PROCEEDINGS 2ND NATIONAL FORUM ON BIOLOGICAL CONTROL

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This Forum was developed by joint agencies/organizations working on biocontrol (USDA Forest Service, Animal and Plant Health Inspection Service, Agricultural Research Service (ARS), DOI Bureau of Land Management, and the University of Florida) to provide an opportunity for the biocontrol community to discuss big picture topics, strategize on opportunities, priorities, and actionable steps forward, and learn about innovative research, management applications, and the impacts of our work. It was hosted by the USDA Forest Service in partnership with the North American Invasive Species Management Association, ARS, and the National Association of State Foresters.

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CONTENTS

KEYNOTE

Willie Cabrera Walsh, Fernando Mc Kay
Fundación para el Estudio de Especies Invasivas/USDA-ARS-South American Biological Control Lab., Argentina

Changing the Culture: How Weed Biocontrol Went from Suspect to Cool in Argentina

Classical weed biocontrol (CWB) depends on international collaboration between the countries that have the invasive (receptor countries), and the ones where the invasive is native (donor countries), in order to obtain the specialized, coevolved biocontrol agents needed to control it. The U.S. has research facilities in other countries precisely for this purpose known as the OBCLs (Overseas Biological Control Laboratories). The FuEDEI has worked on 40 target weeds since its inception in 1962, resulting in 20 biocontrol agents released. But the services provided by the OBCLs are not limited to shipping organisms to the U.S. These include specificity/safety testing, phylogenetics and molecular taxonomy, biogeography (origin and geographical range), analyses of potential impact (is the agent actually going to do anything?), field host range, and agent compatibility. In addition, OBCLs can procure savings in quarantine or post-liberation experiments, perform field studies to minimize the rejection of suitable candidates, transport 'unlimited' samples to the lab., and set-up experimental plots in the field. In addition, the CBD has complicated access to natural resources. We describe our four-pronged strategy to work within these new conditions: Promotion-Initiative-Bargaining-Education (PIBE). Finally, we present a list of South American aquatic and terrestrial invasive plants that may warrant discussion as biocontrol targets.

Guillermo 'Willie' Cabrera Walsh; Sc.D. in Biological Sciences, University of Buenos Aires. Applied entomology and pest control through their natural enemies, has been working on biological control since the 80s. His research projects have ranged from study and breeding of biological control agents for dung flies and problems related to the accumulation of cattle manure in pastures, agricultural pests, such as corn rootworms, fall armyworm, and sugarcane borer, and 15 aquatic and rangeland weeds, as well as studies on plant kairomones and synthetic pheromones with potential in integrated control and monitoring of crop pests. He is a member of several advisory committees of the Ministry of Agriculture, vice president of the Entomological Society of Argentina, and advisor for the IOBC. He currently directs the Foundation for the Study of Invasive Species (FuEDEI), which is the South American USDA-ARS Overseas Biological Control Laboratory (OBCL).

Prioritizing Weeds for Biocontrol Using a Targeted Selection System

Rachel Winston[1], Mark Schwarzländer[2], Hariet Hinz[3], Julia Rushton[2], Paul Pratt[4]
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Weeds negatively impact native ecosystems, and their effects are likely to increase with continuing global trade. Biocontrol has been employed as a cost-effective and sustainable management option for weeds in the USA since 1902. Biocontrol programs require careful prioritization of target weeds to ensure the most appropriate targets are selected to obtain the greatest beneficial outcomes with available resources. The Biological Control Target Selection (BCTS) system was developed by researchers in South Africa as an objective, transparent approach to prioritizing new weed biocontrol targets. The BCTS system was recently modified and applied to 295 state-regulated weeds in the western USA for which no biocontrol agents have yet been released. This presentation discusses the results of that application, identifying the most suitable candidates for new programs as well as problematic weeds for which the likelihood of successful biocontrol is low. Top-ranked species in the western USA are biennial or perennial weeds in stable habitats, are established in more than one state, are difficult to control with conventional methods, have large negative impacts and no conflicts of interest outside the horticultural industry, and have substantial information available on potential biocontrol agents. Fifteen of the 20 top-ranked species are already targets of ongoing biocontrol programs in the USA. The next highest-ranked species largely differ by having less information available on potential biocontrol agents and having native or economically important congeners in the USA. Results from this framework provide valuable insights to the prioritization of current and future biocontrol research programs in the western USA.

Rachel has been involved with weed biological control since obtaining her M.S. in Environmental Science in 2007. In collaboration with public and private organizations in various countries, she produces public outreach/education material for weed identification and biological control, helps petition for new biocontrol agents, and assists developed and developing nations in customizing potential weed biocontrol programs. Since 2010 she has been the curator of the world database *Biological Control of Weeds: A World Catalogue of Agents and Their Target Weeds.*

Genetic Approaches to Managing Invasive Plants: Prospects, Challenges, and the Need for International Collaboration

Kumaran Nagalingam[1], Kurt P. Kowalski[2], Ping Gong[3], and Matthew A. Tancos[4]
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Gene silencing offers promising avenues for developing innovative genetics-based biocontrol tools for the sustainable management of invasive plants. Notably, RNA interference (RNAi) can effectively silence genes that are critical for essential functions (e.g., growth, reproduction) and herbicide resistance. However, using the RNAi process to manage invasive plants is a relatively new approach that faces challenges related to empirical validation, regulatory frameworks, and social acceptance. In October 2024, scientists from Australia and the USA convened in Brisbane, Australia for a two-day workshop to explore these challenges and discuss potential collaborative strategies for addressing them. The participants acknowledged the rapid advancement of gene silencing technologies, noting the availability of RNAi-based pesticides in the market. However, they also recognized that the effectiveness of RNAi varies among different target species, influenced by factors such as the stability and cellular delivery of gene silencing molecules and the target organisms' responses to RNAi-based treatments. To overcome stability issues, participants discussed recent advancements, including the use of 'nano clay' for molecule protection and the development of structurally stable double-stranded RNA molecules. Addressing delivery challenges was a central focus of the discussions, with the group proposing a consortium-based approach to foster collaborative problem-solving. Furthermore, the potential to integrate RNAi-based methods with traditional control measures (e.g., classic insect biocontrol) was explored, including the use of insect biocontrol agents as delivery vectors for RNAi molecules. The workshop also emphasized the critical role of industry engagement and support in ensuring the successful development and deployment of these novel gene-based technologies.

Dr. Kumaran Nagalingam is an ecologist dedicated to advancing the understanding of plant-insect interactions for more effective pest and weed management strategies. With a keen focus on ecological and genomic methodologies, Dr. Kumaran investigates intricate insect pest and weed dynamics, aiming to develop innovative management solutions. Managing a dynamic team, Dr. Kumaran leads the development of biocontrol and genetic control techniques to tackle invasive insect pests and weeds. Through leading-edge research projects, Dr. Kumaran translates novel technologies into practical tools for on-the-ground deployment, facilitating their adoption and implementation by end-users.

Promoting Undergraduate Research in Biocontrol Through Genomics

Dan Bean[1], Emma Shelton[1], Zeynep Özsoy[2], and Amanda Stahlke[3]
[1] Colorado Department of Agriculture, [2] Colorado Mesa University, [3] University of Idaho

Using recently developed technology it is now possible to investigate the genomic structure and molecular genetics of non-model organisms, including biocontrol agents. Through a partnership with the USDA ARS we have sequenced and assembled genomes of four species of *Diorhabda* that feed exclusively on exotic invasive shrubs in the genus *Tamarix*. Hybridization patterns within the *Diorhabda* complex can be explained by genome structure, while further work is needed to identify and characterize genes involved in the diapause response critical to phenology within this system. Since the diapause response has been previously shown to evolve, and is impacted by hybridization within the *Diorhabda* complex, it offers a rich array of research questions involving taxonomic relationships, physiological ecology, and evolution within newly introduced biocontrol agents. Research necessarily begins with gene annotation, the process of defining genes within genomic sequence. Since gene annotation is done manually it offers excellent research opportunities for undergraduates interested in molecular genetics and bioinformatics. Undergraduates at Colorado Mesa University, University of Northern Colorado and Western Colorado University are currently assisting in gene annotation within the Diorhabda complex. Under the auspices of the Genomics Education Partnership (GEP), a national organization promoting genomics research at undergraduate institutions, students investigate the conservation of gene structure and synteny within the *Diorhabda* complex, and with other Coleoptera. The GEP has adopted *Diorhabda* as a non-model organism where gene structure and function can be investigated by undergraduates. Promoting genomics in biocontrol systems will engage undergraduates and elevate interest in biocontrol.

I received a PhD in entomology from the University of Wisconsin, Madison, studying the physiology of an invasive pest, the European corn borer. My early work in insect physiology taught me the need to consider biological relationships in all elements of pest control. I began my career in biocontrol at the USDA-ARS facility in Albany, CA, where I investigated the physiological ecology of the tamarisk beetle and use of that knowledge for suppression of tamarisk. Since 2005 I have been director of Colorado's biological control program, which is part of the Colorado Department of Agriculture, and is headquartered at the Palisade Insectary. I have maintained my interest in using knowledge of insect physiology, behavior and ecology to improve our ability to utilize biological controls. I am also interested in developing better protocols for incorporating biological control into IPM-based weed and pest management strategies.

Emerging Genomic Technologies for Biological Control of Invasive Weeds

Matthew A. Tancos
USDA-ARS FDWSRU

Biological control exploits host-specific natural enemies to control a target pest and is a cost-effective and practical option for managing invasive weeds that occupy diverse habitats across vast, heterogeneous regions. However, numerous challenges associated with agent discovery, testing, and certification, result in prolonged, multiyear developmental timelines that lead to expanded invasions and compounded damage due to delayed treatments. As new agroecological pests emerge and biological invasions expand, it becomes critical to develop novel genomic technologies that leverage molecular advancements needed to rapidly respond to emerging threats. New agricultural biosecurity threats can be targeted pre-emptively with species-specific genetic biocontrol tools. Incorporating flexible, pre-designed genetic biocontrol tools can result in earlier deployment, thereby targeting earlier stages of the invasion curve and minimizing damages. While genetic biocontrol will require substantial research and development (R&D) costs and regulatory oversight, similar to classical biological control, R&D will become modular and streamlined as techniques and technologies are optimized across related weed systems, reducing costs overtime. As with any new technology, demonstrating safety and efficacy will be critical to stakeholder acceptance. Through foundational research targeting these areas of emerging genomic technologies, genetically tailored tools could lead to much needed pre-emptive weed management strategies to rapidly address threats to U.S. Agriculture.

Dr. Matthew Tancos is a Lead Scientist and Research Plant Pathologist with the United States Department of Agriculture – Agricultural Research Service (USDA-ARS) located at the Foreign Disease-Weed Science Research Unit (FDWSRU) at Fort Detrick in Frederick, Maryland. He is originally from Indiana and received his B.S. in Biology, specializing in genetics and ecology, from Ball State University. He received his Ph.D. in Plant Pathology & Plant Microbe Biology from Cornell University in 2016. Matthew's research program is (i) investigating the use of microbes as biological control agents to manage invasive weeds in the United States, (ii) defining the biosecurity risks of pathogen evolution and strain emergence within invasive weed populations, and (iii) investigating novel molecular-based invasive weed management strategies. His research leverages advances in plant genomics and molecular biology to develop enhanced biocontrol solutions to prevent and manage agronomically damaging invasive weeds.

Prioritizing Regions for Native Range Surveys: *Imperata cylindrica* (Cogongrass)

Dean Brookes[1,2] and Greg Wheeler[3]
[1]CSIRO Australia, [2]USDA-ARS ABCL, [3]USDA-ARS IPRL

Prioritizing regions for native range surveys is challenging for weeds that are genetically and phenotypically diverse. *Imperata cylindrica* (cogongrass) exemplifies this challenge. This invasive grass is globally distributed, has several distinct evolutionary lineages, and there have been multiple introductions into the United States. Several promising agents have been discovered across the native range of cogongrass, and although this is great, choosing which agents to prioritise presents further challenges. We have made significant progress in understanding the diversity of cogongrass across its native range, prioritizing candidate biological control agents based on this understanding, and using molecular data to frame our information and observations. The next step for this project is to use this framework to experimentally test how different cogongrass lineages affect the suitability of our biocontrol agents, and choose those that will be suited for, and impactful against, the US lineages of this weed.

Dean Brookes' research background is in ecological genetics and insect-plant interactions in agriculture and biological control. For two years Dean has been working for the Australia Biological Control Laboratory (ABCL), a USDA-ARS overseas laboratory that is partnered with the Australian federal Commonwealth Scientific and Industrial Research Organisation (CSIRO). Dean is currently team leader within ABCL, overseeing the team's research projects, conducting surveys for potential agents throughout Asia and Australia, and building molecular capacity within the team. Dean's current research focus is the broader integration of molecular techniques into biological control to fast-track agent discovery and evaluation, and to better understand the host associations of potential biological control agents across the native and introduced distributions of invasive weeds.

Can We Better Prioritize Potential Biological Control Agents in a Changing Climate?

Lauréline Humair[1], Sergio Rasmann[2], Rodrigo Diaz[3], and **Philip Weyl**[1]
[1] CABI Switzerland, [2] University of Neuchâtel, [3] Louisiana State University

In recent years tropical and sub-tropical plants are invading temperate regions thought to be driven by climate change. One such species is parrots feather, *Myriophyllum aquaticum*, originally from the Amazon and Parana basins, it has now spread worldwide and is considered invasive in several temperate regions including western North America and Europe. Biological control in these environments poses constraints, not only on host specificity but also potential climatic limitations linked to increased extreme weather events and cooler climates than the native range. There are three potential biological control agents worth further investigation for parrots feather management. The leaf-feeding flea beetle (*Lysathia* sp.) and the stem-mining weevil (*Listronotus marginicollis*), both native to South America and have been developed for South Africa; the former has been released. The third, a North American native weevil (*Phytobius vestitus*), was recently identified damaging parrot's feather in Louisiana. In this presentation I will give an overview of my PhD research which combines traditional and novel host specificity testing with thermal physiology studies to evaluate biological control agents' safety and predict their efficacy. By rapidly assessing both the host range and thermal physiology, a biological control program can prioritize which species to invest limited resources and ensure a likely successful outcome.

Lauréline started working at CABI as a summer student in 2020 and is now a Junior Scientist working on the biological control of invasive weeds. She is currently working on the development of weed biological control for several projects which includes field surveys for potential biological control agents and quarantine work testing the environmental safety of the potential biological agents. In 2023, she started a PhD that will investigate prioritizing agents to invest limited resources by understanding their thermal physiology as well as preliminary host range. Lauréline is also involved in citizen science, giving courses on insects and biological control to school classes of ages 5 to 16 years.

