

Larvae of the Genus *Eleodes* Eschscholtz (Coleoptera: Tenebrionidae)



Eleodes Eschscholtz, 1829

- Know for defensive secretions and headstanding
- Endemic to western North America



Photo credit: Whitney Cranshaw



© Ted C. MacRae 2010

Eleodes Eschscholtz, 1829

- Involved in both Müllerian and Batesian mimetic complexes



Eleodes

- Species-rich (190+) and morphologically diverse
- Adult-based taxonomy difficult, but relatively well studied
- Pests of some dry land crops



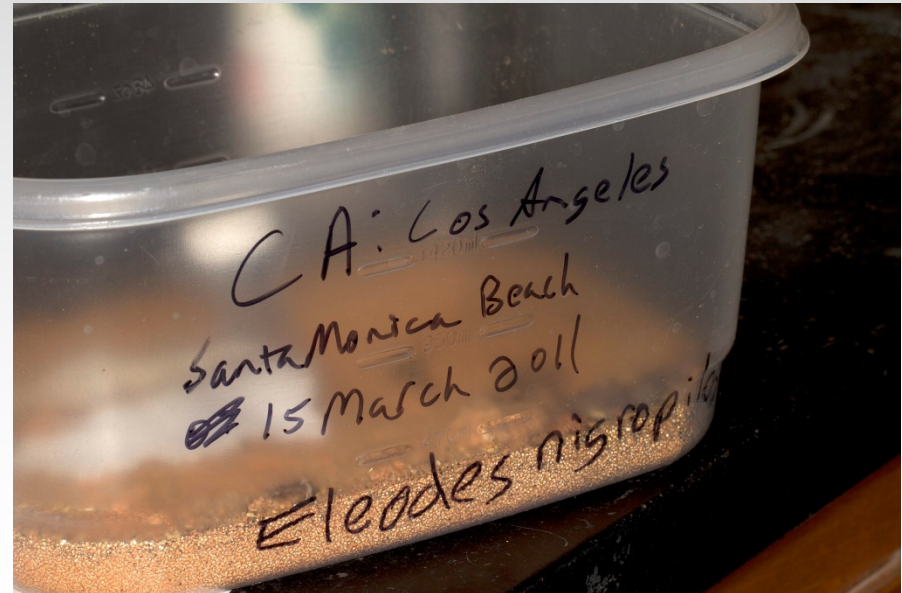
Eleodes Larval Taxonomic History

- Relatively few described

Species	Publication	Remarks
<i>Eleodes armatus</i> LeConte, 1851	Thomas, 1984	egg, larva, and pupa described, larva and pupa imaged
<i>Eleodes dentipes</i> Eschscholtz, 1833	Gissler, 1878; Blaisdell, 1909	Larva briefly described in Gissler (1878); larva redescribed and illustrated in Blaisdell (1909)
<i>Eleodes giganteus</i> Mannerheim, 1843	Gissler, 1878	egg and larva characterized. Larva illustrated.
<i>Eleodes opacus</i> (Say), 1824	St. George, 1924	pygidium imaged. No description.
<i>Eleodes pimelioides</i> (Mannerheim) 1843	Hyslop, 1912	egg, larva, and pupa described. Pygidium of larva imaged.
<i>Eleodes suturalis</i> (Say), 1824	Wade and St. George, 1923	egg, larva, and pupa described, larval natural history discussed, egg and pupa imaged.
<i>Eleodes tricostatus</i> (Say), 1824	McColloch, 1918; St. George, 1924	egg, larva, and pupa briefly characterized, larval natural history discussed; right mandible and pygidium of larva imaged in St. George (1924).
<i>Eleodes vandykei</i> Blaisdell, 1909	Hyslop, 1912	egg, larva, and pupa described, egg, larva, and pupa imaged. Species listed as <i>E. letcheri vandykei</i> .

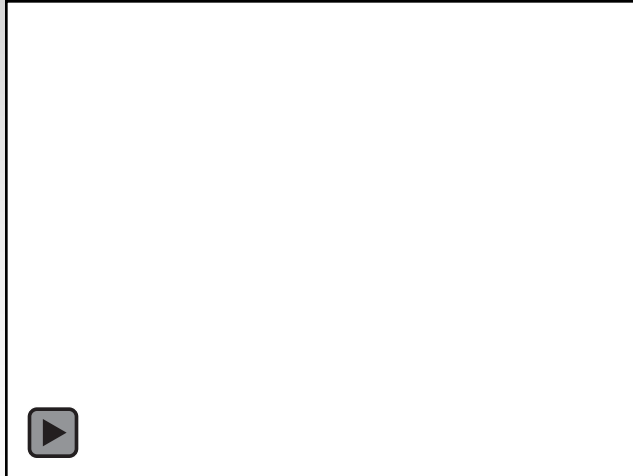
Rearing

- Started August 2010
- 30 *Eleodes* and Amphidorini species attempted
- Larvae, 1st instar or later, collected from 17 species
 - 1,400+ specimens



Rearing

- Two female *E. armatus* (A48) produced 1947 eggs
- 128 persisting to the 2nd instar or later



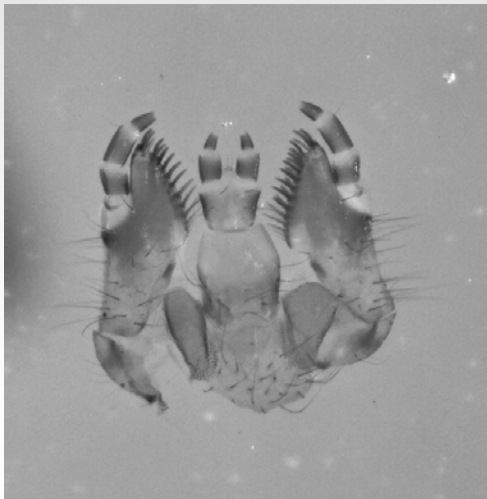
Rearing

- Larvae placed in containers (modified from Brown 1973) with sand and cricket food
- 1-10 larva per container

