

Fantastic bugs and where to find them: the biology of chalcid seed predation



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North Carolina State University

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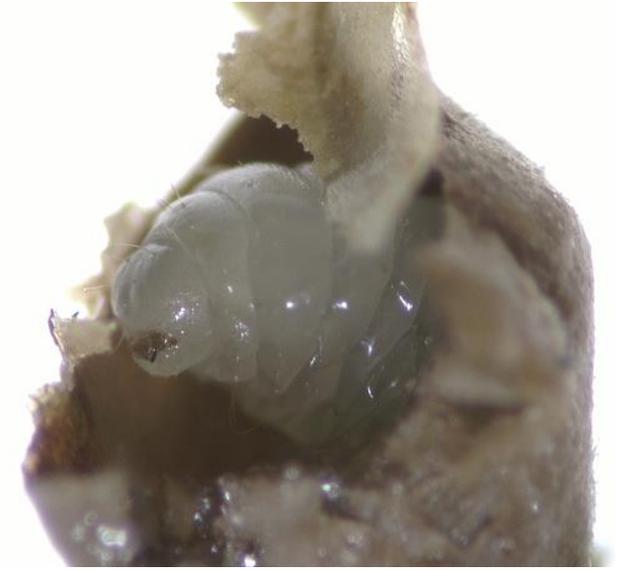
The idea: from SE to seed chalcids

Somatic Embryogenesis (SE) project

~ 4.000 seeds (Summer - 2016)



Seed chalcid wasp project



Seed chalcid infestation patterns on Fraser fir



North Carolina Christmas Tree Association

Our Goals

- Assess clonal variation in Fraser fir seeds infested by seed chalcid.
- Study developmental and infestation patterns of the seed chalcid.
- Determine the taxonomic classification of chalcid wasps and other insects isolated from Fraser fir seeds.

INTRODUCTION



Hymenoptera

(bees, wasps, ants, bumblebees, saw-flies, parasitic wasps)



Suborder Apocrita Parasitica

- Have legless grub-like larvae (obligate egg-larval endoparasitoids)

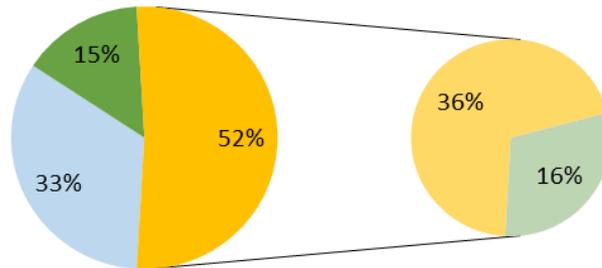


Suborder Symphyta – “Caterpillar-like”

- Have at most 4 pairs of prolegs

“Hymenopteran seed chalcids”

Family: **Torymadae**
Genus: **Megastigmus**
(135 species)



■ Develop in galls

■ Lacking behavioral data

■ Species associated with conifers

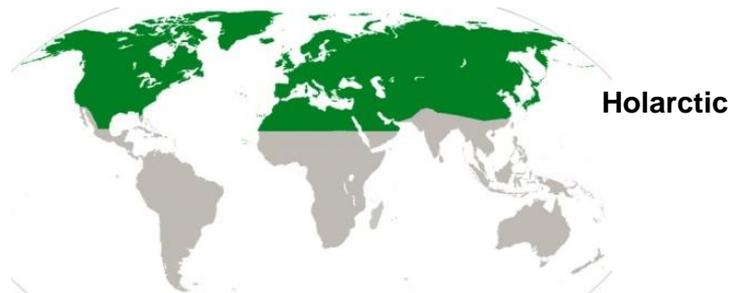
■ Develop within seeds in Angiosperms

Seed feeders

Family: **Pteromalidae**

It is an economically important family regulating the abundance of many insects

Parasitoids of other seed chalcid wasps



Introduction

Adult female *Megastigmus*



Adult male *Megastigmus*

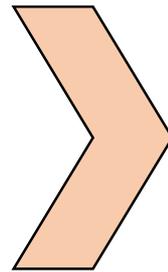


- These species exhibit a large invasive potential facilitated by the globalization of seed trade. Some of their life cycle features tend to facilitate insect introduction.
- Establishment in exotic countries (e.g. parthenogenesis and prolonged diapause, allowing them to cope with the heterogeneity in space and time of host abundance).

