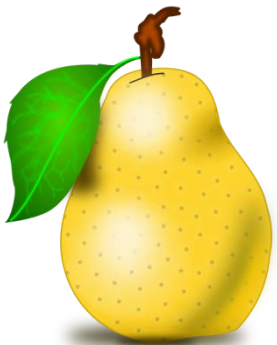




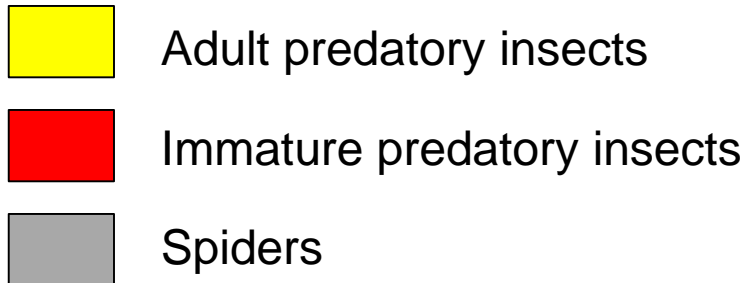
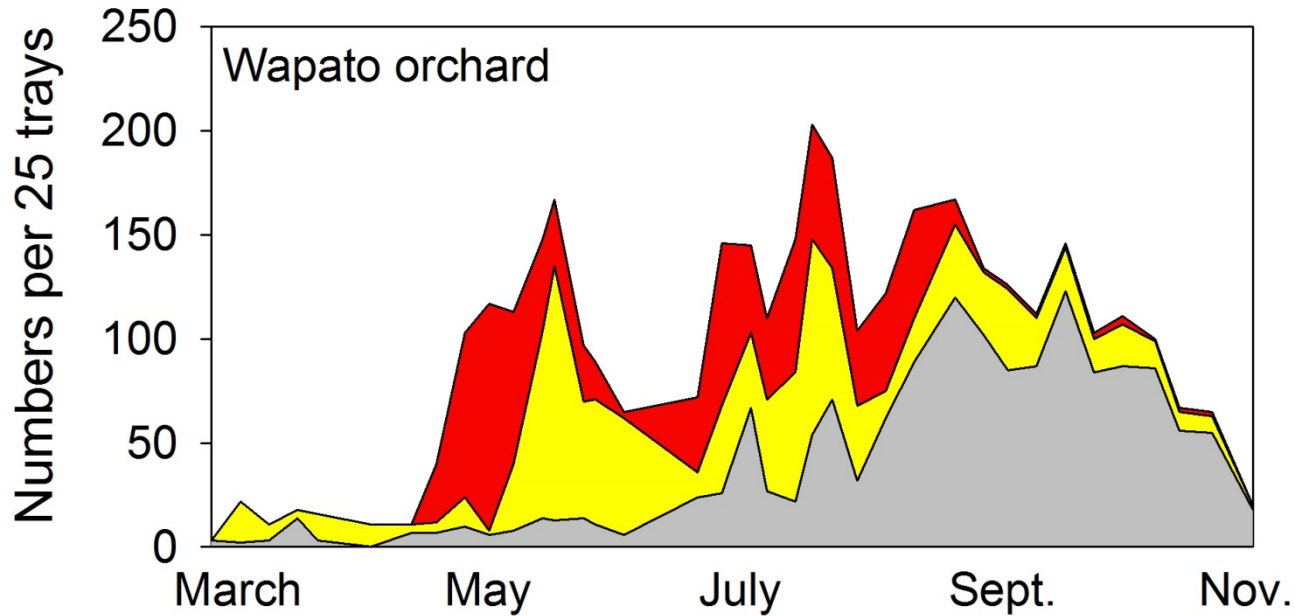
Key natural enemies: life histories and pests controlled

David Horton

USDA-ARS, Wapato, WA



Example of seasonal trends



Hidden diversity: canopy arthropods

COCCINELLIDAE

Adalia bipunctata
Anatis rathvoni
Brumoides septentrionis
Chilocorus stigma
Coccinella novemnotata
Coccinella septempunctata
Coccinella transversoguttata
Cycloneda polita
Harmonia axyridis
Hippodamia apicalis
Hippodamia caseyi
Hippodamia convergens
Hippodamia tredecimpunctata
Hyperaspis sp.
Hyperaspis lateralis
Hyperaspis postica
Hyperaspis quadrivittata
Microweisea misella
Mulsantina picta
Psyllobora vigintimaculata
Scymnus sp.
Stethorus punctum



HETEROPTERA

ANTHOCORIDAE
Anthocoris antevolens
Anthocoris tomentosus
Orius tristicolor

MIRIDAE

Deraeocoris brevis
Campylomma verbasci
Phytocoris spp.

NABIDAE

Nabis sp.



GEOCORIDAE

Geocoris sp.

PENTATOMIDAE

Brochymena quadripustulata

NEUROPTERA

CHRYSOPIDAE

Chrysopa coloradensis
Chrysopa nigricornis
Chrysopa oculata
Chrysoperla plorabunda
Eremochrysa sp.

HEMEROBIIDAE

Hemerobius neadelphus
Hemerobius ovalis
Hemerobius pacificus
Hemerobius stigma
Micromus sp.

ARANEAE

AGELINIDAE

Hololena nedra

ANYPHAENIDAE

Anyphaena pacifica
 Araneidae
Allophanes sp.
Araneus gemmoides
Araniella displicata

CLUBIONIDAE

Cheiracanthium mildei
Clubiona sp.

DICTYNIDAE

Dictyna bostoniensis
Dictyna coloradensis

GNAPHOSIDAE

Sergiolus sp.

LINYPHIIDAE

Collinsia ksenius
Erigone sp.
Meioneta fillmorana
Spirembolus mundus
Walckenaeria subspiralis

MIMETIDAE

Mimetus hesperus

OXYOPIDAE

Oxyopes scalaris



PHILODROMIDAE

Apollophanes margareta
Ebo sp.
Philodromus cespitum
Philodromus insperatus
Philodromus rufus
Tibellus sp.

SALTICIDAE

Eris sp.
Habronattus sp.
Metaphidippus mannii
Pelegrina aeneola
Pelegrina helenae
Phanias watonus
Phidippus audax
Phidippus comatus
Phidippus johnsoni
Salticus scenicus
Sassacus papenhoei
Sassacus vitis

TETRAGNATHIDAE

Tetragnatha sp.

THERIDIIDAE

Enoplognatha ovata
Theridion murarium
Theridion neomexicanum
Theridion melanurum

THOMISIDAE

Coriarachne utahensis
Misumena vatia
Misumenops lepidus
Xysticus cunctator

Targets of today's presentation

- Will be discussing important species in 5 groups
- Emphasis on predators of aphids and pear psylla
- Apple and pear orchards

Objective: brief “biographies” of select species

- True bugs
- Ladybugs
- Lacewings
- Hoverflies (as a group)
- Spiders (as a group)

Data source for much of today's presentation

V. Jones et al.: SCRI grant

- 10 apple orchards, 2 geographic regions, 2 years
- Organic or “soft” (no OP’s)
- Beat tray samples taken weekly from March into October
- Specimens aspirated from trays for lab processing
- Supplementary observations from pear orchards and native habitats



Approach: species' biographies

- **Seasonal phenology of species:** beat tray sampling of 10 apple orchards
- **Post-winter emergence:** tree bands
- **Wintering in orchards:** tree bands

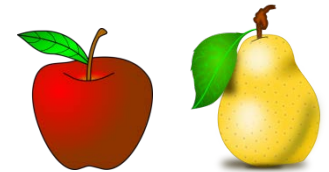


Approach: species' biographies (cont.)

