

Scarabaeidae  
Rutelinae MacLeay 1819

## Shining Leaf Chafers



<http://scienceblogs.com/myrmecos/2008/11/friday-beetle-blogging-beyers-scarab.php>

Beyer's scarab, the largest *Chrysina* in the United States, feeds on oak foliage.



Dynastinae

*Megasoma acteon*

[http://www.formandpheromone.com/piece/  
139-Megasoma-11x14-\(SB-5\)](http://www.formandpheromone.com/piece/139-Megasoma-11x14-(SB-5))



**Dynastinae**

*Aphonides dunnianus*, USA

**Scarabaeinae**



*Copris arizonensis*, USA



**Melolonthinae**

*Phyllophaga* species

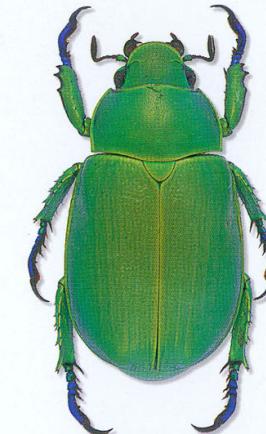
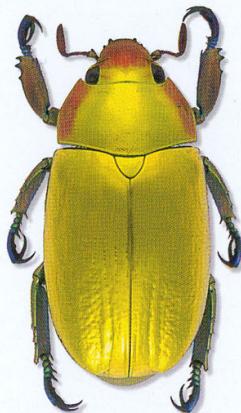
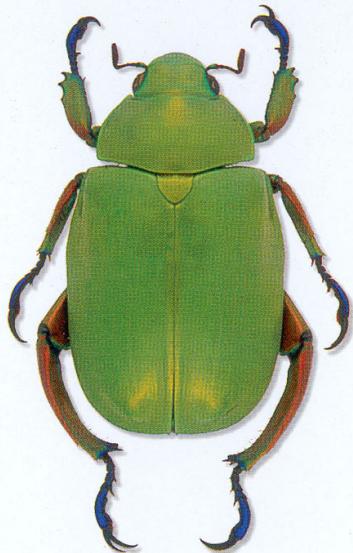


**Aphodiinae**

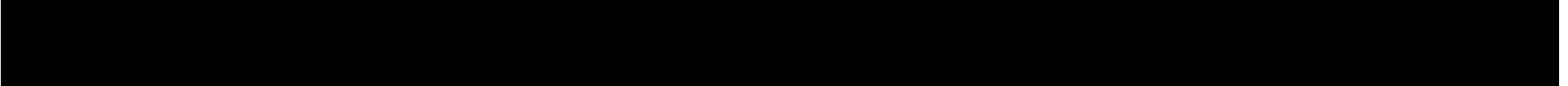
*Ataenius picinus* Harold

<http://bugguide.net/>

# *Jewel Scarabs*



*Chrysina* species (Rutelinae)



# Rutelinae and Human Culture



*Chrysophora chrysochlora* necklace



**Scarabaeidae**  
(Rutelinae)

# Rutelinae and Human Culture



Ecuador headdress



**Scarabaeidae**  
(Rutelinae)

*Chrysophora chrysochlora*

# PHILATELY

## Stamp Collecting



Honduras 2003



Nicaragua 1998

# Rutelinae and Human Culture



Jewelry

# Rutelinae and Human Culture



Fig. 6. Preparation of *P. lutescens*. The elytra, wings, and legs have been removed.



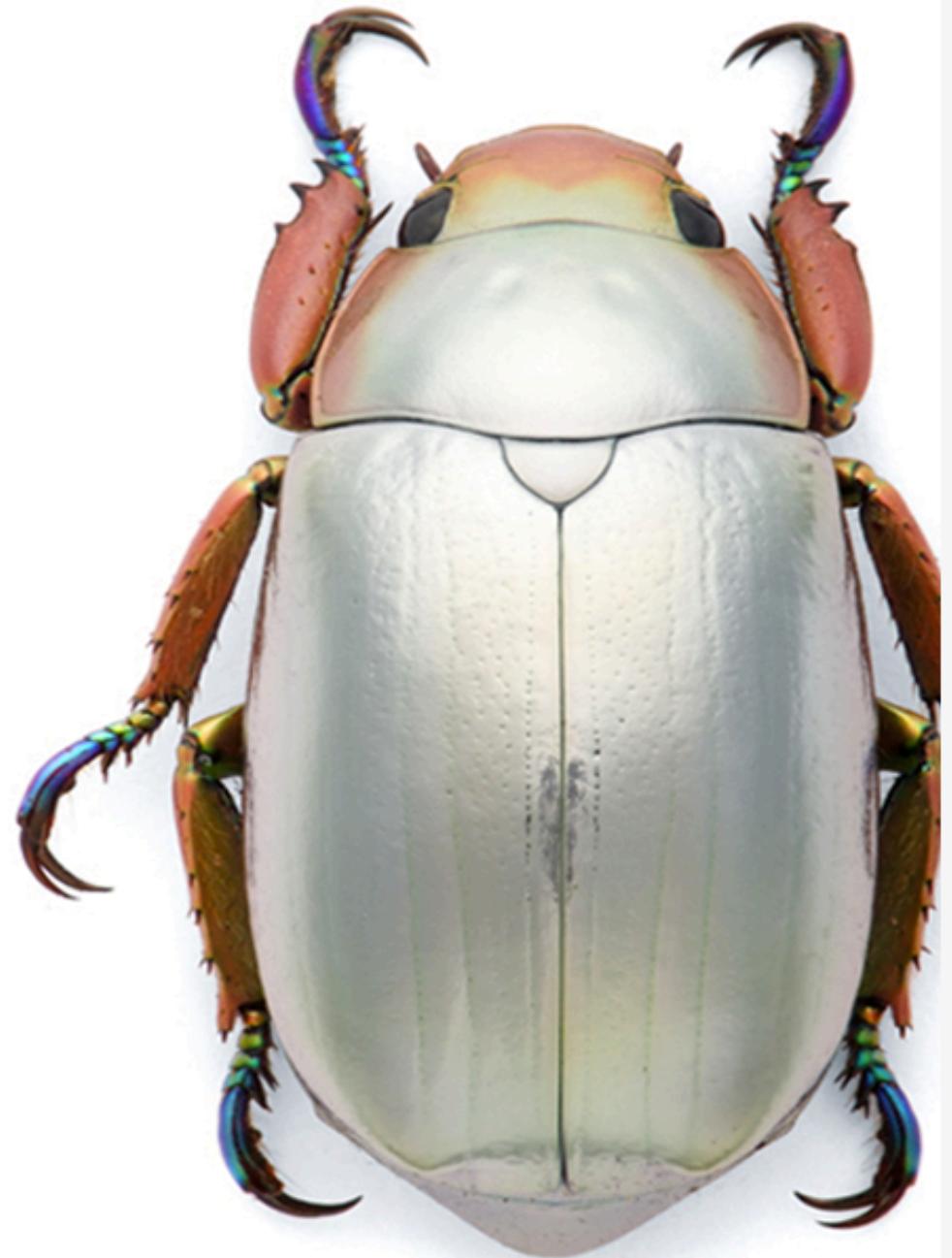
Fig. 8. *P. lutescens* on display at a street market in Quito, Ecuador.



Fig. 7. A typical style of serving *P. lutescens* (on right) with corn (on left).

High cuisine. *Platycoelia* adults are used as food by the indigenous people of the Ecuadorian highlands. Ecuadorians call white-colored *Platycoelia* (mainly *P. lutescens*) “catso blanco.” Adults emerge ‘en masse’ and are seen by the thousands for a short period of time (Smith and Paucar 2000).