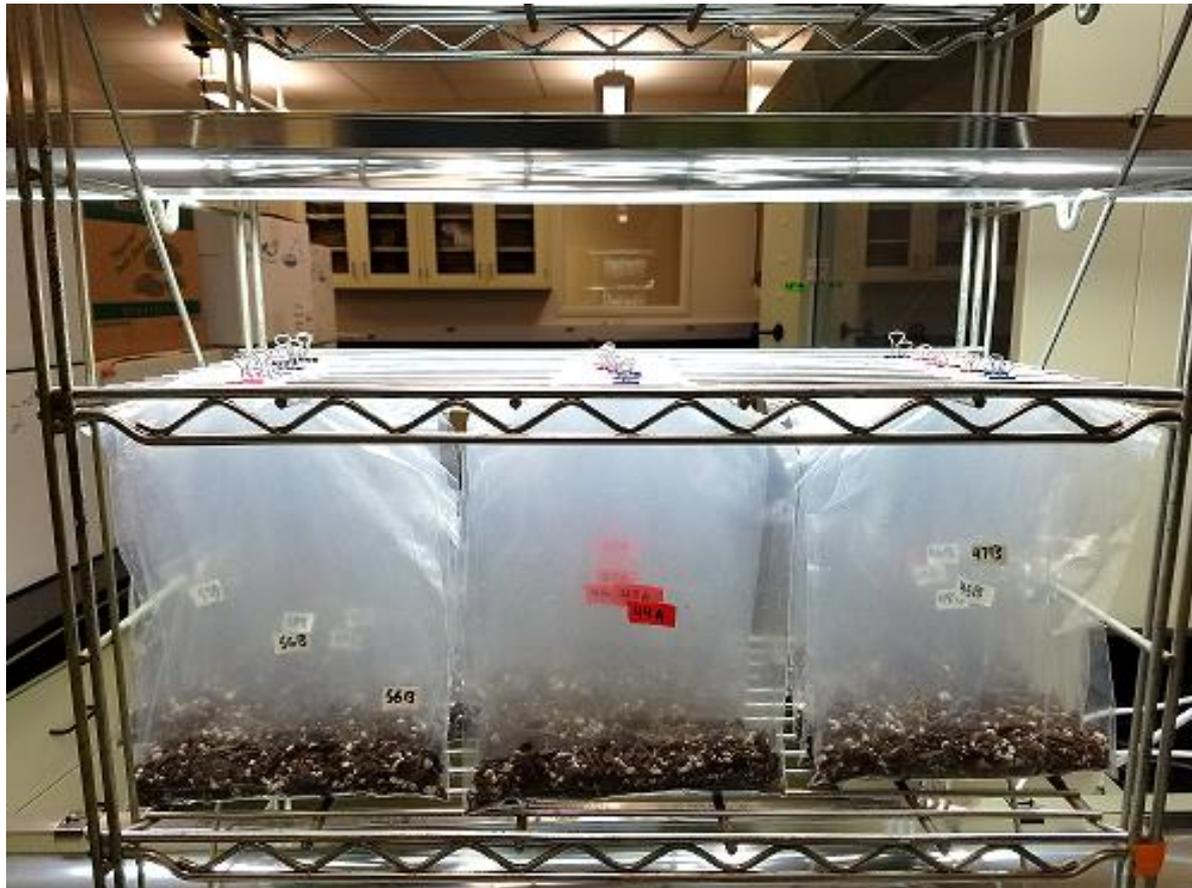
OUTCOMES



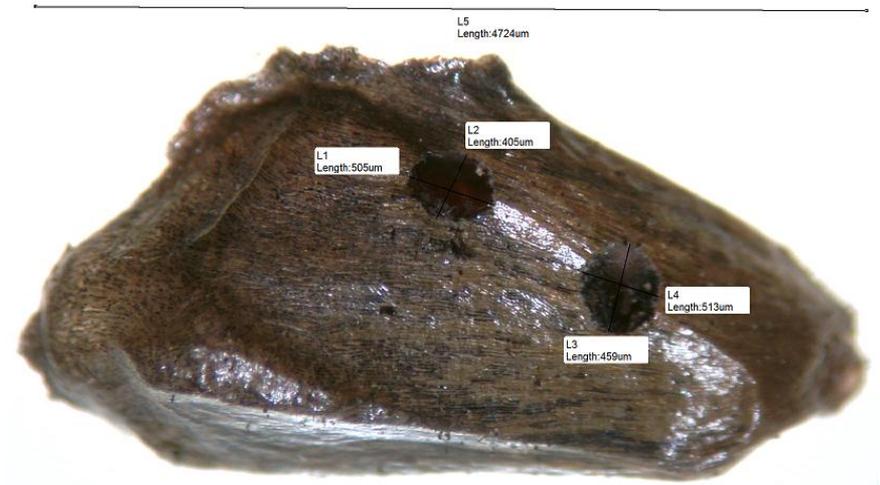
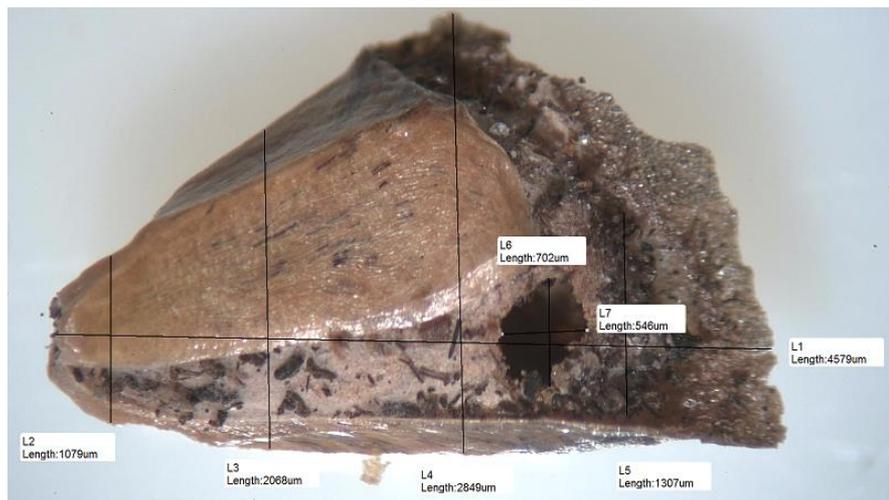
WP1: Rearing seed chalcids in the lab



WP1: Rearing seed chalcids in the lab



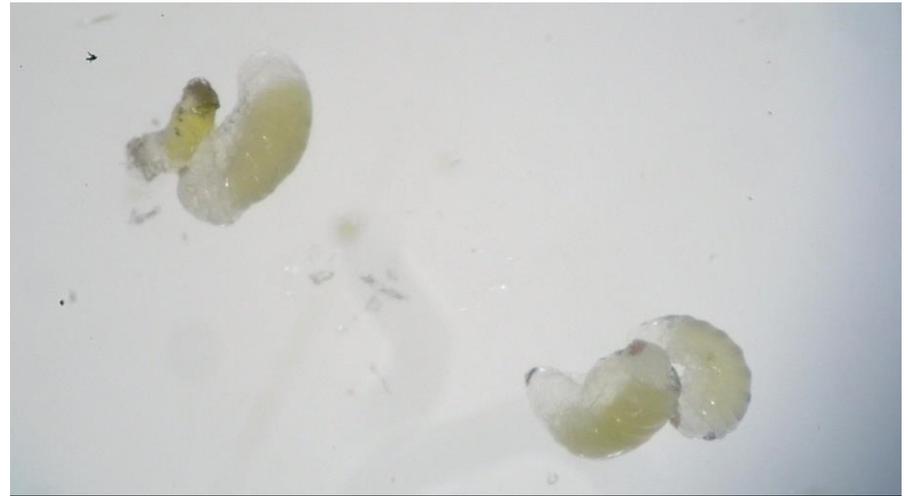
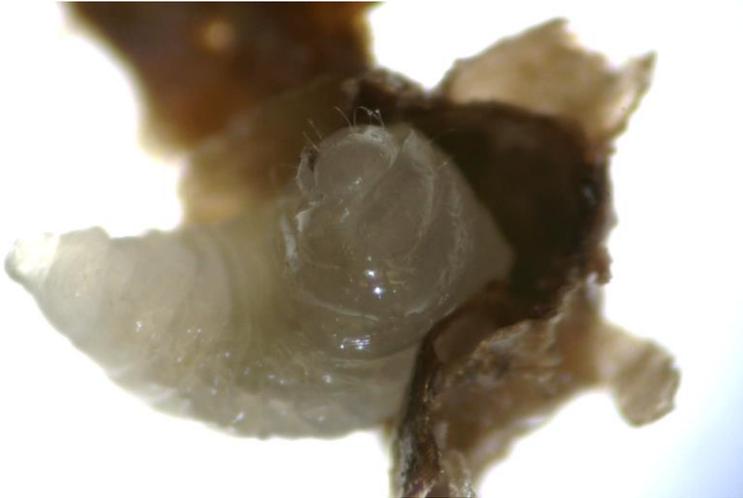
WP1: Rearing seed chalcids in the lab – Life cycle



WP1: *Megastigmus* – Life cycle



Megastigmus larvae



Cannibalism?

