receveur (BS Honors Thesis) – Millersville University (2016)
Rachel McNeish (PhD) – University of Dayton (2016)
Tanawat Yemor (PhD) – Burapha University, Thailand (2015)
Jennifer Lang (PhD) – University of Dayton (2015)
Allison Blystone – University of Dayton (2014)
Jessica Davis (MS) – University of Dayton (2013)
Brandon King (MS) – University of Dayton (2013)
Sean Goins – University of Dayton (2012)
J. Chapman (MS) – University of Dayton (2012)
Jennifer Pechal (PhD) – Texas A&M University (2012)
Peter Levi (PhD) – University of Notre Dame (2012)
Ryan Kimbираuskas (PhD) – Michigan State University (2011)
Sarah Willson (MS) – Michigan State University (2011)
Lindsay Campbell (MS) – Michigan State University (2011)
Heloise Breton (PhD) – University of Ontario Institute of Technology (outside examiner) (2012)
Todd White (MS) – Michigan State University (2010)
Emily Campbell (MS) – Michigan State University (2010)
Kristi Zurawski (MS) – Michigan State University (2009)
Oswaldo Hernandez (PhD) – Michigan State University (2008)
Allison Oleson (MS) – Michigan State University (2007)
Sarah Wolf (MS) – Michigan State University (2007)

Visiting Faculty Scholars

Dr. Tatiana Oliveira – Federal University of Pernambuco (June-July, 2018)
Dr. Luc Djogbénou – Institut Régional de Santé Publique /University of Abomey-Calavi, Ouidah, Bénin (Sept., 2016)
Dr. Guang-hui Zhu – Shantou University Medical College, China (May 2015- May 2016)
Dr. Philip Barton – Australian National University, Australia (June 2015, October 2016)
Dr. Heather Jordan – Mississippi State University, MS, USA (March, 2014)
Dr. Rachel Simmonds - University of Surrey, United Kingdom (October, 2011)

Visiting Student Scholars

Alberto Doretto – PhD Student, University of Turin, Turn, Italy (August – December 2017)
Diego Oliveira – PhD Student, Universidade Federal De Pernambuco, Brazil (May – September 2017)
Juanjuan Guo – PhD Student, Xiangya School of Medicine, Gansha, Hunan, China (September 2016- September 2017)
Andre Akira Yoshikawa – BS Student, University Federal of Santa Catarina, Florianopolis, SC, Brazil (May – August 2016)
Maiara Rodrigues Oliveira Leite – BS Student, University Federal of Viçosa, Brazil (May – August 2015)
Carmella Vizza - PhD Student, University of Notre Dame, IN (April, 2014)
Jennifer Mauer - BS Student, Kettering College, OH (May – August 2013)
Hannah Moore - PhD Student, Keene University, United Kingdom (June, 2012)
Jennifer Pechal - PhD Student, Texas A&M University, TX (June – July 2010 and June – July 2011)
Michael Diaz - BS Student, California State University, CA (May – August 2011)

Undergraduate Research Advisor, Co-Advisor or Supervisor: > 100 students

Mentor of Undergraduate Research Assistants (years in lab) (IS = Independent Study for Credit)

Michigan State University

Katelyn Smiles (2018-Present)
Makayla Scott (2018 – Present)
Brianna Timmons (2018)
Mack McGinn (2017-2018) (Honors Capstone Project and IS)
Ryan Walquist (2017)
Caleb Armstrong (2017)
Katie Kierczynski (2016-2017) (Honors Thesis and IS)
Benjamin Bejcek (2016-2017, IS)
McKinley Brewer (2014-2018)
Sydney Manning (2016)
Sadie Boyd (2014)
Lucy Schroeder (2014-2015)

University of Dayton

Nichole Henger (2012-2013, IS)  Tiffany Blair (2009-2011, IS)

K-12 Science Fair Mentoring

- Josephine Baudendistel - Middle School Student. Mentored from 2011 - 2013 for several county and regional science fairs that resulted in an invitation to the Ohio State Science Day. She received first place several times but was unable to present at state competition because of age restrictions.

