State of Alaska Division of Agriculture

TASC

Technical Assistance for Specialty Crops:

Project Overview:

Eliminating Pest-Related Trade Barriers for the Alaska Peony Industry

Project Focus: Thrips

A presentation to the Alaska Entomological Society 14th Ann. Meeting

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Project Overview and Introduction to

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Agricultural Research Technologist II, Entomology
Washington State University

TASC Program: What Is It?

- The TASC program is designed to assist U.S. organizations by providing funding for projects that address sanitary, phytosanitary, and technical barriers that prohibit or threaten the export of U.S. specialty crops. Eligible activities include seminars and workshops, study tours, field surveys, pest and disease research, and pre-clearance programs. Eligible crops include all cultivated plants and their products produced in the United States except wheat, feed grains, oilseeds, cotton, rice, peanuts, sugar and tobacco.

- (USDA, Foreign Agricultural Service)

TASC: Eliminating Pest Related Trade Barriers for the Alaska Peony Industry

- Division of Agriculture applied for TASC Grant funding in 2018
- Project awarded by USDA Foreign Agriculture Service (FAS)
- Project seeks to eliminate global trade barriers associated with Thrips on Alaska Peonies
- $1.4 million dollar grant awarded in 2018
- Partners include Alaska Division of Ag, Washington State University, USDA Agricultural Research Service, and agreements with University of Alaska Fairbanks.
- Involves in-field and in-lab testing
- Spans three peony regions of the State: Interior, Mat-Su and Kenai-Peninsula

Thrips as a Trade Barrier for Alaska Peonies

- Global Export Market Targets: Many importing countries require phytosanitary certification for cut flower imports. Some countries list specific species of Thrips on their important quarantine list.
- Thrips (Thysanoptera) are tiny, internal-feeding insects that feed on petals and leaves, resulting in unsightly spots, scarring, corky lesions, and deformed flower buds.
- Their minute size and tendency to insert eggs undetectably into plant tissue complicates phytosanitary detection, and infestations can easily go unnoticed.
- While specific thrips species of concern vary from country to country, only adult thrips can be identified by morphological methods.
- Immatures cannot reliably be identified to species using traditional morphological methods.
- TASC funding is helping develop reliable molecular protocols best suited to thrips associated with Alaska peonies.
- Currently when thrips are detected during a phytosanitary inspection, growers must recondition the flowers themselves or send them for treatment at a USDA approved facility.
- Lack of a viable treatment facility for this perishable commodity represents a major trade barrier

Examples of Thrips Damage in Peonies

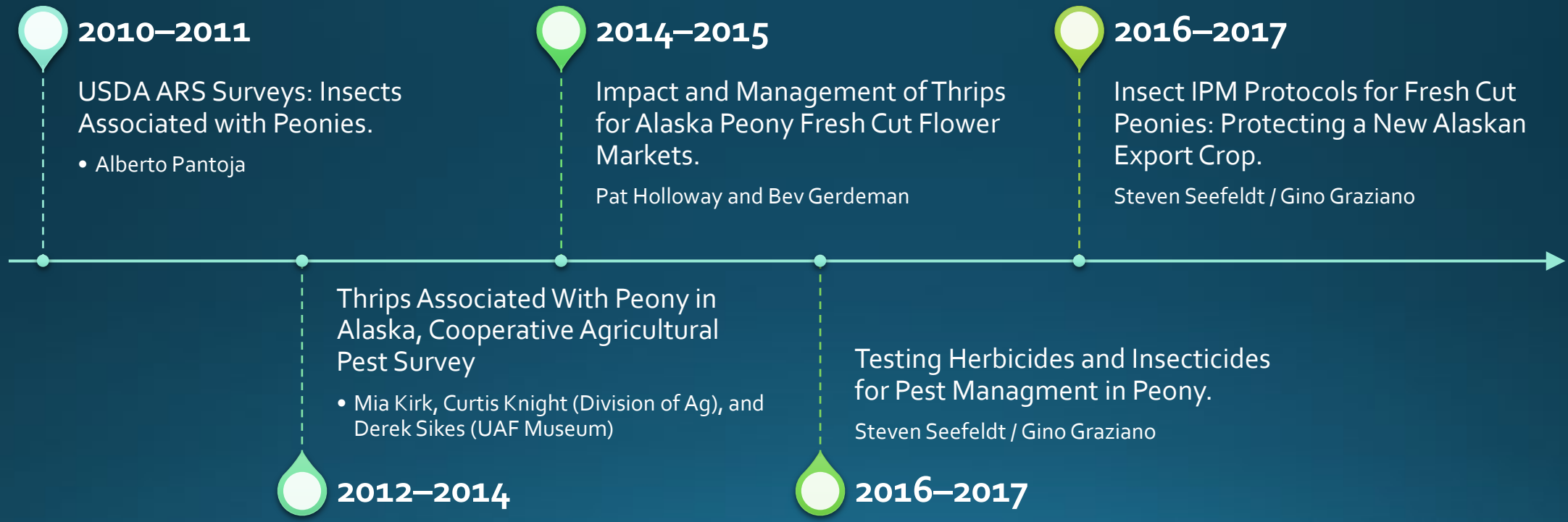
Pantoja

Pantoja

Pantoja

- Streaking of flowers
- Bud distortion
- Tar spots
- Failure to open
- Flower drop

Prior Studies with Focus on Peonies



TASC - 4 Pillars

1. ***Taxonomy/Species Identification-*** Establish identification tools to aid in the development of IPM (Integrated Pest Management) programs, conventional insecticide application regimes, and postharvest treatment

2. ***Field Efficacy Trials-*** Conduct research to determine in-field approaches for control of insect and mite pests of peonies

3. ***Postharvest Trials-*** Conduct research to determine postharvest approaches for control of insect and mite pests of peonies

4. ***Outreach and Grower Training-*** Provide IPM program and project information to growers through APGA conferences and field days, online tutorials and regional grower workshops

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Thank You and Welcome Ben Diehl, WSU




WASHINGTON STATE UNIVERSITY
MOUNT VERNON
NORTHWESTERN WASHINGTON RESEARCH & EXTENSION CENTER

Alaska USDA FAS TASC: Morphological Studies of Thrips Associated with Peonies

Ben Diehl, WSU Mount Vernon Northwestern Washington Research & Extension Center

Order Thysanoptera: Thrips

- Greek *thysanos* = 'fringe' + *pteron* = 'wing'
- Bladderfeet, thunderflies, corn lice
- Thrips used for both singular and plural
- Over 6,000 species in 780+ genera belonging to 9 families worldwide
- About 700 species in 140+ genera belonging to 5 families in North America
- Adults winged, reduced, or wingless (variable within species)
- Asymmetrical, piercing/sucking mouthparts
- Body length between 0.5-**14mm**, typically 1-2mm

Thrips of California 2012


Idolothrips spectrum
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View Observation