WP1: *Megastigmus* – Life cycle

Female and males adults
Megastigmus specularis



Female adult *Megastigmus specularis*

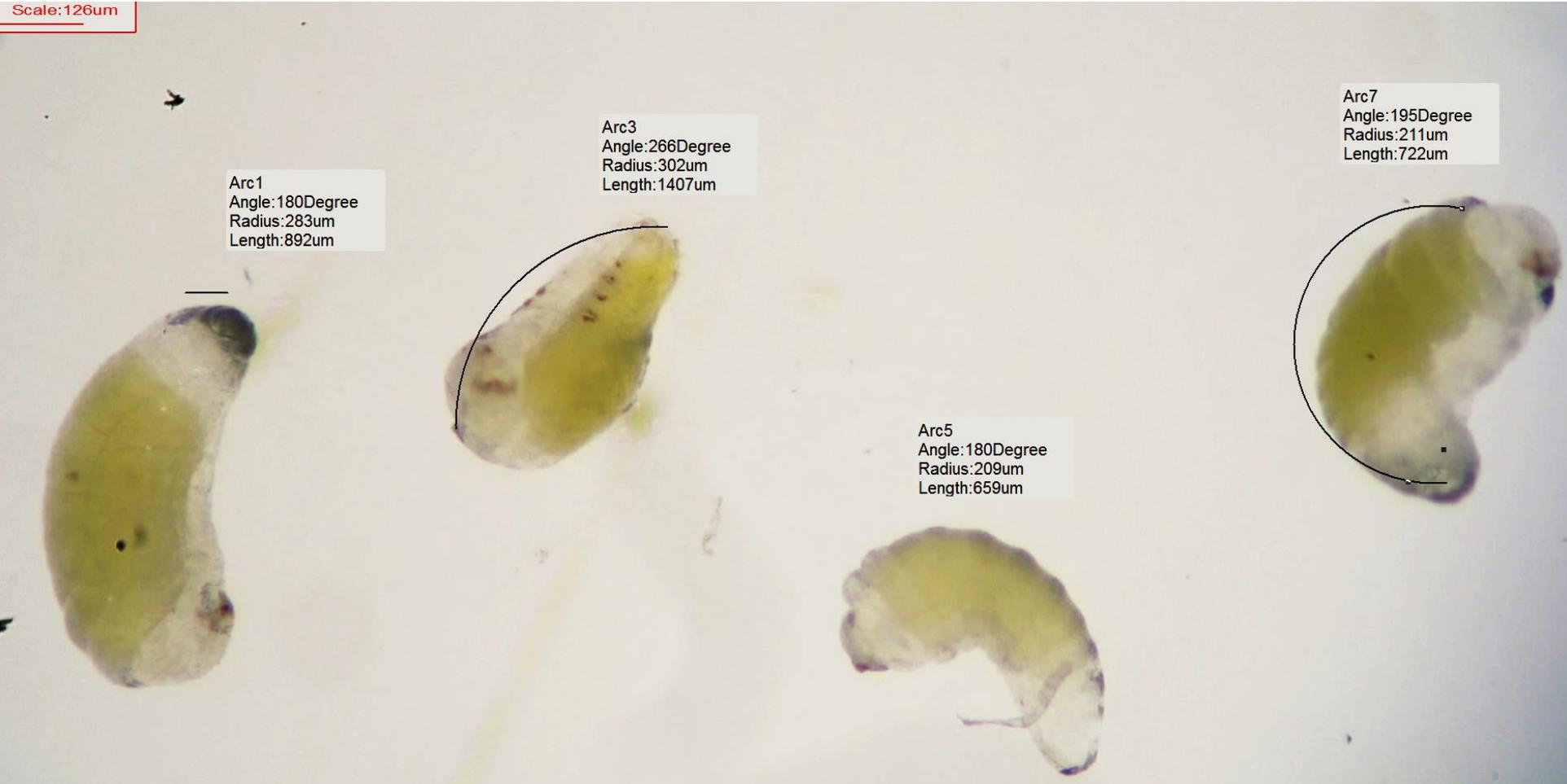


WP2: Taxonomic classification and development of seed chalcid



Preimaginal development: larva to pupa

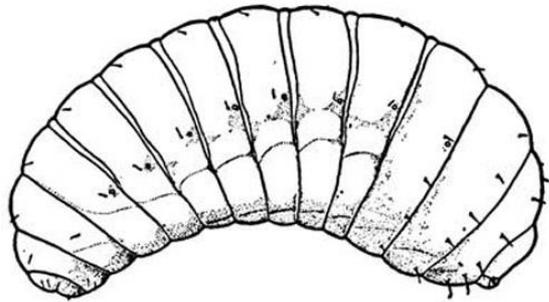
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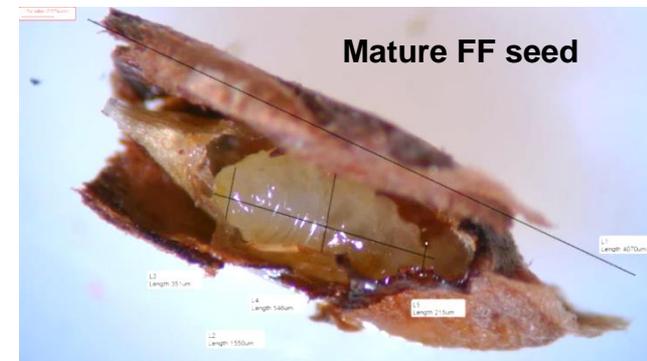
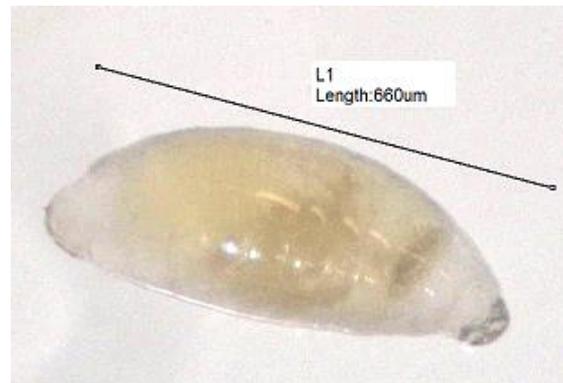
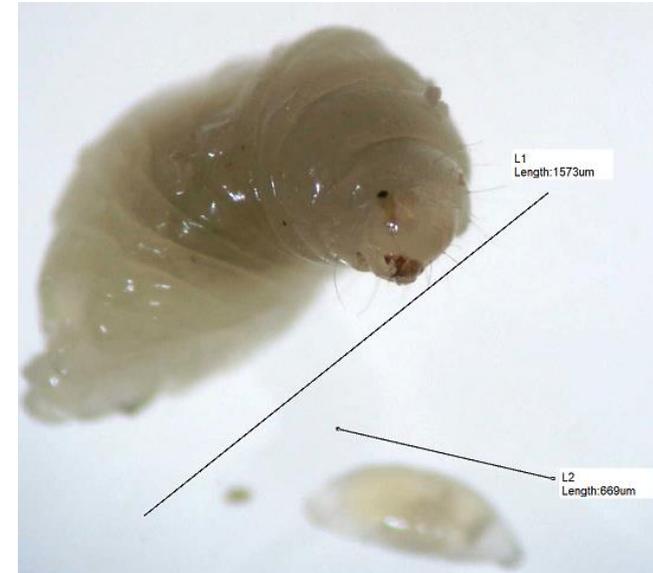
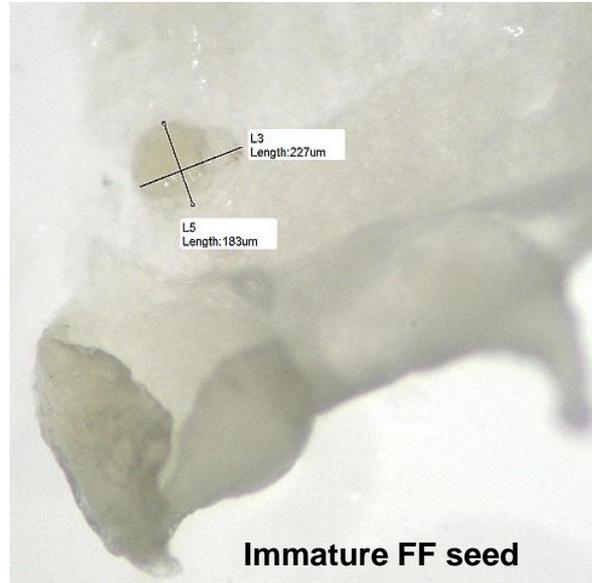
WP2: Taxonomic classification and development of seed chalcid