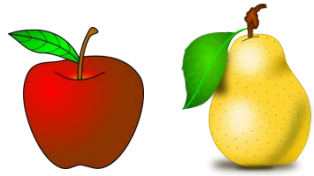
- **Use of non-orchard habitats:** many years of sampling



- **Dietary preferences:** personal observation, assays, literature, and inference



Deraeocoris brevis (Miridae; plant bugs)



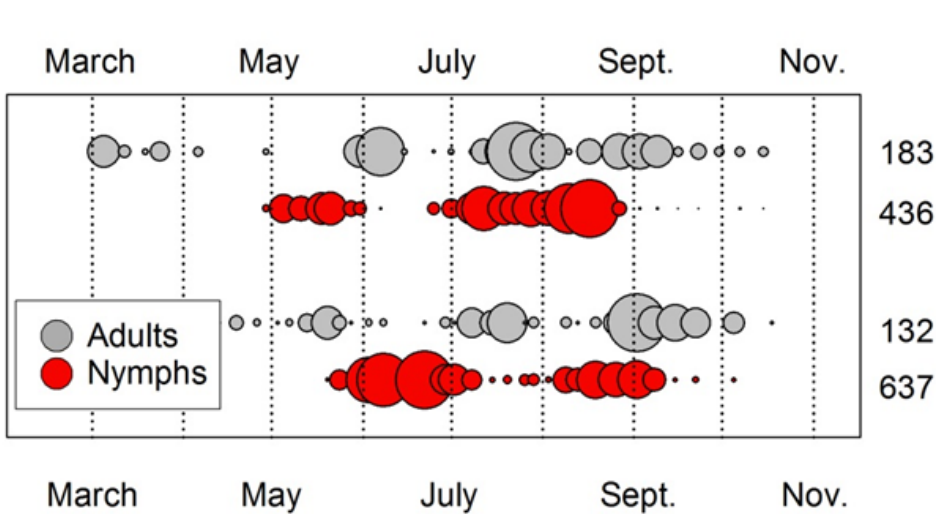
Overwinters as adult (multiple habitats)
Multiple generations per year
Aphids, psylla, other soft-body arthropods
Our best psylla natural enemy (my opinion)

Very common outside of orchards

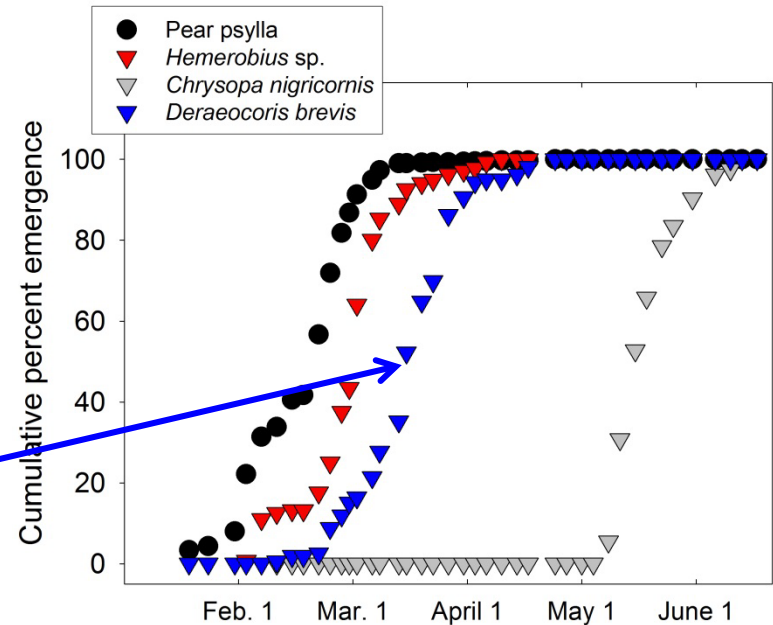
- Willow, alder, poplar, bitterbrush, sagebrush, other woody plants



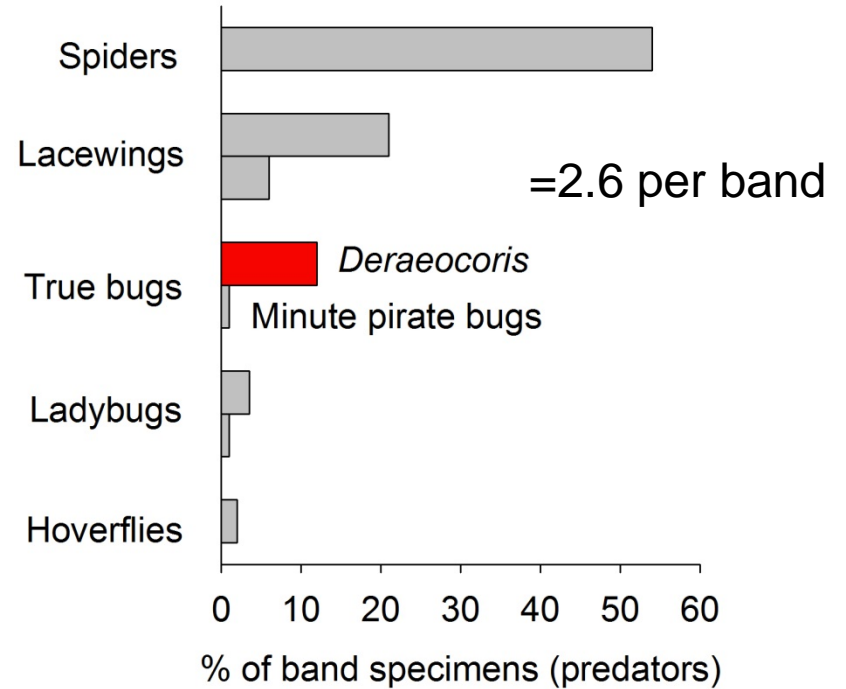
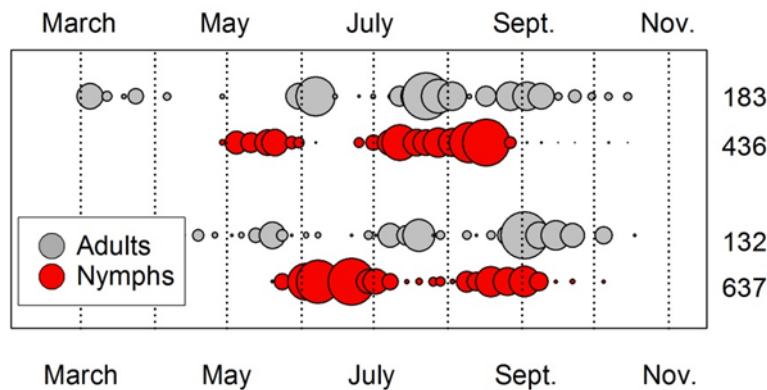
Deraeocoris brevis seasonal phenology and post-winter emergence



Emergence from winter quarters in March ▼



Deraeocoris brevis overwintering



Anthocoris spp. (Anthocoridae; minute pirate bugs)



Overwinter as adults (multiple habitats)
Multiple generations per year
Active very early
Often preference for psyllids

