Newsletter

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In this issue:

Editor's Note

First and foremost, I wish to take a moment to express sincere gratitude to Matt Bowser for his many years as editor of the *Newsletter of the Alaska Entomological Society*. Matt took on editorial duties in 2008 and since has contributed his time and expertise in publishing an impressive fifteen volumes of our society's newsletter. Throughout his editorship Matt worked diligently to improve the accessibility and professionalism of the newsletter. Many of us Alaska entomologists and entomology-enthusiasts look forward to reading the newsletter each year and we thank Matt for his immeasurable contributions toward its sustained production for the past 16 years.

I have so enjoyed working with all of you who have contributed to this seventeenth volume of the newsletter. Many heartfelt thanks to Adam Haberski and Matt Bowser for your guidance during this transition, and to the authors for sharing your entomological pursuits with us all.

Your new editor,

Alex Wenninger

Marine Intertidal Pseudoscorpions in Juneau, Alaska

by Bob Armstrong[1] *& John Hudson*[2]

Figure 1: Marine intertidal pseudoscorpions in Juneau, Alaska

Introduction

Pseudoscorpions, or false scorpions, are small scorpion-like members of the Class Arachnida, which includes spiders, mites, scorpions, and ticks, among others. They lack the tail-like appendage found on true scorpions and do not bite or sting people or pets. Most pseudoscorpions are less than 8 mm long. Like their cousins, pseudoscorpions have 8 legs. The body is reddish or brown in color and pear-shaped. Extending from the head are 2 long pedipalps, each ending in a pincer that is used to grab prey. Venom in the pedipalps paralyze prey.

Pseudoscorpions can be found on land and the intertidal zone. To avoid contact with water when the tide floods their habitat, marine pseudoscorpions enter silk-lined retreats. Mating and molting (shedding of the exoskeleton) also take place in these retreats.

According to the literature a single pseudoscorpion species lives in the marine intertidal areas in Juneau. It belongs in the family Neobisiidae. Its scientific name is *Halobisium occidentale* Beier, 1931. In fact it is the only representative of *Halobisium* in North America. It is known to occur in Alaska, California, Oregon, Washington and British Columbia.

It is a fascinating creature and we have been trying to document its behavior and life cycle with photographs. Here is what we have learned so far.

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Where they live

Figure 2: Intertidal habitat where pseudoscorpions have been found under rocks in Tee Harbor, Juneau.

Figure 3: Some of the intertidal habitat in the Fish Creek Park has numerous pseudoscorpions under the rocks.

Figure 4: We usually find them under rocks. The lower portion of the rocks can be buried up to about 6 inches in the sediment.

Figure 5: On the underside of these fairly small rocks we usually see the pseudoscorpions moving about.

Figure 6: We occasionally see them partially in a small hole on the underside of the rock.

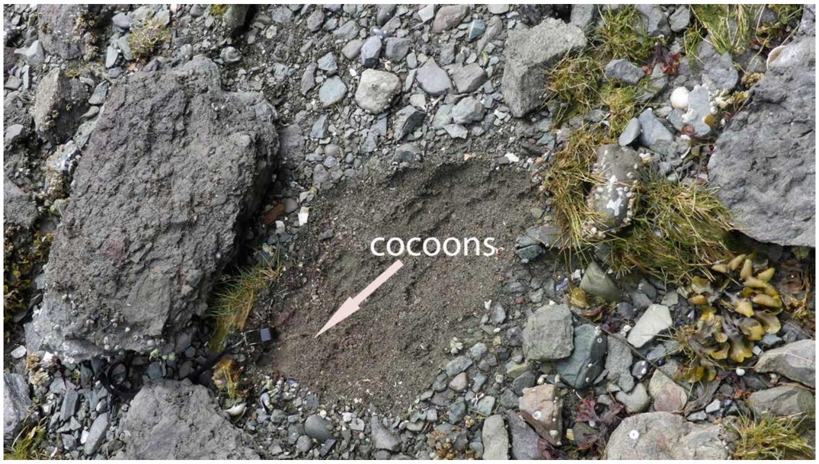

Figure 7: The location of two cocoons on substrate that was exposed when the rock on the left side of the photo was overturned.

Figure 8: Two cocoons pointed out in the previous photo. Pseudoscorpions typically build these cocoons to overwinter in and to mate and molt (shedding of the exoskeleton).

Figure 9: A pseudoscorpion inside one of the two cocoons.

Figure 10: A pseudoscorpion in a cocoon attached to the underside of a rock.

Figure 11: At the Fish Creek Park we often find numerous cocoons on the underside of these larger rocks.

Figure 12: Pseudoscorpions in cocoons attached to a rock that has been turned upside down. At the top of the cocoons is a whitish beach springtail, one of their favorite foods.

Figure 13: Numerous cocoons attached to the substrate that was under a large rock at the Fish Creek Park.

Figure 14: A closer view of a few of the cocoons attached to the substrate.

What they eat

According to the literature they feed on these Beach Springtails which we often see on the same rocks as the pseudoscorpions.

Figure 15: Beach Springtail.

For good information about springtails look at http://www.collembola.org/ These springtails belong to the subfamily Onychiurinae. Some are called Beach Springtails.

Figure 16: Pseudoscorpion and beach springtail.

Figure 17: Pseudoscorpion and beach springtail.

Figure 18: Beach springtails.

According to the literature, pseudoscorpions eat these red velvet mites. We often find them on the same rocks.

Figure 19: A red velvet mite.

Figure 20: A pseudoscorpion about to grab a mite.

How they reproduce and care for their young

Figure 21: Two pseudoscorpions next to each other. We wonder if they are a male and female.

The female carries a silken egg pouch of 12 to 24 eggs on her belly for about 3 weeks.

Figure 22: This shows a female pseudoscorpion in Auke Bay carrying its eggs (photo by Aaron Baldwin).

Figure 23: We found this female with her egg pouch under a rock in Auke Nu Cove on June 2, 2024.

Figure 24: An adult pseudoscorpion with young was found under this rock in Auke Nu Cove. The rock has been turned onto its side in this photo.

Figure 25: A pseudoscorpion and her young in a cocoon that was attached to the underside of a rock in Auke Nu Cove on June 2, 2024.

The following is taken from Hughes (2017): "Pseudoscorpions have 3 juvenile instars (termed protonymph, deutonymph and tritonymph) followed by the adult life stage. The lifestage of a typical pseudoscorpion is easily discerned by examining the movablefinger of the pedipalp chelae which will have 1, 2, 3, or 4 trichobothria dependingon if the specimen is a protonymph, deutonymph, tritonymph or adult (Chamberlin 1931). When pseudoscorpions molt, they use silk from their chelicerate mouthparts to construct small, protective chambers within their confined habitat (Kew 1914)."

Useful References

Anthony et al. (2016): Thermal biology and immersion tolerance of the Beringian pseudoscorpion *Wyochernes asiaticus*.

Buddle (2005): A primer on pseudoscorpions and taxonomic status in Canada.

Gallant et al. (2024): Elemental characterization of the cuticle in the marine intertidal pseudoscorpion, *Halobisium occidentale*.

Hughes (2017): Taxonomy, systematics, and venom components of neobisiid pseudoscorpions (Pseudoscorpiones: Neobisiidae).

Life Cycle

From the Utah Pests Fact Sheet by Erin W. Hodgson (Extension Entomology Specialist), Brooke Lambert, and Alan H. Roe (Insect Diagnostician) (Hodgson et al. 2008).

Pseudoscorpions have an extended life cycle of 1 to 3 years, depending on the location and temperature.

The mating ritual for pseudosporpions is similar to the dance of true scorpions. The male pseudoscorpion produces a spermatophore, or sperm packet, and pulls the female over it during the mating dance.

The female carries a silken egg pouch of 12 to 24 eggs on her belly for about 3 weeks.

The hatched brood ride on the females back until they get older.

The young look like the adults except smaller; they will molt three times over several years before becoming adults.

Adults live for 2 to 3 years and females may produce several broods a year.

Pseudoscorpions overwinter in silken cocoons.

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"No Vacancy": Masking spruce trees from spruce beetles with semiochemicals on the Kenai Peninsula

by Jackson P. Audley[3], *Christopher J. Fettig*[4], *Jason E. Moan*[5], *Jessie Moan*[6], *Steve Swenson*[7], *Elizabeth E. Graham*[8], and *Agenor Mafra-Neto*[9]

Introduction

Bark beetles (Coleoptera: Curculionidae: Scolytinae) are a globally distributed and diverse sub-family of weevils comprised of >6,000 species worldwide, with ~550 species in North America (Fettig and Audley 2021). They are small, (~1–8 mm) cylindrical beetles that feed and reproduce beneath the bark of host trees. Most bark beetle species colonize recently dead and dying trees and are not considered pests; however, ~25 species - including spruce beetle, *Dendroctonus rufipennis* (Kirby) (Figure 1) - are major "tree killers". These tree-killing species primarily occur in North America and Europe (Fettig and Audley 2021) and represent some of the most significant pests of trees as, from time to time, populations can irrupt to epidemic levels causing widespread tree mortality.

Figure 1: Left, adult spruce beetle as seen under a stereo microscope. Right, adult spruce beetle (in yellow circle) crawling on bark. Photo credits: J.P. Audley, Pacific Southwest Research Station.

A *semiochemical* is a compound or mixture of compounds that affects the behavior of receiving individuals (Seybold et al. 2018). Some bark beetles evolved pheromone-mediated (a *pheromone* is a semiochemical that mediates intraspecific (within species) interactions) aggregation which allows these species to overwhelm the defenses of healthy host trees. Aggregation pheromones are typically produced by adults of both sexes as they bore into the bark of viable host trees. Today, aggregation pheromones for many of the tree-killing bark beetle species are well studied and commercially synthesized to produce baits and lures (Seybold et al. 2018). For example, aggregation pheromone components for spruce beetle include frontalin, seudenol, and MCOL. Spruce beetle lures for spruce beetle populations in western North America include frontalin, MCOL, and host cues consisting of spruce terpenes like α-pinene, β-pinene, camphene, and/or 3-carene (Keeling et al. 2021). It has been demonstrated that several species of bark beetles recognize

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and distinguish among volatile compounds from host and non-host trees (Huber et al. 2021), allowing individuals, particularly the first few individuals that encounter a potential host tree (*pioneering individuals*), to locate and select viable hosts to colonize.