Ecological Niche Modeling and Threats to a Temperate Non-target Species from Tropical Biological Control Agents of *Lygodium microphyllum*

Greg Wheeler[1] and Guy Sutton[2]
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Old World climbing fern, *Lygodium microphyllum* is one of the worst environmental weeds of Florida. Two agents are being developed for the biological control of this invasive species, the defoliators *Callopistria exotica* (Lepidoptera: Noctuidae) and *Lygomusotima stria* (Lepidoptera: Crambidae). Both agents were found in tropical regions of Southeast Asia feeding on the target weed. Host range examinations indicated both species are genus-level specialists, completing development only on species of *Lygodium*. However, both completed development on a temperate native species, *L. palmatum*. The threat posed by these potential agents to this temperate non-target species was defined by thermal tolerance and ecological niche modeling studies. The results of these studies indicated that populations of neither potential agent would survive in the temperate areas where the non-target *L. palmatum* grew naturally. These results suggest that both agents will assist land managers reaching weed management objectives without damaging valued non-target species.

Greg Wheeler is a Research entomologist who has been working for over 30 years on biological control of invasive weeds of Florida natural areas. Weed targets have been primarily, Old-world climbing fern, cogongrass, Brazilian peppertree and Chinese tallow tree for which safe agents have been developed.

Evolutionary and Ecological Drivers of Grass-Insect Herbivore Specialization Patterns: Understanding Assumptions Critical to Successful Biological Control of Invasive Weeds

Colin R. Morrison[1], Robert Plowes[1], Guy Sutton[2], Aaron Rhodes[1], Iain Paterson[2], Dino Martins[3], and Lawrence Gilbert[1]

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Understanding evolutionary and ecological dynamics is essential for effective biological control and integrative management of invasive weeds. This study investigates the evolutionary ecology of insects associated with native grassland grasses in Texas, Kenya, and South Africa to identify mechanisms shaping grassland communities so that we can deliver biological control solutions for invasive weeds dominating these ecosystems. Despite well-established predictions about global drivers of plant-insect host usage, their applicability to the evolution and maintenance of grass-insect herbivore assemblages is exceptionally understudied. Our study analyzed 87 grass species from Texas, Kenya, and South Africa, identifying associated insect herbivores via morphotyping, CO1 barcoding, and expert identification, and inferring trophic interactions using comparative phylogenetics, phenological data, and literature. Phylogenetic similarities (ITS locus) and metabolomic profiles (all measurable chemicals compounds) were measured to correlate host grass traits with herbivore assemblage similarities in each biogeographic region. Results showed strong evidence for host specificity in all regions, particularly among internal-feeding herbivores like gall midges (Diptera: Cecidomyiidae), highlighting their potential as biocontrol agents for invasive grasses. Phylogenetic signals in host usage support the Centrifugal Phylogenetic Host Testing Method and highlight host metabolomic similarity as a key mechanism driving herbivore-host specificity. These findings inform ongoing host-choice testing and impact assessments of Guinea grass (*Megathyrsus maximus*) biological control candidates.

Dr. Colin Morrison is a Postdoctoral Research Associate in the Department of Integrative Biology at the University of Texas at Austin, working under the mentorship of Dr. Rob Plowes and Dr. Larry Gilbert. As part of the Invasive Species Research group at UT Austin's Brackenridge Field Laboratory, Colin investigates the ecology and biological control of invasive species. Colin specializes in chemical ecology and species interactions. His work focuses on understanding how host plant metabolomics (complete chemical profile of an organism), host plant phylogenetics, and host specificity influence community structure and stability. This research is particularly relevant to ecosystems dominated by invasive weeds or those with foundational plant species attacked by invasive insects. Current research includes efforts to control invasive perennial grass weeds, such as Guinea grass (Poaceae: *Megathyrsus maximus*) and buffelgrass (Poaceae: *Cenchrus ciliaris*), and mitigating the spread of the invasive cactus moth (Lepidoptera: Pyralidae: *Cactoblastis cactorum*).

Measurement of Biological Control Impact Targeting Attributes of Population Expansion of Two Clonal Weeds

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Assessments of impact of biological weed control must consider impacts on weed population survival and spread. Programs targeting weeds that reproduce mainly or entirely through vegetative means must exploit and measure key determinants of weed population growth without reference to flowering, fruiting and seed dispersal. We present information from ongoing assessments targeting arundo (*Arundo donax*) and Cape-ivy (*Delairea odorata*) in the Central Valley of northern California and along the coast, respectively. Arundo patches persist, expand and disperse through rhizome branching, shoot bud formation and rhizome and shoot movement. A shoot-galling wasp can reduce live shoot biomass in the field, and addition of a rhizome- and shoot-feeding armored scale can increase negative effects on shoots. Both agents were released and are established at 9 sites. Cape-ivy spreads mainly by shoot fragmentation and rooting at nodes. A shoot tip-galling fly that reduced shoot tips and length in lab tests is established at 11 sites. Ongoing impact assessments on both weeds include measurement of biomass, shoot or shoot tip length and density, digitized estimates of cover and plant community diversity. Measurement of attributes known to be important in population invasiveness strengthens assessments, but determination of impacts on dispersal is a challenge because of the presence of factors other than biocontrol that limit clonal dispersal. The use of IWM approaches has created an opportunity to determine the ability of biocontrol to limit regrowth patch expansion following chemical or mechanical control. Efforts to remove arundo and Cape-ivy would benefit from coordination with biological control programs.

Dr. Patrick Moran is a Research Entomologist with 23 years of experience at the USDA-ARS studying classical biological control of invasive, non-native weeds, with a special focus on weeds that threaten scarce water resources in the southwestern U.S. in rangeland, forest, riparian and aquatic systems. He focuses on characterization of the biology, host range and efficacy of candidate biocontrol agents in quarantine lab and overseas studies, release and evaluation of establishment of permitted agents and efficacy assessments, and IWM approaches involving biocontrol.

Threats to Biocontrol—Anticipating Cryptic Species: the Example of Pug Moths *Eueupithecia cisplatensis* and *E. vollonoides*, biocontrol agents of the weed Jerusalem Thorn (*Parkinsonia aculeata*) in Australia

Cody-Ellen Murray[1,2], Michelle A. Rafter[2], Dean Brookes[2,3], Kelli Murree[4], Andrew White[2], Fernando Mc Kay[5], and Walter H. Gimme[1]

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In weed biocontrol, cryptic species in both the target weed and putative agent pose significant threat to each phase of the biocontrol pipeline. Inaccurate taxonomy may impact our understanding of weed origin and distribution, provenance testing of invasive populations and subsequent native range surveys for agents. This extends to identifying host-specific agents, host-testing and mass-rearing. Therefore, cryptic species should be actively anticipated at the outset of research, but clarifying their presence can be complicated. Behavioural, chemical, morphological and molecular approaches may each result in different conclusions being drawn regarding species delimitation. Using the example of two cryptic species of *Eueupithecia* moths, native to South America and introduced to Australia as biological control agents of *Parkinsonia aculeata*, we illustrate how an integrative approach can accurately clarify species boundaries and infer the outcomes for biocontrol. Initially delimited by COI divergence and morphological disparities across their internal genitalia, *Eueupithecia* moths were later found to hybridise in culture and reciprocal pheromone trapping in the field revealed males of each species are attracted to heterospecific females. Nevertheless, genotyping-by-sequencing revealed that the two exist as discrete genetic entities in areas of sympatry both in the native and introduced ranges. These results validate the efforts made in early stages of this program to rear *E. cisplatensis* and *E. vollonoides* independently, matching their releases in Australia to environments like those from which each is distributed in the native range. As such, the unique qualities of each species can be exploited to enhance biological control of the host weed.

Cody is a PhD Candidate at the University of Queensland, Australia and Research Technician for the Weed Management Systems group at the CSIRO. Cody conducts research in weed biological control, integrated pest management and sustainable agriculture. Her research interests and experience include the application of chemical, behavioral and molecular tools to biological and ecological research questions for applied outcomes. She has multidisciplinary experience in behavioral entomology, the chemical ecology of insects (sex pheromones) and their hosts (foliar volatile organic compound emissions), the biological control of weeds, conventional and molecular diagnostics, species delimitation, the development of novel herbicides and insecticides, and the development of accessible programs for implementing safe and practical integrated pest management strategies in rural and developing communities.

Understanding Host Preference in *Mecinus janthinus* and *M. janthiniformis*: Implications of Hybridization for Effective Biological Control

Sharlene E. Sing[1], **Jackson R. Strand**[2], Robert K.D. Peterson[2], and David K. Weaver[2]

[1] USDA-Forest Service RMRS, [2] Montana State University

We examined the efficacy of the stem mining weevils *Mecinus janthinus* and *M. janthiniformis* as biological control agents, respectively, for invasive yellow toadflax (*Linaria vulgaris*) and Dalmatian toadflax (*L. dalmatica*). A confounding factor in their success in the western U.S. is the high frequency with which hybridization occurs between their closely related host plants. Hybridization produces genetically variable and unpredictable populations, complicating *Mecinus*-based biological control. Y-tube bioassays revealed clear differences in host specificity. *Mecinus janthinus* exhibits high host fidelity to yellow toadflax, rarely accepting Dalmatian toadflax as a host. *Mecinus janthiniformis*' broader host acceptance may have implications for hybrid toadflax management. Volatile compound analysis revealed significant differences in the chemical profiles of yellow and Dalmatian toadflax, with confirmed field collected or manipulated hybrids producing unique blends distinct from their parental lines. Electroantennography (EAG) can objectively elucidate the volatile components primarily responsible for driving host acceptance or rejection for each weevil species. This chemical variability, coupled with frequent hybrid backcrossing, poses challenges in achieving effective and predictable biocontrol. By clarifying how hybridization influences host selection in these weevils, our findings underscore the complexities in predicting *Mecinus* biocontrol success in hybrid toadflax populations and provide valuable insights for other weed biocontrol programs.

Jackson Strand is a Ph.D. candidate at Montana State University. He earned his B.S. in Biology from the University of Minnesota in 2017 and his M.S. in Entomology from Montana State University in 2024. His master's research centered on the role of smooth brome in supporting two congeneric parasitoids that target the wheat stem sawfly in dryland agricultural systems in Montana. Currently, he is investigating the biological control of yellow and Dalmatian toadflax in Montana and South Dakota. Broadly, his interests include beneficial insect ecology and chemical ecology.

Abiotic and Biotic Factors Influencing *Niphograpta albiguttalis* Establishment in Southern United States: Implications for Water Hyacinth Biocontrol

Flaminia Mariani[1], Rodrigo Diaz[1], and Paul Pratt[2]

[1] Louisiana State University, [2] Montana State University, [3] USDA-ARS ISPHR

Water hyacinth (*Pontederia crassipes*) is a highly invasive species in the United States, prompting biocontrol measures since the 1960s. Among the introduced agents, water hyacinth moth (*Niphograpta albiguttalis*) has been established in the southern U.S. for several decades but failed to persist in California. This study aims to identify abiotic and biotic factors limiting *N. albiguttalis* distribution to improve water hyacinth control in target regions. Specific objectives included: (i) identify thermal and water quality conditions that affect the survival of *N. albiguttalis*, (ii) assess whether petiole morphology (bulbous vs. elongated petioles) or toughness influences insect establishment, (iii) quantify *N. albiguttalis* density and its relation to interspecific interactions with other biocontrol agents, and (iv) evaluate nutrient availability in plants and water that may impact insect abundance. Sampling was conducted across 25 sites between 25°–32°N latitude in the southern U.S., with 2–4 subsites per location. Central and fringe infestation patches were sampled using a square frame to define the sample area. Biomass, shoot number, petiole toughness and morphology were measured for each sample. Insect presence and herbivory damage from multiple biocontrol agents were recorded for each petiole, with damage levels indicating insect activity. Additionally, the carbon-to-nitrogen ratio was analyzed to assess plant quality as a food source for *N. albiguttalis.* Results from this multi-site study could elucidate ecological and environmental constraints on *N. albiguttalis* population densities, directly informing optimized mass-rearing protocols. Results will guide targeted release protocols, focusing on favorable conditions, particularly in California's San Joaquin Delta, to maximize biocontrol success.

Flaminia Mariani is a postdoctoral researcher at Louisiana State University, where she focuses on the biological control of invasive aquatic plants, including water primrose, water hyacinth, and alligator weed. Her research investigates the effectiveness of natural enemy transfers across diverse U.S. regions and develops mass-rearing techniques for targeted release programs. Flaminia earned her Ph.D. in Environmental Biology from Roma Tre University in Rome, Italy (2021), with a focus on biological control methods for invasive duckweed species in Europe.

KEYNOTE

Stephen Enloe
University of Florida

Plus Sperare Quam sit Possible: Is our Expectation of IPM for Invasive Plants Even Realistic?

The persistence of invasive plant species poses an existential threat to global ecosystems, necessitating the deployment of integrated pest management (IPM) strategies for effective mitigation. While IPM has become an essential paradigm for invasive species management, the integration of its constituent tools often proves intractable, necessitating expedient workarounds that compromise fluidity and efficacy. Biological control, in particular, stands at the confluence of this conundrum, as other IPM tools frequently exhibit potential to negatively impact biocontrol populations, thereby hindering the realization of optimal management outcomes. The paucity of compelling research aimed at refining integration in various systems is partly attributed to the persistence of disciplinary dichotomies, arising from fundamentally divergent philosophical expectations regarding management success within the fields of entomology and weed science. While weed scientists often harbor reservations regarding the efficacy of biocontrol due to its mixed record of performance relative to herbicides, entomologists tend to adopt a more nuanced perspective, emphasizing the strategic value of long-term control outcomes. Can these disparate viewpoints be reconciled? This keynote presentation will engage with the contentious issues surrounding this disciplinary conflict, facilitating a synthesis of insights and fostering a consensus among researchers and land managers to enhance the effectiveness of IPM for invasive plants.

Dr. Enloe is a professor and extension specialist at the IFAS Center for Aquatic and Invasive Plants at the University of Florida. He has been involved with invasive plant research and extension for the past two decades and has worked throughout the western and southeastern United States on developing innovative management strategies for many of the worst invasive tree, shrub, vine, and herbaceous species in the US. Dr. Enloe earned his Ph.D at UC Davis in Plant Biology, a Master's degree in weed science from Colorado State University and an undergraduate degree in Agronomy from N.C. State.