(c) Kristi Ellingsen, some rights reserved (CC BY-NC-ND) | View Observation


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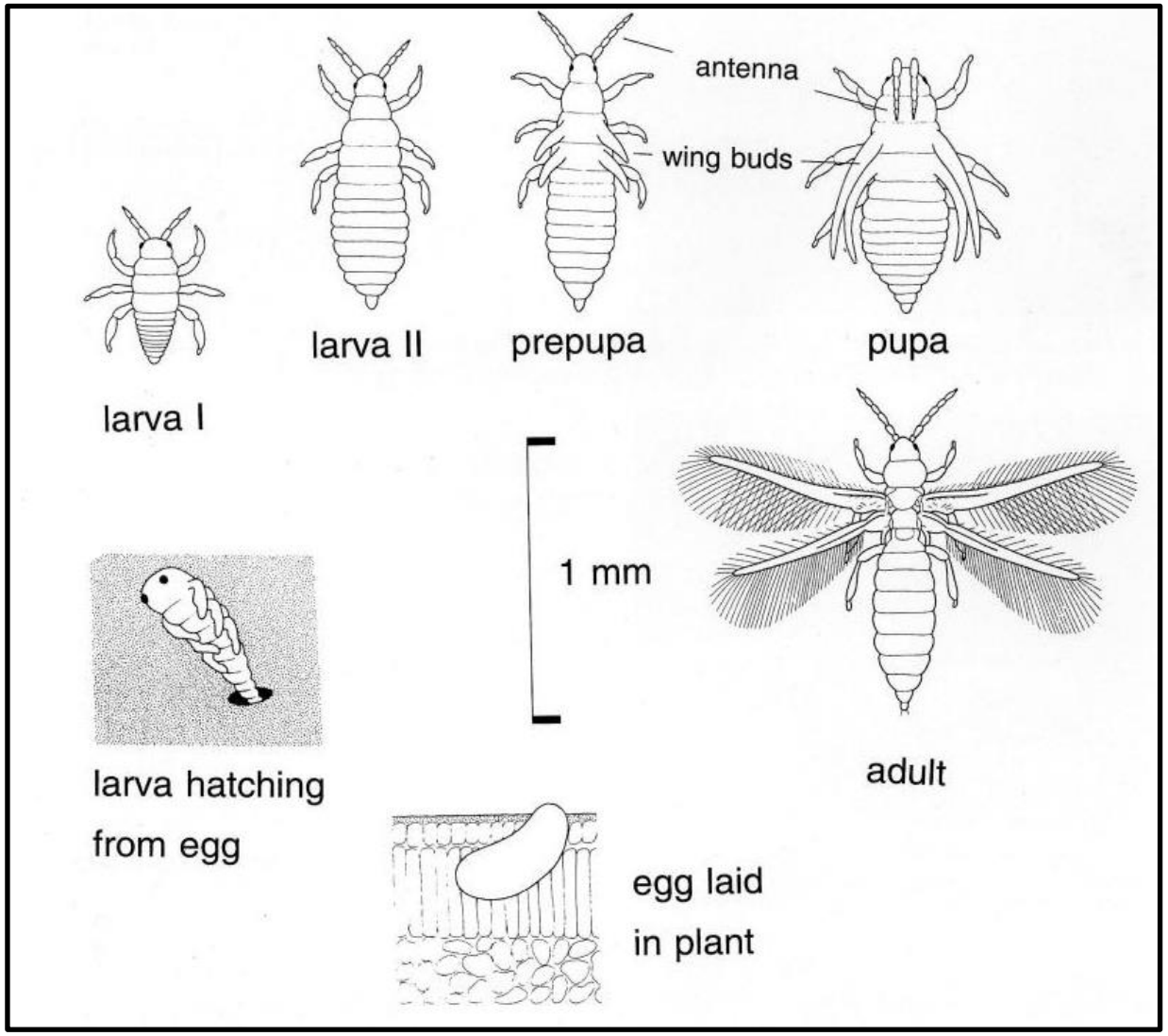


http://nzacfactsheets.landcareresearch.co.nz/Index.html 2019

Life cycle

- Metamorphosis of thrips is an intermediate between simple and complete

Egg (non-feeding)
- Laid in/on or near feeding substrate

Larva (feeding)
- Two stages
- Some species produce silk!

Pupa (non-feeding)
- Suborder Terebrantia –two stages (pre-pupa, pupa)
- Suborder Tubulifera – three stages (two pre-pupa, pupa)

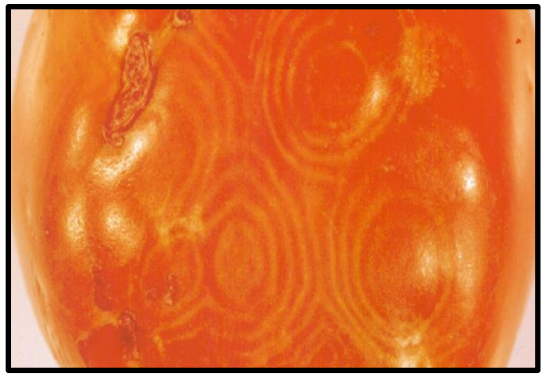
Adult (feeding)
- Males are often rare or unknown. Many species can reproduce without them!
- Eusocial gall thrips

Feeding Preferences

- Most species of the subfamily Terebrantia feed on leaves or in flowers
  - Some species of this group, including the pests *Thrips tabaci* and *Frankliniella occidentalis*, are facultative predators that feed on both plant and arthropod tissue (immature thrips, mites/eggs, and small plant feeding insects)
- Few species in the subfamily Tubulifera are found in flowers (many species of *Haplothrips*) but instead feed on fungi or grasses
  - A few species are predatory on mites or coccids

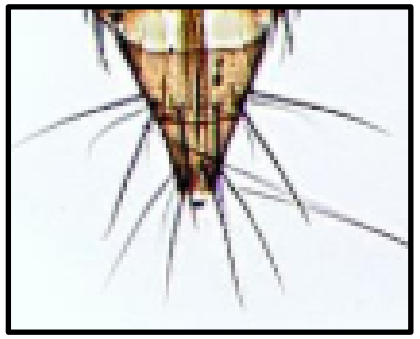
Some flower inhabiting thrips are important pollinators

Thrips of California 2012



Economic Impact

- Plant feeding thrips can negatively affect commercial crops in several ways
  - Leaves/petals can curl, roll or fold around thrips feeding sites
  - Galls or other tissue growths may be formed
  - Feeding may result in spots or damage to the surface of fruits or flowers thus making them not suitable for local sale or export to foreign markets
  - The presence of thrips themselves, even without feeding damage, may case crops to be rejected for export
  - Certain thrips species serve as vectors for diseases, such as tospoviruses
    - These include tomato spotted wilt virus and the impatiens necrotic spot virus
    - Estimated $1 billion annual worldwide loss from tomato spotted wilt virus alone



