UCCE Sacramento Valley Olive Day
Orland, CA, April 12, 2011

Olive Fly Research Update

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Olive Fruit Fly - Olive Cultivars

Preference and larval performance - Wolfskill

Hannah Burrack, currently Assistant Professor of Entomology, North Carolina State University

Burrack, H. J. and F.G. Zalom. 2008. Olive fruit fly (Diptera: Tephritidae) ovipositional preference and larval performance in several commercially important olive varieties in California. J. Econ. Entomol. 101(3): 750-758.

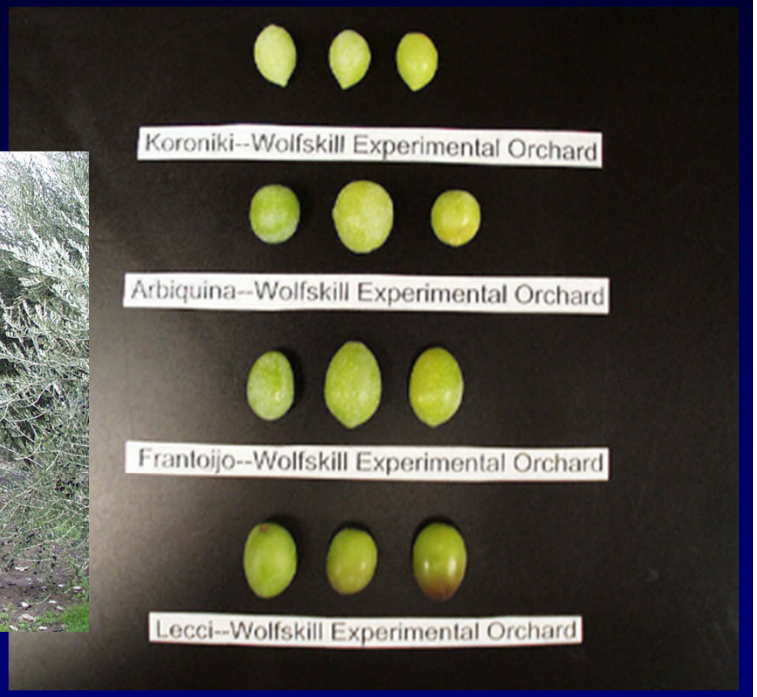
Olive Fruit Fly - Olive Cultivars

Preference and larval performance - Wolfskill

USDA-NCGR - 7 varieties

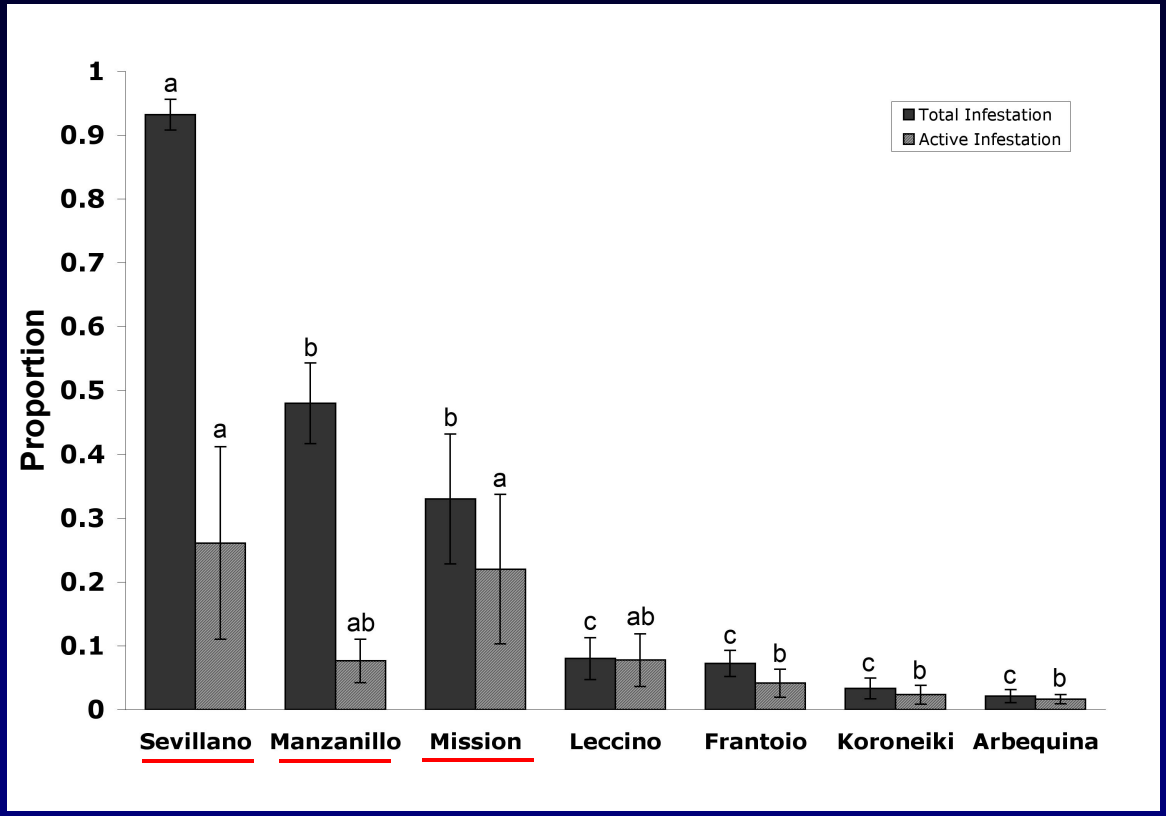
- Koroniki
- Arbiquina
- Frantoijo
- Lecci
- Manzanillo
- Mission
- Sevillano

1 month



Olive Fruit Fly - Olive Cultivars

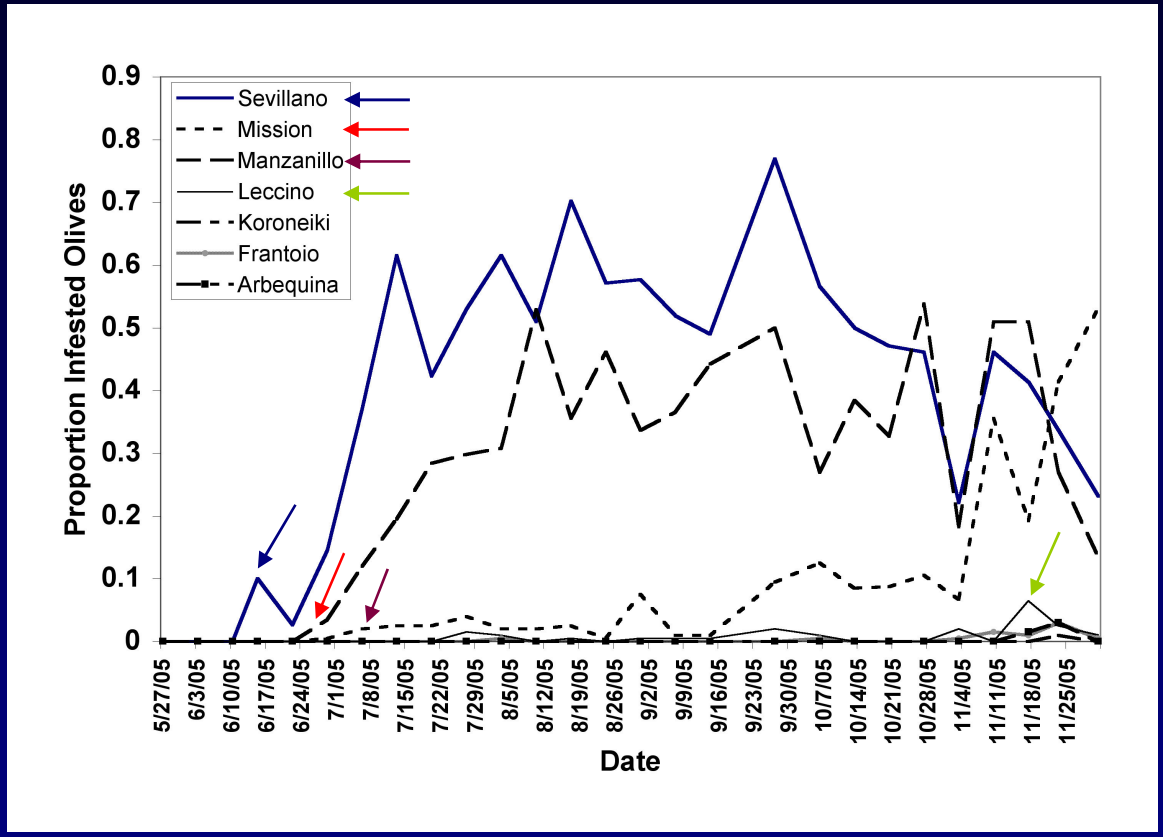
Natural field infestations



Mean±SE proportion of olives with stings and olives with exit holes following one month incubation; collected weekly during the 2003–2004 growing seasons

Olive Fruit Fly - Olive Cultivars

Natural field infestations



Proportion of olives with stings at USDA-NCGR throughout the 2005 field season.