Tallow Tree Biological Control and Beekeeping: Assessing the Misconceptions and Possible Resolutions to Protect Native Ecosystems

Alexander M. Gaffke[1], Greg Wheeler[2], and Rodrigo Diaz[3]
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Chinese tallow (*Triadica sebifera*) is a tree native to southeast Asian that was introduced to north America in the late 1800's. Since its introduction, it has escaped cultivation and has spread throughout the southeastern United States, degrading natural habitats. Numerous attempts to control this invasive tree through conventional means has failed. This resulted in the initiation of a classical biological control program. Petitions for release have been approved for two, host specific, biological control agents. During the petition process, beekeepers expressed broad resistance towards the biological control program, resulting in significant delays to the permitting of the agent. Multiple research studies were therefore conducted to determine the importance of tallow for honey production. The results of these studies are mixed, supporting and contradicting the importance of Chinese tallow to beekeepers. This presentation will compare and contrast the implications of Chinese tallow biological control for honey production and highlight what is needed to move the program forward.

Dr. Alexander Gaffke is a research entomologist at the Center of Medical, Agricultural, and Veterinary Entomology for the United State Department of Agriculture. His research focuses on the integration of chemical ecology, biological control, and integrated pest management. He has worked with multiple invasive weeds across the country and his research has resulted in the development of novel strategies to improve and enhance biological control programs.

Concerns of Impacts to Weed Biocontrol from Mosquito Abatement

Mikenna Smith
Teton County Weed & Pest District

The application of insecticides for the protection of human health against mosquito-borne diseases is one pillar of the integrated mosquito management approach. But how does the chemical treatment of mosquitoes impact non-target insects such as biological control agents that are vital to the integrated pest management approach against invasive species? More commonly than not, there is little crossover between agencies conducting mosquito abatement and the biological control of invasive species. At Teton County Weed & Pest District, however, we have successful programs for both mosquito treatment and the biological control of terrestrial invasive plants. As such, this dual specialization offers a unique perspective to comment on such conflicts of interest. During this presentation, the potential for non-target impact from mosquito control will be discussed through the lens of a critical literature review.

Mikenna has a Master of Science in Entomology from the University of Florida, a Master of Science in Agricultural Sciences from Hohenheim University in Germany, and a Bachelor of Science in Environmental Science and Biology from Westminster University in Utah. At Teton County Weed & Pest District, Mikenna is responsible for laboratory oversight, vector surveillance, biological control, and insecticide resistance and efficacy monitoring. Mikenna has taken her enthusiasm for applied science and entomology to strengthen the District's scientific and research capabilities in both its laboratory and field programs. In her first few years with the District, Mikenna began turning the "laboratory," which was a big storage room with a microscope in it, into a fully equipped BSL2 with BSL3 practices laboratory. Mikenna is continuously bolstering mosquito management and research capacities not only in Teton County, but throughout the state of Wyoming through targeted partnerships and collaborations.

Biological Control as an Early Conservation Effort: Pre-emptive and Early Application in Biological Control of Invasive Plants

Melissa C. Smith[1], Kim Canavan[2], **Carey R. Minteer**[3], Deah Lieurance[4]

[1] USDA-ARS IPRL, [2] Rhodes University Centre for Biological Control, [3] University of Florida, [4] Penn State College of Agricultural Sciences

Invasive alien plants (IAPs) pose serious threats to biodiversity, exacerbated by climate change and habitat loss. Effective management typically involves cultural, chemical, and biological control methods. While cultural and chemical strategies have established protocols for addressing new invasions quickly, biological control is often only considered after significant negative impacts occur. Mounting evidence supports strong early investments in proactive prevention and early biological control as more cost-effective than reactive measures. We propose a framework for earlier biological control investigation and implementation. This framework involves risk assessments and horizon scanning to prioritize and identify targets, literature searches and cursory field searches to find potential control agents, and resource sharing among regions with similar challenges. To further illustrate the utility of early intervention, we provide an example from Florida with *Acacia auriculiformis* that builds on cooperative efforts between state, federal, and international parties. The key strengths of earlier intervention include enhanced collaboration and training opportunities to further support conservation efforts and lessen negative impact from IAPs. Challenges arise from an increasingly austere funding environment that often over emphasizes reaction-based approaches, and lack of knowledge over unrealized costs or savings from thwarting species invasions.

Dr. Melissa Smith is a research ecologist with the USDA's Invasive Plant Research Laboratory in Fort Lauderdale, Florida. Melissa joined USDA in 2012 and focuses on broad ecological interactions of large-scale plant invasions with the native community and introduced biological control herbivores. Some of the species to which Melissa contributes include *Melaleuca quinquenervia*, *Acacia auriculiformis*, *Lygodium microphyllum* and *Pontederia crassipes*. At the Invasive Plant Research Laboratory, Dr. Smith has delved into many collaborative projects to investigate larger ecological questions (e.g., competition, predation, parasitism, succession) within a biological control context.

Leveraging Augmentation Biological Control for Aquatic Weed Management

Rodrigo Diaz[1], Ivan Grijalva[1], Alex Gaffke[2], Flaminia Mariani[1]
[1] Louisiana State University, [2] USDA-ARS CMAVE

Prioritizing regions for native range surveys is challenging for weeds that are genetically and phenotypically diverse. *Imperata cylindrica* (cogongrass) exemplifies this challenge. This invasive grass is globally distributed, has several distinct evolutionary lineages, and there have been multiple introductions into the United States. Several promising agents have been discovered across the native range of cogongrass, and although this is great, choosing which agents to prioritise presents further challenges. We have made significant progress in understanding the diversity of cogongrass across its native range, prioritizing candidate biological control agents based on this understanding, and using molecular data to frame our information and observations. The next step for this project is to use this framework to experimentally test how different cogongrass lineages affect the suitability of our biocontrol agents, and choose those that will be suited for, and impactful against, the US lineages of this weed.

Rodrigo Diaz is an Associate Professor in the Department of Entomology at Louisiana State University working on biological control and invasive species ecology. Since 2014, Rodrigo has conducted research on the biological control of giant salvinia, and leads the mass rearing program of the salvinia weevil in Louisiana. Rodrigo has several scientific publications on the impacts of giant salvinia on aquatic ecosystems in Louisiana, ecology of the salvinia weevil, and quantification of biological control of giant salvinia at the landscape level.

Potential for Indirect Biocontrol for the Invasive Insect, Spotted Lanternfly, via Direct Biocontrol its Host Weed, Tree of Heaven

Chandra Moffat[1], Hester Williams[1], Sonja Stutz[2], Phil Weyl[2], and Francesca Marini[3]

[1] Agriculture & Agri-Food Canada, [2] CABI Switzerland, [3] Biotechnology and Biological Control Agency, Rome

Biological control programs generally target one or more closely related organisms to directly reduce invasive species abundance. However, opportunities may exist for indirect biocontrol, i.e., reducing the abundance of an organism on which a target invasive species relies. Spotted lanternfly (*Lycorma delicatula*, SLF) is an invasive insect species that, since establishment in the USA in 2014, has had heavy impacts in horticulture and threatens forestry, ornamental, and natural resource sectors. SLF is now encroaching on Canada and yet no suitably host-specific candidate biocontrol agents have been identified for its direct biocontrol. An immense challenge is that current management is primarily achieved through insecticide applications; however, an opportunity may exist to use indirect biocontrol to exploit spotted lanternfly's strong association with select hardwood trees of Asian origin, primarily the invasive weed Tree of Heaven (*Ailanthus altissima*, ToH—note, SLF can develop without access to ToH). ToH has reached high densities in some parts of Canada and the USA, often overlapping with primary grape production areas. We began investigating ToH in 2019 due to its own severe environmental impacts, and are now assessing the feasibility of a biocontrol program for ToH in Canada. To date, two ToH candidate agents are being considered for release in Canada. If approved and successful in reducing the spread density of ToH, this weed biocontrol program has the potential toserve as an indirect biocontrol for SLF by reducing its potential for establishment and spread, particularly in Canada.

Dr. Chandra Moffat is a Research Scientist in Entomology and Biological Control with Agriculture and Agri-Food Canada, located in British Columbia. Her team conducts research to develop, evaluate, and improve classical/importation biological control programs for (i) invasive arthropod pests of cultivated horticultural crops and traditional Indigenous food plants, and (ii) invasive hardwood trees and herbaceous plants that impact horticulture, rangeland, Indigenous food systems, and natural areas. Her team uses integrative methods in field ecology, natural history, plant and insect taxonomy, and molecular ecology (both DNA barcoding and population genomics) to develop new knowledge of invasive species impacting diverse agroecosystems, and new potential biological control solutions for invasive species management. Current study systems include (i) insects - spotted lanternfly and spotted wing drosophila, (ii) weeds - Tree of Heaven, St Johns Wort, Russian Olive, knapweed species. Key collaborators include CABI Europe-Switzerland, BBCA Italy, and the British Columbia Ministry of Forests.

Synergism Between Biological and Mechanical Control for the Management of Tree-of-Heaven

René F.H. Sforza[1] and Francesca Marini[2]
[1] USDA-ARS EBCL, [2] Biotechnology and Biological Control Agency, Rome

Tree-of-heaven (*Ailanthus altissima*, Simaroubaceae)(ToH), a fast-growing deciduous tree native to China, is considered a serious invasive species worldwide, including the Americas and Europe. One biocontrol candidate is a phytophagous eriophyid mite (*Aculus taihangensis*, Eriophyidae) recorded in 13+ European countries and in the USA. Recent studies have shown its high host specificity and significant impact on ToH by reducing the fitness and the biomass of new sprouts and seedlings. The current study aimed at evaluating the mite impact in the field by releasing mites on selected young ToH seedlings in the city of Lyon, central France, where ToH is highly invasive. Leaves infested with mites from our laboratory colony were clipped onto seedlings in April and impact measured until September. Over a two-year study, we measured the impact of mites on infested ToH compared to controls, and study the density of mites per plant, the dry and fresh weights of plant biomass, and the survival of plants. In addition, we performed a bark removal on selected trees (over 20 cm in diameter) on 80% of the trunk surface, creating a debarked strip of 20 cm. Length of resprouts, resulting from debarking, were measured over the course of the season. The two treatments alone or combined have been analyzed and will be presented at the conference. The role of released mites alone has shown a high impact on seedlings by reducing growth and inducing a premature leaf fall in June of the same year. These preliminary results are very promising and need to be standardized into a cost-free and less labor-intensive method for releasing mites outdoors.

Since 2000, René F.H. Sforza is a research entomologist and weeds research leader for USDA-ARS, at the European Biological Control Laboratory (EBCL) located in Montpellier, France. His current research focuses on classical biological control of invasive weeds and insect pests with a special emphasis on foreign exploration in Eurasia, Africa and Asia. He aims at collecting insects and mites for potentially negatively impacting and controlling U.S. noxious alien invasive species, both present in environmental and agricultural settings. His main research topics are insect biology and ecology, plant-insect relationships, and phylogeography of invasive target species. He is also interested in developing synergistic controls, combining classical biocontrol with either mechanical approach or Sterile Insect Technique. His current targets are tree-of-heaven, stinkwort, medusahead, swallow-worts for weeds, and bagrada bug for insect pests. For his surveys, he visited 50+ countries.

Understanding the Eradication and Restoration Potential of Sites Following the Removal of *Ailanthus altissima* Using Biocontrol

Harrison Miles, Jacob Barney, Scott Salom, Brian Strahm, and Carrie Fearer
Virginia Tech

Ailanthus altissima (hereafter *Ailanthus*) is an invasive deciduous tree first brought to the United States in 1784. Native to the temperate forests of East Asia, *Ailanthus* is now one of the worst invasive plants in North America. Conventional control methods of *Ailanthus* are ineffective at large scales due to its rapid growth, high rate of sexual reproduction, and ability to vegetatively reproduce from lateral roots and stumps. Compounding these issues is *Ailanthus*' production of an allelopathic quassinoid, ailanthone, known to inhibit growth and germination of native plant species. A native fungus, *Verticillium nonalfalfae*, was identified as highly selective for *Ailanthus* and is currently being tested as a biological control agent to manage *Ailanthus*. This study aims to determine how management of *Ailanthus* using *V. nonalfalfae* impacts the concentration of ailanthone in the soil and the restoration of native plants. In the Summer of 2024, two *Ailanthus* stands near Williamsburg, VA were inoculated with *V. nonalfalfae*. Soil samples were collected every two months from multiple points within each plot and the spatial distribution of *Ailanthus* stems were measured. Ailanthone concentration in soil samples was quantified via seed germination bioassays and high-performance liquid chromatography-mass spectrometry (HPLC-MS). This is the first study analyzing the spatial distribution of ailanthone production by *Ailanthus* following treatment with a biological control. Understanding the persistence of ailanthone in soil will help managers determine the most effective restoration strategy to improve degraded sites and prevent re-establishment of *Ailanthus* and/or other nonnative, invasive plants.

Harrison Miles is a PhD student in the Department of Forest Resources and Environmental Conservation at Virginia Tech. His dissertation research focuses on the use of the native fungus Verticillium nonalfalfae as a biological control for the invasive *Ailanthus altissima* (Tree-of-Heaven). Additional questions include the role of *V. nonalfalfae* in the endosphere of *Ailanthus* and other plant species; whether *V. nonalfalfae* changes the feeding behavior of *Lycorma delicatula* (spotted lanternfly); and whether *L. delicatula* can vector *V. nonalfalfae* in the field. Harrison previously studied psychology, elementary education, and conservation biology at the University of Mary Washington in Fredericksburg, VA. His biology research there focused on entomopathogen production by the fungus *Beauveria bassiana*. Harrison's broader scientific interests include invasion biology, microbial ecology, and the interaction of science and culture. When not doing science, Harrison enjoys spending time with his wife and daughter, playing video games, and attempting home improvement projects.

Real-Time Satellite Monitoring for Early Detection of Giant Salvinia (*Salvinia molesta*) and Optimization of Biocontrol with the Salvinia Weevil (*Cyrtobagous salviniae*)

Victoria Ayala[1], David Kinsler[2], Ivan Grijalva[1], and Rodrigo Diaz[1]

[1] Louisiana State University, [2] Rhodes University Centre for Biological Control

Giant salvinia (*Salvinia molesta*) is an invasive aquatic weed that presents significant management challenges in the southeastern United States. While biocontrol with the salvinia weevil (*Cyrtobagous salviniae*) effectively manages salvinia infestations, the reliance on manual field observations delays rapid detection and optimal deployment of this biocontrol agent. This project utilizes real-time satellite monitoring and machine learning to enhance early detection of giant salvinia and optimize the weevil biocontrol program. Through Sentinel-2 satellite imagery and cloud-based platforms, we developed a real-time monitoring tool to detect salvinia infestations and target weevil releases across southern Louisiana. Machine learning models, using vegetation indices such as NDVI and NDWI, improved the accuracy of detection by distinguishing between healthy and weevil-damaged salvinia mats. Drone surveys were also conducted to validate local detection accuracy. Our results demonstrate that integrating satellite imagery with weevil population data significantly enhances the detection biocontrol impact. The machine learning model achieved a 96% true positive detection rate, and an inverse correlation between NDVI values and weevil densities was observed, highlighting the weevil's effectiveness in reducing plant health. This scalable approach combines satellite monitoring accuracy with machine learning, with potential applications beyond salvinia management. However, consistent data collection and continuous model improvement remain challenges. Future steps include refining drone integration for higher-resolution data and expanding the geographical scope of this biocontrol strategy. This real-time tool empowers stakeholders to make informed decisions, improving salvinia management and serving as an approach for integrating remote sensing with biocontrol in other invasive species programs.