♀ **Abdominal segment X**

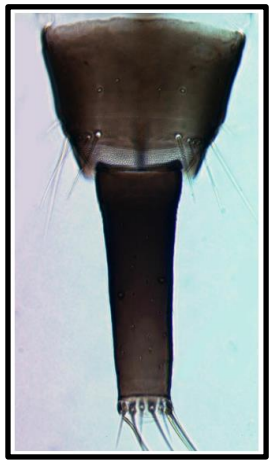
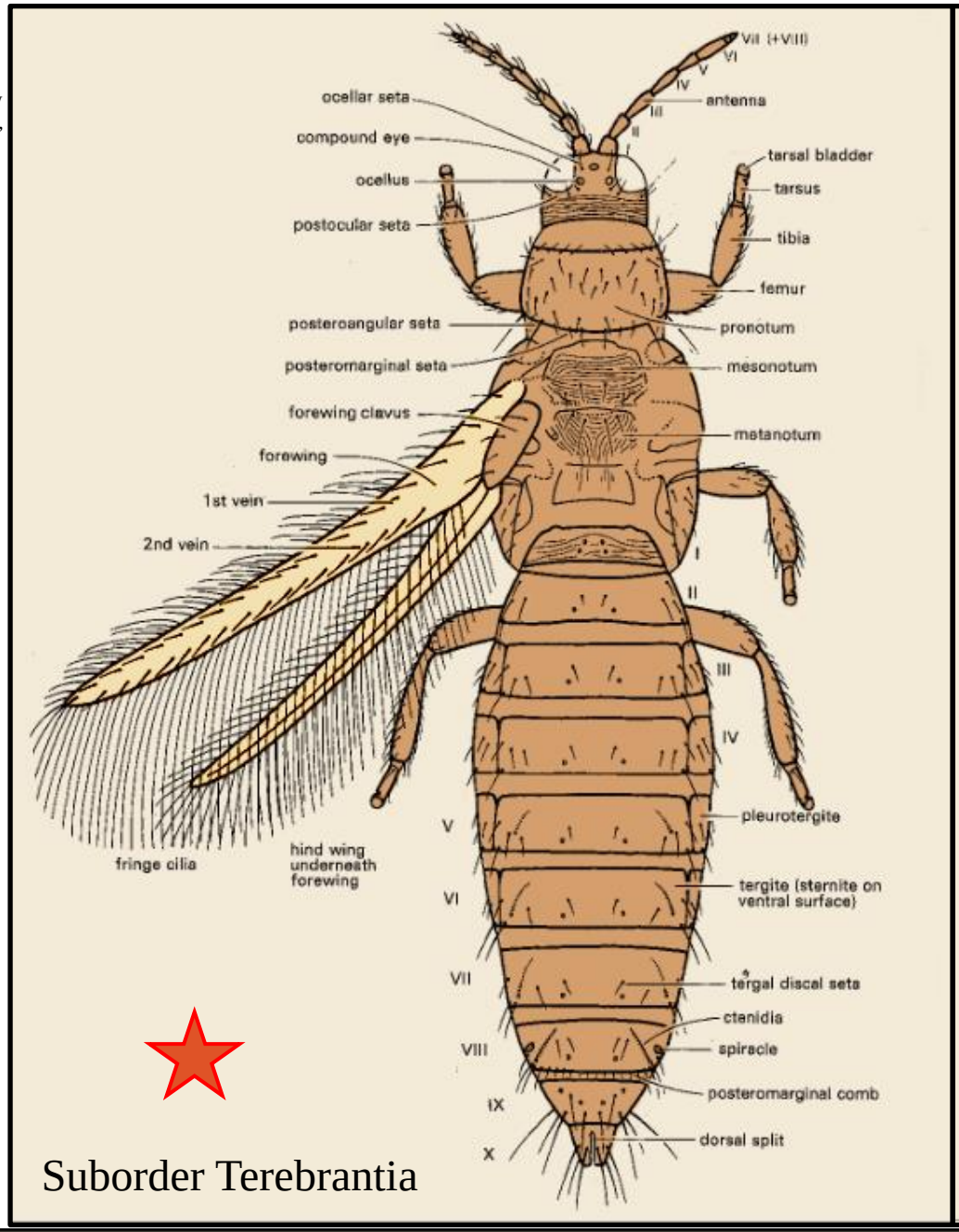


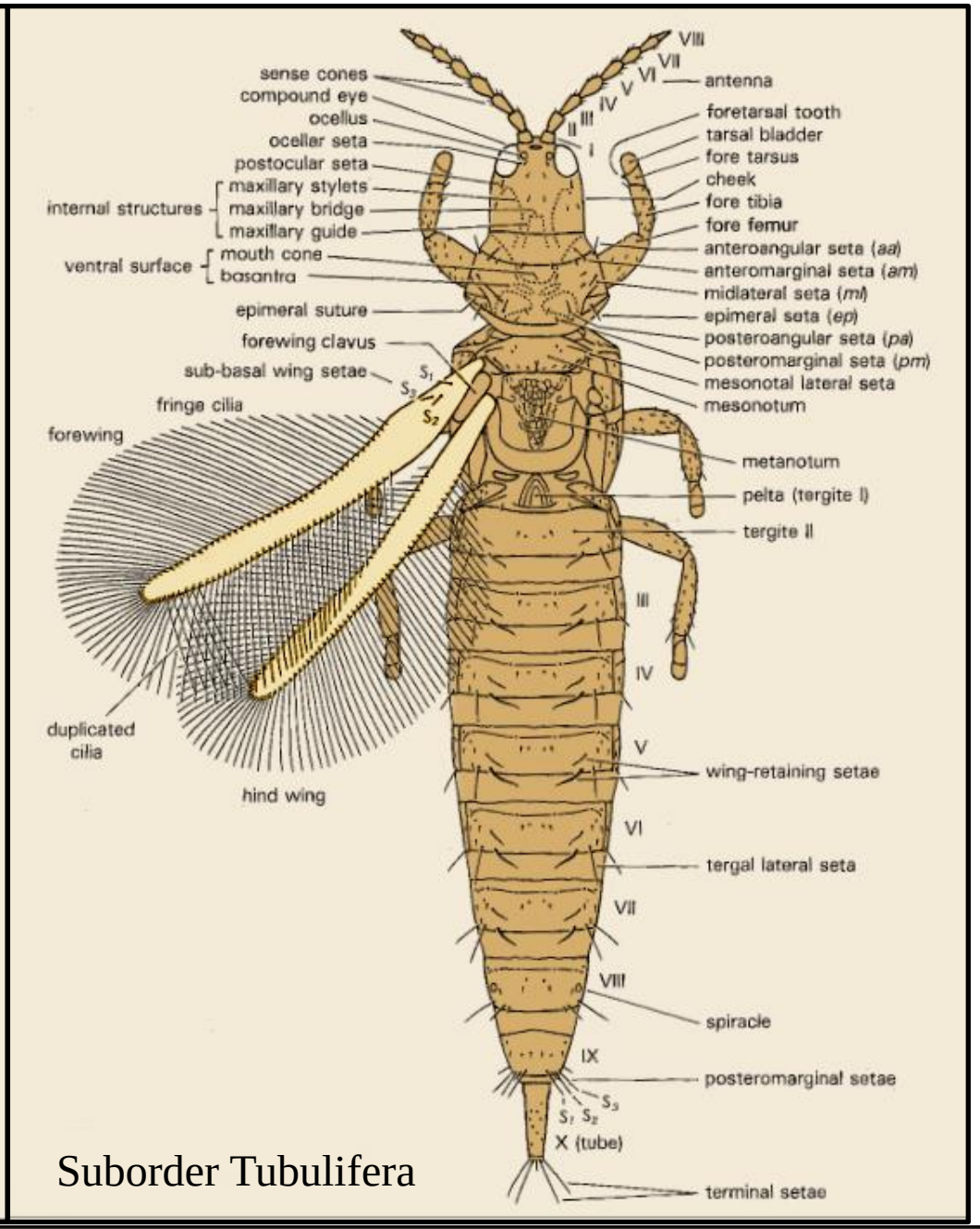
Table 1. Classification of the Order Thysanoptera