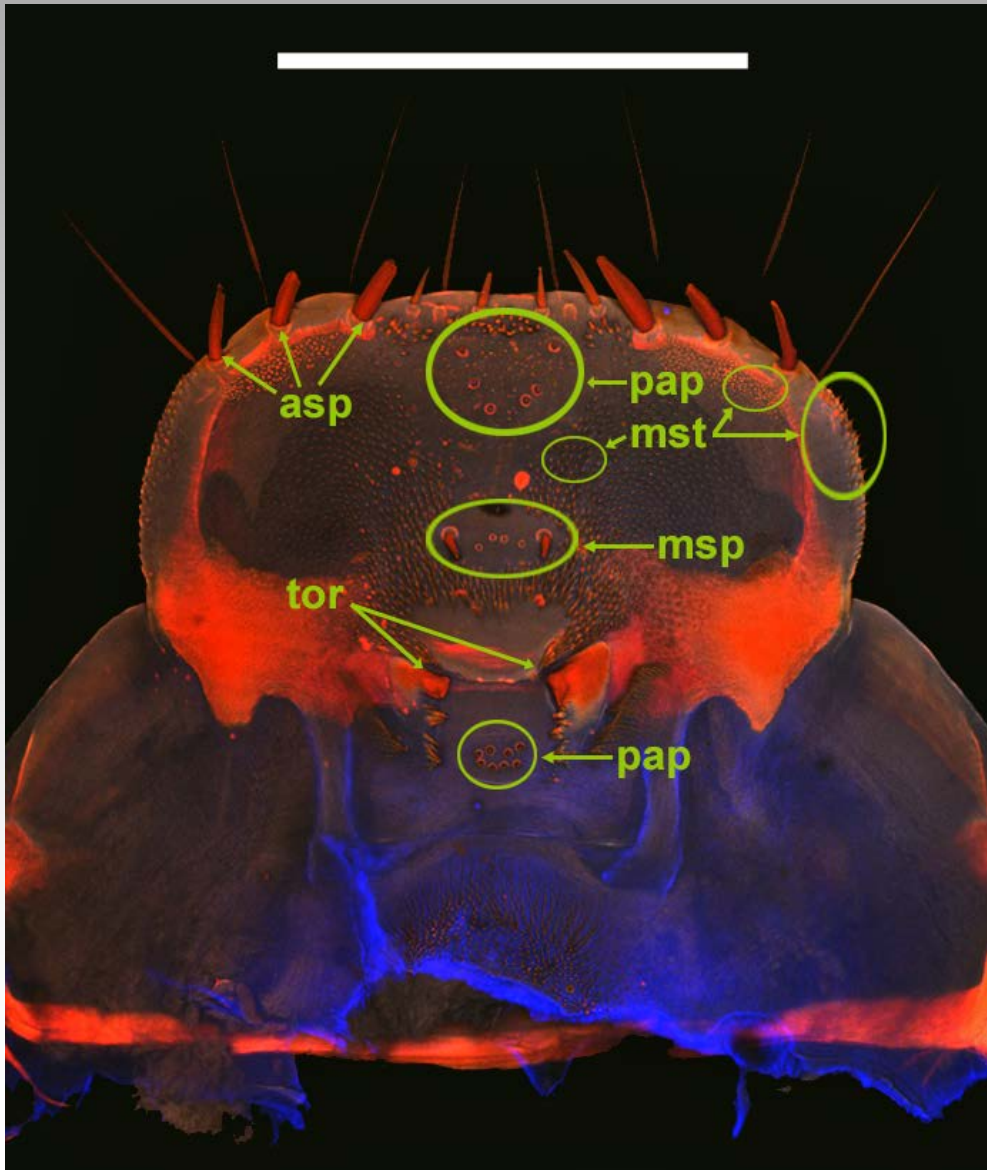


Dissections and Imaging

- Standard dissections with #0 pin and fine forceps on late (7th – 11th) instar larvae
- Mounted in Glycerin jelly for the CLSM
- Images taken with Visionary Digital systems or CLSM