Victoria Ayala was born and raised in San Miguel, El Salvador. She completed her undergraduate studies at the Escuela Agrícola Panamericana – Zamorano in Honduras, earning a degree in Environmental Sciences and Social Development Engineering in 2022. Currently, she is in her second year of a Master's program in the Department of Entomology at Louisiana State University, working under the supervision of Dr. Rodrigo Díaz. Victoria's research focuses on the biological control of the aquatic invasive weed, giant salvinia (*Salvinia molesta*). Specifically, she is developing a real-time web application to monitor the plant across the landscape and enhance targeted salvinia weevil (*Cyrtobagous salviniae*) releases using satellite and drone imagery. After completing her M.S. program, she looks forward to pursuing a Ph.D. to further exploring research interests in invasive species ecology, biocontrol and biodiversity conservation through emerging technologies.

Linking Weed Biological Control "Impacts" to Reductions in Weed Population Density Through Seed Augmentation and Large-Scale Surveys

Natalie M. West[1], Matthew Tancos[2], Patrick Moran[3], Paul Pratt[3], Michael Fulcher[2], and Tatyana Rand[1]

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Reducing seed numbers is a common mechanism for weed biological control. However, we often lack data on how much annual seed numbers influence weed population density in time and space. This knowledge gap creates challenges when linking biological control mechanisms that reduce within-year seed numbers produced (=impacts) to realized reductions in weed density. We used seed augmentation experiments and multi-year plot surveys to: 1) compare how much seed was required to influence weed density in different populations of the federal noxious weed *Crupina vulgaris* (common crupina); and 2) extrapolate the time and within-year seed reductions required to effectively reduce weed density. We found that all populations were seed limited, but that the average seedling density and the relationship between seeds added and number of new plants varied among sites and was key to predicting weed abundance. This density-dependent variation corresponded with site-level differences in recruitment from the seedbank as well as the relative abundance and timing of seedling germination. These factors combined to affect the predicted timelines needed to detect reductions in weed density among sites. These baseline data will be used in quantifying impacts as the new biological control program with the pathogen *Ramularia crupinae* is implemented. Biological control assessments would benefit from coordinated large-scale field experiments and surveys that aid in linking biological control pressure to resulting population-level impacts on target weeds.

Dr. West is a Research Ecologist at the Pest Management Research Unit in Sidney, MT, studying applied weed ecology and classical biological control of weeds. Her research focuses on quantifying interactions between weed populations, introduced biological control agents, and their associated plant and insect communities, with the goal of increasing the efficacy of weed management and improving health and sustainability of wild and rangeland systems.

Revisiting *Rhinocyllus conicus* on Federally Listed Threatened and Endangered Plants

Ikju Park and Remi Flannery
University of California–Riverside

The Eurasian flower-head weevil (*Rhinocyllus conicus*) was introduced into North America in 1969 as a biological control agent for invasive thistle species. While weevils suppressed invasive thistles with remarkable establishment rates, non-target attacks have also been reported on multiple federally listed threatened and endangered (T&E) thistle species. Chorro Creek Bog thistle (*Cirsium fontinale* var. *obispoensis*, current status: Endangered) is one of four T&E thistles in California. However, post-release monitoring efforts on Chorro Creek Bog thistle have remained inconclusive for the last two decades. To conduct a potential threat assessment of *R. conicus* on the natural habitats of Chorro Creek Bog thistle, we examined insect herbivores in seedheads of Chorro Creek Bog thistle in San Luis Obispo and the Los Padres National Forest in California. We also measured seedhead volumes, photosynthesis rates, and volatile profiles of Chorro Creek Bog thistle. Since the introduction of *R. conicus* in 1969, there have been no studies on chemical ecology in this system, except one paper on another T&E thistle, the Sacramento Mountains thistle (*Cirsium vinaceum*, current status: threatened) in the Lincoln National Forest, New Mexico. The findings from this pilot study in California will provide a foundation for developing insect repellents to reduce *R. conicus* populations on seven T&E thistles in North America. It will also support the importance of investigating plant signals during the initial host recognition of prospective biological control agents in pre-release risk assessments.

Dr. Park is an assistant professor in biological control of invasive pests and weeds at the Department of Entomology, University of California, Riverside. His research interest is classical biological control of invasive plants. He has conducted research projects on honey mesquite, houndstongue, musk thistle, and yellow starthistle. Insect Sensory and Behavioral Ecology Laboratory studies the host recognition mechanisms of weed biological control agents in pre-release risk assessment and post-release monitoring. Dr. Park serves on a scientific committee for the XVII International Symposium on Biological Control of Weeds in Rotorua, New Zealand, in 2026.

From Classical Biological Control to Inundative Releases: The Path to Better Management of Waterhyacinth

Megan Reid[1], Melissa C. Smith[2], and Lyn Gettys[1]
[1] University of Florida, [2] USDA-ARS IPRL

Waterhyacinth (*Pontederia crassipes*) is an invasive plant from South America that is problematic worldwide. Several biocontrol agents have been released to manage this plant in regions where it is invasive, including South Africa and USA. Efficacy of these biocontrol agents has been variable, due to challenges such as climatic differences and eutrophication of waterbodies where waterhyacinth is present. In the last few years, researchers in South Africa have had promising reductions in waterhyacinth coverage using inundative releases of *Megamelus scutellaris*, the most recent agent released against waterhyacinth. Through the development of several mass rearing facilities, they have demonstrated the potential for inundative releases to work more effectively than the traditional "classical" biocontrol release strategy. In Florida, efforts are underway to similarly develop mass rearing and frequent releases of *M. scutellaris*. Although there is potential for frequent mass releases to overpower nutrient driven overgrowth of waterhyacinth, it is necessary to optimize rearing strategies and release times. By monitoring waterhyacinth and biocontrol agent populations over time and improving rearing techniques, we hope to improve management of waterhyacinth in the US, and across the world.

Megan Reid completed her MSc. and PhD at Rhodes University in Makhanda, South Africa under the supervision of Julie Coetzee and Martin Hill, where she investigated biocontrol of a waterlily invasive in South Africa but native to Florida. During her studies she met Lyn Gettys at University of Florida, with whom she now works as a postdoctoral researcher investigating IPM for waterhyacinth. Melissa Smith from USDA is also an integral contributor to the research on waterhyacinth, and together they work collaboratively with several international institutions to improve management efforts of invasive plants.

Ecological and Economic Benefits of a Weed Biological Control Program in a Federal Habitat Mitigation Project with Culturally Sensitive Areas

Aaron N. Schad, Megann M. Harlow, and Nathan E. Harms
U.S. Army Engineer Research and Development Center

Classical biological control (CBC) can be a valuable strategy in habitat improvement projects with ecologically or culturally sensitive areas. Here, we present on the implementation and benefits of a CBC program in a federal habitat mitigation project with sensitive archeological sites, which presented limitations to traditional vegetation restoration and management. In 2019, flooding in the McClellan-Kerr Arkansas River Navigation System (MKARNS) caused emergency dredging and disposal impacting emergent and forested wetlands, and bottomland hardwood forests. The MKARNS After-Action Mitigation Project is compensating habitat through the conversion of terrestrial areas—previously leased agricultural land—into respective impacted habitats. Pre-construction cultural resource surveys found several archeological sites within the project. Given the findings, groundwork, such as plantings, was delayed or restricted. Herbicide applications were also restricted in certain areas due to proximity to agricultural irrigation systems. While additional archeological surveys and the environmental clearance process with the National Historic Preservation Act (NHPA), the State Historic Preservation Office (SHPO), and Tribal Historic Preservation Offices (THPOs) was being completed, clearance was given to initiate a CBC program to begin the mitigation process. Alligatorweed flea beetles (*Agasicles hygrophila*) and thrips (*Amynothrips andersoni*) were released for alligatorweed (*Alternanthera philoxeroides*) control, which reduced weed coverage and biomass by approximately 50%. This effort not only substantially reduced the invasive species but saved federal agencies $1.5M by allowing mitigation efforts to commence immediately and not force an increased mitigation acreage requirement at 10% per each year delayed.

Aaron Schad is a Research Biologist with the U.S. Army Engineer Research and Development Center. As a part of the Aquatic Ecology and Invasive Species Branch, his research and work focus include aquatic ecosystem restoration, habitat mitigation, and vegetation establishment and management.

Africa as a Source for Weed Biological Control Agents

Iain Paterson[1], Greg Wheeler[2], Quentin Paynter[3], Patrick Moran[4], and Robert Plowes[5]

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Africa is a prolific donor of invasive alien plants to other parts of the world. There are 1863 plants indigenous to African that are naturalized outside of the continent and, of the 200 most widely distributed invasive plants globally, 40 are of African origin. Despite being a donor of invasive plants, there are few cases of biocontrol agents from Africa being released elsewhere. Only 24 species of African origin have ever been released as biocontrol agents, with only eight released in North America. The majority of the agents were sourced from South Africa (58%), with others from Kenya, Morocco, Ghana, Tunisia and Egypt. Recent releases of agents sourced in Africa are the rust fungus, *Puccinia rapipes* collected in South Africa and released in Australia for the control of Boxthorn, (*Lycium ferocissimum*); and the Eriophyid mite, *Colomerus spathodeae*, and flea-beetle, *Paradibolia coerulia*, sourced in Ghana and released in the Cook Islands for the control of African tulip tree (*Spathodea campanulata*). Weeds that are problematic in North America include Cogongrass (*Imperata cylindrica*) where surveys are underway in East Africa; Crystalline ice-plant (*Cryophytum crystallinum*) for which a promising candidate, the stem-mining weevil *Lixus carinerostris* from South Africa, has been prioritized; and Guineagrass (*Megathrysus maximus*) where two stem-galling midges (*Arabukodiplosis basalis* & *A. vesicaria*) and a seed-feeding midge are currently undergoing host specificity testing in South Africa. Africa is a largely untapped resource of biocontrol agents for invasive alien plants both globally and in North America, with many opportunities for developing new biocontrol programmes.

Professor Iain Paterson is a biocontrol researcher specializing in exploratory surveys and pre-release assessments of weed biocontrol agents. He works on several projects on African plants that are problematic elsewhere in the world, including the USA. Although he is based in South Africa, he has worked in several other African countries, including countries in West, Central and East Africa. His work emphasizes the importance of data collected in field studies in the indigenous distribution of target weeds to complement laboratory host specificity testing and pre-release efficacy assessments.

Extirpation of a Legacy Biocontrol Parasitoid Assemblage Following Arrival of an Adventive Exotic Pathogen

Dylan Parry[1], Ann E. Hajek[2], Patrick C. Tobin[3], and Nathan W. Siegert[4]

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One of the most comprehensive biological control efforts in history was directed against the spongy moth (*Lymantria dispar* L.) after its invasion of North America. A suite of natural enemies were established and persisted, many for more than a century. In 1989, a fungal pathogen *Entomophaga maimaiga* arrived, apparently accidentally from Asia, and fundamentally changed the population dynamics of spongy moth, out-competing all other biocontrol agents. Following its advent, regional outbreaks of spongy moth disappeared in northeastern US for more than two decades. However, in 2015 a series of discrete outbreaks have occurred in northeastern North America. We collected contemporary samples from these resurgent spongy moth populations and extracted historical data to retrospectively compare parasitoid communities pre-and post-*E. maimaga*, focusing on three abundant tachinids most likely to be negatively affected by competition. We found that the formerly most abundant tachinid (*Blepharipa pratensis* Meigen) was absent entirely in contemporary outbreaks and two other once common species *Parasetigena sylvestris* R.-D and *Compsilura concinnata* (Meigen) occurred only sporadically in our samples. The biology of these species makes them highly vulnerable to competition with the fungus which is the most parsimonious explanation for their decline. While *E. maimaiga* is viewed as an effective control agent, its simplification of this system may have unintended consequences under drier conditions or in areas where the fungus is less successful. This fungus was also deliberately introduced to Europe where *L. dispar* is native and supports a diverse parasitoid assemblage, which may also be vulnerable to competition.

Dylan Parry is a professor and ecologist at the State University of New York College of Environmental Science. His research focuses on biological invasions, especially insects in temperate forests. The spongy moth and other invasive lymantriid moths and the long-running biological control programs directed against them have been of particular interest, including both the intended and unintended effects of these efforts. In addition, Parry has ongoing research projects on the biological control of invasive weeds, interactions between invasive earthworms and non-native plants and has previously worked with native and introduced parasitoids of the invasive sirex woodwasp. He teaches a long-running course on the ecology and management of invasive species.

Enhancing Market Feasibility of Biocontrol Products Through Smart Rearing Technologies

Hung-Jen Lin and Joe-Air Jiang
National Taiwan University

This study aims to explore the application of smart production technologies in the manufacturing of biocontrol products, using the natural enemy insect *Mallada basalis* and the nucleopolyhedrovirus (SeMNPV) production process as case studies. In the case of *Mallada basalis*, through an automated egg-sorting system, the complex manual work can be completely replaced. Additionally, this automated system integrates an AI-based imaging recognition system to distinguish between healthy or unfertilized eggs. As a result, the hatching rate of eggs selected by the system has increased from 80% to 94%, significantly enhancing rearing efficiency. The automated feeding system, combined with image recognition technology, can detect larval survival in individual rearing cells and determine whether to feed, reducing feed consumption by 20–50%. For *Spodoptera exigua,* an automated relocation system has been implemented, achieving twice the efficiency of manual labor. Furthermore, by integrating an AI-based image recognition system, the system can identify larvae suitable for virus production, resulting in an overall tenfold increase in virus production efficiency.