SUB-ORDER	FAMILY	SUB-FAMILY	GENERA	SPECIES
Terebrantia	Merothripidae		5	18
	Melanthripidae		6	75
	Aeolothripidae		28	200
	Fauriellidae		4	5
	Stenurothripidae		12	24
	Heterothripidae		7	75
	Thripidae	Panchaetothripinae	40	140
		Dendrothripinae	15	100
		Sericothripinae	3	145
		Thripinae	240	1700
	Uzelothripidae		1	1
Tubulifera	Phlaeothripidae	Phlaeothripinae	375	2820
		Idolothripinae	80	715

Thrips of California 2012

Mound LA, Nielsen M & Hastings A (2017). *Thysanoptera Aotearoa* – Thrips of New Zealand. Lucidcentral.org, Identic Pty Ltd, Queensland, Australia





Thrips Recorded From Alaska

- *Haplothrips leucanthemi* (Schrank) – No common name
- *Aeolothrips* sp. – No common name
- *Anaphothrips obscurus* (Müller) – No common name
- *Apterothrips sectocornis* (Trybom) – No common name
- *Frankliniella fusca* (Hinds) – Tobacco thrips
- *Frankliniella intonsa* (Trybom) – No common name
- *Frankliniella occidentalis* (Pergande) – Western flower thrips
- *Odontothrips* sp. – No common name
- *Taeniothrips orionis* Treherne – No common name
- *Thrips brevialatus* Nakahara – No common name
- *Thrips fallaciosus* Nakahara – No common name
- *Thrips sieversiae* Hood – No common name
- *Thrips simplex* (Morison) - Gladiolus Thrips
- *Thrips tabaci* Lindeman – Onion Thrips
- *Thrips trehernei* Priesner – No common name
- *Thrips vulgatissimus* Haliday – No common name
- *Thripsaphis cyperi* – No common name
- *Thripsaphis verrucosa*– No common name

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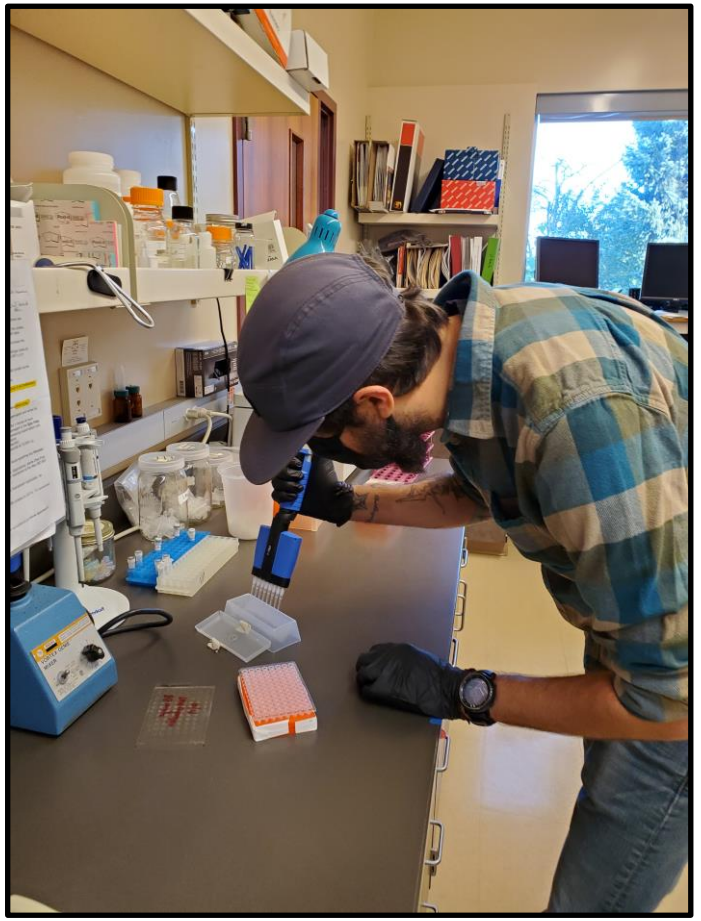
- *Thripsaphis verrucosa*– No common name

RECORDED FROM PEONIES - 13 SPECIES

WSU Project Objectives

- Morphological studies – Ben Diehl
  - Identify thrips species present in Alaska peonies
  - Develop keys specific to Alaska thrips fauna
    - Traditional and Lucid
  - Participate in outreach/training
- Molecular studies – Lydia Tymon
  - Extract DNA from thrips collected from Alaska peonies
  - Amplify target gene regions and develop quicker identification protocols using RFLP data
  - Link to identifications based on morphology
- Field bioassays – Beverly Gerdeman
  - Explore efficacy of pesticides for thrips in peonies



Why is proper identification necessary?

- If control strategies are similar for most thrips, why do we need to know which species are found on Alaska grown peonies?
- Phytosanitary/export implications
  - Trade barrier!
  - Not all importing nations treat thrips similarly
- Several species are of greater economic concern
  - Vectors of tospoviruses
  - Only 14 of ~ 6,000 species of thrips
  - *Frankliniella fusca* – Tobacco thrips
  - *Frankliniella intonsa* – No common name
  - *Frankliniella occidentalis* – Western flower thrips
  - *Thrips tabaci* – Onion Thrips
- Early detection of invasive species
  - Useful for all of Alaskan agriculture

Peony Bud Sampling Protocols

- Conduct survey of thrips fauna associated with Alaska grown peonies
  - Collect buds from various farms
  - Ship to WSU laboratory for dissection
  - Thrips housed in 100% ETOH to preserve DNA quality
  - After DNA extraction, remaining exoskeleton mounted on a microscope slide

Peony Bud Sampling

2019 Peony Bud Sampling Results

- 556 peony buds dissected from 12 localities
- Single cultivar sampled: Sarah Bernhart (pink)
- 272 adult and larval thrips collected
- Eight thrips species identified:
  - *Apterothrips sectocornis* (Trybom)
  - *Frankliniella fusca* (Hinds)
  - *Frankliniella intonsa* (Trybom)
  - *Frankliniella occidentalis* (Pergande)
  - *Haplothrips leucanthemi* (Schrank)
  - *Taeniothrips orionis* Treherne
  - *Thrips fallaciosus* Nakahara
  - *Thrips vulgatissimus* Haliday

Frankliniella occidentalis

2020 Peony Bud Sampling Results

- 2,320 peony buds dissected from 25 localities
- 80 cultivars sampled
  - White, pink, yellow, red, purple
- 1,523 adult and larval thrips collected
- Slide mounting and identifications ongoing