Conclusion: infestation related to fruit size, ~ 1.4 mm

Olive Fruit Fly - Olive Cultivars

Laboratory infestations for performance - measurements

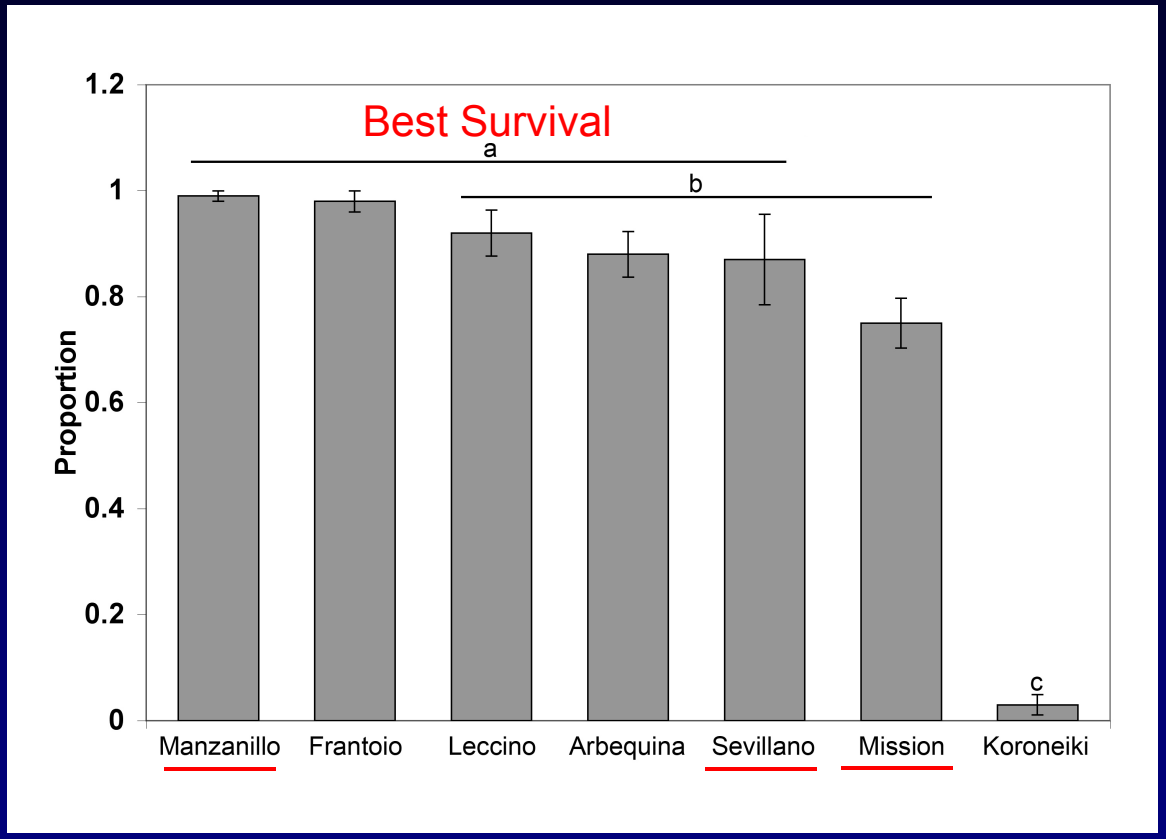
- Proportion of eggs developing to pupae (survival)
- Pupal mass (related to adult fitness)
- Developmental time

2005 - Four replicates of 25 olives of each of the varieties were infested by 100 gravid female *B. oleae* over the course of 1 week

2006 - Four replicates of 50 olives of each of the varieties were infested by 100 gravid female *B. oleae* over the course of 1 week

Olive Fruit Fly - Olive Cultivars

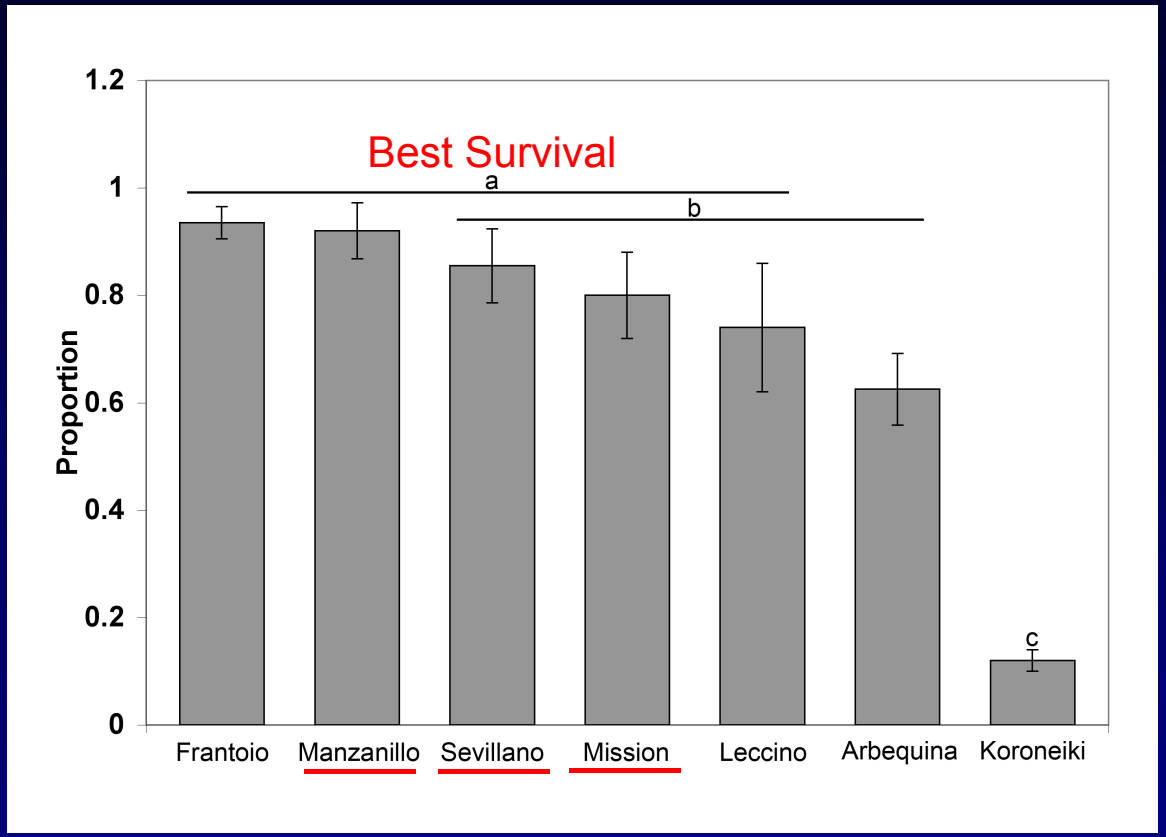
Laboratory infestations for performance



Proportion of eggs developing to pupae in laboratory performance assay, 2005.

Olive Fruit Fly - Olive Cultivars

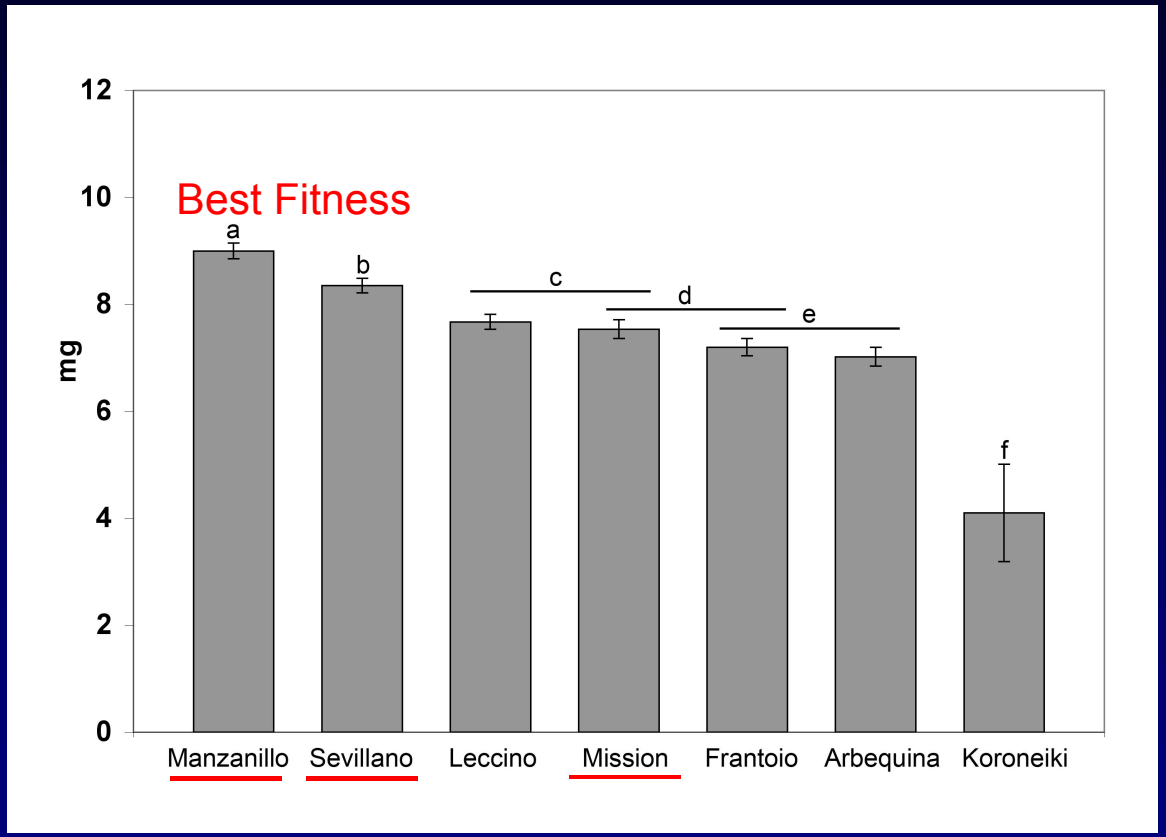
Laboratory infestations for performance



Proportion of eggs developing to pupae in laboratory performance assay, 2006.