**Leaf chafers SHINE!**



<http://www.formandpheromone.com/catalog/search/scarab>

J E W E L



S C A R A B S

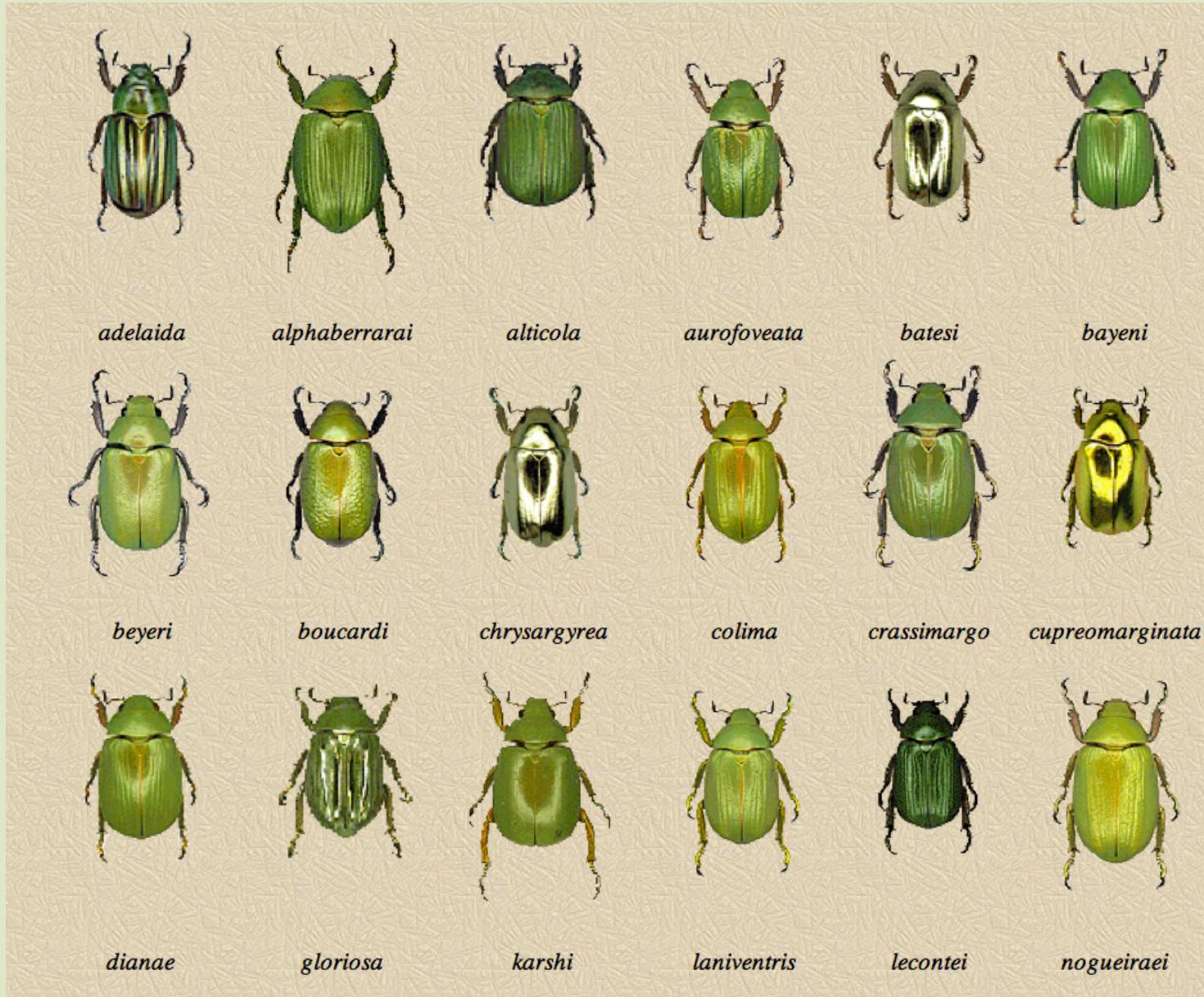




Silver Jewel Scarab (*Chrysina chrysargyrea*)  
Costa Rica



# Jewel Scarabs: Circular Polarized Light



## Beetles Stand Out Using 'Avatar' Tech

April 19, 2010

redOrbit

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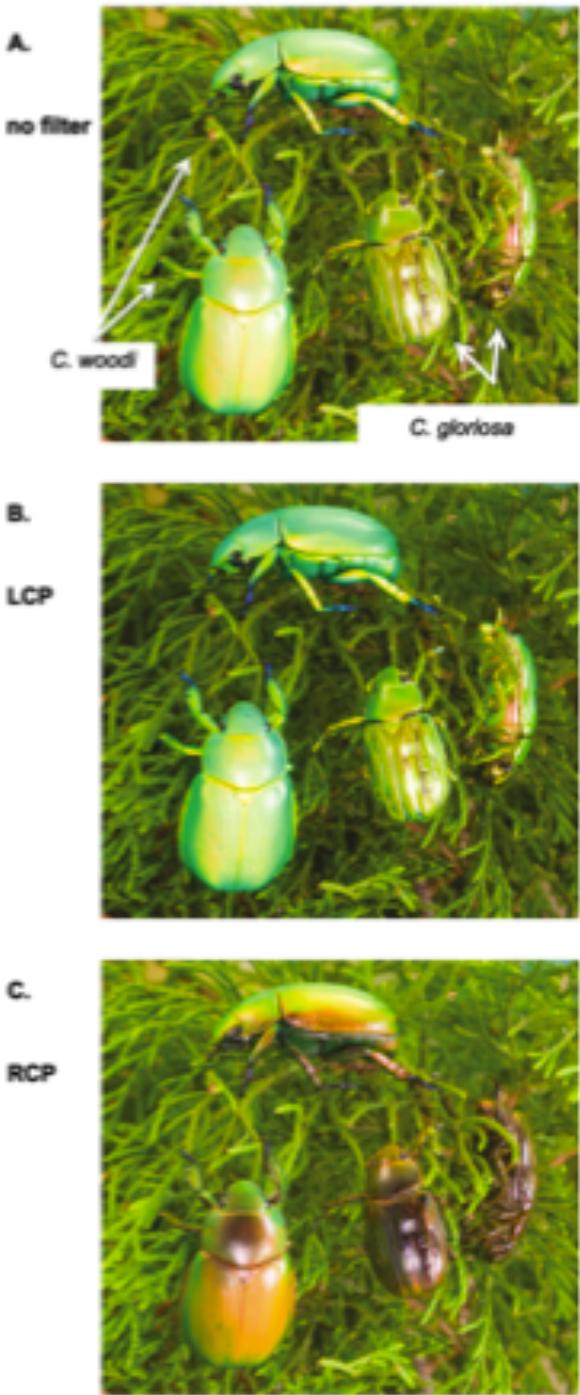
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[http://www.redorbit.com/news/oddities/1851902/  
beetles\\_stand\\_out\\_using\\_avatar\\_tech/index.html](http://www.redorbit.com/news/oddities/1851902/beetles_stand_out_using_avatar_tech/index.html)



A new study suggests that jewel scarab beetles find each other "and hide from their enemies" using the same technology that creates the 3D effects for the blockbuster movie Avatar.

According to researchers from the University of Texas, the jewel scarab species *Chrysina gloriosa* can distinguish between circularly polarized and unpolarized light. That ability could provide the beetles with a tremendous advantage, the researchers say, because most of the light reflected off these beetles' colorful bodies happens to be circularly polarized.



# Circular Polarized Light

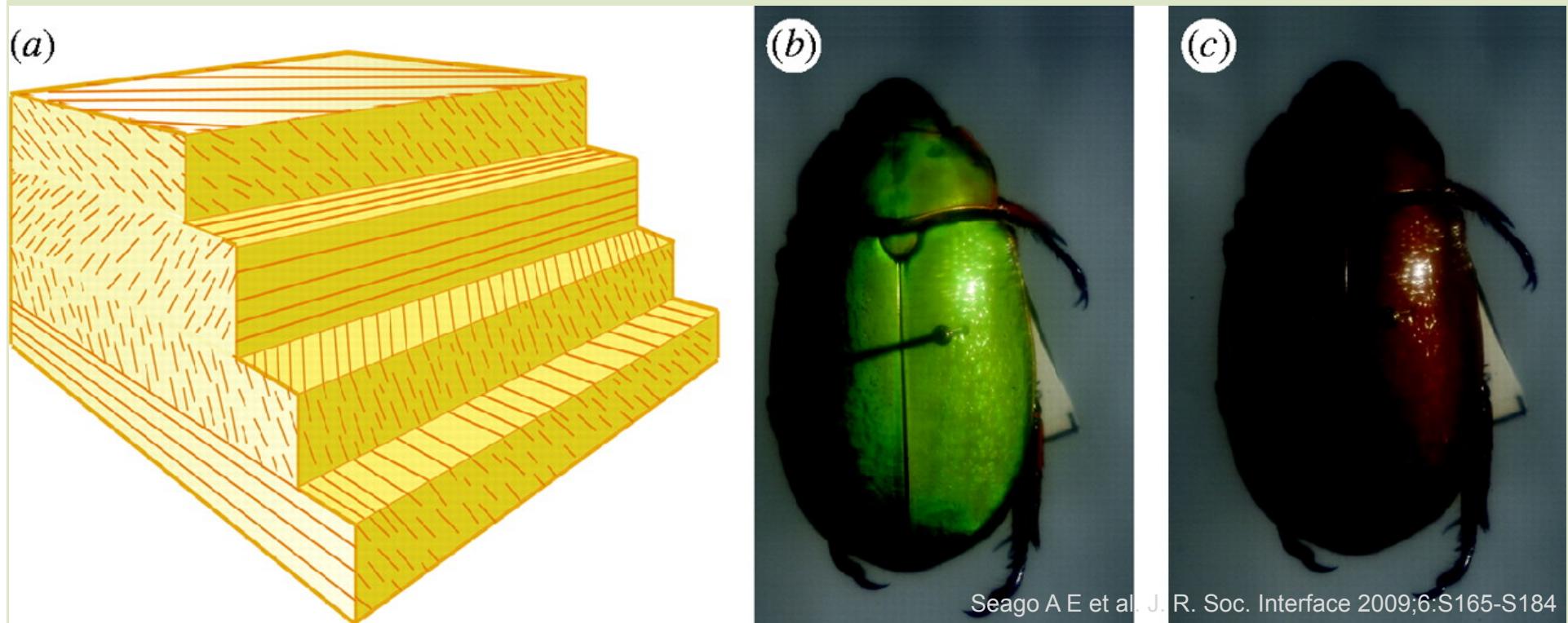
The ability to see circular polarized light is very rare in nature. *Chrysina gloriosa* is only the second species on Earth known to be sensitive to circular polarized light—the other being a species of shrimp. Thus, it's not likely that any of the beetles' predators can see it.

So the ability to both see and reflect circular polarized light probably evolved to allow jewel scarabs to communicate with each other while staying hidden from predators.

Photographs of *Chrysina gloriosa* (smaller) and *Chrysina woodi* (larger) on juniper branches, with (A) no filter and (B) left circularly polarized and (C) right circularly polarized filters. Photographs by John C. Abbott.

Brady and Cummings. 2010. American Naturalist 175: 5

# Circularly Polarized Multilayer Reflectors



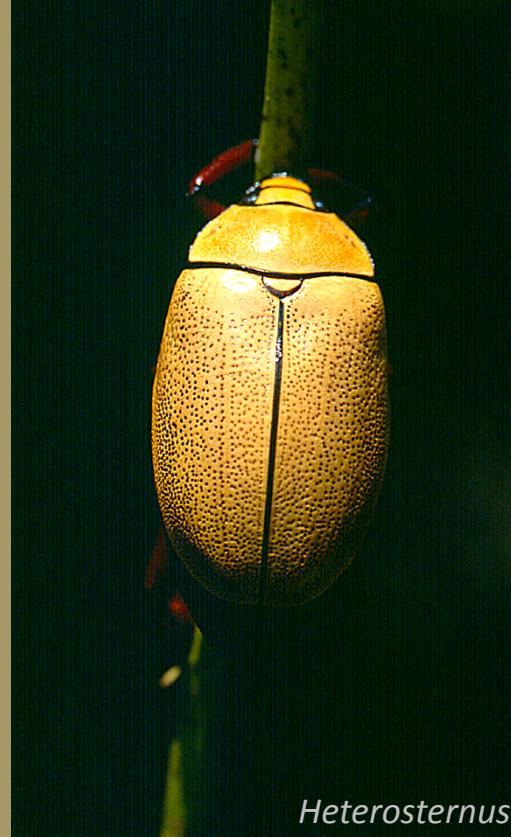
Circularly polarized multilayer reflectors.

(a) Schematic of helical multilayer reflector, (b) *Chrysina boucardi* viewed through quarter wave plate rotated 0°, and (c) *Chrysina boucardi* viewed through quarter wave plate rotated 90° clockwise.

# Wide Array of Forms: Enlarged Hind Legs



*Macropoidelimus mnizechi*



*Heterosternus oberthuri*, Panama



*Heterosternus oberthuri*, Panama

# Wide Array of Forms: Horns



Brett Ratcliffe and the horny gate in Saskatchewan, Canada

# Rhino Beetle Horns



*Allomyrina dichotomia*



*Chalcosoma atlas*



*Eupatorus gracilicornis*



*Golofa pizarro*

# Horny, But Not Rhino Beetles!



*Cyprolais cornuta*



*Dicranocephalus wallichi*



*Cyprolais loricata*



*Eudicella gralli*



*Rhamporrhina bertolonii*



*Stephanorrhina guttata*

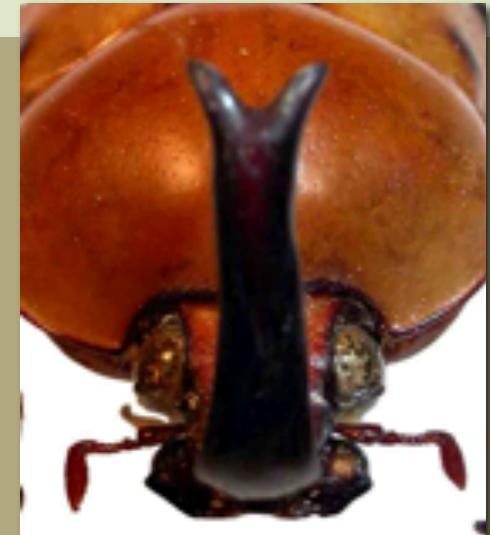
# Horny, But Not Rhino Beetles!