Haplothrips larva

Cultivar	#buds	#thrips	#larvae	#adults	Ave thrips/bud	Highest thrips/bud	Color
Allen Rogers	19	3	0	3	0.16	1	White
Ann Cousins	10	7	1	6	0.70	0.8	White
Avalanche	48	99	2	97	2.06	9	White/Pink
Avis Varner	20	0	0	0	0.00	0	Purple
Ben Franklin	30	2	1	1	0.07	0.4	Crimson
Best Man	1	0	0	0	0.00	0	Fuchsia/Pink
Big Ben	44	11	0	11	0.25	2.5	Red
Boule de Neige	49	47	0	47	0.96	5	Cream/White
Bowl of Beauty	15	4	0	4	0.27	1.33	Pink/Yellow
Bowl of Cream	35	38	7	31	1.09	5	White
Bridal Icing	4	0	0	0	0.00	0	White
Charles White	42	36	1	35	0.86	5.75	White
Cheddar Supreme	15	5	1	4	0.33	0.8	White/Yellow
Chestine Gowdy	12	0	0	0	0.00	0	Pink/Cream
Claudia	13	16	0	16	1.23	1.8	Coral
Coral Charm	5	0	0	0	0.00	0	Coral
Coral Sunset	15	1	0	1	0.07	1	Coral
Corinne Wersan	20	0	0	0	0.00	0	White/Pink
Couronne D' Or	10	1	0	1	0.10	0.67	White
Double White	15	0	0	0	0.00	0	White
Dr. Alexander Fleming	15	7	0	7	0.47	1.5	Pink
Duchess de Nemourus	189	211	99	112	1.12	17	White
Eden's Purfume	11	0	0	0	0.00	0	Light Pink
Edulis Superba	25	4	0	4	0.16	3	Pink
Eskimo Pie	12	83	0	83	6.92	16	White
Felix Supreme	60	0	0	0	0.00	0	Ruby
Festiva Maxima	259	108	6	102	0.42	5	White
FG Brethour	21	62	0	62	2.95	4.4	White
Fragrent Pink Imp	20	2	0	2	0.10	0.2	Pink
Francis Ortegat	20	11	1	10	0.55	1	Red
Gay Paree	30	6	1	5	0.20	0.8	Pink/Cream
General McMahon	20	13	0	13	0.65	1.2	Crimson
Glory Hallelujah	15	0	0	0	0.00	0	Pink/Red
Going Banannas	12	2	0	2	0.17	1	Yellow
Heidi	15	0	0	0	0.00	0	Pink
Henry Sass	3	4	0	4	1.33	1.33	White
Joker	20	10	0	10	0.50	1.33	Pink/White
Julia Rose	12	2	0	2	0.17	0.4	Red/Orange/Yellow
Kansas	60	7	0	7	0.12	1	Fuchsia
Karl Rosenfeld	20	0	0	0	0.00	0	Red
Kun Shan Xia Guang	5	16	0	16	3.20	3.2	White
La Lorraine	7	9	0	9	1.29	1.25	Cream/White/Pink
Largo	20	0	0	0	0.00	0	Pink
Lady Alexandria Duff	20	4	0	4	0.20	0.8	Light Pink
Lady Kate	12	4	0	4	0.33	0.5	Pink
Lauren	13	4	0	4	0.31	0.8	Pink
Lemon Chiffon	39	62	0	62	1.59	6.5	Yellow
Leslie Peck	40	15	1	14	0.38	0.8	Pink/Peach
Lora Dexheimer	20	3	0	3	0.15	0.6	Crimson
Lottie Dawson Rea	20	96	0	96	4.80	11.5	Light Pink
Love's Touch	42	14	0	14	0.33	0.83	Pink/White
Lowell Thomas	20	21	0	21	1.05	2	Crimson
Madame de Verneville	3	6	0	6	2.00	2	White
Madame Emile Debatene	30	9	1	8	0.30	0.83	Pink
Magical Mystery Tour	9	0	0	0	0.00	0	Pink/Cream
Marie Lemoine	5	15	0	15	3.00	5	White
Marietta Sisson	4	1	0	1	0.25	0.25	Pink
Mary Jo Legare	30	3	0	3	0.10	0.5	Pink
Mons Jules Elie	40	40	2	38	1.00	1.8	Pink
Mystery Pink	20	0	0	0	0.00	0	Pink
Nick Shaylor	20	6	0	6	0.30	2	Pink/White
Nippon Beauty	20	13	1	12	0.65	1.8	Garnet
Paula Fay	20	13	0	13	0.65	0.8	Pink
Pecher	19	17	10	7	0.89	1	Light Pink
Petite Renee	20	12	0	12	0.60	1.8	Pink
Princess Juliana	9	3	0	3	0.33	0.43	Pink
Raspberry Sundae	10	19	2	17	1.90	6	Pink/Yellow
Red Champion	10	16	0	16	1.60	3	Purple-Red
Red Charm	65	50	6	44	0.77	2.4	Red
RP (Rogue Pink)	8	5	0	5	0.63	0.75	Pink
Ruth Cobbs	2	0	0	0	0.00	0	Pink

- Potential cultivar/color associations?

2021 Project Goals

- Revisit farms that did not have all buds dissected in 2020
  - Focus on Fairbanks and Mat-Su Valley regions
  - Non-destructive sampling of buds in the field
- Continue Lucid key development to include all species of thrips recorded from peony samples
- Explore outreach opportunities for phytosanitary inspectors, researchers, and growers
  - Possibly in a virtual format

Lucid Keys: Morphological Characters

- What can make Lucid keys more helpful than traditional dichotomous keys?
  - Often a user can become stuck on a couplet in dichotomous keys and cannot progress further
  - More user friendly (especially for non-specialists)
  - Easy to incorporate pictures
  - Potential to include molecular data (RFLP banding patterns)

pronotum and head not close set, occasionally weakly indicated; metasternum lacking spinula;ctenidia on abdominal tergite VIII anterolaterad of spiracle 3

Anteromarginal and anteroangular setae not developed; pronotum and head with numerous, close-set striae; metasternum with spinula; ctenidia on tergite VIII mesad of spiracle ..... *Chaetisothrips*

3(2) Antennal segments III and IV with simple sense cones; 2 median setae on metanotum in anterior 1/4 to 1/3 of notum ..... *Iridothrips*

Antennal segments III and IV with trichomes; 2 median setae on anterior margin of metanotum ..... *Frankliniella*

4(1) Abdominal sternites II-VI with B1 setae anterior of posterior margin, sternite II with 3 posteromarginal setae ..... *Baliothrips*

Abdominal sternites II-VI with B1 setae on posterior margin, sternite II with 2 posteromarginal setae 5

5(4) Ovipositor well developed, extending to apex of abdominal segment X; head not produced anterior of eyes; males lack stout spines on abdominal tergite IX 6