Common outside of orchards
Strong preference for trees and shrubs

- Willow, alder, poplar, bitterbrush

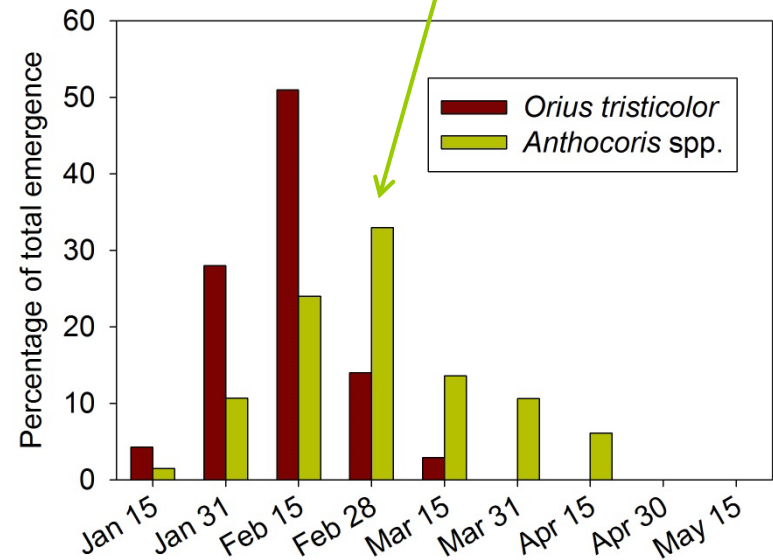


Photograph: University of California

Anthocoris spp. post-winter emergence



Peak emergence
in February



Anthocoris sp. looking for psyllids
on catkins of *Salix*

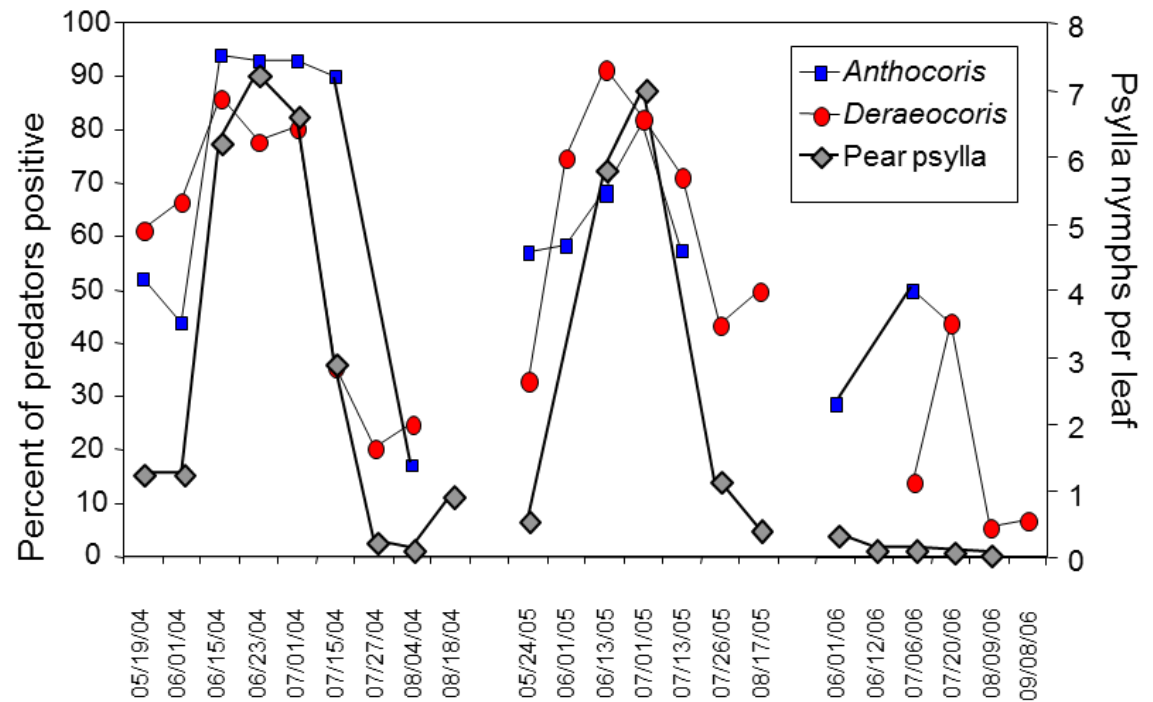
Deraeocoris and *Anthocoris*: Our leading psylla predators

Molecular methods to detect psylla protein in guts of predators (Unruh et al. 2009)

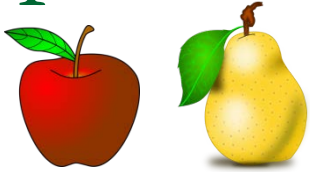


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Photograph: University of California



Orius tristicolor (Anthocoridae; minute pirate bugs)



Overwinter as adult females (many habitats)
Multiple generations per year
Thrips, mites
Abundant; important and useful group

Preference for low vegetation
Common outside of orchards

- Follow bloom extensively

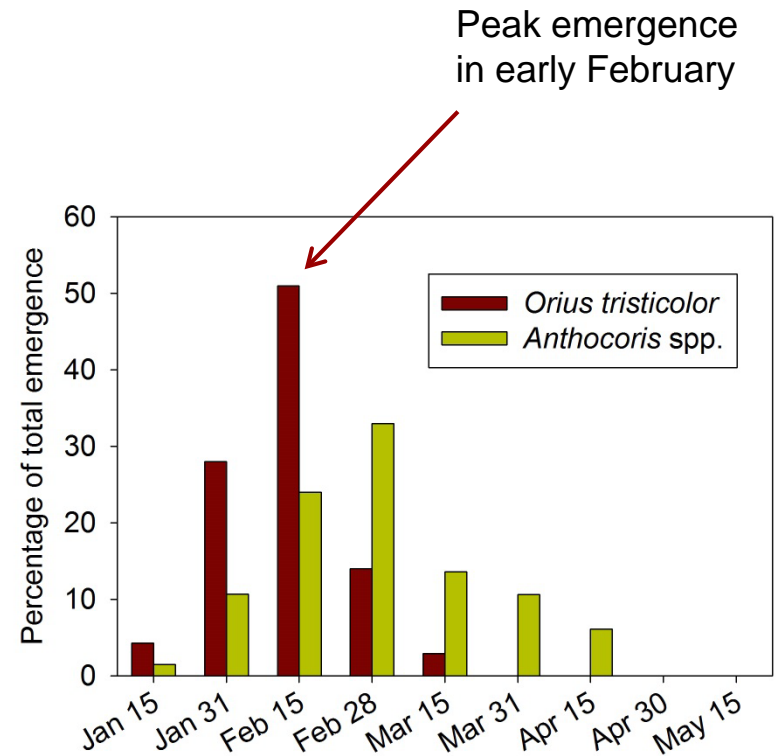
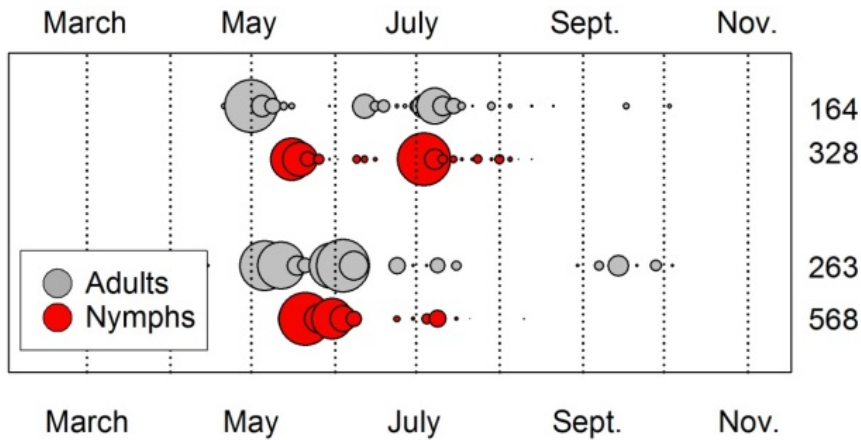


Photograph: University of California

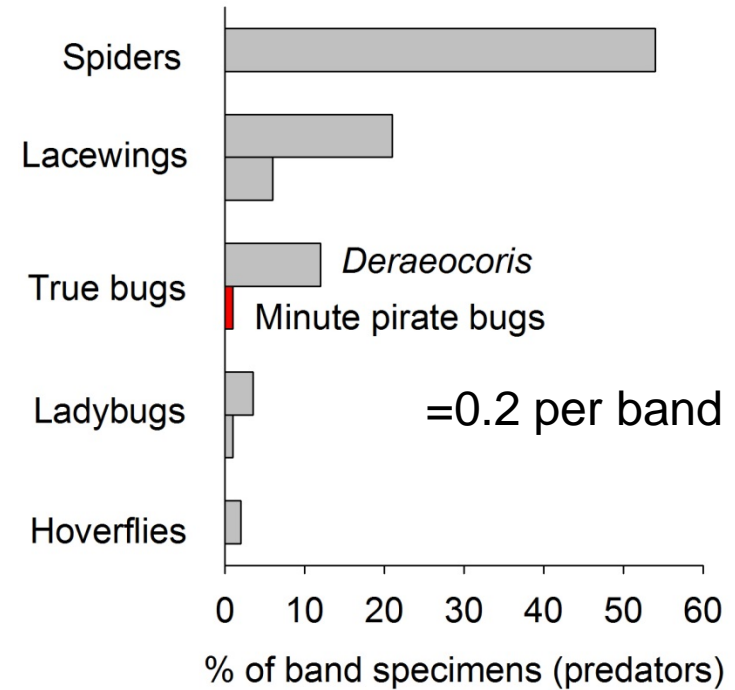
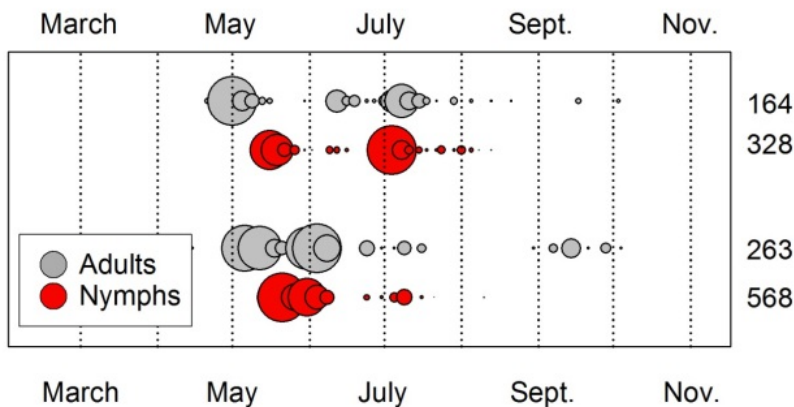