While large numbers of bark beetles are necessary to overwhelm the defenses of healthy trees, too many can result in high levels of intraspecific competition for the limited food source (phloem) negatively affecting beetle populations. Accordingly, some species also produce antiaggregation pheromones. As the name implies, these semiochemicals illicit the opposite behavioral effect of aggregation pheromones, essentially serving as a "no vacancy" sign for the host tree. Individuals receiving the antiaggregation pheromone either orient to a portion of the tree bole with lower concentrations of antiaggregation pheromone or to another host entirely. The primary antiaggregation pheromone of spruce beetle, 3-methylcylcohex-2-en-1-one (MCH), has been known since the 1970s, yet development of MCH as a tree protection tool for spruce beetle has remained elusive. Conversely, verbenone is well known for its use as a semiochemical repellent for mountain pine beetle, *D. ponderosae* Hopkins, in Canada and the United States (Progar et al. 2014). Verbenone was first discovered in the 1960s and has since been evaluated for management of several bark beetle species in North America, Europe, and Asia (Frühbrodt et al. 2024).

Spruce beetle poses the most significant threat to mature spruce in North America. In general, the beetle's range tracks the distribution of spruce across Canada and the United States (Bleiker 2021). Spruce beetle can attack all species of spruce native to North America; however, regional host preferences are observed. Primarily Sitka spruce is attacked in the temperate rainforests of the Pacific Coast, white and hybrid spruce in boreal forests, and Engelmann spruce in the Rockies (Bleiker 2021). Lutz and white spruce are the primary hosts in Alaska. Black and blue spruce are considered rare hosts (Bleiker 2021, Ott et al. 2021). Like other tree-killing bark beetle species, during outbreaks, spruce beetle occasionally attacks other tree species typically thought of as non-hosts (Figure 2).

Figure 2: Left, spruce beetle attacks (pitch tube and frass, in yellow circle) on Lutz spruce, a host, near Soldotna, 2021. Photo credit: J.P. Audley, Pacific Southwest Research Station. Right, spruce beetle attack on mountain hemlock, considered a non-host, near Cooper Landing, 2023. Photo credit: C.J. Fettig, Pacific Southwest Research Station.

Management options for bark beetles broadly fall into two categories: direct and indirect control (Fettig and Hilszczański 2015). Direct control targets reducing a population in a local area. These measures are typically reactionary to a local population irruption or outbreak and are short-termed strategies that include the use of insecticides, semiochemical repellents, trap trees, and sanitation to name a few (Holsten et al. 1999, Bentz and Munson 2000).

The use of semiochemical repellents is a direct control strategy whereby the chemical ecology of a target organism is manipulated to alter its behavior. In bark beetle systems, this typically involves the use of synthetic antiaggregation pheromone(s) and/or non-host volatiles. For example, this strategy has been successfully applied to Douglas-fir beetle, *D. pseudotsugae* Hopkins, utilizing MCH, its primary antiaggregation pheromone (Ross 2021). In some cases, additional semiochemical repellents are necessary to complement the primary antiaggregation pheromone. For example, in western pine beetle, *D. brevicomis* LeConte, its primary antiaggregation pheromone (verbenone) alone is insufficient for tree protection. However, the addition of non-host compounds (acetophenone, (E)-2-hexen-1-ol, and (Z)-2-hexen-1-ol) to verbenone yields sufficient repellency to impart tree protection (Fettig et al. 2023).

Discussions with resource managers, policy makers, and others prompted our team to investigate the effectiveness of novel semiochemical repellents to protect spruce trees from mortality attributed to spruce beetle. In general, developing bark beetle semiochemical repellents is a tedious process involving several steps conducted over many years (Figure 3).

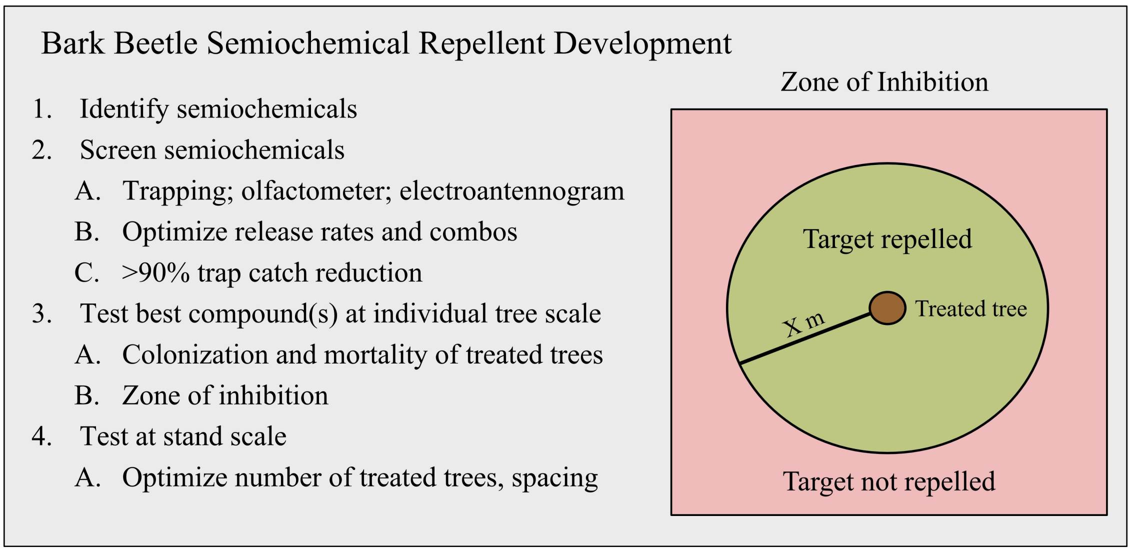

Figure 3: General steps for developing bark beetle semiochemical repellents.

Related Studies

We began work on an effective semiochemical repellent for spruce beetle following availability of SPLAT® MCH (Figure 4), a biodegradable formulation containing 10.0% MCH by weight (ISCA Inc.), and its demonstration as an effective semiochemical repellent for Douglas-fir beetle (Foote et al. 2020). We began in June 2021 by evaluating potential repellents (Table 1) in trapping assays (Figure 3, Step 2) near Soldotna. Twenty-one, 12-unit funnel traps were suspended from metal conduit poles with a spruce beetle lure attached to each trap (Figure 5). Traps were then assigned to one of seven treatments, each replicated three times. Traps were left in place for 24 hr after which samples were collected and traps were re-randomized.

Spruce beetle trap captures were reduced by 87% across all semiochemical repellent treatments compared to the control and no significant differences were observed among semiochemical repellent treatments (Figure 6) (Audley et al. 2024). While we were encouraged by the results from our June trapping assay, we amended the treatments (Table 1) and conducted a second assay in July 2021 using the same location and methods. Once again, all semiochemical repellent treatments significantly reduced spruce beetle trap catches compared to the control and no significant differences were observed among semiochemical repellent treatments (Figure 6). We observed a slightly greater reduction in trap catch (94% versus 87%) during the July assay (Audley et al. 2024).

Table 1: Treatments and corresponding semiochemicals used in trapping assays and tree protection studies.

Treatment	Semiochemicals	Assay/Study
Spruce beetle lure (SBL)	frontalin + MCOL + spruce terpenes	All trapping assays
Spruce beetle bait (SBB)	frontalin + MCOL	All tree protection studies
SPLAT® MCH (3.5 g A.I.)	3-methylcyclohex-2-en-1-one	2023 tree protection study and Zone of Inhibition assay
SPLAT® MCH (7 g A.I.)	3-methylcyclohex-2-en-1-one	All tree protection studies
AKB	linalool + β-caryophyllene + (E)-3-hexen-1-ol	All assays and all studies except MCH only study
PLUS	acetophenone + (E)-2-hexen-1-ol + (Z)-2-hexen-1-ol	All assays and all studies except MCH only study
Octenol	1-octen-3-ol	2021 trapping assays and 2022 tree protection study
Competitors Combo	exo-brevicomin + endo-brevicomin + ipsenol + ipsdienol	2021 trapping assay - June
Limonene + Verbenone	R-(+)-limonene + S-(−)-verbenone	2021 trapping assays

Figure 4: A dollop of SPLAT® MCH (in yellow circle) on Lutz spruce with the SPLAT® MCH tube and deployment device shown. Photo credit: C.J. Fettig, Pacific Southwest Research Station.

Informed by data from our trapping assays, we established a tree protection study (Figure 3, Step 3) near Tern Lake in 2022. We selected 100 Lutz spruce and randomly assigned each to one of five treatments (Table 1). Trees were treated in May 2022, assessed for spruce beetle colonization in August 2022 based on the presence of boring dust and/or pitch tubes (Figure 2), and assessed for mortality in August 2023 based on crown fade. All semiochemical repellent treatments significantly reduced spruce beetle colonization and tree mortality compared to the control (Figure 7) (Audley et al. 2024).

In 2023, we established two new tree protection studies near Cooper Landing. Trees were treated in May 2023, assessed for spruce beetle colonization in August 2023, and assessed for mortality in 2024. No tree

Figure 5: Left, 12-unit funnel trap used in two trapping assays for screening semiochemical repellents near Soldotna, 2021. All semiochemicals (in yellow circle), including SPLAT® MCH, were attached to the center of the trap. Photo credit: J.P. Audley, Pacific Southwest Research Station. Right, J.P. Audley re-randomizing funnel traps near Soldotna, 2021. Photo credit: C.J. Fettig, Pacific Southwest Research Station. Dead spruce in the background were colonized and killed by spruce beetle during a recent outbreak.