Morphology: Epipharynx

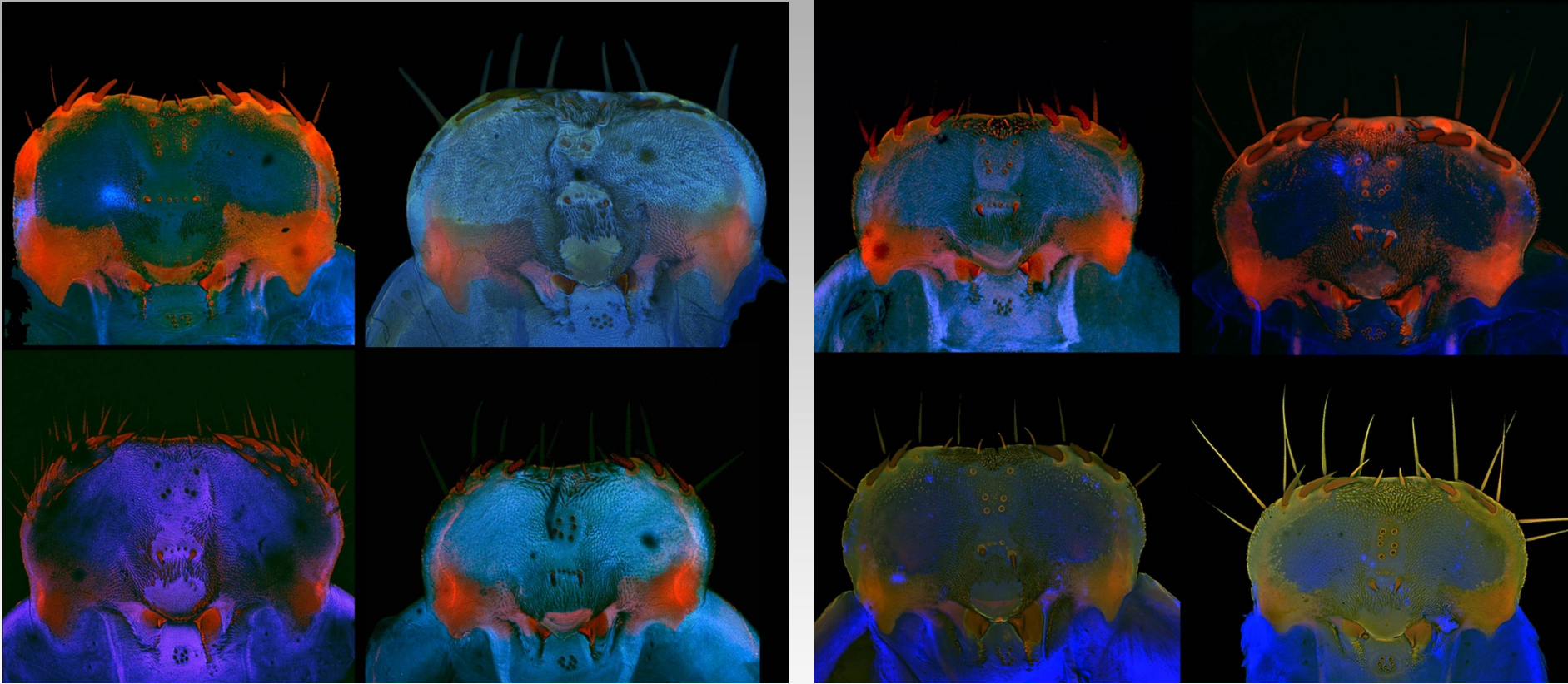


Eleodes anthricinus Blaisdell

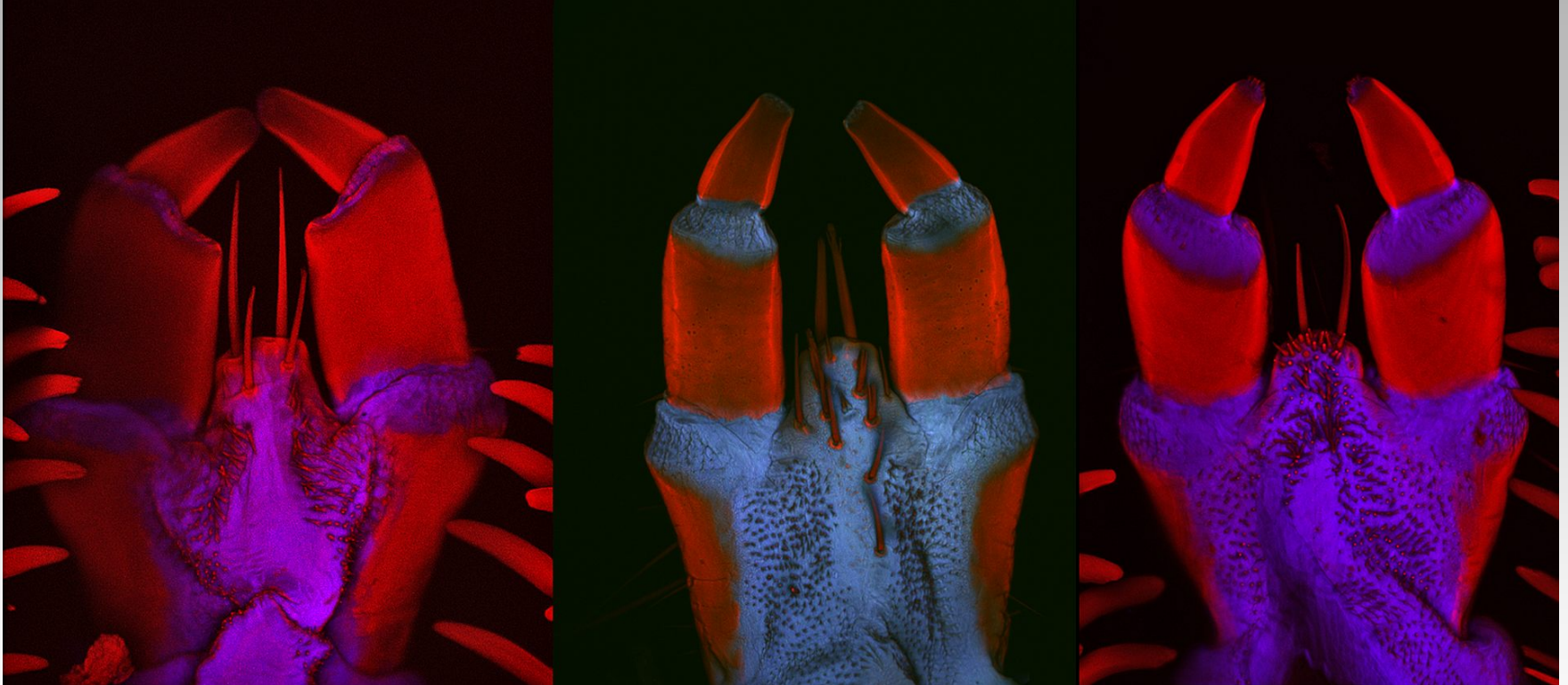
asp = anterior spines,
msp = medial spines,
mst = microsetae,
pap = sensory papillae,
tor = tormae

Scale bar = 1 mm

Morphology: Epipharynx



Morphology: Ligula

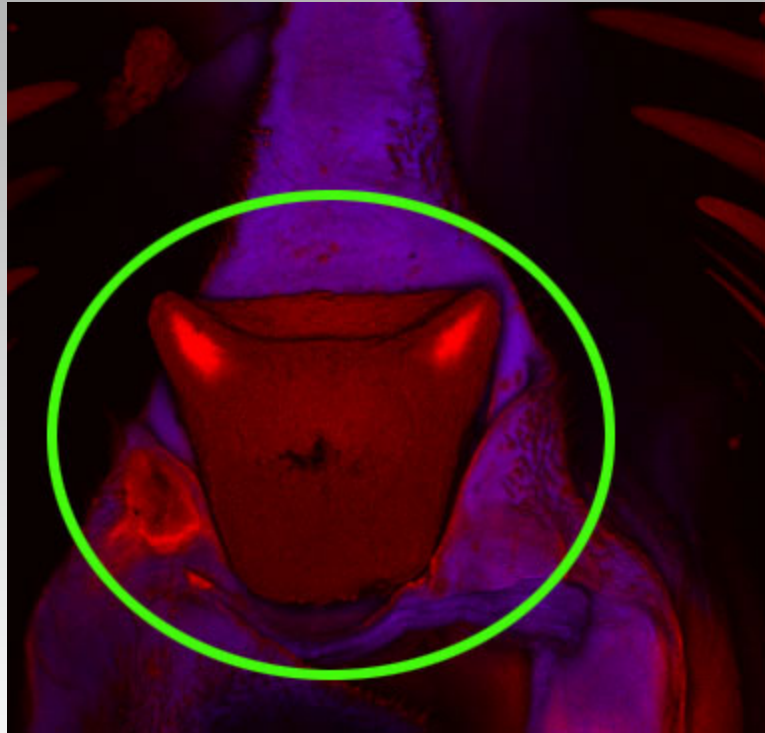


Eleodes carbonarius (Say)