Photograph: John Obermeyer

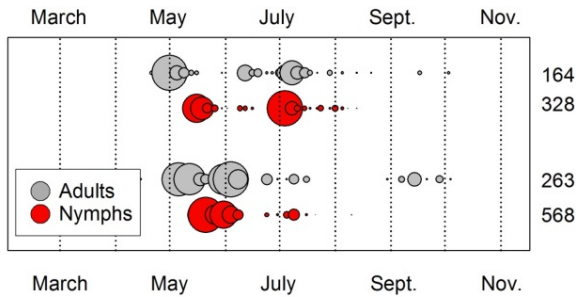
Orius tristicolor seasonal phenology and post-winter emergence



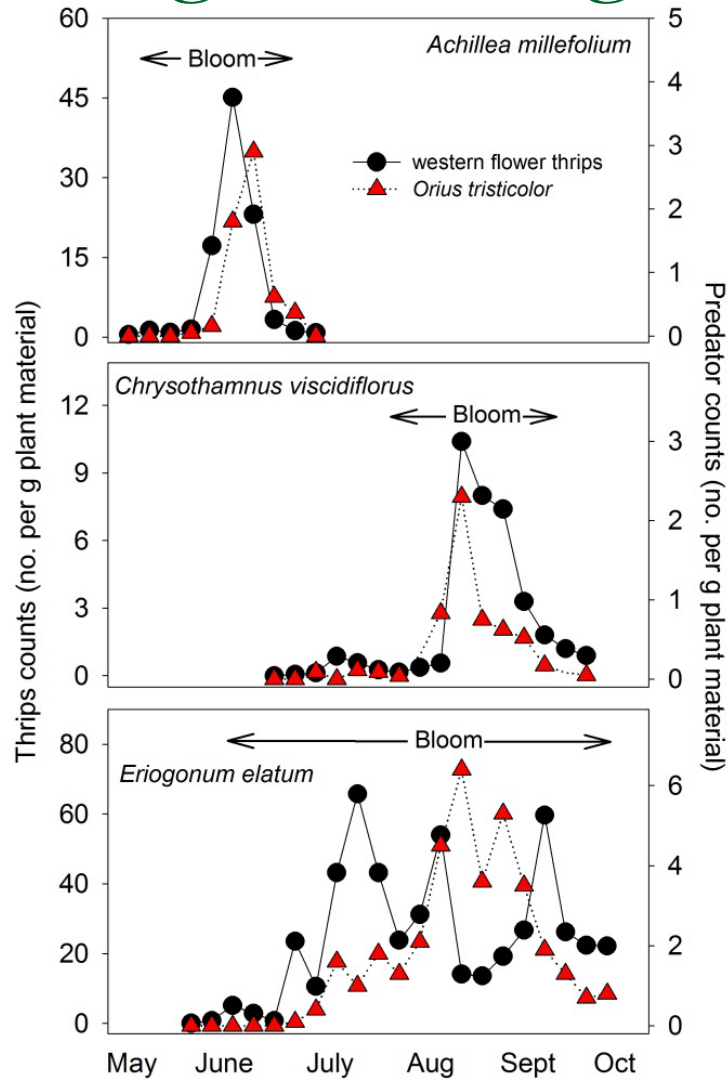
Orius tristicolor overwintering



Minute pirate bugs: chasing bloom?



Photograph: University of California



Photograph: Andy Fyon



Photograph: USFS



Photograph: Butterflies of America

Campylomma verbasci (Miridae; mullein bug)



Overwinter in egg stage (e.g., in apple wood)
Multiple generations per year
Aphids and psylla; other soft-body arthropods
Can damage very young apple fruit

Common outside of orchards

- Herbaceous (e.g., mullein) and woody plants

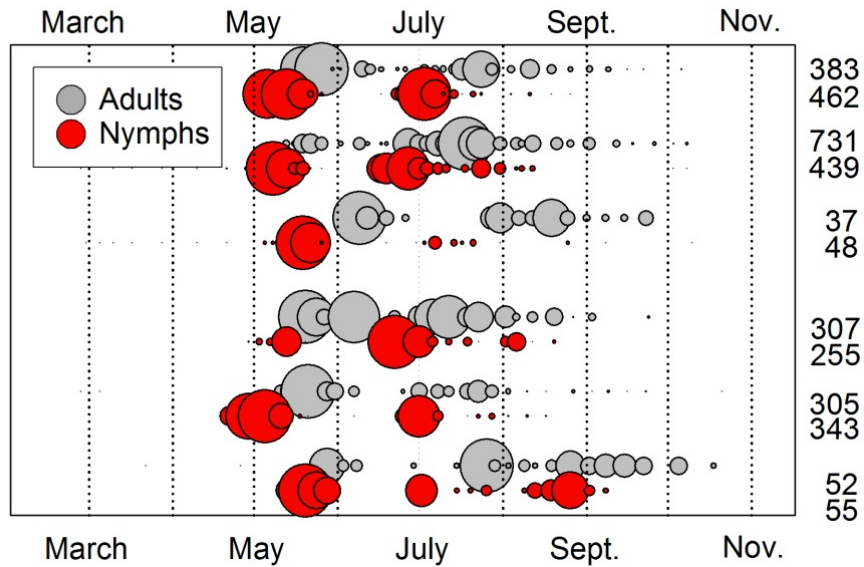


Photograph: British Bugs



Photograph: WSU-TFREC

Campylomma verbasci phenology



Hemerobius spp. (Hemerobiidae; brown lacewings)



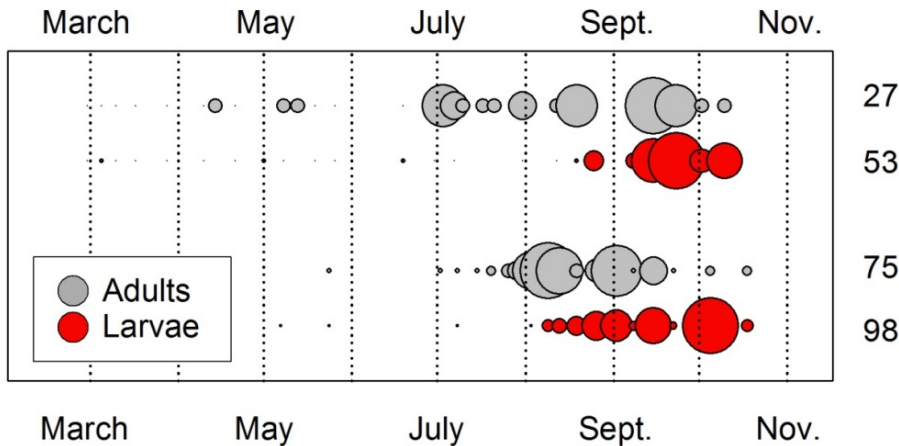
Overwinter as mix of stages
Multiple generations per year
Among earliest of our predators
Aphids, psylla, mites