Hung-Jen Lin is a dedicated expert in biological pest control, with a strong focus on developing innovative insect mass production technologies. Since 2016, he has successfully advanced the production of natural enemy insects and insect carriers, contributing significantly to sustainable agricultural practices. As the founder of BuggiPro CO., Ltd., Hung-Jen Lin has been actively promoting biological pest control solutions in the agricultural industry, striving to reduce the reliance on chemical pesticides. His dedication have played a crucial role in improving eco-friendly pest management strategies, fostering healthier ecosystems, and supporting sustainable food production.

Thursday, April 17

KEYNOTE

Christy Martin
University of Hawai‘i at Mānoa

Biological Control: Programs, Plans, and Policies

The annual estimated costs of invasive species to the U.S. exceeds $21B, with impacts to agriculture, the economy, and public health. Invasive species are as costly as natural disasters, yet unlike storms, earthquakes, and other disasters, invasive species can result in long-lasting, if not permanent, damage. Invasive species are the greatest driver of biodiversity loss on islands and a top driver of global biodiversity loss. Invasive weeds, pests, and pathogens can alter the composition of forests and ecosystems, increase fire susceptibility, and reduce a forest's ability to buffer severe weather, keep soil moist, accelerate water infiltration, hold topsoil, and store carbon. At the same time, the incidence and impacts of vector-borne diseases are increasing as the U.S. warms. The need for controlling invasive species and their impacts is immense, yet classical biological control is an available but underutilized tool, while new biotechnology tools may also offer relief. Programs, plans, and policies can be modernized to meet the invasive species challenge.

Christy Martin has worked on terrestrial and marine invasive species issues in Hawai‘i and the Pacific region for more than twenty years. She is the program manager and spokesperson for the Coordinating Group on Alien Pest Species (CGAPS), a partnership of agencies and organizations working to protect Hawaii from the impacts of invasive species. Christy is also one of the co-founders of the Pacific Regional Invasive Species and Climate Change (Pacific RISCC), whose aim is to focus research and communications on the confluence of invasive species and climate change in the Pacific Island region. Social science and communications are integral parts of her work. CGAPS is a project of the Pacific Cooperative Studies Unit of the University of Hawai‘i at Mānoa.

European Biological Control Laboratory Perspectives and Updates

Nicholas Minoukis
USDA-ARS EBCL

For over 100 years, USDA Agricultural Research Service's (ARS) European Biological Control Laboratory (EBCL) has helped provide solutions for invasive weeds and insect pests impacting U.S. agriculture and the natural environment. EBCL belongs to a wider network of overseas biological control laboratories (OBCLs) and ARS domestic locations that collaborate on biological control. EBCL has made significant contributions to the classical biological control research and delivery pipeline, as demonstrated by important recent success stories and current projects. However, this pipeline is showing signs of stress, reducing the pace at which biological control solutions are delivered to solve U.S. agricultural and environmental problems. EBCL is working to address these obstacles with some novel and multi-pronged research approaches. If this strategy succeeds, the next century of research at EBCL may be even more productive than the last.

Since October 2024 Nicholas Manoukis is the director of USDA-ARS' European Biological Control Laboratory (EBCL) in Montpellier France and Thessaloniki Greece. His regular post, to which he plans to return in October 2026, is as research leader of the Tropical Crop and Commodity Protection Research Unit in Hilo, Hawaii, where he has been since 2010. His research focuses on the ecology, behavior, and biocontrol of tephritid fruit flies, particularly species of economic importance in Hawaii and potential invaders of the US Mainland. He has also worked on other invasive tropical pests of economic importance like the coffee berry borer. Prior to working at ARS, Dr. Manoukis spent almost a decade studying the ecology, evolution and behavior of the malaria vector *Anopheles gambiae* in Mali, West Africa.

APHIS Regulations

Robert S. Pfannenstiel
USDA-APHIS PPQ

The Animal Plant Health and Inspection Service (APHIS), Plant Protection and Quarantine (PPQ) Pests, Pathogens and Biocontrol Permitting (PPBP) Unit is responsible for policies and processes to approve movement and release of commercial and classical biological control agents to and within the United States. Updates will be given on the new eFile permit system and the petition process for biocontrol agents of noxious weeds and invasive invertebrate pests, including current pending and potential future petitions for novel biocontrol agents. Permitting challenges, such as jurisdictional and permitting issues and biocontrol of plant pathogens, will be discussed.

Bob Pfannenstiel is a Senior Entomologist and the Biological Control Specialist with the U. S. Department of Agriculture, Animal Plant Health Inspection Service (USDA-APHIS) Pest, Pathogen and Biological Control Permitting Unit. Bob coordinates the environmental compliance and risk assessment for petitions proposing the release of novel biological control agents of insect pests and weeds in the U.S. Additionally, Bob is in charge of permitting functions within USDA-APHIS for importation and interstate movement of biological control agents in the U.S. Before coming to USDA-APHIS in 2017, Bob was a Research Entomologist for 17 years with the Agricultural Research Service (USDA) and studied the ecology and behavior of biological control agents of insect pests in annual and perennial crops.

Biological Control of Emerald Ash Borer: A Sustainable Solution to Ash Recovery and Regeneration

Jian J. Duan[1], Toby Petrice[2], and Therese Poland[2]
[1] University of Deleware, [2] USDA-Forest Service NRS

Emerald ash borer (EAB) is the most devastating invasive forest insect pest in North America, killing 100's of millions of ash trees across 37 states since it was discovered near Detroit, Michigan in 2002. The loss of ash trees threatens vertebrate and invertebrate ash specialists, degrades ecological services, and causes both economic hardship and health issues to societies. Four natural enemies (parasitoids) were introduced from EAB's native range at different times: three from Northeast China in 2007, including two larval parasitoids (*Tetrastichus planipennisi* and *Spathius agrili*) and one egg parasitoids (*Oobius agrili*), and additional larval parasitoid (*Spathius galinae*) from the Russian Far East in 2015. These parasitoids have now been released in 32 states plus the District of Columbia and four Canadian Provinces as a long-term management strategy for ash recovery and regeneration. Here, we present data from Northern U.S., which indicate we are moving closer to the goal of maintaining ash as a viable component of North American forests. However, there may be significant challenges in Southern U.S., as well as in the most recently invaded west coast (Oregon), where the successful establishment of those parasitoids introduced from Northeast Asia remains limited and largely unknown.

Dr. Jian Duan is a research entomologist. His current research focus is on biological control of invasive wood-boring pests such as emerald ash borers and Asian longhorned beetle, which involves natural enemy introduction, quarantine safety testing, and non-target risk assessment as well as evaluation of the establishment and impact of introduced natural enemies on the target pest.

Success in Weed Biological Control: Revisiting Old Programs with Shifting Goal Posts

Philip Weyl[1], Jennifer Andreas[2], Melissa Maggio[3], Joseph Milan[4], and Rachel Winston[5]
[1] CABI Switzerland, [2] Washington State University, [3] Missoula County Ecology and Extension, [4] USDOI-BLM, [5] MIA Consulting

Many invasive plant species are managed once they start causing economic or ecological impacts above a perceived damaging threshold. Biological control can offer a sustainable, cost effective management method of invasive plants, but understanding whether success has been achieved can be challenging. Success is often poorly defined and varies depending on the entity defining it, even if "control" is clearly defined at the outset. When applied to biological weed control, this usually involves reducing the population of the invasive plant species below a certain damage threshold and not eradication. Depending on the invasive plant species, habitat, land use and land manager goals, this threshold will vary, and an understanding of the opportunities and limitations of biological control, will guide the decision-making process and help manage expectations. Once populations of an invasive plant are reduced, the perceived damage threshold may change and thus a program once deemed a success may no longer be considered successful. In recent years, several examples of systems that had previously been considered biocontrol success stories (e.g., leafy spurge, St. Johnswort, and spotted/diffuse knapweed), are now often a source of concern for land-managers but it is not clear whether this is a result of perception or a change in biocontrol efficacy. In this presentation, we will discuss whether revisiting some old programs would be a worthwhile option by reassessing agents that were once permitted for release but may not have established, or potentially sourcing populations better genetically or climatically suited to the invaded range. We will also discuss the viability of better managing expectations under scenarios where biological control needs to be part of an integrated management approach.

Dr. Philip Weyl is an entomologist with CABI where he currently leads a team of researchers in the weed biological control section at the Swiss center, working with existing biological control agents as well as developing new agents for release. This role involves managing approximately 20 projects, mainly for the USA and Canada, but also for Australia and South Africa. He remains active in student supervision, with MSc and PhD students at the University of Neuchatel, Switzerland, CBC, Rhodes University, South Africa and the University of Idaho, USA.

Opportunities in a NISC Strategic Framework for Biological Control

Bryan Falk
National Invasive Species Council

The National Invasive Species Council (NISC) prioritized the development of a Strategic Framework for Biological Control. The framework is being drafted by a federal interagency team with expertise in the regulation, research, and management application of biological control, and it will identify challenges facing biological control as well as strategies for the federal government to overcome them. In this working session, we will first give an overview of the progress made to date and outline future directions. We will then facilitate a discussion to hear individual perspectives on how a federally focused framework can support not just federal but also non-federal efforts to advance biological control.

Dr. Bryan Falk is a program analyst for the National Invasive Species Council, where he leads interagency teams to complete tasks prioritized by the Council.

The Importance of Science and Research for America's Forest Landowners

Robert S. Simpson
National Association of State Foresters, Forest Science & Health Committee

US private forest landowners currently hold approximately 60% of this nation's forest land. For decades they have relied on several sources of information to help them manage their forests in a productive manner. These sources include state forestry agencies, consulting foresters, and university extension programs to name just a few. These service providers all share one common denominator: the need for the most current forest management research available. Bob Simpson will discuss the sources these forest managers rely upon, examples their research has provided private forest management, the current state od forest management research in the US, and what research capacity it will take to keep America's private forests productive, sustainable and profitable.

Bob Simpson is President and CEO of GreenWoodGlobal Consulting, Ltd. His firm specializes in working with forest products companies, natural resource and other governmental agencies and natural resource NGOs, helping them meet their strategic directives involving forest sustainability, with focus on family forest owners, cooperatives and communities owning and managing forest land.

Non-Federal Biocontrol Prioritization and Actionable Steps Forward

Jennifer Andreas[1], Carey R. Minteer[2], and Joseph Milan[3]
facilitated by Bryce Christiaens[4]
[1] Washington State University, [2] University of Florida, [3] USDOI-BLM, [4] Missoula Co. Dept. of Ecology and Extension

In recent years, biocontrol has been garnering interest and attention from invasive species organizations, potentially offering opportunities to develop partnerships and increased advocacy. Given current challenges and uncertainties, the biocontrol community will need to build on these relationships and work together to develop a road map that provides cohesive messaging and objectives that aim to maintain support for research, development, education, and implementation. In the first hour of this facilitated session, participants will offer recommendations and insights for broad biocontrol needs and resources. Based on this input and participant interest, we will break into working groups during the second hour to develop actionable items that will help guide strategies for moving forward in turbulent times.

Jennifer Andreas received her Master of Science in Entomology from the University of Idaho in 2004 and has worked in biocontrol since 1998 in Canada, Switzerland, Idaho, and Washington. She joined Washington State University Extension in 2005 and leads the Integrated Weed Control Project (IWCP). The IWCP provides biocontrol education and biocontrol agents to land managers and landowners across Washington State. In addition to this work, Jennifer is chair for the Flowering Rush Biocontrol Consortium, co-chair of the Columbia Basin CWMA, member of NAISMA's Classical Biological Control Committee, and conducts research for several weed-biocontrol systems.

Dr. Carey Minteer received her undergraduate degree in Biology from the University of Central Arkansas. She received her master's degree in Biology and her PhD in Entomology from the University of Arkansas. Dr. Minteer is now an Assistant Professor at University of Florida Indian River Research and Education Center where she leads a research program focusing on the classical biological control of invasive plants. Dr. Minteer has worked in the field of biological control for 15 years. Dr. Minteer has particular interests in developing sustainable control methods for invasive plant species, integrating classical biological control with other weed management techniques, and educating the public about invasive species.

Joseph "Joey" Milan is the National Biological Control Specialist for the Bureau of Land Management (BLM) based in Boise, ID USA. Joey received his B.S. in Biology from the College of Idaho and his M.S. in Entomology from the University of Idaho. His work focuses on promoting biological control in the Great Basin region, combating invasive weeds in sagebrush steppe communities, restoring natural controls, and reducing the dominance of invasive plants. Joey serves as the co-chair of the North American Invasive Species Management Association (NAISMA) Classical Biocontrol Committee, chair of the Biocontrol Task Force, and the secretary of the Western Weed Coordinating Committee.

Bryce Christiaens is the director at Missoula County Department of Ecology & Extension. Bryce has been working on invasive species management and plant restoration in Western Montana for over 20 years. He has worked for Missoula County since 2011, assisting residents, landowners and public agencies meet their management goals. He was a founding member of the Montana Invasive Species Council and served as its chair from its from 2014 to 2023.

POSTERS

Biological Control of Harrisia Cactus Mealybug in Puerto Rico

María Belén Aguirre[1], Mariel E. Guala[1], C.P. Krug[1,2,3], Marina I. Oleiro[1], Sol A. Bovina[1], Luis M. Franco Tadić[1], Andrés F. Sánchez Restrepo[1,2], Serguei V. Triapitsyn[4], Stephen D. Hight[5], Hilda Diaz-Soltero[6], Lucia Claps[7], Daniel Poveda-Martínez[8], Esteban Hasson[2,9], Christian W. Torres-Santana[10], Eduardo A. Ventosa-Febles[11], and Guillermo A. Logarzo[1]; presented by **Willie Cabrera Walsh**[1]

[1] Fundación para el Estudio de Especies Invasivas, Argentina, [2] Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina, [3] Universidad Nacional de Hurlingham, Argentina, [4] University of California–Riverside, [5] USDA-ARS (retired), [6] Caribbean Advisor to the USDA-APHIS Administrator (retired), Puerto Rico, [7] Universidad Nacional de Tucumán, Argentina, [8] Centre de Biologie pour la Gestion des Populations France, [9] Universidad de Buenos Aires, Argentina, [10] Coccoloba AgroEnvironmental LLC, Puerto Rico, [11] Effective Environmental Restoration, Puerto Rico

A South American mealybug in the *Hypogeococcus pungens* species complex (Hemiptera: Pseudococcidae) has been devastating cactus populations in Puerto Rico, including two federally endangered species, and potentially threatening cactus-rich ecosystems across the Caribbean and Central and North America. Since 2010, researchers from the Foundation for the Study of Invasive Species (FuEDEI, by its acronym in Spanish), Animal and Plant Health Inspection Service, Plant Protection and Quarantine (APHIS-PPQ, USDA), Agricultural Research Service (ARS, USDA), Center of Excellence for Quarantine and Invasive Species at the University of Puerto Rico (CEQUIS-UPR), and the NGO Effective Environmental Restoration (EER) have cooperated in a biocontrol program against this pest mealybug. Project accomplishments to date include: (1) extensive surveys in Argentina, Paraguay and Brazil to determine pest area of origin and natural enemies; (2) identification and description of several species that compose the *H. pungens* species complex (formerly believed to be a single species); (3) identification and prioritization of two potential biocontrol agents [*Anagyrus cachamai* and *A. lapachosus* (Hymenoptera: Encyrtidae)], which are already being reared at the CEQUIS-UPR facility in Puerto Rico; (4) field host range studies of *Hypogeococcus* spp. natural enemies in Argentina and Puerto Rico; and (5) Puerto Rican quarantine risk assessment studies of potential biocontrol agents. Neither *A. lapachosus* nor *A. cachamai* will pose a threat to non-target mealybugs, or cause harm to the environment in Puerto Rico. A petition requesting release of both *Anagyrus* parasitoids will be submitted in 2024.