Preimaginal development: larva to pupa



Line drawing of mature larva of *Megastigmus* wasp. Drawing by H.E. Milliron (1949)



Identification of different larva instars



WP2: Taxonomic classification and development of Chalcids



Larva development: changes in mandible size

S



M



XL



WP2: Taxonomic classification and development of seed chalcids



Male pupa of *M. specularis* prior to adult emergence



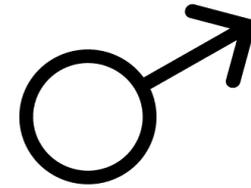
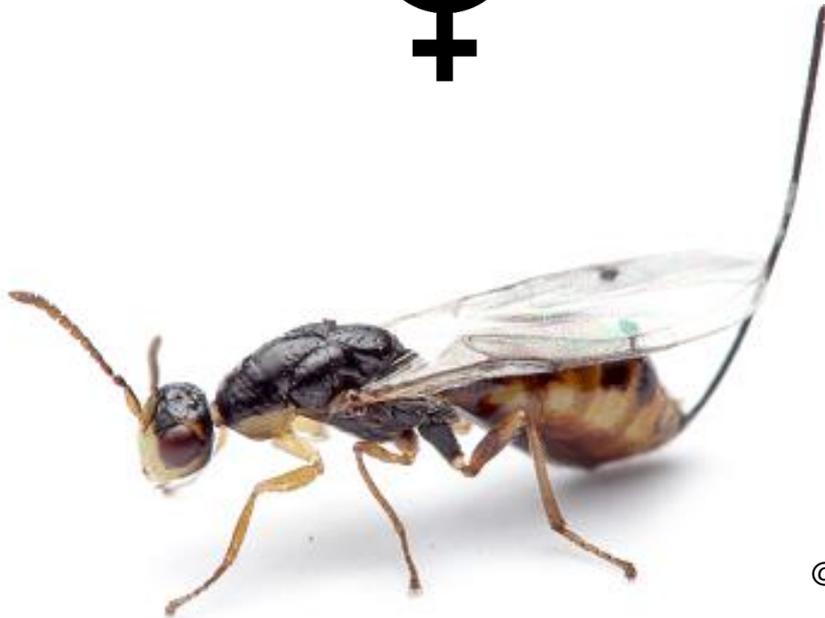
Female pupa of *Megastigmus* wasp. Photograph by H.E. Milliron (1949)



WP2: Taxonomic classification and development of seed chalcids



Female and male adults of *Megastigmus specularis* Walley



© Matt Bertone

WP3: Taxonomic classification and development of *Pteromalid* (parasitoid)

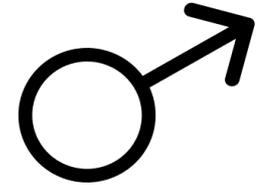


Female and male adults of *Pteromalid* spp.

(*Platymesopus* sp.)



© Matt Bertone



© Matt Bertone





Male adults of *Pteromalid* spp.