Common outside of orchards

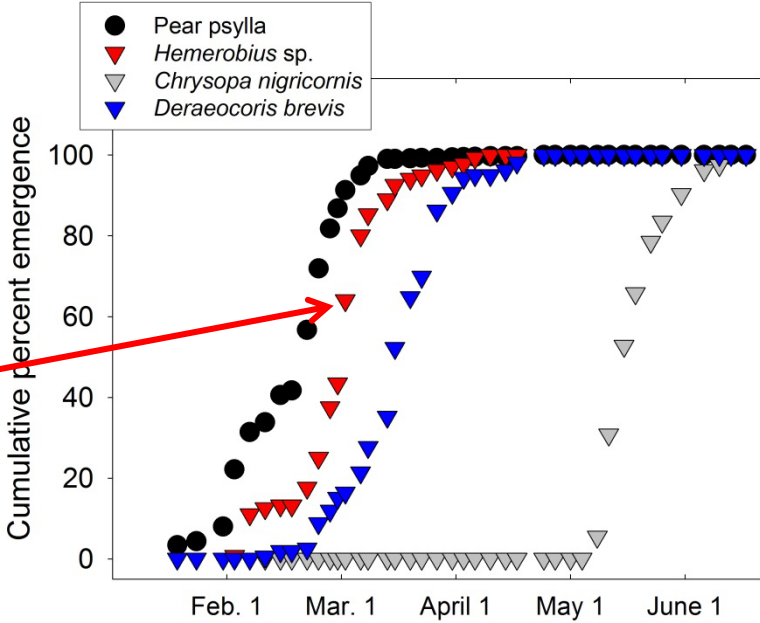


All photographs: University of California

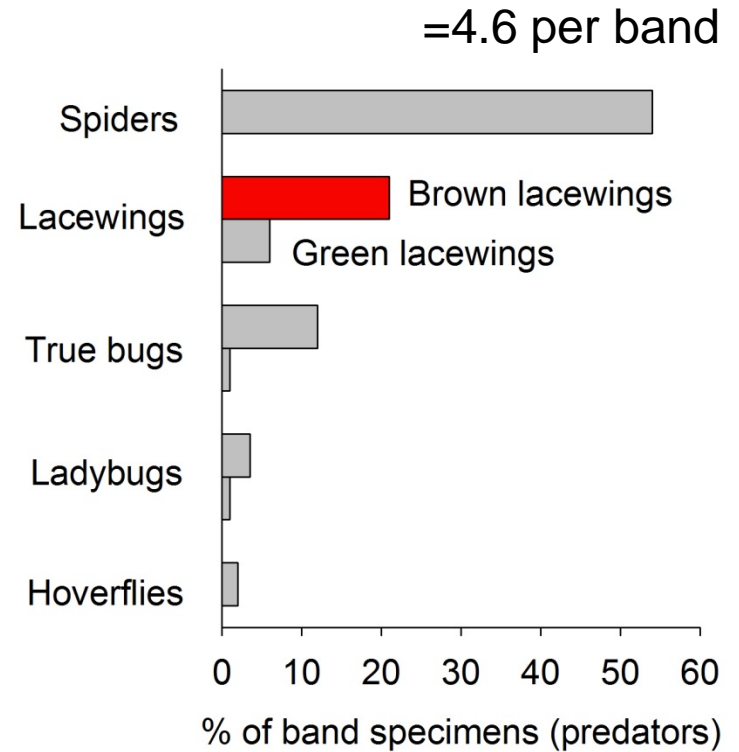
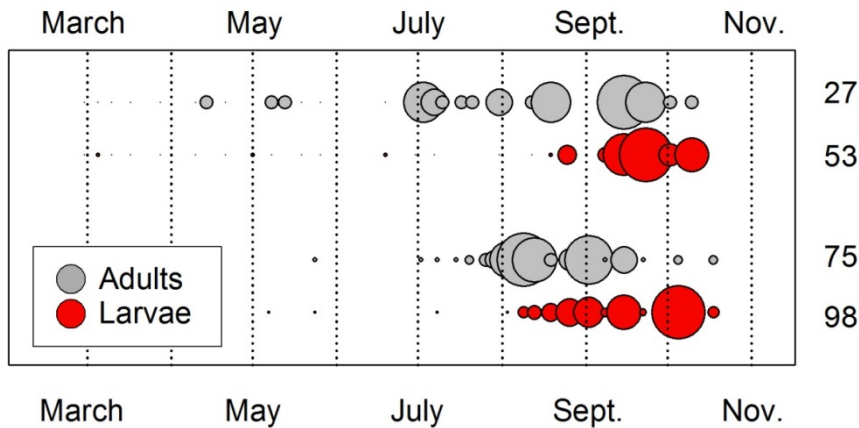
Hemerobius spp. phenology and post-winter emergence



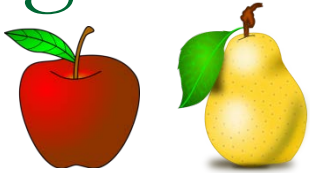
Emergence from winter quarters in February - March ▼



Hemerobius sp. overwintering



Chrysoperla plorabunda (Chrysopidae; green lacewings)



Overwinters as adult
Larval presence late-June to early Sept.
Fairly early post-winter emergence?
Aphids, psyllids to some extent

Common outside of orchards

- Multiple plants; woody and herbaceous



Photograph: Alice Abela

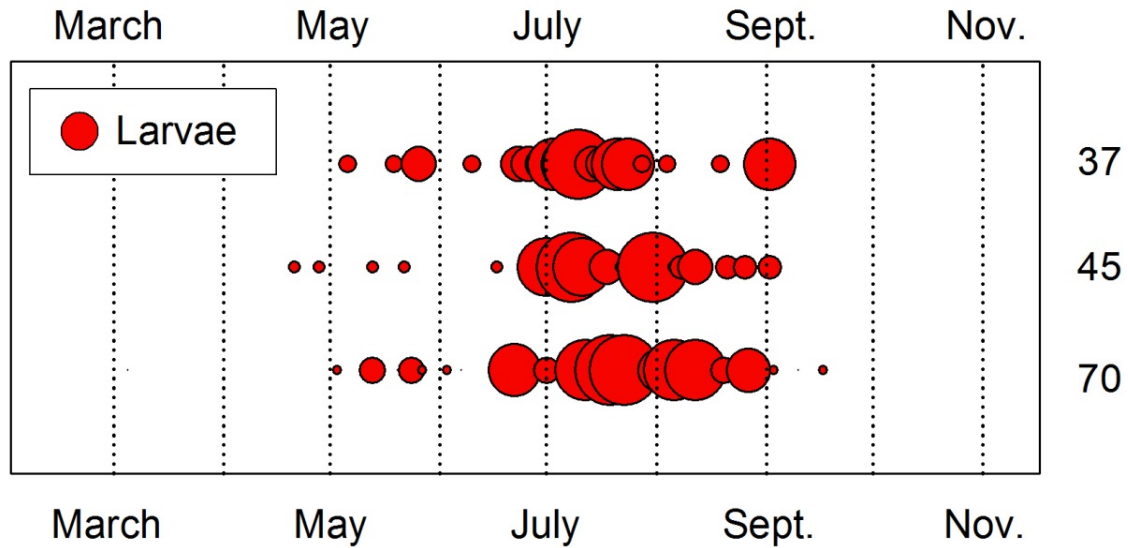


Photograph: WSU-extension

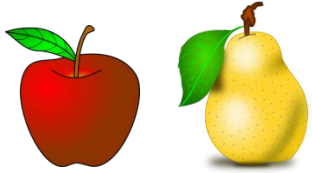


Photograph: BugGuide.Net

Chrysopa plorabunda: phenology of larvae



Chrysopa nigricornis (Chrysopidae; green lacewings)



Large lacewing
Overwinters as cocooned last instar larva
Very late post-winter emergence
Aphids; psyllids to some extent