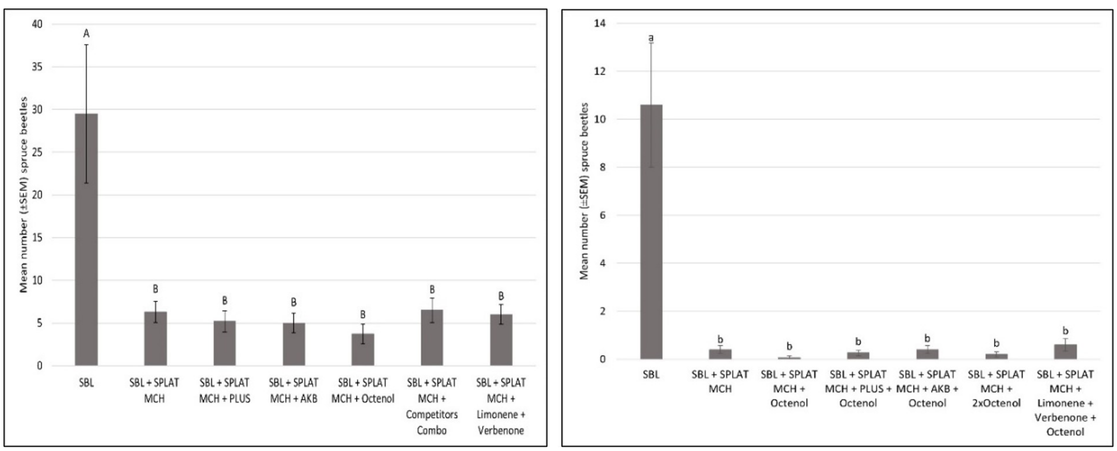

Figure 6: Left, June 2021 trapping assay. Right, July 2021 trapping assay. Both assays were conducted along Funny River outside of Soldotna. Different letters indicate statistically significant differences.

mortality was observed in any semiochemical repellent treatment in the first study (Figure 8). Interestingly, in the second study we observed a difference in tree protection between SPLAT® MCH and the MCH bubble caps (Synergy Semiochemicals Cop., Burnaby, BC) with more spruce beetle colonization occurring on trees treated with SPLAT® MCH (Figure 9). However, all three doses of SPLAT® MCH and MCH bubble caps significantly reduced tree mortality compared to the control (Figure 9). Mortality in the control was lower than anticipated, suggesting a decline in spruce beetle populations in the area.

Following several years of successful tree protection studies (including related efforts conducted in the Rockies (Audley et al. 2024 and J.P.A. et al., unpublished data)), we sought to delineate the distance from repellent point sources at which each combination interrupted spruce beetle host searching and aggregation behavior, or what we like to call the "zone of inhibition" (Figure 3, Step 3). To accomplish this, we created trapping arrays around treated Lutz spruce trees with concentric rings of trapping stations at five distances (2, 4, 8, 12, and 16 m from treated trees) along five azimuths (0, 72, 144, 216, and 288° from treated trees)

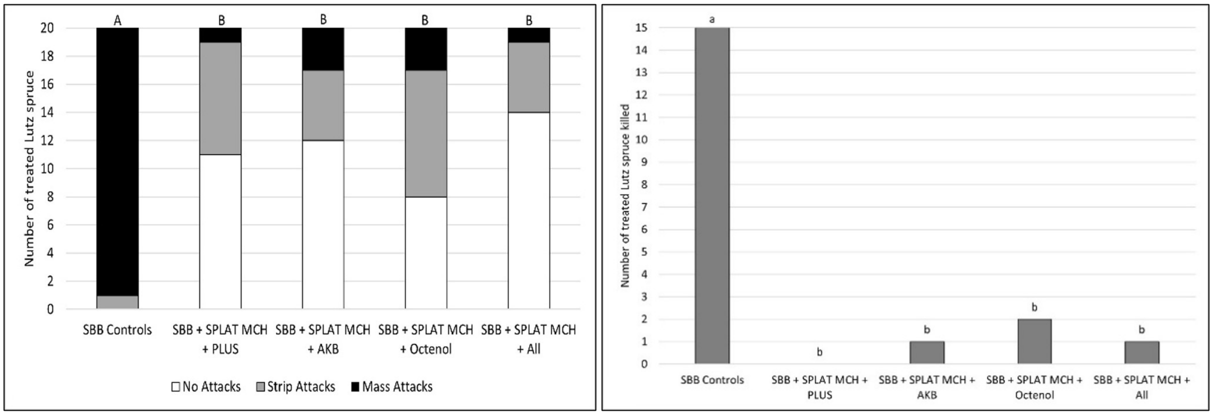

Figure 7: Results from the 2022–2023 tree protection study near Tern Lake. Left, number of treated Lutz spruce colonized by spruce beetles. Right, number of treated Lutz spruce killed by spruce beetles. Different letters indicate statistically significant differences.

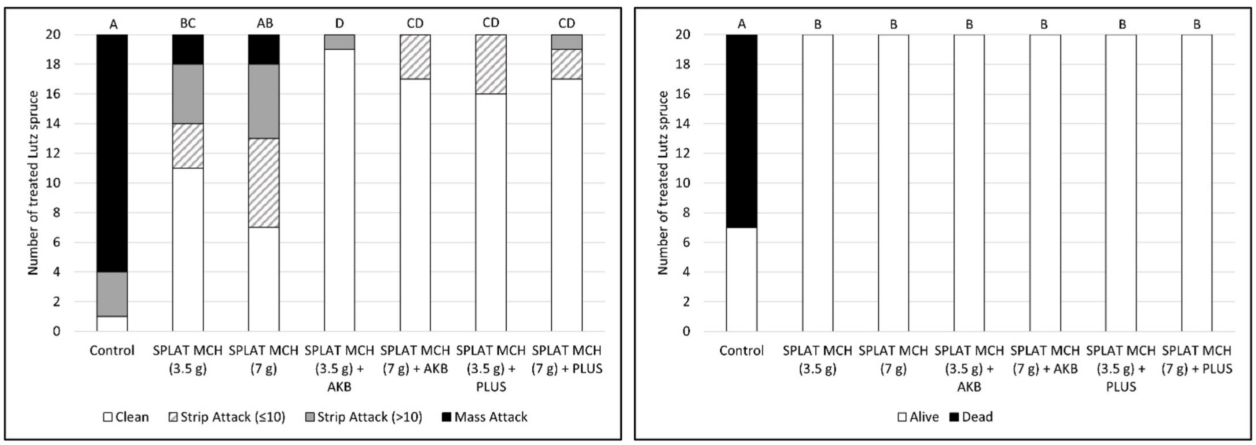

Figure 8: Results from the first 2023–2024 tree protection study near Cooper Landing. Left, number of treated Lutz spruce colonized by spruce beetles. Right, number of treated Lutz spruce killed by spruce beetles. Different letters indicate statistically significant differences.

for a total of 25 stations per array. Each array received five 12-unit funnel traps, each with a spruce beetle lure. Trap placement within each array was randomly assigned so that there was one trap per distance and azimuth per day. Three replicates of arrays were established. We assessed the zone of inhibition for SPLAT® MCH (3.5 g A.I.) alone, SPLAT® MCH with AKB, and SPLAT® MCH with PLUS (Table 1). Samples were collected and trapping positions were re-randomized daily for 10 d. Analyses of trap catches revealed that all three semiochemical repellent treatments significantly reduced spruce beetle catches within 4 m. It appears the zone of maximum inhibition provided by the semiochemical repellents is ~4 m, after which levels of repellency decline. This finding is useful for optimizing the number of treated trees for stand protection in future studies (Figure 3, Step 4).

Conclusions and Future Work

Having observed consistent reductions in trap catches, spruce beetle colonization and tree mortality, we are very encouraged by the results of our work, especially considering that our tree protection studies used a baited design (i.e., each tree is baited to induce spruce beetle colonization). A particularly interesting result is the efficacy of SPLAT® MCH alone (Figures 8 & 9); both doses significantly reduced spruce mortality. In earlier studies, the efficacy of MCH alone (bubble cap formulations) for protecting spruce from spruce

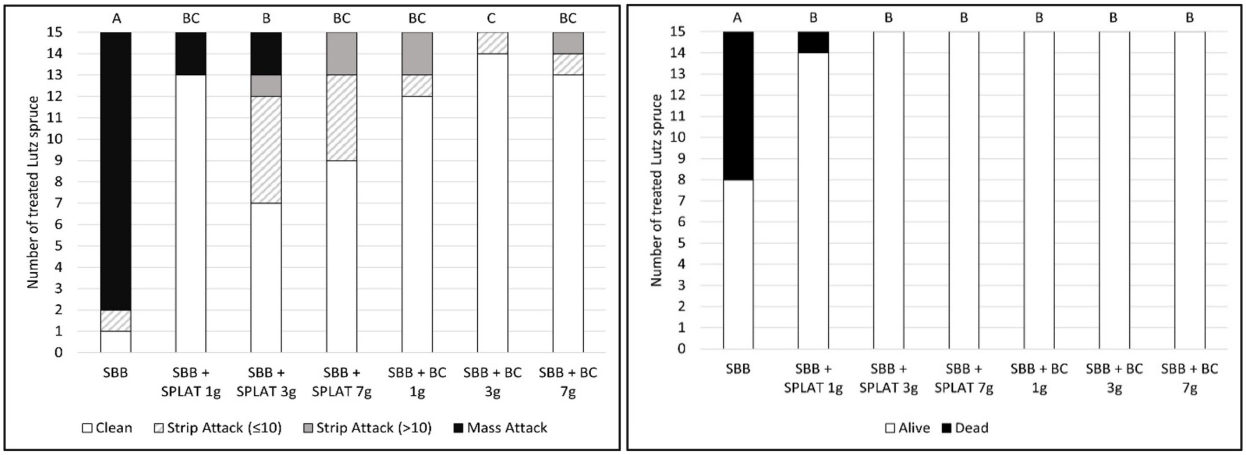

Figure 9: Results from the 2023–2024 SPLAT® MCH versus MCH bubble cap (BC) tree protection study. Left, number of treated Lutz spruce colonized by spruce beetles. Right, number of treated Lutz spruce killed by spruce beetles. Different letters indicate statistically significant differences.

beetle was mixed, with consensus being that MCH alone is ineffective (Jenkins et al. 2014). However, these early studies evaluated much lower doses of MCH than in our studies (Table 1), as they were informed by work on Douglas-fir beetle where low doses are effective for tree protection (Ross 2021). Early failures to protect spruce from spruce beetle with MCH alone may simply be an artifact of the low MCH doses used. We hope to further evaluate this by investigating various doses of SPLAT® MCH alone in trapping assays in 2025. Our research team is committed to delivering a semiochemical repellent for protecting spruce from mortality attributed to spruce beetle in Alaska.

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Seed-feeding and fruit deformity of crabapple caused by the apple seed chalcid in Southcentral Alaska

by Alexandria Wenninger[10]

Figure 1: An apple seed that has been partially opened to reveal the chalcid larva inside. Photographed 13 December 2022.

Introduction

The apple seed chalcid (*Torymus druparum* Boheman (1834)) has been identified as a seed-feeding insect of apple (*Malus* sp.) in Southcentral Alaska. Small larvae were initially discovered in the seeds while processing apples grown in Wasilla, Alaska in October 2022 (Figure 1). The affected Alaska apples were reported to be of the variety Kerr, which is an edible crabapple that was developed in Manitoba, Canada in 1952 by cross breeding the Dolgo crabapple (Siberia, Russia) with the Haralson apple (Minnesota, USA). Reared specimens were sent to chalcidoid taxonomist Dr. Petr Janšta for identification.