*Kibakoganea formosana*



*Ceroplophana modiglianii*



*Ceroplophana modiglianii*



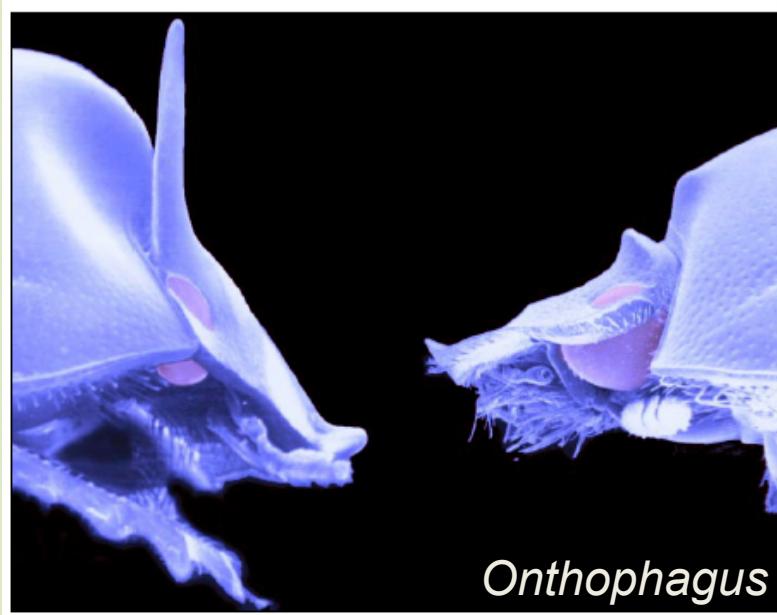
*Dicauchocephalus feae*



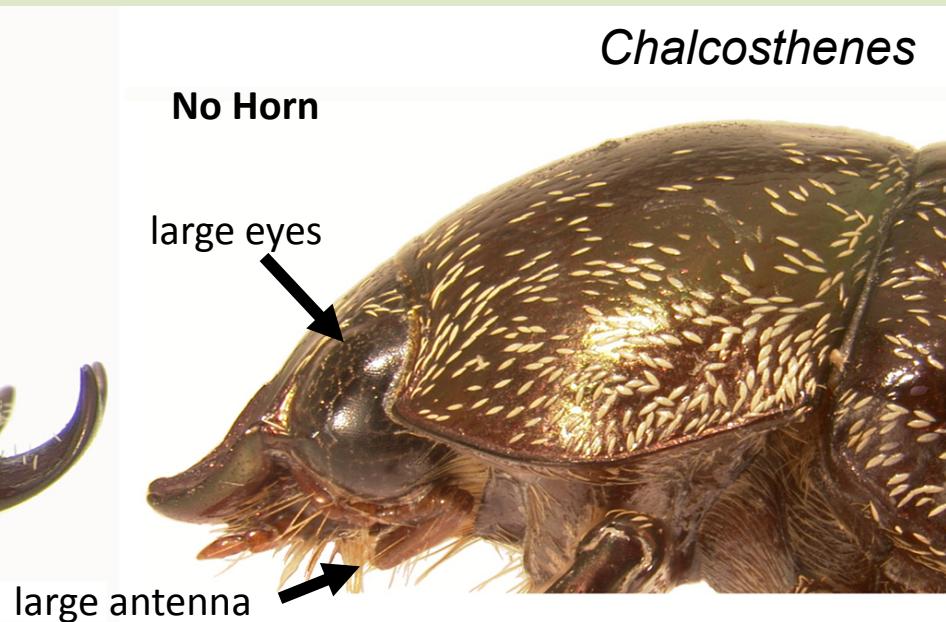
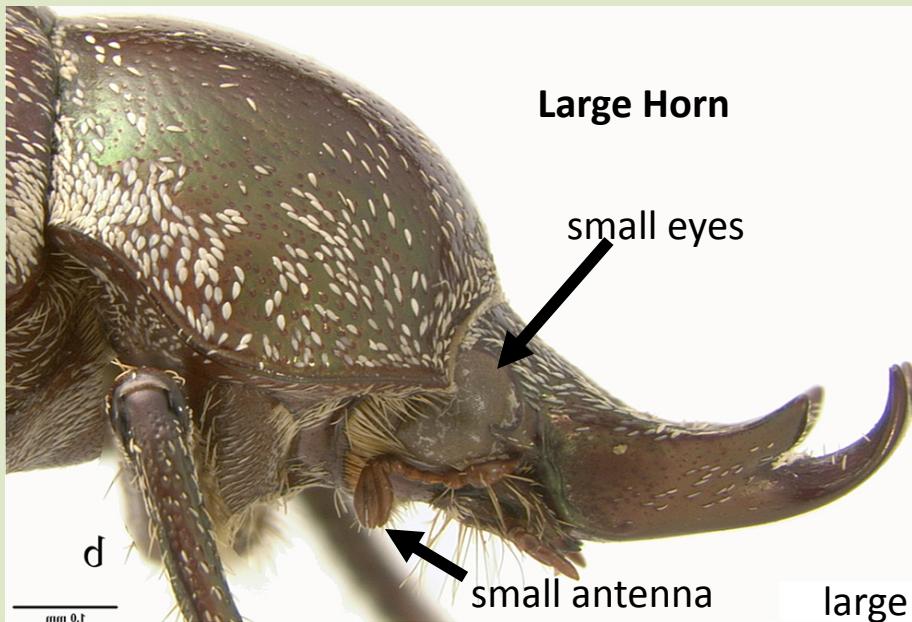
*Peppernota harringtoni*

# Developmental Trade-offs

In the same species of *Onthophagus*, males with long horns have proportionately smaller eyes than males with short horns.



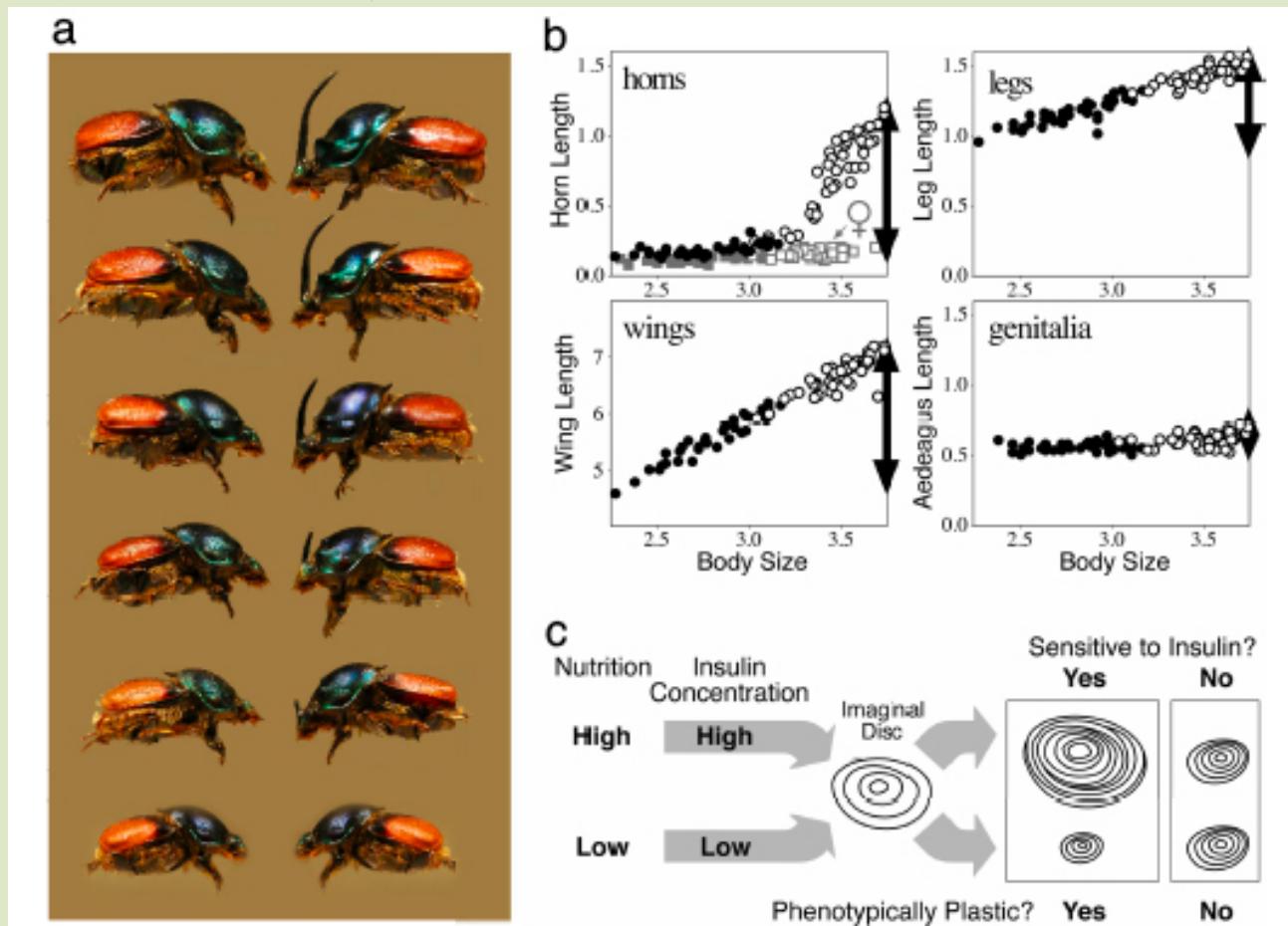
Developmental trade-offs can be observed between species in the same genus as well (such as *Chalcosthenes*).



# Developmental Trade-offs

Nutrition-dependent phenotypic plasticity and allometry affect development of horns, wings, genitalia, and legs.

Developmental trade-offs result in stunted relative growth of adjacent structures.

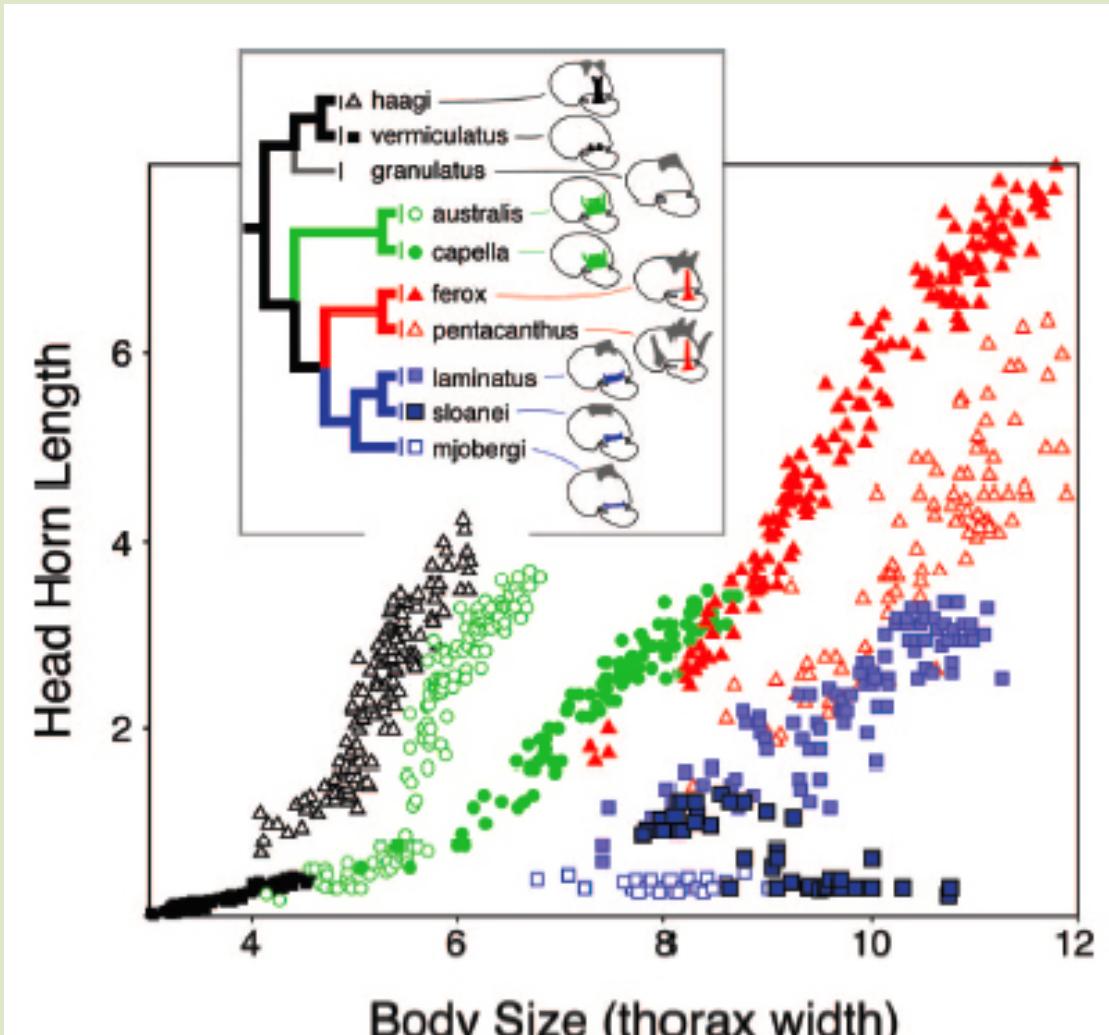


Emlen et al. 2007

# Modifications in Development Drive Morphological Divergence

Rapid evolutionary-developmental modification leads to diversification in populations

Insularity, such as on different islands or on mountain ranges, could lead to divergence between populations.



**Fig. 1.** Evolution of horn allometry. Horn length–body size scaling relationships shown for the head horns of nine Australian species of *Onthophagus*, representing a well supported monophyletic clade within the phylogeny of Emlen et al. (29).