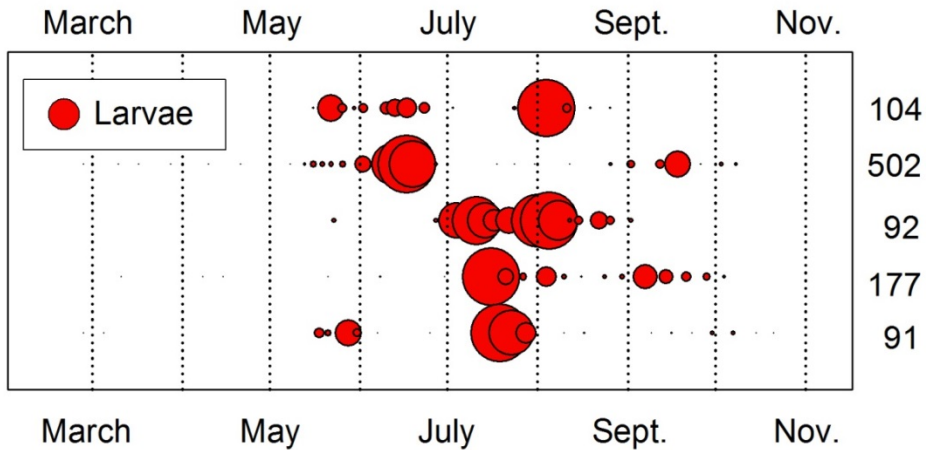
Common outside of orchards

- Tree-loving

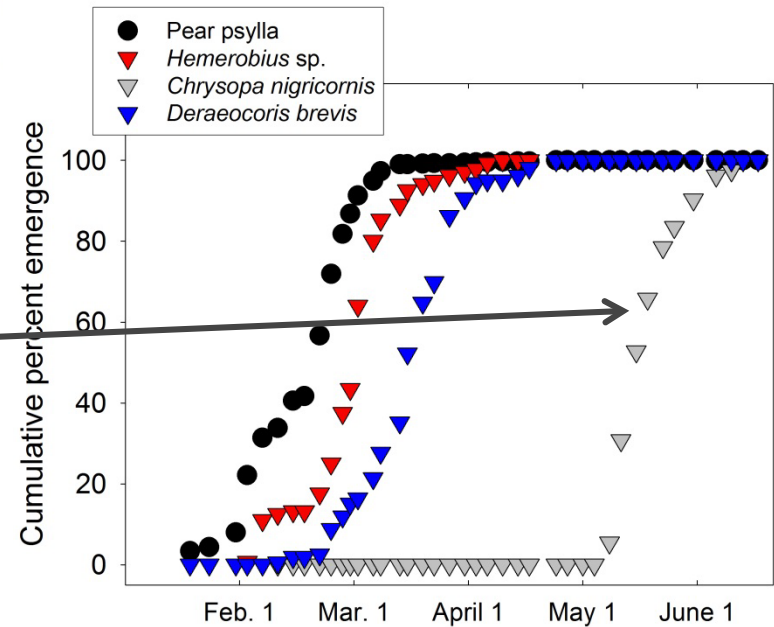


Photograph: BugGuide.Net

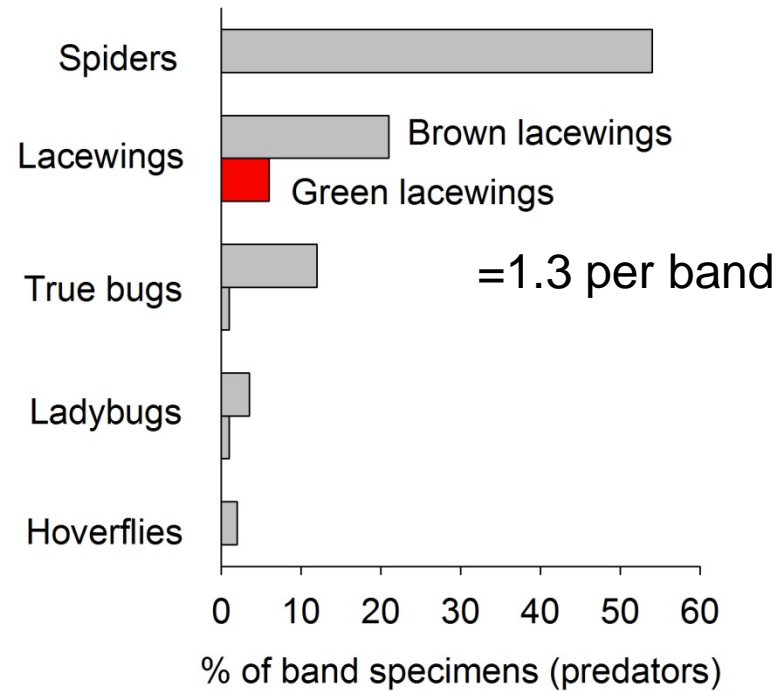
Chrysopa nigricornis phenology and post-winter emergence



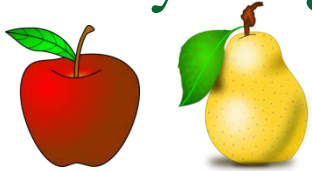
Emergence from winter quarters in May ▼



Chrysopa nigricornis overwintering



Hippodamia convergens (Coccinellidae; ladybugs)



Overwinter as adult aggregations in mountains
Single larval generation per year?
Aphids especially

Common outside of orchards

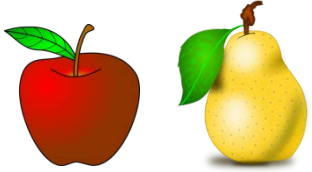
- Multiple plants; preference for herbaceous plants or low shrubs



All photographs: University of
California

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Coccinellidae; aphid-loving ladybugs)