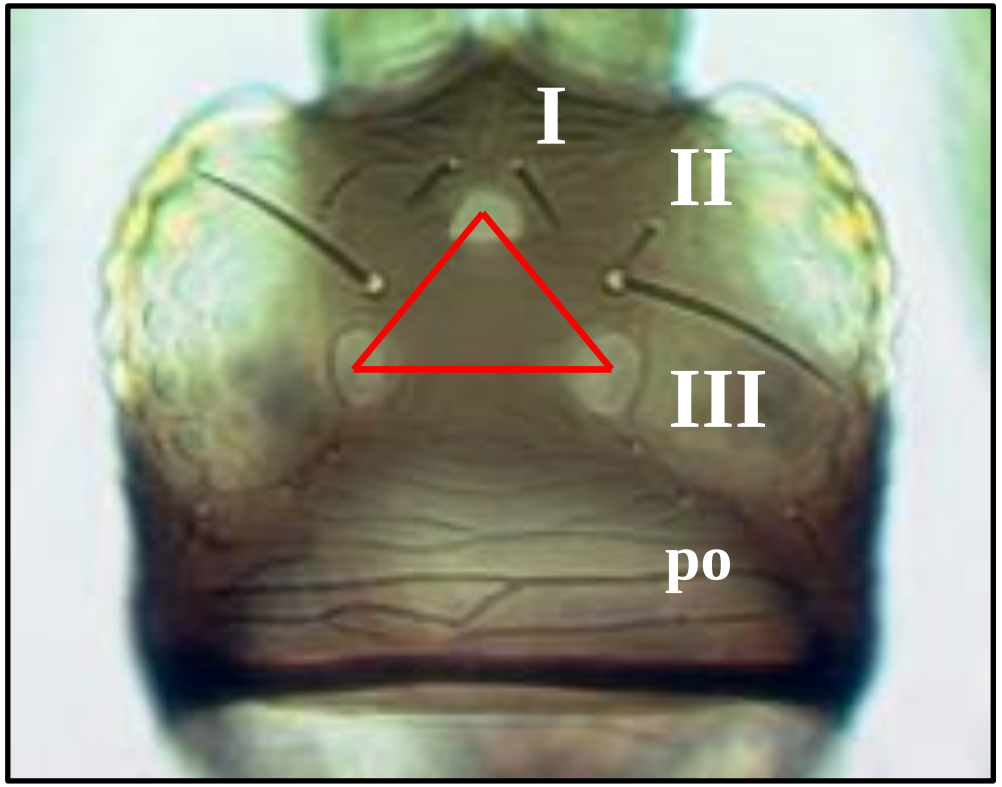
Ovipositor reduced, extending to about midlength of segment X or less; head produced anterior of eyes; males with a pair of stout spines on abdominal tergite IX ..... *Plesiothrips*

6(5) Posterior margins of abdominal tergites II-VII with conical teeth; pronotum about 1 1/2 times as long as head, with 5-7 pairs of posteromarginal setae ..... *Microcephalothrips*

Posterior margins of abdominal tergites II-VII without conical teeth, low scallops may be present; pronotum normally about as long as head, usually with 2-4 pairs of posteromarginal setae 7

7(6) Vertex of head rounded, interantennal process almost as wide as antennal segment I; males with reduced dorsal setae on abdomi-

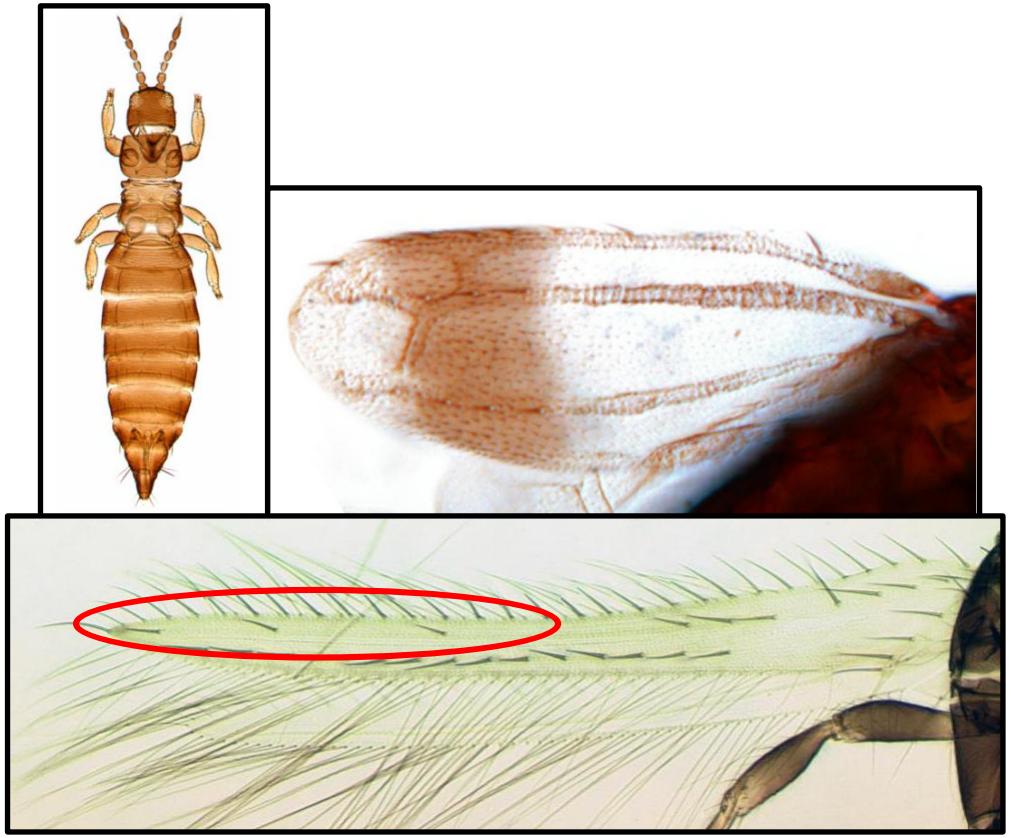
Head - Ocellar Setae



Thrips of California 2012

- Number of pairs
  - Typically, 2 or 3 pairs of ocellar setae
  - Not to be confused with postocular setae (po)
  - Commonly referred to as Pair I, Pair II and Pair III
  - All *Thrips* spp. lack Pair I
  - Position of Pair III with relation to the ocellar triangle often important
- Length
  - Length of ocellar setae are often compared to each other or to setae on the head or pronotum