Olive Fruit Fly - Olive Cultivars

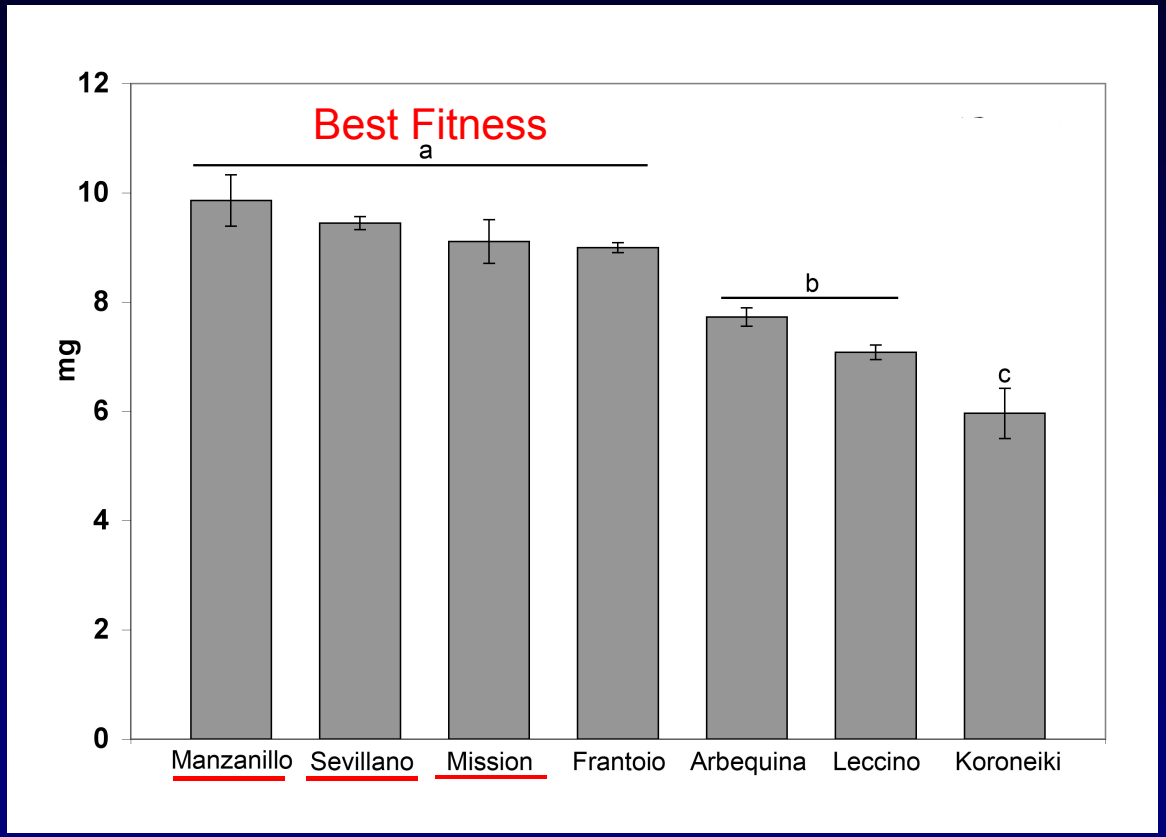
Laboratory infestations for performance



Mean ± SD pupal mass by variety, 2005.

Olive Fruit Fly - Olive Cultivars

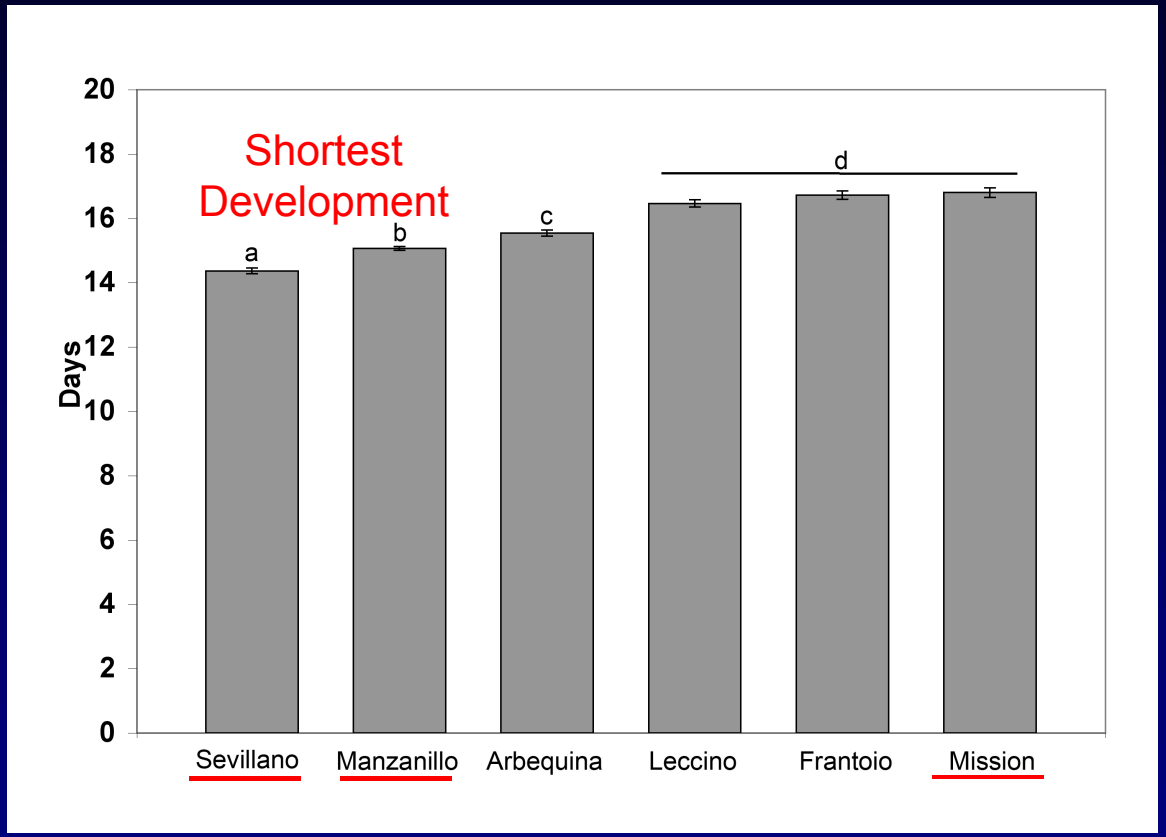
Laboratory infestations for performance



Mean ± SD pupal mass by variety, 2006.

Olive Fruit Fly - Olive Cultivars

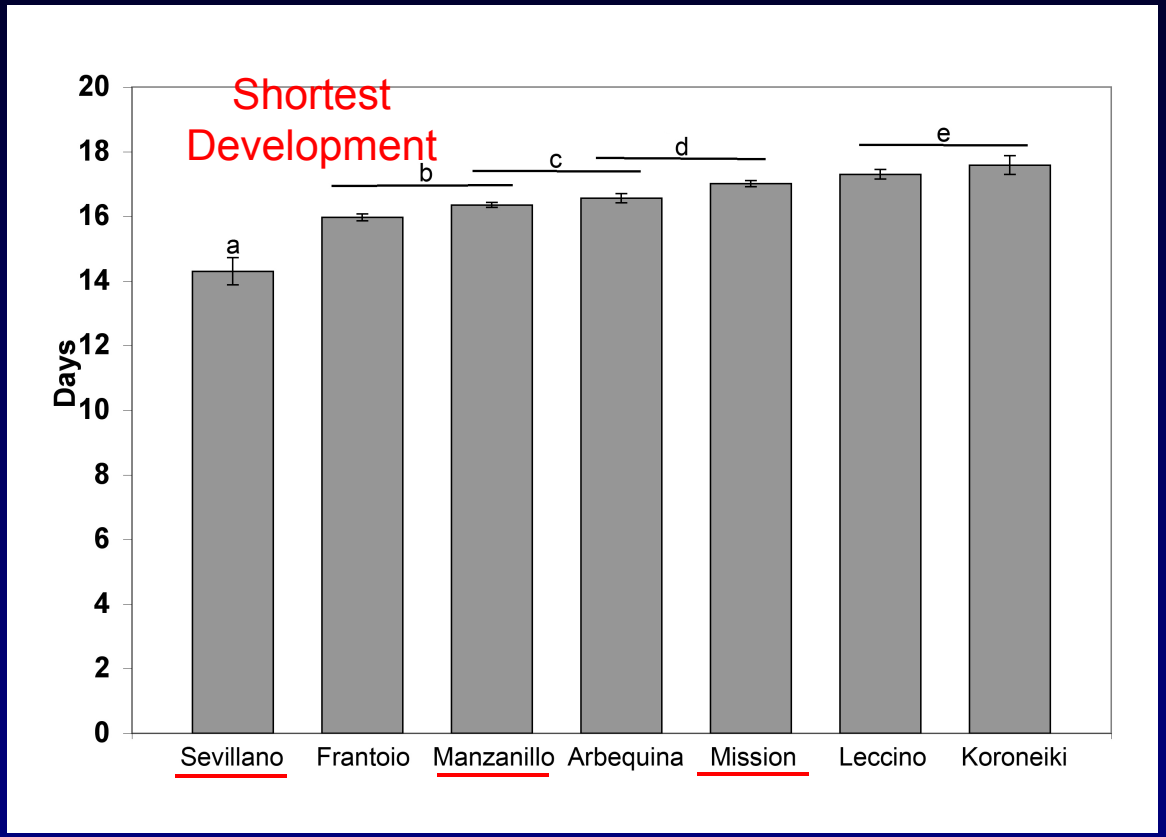
Laboratory infestations for performance



Mean ± SD larval development time by variety, 2005.