Apple Seed Chalcid Description & Life History

The apple seed chalcid oviposits into a host fruit in spring; work in Eastern North America found that the eggs are laid in June into developing apples that are ~1–1.5 cm in diameter (Crosby 1909). The female wasp inserts her long ovipositor through the fruit, ovipositing directly into the developing seed (Crosby

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1909). Larvae of the apple seed chalcid are white in color, translucent, and reach ~3–5 mm in length[11] (Figure 1). They are legless but feature sclerotized, pointed mandibles. The larvae feed within the seed, consuming the entirety of the kernel. While several eggs may be laid and hatch into larvae within a single seed, only one larva is typically able to develop to a fifth instar within one seed; the ultimately maturing larva kills and consumes the additional larvae within the seed (Cushman 1916). The species overwinters as a late-instar larva before pupating and emerging as an adult. Pupation may occur either the following spring (annual life cycle) or in the second spring (biennial life cycle); delayed emergence to the second spring may be more typical when the fruit does not substantially decay off of the core before the first spring (Turnipseed 1960). Cushman (1916) suspects this delayed emergence in some offspring may be an adaptation to overcoming seasons of poor fruit set. Female pupae (~4 mm) are larger than male pupae (~3 mm) and can be distinguished by the presence of the ovipositor which is held folded up over the dorsum (Figure 2). Initially, pupae are entirely a pale off-white color; as time proceeds the eyes turn a bright red color, and next the pupae begin to darken to brown and a greenish reflection becomes visible through the thin, clear pupal casing (Figure 2). Adult wasps have a shiny metallic green to brown body color with yellow to orange legs and reach ~4–5 mm in length, with males being slightly smaller than females (Figure 3).

Figure 2: Pupal development. Left – the first day pupae were observed (28 November 2022). Right – the same pupae photographed 10 days later (8 December 2022). (These two pupae both eclosed by 13 December 2022.)

Records & Distribution

Apple seed chalcids were first recorded in North America in 1906 (Crosby 1908) from both native and cultivated crabapples in Ithaca, New York, USA. Early records list the species as *Torymus druparum* Boheman, 1834 (syn. *Syntomaspis druparum*). Later reviews of *Torymus* consider *T. druparum* to be Palearctic in distribution and treat the Holarctic species *Torymus varians* (Walker 1833) as the species that occurs in apple seeds in North America (Grissell 1976). While both *T. varians* and *T. druparum* occur in Europe, the European review of *Torymus* (De Vere Graham and Gijswijt 1998) puts *Malus* (apple) as the host for *T.*

[11] Earlier literature describes the larvae as 2.5–3.5 mm in length, dependent upon the size of the seed (Crosby 1909). The Alaska larvae I measured range slightly larger at 3–5 mm. The apple seeds I measured ranged 7–9 mm in length. The Alaska seeds were from the apple variety Kerr which an edible crabapple developed by cross breeding a Dolgo (crabapple) with a Haralson (apple); it's possible that this crab variety could produce larger seeds than the crabapples examined by (Crosby 1909). It is also worth noting that the larvae measure 1–2 mm longer when alive compared to their length after preservation in 70% ethyl alcohol.

Figure 3: Adult apple seed chalcid wasps, male (left) and female (right).

druparum and *Crataegus* (hawthorn) as the host for *T. varians*, conflicting with the North American records which place *T. varians* on both *Malus* and *Crataegus* spp. hosts (Noyes 2019). The published morphological differences between these two species are relatively minor, described as small differences in the shape of the antennal anellus and head width (De Vere Graham and Gijswijt 1998).

To help sort out some of the confusion about which species we may have here in Alaska I consulted Dr. Petr Janšta, Hymenoptera Curator at the State Museum of Natural History in Stuttgart, Germany (Staatliches Museum für Naturkunde Stuttgart). Dr. Janšta has experience with both species and has found that while typically *T. varians* develops on *Crataegus* hosts and *T. druparum* develops on *Malus*, uncommonly they can switch hosts, and further complicating matters, the two species may also hybridize (Dr. Petr Janšta, personal communication 29 November 2022). In January 2023, I sent several male and female specimens to Dr. Janšta for identification. Dr. Janšta identified the specimens as *T. druparum* based on morphological features, and added that his opinion is that the two species are more host-specific (*T. druparum* on *Malus* sp. and *T. varians* on *Crataegus* sp.) than is mentioned in the literature (Dr. Petr Janšta, personal communication 16 March 2023).

Rearing Methods

I use the general methods outlined by Eiseman (2016) for rearing. The samples I received 21 October 2022 included a variety of plain seeds, cores, and whole apples that were suspected to contain the larvae, and came from apples that had been stored outside in a tote after harvest where temperatures fluctuated between 20 °F to 45 °F according to the donor of the samples. To simulate a continuation of winter diapause, all samples were held in the refrigerator without any further preparation until 16 November 2022. On 16 November I prepared the insects for rearing by separating the seeds from the apple or core sample and briefly rinsed the seed in water to remove most of the decaying fruit from the outside of the seed. A few larvae were removed from their seeds for observation. Each larva or rinsed seed was placed singly in a prepared vial; for this species I used 5-dram clear polystyrene plastic vials (Thornton Plastics) with 1 sheet of toilet paper crumpled and pressed into the bottom of the vial and moistened with a couple drops of water. The prepared vials were separated into 3 subsets: one subset that was held at room temperature (~68 °F to 72 °F) and two subsets that went back in the refrigerator to be removed at a later time in case a longer diapause was required for development. If mold appeared in the vial I moved the specimen into a clean, newly prepared vial. (To prevent data loss through the vial changing process I find it easiest to put the collection data on the lid, keeping the same lid with the specimen through each vial change.) Note that adults of this species need to be removed from the vials promptly after emergence; within a day or two the adult wasps are capable of releasing themselves from captivity by chewing a 1 mm circular hole in the lid of the snap caps on the vials (Figure 4), much to my chagrin.

Figure 4: An escape hatch measuring 1 mm in diameter created by an adult apple seed chalcid. These escapes largely occurred with wasps which had emerged over weekends when I was not at the office to monitor them.

For the first subset of samples which were removed from refrigeration on 16 November, pupae were first observed on 28 November and first adults emerged 13 December. The pupal development period has previously been reported to take ~4 weeks time (Cushman 1916), however, many wasps were able to develop in nearly half that time under the rearing conditions described here. The first larvae to develop to adults were those that were removed from their seeds, suggesting that a larva removed from its seed may develop more quickly. By 16 December all 4 larvae which had been removed from their seed had emerged so I went ahead and opened the remaining 24 seeds. All 24 seeds contained a larva, none had advanced to the pupal stage, which is consistent with the idea that they may develop more quickly when removed from the seed. All remaining 24 larvae were removed from their seed and placed back into their respective vials to continue development, the adults of which had a more extended emergence period that continued until 7 April 2023. Another advantage of removing the larva from the seed is that the wasps can then be sexed at the pupal stage rather than waiting for adult emergence (Figure 2). On 13 December I removed a second subset of the larvae from the refrigerator; I extracted all larvae from their respective seeds, returned each insect to its respective vial, and kept them at room temperature to develop. All adults from this subset emerged between 9-11 January 2023.

Integrated Pest Management

The apple seed chalcid is generally not considered to be a pest of economic importance as infested apples typically are still marketable and often don't show signs of infestation (Cushman 1916). Crabapples and other small-size apple varieties may be more prone to heavy infestation than others, possibly because the wasp's ovipositor is better able to reach the seed through the fruit in these smaller varieties (Crosby 1909, Cushman 1916). Heavy infestation can cause scarring or dimpling of the fruit (Figure 5). Crosby (1909) describes the damage caused by oviposition punctures as "distinct depressions [that] give the apple a decidedly knotty form". The damage from the apple seed chalcid can be mistaken for other conditions such as poor pollination or damage from other insects. Distorted fruit from the chalcid can be distinguished from poor pollination by opening the apple and checking the seeds: if the core lacks developed seeds then poor pollination is likely (Turnipseed and Mitchell 1955).

Figure 5: A cross-section of an apple that contains several chalcid larvae within the seeds. Repeated oviposition by this species can cause scars on the developing fruit and can lead to dimpling of the fruit once developed. Photographed 16 November 2022.

Because crabapples are a popular choice in Alaska due to their cold-hardiness, Alaska has the potential to be disproportionately affected by this insect relative to other areas of the United States. One way to help manage damage in orchards is to rake up any dropped apples off the ground and dispose of or destroy them in the fall, thereby reducing the number of wasps able to emerge in spring to infest new apples on the tree (Pettit 1922).

The apple seed chalcid previously was an economic concern for those gathering seeds from which to grow nursery stock. Loss from infested seed was managed by obtaining seeds from apples that had gone through processing at cider mills; the process by which the machines wash out the pomace eliminates the seeds containing larvae as the infested seeds are lighter weight than the viable seeds (Crosby 1909).

Reporting

Observations of the apple seed chalcid can be submitted directly to Integrated Pest Management Technician Alex Wenninger via email at akwenninger@alaska.edu or via our monitoring portal at https://alaskapestreporter.org. Please include the variety of apple in your report if known – I am curious to monitor which apple varieties in Alaska may be affected by the apple seed chalcid.

Acknowledgments

Thank you to Dr. Petr Janšta, Hymenoptera Curator at State Museum of Natural History Stuttgart, Germany, for identifying the species of Torymus. Thank you to Robert Mennis for providing the affected apple samples. Reference specimens will be deposited into the University of Alaska Museum of the North Insect Collection. This work was supported by funds from the Western Region of the National Plant Diagnostic Network and from the Crop Protection and Pest Management Program of the USDA National Institute of Food and Agriculture (grant numbers 2021-70006-35561 & 2024-70006-43668).

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Community science collaboration enhances understanding of fireweed flower gall midge distribution in Alaska

by Alexandria Wenninger[12]

Figure 1: Left: Fireweed (*C. angustifolium*) with a galled bud on left side of flower spire (Anchorage, 23 August 2023). Middle: Galled buds on dwarf fireweed (*C. latifolium*) (Butte, 26 July 2023). Right: An opened bud gall reveals several small, orange fireweed flower gall larvae within (27 July 2023).