Academic Advising (University of Dayton)

2008-2009: 8 Advisees
2009-2010: 12 Advisees
2010-2011: 20 Advisees
2011-2012: 22 Advisees
2012-2013: 24 Advisees
2013-2014: 24 Advisees

Student Achievements

- Courtney Larson (PhD) – Kellogg Biological Station Graduate Student Research Fellowship, Michigan State University, $2000 (2019)
- Sierra Kaszubinski (MS) – The Forensic Science Foundation Student Travel Grant, $1,500 (2018)
- Breanna Wydra (MS) – The Forensic Science Foundation Acorn Grant, $1,500 (2018)
- Nick Babcock (MS) – The Merritt Endowed Fellowship in Entomology, Michigan State University, $2,000 (2018)
- Joe Receuver (MS) – The Gordon E. Guyer Fellowship in Aquatic Entomology, Michigan State University, $4,000 (2018)
- Courtney Larson (PhD) – Department of Entomology Eugenia McDaniel Award, Michigan State University, $500 (2018)
- Courtney Larson (PhD) – Kellogg Biological Station Graduate Student Research Fellowship, Michigan State University, $3500 (2018)
- Courtney Larson (PhD) – Kellogg Biological Station Graduate Student Research Fellowship, Michigan State University, $1700 (2017)
- Joe Receuver (MS) – The Gordon E. Guyer Fellowship in Aquatic Entomology, Michigan State University, $5,000 (2017)
- Courtney Larson (PhD) – Merritt Endowed Fellowship, Michigan State University, $2000 (2017)
- Courtney Larson (PhD) – Lechel Memorial Scholarship Presentation Winner, Michigan Mosquito Control Association, $600 (2016)
• Courtney Larson (PhD) – Graduate School Travel Fellowship, Michigan State University, $350 (2016)
• Courtney Larson (PhD) – National Science Foundation Graduate Fellowship (2016-2019)
• Courtney Larson (PhD) – The Gordon E. Guyer Fellowship in Aquatic Entomology, Michigan State University, $2000 (2016)
• Courtney Weatherbee (MS) – Merritt Endowed Fellowship, Michigan State University, $2000 (2016)
• Courtney Larson (PhD) – General Fund Research Award, Society for Freshwater Science, $1000 (2016)
• Courtney Weatherbee (MS) – Graduate School Travel Fellowship, Michigan State University, $350 (2016)
• Courtney Larson (PhD) – The Gordon E. Guyer Fellowship in Aquatic Entomology, Michigan State University, $1500 (2015)
• Courtney Larson (PhD) – 13th Annual Plant Science Graduate Research Symposium, Michigan State University, 3rd Place Winner of Applied Poster (2015)
• Scooter Nowak (MS) – The Gordon E. Guyer Fellowship in Aquatic Entomology, Michigan State University, $1500 (2014)
• Lauren Shewhart (BS) – The Ohio Academy of Science: The Environmental Science & Engineering Scholarship Program, $1500 (2013)
• Rachel McNeish (PhD) – Sigma Xi Grants-In-Aid of Research, $1000 (2013)
• Lauren Shewhart (BS) – Sigma Xi Symposium, University of Dayton Chapter Best Poster Award, $100 (2013)
• Lauren Shewhart (BS) – Lancaster-McDougal Undergraduate Research Award, $1000 (2013)
• Alex Ulintz (BS) – Invited presentation at the 2013 National Collegiate Research Conference (2013)
• Jennifer Lang (MS) – Entomological Society of America Monsanto Student Travel Award, $424 (2012)
• Andrew Lewis (MS) – Award for Best MS Student Presentation at the 9th Annual Meeting of the North American Forensic Entomology Association, College Station, TX, $500 (2011)
• Maureen Berg (BS) – The Ohio Academy of Science: The Environmental Science & Engineering Scholarship Program, $1500 (2011)
• Andrew Lewis (MS) – Award for Best MS Student Presentation at the 8th Annual Meeting of the North American Forensic Entomology Association, Windsor, Canada, $500 (2010)
• Kathy Gorbach (PhD) – University of Dayton Dissertation Fellowship (2010)
• Allison Gansel (BS) – Invited Presentation on Vernal Pools at Cox Arboretum, Dayton, OH (2010)
• Tiffany Blair (BS) – Learn, Lead Serve Award, $500 (2010)
• Elizabeth Gazdick (BS) & Allison Gansel (BS) – Posters on the Hill, Council for Undergraduate Research. Invited poster and meetings with congressional representatives and senators on Capitol Hill. (2010)
• Elizabeth Gazdick (BS) – International Learn, Lead Serve Award, $1500 (2009)
• Andrew Lewis (MS) – Dean’s Graduate Fellowship Award (2009)

University of Dayton Stander Symposium Presentations by students (beginning 2009)