María Belén Aguirre holds a doctorate in Biological Sciences from the Faculty of Exact and Natural Sciences at the University of Buenos Aires, Argentina. Since 2010, she has worked at the Foundation for the Study of Invasive Species (FuEDEI, by its Spanish acronym), formerly known as the USDA-ARS South American Biological Control Laboratory. Her research focuses on natural enemies, particularly parasitoids, and she has been involved in a biological control program aimed at mitigating the impact of the Harrisia cactus mealybug in Puerto Rico.

Finding a New Home for Western Silver Flies: Laboratory Studies and Field Releases of *Leucotaraxis* spp., Specialist Predators of Hemlock Woolly Adelgid

Olivia Andrews[1], Scotty Yang[1], Thomas Kuhar[1], Albert Mayfield III[2], Mark Whitmore[3], and Scott Salom[1]

[1] Virginia Tech, [2] USDA-Forest Service SRS, [3] Cornell University

For two decades, the focus for biological control of the invasive hemlock woolly adelgid (HWA), *Adelges tsugae* Annand (Hemiptera: Adelgidae) has been two predatory beetles in the genus *Laricobius* (Coleoptera: Derodontidae). Rearing and releases of these two predatory species has resulted in their establishment throughout the eastern U.S. and demonstration of impact on the first generation of HWA. However, the beetles drop to the soil to complete development and are not present on the second generation of HWA in the late spring. Due to HWA being parthenogenic and the absence of a predator during the second generation, populations can bounce back. The second most abundant predators of HWA on western hemlock, *Tsuga heterophylla* (Raf.) Sarg., in the Pacific Northwest, are two silver fly species, *Leucotaraxis argenticollis* and *Le. piniperda* (Diptera: Chamaemyiidae). The silver flies emerge in the spring and continue their activity after *Laricobius* spp. drop to the soil. Current efforts in biological control of HWA have shifted towards studying these two silver fly species. To better understand their potential for biological control of HWA-infested eastern hemlock, *Tsuga canadensis* (L.) Carrière, we conducted both field and laboratory studies of these silver flies assessing the predators' biology and behavior. Release and recovery efforts assessing release timing and methods will help guide better chances for establishment. Laboratory studies assessing functional and numerical responses, interspecific competition, and oviposition behavior are biological components that will allow for a better understanding of the potential *Leucotaraxis* spp. have for impacting HWA populations in eastern North America.

Olivia Andrews has been a PhD student in Dr. Scott Salom's Forest Entomology Lab at Virginia Tech since 2021. Her research focuses on biological control of the invasive forest pest, hemlock woolly adelgid (HWA). She works with specialist predators of HWA, the *Leucotaraxis* silver flies and *Laricobius* beetles. Her PhD research involves both field and laboratory studies assessing the biological control potential of *Leucotaraxis* spp. With little known about these biological control agents, she seeks to better understand the basic biology of these two fly species and evaluate potential interspecific competition with the already established predators, the *Laricobius* beetles. She is also working to establish populations of silver flies at various sites throughout the eastern United States. She is passionate about educating the public about invasive species and the importance that biological control can play within the framework of integrated pest management.

Developing Diagnostic Markers and Predictive Models for Managing the Invasive Box Tree Moth (*Cydalima perspectalis*) in North America

Aarati Basnet, Dominique Costarella, Carter Henry, and Sangeet Lamichhaney
Kent State University

The box tree moth (BTM) (*Cydalima perspectalis*), native to East Asia, was first recorded in Europe in 2007, with its initial sighting in Germany. Since then, it has rapidly spread across the continent. In North America, BTM was first detected in Ontario, Canada, in 2018, followed by its identification in New York, USA, in 2021. Subsequently, the moth has been confirmed in several U.S. states, including Michigan (2022), Massachusetts (2023), Ohio (2023), Delaware (2024), and Pennsylvania (2024). Box tree moths pose a significant threat to boxwoods (*Buxus* spp.), a vital component of the U.S. horticulture industry, which generates approximately $140 million annually in wholesale and retail sales. Without natural predators in these introduced regions, BTM larvae feed on boxwoods, causing severe defoliation that can lead to plant death. This study focuses on the genetic analysis of BTM populations from their native range as well as invasive populations in Europe, Canada, and the U.S. The main objective is to develop diagnostic molecular markers that can trace the source populations of new invasions and identify invasion routes. Additionally, genetic data will also be combined with landscape and boxwood usage information to model potential future invasion pathways. The findings of this study aim to inform effective control strategies to mitigate the impact of BTM in the U.S.

Aarati Basnet is a PhD student in the Ecology and Evolutionary Biology program at Kent State University. She completed her master's degree in applied Ecology and Conservation Biology from Frostburg State University, Maryland. She is currently part of an Omics lab (https://theomicslab.com), working to uncover the genetic mechanisms driving biological invasions. Aarati's research focuses on invasive species, particularly the avian vampire fly (*Philornis downsi*), which parasitizes the nests of Darwin's finches in the Galápagos, and the box tree moth (*Cydalima perspectalis*), a significant threat to U.S. horticulture, specifically to boxwoods (*Buxus* species). In collaboration with the USDA, she is currently applying genomic and bioinformatics techniques to uncover the spread and adaptation of the box tree moth, aiming to inform conservation and management strategies.

Rearing, Life History Evaluations, and Host Range Testing of *Dryinus sinicus*, a Promising Biocontrol Agent of Spotted Lanternfly

Hannah Broadley[1], Xingeng Wang[2], and Juli Gould[1]
[1]USDA-APHIS PPQ S&T, [2]USDA-ARS BIIRU

Spotted lanternfly (*Lycorma delicatula*, Hemiptera: Fulgoridae) is an invasive insect with a broad host range that was first noted in Pennsylvania ten years ago and since has spread to 16 additional states. To complement current containment and management strategies, we are working to develop classical biological control methods. Initial efforts focused on *Anastatus orientalis* (Hymenoptera: Eupelmidae), an egg parasitoid, which is native to China and was released as a biological control agent for invasive spotted lanternfly in South Korea. However, after extensive testing, we determined that it was not sufficiently host specific. Our recent work focuses on *Dryinus sinicus* (Hymenoptera: Dryinidae). *Dryinus sinicus* is a univoltine nymphal parasitoid of spotted lanternfly also native to China. Importation and rearing of *D. sinicus* has been challenging but we have made significant progress and have completed initial life history and host specificity evaluations. We have found that *D. sinicus* uses a range of spotted lanternfly nymphal sizes but shows a preference for using the small instars for host feeding and the middle instars for parasitization. In preliminary host range testing, we also have found that *D. sinicus* can host feed on small instars of a few related Hemiptera but shows a preference for spotted lanternfly nymphs. Collecting and rearing non-target Fulgorids and other planthoppers, which are cryptic and understudied, has been challenging. Genetic, life history, rearing, and host specificity evaluations are all in progress and will continue this coming field season to prepare for writing a petition for release.

Dr. Hannah Broadley is a biological scientist with USDA APHIS Plant Protection and Quarantine at the Forest Pest Methods Laboratory. Her research focuses on developing biological control methods with an emphasis on importation biological control. She works on all aspects of developing biocontrol methods from initial surveys in the native range to importation, rearing, and host range testing, and to release and evaluation. The focus of Hannah's work currently is developing biological control methods for the spotted lanternfly. Other research in progress is evaluating the parasitoid community of the scale insect Roseau cane scale in both its invasive range in the U.S. and its native range across East Asia. She also is starting to work on biocontrol of box tree moth. Previously she worked on invasive winter moth and its interactions with a native congener in the northeast and spongy moth.

Why is Purple Loosestrife *SO* Invasive in the Americas?

Dominique Costarella and Sangeet Lamichhaney
Kent State University

Purple loosestrife (*Lythrum salicaria*) is one of the most invasive plant species of Northern America. Stands of these purple perennial herbs choke out other plant growth and create monocultures in wetlands and surrounding areas across America. These invasive plants seem to thrive under diverse conditions in nearly every state of the United States. While the devastating impacts of purple loosestrife invasion are well-documented and understood, the mechanisms for this plant's invasive capability are poorly understood. Our goal is to explore the biology behind this plant's remarkable invasiveness by integrating morphological and genetic analyses. We hypothesize that two key pathways contribute to its invasive capacity: phenotypic plasticity and localized genetic adaptation in populations throughout the USA. We will examine phenotypic plasticity in morphological traits by utilizing herbarium specimens and data from the National Wetlands Inventory (NWI). Additionally, destructive sampling will be employed to gather DNA from these herbarium specimens across various habitats to conduct population genomic analyses, identifying genetic variations among local populations. Through the identification of distinct populations or genetic lineages of purple loosestrife, we can target biocontrol strategies more effectively, selecting specific agents or approaches suited to genotypes or regions where purple loosestrife is most problematic. Ultimately, we aim to identify population-specific susceptibilities to different biocontrol strategies, allowing for a more effective control of this plant's spread and ecological impacts. The study has the potential to significantly contribute to the management and understanding of invasive species, with implications for conservation efforts and ecological health in North America.

Dominique Costarella is a second-year PhD student in the Cellular and Molecular Biology program at Kent State University. She obtained her B.S. from the University of Tennessee, Knoxville. She aims to work with plants and study how they adapt to succeed in their given environments. Her current research focuses on investigating invasive *Lythrum salicaria* (purple loosestrife) from a genetic perspective, with special attention to population differences and genetic adaptations in North American populations. The work presented here is currently being conducted by Dominique with the expert supervision of her principle investigator, Sangeet Lamichhaney.

Insights into Life History, Behavior, and Host Specificity of *Eriborus* sp., a Prospective Biocontrol Agent of Box Tree Moth

Christine Dodge[1], Angela Hoover[1], Hannah Broadley[1], Damon Crook[1], Lukas Seehausen[2], Marc Kenis[2], and Greg Simmons[1]

[1] USDA-APHIS PPQ S&T, [2] CABI Switzerland

The box tree moth (*Cydalima perspectalis*) (BTM) is a newly invasive species in the U.S. First discovered in New York in 2021, BTM has since been found in Massachusetts, Michigan, Ohio, Delaware, and Pennsylvania. BTM is a specialist on boxwood, which is widely planted as an ornamental shrub and is common in green spaces across the nation. We are working to develop classical biological control for BTM, which is native to East Asia. Our candidate biocontrol agent, discovered in South Korea, is an ichneumonid wasp in the genus *Eriborus*. *Eriborus* sp. is a solitary koinobiont larval parasitoid of BTM and appears to be thelytokous, producing daughters from unmated females. Based on results to date from host specificity testing, *Eriborus* sp. appears to be at least somewhat specialized, as it has not attacked larvae in any of 7 non-target families tested; however, we are notably lacking data about its specificity within Crambidae, the family to which BTM belongs. Work is ongoing to collect and rear native non-target crambids to test, but this work has proven challenging. Additionally, we are using behavioral bioassays and chemical ecology to investigate *Eriborus* sp. host-seeking behavior. We have found that, while the wasp displays no attraction to boxwood host plant material, it is highly attracted to boxwood-fed BTM larval frass. We will discuss our findings in the context of release potential for *Eriborus* sp. Future steps for this project include crambid host specificity tests and additional studies to identify host-seeking cues used by *Eriborus* sp.

Dr. Christine (Chrissy) Dodge is a biological scientist with USDA-APHIS Plant Protection and Quarantine at the Forest Pest Methods Laboratory in Buzzards Bay, MA. Chrissy's research focuses on development and management of classical biological control programs for invasive insects. Her work spans all aspects of classical biocontrol research, from foreign exploration for natural enemies to post-release evaluation and monitoring. Chrissy is currently focused on rearing and evaluation of biocontrol agents for box tree moth and shot hole borers in the *Euwallacea fornicatus* species complex. She also manages the emerald ash borer biocontrol program and is leading studies focused on development of IPM strategies incorporating introduced biocontrol agents. Previously, she has worked on biocontrol of invasive snails and slugs using nematodes.

Environmental Niche Modeling and Management of Invasive Species: *Tithonia diversifolia* and *Mimosa diplotricha* Impact on Native Plant Diversity

Omomoh Bernard Eromosele
Federal University of Technology, Nigeria

This study investigates the impact of two invasive species, *Tithonia diversifolia* and *Mimosa diplotricha*, on native plant diversity in built-up areas and roadsides within the Federal University of Technology, Akure (FUTA), Ondo State, Nigeria. Field surveys were conducted using a stratified random sampling approach with along transects in selected sites, including abandoned areas, major roadsides, and developed regions. The presence and cover of the invasive species were recorded, while native plant species richness and diversity indices were assessed through species identification and abundance counts. Results indicated that *Tithonia diversifolia* covered 35.9% of the sampled plots, primarily in abandoned areas near built-up regions, while *Mimosa diplotricha* covered 59% of the plots, with higher prevalence along major roadsides. Statistical analysis revealed a significant reduction in native plant species richness and diversity indices in plots dominated by these invasive species, with species richness decreasing by an average of 40% compared to non-invaded plots. The species diversity was notably lower in invaded areas, indicating a loss of plant community diversity. Correlation and regression analyses demonstrated a strong negative relationship between invasive species cover and native plant diversity, with statistical tests (t-tests and ANOVA) confirming that these differences were statistically significant ($p < 0.05$). The findings underscore the detrimental impact of *Tithonia diversifolia* and *Mimosa diplotricha* on local plant communities and highlight the urgent need for effective management strategies. Biological control, through the introduction of natural enemies such as specific insect herbivores or pathogens, is proposed as a promising mitigation strategy. Additionally, environmental niche modeling, a technique that predicts where these invasive species are most likely to spread based on environmental conditions, can be used to guide and improve control efforts. This approach is particularly useful in adapting to climate-driven ecological changes. Addressing these invasions is crucial for preserving the ecological balance and biodiversity of the region.