Introduction

In late summer 2023 swollen flower buds containing small, orange larvae on fireweed (*Chamaenerion angustifolium* (L.) Scop.) and dwarf fireweed (*C. latifolium* (L.) Sweet) were initially noticed in several areas of Southcentral Alaska (Figure 1). Evidence of prior records of this insect in Alaska were lacking which led to two predominant questions: what is the identity of this gall-maker and what is its distribution in Alaska? Initially, I suspected that this may be an insect called the fireweed flower gall midge (*Dasineura epilobii* (Löw 1889)) which produces galls with the same morphology on fireweed in Europe but previously was not recorded from North America. I quickly began collecting galls to rear out in an effort to obtain adults for identification (Figure 2). While the identity of the gall-maker was not known at the time this distribution project was undertaken, a combination of morphological and genetic examination of specimens from Alaska, Washington, and Denmark have since confirmed the identity of the causal organism as the fireweed flower gall midge, now redescribed as a Holarctic species (Gagné et al. 2024). *D. epilobii* is presumed to be a native species, which is supported by its dependence on a native plant species, its association with Beringia, and its widespread distribution within the state (including coastal and inland areas) (Gilligan et al. 2020). Gall-forming organisms and their ecological interactions have long been understudied which likely contributed to this species' evasion of the scientific record for so long.

Distribution can be a difficult question to address quickly, especially considering Alaska's large size and limited road access. In an effort to try to map the distribution of the galls as best as I could with what remained of the summer I enlisted the help of the public through social media to record locations where these galls occur. Community science, in which volunteers participate in scientific projects without

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requirement of formal training nor employment in the sciences, has been increasingly recognized over the past several years for its successes in advancing scientific knowledge (Bonney et al. 2009, Acorn 2017). Two primary challenges to the success of community science projects are concerns over data quality (e.g. observer biases, misidentifications) and lack of public interest (Dickinson et al. 2010, McKinley et al. 2017, Gardiner and Roy 2022). While community-collected distributional data can be prone to spatial bias, with more populated areas receiving more observation effort than remote areas, spatial biases are not unique to community-driven data collection; professionally-collected data also contends with spatial bias though often in the opposite direction, with urban or fragmented habitats receiving less sampling effort (Binley and Bennett 2023). Misidentification as a data quality issue is a common concern in projects involving insects due to their wide diversity and small physical size, but in this case, the distinct morphology of the fireweed flower galls lends a low barrier to accurate identification and also allows for professionals to verify the identification via photographs. While challenges with data quality can often be mitigated by careful study design and interpretation, public interest can be more difficult to control or predict. Unfortunately, the fireweed flower gall midge itself is not particularly charismatic and is unlikely to garner public interest, however, Alaskans do have a longstanding appreciation for fireweed and its iconic seas of pink blooms that cover our roadsides and post-burn areas in late summer. All of the aforementioned concerns considered, a project aimed at broadening our understanding of the distribution of the fireweed flower gall midge seemed to be a good opportunity for community science involvement in the data collection process.

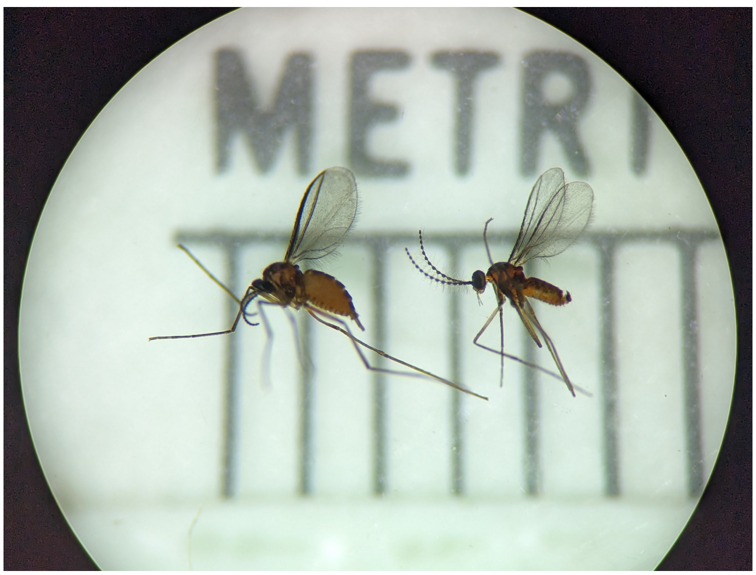

Figure 2: Adult fireweed flower gall midge (*Dasineura epilobii*) female (left) and male (right) under approximately 25x magnification. Vertical scale lines indicate one-millimeter intervals.

Methods

2023 Community Science Project

On August 17th, 2023, I made a post on the social media platform Facebook soliciting photos and location information for sightings of the fireweed flower galls from the general public via email. The post included a description of the galls and larvae, as well as an infographic comparing the appearance of the galled buds and typical fireweed buds (Figure 3). This post was initially shared on two pages: the “Alaska IPM” page and the “Matanuska Experiment Farm and Extension Center” page (both of which are managed by the University of Alaska Fairbanks Institute of Agriculture, Natural Resources, and Extension).

I visually inspected all submitted photos to confirm presence of galls. The location data was provided in the form of GPS coordinates, street address, or milepost; I standardized all location data to GPS coordinates (decimal degrees) for processing.

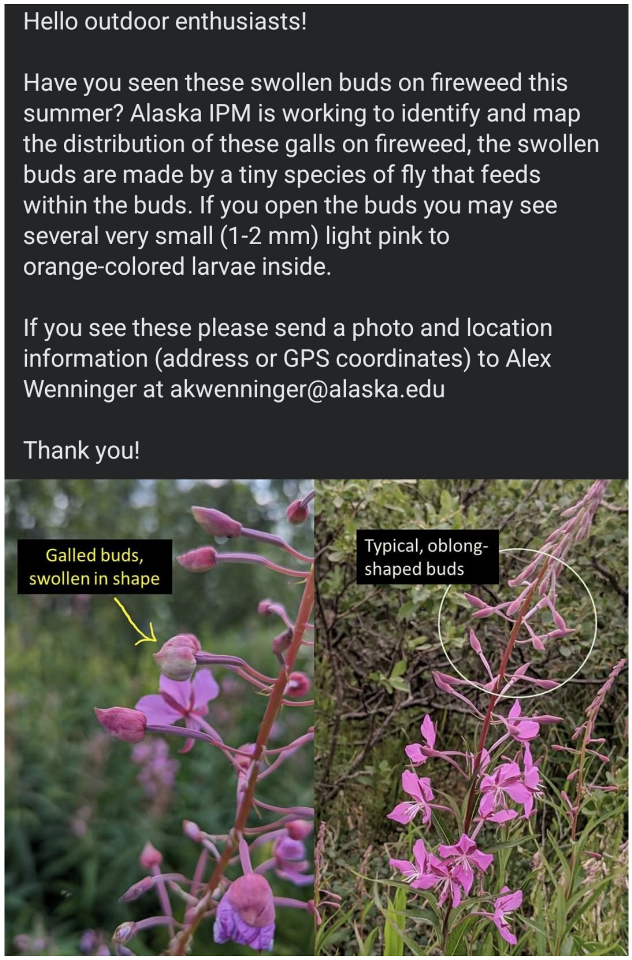

Figure 3: Text and infographic shared on social media soliciting records of the galled fireweed buds from the public (August 17th, 2023).

2023 Community Science Data via iNaturalist

I also collected records of the fireweed flower gall midge from the online community science platform iNaturalist. iNaturalist is a social network which crowdsources both organism occurrences and species identifications on those occurrence records; individual users upload photos of organisms along with corresponding data, and other users are able to view and add comments and identifications to those records. Typically, to use iNaturalist data for research-purposes one would download the data that has met the quality assessments for inclusion in the Global Biodiversity Information Facility (GBIF), however, because this species did not have a confirmed name at the time, the records of the fireweed flower gall midge were not identified to species-level and thus were ineligible for inclusion in GBIF, so I exported the data directly from iNaturalist. Gallformers administrator Ramsey Sullivan created a unique “Gallformers Code” with the value “c-angustifolium-flower-gall” (Gallformers Contributors 2024) which allowed observations of this particular species to be tracked in the iNaturalist database despite not having a species name. Throughout the season, Ramsey and I labeled observations of the fireweed flower gall midge with the unique Gallformers code; before data export, I visually inspected all records to confirm presence of the target galls. I exported data from all “c-angustifolium-flower-gall”-coded records from 2023 that met the criteria for the quality grade of “verifiable” on iNaturalist (iNaturalist Community 2024). (Four criteria must be met for verifiable-grade status: the observation must contain a valid date, a location, an attached photo or audio recording, and the organism cannot be captive or cultivated.) I excluded all of my own observations from this data as well as any duplicate observations that were also submitted to me directly via the solicitation for observations posted to Facebook.

Pre-2011 Record-tracing via iNaturalist

To trace back past records of the fireweed flower gall in Alaska I conducted a visual search of fireweed records collected through the community science online platform iNaturalist that meet the data quality requirements for inclusion in the Global Biodiversity Information Facility (GBIF). For iNaturalist records to be included in GBIF they must meet two criteria; first, the observation must be published under a CC0, CC-BY, or CC-BY-NC license, and second, they must have a quality grade of "research" on iNaturalist. (Within iNaturalist, five criteria must be met for research-grade status: the observation must contain a valid date and location, include an attached photo or audio recording, the organism cannot be captive or cultivated, and there must be a two-thirds consensus on a species-level identification.) My goal was to target the oldest records, so I narrowed the search to records identified as fireweed (*C. angustifolium*) in Alaska that were observed between January 1, 1950 and December 31, 2010. I visually inspected the photographs for all records that fit those parameters looking for the presence of the bud galls.

2023 Wenninger Data Collection

For comparative purposes, I also include location records that I was able to collect myself opportunistically; I stopped to check fireweed for the presence of galls in as many locations as I could during travel for work on other projects or recreation.

Results

2023 Community Science Project

Eighty-eight reports of the galled fireweed buds were submitted by eighty different members of the public, and only one of those reports had to be excluded from further analysis due to lack of sufficient location information (n = 87, observers = 80, average reports per observer = 1.1) (Figure 4A). These reports came from six different boroughs/census areas: Bethel Census Area (n = 2), Fairbanks North Star Borough (n = 5), Kenai Peninsula Borough (n = 43), Kodiak Island Borough (n = 2), Matanuska Susitna Borough (n = 21), and the Municipality of Anchorage (n = 14). The observations ranged as far south as Kodiak Island, as far north and east as Fairbanks, and as far west as Bethel.

Community scientists were exceptionally adept at recognizing the bud galls on fireweed; all 114 photos of galls I received matched the targeted gall morphology. Some community scientists went so far as to include photos of the dissected galls as well, showing the larvae inside.