Olive Fruit Fly - Olive Cultivars

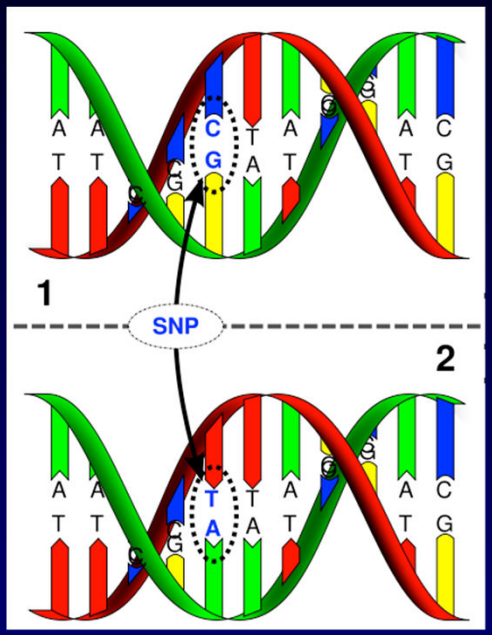
Laboratory infestations for performance



Mean ± SD larval development time by variety, 2006.

Olive Fruit Fly - Origin

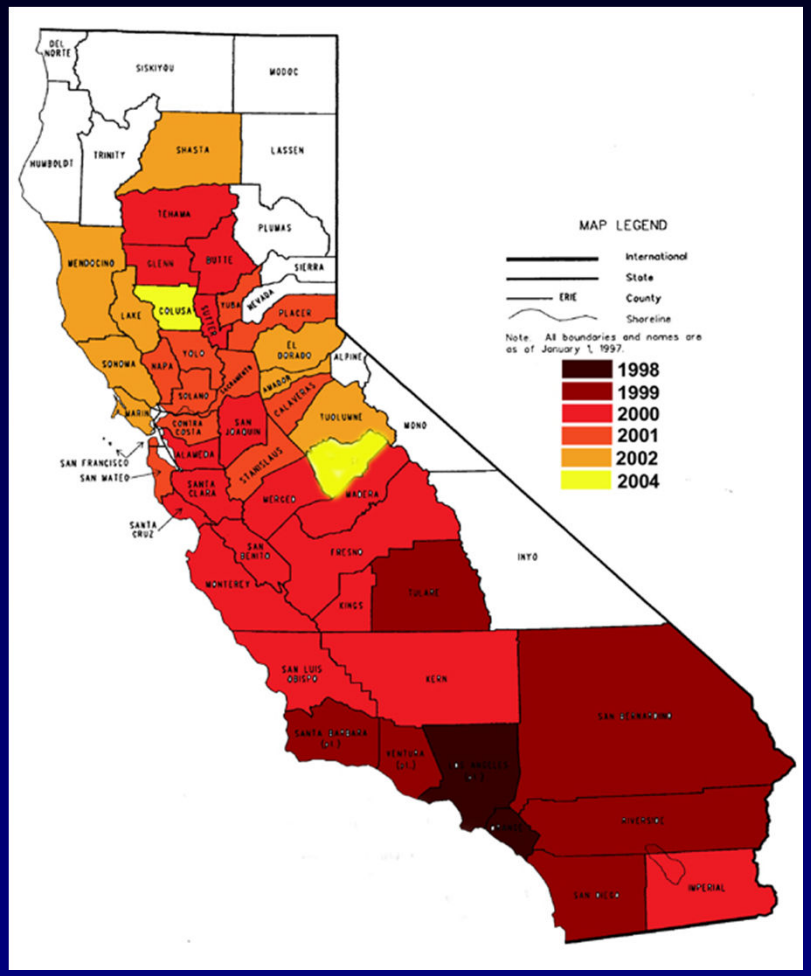
Study of California and European populations using 10 microsatellite markers including genes for organophosphate resistance.



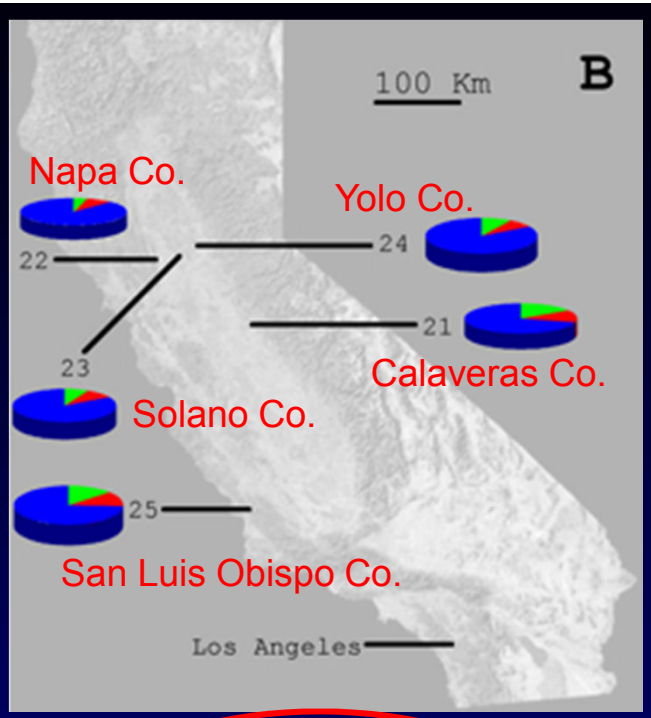
Zygouridis, N.E., A.A. Augustinos, F.G. Zalom, and K.D. Mathiopoulos. 2009. Analysis of olive fly invasion in California based on microsatellite markers. Heredity 102(4): 402-12.

Olive Fruit Fly - Origin

Invasions such as those of the olive fly are often characterized by a unique set of demographic and genetic features depending on the number of colonizing individuals and the rapidity of growth and spread of the new population.

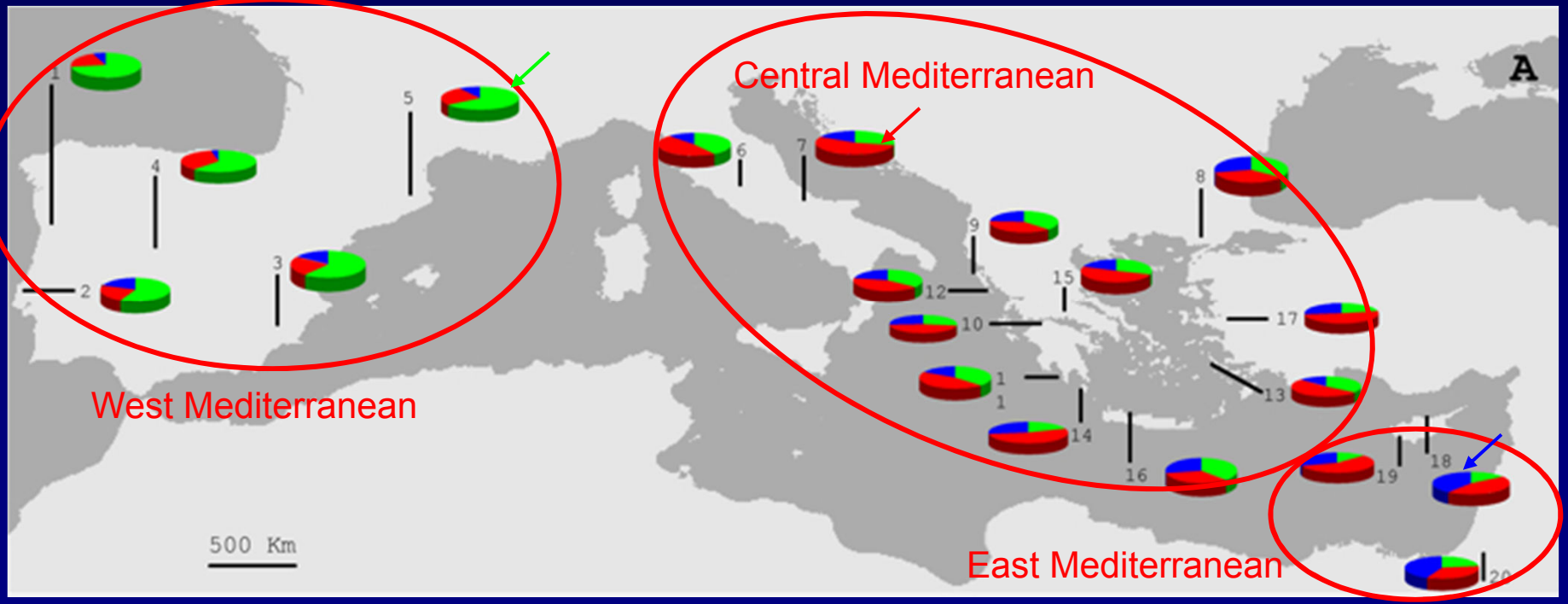


Few colonizing individuals = *less* genetic diversity
Rapid growth and spread = *less* of a bottleneck (similar)