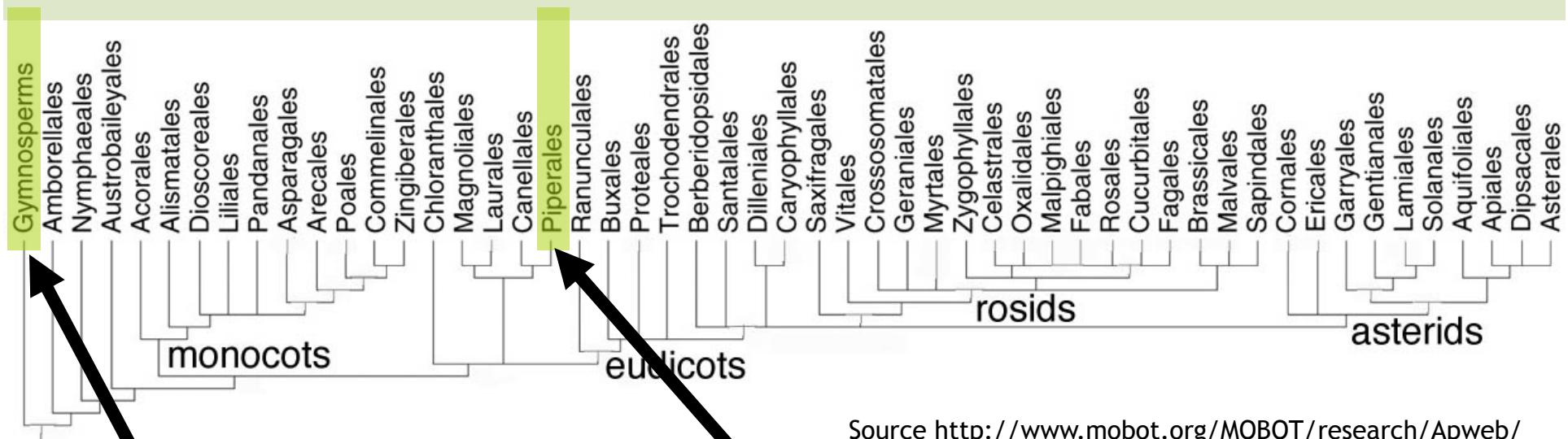
Emlen et al. 2007

# Ruteline Pollinators and Pollen Feeders

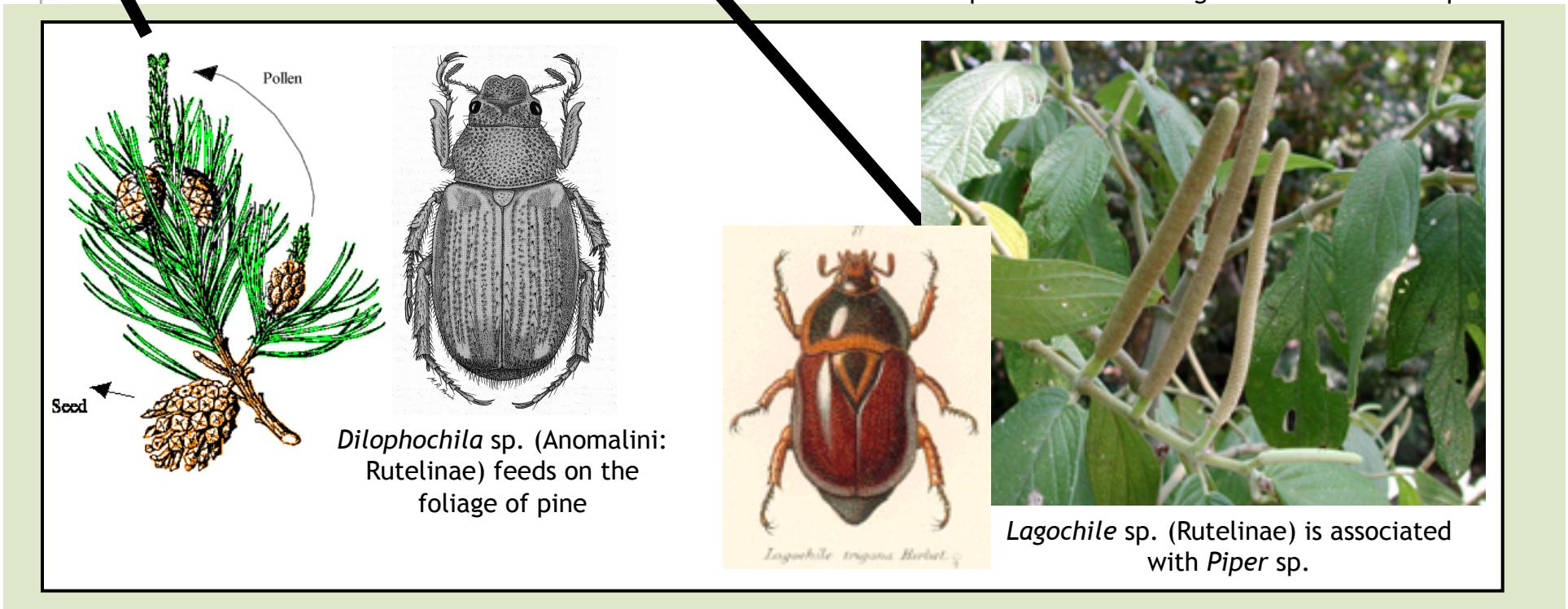


*Chaetopteroplia segetum* feeding on grass pollen

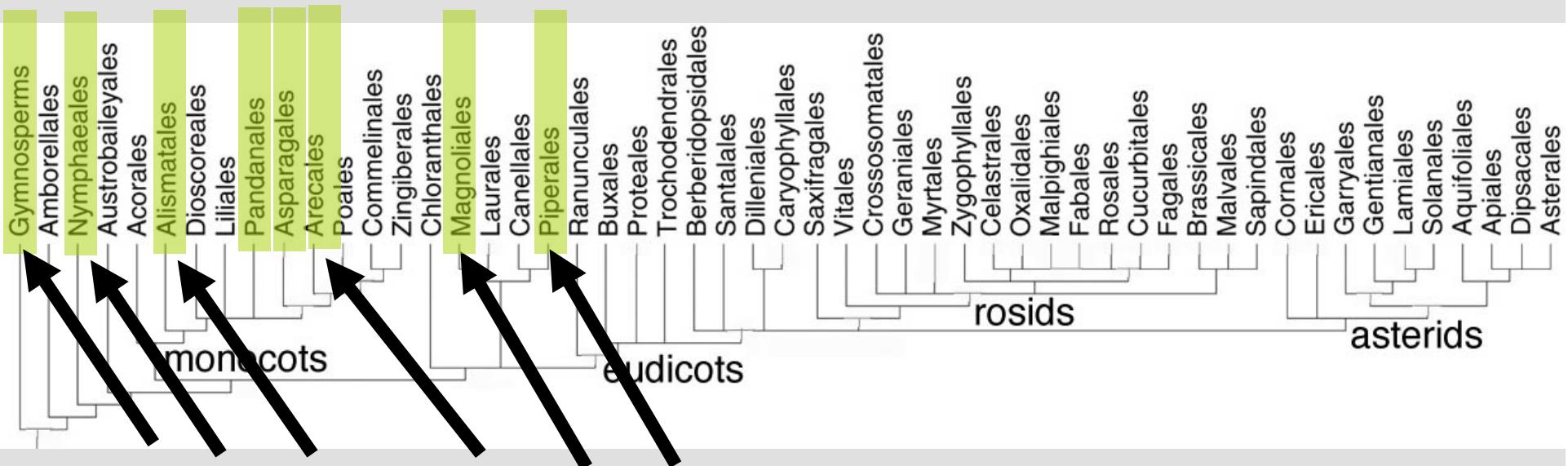
# Ruteline Pollinators and Pollen Feeders



Source <http://www.mobot.org/MOBOT/research/Apweb/>



# Scarab Beetles and Palms



Palms  
(Arecales)



*Cyclocephala* sp.  
(Dynastinae)  
on palm



*Cyclocephalini*  
(Dynastinae) enter flowers  
at night



*Cyclocephala* sp.  
(Dynastinae)  
on *Dieffenbachia* sp.