2023 Community Science Data via iNaturalist

Fifteen reports of the galled fireweed buds were submitted by five different iNaturalist contributors, however two records were excluded due to duplication with observations submitted to me directly (n = 13, observers = 3, average reports per observer = 4.3) (Figure 4B). These reports came from six different boroughs/census areas: Denali Borough (n = 1), Fairbanks North Star Borough (n = 1), Haines Borough (n = 1), Kenai Peninsula Borough (n = 3), Matanuska Susitna Borough (n = 3), and the Municipality of Anchorage (n = 4).

Pre-2011 Record-tracing via iNaturalist

A total of 78 observations of fireweed (*C. angustifolium*) made before 2011 were recorded on iNaturalist that meet the criteria for inclusion in the Global Biodiversity Information Facility (GBIF.Org 2024); from these records I identified three that included visible galled buds in the photos (n = 3, 3.8%) (ranging in date from 2007-2010) (Figure 4C). These three observations were recorded by three separate observers in three boroughs/census areas: Fairbanks North Star Borough (2010), City and Borough of Sitka (2007) and Yukon-Koyukuk Census Area (2010).

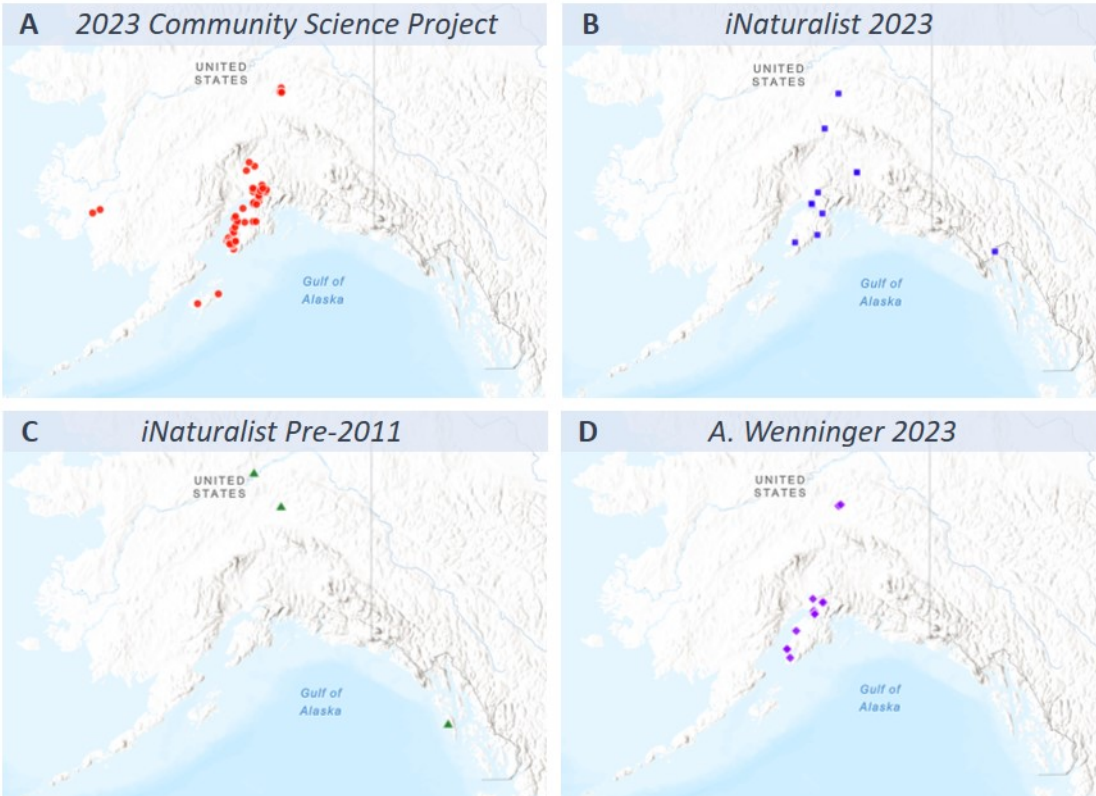

Figure 4: Map of all fireweed flower gall known locations in Alaska. A: Each red circle represents one report submitted by a community member in response to the Facebook post (n = 87). B: Each blue square represents one report from iNaturalist in 2023 (n = 13). C: Each green triangle represents one pre-2011 observation from iNaturalist/GBIF (n = 3). D: Each purple diamond represents one location recorded by me (A. Wenninger) (n = 19). This map was generated using ArcGIS Online software by Esri and incorporates the 'Terrain with Labels' basemap (basemap credits & sources: Esri, USGS | Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS).

2023 Wenninger Data Collection

I opportunistically recorded 19 observations of the fireweed flower gall midge in 2023 (n = 19) (Figure 4D) from four different boroughs/census areas: Fairbanks North Star Borough (n = 3), Kenai Peninsula Borough (n = 5), Matanuska-Susitna Borough (n = 6), and Municipality of Anchorage (n = 5).

Geographic distribution of the fireweed flower gall midge

Combining all above methods of data collection, the fireweed flower gall midge has been mapped at 122 locations in Alaska (Figure 5) across 10 boroughs/census areas thanks to contributions from 87 unique observers. Of these records, 84% (n = 103) were contributed through community science.

Discussion

Community science contributions rapidly advanced the scientific understanding of the distribution of the fireweed flower gall midge in Alaska. Not only did community science capture 5 ½ times as many observations of the midge as I was able to over the same time span, but it also captured data from an impressive third of the state's boroughs/census areas (10 out of 30). Given the large size and limited access of much of the state of Alaska this is no small feat. The location data provided here is not exhaustive, absence data was not tracked in this project so it's very likely that this species is present in many other

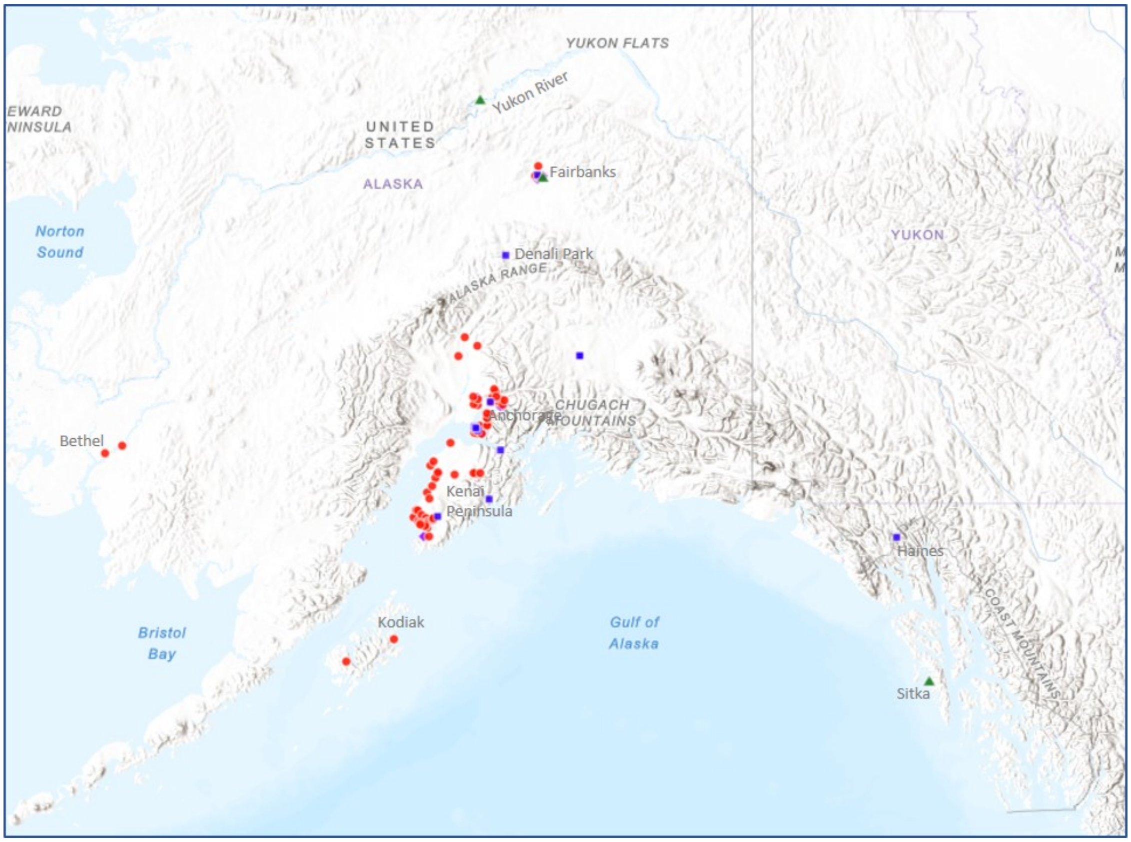

Figure 5: Map of all fireweed flower gall known locations in Alaska combined into one map. Each red circle represents one report submitted by a community member in response to the Facebook post (n = 87), each blue square represents one report from iNaturalist in 2023 (n = 13), each green triangle represents one pre-2011 observation from iNaturalist/GBIF (n = 3), and each purple diamond represents one location recorded by me (n = 19). Some points are not visible due to overlap. This map was generated using ArcGIS Online software by Esri and incorporates the 'Terrain with Labels' basemap (basemap credits & sources: Esri, USGS | Esri, TomTom, Garmin, FAO, NOAA, USGS, EPA, USFWS).

locations that are yet to be recorded, however, this data does show that the species is much more widespread than was known from the data that I collected alone. Community participation is truly what made this work possible; more traditional data-collection methods can be financially burdensome, especially in Alaska which is not only vast but also has limited area that can be surveyed by ground travel. For me to have personally surveyed all community-science contributed locations I estimate that it would have taken me 3.5 weeks (140 hours) of work time and incurred ~$13,440 in travel and salary expenses (mileage, airfare, lodging, salary, benefits, etc.); without the contributions from the community this work simply would not have occurred. Encouraging public participation in data collection toward the goal of answering questions that are of public interest has been shown to yield mutually beneficial outcomes in other projects as well (Bonney et al. 2016) and is a method I certainly will continue to consider for future projects.