Bernard Ommoh is a dedicated researcher specializing in the biological control of alien plant species and the protection of native flora. His work is centered on developing sustainable strategies to manage invasive species that threaten biodiversity and disrupt ecosystems. By leveraging natural predators, competitive plants, and innovative control methods, Bernard aims to restore ecological balance and safeguard native species in affected regions. His research contributes to preserving the natural heritage and ensuring the resilience of local ecosystems against the challenges posed by invasive species.

Exploring Foliar Fungal Endophyte Communities as a Source of Weed Biological Control Agents

Riley L. Fitz and Michael R. Fulcher
USDA-ARS FDWSR

Wavyleaf basketgrass (*Oplismenus undulatifolius* (Ard.) P.Beauv.) is an invasive perennial grass native to East Asia that is spreading in the Mid-Atlantic United States. Basketgrass forms dense mats in forest understories that suppress the growth of desirable, native herbaceous species, homogenize soil microbiomes, and alter insect communities. The relatively recent introduction of this species provides an opportunity to study novel weed-microbe associations formed during invasion. The aim of this research was to identify fungi inhabiting healthy basketgrass and assess their potential use as non-traditional biological control agents. A total of 317 foliar endophyte cultures were collected and identified to genus with DNA sequences. Radial growth rates were recorded in culture as a measure of saprophytic fitness, detached leaf assays were conducted to record a preliminary plant-fungus interaction phenotype, and a subset of phylogenetically dispersed endophytes were tested to identify those capable of inhibiting seed germination. Findings from this work will be used to select endophytes for secondary metabolite screening and further research on conserved basketgrass-endophyte associations.

Riley is currently a graduate student at Hood College, from which she will be graduating with her M.S. in Environmental Biology this May. Last year, she also received her undergraduate degree in Environmental Science & Policy, with minors in Chemistry and Political Science. Riley assisted in the development of microbial weed biological control agents during her internship at the USDA-ARS Foreign Disease-Weed Science Research Unit on Fort Detrick in Frederick, MD. Her past research experience spans several fields, from the thermal tolerance of lobster larvae in the Gulf of Maine, to aquatic invasive species and freshwater fisheries.

Southern Idaho Biocontrol (SIBC) Program: The Bug Crew Growing Community and Biocontrol

Becky Freiberg[1,2], Terry Ruby[1], Joseph Milan[3], Anna Webb[4], and Carl L. Jorgensen[4]
[1] SIBC, [2] Gooding High School, ID, [3] USDOI-BLM, [4] USDA-FS FHP

For nearly 25 years the Southern Idaho Biocontrol (SIBC) program has provided an opportunity for kids to develop their science skills and become familiar with biological control. The program is supported by Cooperative Weed Management Areas (CWMAs), counties, USDA Forest Service-Forest Health Protection, Bureau of Land Management and Idaho State Department of Agriculture. Besides the large number of sites monitored, releases made, and enhanced understanding of biological control and invasive weed management in local communities, the real success is the opportunities for students to be exposed to science and associated career building skills. Some participants have moved on natural resource management careers or used the skills and confidence in other fields. The two primary challenges for the program are logistics and financial resources. Finding and maintaining crew leads and vehicles highlight the logistical challenges. Not having a stable source of funding from all partners has led to counties or CWMAs opting out. This program has persisted by maintaining a broad local network and continuous community engagement to overcome some of the challenges.

Becky Freiberg is a science teacher at Gooding High School in Gooding, ID and SIBC Program Administrator for over fifteen years. **Terry Ruby** is Chair of the SIBC program and retired after an illustrious thirty plus year career as the Tri-County Noxious Weed Superintendent. **Joseph "Joey" Milan** is National Biological Control Specialist for the Bureau of Land Management and worked in Idaho for over two decades. **Anna Webb**, Entomologist, and **Carl Jorgensen**, Supervisory Entomologist, work for the USDA Forest Service; Intermountain Region; State, Private, and Tribal Forestry; Forest Health Protection in Boise, Idaho providing technical and financial assistance to forest pest programs. Anna works closely on a local and state level to ensure different agencies across Idaho and Utah have access to biological control agents. Carl leads a team of specialists who monitor forest pests and provide project assistance to federal and non-federal partners across Idaho, Nevada and Utah.

Renewed Hope to Control Invasive Swallow-wort in North America with *Chrysochus asclepiadeus*

David C. Harris[1], René F.H. Sforza[2], Ghislaine Cortat[3], and Dylan Parry[1]
[1] SUNY Environmental Science & Forestry, [2] USDA-ARS EBC, [3] CABI Switzerland

Black and pale swallow-wort (*Vincetoxicum nigrum* and *V. rossicum*) is an invasive plant in the American northeast and Great Lakes region. Biocontrol efforts since 2009 have focused primarily on an herbivorous moth, *Hypena opulenta,* but subsequent years of releases have yielded few results at sites in the US. Another potential biocontrol agent, *Chrysochus asclepiadeus* is now considered a viable candidate despite early host testing challenges after it was determined that in a lab setting, the fundamental host range for a native congener did not predict its ecological host range. *Chrysochus asclepiadeus* has been collected from a population in eastern France to determine its fundamental host range, quantify its impact on swallow-wort, and determine its behavior and feeding patterns when presented with multiple potential hosts. The larval stage feeds heavily on the root systems of swallow-wort, which are robust and normally allow it to emerge before many of its potential native competitors. The adult stage is long-lived and feeds on the above-ground portions of swallow-wort, reducing photosynthetic activity and opening wounds for the potential ingress of pathogens. If *C. asclepiadeus* maintains the limited host range it displays in its native habitat, release of this leaf beetle could prove essential to controlling populations of swallow-wort in full-sun settings. Typically, larvae feed underground for two years before pupating and emerging in early summer which presents a challenge for in vitro rearing. Swallow-wort strongly resists other methods of control; attack from above and below ground simultaneously may be required to produce significant impact.

David Harris has worked in the area of biocontrol research since 2016 at Cornell, focused primarily on nematode and fungal pathogens of the sirex woodwasp, brown marmorated stink bug, and spotted lanternfly. In those areas he has co-authored six published journal articles and presented research at several national conferences. He began his PhD work at SUNY ESF in 2022 where he has worked, alongside collaborators in Europe, to expand host range testing and target impact studies of *Chrysochus asclepiadeus* with the aim of submitting a petition for release to USDA-APHIS.

Factors Affecting Success of Biocontrol of Diffuse Knapweed (*Centaurea diffusa*)

Erica Heid[1], Joseph Milan[2], and Olivia Cope[1]
[1] Whitworth University, [2] USDOI-BLM

Biocontrol agents are specialized organisms released to decrease populations of an invasive species that have no established natural enemies in their invaded range. Diffuse knapweed (*Centaurea diffusa* Lam.), a notably invasive plant in Idaho, has a variety of insect biocontrol agents that have been released to control its populations. Factors affecting the spread of diffuse knapweed and factors that promote effective biocontrol of this invasive species are not yet fully understood. Here we show the use of the Standard Impact Monitoring Protocol (SIMP) to observe biocontrol outcomes and to determine what site factors promote the effectiveness of biocontrol in controlling invasive plant species. We found that for diffuse knapweed in Idaho, biocontrol was successful in sites with lower mean precipitation and higher mean temperature. High abundance of biocontrol agents was not necessary for control to be successful. Results demonstrate that biocontrol of diffuse knapweed should be prioritized in warmer, drier climates where plants are experiencing more stress.

Erica Heid is a recent graduate from Whitworth University. Their research focuses on the outcomes of biocontrol on invasive plants in the Pacific Northwest. Previous research has focused on interactions between insects and sagebrush species, both in genetic variation and effects of wildfire on insect abundance.

Discovery and Development of a Biological Control for Nuisance *Neotrypaea californiensis* (Burrowing Shrimp) in Washington State

Brady Hirshfeld, Pam Marrone, Amit Vasavada, Namrata Baruah, and Kara Talbott
Invasive Species Corporation

Human interventions to control invasive and pest crustaceans have primarily relied on nonspecific synthetic chemical pesticides, which are often associated with negative health effects on nontarget species including humans. This has led to local and international bans of such compounds, resulting in significant demand for lower risk and more specific interventions such as biological control agents. This pattern is exemplified in the state of Washington's efforts to control populations of *N. californiensis*, a burrowing shrimp pest that destabilizes coastal sediments and makes oyster farming impossible in large areas. Chemical pesticides imidacloprid and carbaryl were banned after their application to control *N. californiensis* populations resulted in negative ecosystemic and human health outcomes, and mechanical interventions have been nonviable to date. Microorganisms are a vast and underexplored source of bioactive compounds, including those that may be antagonistic against species found in their native ecosystems, and are being explored as a source for a biopesticide targeting *N. californiensis*. Microbial natural products research has produced successful biopesticides used to control invasive species such as spotted wing drosophila (*Drosophila suzukii*) and Asian citrus psyllid (*Diaphorina citri*), and tools like artificial intelligence-assisted selection of candidate microbes based on next generation sequencing data, fermentation optimization, and bioassay-guided formulation have lowered costs and expedited biopesticide development and production. This poster details ongoing efforts to discover and develop a microbe-derived biological control for *N. californiensis* in collaboration with the Washington State Department of Agriculture and Commission on Integrated Pest Management, and the Willapa-Grays Harbor Oyster Growers Association. More than 25 microbes sourced from the shrimp's habitat have been associated with anti-crustacean activity, and work continues to improve target species bioassay development and identification and upregulation of active compounds.

Brady Hirshfeld is an Associate Scientist at Invasive Species Corporation, where his work centers on bioprospecting and bioassay development targeting invasive and pest crustaceans and mollusks. He received his B.S. in Zoology, Neurobiology, and Environmental Studies from the University of Wisconsin - Madison in 2017, and M.S. from the University of California - Davis where his thesis focused on antimicrobial resistance in seafood-borne pathogenic bacteria. His other professional experiences span marine microbiology, aquaculture, cognitive aging, and animal behavior.

Advancing Development of Next-Generation Bioherbicides for Invasive *Phragmites*: New Partnerships and Biotechnologies

Kurt P. Kowalski[1], Ping Gong[2], Seung Ho Chung[2], Maheshi Dassanayake[3], James F. White[4], Keith Clay[5], Wesley A. Bickford[1], Spenser L. Widin[1], Kathryn Kingsley[4], Nagalingam Kumaran[6], and Meagan Froeba[1]

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Management of the non-native invasive grass common reed (*Phragmites australis* ssp. *australis*) is a priority for federal, state, provincial, and private land managers throughout North America. Existing approaches to managing non-native *Phragmites* and other invasive plants often are resource intensive and not species specific, so an international team of researchers is exploring the development of next-generation bioherbicides that may provide resource managers with more tools to manage invasive plants. A species-specific approach activates a natural plant defense mechanism (RNA interference) that limits the expression of target genes that promote plant growth. A second approach targets the symbiotic relationships between invasive *Phragmites* plants and their microbiome (e.g., bacteria, fungi) as a way to harm the plant (e.g., disrupt beneficial relationships). Extensive collaboration among U.S. Federal agencies (USGS, USACE, USDA), Australian research organization (CSIRO), and universities (Rutgers, Tulane, Louisiana State University) is creating a solid foundation for innovative bioherbicide development. Advancements in biotechnology research are stimulating the development of new treatment options for resource managers targeting invasive *Phragmites*.

Dr. Kurt Kowalski is a research wetland ecologist at the U.S. Geological Survey Great Lakes Science Center based in Ann Arbor, MI USA. His research focuses on the restoration and management of Great Lakes coastal wetland habitats, including the development of novel management approaches for the invasive grass Phragmites australis. He has extensive involvement in the application of research results into practice and policy, including the development of adaptive management approaches and online decision support tools.

A Comprehensive Assessment of the Non-Native and Invasive Species in Florida, USA

Yunpeng Liu, Diane J. E. Sturgeon, Paul M. Evans, and Matthew B. Thomas
University of Florida

The various climates and high levels of human disturbances and global trade in Florida has made the state a hotspot for biological invasions. Although various institutes have evaluated different invasive taxa, we still lack a comprehensive checklist summarizing all the non-native plants and animals. To fill this gap, we integrated the existing global, continental, national and state level evaluations, and developed a checklist covering both invasive and non-invasive species in Florida. Then we constructed a comprehensive distribution dataset for these species, by integrating multiple online databases, specimens and field investigations. We found that angiosperms and Arthropoda are the two largest non-native taxa in Florida, which are 5,384 (1,707 of them are invasive) and 3,823 (593 of them are invasive) species, respectively. Among all the taxa, the non-native species in bacteria, fungi and Mammalia contain the highest proportion of invasive species (> 50% of the non-natives are invasive), although the absolute number of species in these taxa are the highest. Distribution patterns of the invasives are similar across different taxa, where large cities (such as Tampa, Orlando, Miami and Jacksonville) and the coastal regions in southern Florida harbored the most abundant species. The Simpson dissimilarity across the invasion hotspots is similar, indicating that these regions were generally invaded by similar non-native species. The average range sizes are larger in the invasives than in the non-invasive non-natives, and the range sizes of the invasives increase faster through time than the non-invasives. Our study revealed the completed current invasion status in Florida.

Yunpeng Liu earned his PhD in Ecology from Peking University, China in 2021. He served as a visiting scholar at the University of Copenhagen, Denmark from 2019 to 2020, and as a postdoctoral researcher from 2021 to 2023, co-funded by Peking University and the University of Florida (UF). In mid-2023, he joined the Invasion Science Research Institute (ISRI) at UF as a postdoctoral researcher. His expertise includes biogeography, macroecology, and biodiversity conservation, focusing on dynamics and drivers of plant diversity, ecological niche shifts in non-native plants, and the relationship between forest diversity and ecosystem functioning. At ISRI, he assesses invasion risk in the eastern US by integrating big data. This involves modeling invasive plant invasion under future climate change and exploring temporal trends and their impact on native community diversity and productivity.