Henger, N, J Alfieri, J Pechal, E Watson, J Baudendistel, ME Benbow. 2013. Succession and Female Gravid Status of *Chrysomya rufifacies* and *Cochliomyia macellaria* on Carrion, University of Dayton Stander Symposium, April 17, 2013, Dayton, OH
Lang, JM, R Erb, W Kmetz, J Baudendistel, J Wallace, ME Benbow. 2013. Using Epinecrotic Biofilms for Applications in Forensic Science, University of Dayton Stander Symposium, April 17, 2013, Dayton, OH
Shewhart, L, R McEwan, ME Benbow. 2013. Impact of Amur Honeysuckle (Lonicera maackii) Leachate on Culex pipiens Survivorship, Growth, and Pupation, University of Dayton Stander Symposium, April 17, 2013, Dayton, OH
Sullivan, K, ME Benbow. 2013. Bioassessment of an Outfall of the Mad River as well as Its Effects Downriver Using Aquatic Insects as an Index, University of Dayton Stander Symposium, April 17, 2013, Dayton, OH
Wright, A, T Blair, W Kmetz, K Fochesato, L Shewhart, ME Benbow, Outfall Water Quality Assessments of the Major Rivers of Dayton, Ohio, University of Dayton Stander Symposium, April 17, 2013, Dayton, OH
Teter, C, A Lewis, ME Benbow. 2011. Growth rates of the blowfly, Lucilia sericata, on different bovine body tissues. 2011 University of Dayton Stander Symposium, April 13, 2011, Dayton, OH.


Gansel, Allison, MD McIntosh, ME Benbow. 2011. Hydrology Effects on Invertebrate Communities in Artificial and Natural Vernal Pools. 2011 University of Dayton Stander Symposium, April 13, 2011, Dayton, OH.


Lewis, A, ME Benbow. 2010. Microbial and necrophagous insect community assembly, succession, and species richness associated with Sus scrofa carcasses across multiple seasons. 2010 University of Dayton Stander Symposium, April 14, 2010, Dayton, OH.


Ernst, M, K Gorbach, ME Shoda, ME Benbow, AJ Burky. 2010. Effects of Water Withdrawal on Terrestrial and Aquatic Drift in Four West Maui Streams. 2010 University of Dayton Stander Symposium, April 14, 2010, Dayton, OH.


Mentoring before 2009

- Co-Mentor for 20 undergraduates from the University of Dayton and Michigan State University involved in various research projects where they were included as an author on national conference abstracts or referred publications
- Co-Mentor for 29 undergraduates who presented posters at University of Dayton’s Stander Symposium
- Co-Mentor for 12 University of Dayton students that received institutional undergraduate Learn, Lead, Serve Awards

PROFESSIONAL SERVICE

National Service:

The National Academies of Sciences, Engineering and Medicine (formerly the National Research Council) Review Committee Member (2016-2018) — Appointed Committee Member of the Review of the Edwards Aquifer Conservation Program.
The National Academies of Sciences, Engineering and Medicine (formerly the National Research Council) Review Committee Member (2015-2016) — Appointed Committee Member of the Review of the Edwards Aquifer Conservation Program.
American Academy of Forensic Sciences, Pathology/Biology Research Committee Member (2016-2018) — Committee member to review research efforts and conference abstracts.
American Academy of Forensic Sciences, Pathology/Biology Awards Committee (2018) — Committee member to review society award nominees.
American Academy of Forensic Sciences, Pathology/Biology Forensic Biologist Trainee Paper Award Committee (2018) — Committee member to review trainee papers.
Society for Freshwater Science: Local Arrangements Committee (Detroit 2018) (2016-2018) — Committee member for local arrangement planning and organization.

Regional and Local Service:

Saginaw County Mosquito Abatement Commission, Technical Advisory Committee (2014-present)
Promotion and Tenure Review for Ohio State University (2017)

Service at Michigan State University:

Medical Entomologist (Chairperson): Department of Entomology (2018-Present)
CANR Global Strategy Advisory Committee – (2018-present)
CANR College Advisory Council – (2018-present)
Ecology, Evolutionary Biology and Behavior Program Executive Committee – (2016-present)
Reappointment, Promotion and Tenure Committee – Lyman Briggs College (2016); College of Osteopathic Medicine, Department of Family and Community Medicine (2017)
Communications and Marketing Committee: Department of Entomology (2014 – 2017)
Search Committee - Quantitative Entomologist (Chairperson): Department of Entomology (2015-2016)
Interview Committee (Administrative Assistant): Department of Entomology (2015)
Academic Program Review Coordinating Committee: Department of Entomology (2014 – 2015)
DOW Internship Program Development Committee Member: MSU-DOW New Era Internship Program (2006-2007)