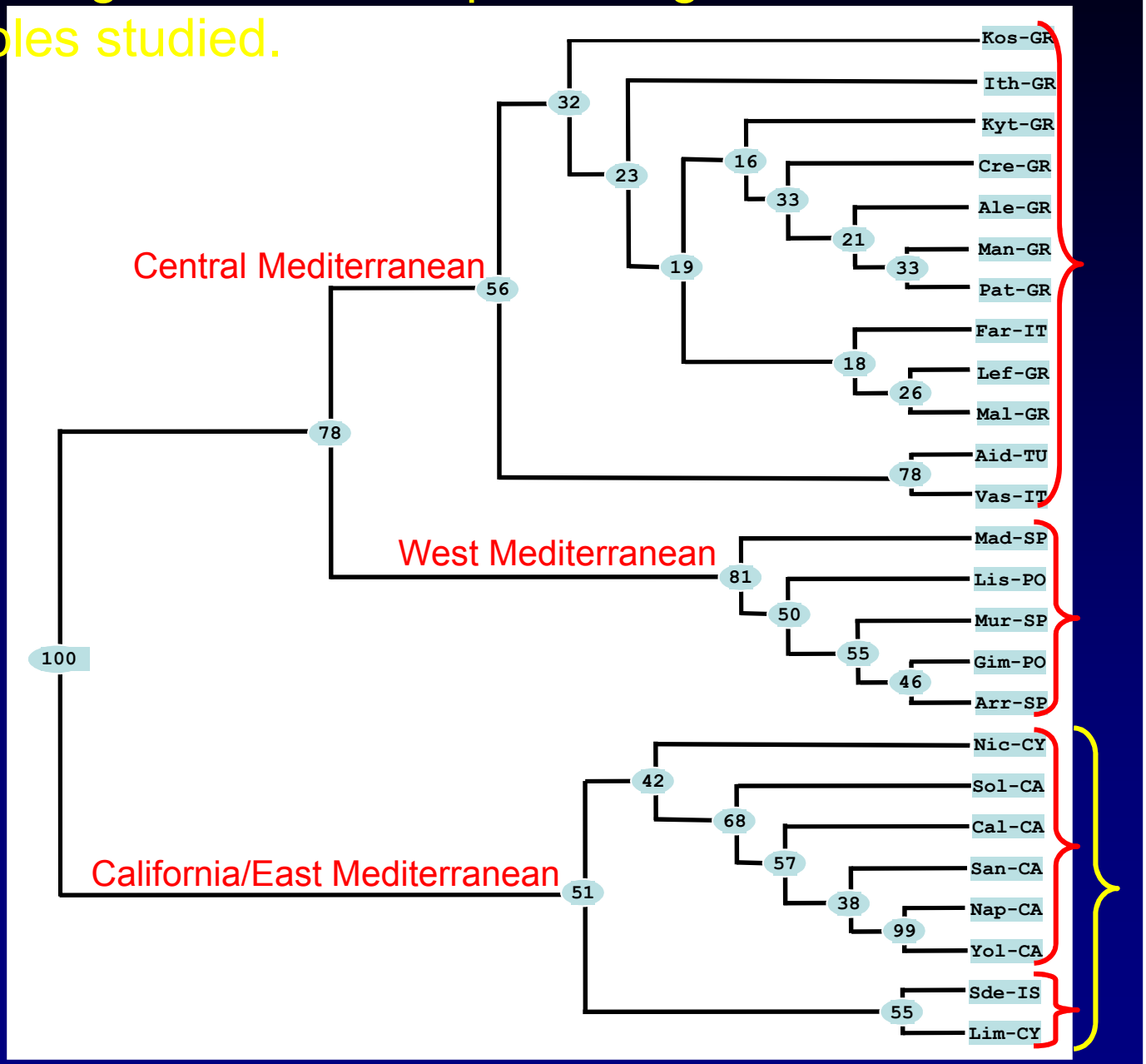
Collection sites and geographical representation of the clustering outcome, assuming three hypothetical clusters

Colored components in each pie show the co-ancestry distribution of individuals in each of the 3 clusters.



Dendrogram showing the relationships among the twenty-five samples studied.

TU=Turkey,
IS=Israel,
CY=Cyprus,
GR=Greece,
IT=Italy,
SP=Spain,
PO=Portugal,
CA=California



Assignment of groups of individuals of California samples to the three described genetic groups plus Israel, according to GeneClass 2.0 software

Samples	Reference groups							
	1	%	2	%	3	%	4	%
Cal-CA	Cypriot	99.828	Israeli	0.165	Central Med	0.007	Iberian	0.000
Nap-CA	Cypriot	77.477	Israeli	22.523	Central Med	0.000	Iberian	0.000
Sol-CA	Israeli	100.000	Cypriot	0.000	Central Med	0.000	Iberian	0.000
Yol-CA	Israeli	99.993	Cypriot	0.007	Central Med	0.000	Iberian	0.000
San-CA	Israeli	100.000	Cypriot	0.000	Central Med	0.000	Iberian	0.000

Olive Fruit Fly - Spinosad resistance

GF-120 Naturalyte Insecticide registered in 2004

Olive Fruit Fly - Spinosad resistance

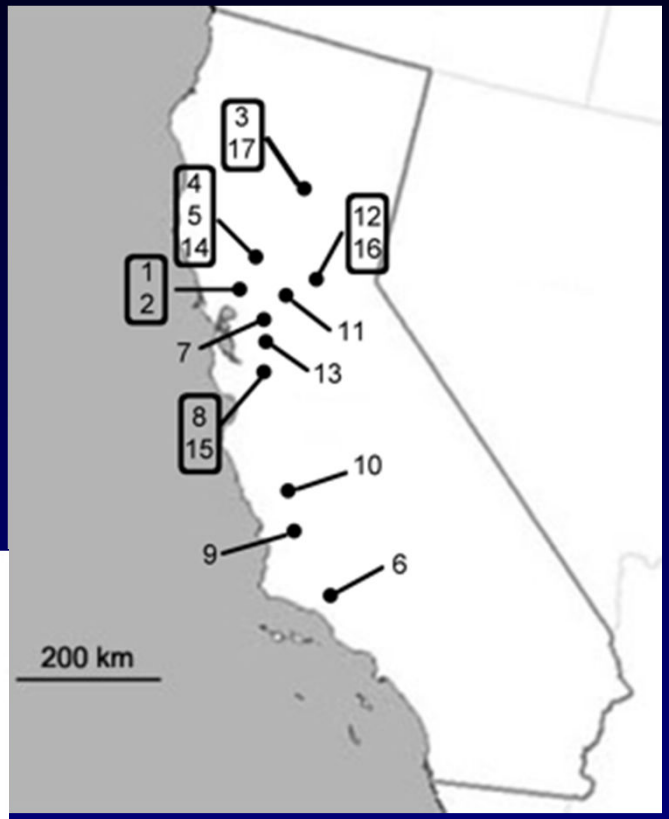
Topical Bioassay - 2007
Ingestion bioassay - 2008

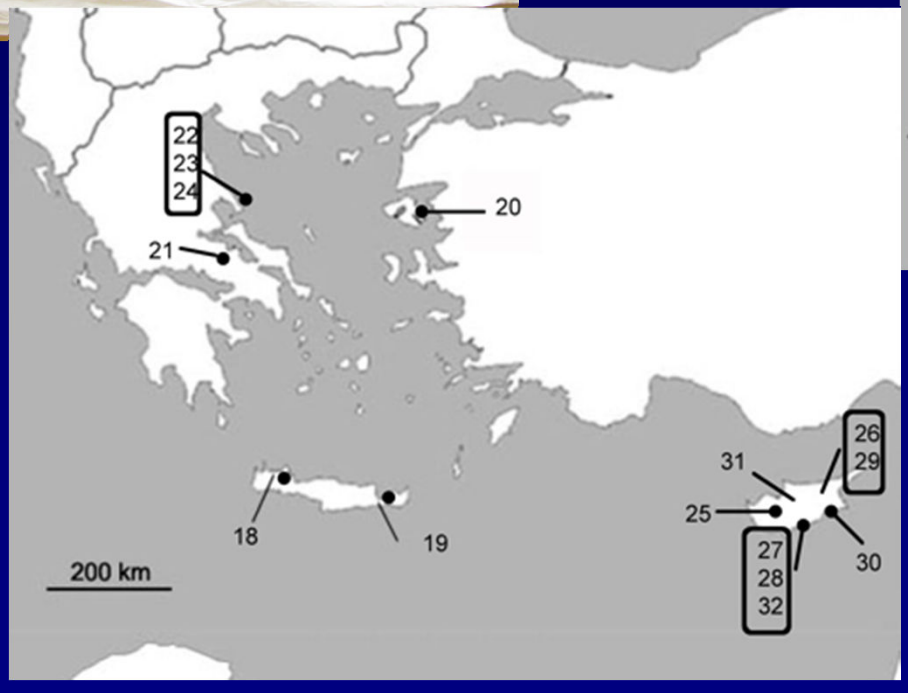
Comparison of flies reared from field infested olives from sites in Greece, Cyprus and California to a susceptible control = Demokritos laboratory strain (has not been exposed to insecticides for 40 years)

* Probit analysis with 4 to 7 doses.

Kakani, E.G. , N.E. Zygouridis, K.T. Tsoumani, N. Seraphides, F.G. Zalom and K.D. Mathiopoulos. 2010. Spinosad resistance development in wild olive fly populations in California. Pest Management Science. 66(4): 447-453.

Olive Fruit Fly - Spinosad resistance





Collection sites

Olive Fruit Fly - Spinosad resistance

Correspondence between contact and ingestion bioassay protocols.

Population	LD_{50}-C (ng/fly)	LC_{50}-I (ng/µl)	LD_{50}-C / LC_{50}-I
Lab strain	4.98	0.32	15.56
Ohlone	51.93	3.66	14.19
Silverado	29.61	1.82	16.27
Tux	22.47	1.43	15.71
Solano	21.92	1.38	15.88
		Average	15.52

LD_{50}-C: Lethal dose by topical bioassay - 2007
LC_{50}-I : Lethal concentration by ingestion bioassay - 2008

Olive Fruit Fly - Spinosad resistance

California Location	# of apps	RR
Sonoma 1-CA	69	13.28
Ohlone-CA ←	49	11.44
Sonoma 2-CA	60	10.69
Butte-CA	69	10.09
Stags Leap-CA	66	9.13
Silverado-CA	66	5.69
Ventura-CA*	43	5.50
Tux-CA	34	4.47
Chania-GR*	25	4.34
Solano-CA	16	4.31
Livermore-CA	0	4.03
Hudson-CA	0	3.78
Paso Robles-CA	13	3.69
San Luis Obispo-CA	17	3.16
San Jose-CA*	0	2.78
Davis-CA	0	2.47
UC Davis-CA	3	1.81
Oroville-CA	0	1.47

Greece Location	# of apps	RR
Aghios Nicolaos-GR*	8	3.09
Promiri-GR*	0	3.06
Livadia-GR	3	1.47
Drakia-GR	0	1.13
Argalasti-GR	0	0.94
Mytilini-GR	2	0.38

Cyprus Location	# of apps	RR
Nicosia-CY*	0	1.31
Pafos-CY*	3	1.28
Limassol-CY*	0	1.19
Katokopia-CY*	0	1.16
Mazotos-CY*	0	1.00
Dromolaxia-CY*	0	0.69
Evrychou-CY	0	0.19
Zygi-CY	0	0.16

LAB STRAIN	0	1.00

Olive Fruit Fly - Spinosad resistance

Future research

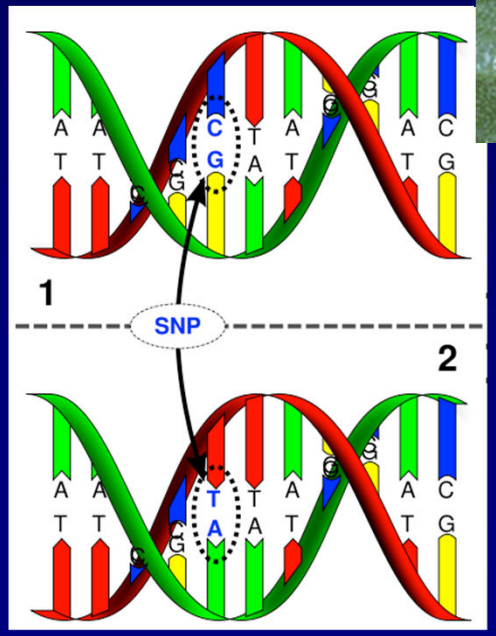
How localized is spinosad resistance?