Community science contributors also inspired me to trace back records of the fireweed flower gall midge by looking at past records of fireweed added to iNaturalist. The first time I showed the galled buds to my husband he was surprised they were insect-induced; he remembered seeing the rounded buds on fireweed since childhood and thought that was just how some fireweed buds are. When I started the community science project I received a few additional comments from the public about the rounded buds being "nothing new". As scientists we sometimes tend to brush these insights off as anecdotes but I found it intriguing that the swollen buds were noticed by many yet the species had evaded scientific record for so long. I spend a lot of time mulling over what seemed to be an impossible task: how could I find past evidence of a species that not only wasn't known from Alaska, but also didn't yet have a confirmed identity? Out of curiosity I turned to some of my own observations on fireweed first; while I don't take many photos of fireweed I do have an interest in aculeate Hymenoptera visitation on native plants, so I went through my photos of pollinating bees and wasps looking for fireweed. To my own bemusement I found a photo I took in 2018 of a bumble bee resting on a fireweed flower with several galled buds clearly visible (Figure 6). I was so preoccupied by the bee I had missed the galls, and those galls wouldn't come to my attention for another five years! I promptly duplicated the record on iNaturalist to record the presence of the galls in the photo, to which another iNaturalist contributor, Matt Muir, pointed out that there are 3000+ observations of fireweed recorded on iNaturalist that could be checked, inspiring the record-tracing piece of this project. I didn't have the time nor inclination to wade through thousands of observations of fireweed, but since I was interested in the oldest records I settled on going through the fraction of the records that were from before 2011. This is not a perfect method; iNaturalist was first created in 2008 so data prior to this time is sparse and limited to records that contributors uploaded from their photo history which is a bit more onerous than uploading data in real time. The relatively young age of iNaturalist makes it difficult trace records back very far but the value of using iNaturalist for this purpose will likely continue to increase in the coming decades[13]. I think the biggest lesson to be learned here is when conducting community science there is value in being open to allow contributor input to lead the research question in additional directions.

Figure 6: Photo I took in 2018 of a bumble bee resting on a fireweed bloom with several galled buds in clear view.

Through this work I was also interested to see how the effectiveness of different community-based participatory research approaches would compare, in this case the comparison of the direct solicitation of specific data from the more general public versus the use of crowd-sourced data from iNaturalist, a community whose members share an interest in local biodiversity but individuals are contributing data across a range of taxa and with varying motive (i.e. contributors are not necessarily contributing data with the intent of mapping the distribution of the fireweed flower gall midge). In this study, each of the different community-science contributed methods uniquely enhanced the recorded distribution of the fireweed flower gall midge in Alaska by providing data from regions that were not captured by other methods.

[13] I also attempted to take this record tracing a step further by searching for fireweed photos within Alaska's Digital Archives, a website which includes digital content from 17 museum, library, and university collections around the state (Alaska's Digital Archives n.d.). There are not many photos included, and of those that are, several are missing precise date and location information and/or lack adequate focus or resolution for confident identification, however two photos clearly show the galls: the first is from an unknown date and location in Alaska between 1964-1992 (Stewart's Photo Shop n.d.), and the second was taken in 1999 at Chugach National Park (Taft 1999), both included in the Archives by the University of Alaska Anchorage Consortium Library.

The Community Science Project uniquely provided data from Bethel, Akiak, Kodiak, and Talkeetna, and the observations from iNaturalist uniquely provided data from Denali Park, Lake Louise, Seward, and Haines. Even the pre-2011 iNaturalist visual search of fireweed observations, a method in which I co-opted observations intended to record one organism (fireweed) to search for evidence of another (the gall midge), contributed both the northernmost (Yukon River) and southernmost (Sitka) records of the species, despite also being the smallest dataset. While the direct-solicitation method resulted in both a greater number of data points and involved a higher number of observers, the iNaturalist approach offered a higher ratio of contributions per observer. Despite these differences, ultimately each dataset provided additional value to our understanding of the distribution of the fireweed flower gall midge.

It can be difficult to recruit participation from the broader public in data collection projects, however, there are two aspects of this project that I think contributed its success: public interest in the host plant, fireweed, and the ease with which the galls can be identified. Social media platforms like Facebook make it possible to share information widely; not only are we able to post information to be seen by the people who follow our Alaska IPM page, but anyone can share that original post to groups they participate in or directly with friends and family. However, not all community science projects garner public interest, without which it can be difficult to recruit participation in a project (McKinley et al. 2017). Most published entomological community science projects have focused on the more charismatic insects: butterflies, bees, and lady beetles (Gardiner and Roy 2022). I was initially surprised at the size of the response to this project; the tiny gall fly investigated in this project is not charismatic and several of my previous attempts at community science participation for assessing distribution of insects that feed on plants have fallen flat (e.g. chokecherry gall midge, toadflax seed capsule weevil, and toadflax flower-feeding beetle projects). The broad interest shown for this project was likely due to strong local fondness for fireweed as well as coincidental timing with environmental conditions that negatively impacted fireweed bloom in 2023. Fireweed is a well-loved native perennial with many traditional uses; the young shoots can be harvested for greens or sautéed like asparagus, the leaves can be steeped into a tea with a light, sweet flavor or prepared medicinally for their mild laxative properties, and the flower petals can be used to add a light, floral flavor to jellies and syrups (Lewis et al. 2023). Additionally, fireweed is the subject of local folklore which purports that once the fireweed blooms reach the top of the spire summer has ended and winter is on its way (Reamer 2020). Fireweed did not produce many blooms in 2023, a phenomenon which raised public concern about the lack of pink blooms along roadsides. This unusual fireweed year likely fueled interest in the gall midge as the public wanted answers, however, the gall midge was not the cause of the lack of fireweed bloom; in many cases fireweed was not producing buds at all and the gall midge needs fireweed to produce buds to be able to complete its development. The lack of fireweed bloom was likely caused by a particularly cool spring (Neyman 2023, Thoman 2023). The second aspect of this project that facilitated broader public participation is the ability to use the distinct morphology of the gall to identify the presence of the fly. The rounded buds serve as an "extended phenotype" of the fly (Stone and Schönrogge 2003) and allow for identification of the flies without need for a microscope nor knowledge of insect anatomy, increasing the accessibility of participation in a project which requires identification.

Gall-inducing organisms have received relatively little research attention for how diverse they are, but on the bright side interest in these organisms has been growing in part due to the recently developed Gallformers project. Gallformers is a relatively new online database devoted to cataloguing known species of gall-inducing organisms in North America along with photos and known biology of the organisms (Kranz et al. 2024). As of January 2025, the Gallformers catalogue contains 3472 species entries of which 1321 (38%) are undescribed. I think one of the larger challenges in working with gall-inducing organisms is that the study of these organisms is inherently multidisciplinary; describing these organisms requires attention to both the inducing organism and its plant host. Many of us ecologists begin our careers working with a narrow taxonomic group of organisms or working in a specific habitat or system but galls are induced by a wide variety of not only arthropods but also fungi and bacteria. Developing the skills to not only identify and rear or culture those gall-inducing organisms, but also to understand the morphology of plant species well enough to notice when tissue growth appears abnormal, takes dedication and time. These kinds of projects often benefit from collaboration which the Gallformers project has played a role in facilitating by creating a forum where gall-enthusiasts from across North America can share their observations or projects they're working on and get feedback from others. As more people have gotten involved in the project the increase in gall interest has also led to designation of "Gall Weeks" during which local gall enthusiasts organize bioblitzes and other educational activities. In September 2023, Ramsey Sullivan and I organized a "Gall Walk" event for Gall Week at a local park in Anchorage. Chelsea Niles even designed a beautiful commemorative sticker for participants of the Gall Week which featured the fireweed flower gall midge (Figure 7). It's my hope that these sparks of interest will bring new scientists into the field in the coming years to help improve the collective understanding of gall-inducing organisms.

Figure 7: 2023 Gall Week artistic design by Chelsea Niles featuring fireweed with galled buds and adult fireweed flower gall midges watermarked in the background. Participants of the Gall Walk held in September in Anchorage were each given a sticker with this design.

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Review of the seventeenth annual meeting

by Dana Brennan[15]

Figure 1: Figure 1: Members present at the business meeting. Virtual attendees from top left: Derek Sikes, Chris Fettig, Taylor Kane, Dennis Fielding, Susan Wise-Eagle, Adam Haberski, Robin Andrews, Matt Bowser, Garret Dubois, Jessie Moan. In-person attendees from left: Dan Bogan, Joey Slowik, Dana Brennan, Alex Wenninger, Mike Baldwin, Roger Burnside, Ramsey Sullivan.

Presentations

In his talk titled, "The Museum Research Apprenticeship Program at the University of Alaska Museum," **Derek Sikes** discussed the museum's efforts to collect more representative non-marine arthropod specimens through a research apprenticeship program. What began in 2011 has seen many students gain relevant research experience working with a curator to finish a project. Recent student efforts include digitizing the pinned insect collection and better verifying the accuracy of guesstimate counts of specimens in the museum wet collections, which found true numbers to be about double what guesstimates were.

Jackson Audley gave the meeting an update on continued spruce beetle semiochemical research in Alaska in his talk titled, "Semiochemical interruption of spruce beetle host searching and aggregation behaviors to protect spruce trees in Alaska." In 2023 continued work was done on the Kenai Peninsula, this year evaluating different dosages of SPLAT (a biodegradable paste infused with spruce beetle anti-aggregation pheromone MCH) and comparing SPLAT against MCH pouches for spruce protection from spruce beetle. Promising results showed reduced spruce beetle colonization with final assessments occurring in 2024. Also up for 2024 is a trapping assay to see how far SPLAT is reducing beetle catches from treatment trees.

With the Cooperative Extension IPM office, **Alex Wenninger** shared some of her work and findings in 2023. Fireweed blossom gall midge was quite prolific the summer of 2023 with lots of observations submitted to Extension. Genetic analysis of these gall formers appears to match a European species which brings up the question: is this part of the midge's native range? In a sampling of aculeate pollinators on native and

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nonnative plants, it was found that native plants had increased species richness and visitation. Pollinator presence will be resampled in 2024 and the impacts of residual herbicides from invasive plant management on restoration will be evaluated.

In “Way up north (to Utqiagvik): An update on the Diptera of the northernmost point in the U.S.A.,” **Thalles P. L. Pereira** discussed work in an area highly impacted by climate change: the arctic. Understanding arctic species diversity is an urgent need and Pereira discussed his efforts to quantify Dipteran diversity near Utqiagvik, the sources of information used to determine species presence, and areas where more information is needed.

Adam Haberski discussed his dissertation work in “A long way from home: species common to Alaska and the southern Appalachian Mountains.” Haberski’s work took him to the southern-most spruce forest in Appalachia, which can be used as a boreal forest analogue that shares 73% of plants with northern spruce forests. The southern spruce forests are threatened by balsam wooly adelgid, which feeds on spruce but kills Fraser fir. Haberski compared southern Appalachia insect species and Alaska specimens, which were cross referenced in Arctos with distributions compared in GBIF and found about 8 percent of species from Appalachian litter traps were species shared in Alaska. Future desired work includes phylogenetic and phylogeography work to determine if these shared species were part of the Beringia refugia or if their presence happened post glaciation.