WP4: X-ray analyses – seed cleaning method



Seeds collected on **11-14-2016**

25 Clones (5 Clones x 2 bags)

Air screen seed cleaner

Clone 51 - Bag 1



Clone 51 - Bag 2



A.T. FERRE Saginaw Michigan #27



A.T. FERRE Saginaw Michigan #27



A.T. FERRE Saginaw Michigan #27



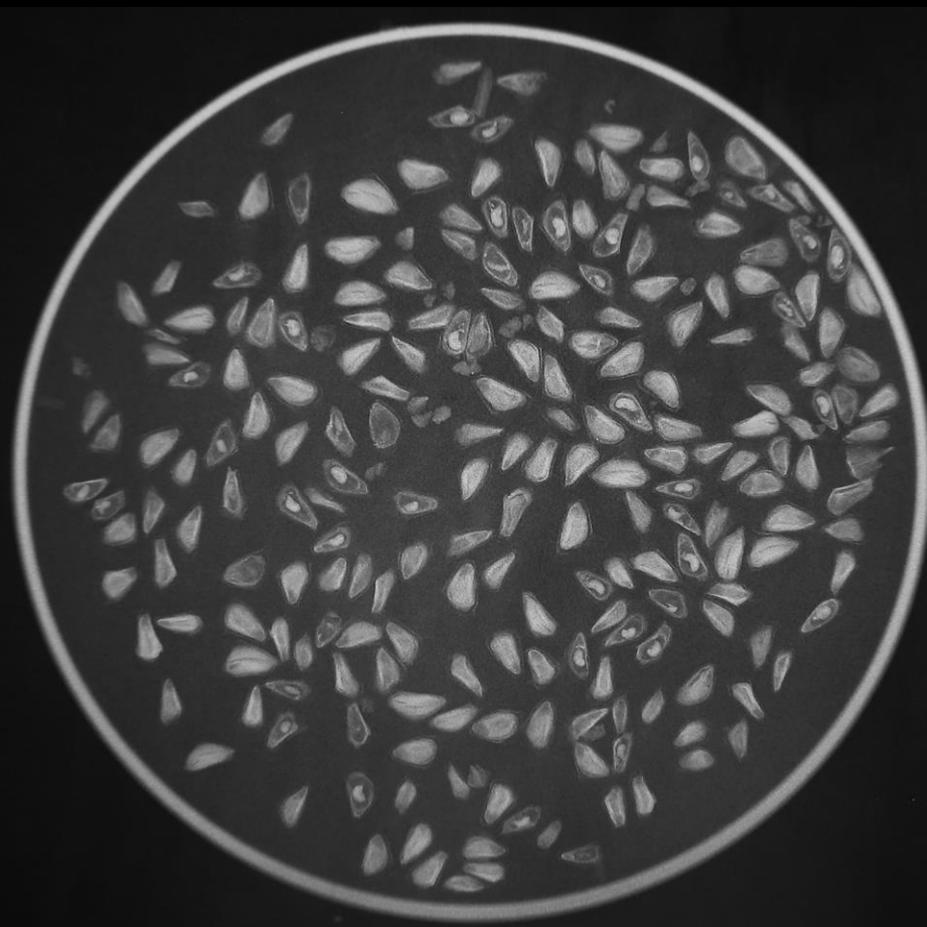


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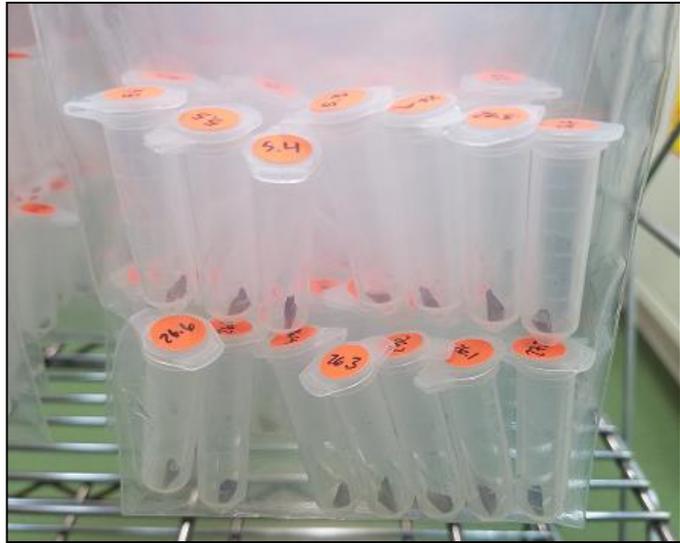
X-ray analyses

Clone 51 - Bag 1
200 seeds

Clone 51 - Bag 2
200 seeds



WP4: X-ray analysis – seed cleaning method



Experiment 1A: Effect of temperature and photoperiod on adult emergence

Seeds collected on **09-09-2016** (directly from the field)

Clones	Replicates	Seeds	Conditions
13	4	25/rep.	~6 °C and RT° ~22 °C

Total EU = 104
56 EU @ 6°C + D
56 EU @ RT + L

- 2-3 cm of media
- 7in x 7in piece of tulle
- Secured with a rubber band

Experimental Unit (EU)



[Clone#]-[Magenta#]-[Storage Condition]



Experiment 1A: Effect of temperature and photoperiod on adult emergence



- Our results showed that exposure to low temperature is required for the completion of development of the larva of *Megastigmus specularis* in Fraser fir seeds.

Experiment 1B: Effect of temperature and photoperiod on adult emergence

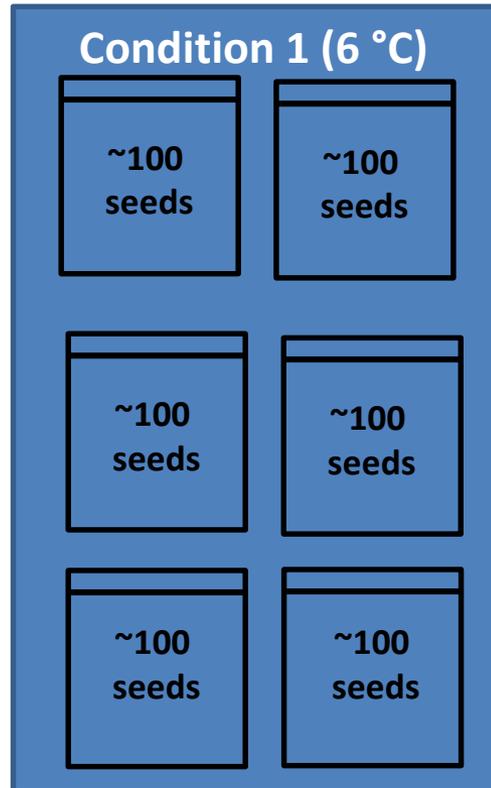


2 Clones (32 and 51)

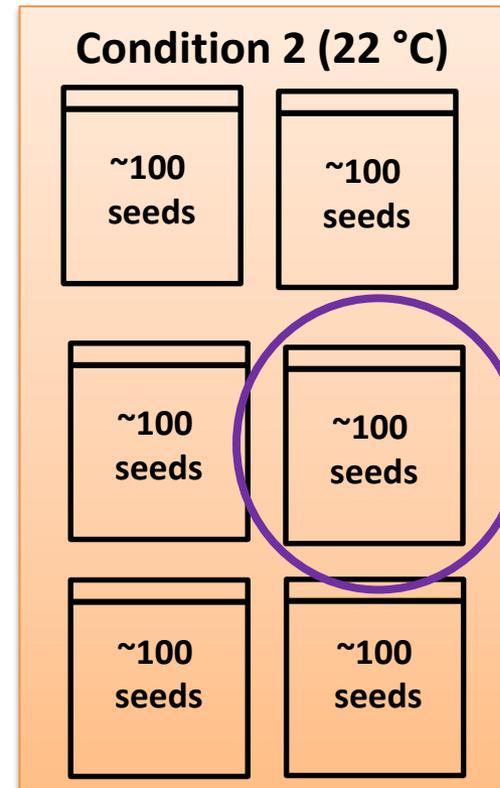
(most infested based on previous data)

Collected on **11-14-2016** (2 bags of cleaned seeds after harvest)

Condition 1
Darkness + Cold ($\sim 6^{\circ}\text{C}$)



Condition 2
Light + RT ($\sim 22^{\circ}\text{C}$)