Service at the University of Dayton:

Departmental Search Committee (2 faculty searches) — 2008/2009, 2011/2012
Undergraduate Curriculum Committee — 2012-2013
Graduate Admissions Committee — 2011/2012
Environmental Biology Program Steering Committee — 2008-2014
Undergraduate Recruitment Committee — 2010-2014
Career Seminars Committee — 2009/2010
Career Seminars Committee (Chairperson) — 2010-2011
Departmental By-laws Committee — 2009/2010
Discovery Day Lab Participant — 2011, 2012

Professional Development Activities (2015 – Present)

16 May 2017 – Improvisation for Scientists to Strengthen Public Communication Skills. Michigan State University (attendee)
1 January 2016 – 31 December 2016 – MSU Academy for Global Engagement (fellow)
8 January 2015 - Write Winning Grant Proposals. Michigan State University (attendee)
13 February 2015 – CSTAT Workshop Hierarchical Linear Models (attendee)

Forensic Casework and Expert Witness Service

Forensic Case: June - December 2018 — Evaluated evidence and executed an experiment to determine aquatic and terrestrial insect evidence related to postmortem submersion interval estimate range in Michigan.

Forensic Case: September 2017 — Identified arthropod evidence and constructed a minimum postmortem interval estimate range with Dr. Jennifer Pechal for a death scene investigation in Kalamazoo, MI.

Forensic Case: December 2013 — Identified arthropod evidence and constructed a minimum postmortem interval estimate range with Dr. Jennifer Pechal for a death scene investigation in Summit County, OH.

Forensic Case: October 2013 — Identified arthropod evidence and constructed a minimum postmortem interval estimate range with Dr. Jennifer Pechal for a death scene investigation in Summit County, OH.

Forensic Case: August 2011 — Identified and examined arthropod evidence with Mr. Andrew Lewis from a suspected stored product case in Dayton, OH.

COMMUNITY OUTREACH & EXTENSION

Outreach Activities

- CSI Fright After Dark, Cranbrook Institute of Science, Bloomfield Hills, MI (http://science.cranbrook.edu/find-program-event/cis-after-dark - October) Maggot Art Activity (Oct. 2015)
- Michigan State University Science Festival (April 2015)
- Science Reviewer for Indiana University’s PODcast, A Moment of Science (2013-present)
- Michigan State University Honors College Fireside Chat, Faculty Host (Oct. 2014)
- Michigan State University Bug House Halloween Open House – Maggot Art Activity (Oct. 2014)
- Michigan State University Middle School Girls’ Math & Science Day – Maggot Art Activity (Mar. 2014)
- ShamROCK Science Day, Boonshoft Museum of Discovery – Maggot Art Activity (Mar. 2013)
- Family Science Fest, Liebold Catholic High School – Maggot Art Activity (Feb. 2013)
- STEMM Celebration for Families, Ignite Innovation, Dayton Regional Science Festival, Chaminade Julienne Catholic High School – Maggot Art Activity (Nov. 2012)
- Chemistry and Cocktails, Ignite Innovation, Dayton Regional Science Festival, Boonshoft Museum of Discovery – Maggot Art Activity (Nov. 2012)

Outreach Presentations

The Living Dead: Using postmortem microbiomes to solve crimes and monitor public health. Lansing Torch Club, East Lansing, MI: Apr. 2019

Frontiers in Forensic Entomology. MSU Bug Club, Michigan State University, East Lansing, MI: April 2019

The Living Dead: Tales of Science and Crimes. Kinawa Middle School, Okemos, MI: Oct. 2018

The Dark Side of the Necrobiome: The Role of Carrion in Ecosystems. Waldgeschichtliche Museum at the Nationalparkverwaltung Bayerischer Wald (Bavarian National Forest), Germany: Oct. 2018

The Living Dead: Tales of Science and CSI — Science on Tap, The Loft, Lansing, MI: Oct. 2017


An Introduction to Forensic Entomology — Oakwood High School, Oakwood, OH: Oct. 2011

Buruli ulcer: A Mysterious Infectious Disease — West Carrollton Middle School, West Carrollton, OH: April 2011