Beetles on  
spathe  
covered  
with resin and  
pollen

# Ruteline Pollinators and Pollen Feeders

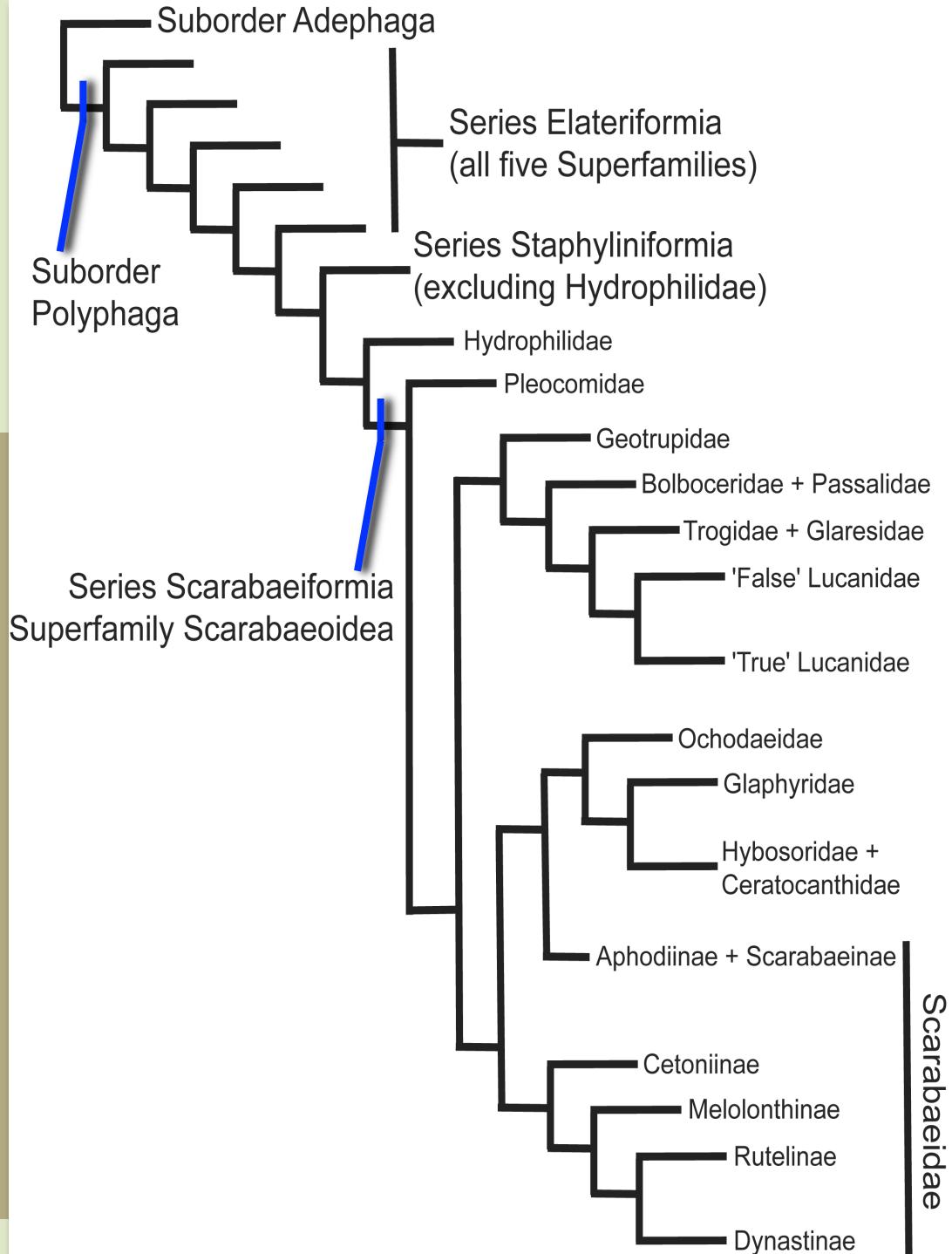


<http://www.koleopterologie.de/gallery/>

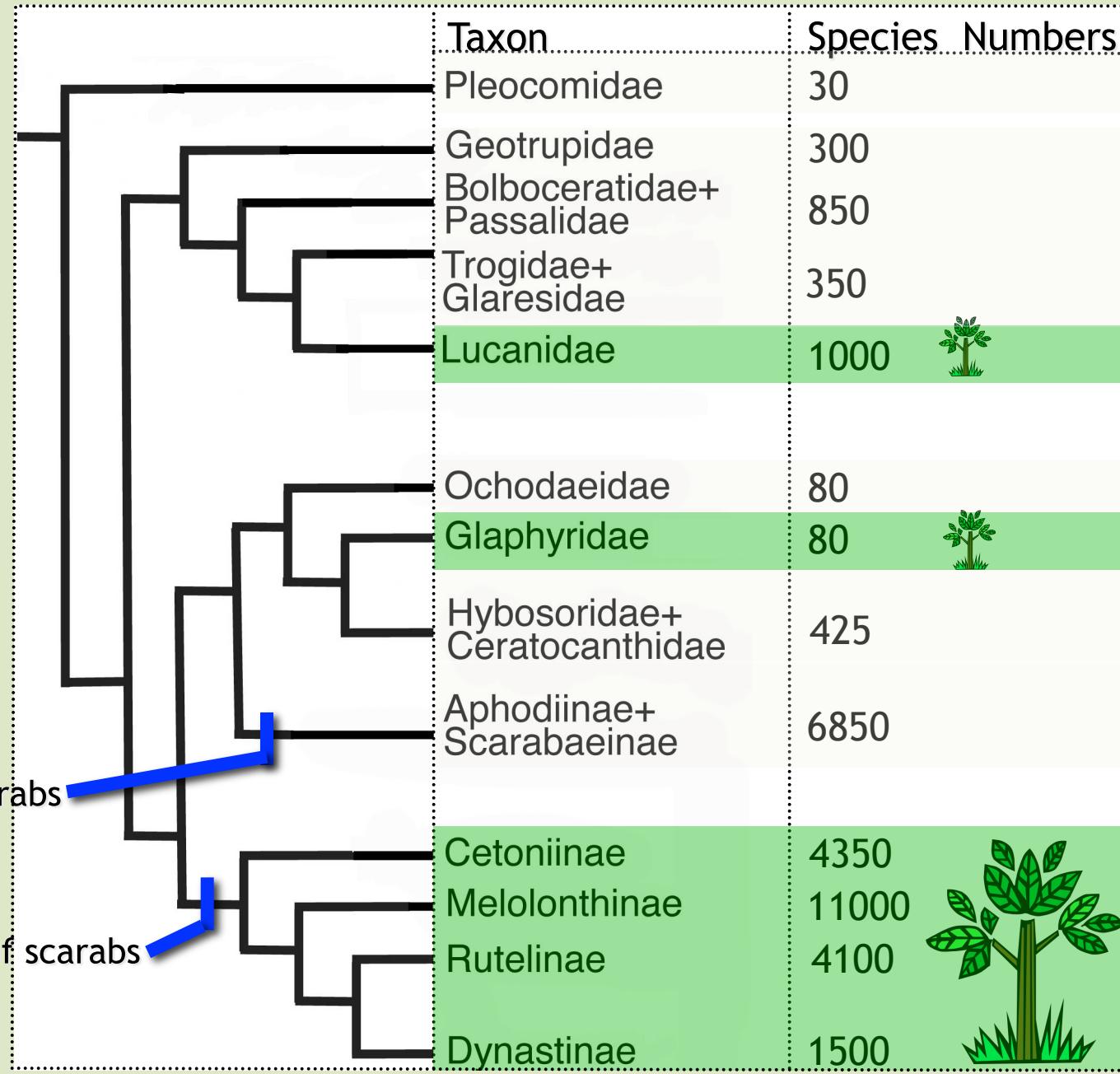
*Blitopertha campestris* (Anomalini) with pollen grains on cuticle

# Phylogeny of Scarabaeoids Based on Molecular Data

- 28S D2/D3, 18S rDNA (2077 bp)
- About 700 exemplars
- 936 informative characters in Scarabaeoidea
- Maximum parsimony



# Diversity in Angiosperm-Associated Scarabs

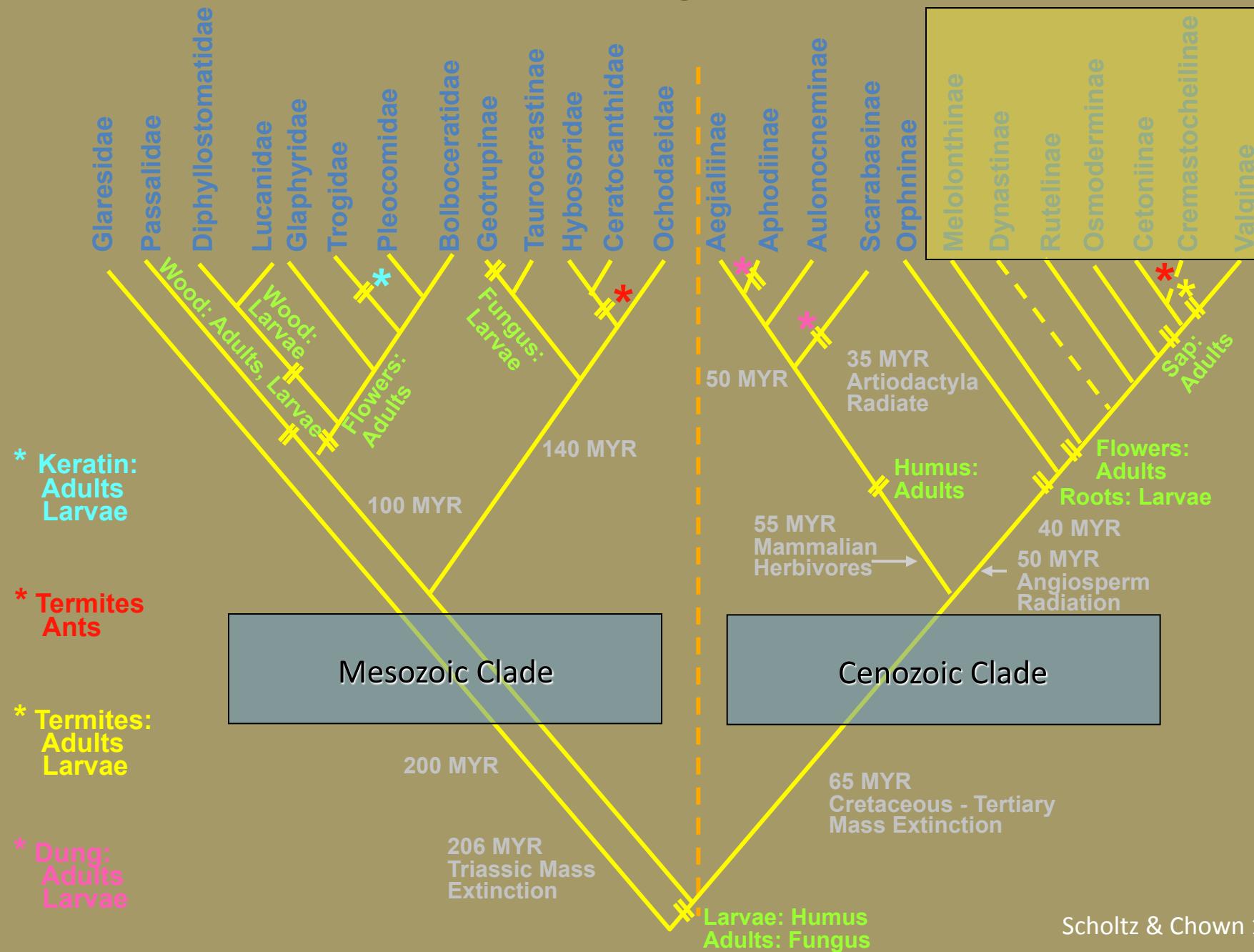


# Clean-Living Scarab Beetles



Can you find the  
non-scarab?

# Evolution of Feeding Habits in Scarabs



# Generalized Life Cycle



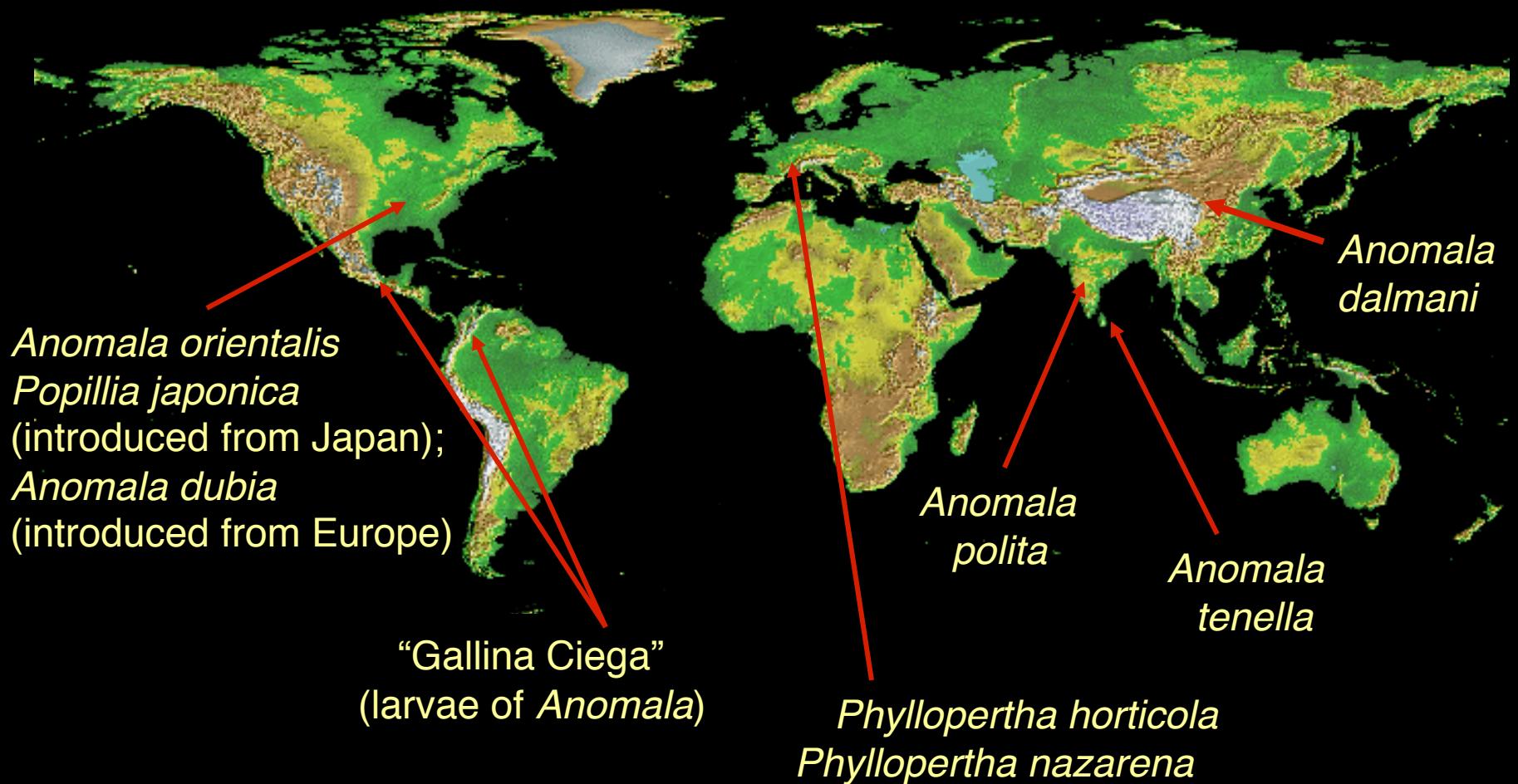
Adults → leaf feeders

Larvae → root feeders



*Popillia japonica*  
The Japanese Beetle

# Agricultural Pests



The USDA/APHIS at Miami averages 20 interceptions of *Anomala* per year.  
In the last five years, only one could be reliably named to species.

# Collecting Rutelinae

- Adults are *both diurnal and nocturnal*, and they have many feeding habits.
- Adults can be collected using many methods:  
Lights, flight intercept trap, fruit traps, chemical lures, gleaning, beating.







# Like Moths to a Flame

Why are insects attracted to lights at night?

Idea #1: Unnatural light sources throw off internal navigation systems. Insects navigate by transverse orientation -- flying at a constant angle relative to a distant light source, such as the moon. Around human-made lights, such as a porch light, the angle to the light source changes as the insect approaches.

Idea #2: Artificial light and fire light emit a few of the exact same frequencies of light given off by female moths' pheromones (yup... some pheromones are very weakly luminescent).

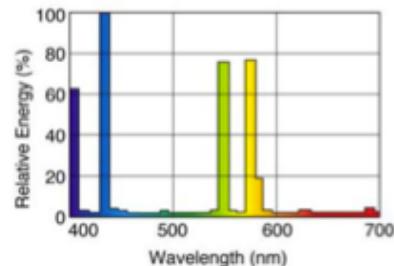
Idea #3: Some insect eyes, which contain multiple lenses, cannot easily adjust from light to dark. Once attracted to the light, it may be safer for the insect to remain there rather than fly away and become too blind to react to threats and obstacles.

Many diurnal insects use the sun to navigate, and it has been discovered some nocturnal insects use the moon to navigate.