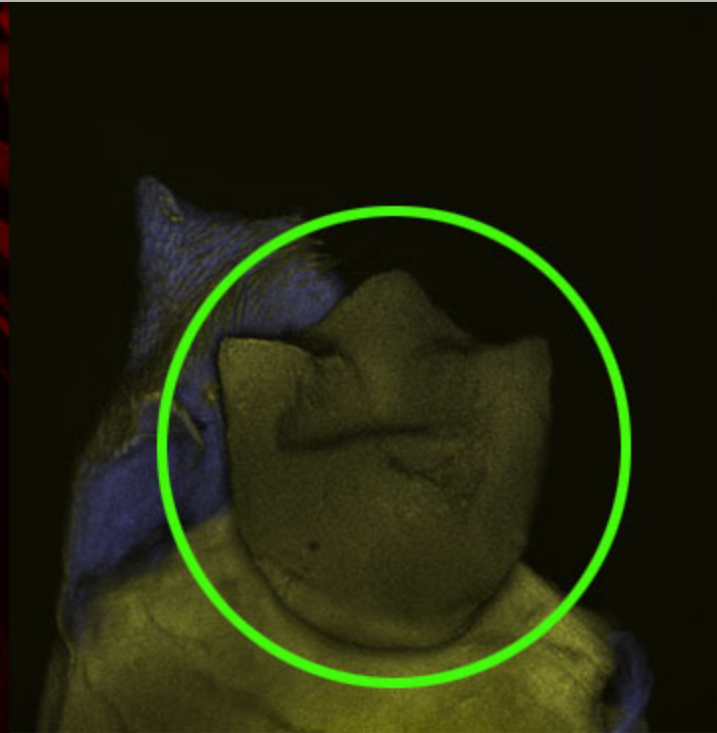
Eleodes armatus LeConte

Eleodes goryi Solier

Morphology: Hypopharyngeal sclerome



Eleodes carbonarius (Say)



Eleodes extricatus (Say)

Morphology: Ventral head characters

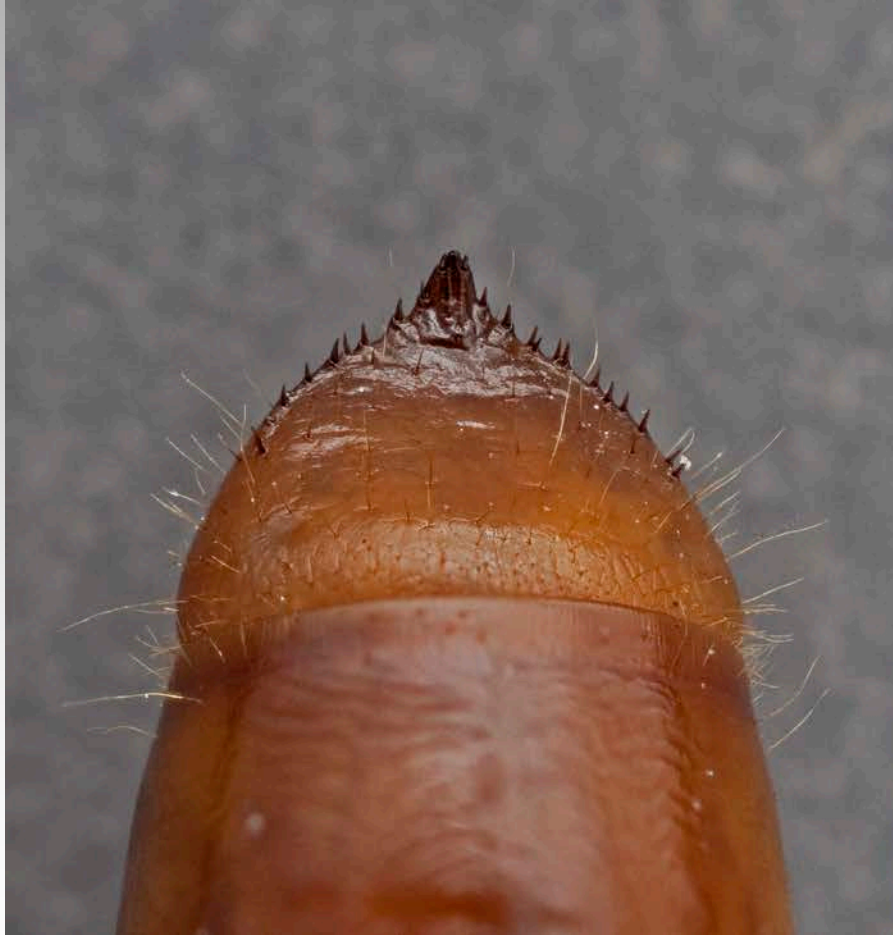


Eleodes subnitens LeConte



Eleodes extricatus (Say)

Morphology: caudal projection



Eleodes hispilabris (Say)



Eleodes pilosus Horn

Morphology: thoracic characters

Eleodes anthricinus Blaisdell



Eleodes extricatus (Say)



Eleodes subnitens LeConte

Data management: revision

- Mx
 - Specimen databasing
 - Image management
 - Character matrix construction
 - Matrix-based descriptions