Looking into the Limiting Factors of *Aculus taihangensis* as a Biological Control Agent of Tree of Heaven (*Ailanthus altissima*) in North America

Francesca Marini[1], Giorgia Barbati[1], Markus Neteler[2], Sonja Stutz[3], Marie-Claude Bon[4], Tatjana Cvrković[5], Enrico de Lillo[6], and Biljana Vidovic[7]

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The success of a biological control program is contingent upon the establishment of the agent in the area of release and its impact on the target. The primary limiting factors to this approach are phenological, climatic or genetic mismatches between the agent and the host. In the case of eriophyid mites as biological control agents against weeds, the high level of host specificity, often at the intraspecific level, the potential host plant resistance and predation may act as additional constraints. We discuss these challenges and the ways they are being addressed in the case of *Aculus taihangensis* (Hong et Xue), an eriophyid mite native to China and currently under evaluation as a biological control agent for the global invader tree of heaven (*Ailanthus altissima*). In particular, host range testing was conducted on North American populations of the target, by exposing seedlings to *A. taihangensis* under laboratory conditions. The ecology of the mite was investigated, with a particular focus on overwintering requirements. Furthermore, a map of the different haplotypes of the mite currently known and their relation to the climate classification defined by Wladimir Köppen and Rudolf Geiger was compiled. The findings of our investigations, possibly corroborated by the study of the genetic variability in host populations, will contribute to the development of an effective management strategy for Tree of heaven in North America by the use of *A. taihangensis* as a biological control agent.

Francesca Marini is a researcher with approximately a decade of experience in classical biological control of weeds. In her role as Research Leader of the Biotechnology and Biological Control Agency (BBCA) in Italy, she is primarily engaged in the management and coordination of weed projects, from the exploration of the area of origin of the target weeds, through the collection of the related biological control organisms, to the evaluation of their specificity and efficacy through laboratory and field host range tests. Additionally, she oversees MSc and PhD students and is currently involved in projects on integrated pest and weed management.

Discovery, Development and Deployment of Microbial Natural Products for Invasive Species Management

Pam Marrone, Amit Vasavada, Namrata Baruah, Brady Hirshfeld, and Kara Talbott
Invasive Species Corporation

Microorganisms provide a rich source of natural products for controlling pests, registered by the EPA and sold as biopesticides. The biopesticide market, now estimated at $6 billion is growing at double digits around the globe, compared to single digit growth for synthetic chemical pesticides. Most products are used in agriculture, including those for invasive pests such as spotted wing Drosophila (*Drosophila suzukii*) and Asian citrus psyllid (*Diaphorina citri*). A smaller number are deployed for control of invasive species in forestry and water such as *Bacillus thuringiensis* kurstaki and israelensis and *Pseudomonas fluorescens* CL145A for invasive zebra (*Dreissena polymorpha*) and quagga (*Dreissena bugensis*) mussel control. Biopesticides have been perceived as less effective and more expensive than synthetic chemical solutions, however, biopesticides' safety, biodegradability, and lower carbon footprint make them desirable for pest management practitioners and consumers. Only a small fraction of the earth's microbial diversity has been searched for microorganisms that produce natural compounds to control invasive species. Artificial intelligence and machine learning for data mining microbial genomes, genomics, metabolomics and precision fermentation now provide a faster, more targeted way to discover and develop effective pesticidal microbial natural products. This talk will elucidate successful examples of rapid discovery and commercialization of naturally occurring microbial natural products for pest management of invasive species and other problematic pests.

Dr. Marrone spent her 30+ year career focused on biological products for pest management and plant health, having started and led three previous bioag companies, all of which were sold to larger companies. In 2023, Pam and co-founder Jim Boyd, launched the Invasive Species Corporation, to bring effective, environmentally friendly biological solutions to control destructive invasive species, in water, forestry and agriculture, including Zequanox® for invasive mussel control and Piscamycin® for invasive carp control. The company also has a microbial natural product discovery platform to find herbicides, algaecides and biological solutions to control problematic crustaceans. She has a B.S. in entomology with Honors and Distinction from Cornell University and a Ph.D. in entomology from North Carolina State University. She is a Fellow of the AAAS, and in 2024 she was elected to the National Academy of Engineering. She holds over 400 patents (>80 US).

Towards a Quantitative Meta-Analysis of Pathogen Efficacy in Global Weed Biocontrol Efforts

Matthew McMahon and Michael R. Fulcher
USDA-ARS FDWSR

There have been 169 releases of 71 pathogen species in 40 countries from 1943 to 2023, but attempts to synthesize the results of this body of work have not yet included a formal, quantitative meta-analysis of biocontrol efficacy. The goal of this research was to apply linear modeling to a global data set of pathogen releases and field applications. Our objectives were to (i) compile data on the effects of released pathogens on weed health, reproduction, and/or populations; (ii) curate subsets of data containing enough information to support quantitative modeling of pathogen effects; (iii) draft preliminary meta-analytical models; and (iv) identify best reporting practices that enable data reuse and cross-study comparison. Data, including mean effect sizes for weed dry weight, population or ground cover, seed viability, height, age, disease occurrence, flower production, and changes in plant diversity were derived from a systematic review of existing secondary resources and primary literature. Out of the 169 release reports considered, only 43 contained data suitable for inclusion in meta-analyses. Linear models were constructed for weed population density, weight, height, reproductive ability, and disease severity. Importantly, long-term monitoring of weed density and mortality are lacking from a majority of release studies. Overall, results showed slight but significant mean reductions in weed health, but conclusions are limited by a paucity of reusable data. Enhanced community standards for reporting impact data, particularly sample sizes and measures of sample variation, could improve the long-term utility of new pathogen release literature.

Matthew McMahon is an ORISE Research Assistant at the United States Department of Agriculture, Agricultural Research Service, Foreign Disease-Weed Science Research Unit. He has a degree in statistics and is currently working on global analyses of biocontrol pathogen release impacts and new map- and network-based risk assessments of weed-to-crop pathogen transfer.

The Host Range of the Non-Native Ligustrum Weevil: Beneficial or Pest Insect?

Brandi Misiaszek[1], Amy Roda[2], and Rodrigo Diaz[1]
[1] Louisiana State University, [2] USDA-APHIS PPQ

The ligustrum weevil (*Ochyromera ligustri*), a non-native seed-feeding weevil, is a natural enemy of the invasive Chinese privet (*Ligustrum sinense*). Both species, native to China, are now widely distributed throughout the southeastern United States. The immature stages of the weevil develop inside privet fruits, destroying seeds and thereby limiting reproduction of Chinese privet. This suggests the ligustrum weevil holds promise as an adventive biological control agent. However, its full host range remains unexplored, raising concerns about non-target impacts. To address its potential risk on native species and ecosystems, ornamental plants & the nursery industry, while evaluating effectiveness against invasive privet, no-choice and multiple-choice host range tests were conducted. No-choice tests revealed that the weevil fed on leaves of certain non-privet species, though multiple-choice tests—still ongoing—may yield additional insights. This study provides initial findings on the ligustrum weevil's host specificity and highlights both the promise and challenges of its use as a biological control agent. Future research will focus on confirming its host specificity, efficacy, and environmental safety to fully assess its potential as a sustainable biological control option.

Brandi Misiaszek is a Master's graduate assistant in the Diaz Laboratory at Louisiana State University, specializing in biological control. She began her career at the University of Rhode Island (URI) as an undergraduate at the URI Biocontrol Laboratory, maintaining non-target insect colonies for the spotted lanternfly project and conducting invasive insect surveys across Rhode Island. After earning her bachelor's degree, she became a research assistant, managing the spotted lanternfly rearing project and student workers. Currently, her research at LSU focuses on the non-native ligustrum weevil (*Ochyromera ligustri*) and its invasive host, Chinese privet (*Ligustrum sinense*). She investigates the weevil's host-range, phenology, and distribution, also conducting field surveys for weevils and other Chinese privet herbivores. Here, Brandi also contributes to the *Phragmites* and giant salvinia projects in her lab.

Unlocking RNAi Potential to Develop Next Generation Weed Management Tools

Kumaran Nagalingam, Amol Ghodke, and Tess James
CSIRO Australia

With the steady increase in the number weeds developing resistance and ongoing challenges of social unacceptance due to their non-target effects, reliance exclusively on herbicides is unlikely to sustain existing chemistries in weed management. RNA-interference (RNAi) based herbicides can be an effective additional tool for weed control. RNAi disrupts the expression of essential genes in the target population without genetically modifying the target, leading to aberrant growth and lethality. Our current research focuses on developing RNAi-based sprayable herbicides for wild radish *Raphanus raphanistrum*, an important weed of cropping and natural environment in Australia. We have successfully developed high-quality annotated genome and transcriptome resources for *R. raphanistrum*, prioritized target genes and conducted targeted bioassays demonstrating the feasibility of spraying RNAi herbicides onto plants and their subsequent uptake. Preliminary results show significant silencing of functional genes and reduction in plant height and flowering when targeting genes involved in the biosynthetic and developmental pathways. These preliminary results are looking promising to develop RNAi herbicides as next generation biocontrol for sustainable weed management.

Dr. Kumaran Nagalingam is an ecologist dedicated to advancing the understanding of plant-insect interactions for more effective pest and weed management strategies. With a keen focus on ecological and genomic methodologies, Dr. Kumaran investigates intricate insect pest and weed dynamics, aiming to develop innovative management solutions. Managing a dynamic team, Dr. Kumaran leads the development of biocontrol and genetic control techniques to tackle invasive insect pests and weeds. Through leading-edge research projects, Dr. Kumaran translates novel technologies into practical tools for on-the-ground deployment, facilitating their adoption and implementation by end-users.

The Identification of Arthropod Herbivore Assemblages and Empty Niches on Cogongrass (*Imperata cylindrica*) in Florida

Jean Palacios[1,2] and Greg Wheeler[1]
[1] USDA-ARS IPRL, [2] University of Florida

Cogongrass, (*Imperata cylindrica* (Beauv.)), is classified as a federal noxious weed, threatening the natural resources of the United States. Being expensive to control, cogongrass is an ideal candidate for biological control. Foreign explorations in Australia, Japan and Korea have yielded multiple potential biological control agents currently under colonization in the laboratory. Arthropod surveys conducted in South and Central Florida, the introduced range of cogongrass, determined if native herbivores are utilizing cogongrass and documented co-evolved natural enemies that may have accompanied cogongrass from its native range to south Florida. This survey determined the herbivore and predator assemblage of cogongrass and assed open niches available for future biological controls. Through a combination of sweep netting and tissue dissections, 1,718 arthropods were collected, including two *Sphenophorous* sp. found in the rhizomes, and thirty-eight Cecidomyiidae in the culms. These herbivores represented only 1.3% of insects collected indicating little competition for stem-boring biological control agents. While predators found comprised 26.1% of the collection, they are unlikely to inhibit establishment as stem-borers are difficult to access. While these results are promising for the pursuit of biological control, this survey was limited to cogongrass distributed in Florida. Cogongrass invasions at more northern latitudes, Alabama and Mississippi, may support different arthropod communities.

Jean Palacios is pursuing a master's degree in entomology at the University of Florida. She is currently in her second year, focusing on her research on the impacts of cogongrass, *Imperata cylindrica*, on arthropod communities. Previously, she worked for the USDA as a biological science technician, rearing biological control agents for Brazilian peppertree.

Impending Jailbreak: A BC Agent (*Eucryptorrhynchus brandti*) of Tree-of-Heaven (*Ailanthus altissima*) May Finally See the Light of Day in the USA

Scott Salom[1], Thomas J. McAvoy[1], Carrie Jubb[1], Cyndi Detweiler-Hill[2], Yu-Zhou Du[3], and Stacy Endriss[1]

[1] Virginia Tech, [2] New Jersey Department of Agriculture, [3] Yangzhou University, China

Eucryptorrhynchus brandti is a major pest of tree-of-heaven (TOH) in China, where both species are native. As a result, it has long been considered a potential BC agent for release in North America. *Eucryptorrhynchus brandti* was first shipped to Virginia in 2006 and has been studied under quarantine at Virginia Tech in Blacksburg, VA and also for a short period of time at the USDA-ARS Invasive Species Plant Laboratory in Ft. Lauderdale, FL. Long-term research, including host-range testing studies, led to the petitioning for release of this insect to the USDA Technical Advisory Group (TAG) for BC Agents of Weeds in 2021. This led to a 2022 TAG recommendation for the North American field release of *E. brandti* due to the low risk of direct or indirect nontarget impacts on federally listed species or to U.S. agricultural interests. Following the development of a Biological Assessment by APHIS and review by USFWS, a Letter of Concurrence has been prepared at the time of this writing and the remaining steps in the review process will follow. With its impending approval (jailbreak), we need to ramp up rearing capacity as well as start developing and testing release strategies. Lab studies have shown that this weevil has the ability to inoculate TOH with *Verticillium nonalfalfae*, a native fungus causing wilt and mortality in TOH in PA, VA, and OH. Using the weevil with this prospective bioherbicide has great potential and should be considered as part of the release strategy.

Scott Salom is a Professor of Entomology at Virginia Tech focusing on forest pests. He has 25 years of experience in classical biological control research and implementation. Much of the focus has been with hemlock woolly adelgid specialist predators as well as tree-of-heaven quarantine studies of an herbivore specialist and helping develop a naturally occurring fungal wilt as a bioherbicide for this invasive weed tree. He has served as the graduate supervisor to over 30 graduate students, many of whom are professionals throughout and outside the USA.

Evaluation of a North American Dryinid for Biocontrol of Spotted Lanternfly

Lisa Tewksbury, Alexandra Johnson, Carly Tribull, and Nick Durinzi
University of Rhode Island

Spotted lanternfly (*Lycorma delicatula*) is an invasive planthopper in eastern North America threatening viticulture and other agricultural industries. A classical biological control program has been initiated by USDA APHIS Forest Pest Methods lab, and the URI Biocontrol Lab is working in collaborating on host range testing of the proposed biocontrol agent *Dryinus sinicus* by collecting and rearing native hopper species for no-choice testing. While collecting nymphs from the field in Rhode Island, we have recovered multiple dryinid wasps from native planthopper species green coneheaded planthopper (*Acanalonia conica*) and two-striped planthopper (*A. bivittata*). Pilot no-choice experiments in 2024 of recovered native *Gonatopus* sp. wasps with SLF resulted in no oviposition, but one instance of host feeding. Understanding the potential for native wasp species to provide control of SLF should be investigated further as part of the pre-release studies for classical biocontrol of SLF.

Presenter has conducted classical biological control research for over 30 years in natural and agricultural systems. They act as Director of the Biological Control lab at the University of Rhode Island, which has a USDA inspected containment facility. Biological control research has included invasive weeds common reed (*Phragmites australis*), swallow-worts (*Vincetoxicum* spp.) and exotic insects lily leaf beetle (*Lilioceris lilii*) and spotted lanternfly (*Lycorma delicatula*). Current research focuses on host range testing of *Dryinus sinicus* in collaboration with the USDA for spotted lanternfly classical biological control and conducting a survey for parasitoids of native planthoppers to evaluate their potential to parasitize potted lanternfly.

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