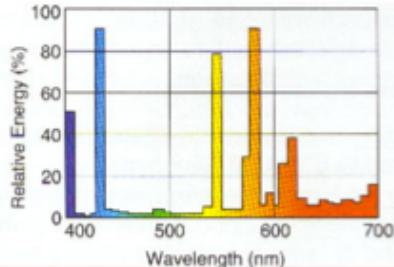


# Insects and Light

Mercury Vapor, 250W Ballasted, 5,700K

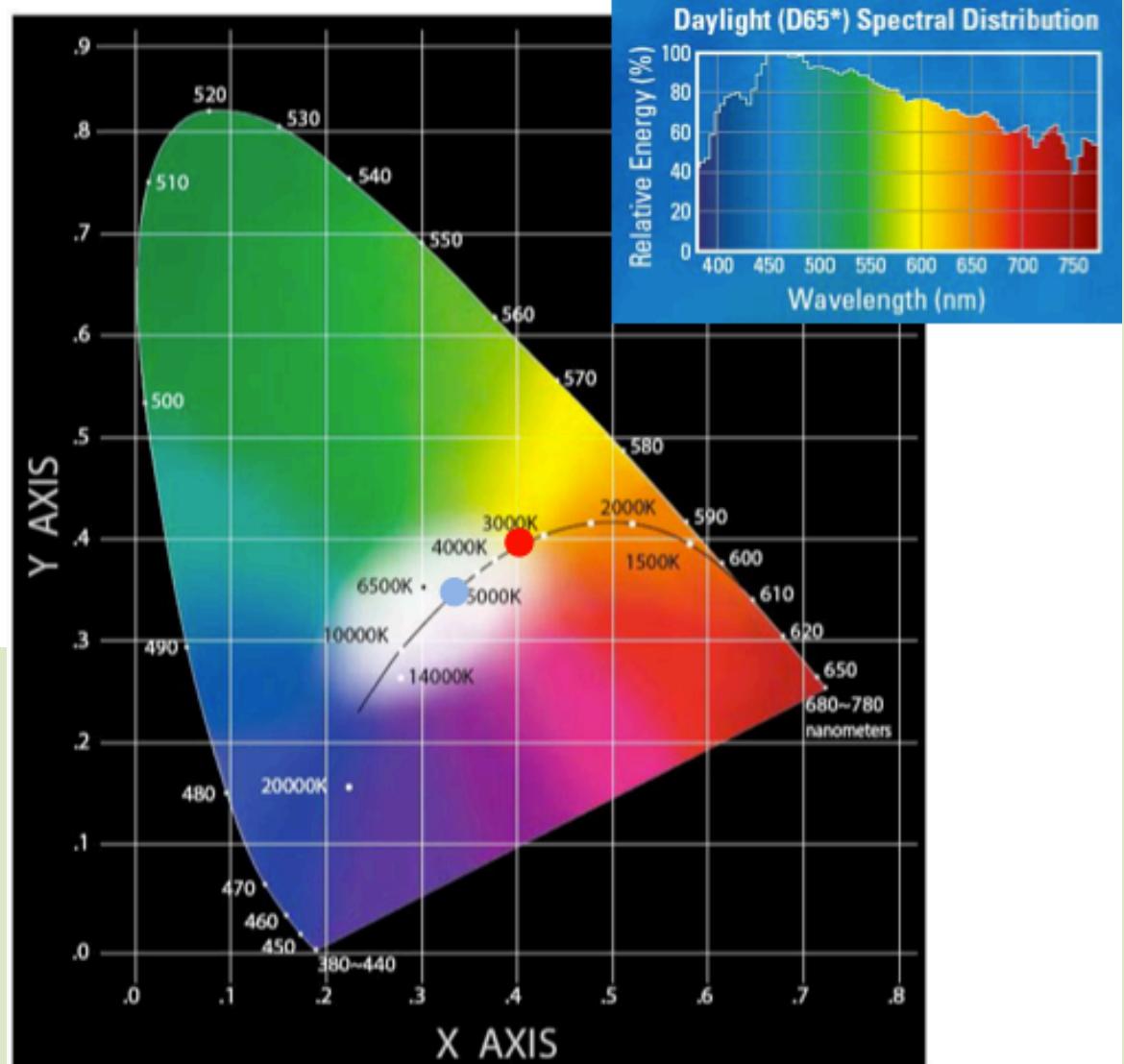


Mercury Vapor, 250W Self-Ballasted, 3,300K



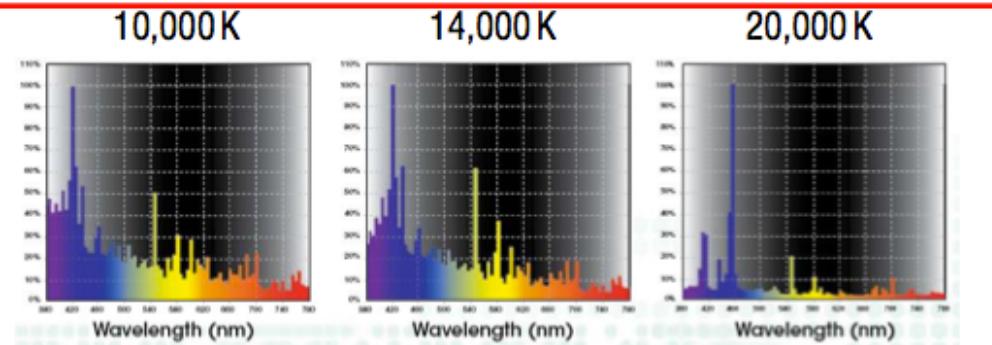
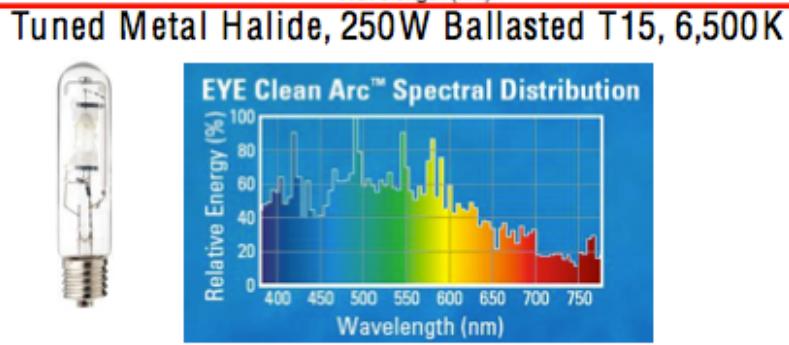
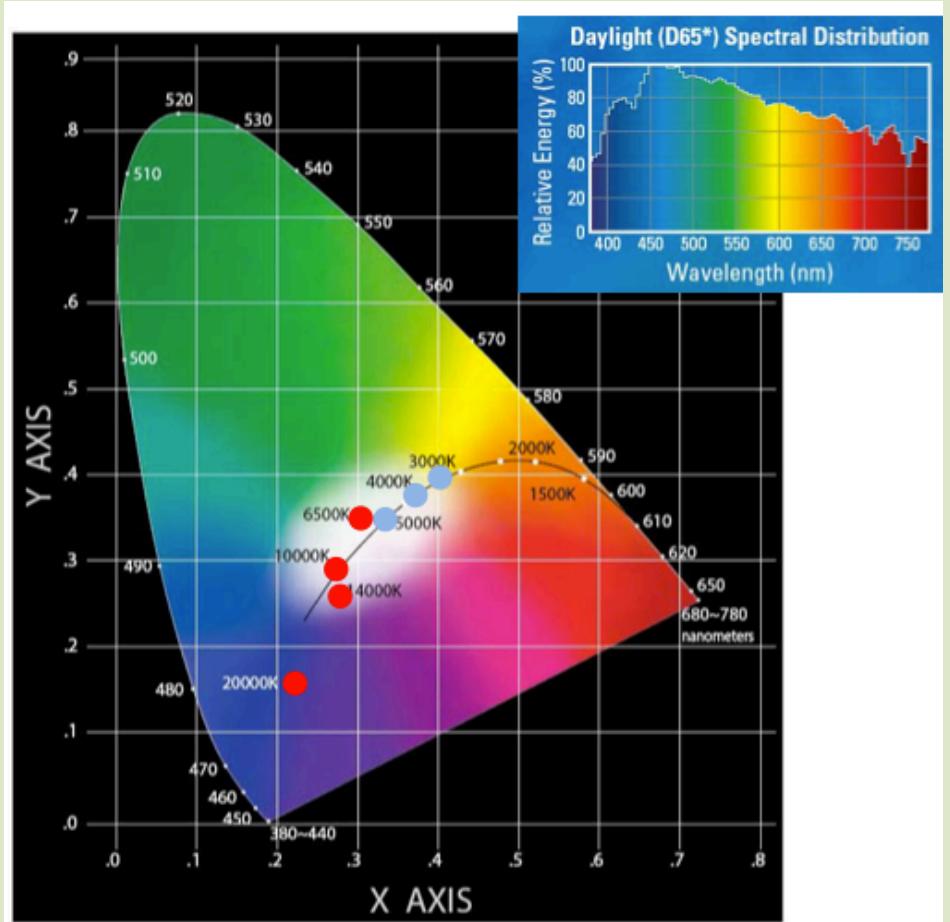
The light that we are using here is a frosted, self-ballasted MV. Note that it provides much light in the red spectrum. An unfrosted bulb is better.

However, MV bulbs will soon be discontinued.



# Insects and Light

Bulbs that are developed for aquarium fish provide a better spectrum for insects. The 20,000 K tuned metal halide bulb provides a wavelength that may be the most attractive to the most insects.



# What is a Ruteline?

- Form elongate oval.
- Labrum produced weakly beyond apex of clypeus (except in *Anomalacra* [Anomalini]).
- Antenna with 9 or 10 segments, antennal club with 3 segments.
- Mesotibial apex with 2 spurs; spurs mesad, adjacent (not separated by basal metatarsal segment).
- Tarsal claws on all legs independently movable, claws unequal in length or size and frequently weakly split at apex, 1 claw of each pair greatly reduced (1 claw lacking on all legs in *Leptohoplia* [Anomalini]).
- Onychium laterally flattened.
- Pygidium exposed beyond apices of elytra.
- Anterior coxae transverse.
- Scutellum exposed.



*Chrysina beyeri*, Arizona

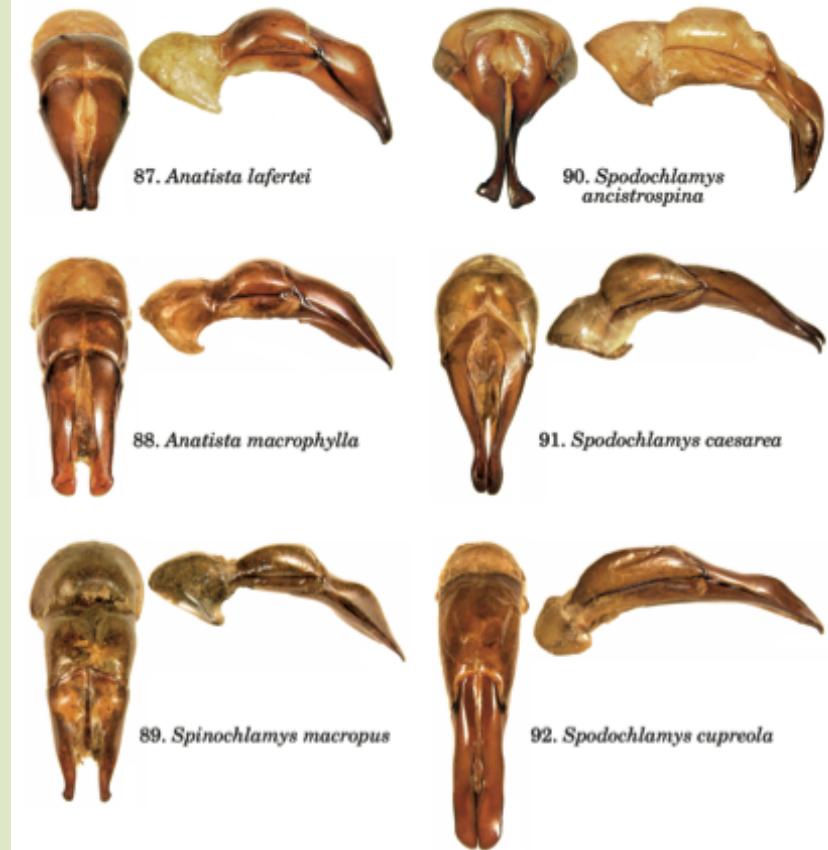
<http://scienceblogs.com/myrmecos/2008/11/friday-beetle-blogging-beyers-scarab.php>

# What is a Species?

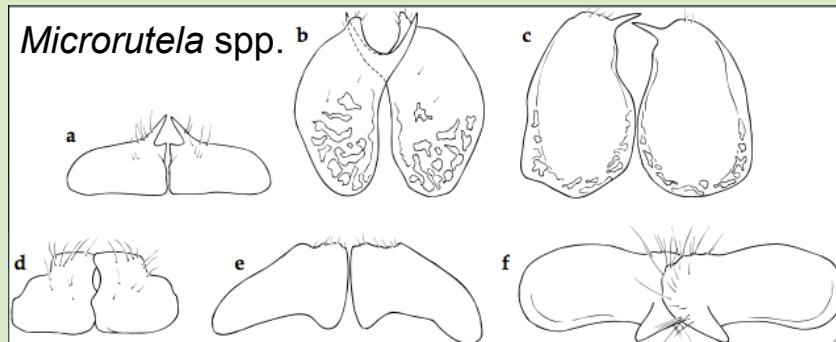
“... a species is the smallest aggregation of (sexual) populations or (asexual) lineages diagnosable by a unique combination of character states.” (Wheeler and Platnick 2000)

He who loves practice without theory is like a sailor who boards ship without a rudder and compass and never knows where he may cast.