The screenshot displays a web application interface for managing OTU groups. The top navigation bar includes tabs for Material, OTUs, Characters, Matrices, Content, Measurements, DNA, Refs, Associations, Taxon names, Images, Ontology, Keys, Tags, and Phylo. The current page is titled 'OTUs' and 'OTU groups'. The main content area shows details for 'Eleodes larvae (id: 640)'. On the left, there is a sidebar with options like 'show', 'edit', 'Tag | Destroy', 'Material', 'material', 'collecting events', 'verbose specimens', 'Content', 'grid', 'Descriptions', 'working', 'print', 'DNA', 'extract grid', 'extract by gene grid', 'extract grid by extracts', and 'Other images'. The main content area includes a 'Record details' section with fields for 'Last updater', 'Creator', 'Created on', 'Last updated', and 'Is public?'. Below this is a 'Members 14' section with a 'Drag to sort.' instruction and a table of members. A 'Reorder by id' dropdown and 'sort' button are also present. On the right, there are two panels: 'Add a single OTU' with an 'add' button, and 'Add/subtract another OTU group' with a dropdown and 'submit' button. At the bottom, there is a control bar with 'edit' or 'show' buttons and a 'members for content:' dropdown.

Material | OTUs | Characters | Matrices | Content | Measurements | DNA | Refs | Associations | Taxon names | Images | Ontology | Keys | Tags | Phylo

OTUs | OTU groups

new | list | | show | edit
more options ...

Eleodes larvae (id: 640)

id: 640 | Is public?: true
show
< edit >
Tag | Destroy

Material
material
collecting events
verbose specimens

Content
grid

Descriptions
working
print

DNA
extract grid
extract by gene grid
extract grid by extracts

Other
images

Record details
Last updater: Aaron Smith
Creator: Aaron Smith
Created on: over 1 year ago
Last updated: over 1 year ago
Is public?: Yes

Members 14
Drag to sort.

Reorder by id | sort

Add a single OTU
 | add

Add/subtract another OTU group
A one time addition of subtraction of OTUs to this group. See help.
add | | submit

edit | or | show | members for content:

[drag]	21544	Eleodes (Blapyllis) nigropilosus	Eleodes nigropilosus larvae	x
[drag]	21543	Eleodes (Eleodes) tribulus	Eleodes tribulus larvae	x
[drag]	21546	Eleodes (Caverneleodes) wheeleri	Eleodes wheeleri larvae	x
[drag]	21773	Eleodes (Melaneleodes) anthracinus	Eleodes anthracinus larvae	x
[drag]	21553	Eleodes (Melaneleodes) carbonarius	Eleodes carbonarius knausi larvae	x
[drag]	21540	Eleodes (Eleodes) armatus	Eleodes armatus larvae	x
[drag]	21539	Eleodes (Eleodes) caudiferus	Eleodes caudiferus larvae	x
[drag]	21536	Eleodes (Eleodes) hispilabris	Eleodes hispilabris larvae	x
[drag]	21542	Eleodes (Eleodes) tenuipes	Eleodes tenuipes larvae	x
[drag]	21537	Eleodes (Litheleodes) extricatus	Eleodes extricatus larvae	x
[drag]	21545	Eleodes (Promus) goryi	Eleodes goryi larvae	x
[drag]	21538	Eleodes (Promus) knullorum	Eleodes knullorum larvae	x
[drag]	21541	Eleodes (Promus) subnitens	Eleodes subnitens larvae	x
[drag]	21547	Eleodes (Tricheleodes) pilosus	Eleodes pilosus larvae	x