Thorax - Wings



Thrips of California 2012

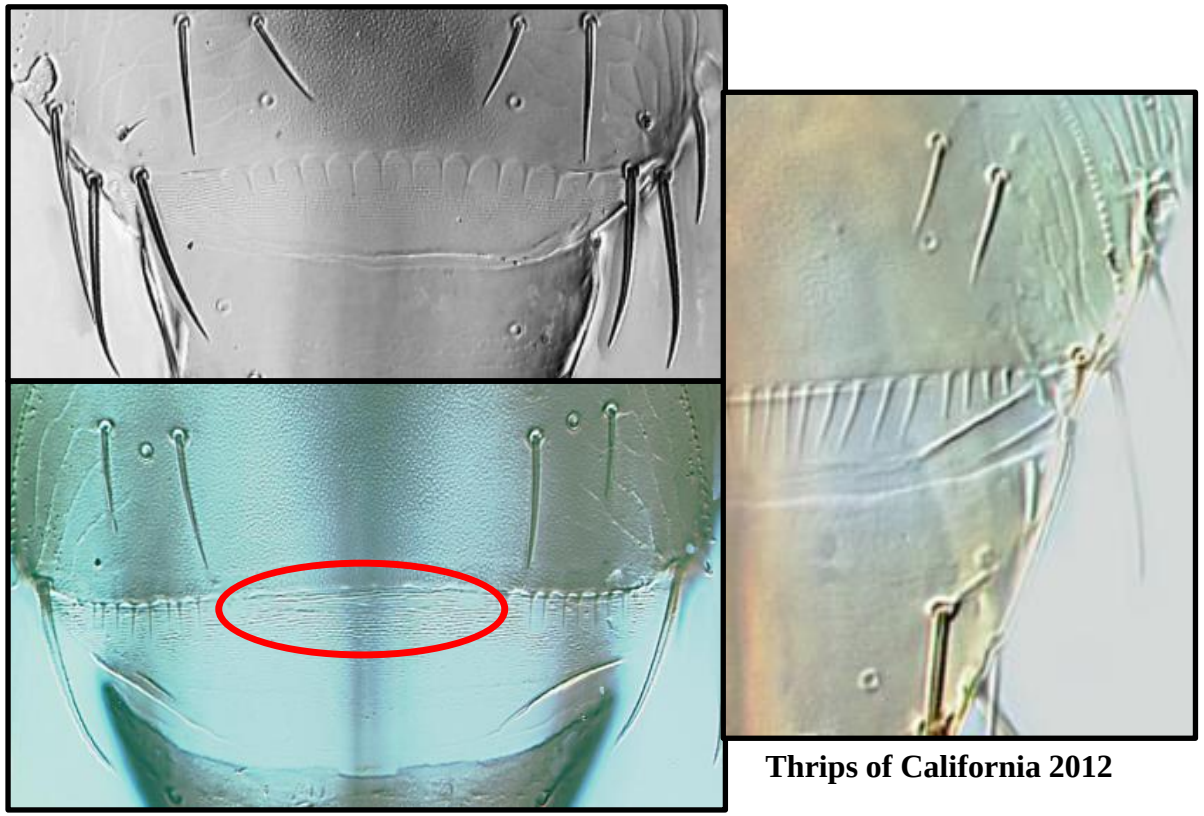
Presence/absence

- Adults can be fully winged, have wings that are reduced in size, or fully apterous
- Interestingly this character can vary within a single species in a few different ways!

Number of venal setae

- Three veins in forewing:
  - A) Costal vein
  - B) First vein
  - C) Second vein
- Number of distal setae (located in distal half of wing) in first vein used to separate taxa

Abdomen - Tergites

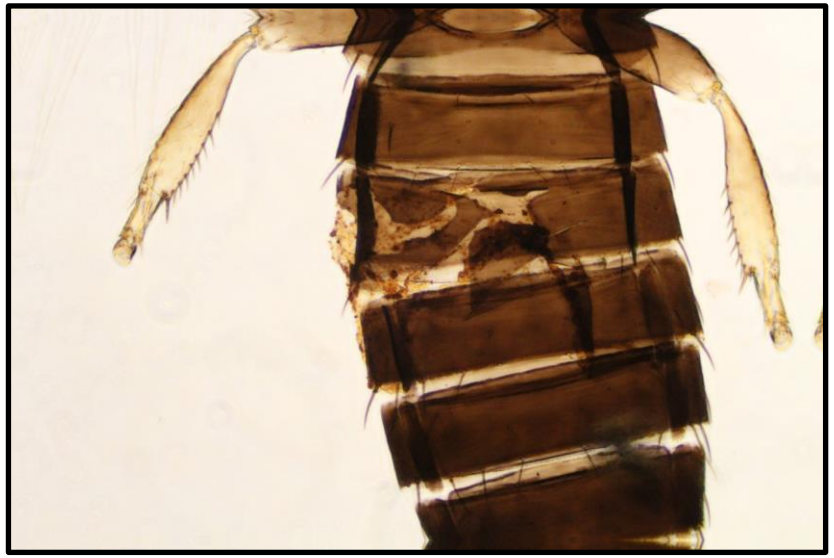


Thrips of California 2012

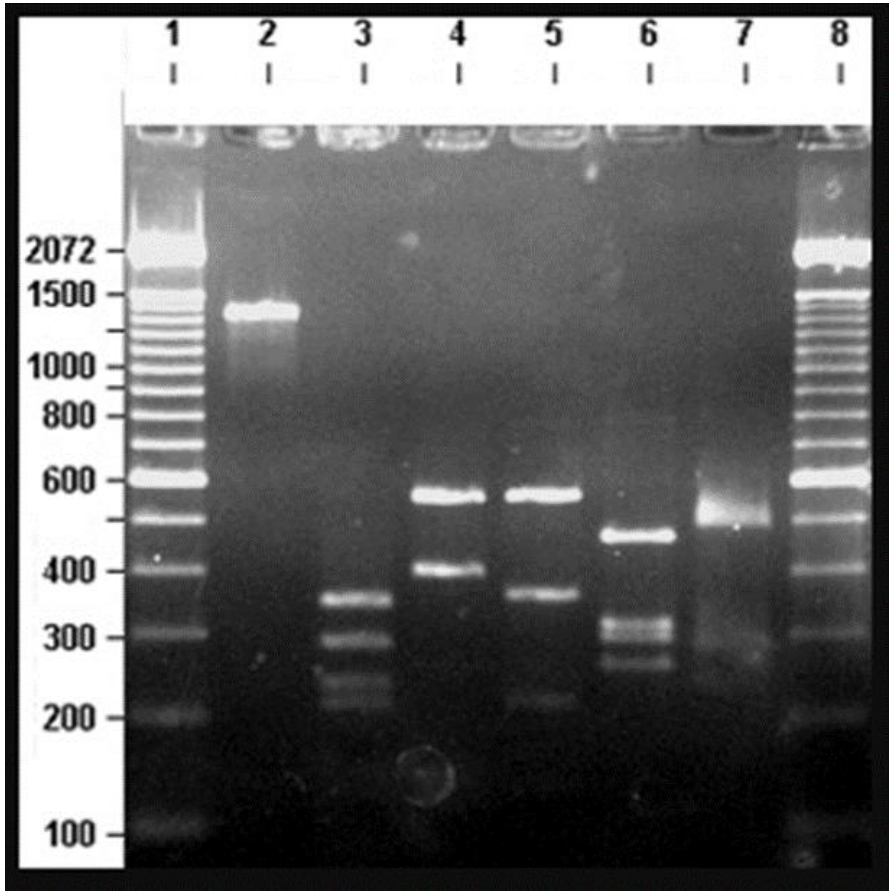
- VIII posteromarginal comb
  - Can be used to separate genera or species
  - Three main character states:
    - A) Comb complete
    - B) Comb incomplete (usually medially)
    - C) Comb absent
  - Shape and length of microtrichia are also commonly used in keys