--Leonardo da Vinci



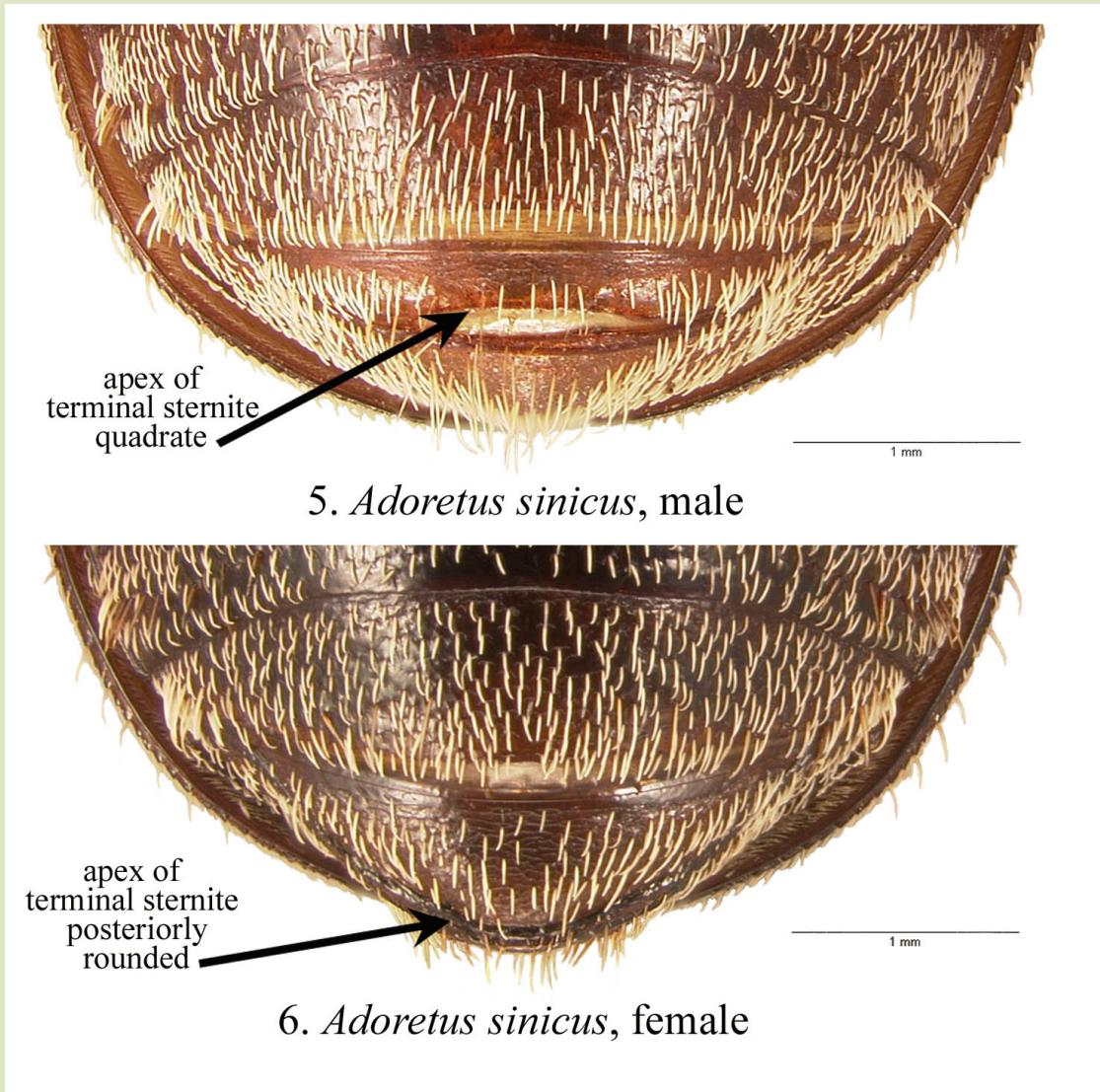
Form of the male parameres is used to separate most species.



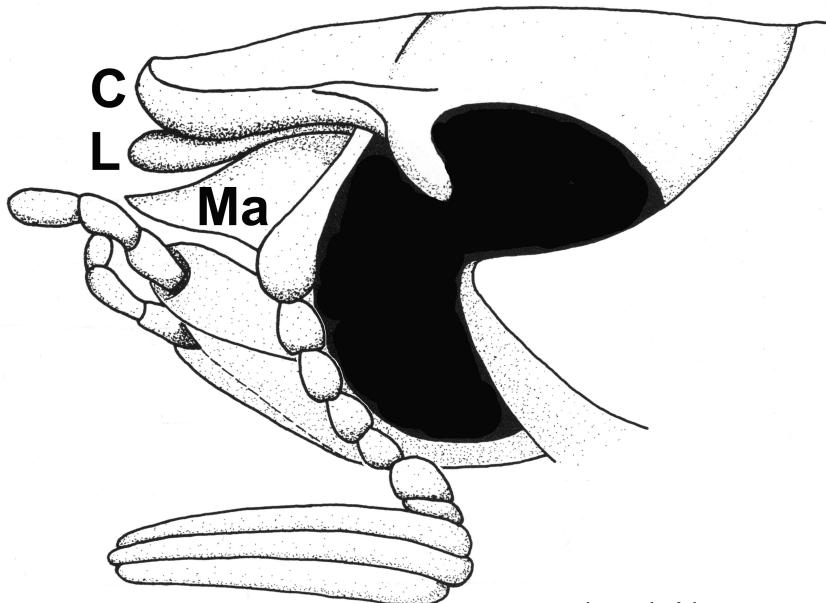
Form of female gonocoxites may or may not be useful for separating species.

# Male or Female?

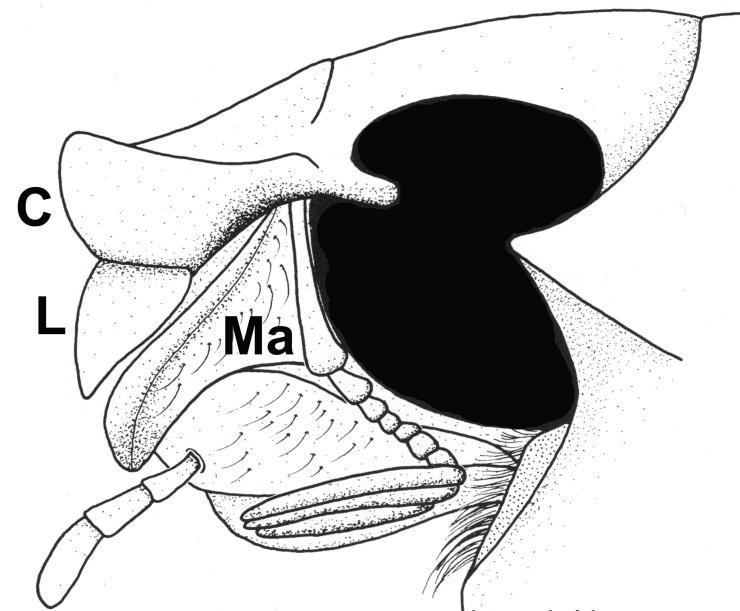
- Foreclaws of males versus females (one claw enlarged in males; both claws similar in females)
- Epipleuron of females wider than males
- Sternites of male concave; sternites of female convex
- Apex of terminal sternite quadrate in males; posteriorly rounded in females.



# Two Basic Ruteline Groups

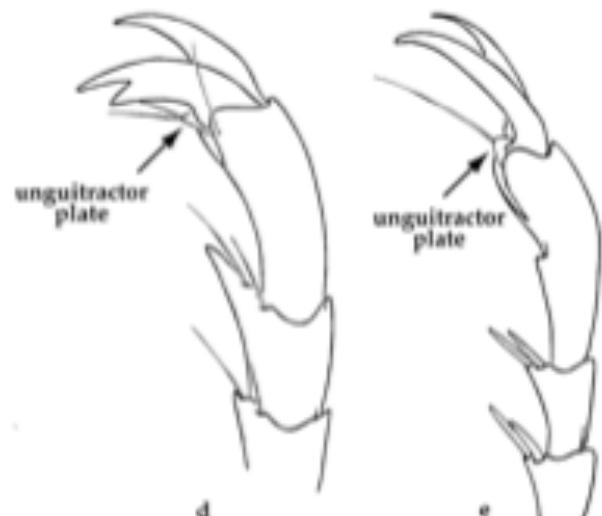
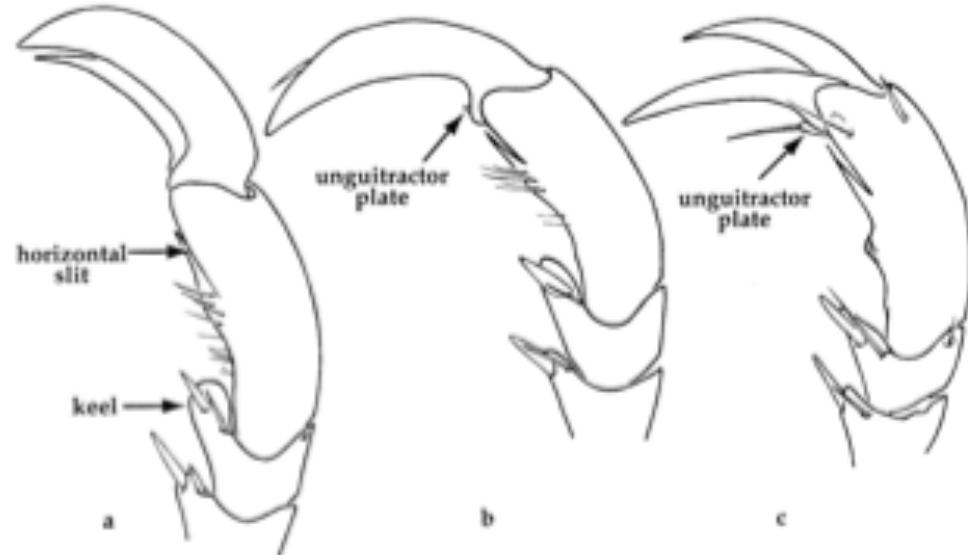


Homalochilous



Orthochilous

# Ruteline Claws: A Discerning Character



Dynastinae



Claws of Rutelinae are independently movable, unequal in size, and usually split at the apex. The unguitractor plate is laterally flattened. Compare the claws on this slide with a typical dynastine.

# Ruteline Claws: A Discerning Character

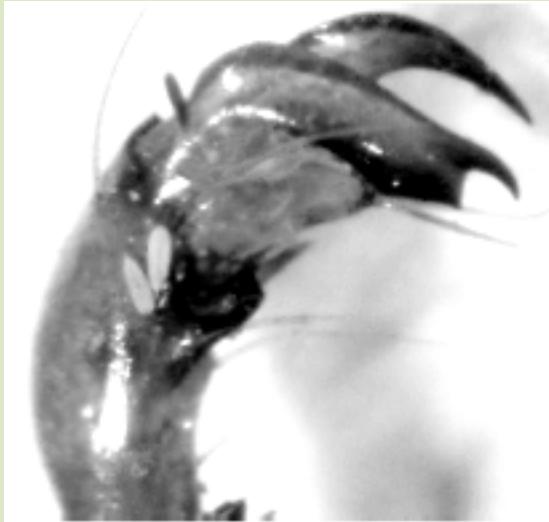


Fig. 11. *Platycocelia alternans* male protarsal claw.