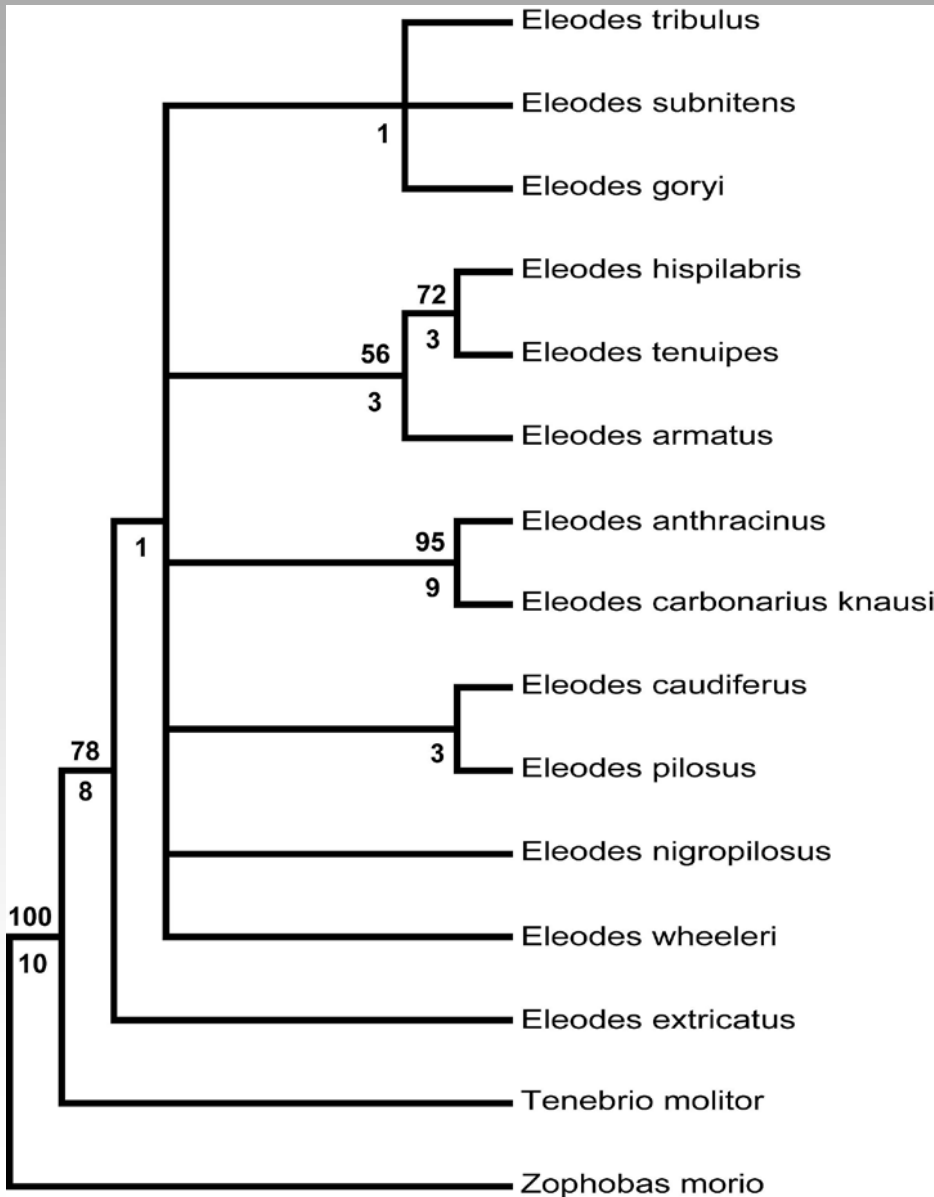
Data management: revision

- Mx
 - Specimen databasing
 - Image management
 - Character matrix construction
 - Matrix-based descriptions

The screenshot shows a web interface for managing OTU groups. The main header includes tabs for Material, OTUs, Characters, Matrices, Content, Measurements, DNA, Refs, Associations, Taxon names, Images, Ontology, Keys, Tags, and Phylo. The current view is for 'Eleodes larvae (id: 640)'. The interface is divided into several sections:

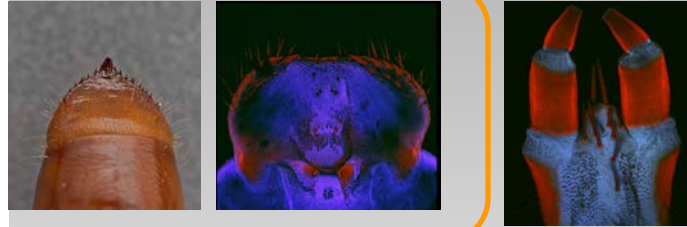
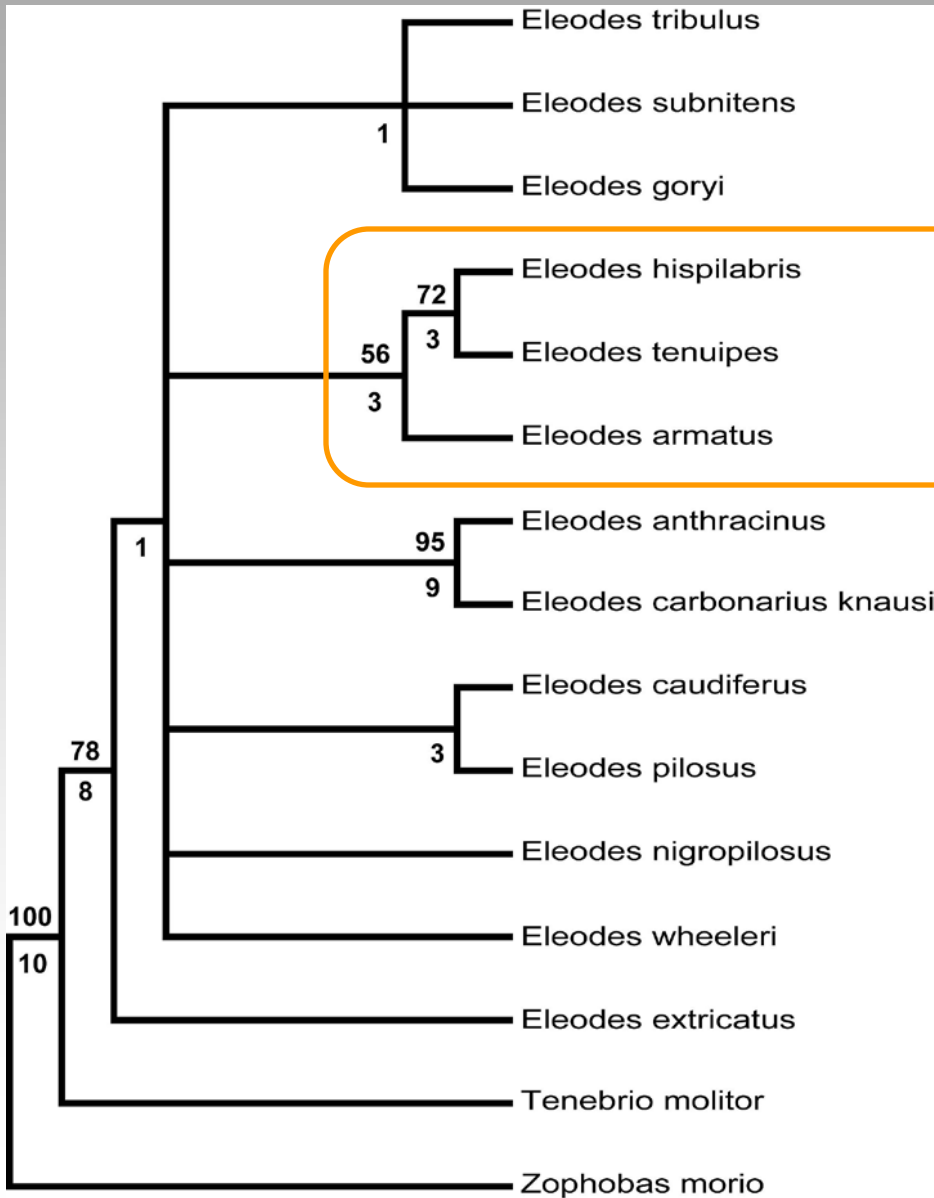
- Left sidebar:** Contains navigation links for 'id: 640', 'show', 'edit', 'Tag | Destroy', 'Material', 'material', 'collecting events', 'verbose specimens', 'Content', 'grid', 'Descriptions', 'working', 'print', 'DNA', 'extract grid', 'extract by gene grid', 'extract grid by extracts', and 'Other', 'images'.
- Record details:** Shows 'Is public?: true', 'Last updater: Aaron Smith', 'Creator: Aaron Smith', 'Created on: over 1 year ago', 'Last updated: over 1 year ago', and 'Is public?: Yes'.
- Members 14:** A list of 14 members with their IDs and names, each with a '[drag]' icon and an 'x' icon. The list is: 21544 *Eleodes (Blapyllis) nigropilosus* *Eleodes nigropilosus larvae* x, 21543 *Eleodes (Eleodes) tribulus* *Eleodes tribulus larvae* x, 21546 *Eleodes (Caverneleodes) wheeleri* *Eleodes wheeleri larvae* x, 21773 *Eleodes (Melaneleodes) anthracinus* *Eleodes anthracinus larvae* x, 21553 *Eleodes (Melaneleodes) carbonarius* *Eleodes carbonarius knausi larvae* x, 21540 *Eleodes (Eleodes) armatus* *Eleodes armatus larvae* x, 21539 *Eleodes (Eleodes) caudiferus* *Eleodes caudiferus larvae* x, 21536 *Eleodes (Eleodes) hispilabris* *Eleodes hispilabris larvae* x, 21542 *Eleodes (Eleodes) tenuipes* *Eleodes tenuipes larvae* x, 21537 *Eleodes (Litheleodes) extricatus* *Eleodes extricatus larvae* x, 21545 *Eleodes (Promus) goryi* *Eleodes goryi larvae* x, 21538 *Eleodes (Promus) knullorum* *Eleodes knullorum larvae* x, 21541 *Eleodes (Promus) subnitens* *Eleodes subnitens larvae* x, and 21547 *Eleodes (Tricheleodes) pilosus* *Eleodes pilosus larvae* x.
- Right sidebar:** Contains two panels: 'Add a single OTU' with an 'add' button, and 'Add/subtract another OTU group' with a dropdown menu set to 'add' and a 'submit' button. Below these is a 'Reorder by id' dropdown and a 'sort' button.
- Bottom:** A bar with 'edit' or 'show' buttons and a 'members for content:' dropdown.