**Experimental Unit
(EU)**

Experiment 1B: Emergence and cold-darkness treatment

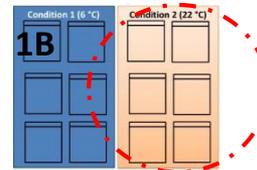
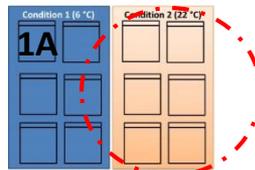
2 Clones (most infested based on previous data)

Collected on 11-14-2016 (directly from the field)

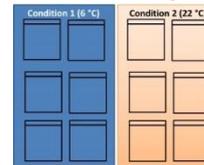
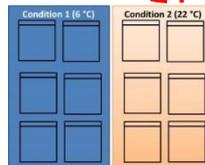
A=L32

B=L51

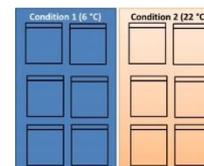
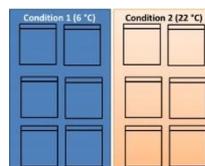
2nd January (01.02.2017)



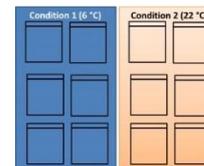
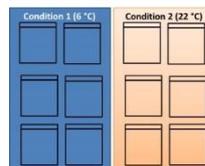
27th January (01.27.2017)



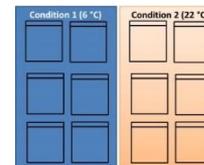
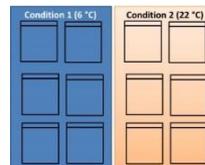
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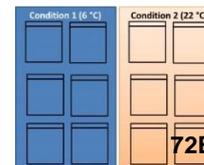
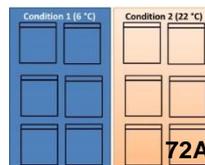
27th March (03.27.2017)



28th April (04.28.2017)



29th May (05.29.2017)

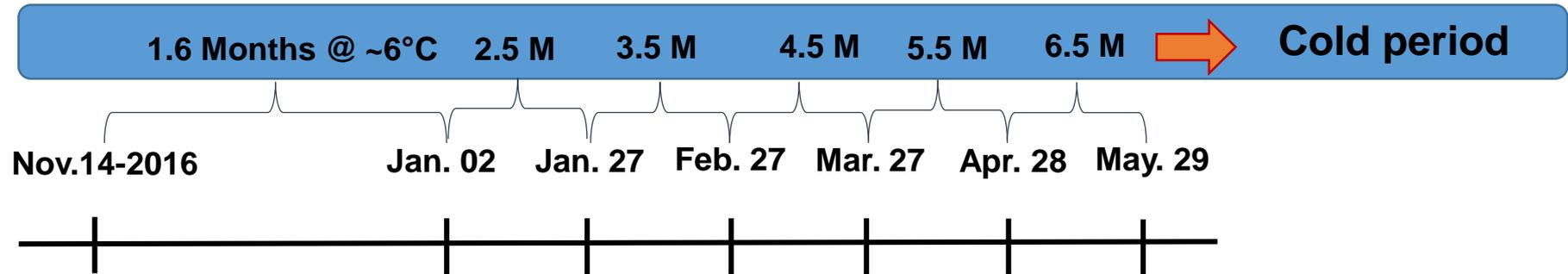


72 EU/Clone
With ~100 seeds/EU

Experiment 1B: Work timeline

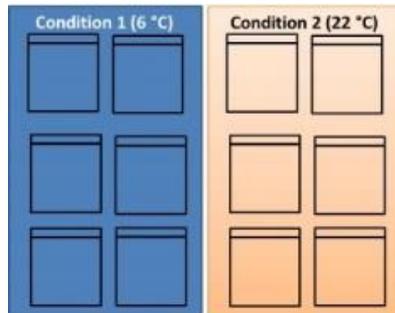


6 Time points



Seed collection

EXP-Start



30 – 35 Observations
~ 4 (observations/Month)



Experiment 1B: Effect of temperature and photoperiod on adult emergence



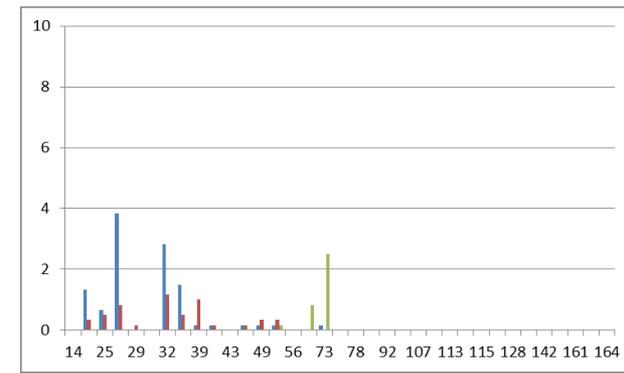
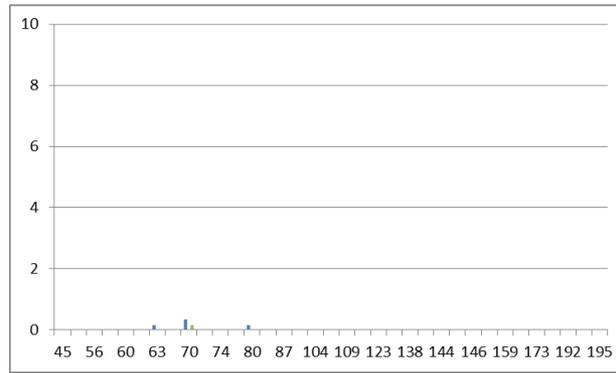
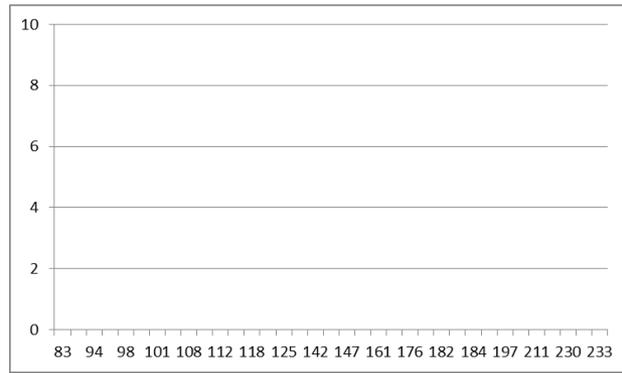
- Males (*Megastigmus*)
- Females (*Megastigmus*)
- M & F (Parasitoids)