Becky Wheeler, UC Davis

Establish spinosad-resistant lab colony

Identify genetic sites for spinosad resistance…

Kostas Mathiopoulos, Uth



Olive Fruit Fly Research -

Some incomplete and unpublished studies

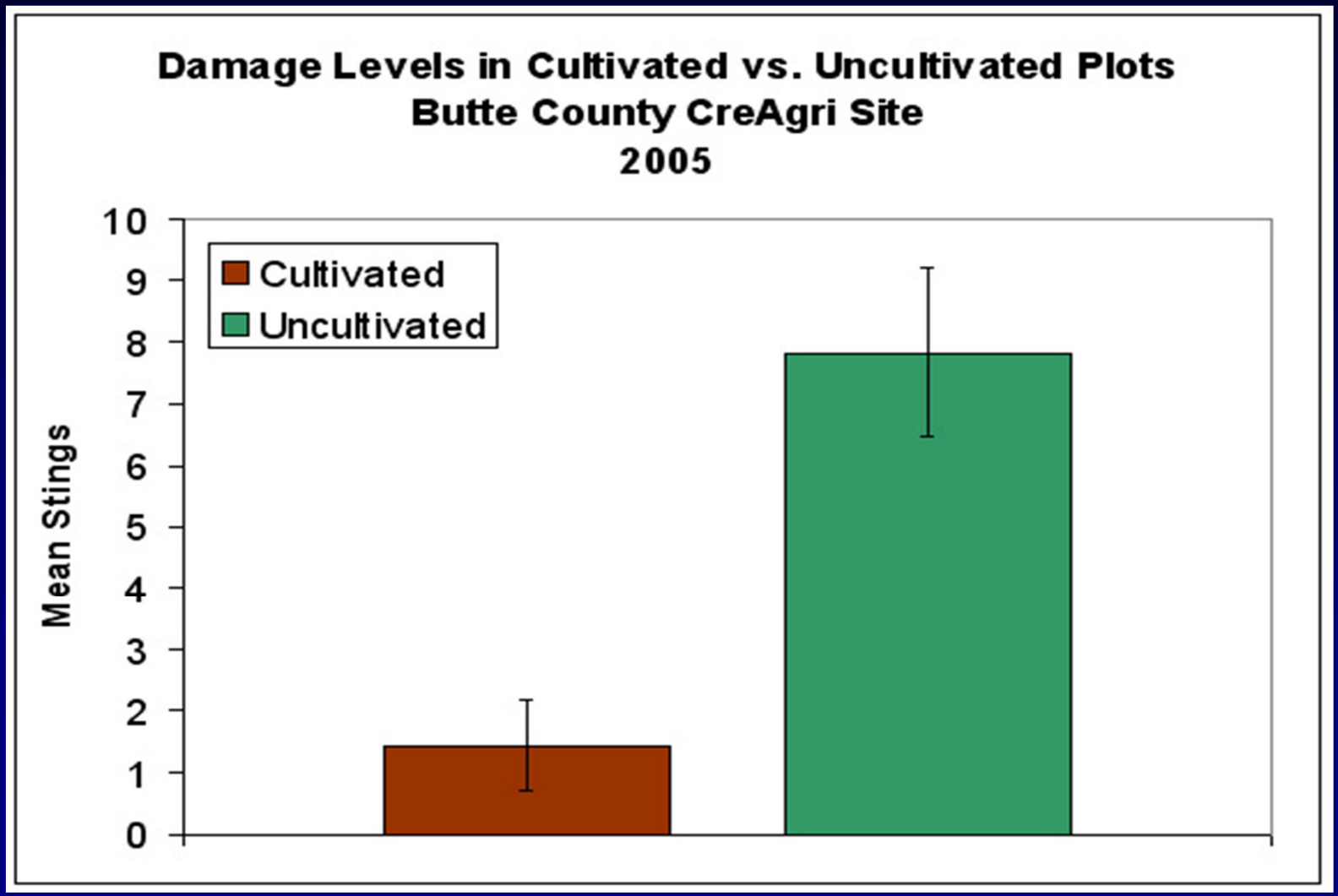
Cultivation as control - Burrack and Connell
Olive fly movement - Burrack
Evaluation of pest management districts - Cobourne
Olive fly damage functions - Cobourne
Mating behavior - Villamil
Yeast associations - Boundy-Mills and Burrack

Olive Fruit Fly Management - Cultivation?

- Site: CreAgri Olive Orchard, Palermo, Butte County, CA
- Treatments: (3 reps; 144 trees each)
  - Tilled sites
  - Untilled sites
- Tillage:
  - Tilled sites were cultivated 2x's: During the weeks of June 22 and August 12, 2005
  - Tillage depth was ideally 4", but depth varied
- Evaluation:
  - 100 olives collected from 4 trees in each replicate
  - Stings and exit holes counted

Olive Fruit Fly Management - Cultivation?