Cladistic analysis



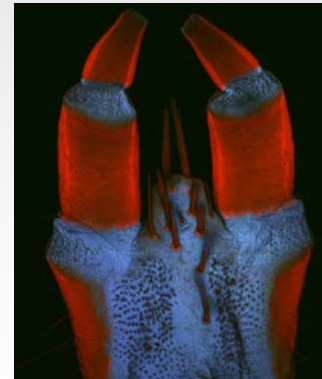
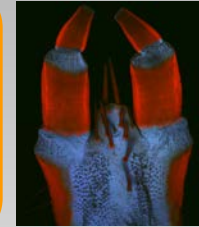
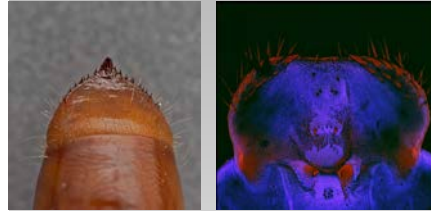
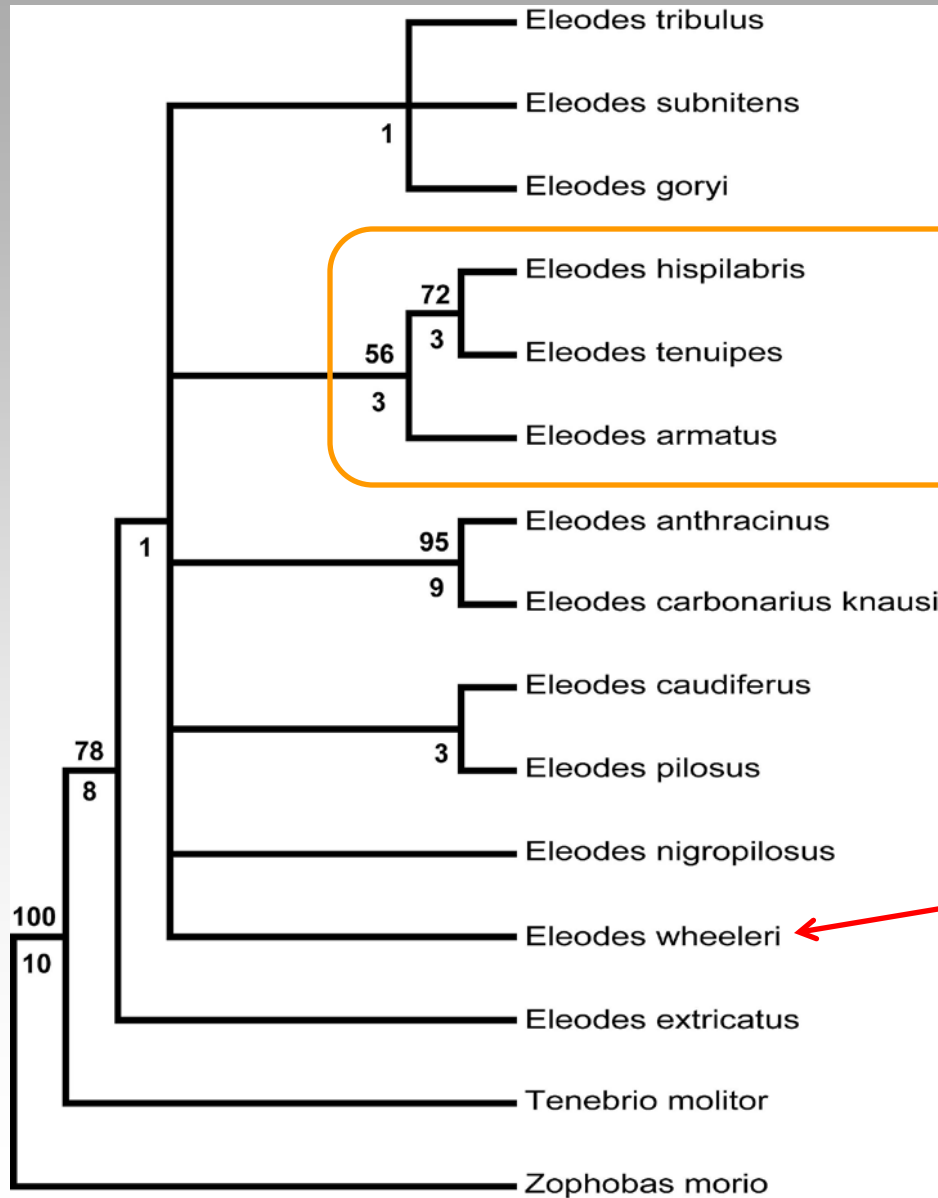
Strict consensus of two most parsimonious trees (L=210) based on larval morphology. Numbers above branches are bootstrap support values, numbers below are Bremer support values.