Clone 32

1.6 Months @ ~6°C

2.5 Months @ ~6°C

3.5 Months @ ~6°C



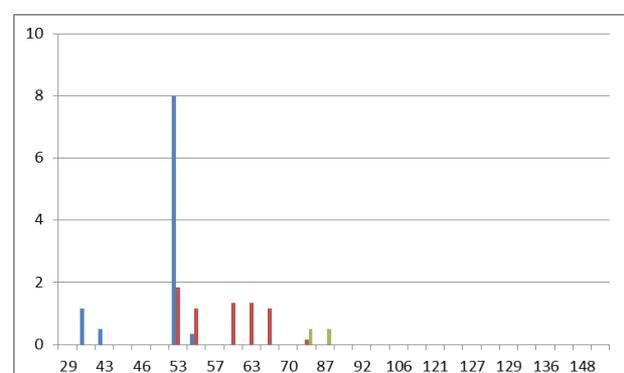
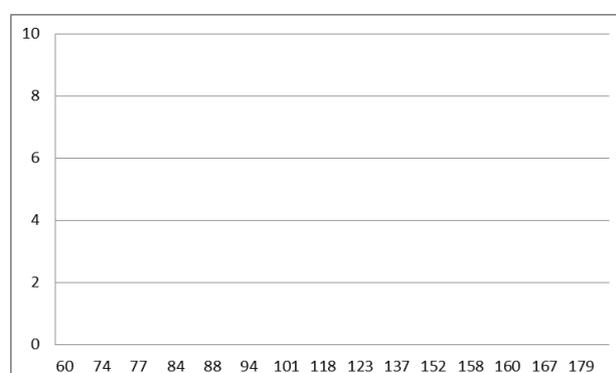
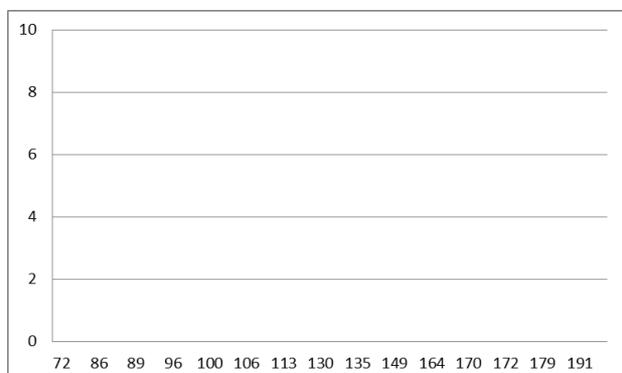
← Days expose to light →

Clone 51

1.6 Months @ ~6°C

2.5 Months @ ~6°C

3.5 Months @ ~6°C



← Days expose to light →



Experiment 1B: Effect of temperature and photoperiod on adult emergence

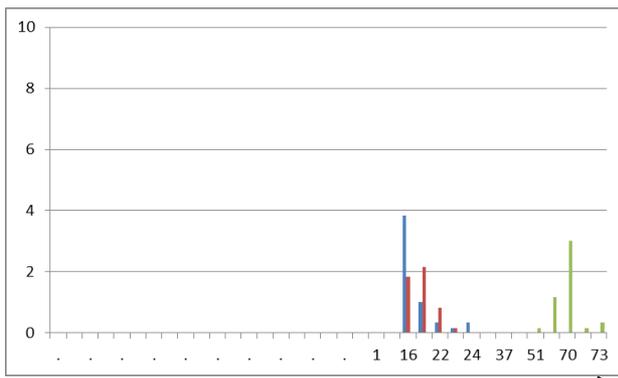
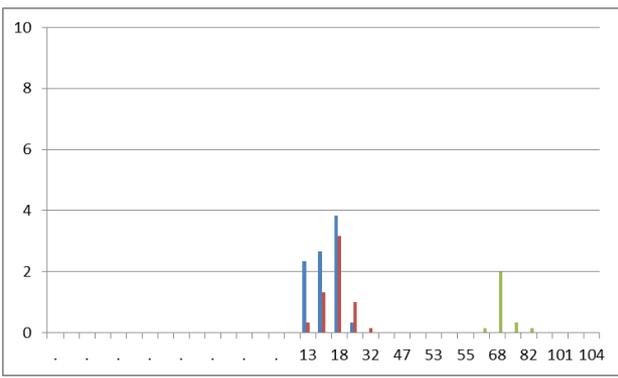
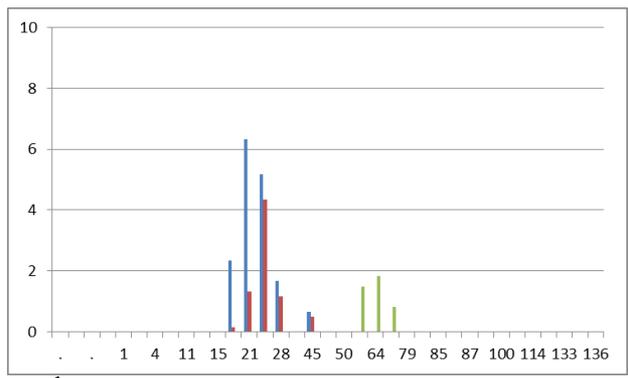
- Males (*Megastigmus*)
- Females (*Megastigmus*)
- M & F (Parasitoids)

Clone 32

4.5 Months @ ~6°C

5.5 Months @ ~6°C

6.5 Months @ ~6°C



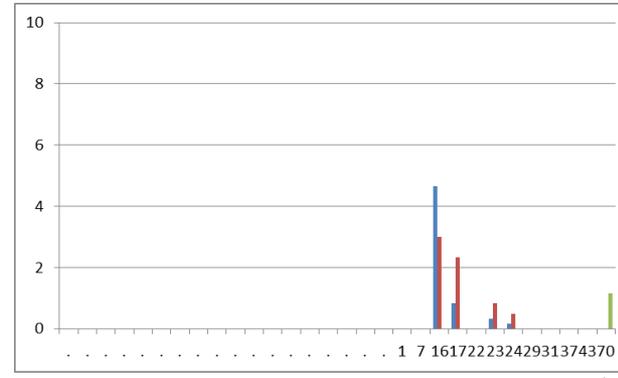
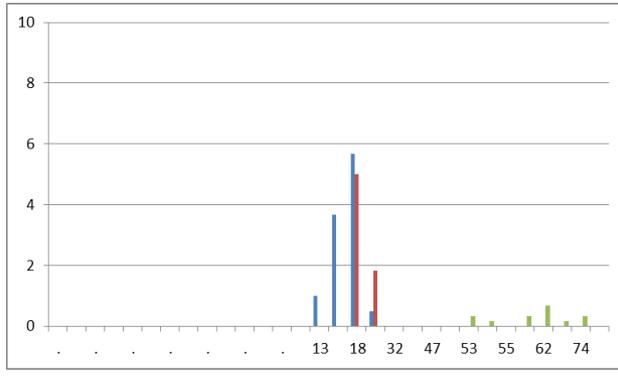
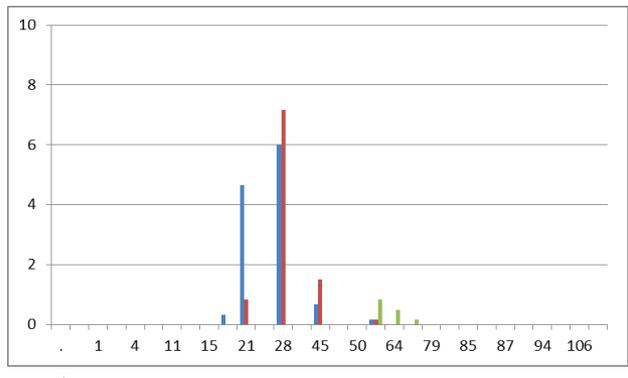
Days expose to light