Molecular Studies

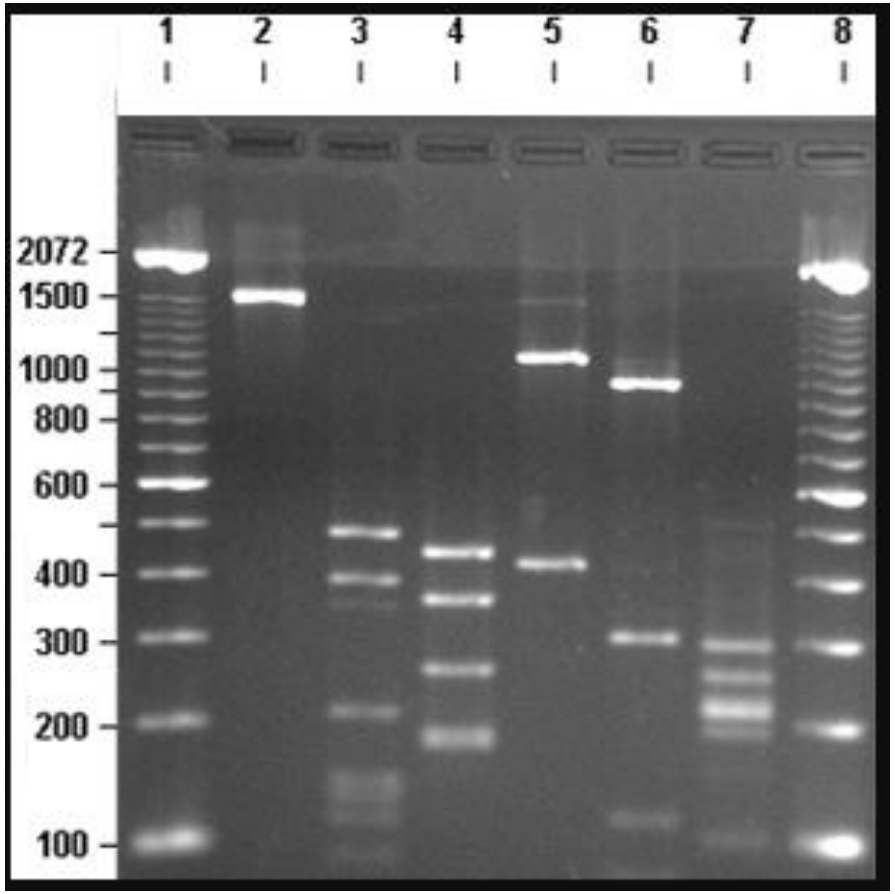
- To decrease identification time and increase accuracy, ITS-RFLP data will be generated for each species we collect from buds
- Advantages to this system include:
  - Avoid time mounting specimens and learning morphological character systems
  - Results available in only a few days
  - No need to send samples out for sequencing
- DNA linked to physical specimen
  - Can compare identification results



Frankliniella occidentalis

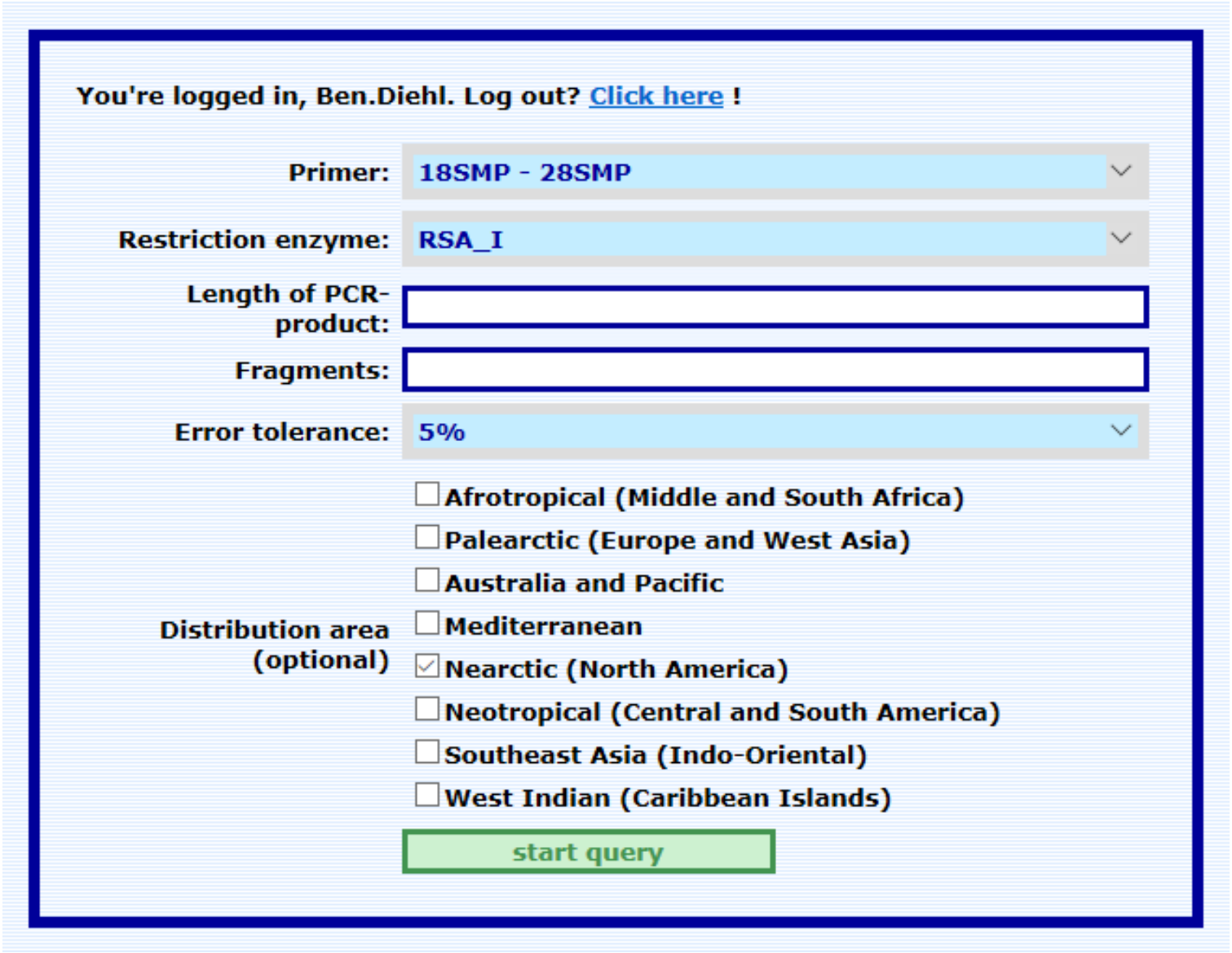


Thrips tabaci



Compare banding pattern of lane 3 (digested with RSAI enzyme)

Mound LA, Nielsen M & Hastings A (2017). *Thysanoptera Aotearoa* – Thrips of New Zealand. Lucidcentral.org, Identic Pty Ltd, Queensland, Australia



http://thripsnet.zoologie.uni-halle.de/

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Alaska Peonies

Alaska GROWN

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