Cladistic analysis



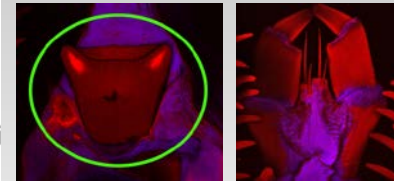
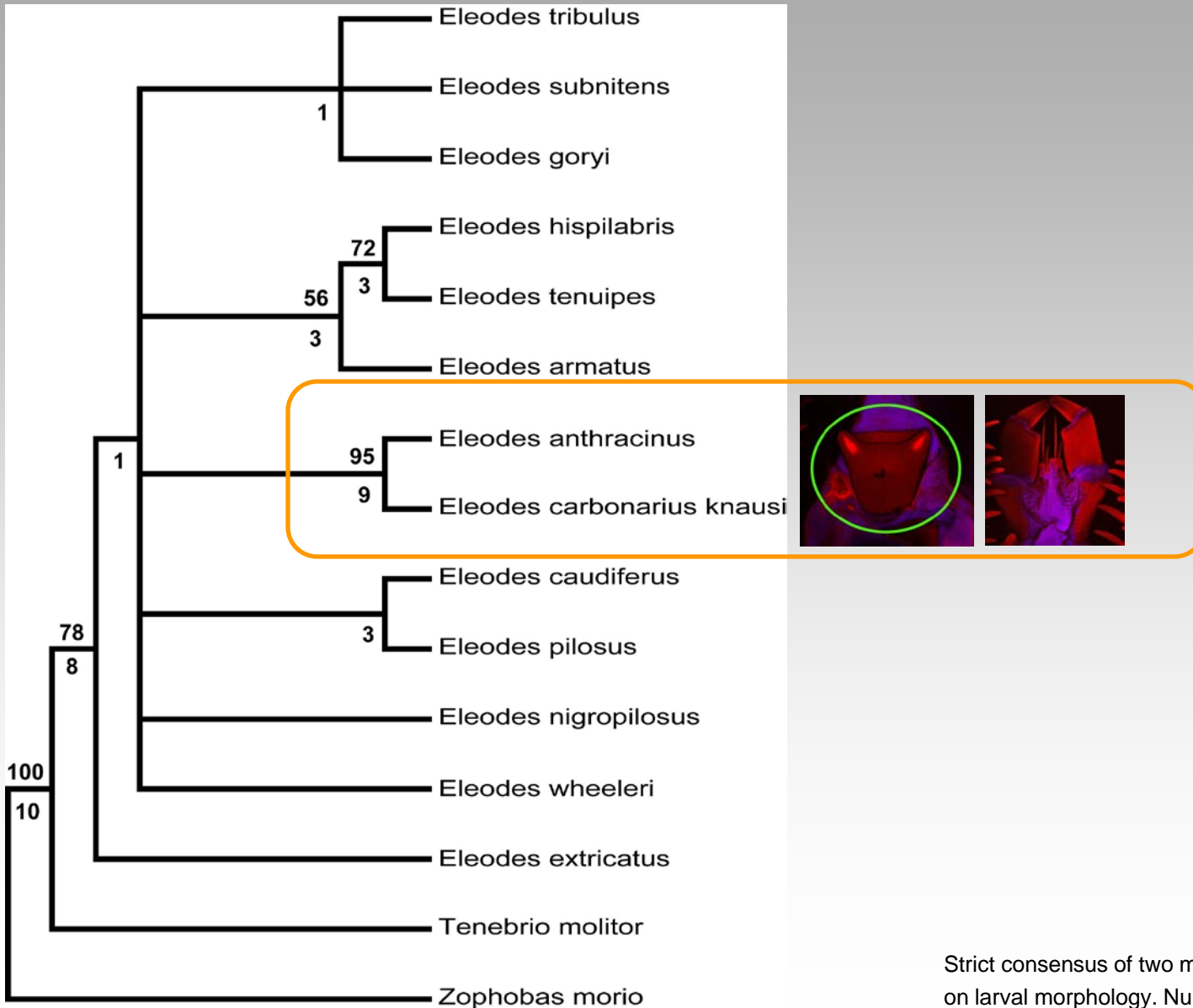
Strict consensus of two most parsimonious trees (L=210) based on larval morphology. Numbers above branches are bootstrap support values, numbers below are Bremer support values.

Cladistic analysis



Strict consensus of two most parsimonious trees (L=210) based on larval morphology. Numbers above branches are bootstrap support values, numbers below are Bremer support values.

Cladistic analysis



Strict consensus of two most parsimonious trees (L=210) based on larval morphology. Numbers above branches are bootstrap support values, numbers below are Bremer support values.

Ongoing Work

- Rearing more species
 - Particularly from un- or underrepresented subgenera
 - 4 *Blapylis* species from Ron Somerby
- Compare phylogeny to other *Eleodes* datasets
 - Adult morphology
 - DNA
 - 8 genes
 - transcriptomes
- Build multi-entry online key to *Eleodes* larvae

Acknowledgements

- Nico Franz, Charles Triplehorn, Rolf Aalbu, Warren Steiner, Ron Somerby, Kojun Kanda, Paul Skelley, David Grimaldi
- Lab assistants and volunteers: Stephanie Delgado, Soon Flynn, Amanda Smith, Jazmine Mayberry, Tiffany Gruna, Erik Posch, Wade Wilbur
- Images: April Rodriguez, James Thostenson, and Andrew Johnston
- Funding: International Institute for Species Exploration, NSF ARTS program (DEB-1258154)



Questions?