With an update on *Lygus* bugs in peonies and root maggot in turnips, **Dennis Fielding** shared findings on *Lygus* bug identifications and noted *Lygus*-related damage to peonies when introduced in a mesh enclosure. To understand the phenology of turnip root maggot, Fielding planted pupae in soil and recorded emergence compared to degree day accumulation and calendar date to determine which is the best predictor for maggot emergence. A weekly maggot census was done in which a subset of plants were dug up and cut to look for maggots. Overall, calendar dates might work as well as degree days for predicting maggot emergence with the recommendation to begin monitoring for eggs in late June. Maggot controls should be applied when eggs are first seen and crop residues should be buried or otherwise cleaned up immediately after harvest as maggots remain viable into September.

“An unusual grasshopper outbreak in Wood River, Alaska: A relic population of the presumed extinct Rocky Mountain Locust, *Melanoplus spretus*?” In this talk by **Luke Lawson**, a brief history of the American west’s great herds (Rocky Mountain locust, *Melanoplus spretus*) was presented as well as a recent outbreak of grasshoppers in Wood River, Alaska and efforts to identify these species. Fortunately, this presumed extinct species has been preserved in glaciers, allowing genetic and morphological comparison. The cause of extinction is not understood, though it is possible this is the migratory phase of *M. sanguinipes*. Specimens from the recent outbreak in Wood River were identified as *M. sanguinipes*, showing resemblance to the extinct *M. sprectus*. When comparing the Wood River specimens to UAM specimens, there was a significant difference between tegmina, supporting the hypothesis that Wood River specimens may be distinct from what is already known in the collection. Future genetic work to determine differences could be difficult because many of these specimens are genetically similar.

Thanks to Luke for his student presentation this year which earned him the 2024 Student Presentation Award. Congratulations Luke!

Business items - highlights

- The AKES t-shirt committee was revisited, an email loop will be started regarding design options.
- Matt Bowser will be stepping down from his role in managing the AKES newsletter and website after leading it for many years. We thank Matt for all he has done to maintain the AKES digital footprint! Alex Wenninger and Adam Haberski will take on these roles moving forward.
- Joey Slowik was voted in as the new secretary, all other current officers were retained: Dana Brennan (president), Robin Andrews (vice president), and Roger Burnside (treasurer).

Minutes from our business meeting are available on the website.

Review of the eighteenth annual meeting

by Jozef Slowik[16]

Figure 1: Members present after the business meeting. From left to right: Ramsey Sullivan, Julie Riley, Taylor Kane, Robin Andrews, Joey Slowik, Alex Wenninger, and Derek Sikes.

Presentations

On February 21st the annual meeting for the Alaska Entomological Society was held at the lovely Fairbanks DNR building. There were 31 attendees this year with about a dozen in the room and the rest via zoom. The morning began with a great presentation by **Jason Grant** (University of Neuchâtel) about 51 new species of moth that he has documented in Alaska. He was pinging in from Switzerland thanks to the wonders of Zoom. Jason has been collecting moths in the short dark summer nights in Fairbanks when he travels up in the summers. He shared his method of cooling them down in the fridge and photographing them on a uniform-colored background. He posts his data on iNaturalist and then takes a subsample to be DNA barcoded so those records get molecular identifications to go with the photos. He presented some of the similar species which look like some more common species, but thanks to the DNA and pictures we can validate those species.

Next **Jackson Audley** (USDA Forest Service) provided an update on their ongoing work with SPLAT

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MCH. They have been working sister studies in both the Kenai and in Colorado. Playing around with various adjuvants they have some promising data showing that the SPLAT treated trees were not being killed compared to control trees. They may get attacked but the trees are surviving. They also did some trials looking at the zone of protection that a treated tree may provide to others nearby and it looks like somewhere around 8 m out there is in uptick in beetles, implying the effect of the MCH is wearing out about then. But these are promising data for the product, and they are moving to get the product registered.

Alex Wenninger (University of Alaska Fairbanks) gave an informative talk about her research on the bee and wasp species found on some native flowers compared to two invasive weeds: bird vetch and white sweetclover. She found much more diversity on the native flowers than on the invasives, providing some nice real data to use when arguing for removing invasive flowers. Yes, some bees do visit them, but not too many compared to a native option. She also provided some seed mix options for encouraging pollinators. A mix of Dwarf Fireweed, Prairie Cinquefoil and Northern Goldenrod could produce 14 bee and 9 wasp species. That's some real diversity for just a few species of flower.

Next, I (**Joey Slowik**, University of Alaska Fairbanks) gave a quick talk on a small side study I did on whether the essential oil pesticides I've been experimenting with for slug control may be killing other arthropods common in the fields. The study exposed the grasshopper, *Camnula pellucida*, and the harvestman, *Phalangium opilio* to two essential oil pesticides in the lab. Results found spearmint oil had a much more lethal effect, killing 3/5 grasshoppers and 4/5 harvestmen than thyme which only killed one grasshopper. But essential oils are complex pesticides and sometimes cause delayed responses, like reduced egg laying activity or restricting the ability for an insect to molt. So, the take home was that yes, these can kill arthropods, and that you would need to test the specific essential oil pesticide on the specific arthropods you have.

The last talk before lunch was **Derek Sikes** (University of Alaska Museum) who discussed progress on a heavy philosophical question, how many mosquitos are there in Alaska? Derek talked about how a quick estimate he made in 2014 using some back of a napkin numbers in an email, has now been cited in an actual paper. This prompted this work into trying to find a better estimate. Derek provided an equation which uses the kill rate by spiders in pounds of insects per square mile times the area of mosquito habitat in Alaska, divided by the percent of insects killed annually by spiders. This was then multiplied by the percent of insects which are thought to be mosquitos, all divided by the wet weight of a mosquito. He mentioned the difficulty in estimating any of these values and the error but did come up a value of 662,000 to 283,000,000 mosquitos per square mile, or 440 billion to 188 trillion for the state. He said more work is needed, but regardless, that's a lot of mosquitos!

After lunch **Debbie Hinchey** gave a wonderful talk about her happenstance discovery of parasitoid wasps. It began with bringing in some peppers which were outside. As we all know peppers seem to have aphids from the start. But then she noticed aphid mummies, and watched how they reduced the number of pest aphids. She then took her newly found wasps and shared them with an elementary school who was growing basil indoors and had an aphid problem. She transferred some leaves with infected aphids to the school and when they hatched, they did some real damage to their pest aphids. In researching biocontrol options, she did find two species which are available for commercial sale, *Aphidius colemani* and *Aphidius ervi*, but she's not sure if her wasp is one of those or just a native which is working similarly. She also discussed the question of Banker plants to keep the wasp population going in between aphid outbreaks. But her assistance has introduced the concept of effective biocontrol to many elementary students who got to watch it in action. Pretty awesome.

Student Presentations

We then moved onto our student's presentations. First up was our beloved vice president **Robin Andrews** (University of Alaska Fairbanks) who has been trying to figure out what those tiny little soil arthropods like mites and collembola, are eating. It's a really tough question to answer because they are so small and for the most part unobservable. She began with using stable isotopes to try to define the trophic level they fill. She found many of them to be root channel feeders or a mixture of root channel and detritivores. But these finding were confused by the problem that fungi give isotope signals across various levels. So, to clear up what things they are really eating she has been trying to do gut content analyses using DNA metabarcoding. She shared some neat preliminary results, and discussed the difficulty of washing all the potential DNA contamination off an animal which is less than a millimeter. Her project is really fascinating in which the isotope information will provide the quantity and the DNA will provide the identity of what these little bugs are eating.

Our last presentation of the day was another student talk given by **Taylor Kane** (University of Alaska Fairbanks). For the last few years Taylor has kept us attendees up to date on her work with the snow scorpionfly genus *Boreus*. She talked about the scant number of specimens of Alaska *Boreus* until her work began. And how these new specimens have really opened the door into exploring the species hypotheses questions in the genus. She talked about the currently recognized species occurring in the state and her work to put together a key for the species found in the state, including information on female morphology as well as the male's for the first time! This will make identification of all those rare specimens possible. She then discussed a couple species hypotheses she is digging deeper into using DNA and morphology. And she's getting some mixed messages depending on the analyses. We're all looking forward to her publishing her results, and there were many questions about how to find these curious little insects.

Because there were only two student talks it was decided to award both a student award of $100, as we usually give a poster and presentation award but there were no posters this year. Congratulations Robin and Taylor!

Business items - highlights

- Apart from the interesting talks Julie Riley brought a cute insect motif jumper as the door prize which was won by Susan Wise-Eagle. Way to go Susan!
- New elections were held. We have to say goodbye to our current president, Dana Brennan who has taken a new job in Washington. Congratulations Dana, we all hope you have some wonderful new bug adventures in your new position. With Dana's departure Derek Sikes was elected as new President with all in attendance voting yea. Robin was retained as Vice President, Joey Slowik as Secretary, and Roger Burnside as Treasurer. Ramsey Sullivan will work with Roger in an apprentice role for treasury duties.
- Alex Wenninger is working with Roger Burnside (treasurer) to reconnect the website to PayPal for paying dues with a credit card online.
- Our Facebook page has over 2400 followers but we've not been posting anything.
- Robin mentioned ongoing work to have past issues of the AKES newsletter archived at the UAF library and that work is continuing as to what we need to submit to make that happen.
- Last year we discussed the possibility of a new logo, but no progress was made on that. Those in attendance feel the current logo would be nice in conjunction with something else. Sayde Riding mentioned a young artist in Southeast who makes some really neat native insects art and she offered to look into that.
- We had no submissions for the Ken Phillips award this year. So, if you know someone working on Alaska arthropods and need a few hundred dollars, please spread the word or apply yourself. Information on the award can be found on the AKES webpage. Several Science Fair students were awarded collection materials and a small cash prize in the projects in the Fairbanks area. But no bug projects were found in the Southcentral or Southeast areas, so no awards were given.

After the meeting a number of us popped over to the museum for a little scramble scope photography work before we headed over to East Ramp Pizza for some Kombucha, Pizza and beer. A great way to wrap up the meeting. Hope to see you all next year when the 2026 AKES annual meeting heads back south to Anchorage.

Minutes from our business meeting are available on the website.