Adalia bipunctata

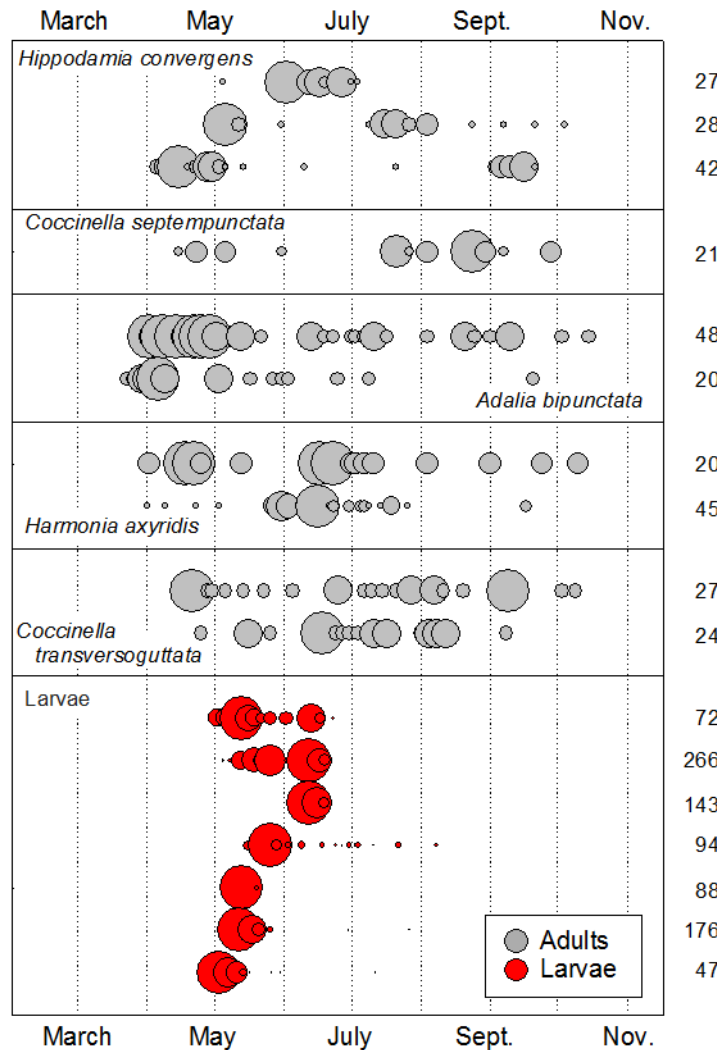


Photograph: James Lindsey

Harmonia axyridis



Photograph: Univ. California



Coccinella septempunctata



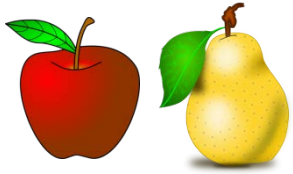
Photograph: Dominik Stodulski

Coccinella transversoguttata



Photograph: BugGuide.Net

Stethorus sp. (Coccinellidae; ladybugs): spider mite destroyer



Tiny black beetle
Overwinters as adult
Strong preference for mites

Common outside of orchards
Apparently woody and herbaceous plants



Photograph: WSU-TFREC

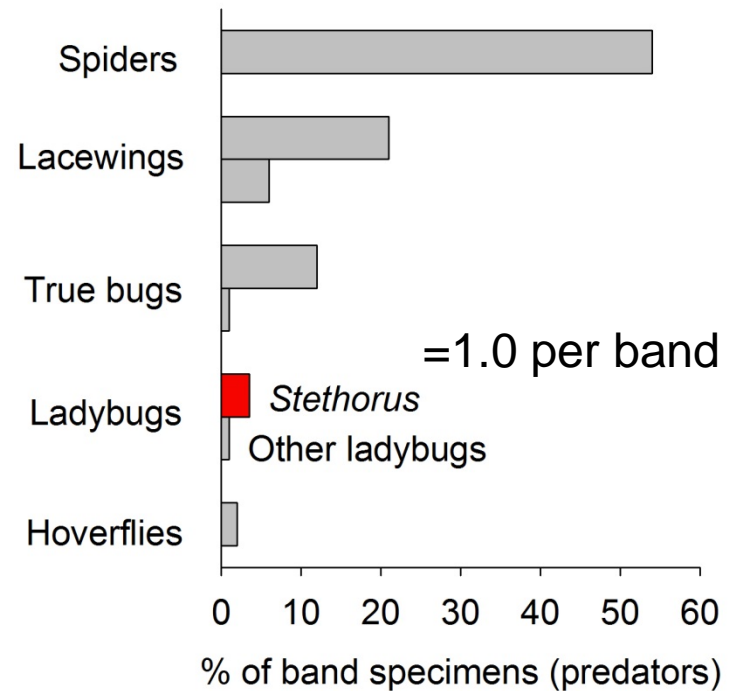
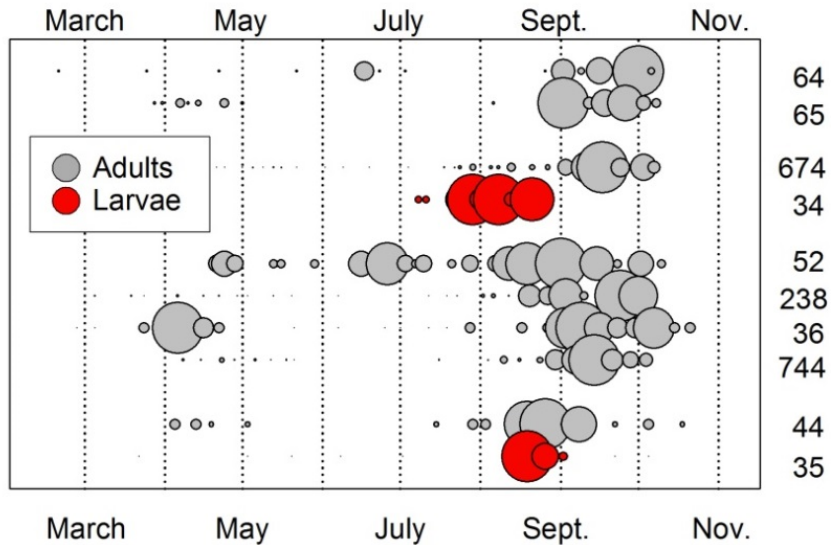


Photograph: Univ. California



Evergreen Growers Supply, LLC

Stethorus sp. phenology and overwintering



Syrphidae species complex (hoverflies)



Adults often resemble bees or wasps (mimicry)
Adults are pollinators; larvae are aphid-predators
Difficult species complex in orchards
Overwintering stage not consistent across species

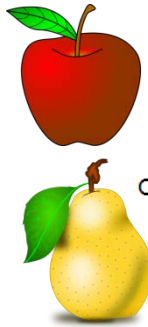


Common outside of orchards
Trees, shrubs, herbaceous vegetation



All photographs: University of California

Spiders: multiple life history strategies

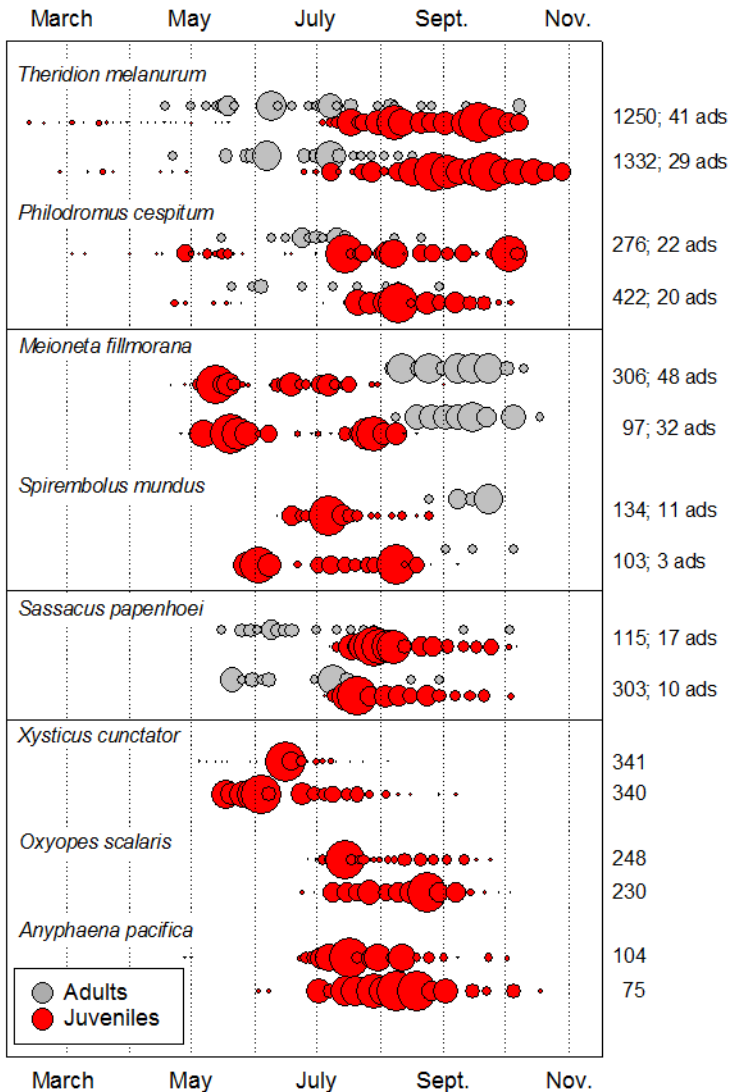


Overwinter as juveniles

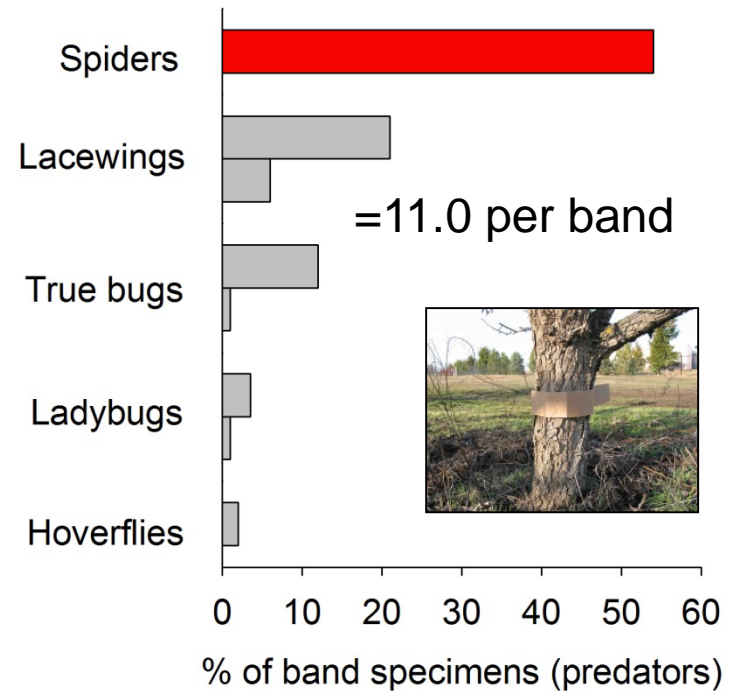
Overwinter as eggs?

Overwinter as juveniles (where?)