Road Salt Effects on Aquatic Invertebrates — Minnesota Road Salt Symposium: Feb. 2008


Applied Forensic Entomological Research — Lorain County Community College, Cleveland, OH: Oct. 2003
The Hawaiian Invertebrates — Pacific Whale Foundation, Maui, Hawaii: July 2000

Media Interviews

- Television Interview, Spartan News Room, MSU (https://www.youtube.com/watch?v=tYjx3n8h8f8) (April 2019)
- Magazine Interview, MSU’s College of Osteopathic Medicine Communiqué Magazine, (Nov. 2015)
- Magazine Interview, MSU’s AgBioResearch Futures Magazine, lab spotlight (http://agbioresearch.msu.edu/news/mystery_solved_thanks_to_insects) (Oct. 2015)
- Online Media Interview, MSU Today (http://msutoday.msu.edu/feature/2015/spartan-crime-fighters/) (Oct. 2015)
- Online Media Interview, MSU Today, East Lansing, MI (Nov. 2014)
- Radio Interview, Michigan Business Network, Lansing, MI (Nov. 2014)
- Radio Interview, Detroit Public Radio, Detroit, MI (Oct. 2014)
- Online Media Interview, Science for the People (www.scienceforthepople.ca/) (April 2014)
- Online Media Interview, DugDug.com (Oct. 2013)
- Magazine Interview, Science News (Sept. 2013)
- Magazine Interview, University of Dayton Alumni Magazine (May 2012)
- Newspaper Interview, The Villages Daily Sun (Mar. 2012)
- Television Interview, WDTN, Dayton, Ohio (Feb. 2012)
- Newspaper Interview, Kettering-Oakwood Times (Mar. 2010)
- Phone Interview, Scripps Howard Foundation Wire, Washington, DC (Feb. 2010)
- Television Interview, WHIO, Dayton, Ohio (Aug. 2009)
- Television Interview, WHIO, Dayton, Ohio (Sept. 2009)
- Television Interview, AKAKU Public Broadcasting, Maui Community Television, Maui, Hawaii (Oct. 2006)
- Television Interview, AKAKU Public Broadcasting, Maui Community Television, Maui, Hawaii (Feb. 2003)
- Radio Interview, NPR Honolulu, Hawaii (Apr. 2001)
- Internet Interview, The JASON Foundation, Needham Heights, MA (Apr. 2001)

**SCHOLARLY PRESENTATIONS**

**Papers and presentations for learned professional organizations and societies from 2014-Present**  
*(244 citations from 1994 - 2013 are available upon request)*

2019


2018


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Program First Annual Research Symposium, Michigan State University, 1 May, East Lansing, MI.


2016


2015


66. Larson, C, CR Weatherbee, JL Pechal, B Gerig, G Lamberti, and ME Benbow. 2015. Aquatic macroinvertebrate and microbial community responses to salmon carrion introduction into a
headwater stream. 63rd Entomological Society of America Annual Meeting, Minneapolis, MN, 15-18 November.


73. McEwan, RW, ME Benbow, KW Custer, RE McNeish. 2015. A mechanistic framework for cross-habitat bottom-up effects of the invasive terrestrial shrub Lonicera maackii on the biology of headwater streams. 100th Ecological Society of America Meeting, Baltimore, MD, 9-14 August.


78. Lang, JM, RW McEwan, ME Benbow. 2015. Abiotic autumnal organic matter deposition and grazing disturbance effects on epilithic biofilm succession. 115th Annual Meeting of the American Society for Microbiology, New Orleans, LA, 30 May – 2 June.


88. Jordan, HR, JL Pechal, **ME Benbow**. 2015. Utility of Carrion Microorganisms for Forensics and Health...and a bit from the living. Anthropology and Middle Eastern Cultures Brown Bag Event, Mississippi State University, Starkville, MS, 9 April.


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2014


98. Lang, JM, RW McEwan, ME Benbow. 2014. Do grazers respond to and influence epilithic biofilm successional trajectories? Joint Aquatic Sciences Meeting, Portland, OR, 18-23 May.


100. Pechal, JL, R Erb, JM Lang, JR Wallace, ME Benbow. 2014. Living on the Dead: Microbial Community Succession on Decomposing Carrion in a Headwater Stream and Possible Applications for Forensics. Joint Aquatic Sciences Meeting, Portland, OR, 18-23 May. (poster)