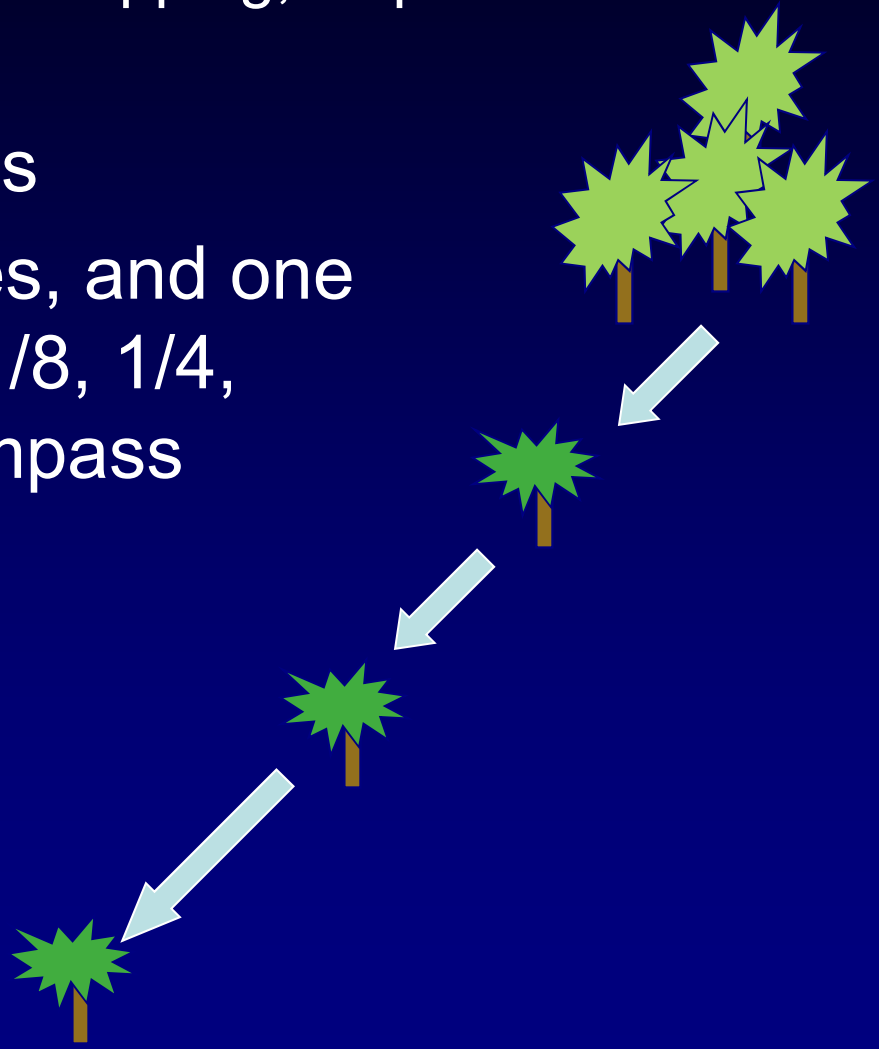
Results



Olive Fruit Fly - Movement

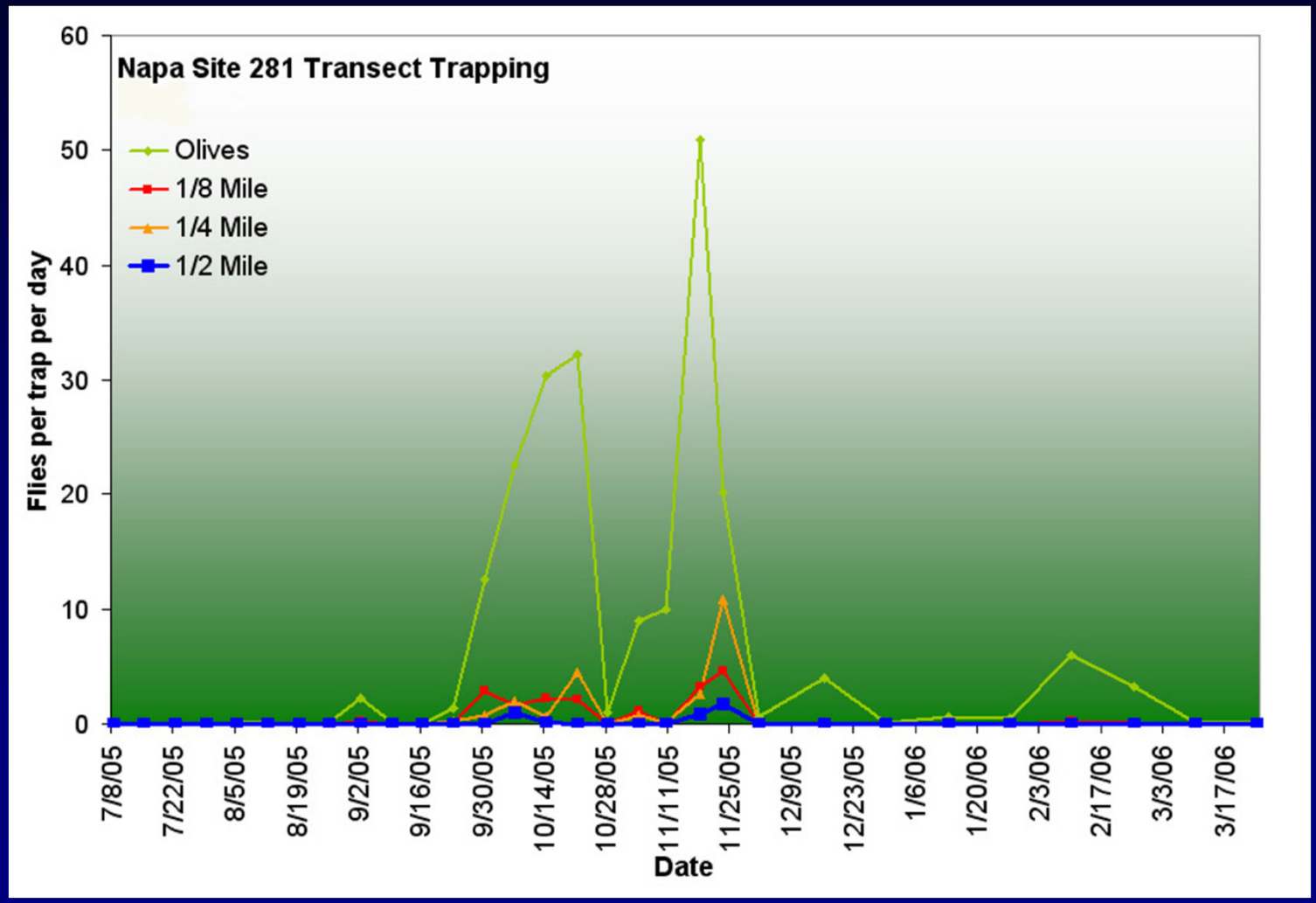
Transect trapping - Non-host trapping, Napa and Solano Co.

- Isolated olive plantings
- 2 traps placed in olives, and one each at distances of 1/8, 1/4, and 1/2 mile in all compass directions



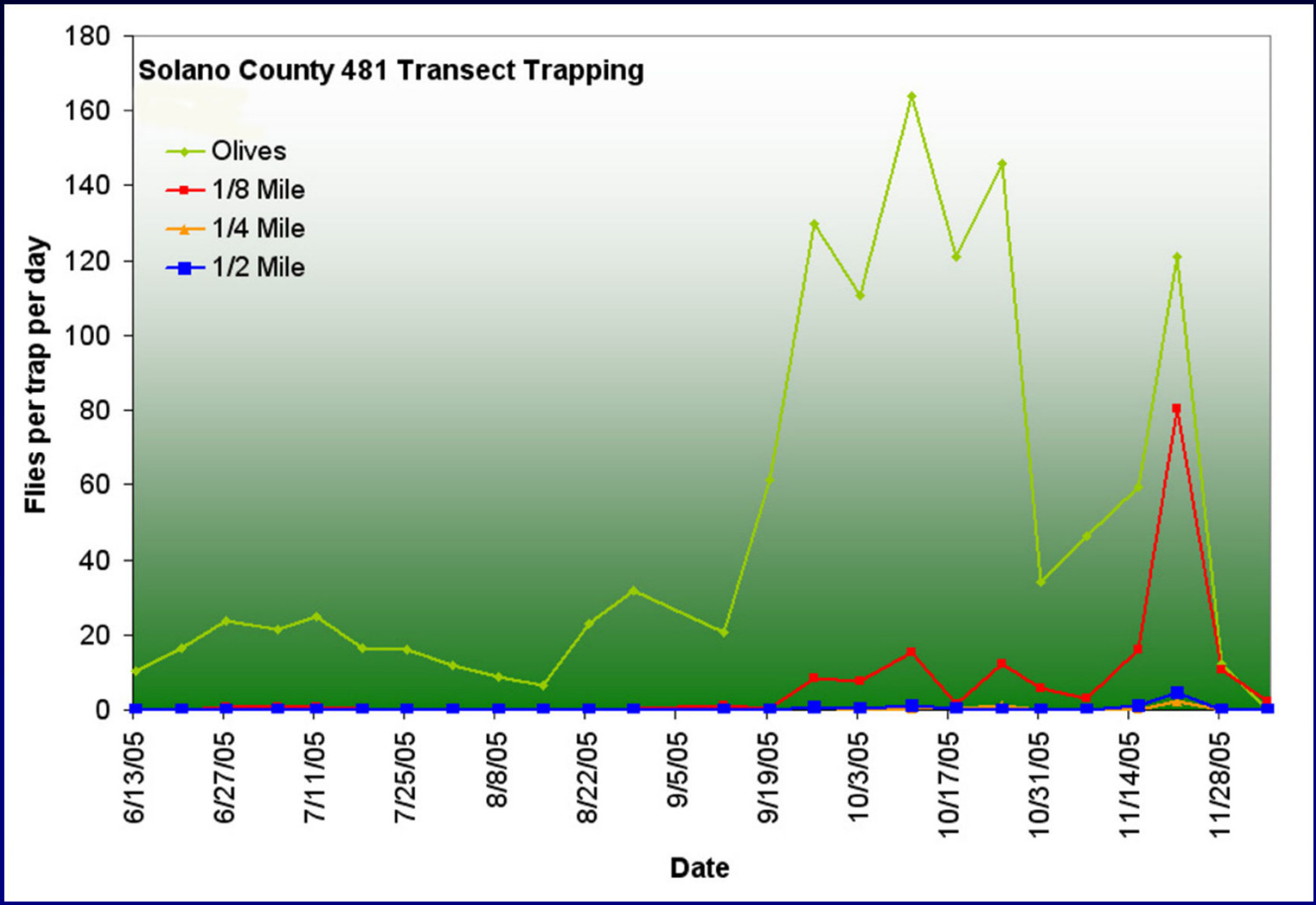
Olive Fruit Fly - Movement

Transect trapping - Non-host trapping, Napa Co.



Olive Fruit Fly - Movement

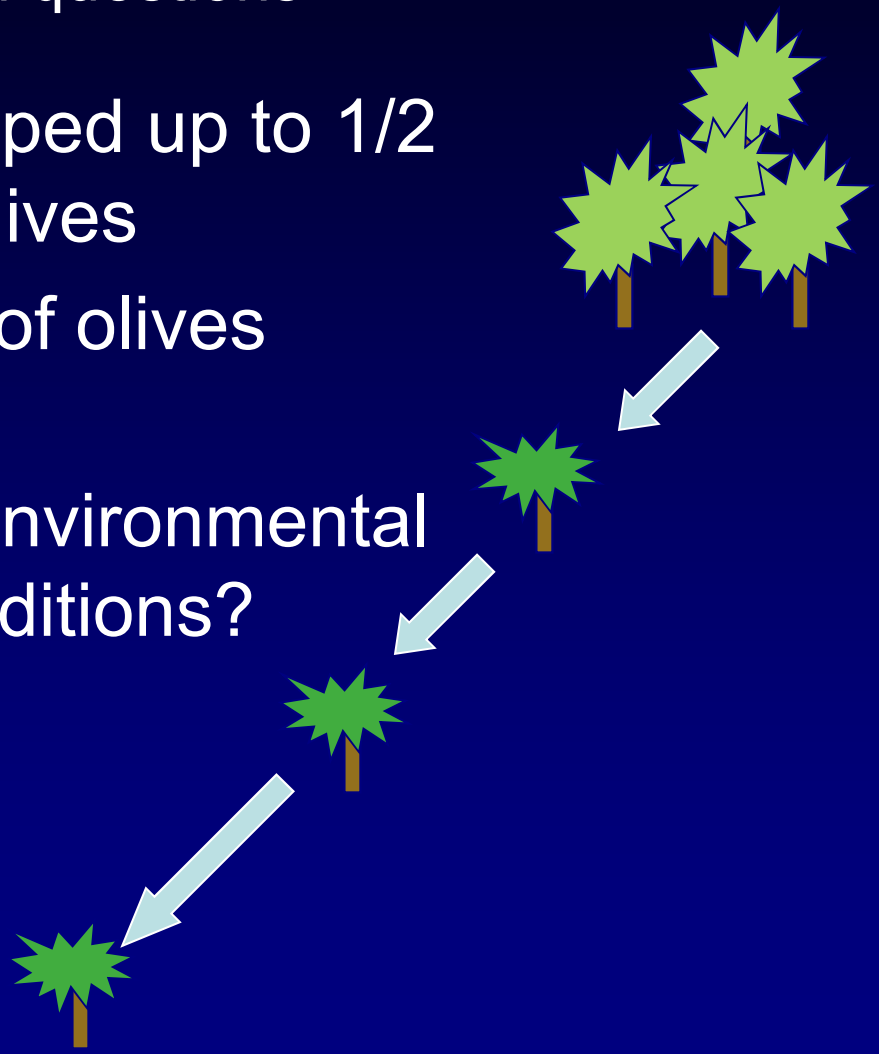
Transect trapping - Non-host trapping, Solano Co.