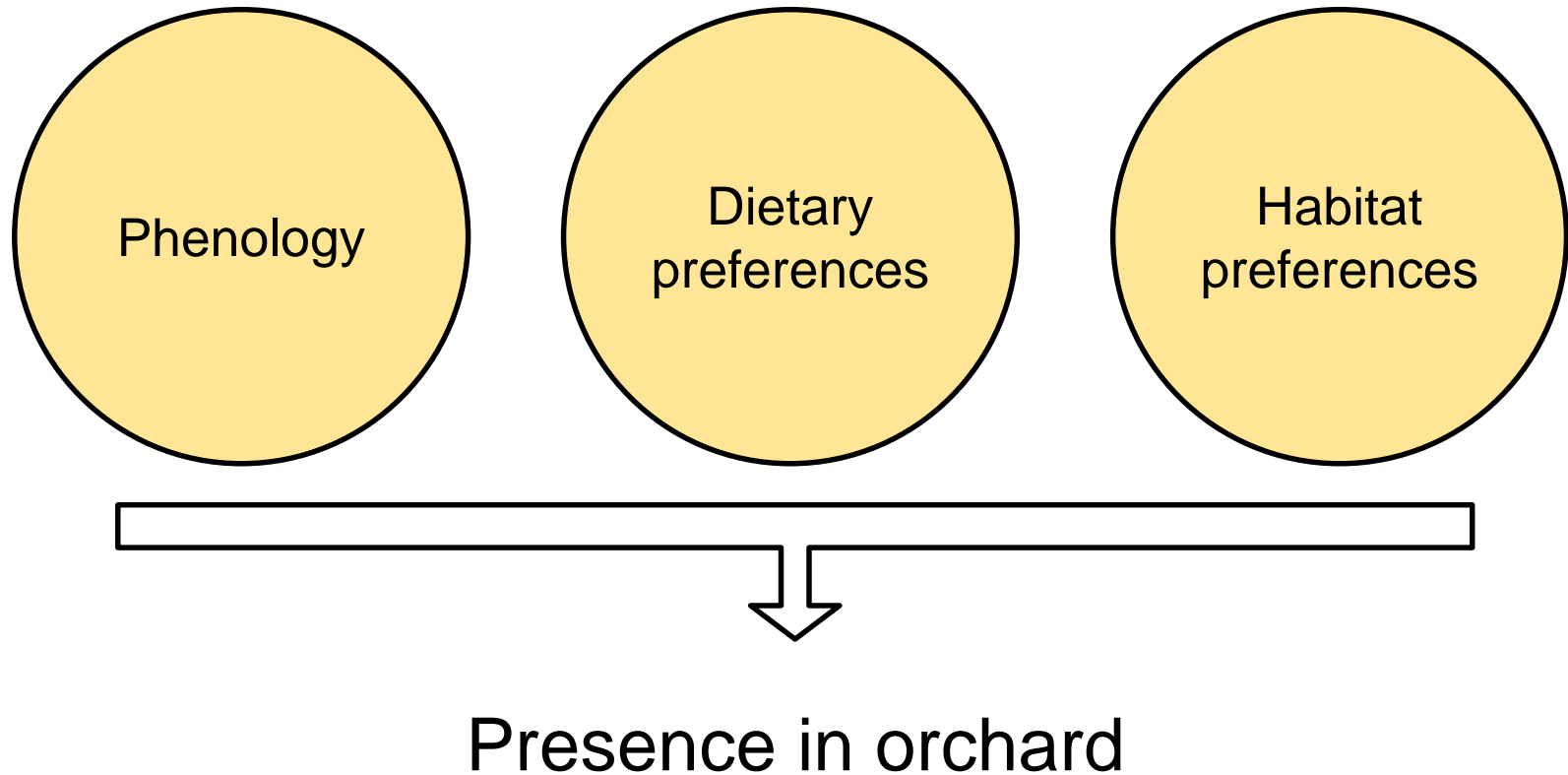
Where are the adults?



True dietary generalists
One generation per year



Wrap-up: Putting it all together



Presence in orchard

Putting it all together: primary prey of common species

Lacewings

Chrysoperla plorabunda (green LW)

Chrysopa nigricornis (green LW)

Hemerobius spp. (brown LW)

Aphids	Psylla	Mites	Thrips
Yellow	Yellow	White	White
Yellow	Yellow	White	White
Yellow	Yellow	Yellow	White

True bugs

Deraeocoris brevis

Campylomma verbasci (mullein bug)

Anthocoris spp. (minute pirate bug)

Orius tristicolor (minute pirate bug)

Yellow	Yellow	Light Yellow	White
Yellow	Yellow	Light Yellow	White
White	Yellow	White	White
Light Yellow	Light Yellow	Yellow	Yellow

Ladybugs

Hippodamia convergens (convergent LB)

Harmonia axyridis (Asian LB)

Coccinella septempunctata (7-spot LB)

Coccinella transversoguttata (transverse LB)

Adalia bipunctata (2-spot LB)

Stethorus sp. (spider mite destroyer)

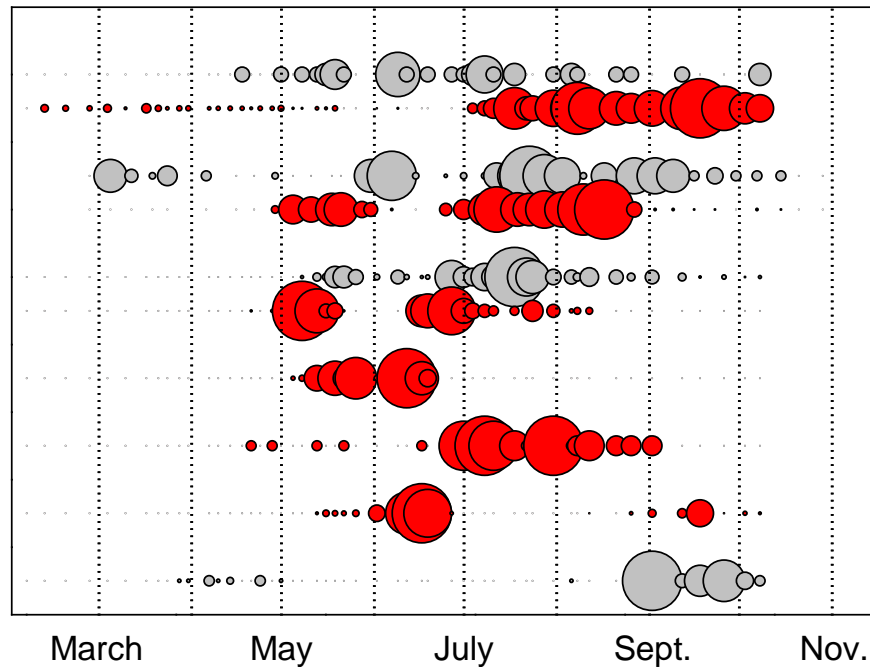
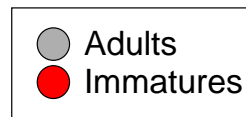
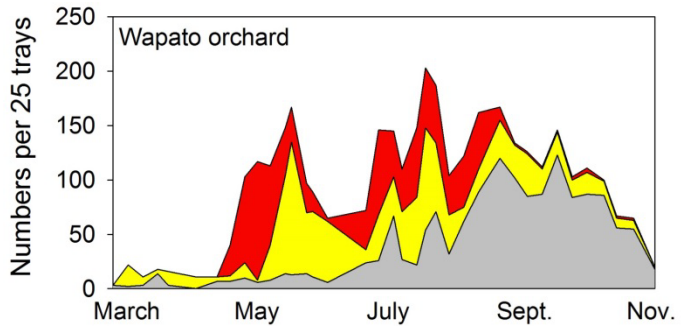
Yellow	Light Yellow	White	White
Yellow	Light Yellow	White	White
Yellow	Light Yellow	White	White
Yellow	Light Yellow	White	White
Yellow	Light Yellow	White	White
White	White	Yellow	White

Hoverflies

Multiple species

Yellow	White	White	White
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Putting it all together: A season-long presence – as a relay



Conclusions

- Extraordinary diversity of predatory arthropods in orchard tree canopy
- Phenology is variable across species
- Prey preferences are variable across species and this affects habitat use
 - Substantial presence in habitats outside of orchards



Conclusions

- Habitat choices help drive seasonal presence/absence
- Species which are abundant in orchards at end of season also overwinter in orchards
- Top of my list as our best friend: *Deraeocoris brevis*