Clone 51

4.5 Months @ ~6°C

5.5 Months @ ~6°C

6.5 Months @ ~6°C



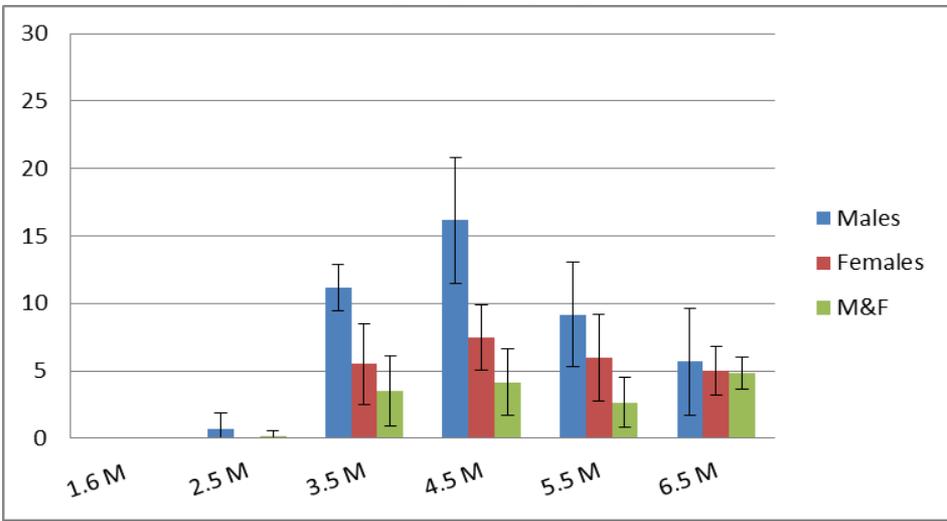
Days expose to light

Experiment 1B: Effect of temperature and photoperiod on adult emergence

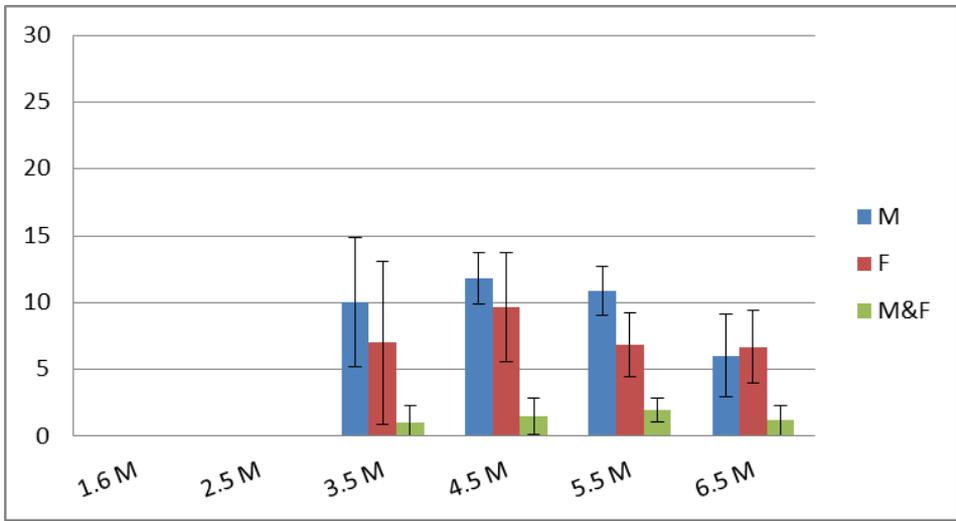


Percentage of adults after ~ 8 Months
(Different cold treatments and days exposed to light)

Clone 32



Clone 51



- Males (*Megastigmus*)
- Females (*Megastigmus*)
- M & F (Parasitoids)

Looking ahead...



- Complete actual data (emergence, diapause, body size)
- Examine chalcid seed wasp life cycle (compare with FF zygotic embryo development)
- Confirm infestation patterns (compare with previous data)
- Study the relation between infestation patterns and embryo quality
- Study the relation between infestation and embryo abortion



Acknowledgments



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Christmas Tree Genetics
and Breeding



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Genetics Department at NC State.



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Entomology - NCSU Plant Disease
and Insect Clinic



Dr. Robert Jetton
Gene Conservation and Forest
entomology/pathology



Joe Freeman
Christmas tree grower.
He founded Mistletoe
Meadows in 1988.

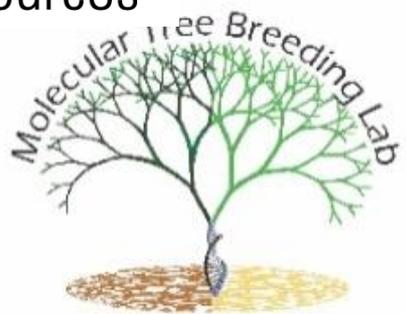


Anne Margaret Braham
Research Spec./Christmas Tree
Genetics



College of
Natural Resources

North Carolina's Premium Fraser
seed orchard cooperative
(NCFFS Coop)





Thank you for your attention!

Experiment 1B: Effect of temperature and photoperiod on adult emergence



Clone 32

Cold-NL treatment (6°C)		M	F	M&F	M/F	M/F ratio	M/M&F	F/M&F
2.5	DL	63	0	70	(-)	(-)	7	(-)
	Adults	1	0	1				
3.5	DL	22	22	59	0	4	37	37
	Adults	8	2	53				
4.5	DL	18	18	59	0	14	41	41
	Adults	14	1	9				
5.5	DL	13	13	60	0	7.0	47	47
	Adults	14	2	1				
6.5	DL	16	16	51	0	2.1	35	35
	Adults	23	11	1				

Clone 51

Cold-NL treatment (6°C)		M	F	M&F	M/F	M/F ratio	M/M&F	F/M&F
3.5	DL	42	53	80	11	0.6	38	27
	Adults	7	11	3				
4.5	DL	18	21	59	3	0.4	41	38
	Adults	2	5	5				
5.5	DL	13	18	53	5	0.2	40	35
	Adults	6	30	2				
6.5	DL	16	16	70	0	1.6	54	54
	Adults	28	18	7				