Olive Fruit Fly - Movement

Preliminary conclusions and questions

- Olive flies can be trapped up to 1/2 mile away from any olives
- Is movement outside of olives seasonal?
- Is movement due to environmental or developmental conditions?



USDA-ERS PREISM Grant, 2007-09 (Co-investigator with Rachael Goodhue)

Dissertation Title - "Encouraging cooperation between commercial producers and residential users of an invasive species host: designing collective pest management institutions for the olive fruit fly in California."

Dissertation in Agricultural and Resource Economics completed June, 2009

Kelly Cobourne, currently Assistant Professor of Economics, Boise State University

USDA-ERS PREISM Grant, 2007-09

Kelly's dissertation includes damage function estimates for olive fruit fly

Cobourn, K.M., R.E. Goodhue, J.C. Williams, and F.G. Zalom. 2008. Pests and agricultural commodity losses: evaluating alternative approaches to damage function estimation. (Selected paper for presentation at the Agricultural and Applied Economics Association Annual Meeting, July 27-29, Orlando, FL; http://purl.umn.edu/6530)

Olive Fruit Fly - Mating behavior

Dissertation project - Soledad Villamil

Observation - Males are present and mated females occur at some level throughout the year, but the males only appear responsive to the spiroketal pheromone in the Spring and Fall.

Why?

Olive Fruit Fly Yeast-Insect Interactions - a Model for Tephritids

Commercial torula yeast (*Candida utilis*)/borax pellets are more effective in attracting olive fruit flies in the field than ammonia or pheromone-based lures. However, only two of 900 known yeast species have been evaluated for use as insect lures.

Studies of *Drosophila/*yeast ecology has shown that flies are significantly more attracted to yeasts of familiar species. If this is true for Tephritids also, then yeasts associated with flies or infested olives may be superior baits.

Olive Fruit Fly Yeast-Insect Interactions - a Model for Tephritids

Collaboration with Kyria Boundy-Mills, UC Davis

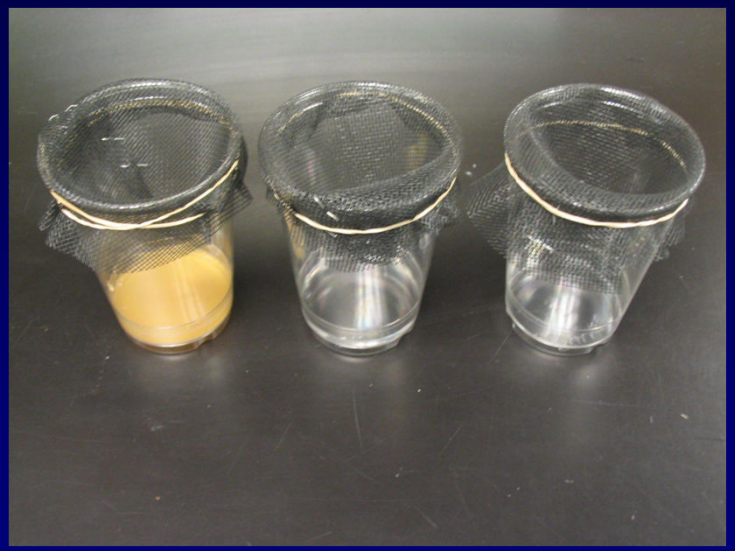
(rose bengal-chloramphenicol agar)

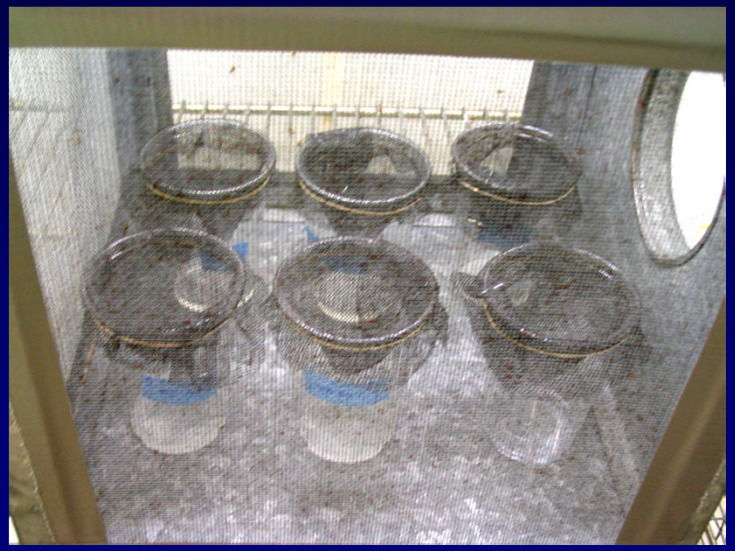
We have isolated and identified over 300 yeasts belonging to 40 different species from olive flies and infested olives, demonstrating that yeasts are abundant in larvae and adults

Choice tests

Methods

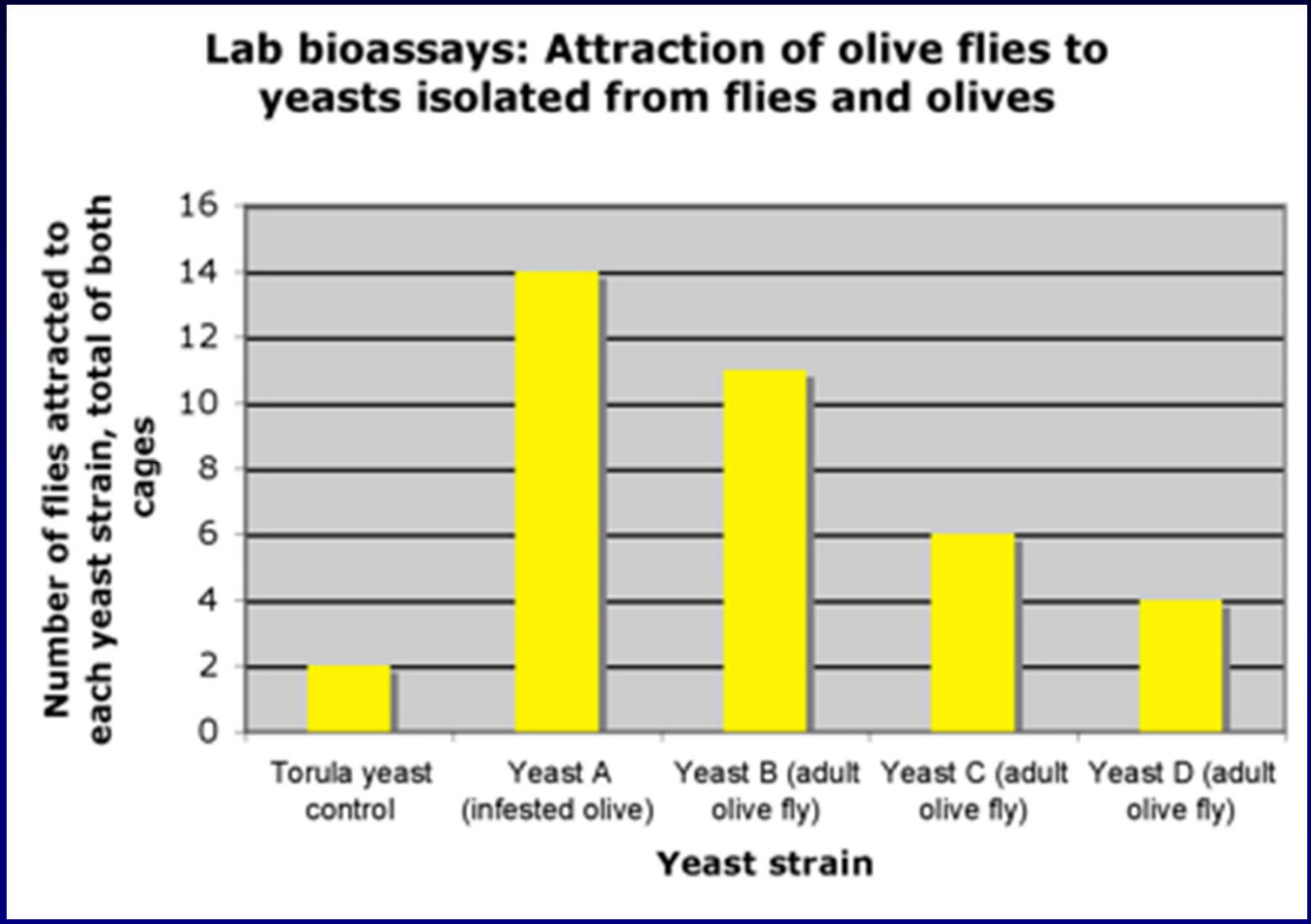
8 mL of 4- to 5-day yeast cultures were placed in a cup, covered with a mesh cone with a 1-cm hole in the center.





Five experimental yeast cultures and one control yeast culture (torula yeast *Candida utilis* strain 75-33) were randomly placed in two population cages, each containing 40 male and 40 female olive flies; counted hourly for 7 hours.

Over 130 yeast species were tested in choice tests for attraction of olive flies. Of these, 15 yeast strains appeared to attract flies as well or better than torula yeast.



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