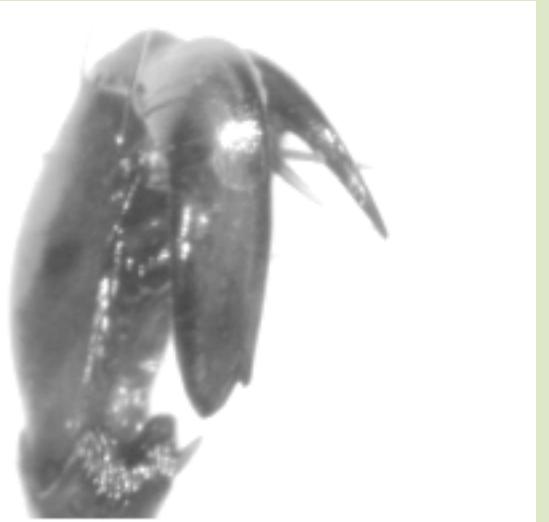


Fig. 12. *Platycocelia valida* male protarsal claw.

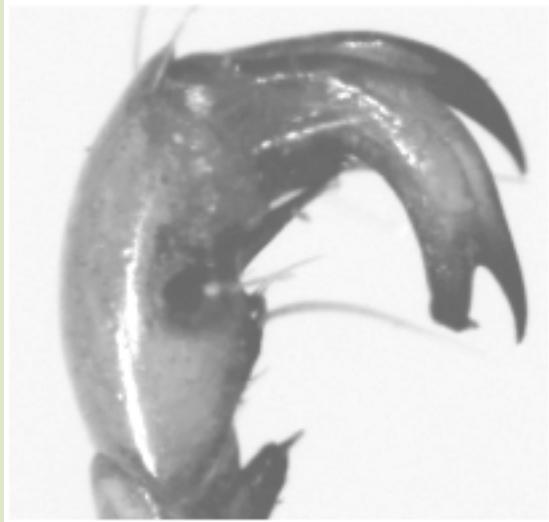


Fig. 13. *Platycocelia grandicula* male protarsal claw.

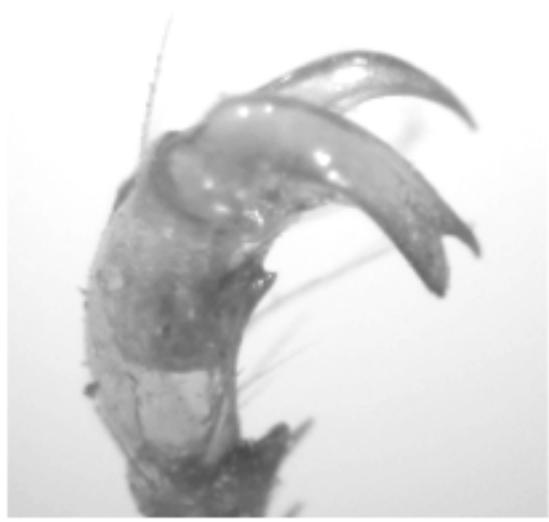
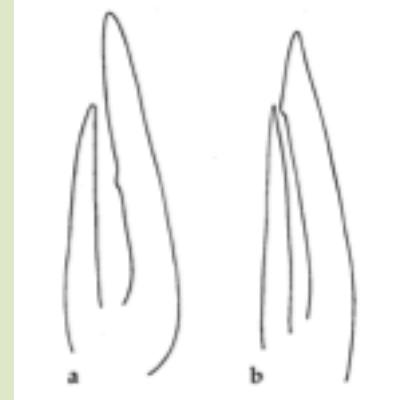
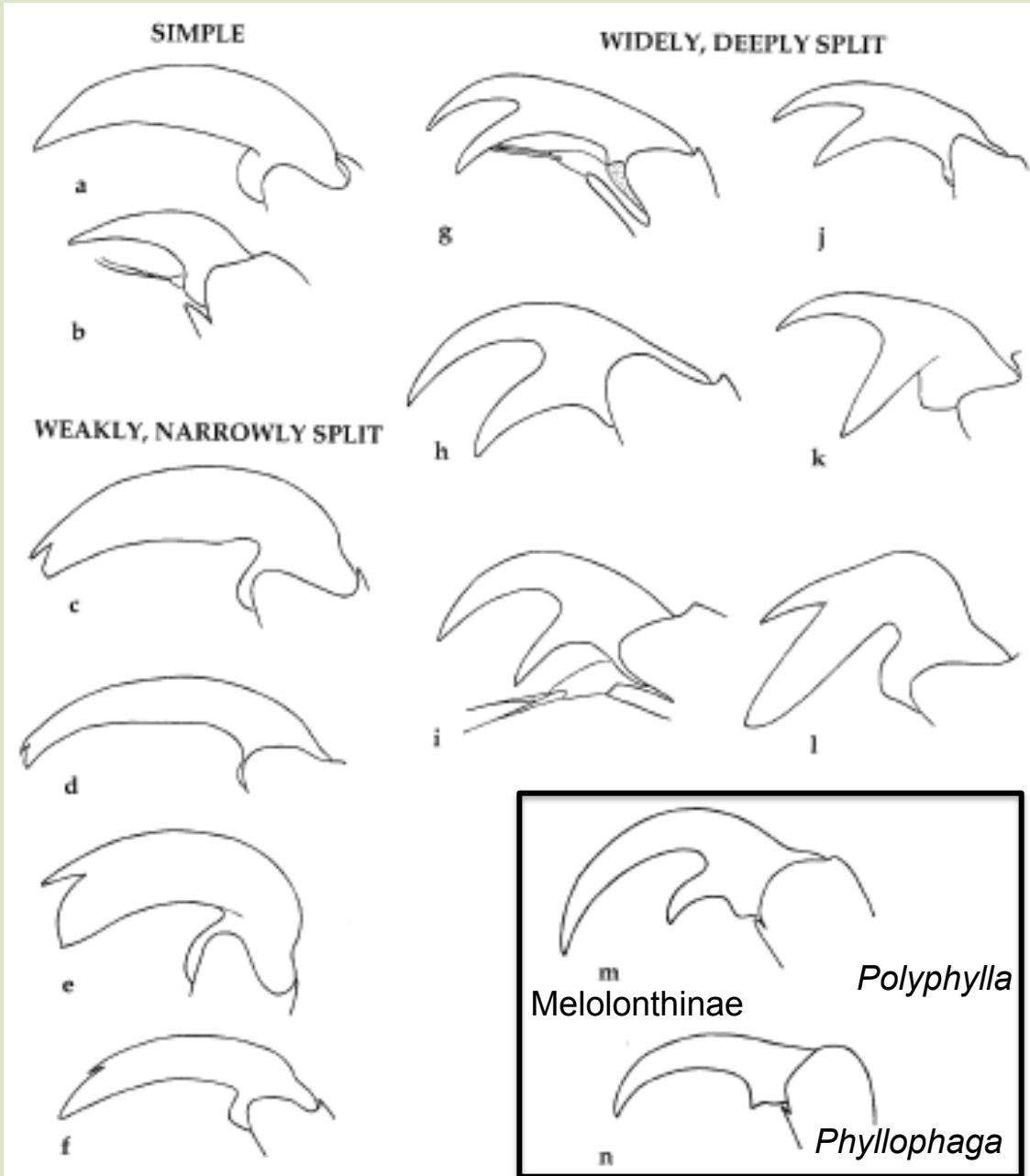


Fig. 14. *Platycocelia chrysotina* male protarsal claw.

Smith 2003

# Ruteline Claws: A Discerning Character



Protarsomere claws often have an inner tooth (above).

The split in Rutelinae differs slightly from the Melolonthinae, but the key characteristic is that the claws are independently movable in the Rutelinae.

# Rutelinae Diversity

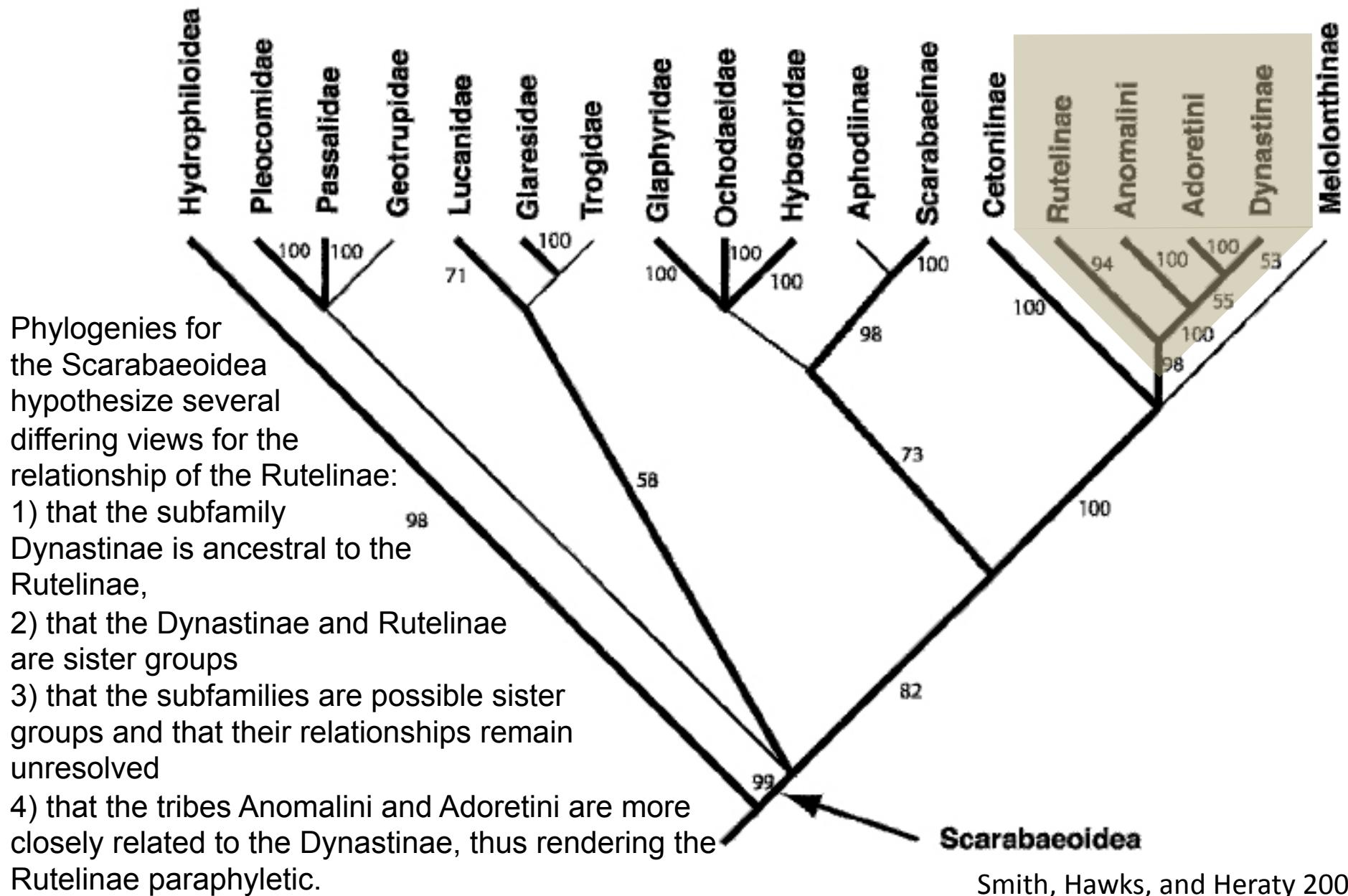
The subfamily includes 7 tribes, 235 genera, and 4197 species (Krajcik 2007)

- Tribe Anomalini: 5 subtribes, ~54 genera, and ~2000 species,  
(*Anisopliina*, *Anomalina*, *Isopliina*, *Leptohopliina*, *Popilliina*)
- Tribe Adoretini: 5 subtribes, 26 genera, and ~500 species  
(*Adoretina*, *Adorrhinyptiina*, *Pachyrhinadoretina*, *Prodoretina*,  
*Trigonostomusina*)
- Tribe Alvarengiini: 3 genera, 3 species
- Tribe Anatistiini : 4 genera, 21 species
- Tribe Anoplognathini: 5 subtribes, 25 genera, and 202 species  
(*Anoplognathina*, *Brachysternina*, *Phalangogonina*, *Platyceoliina*,  
*Schizognathina*)
- Tribe Geniatini: 13 genera, 327 species
- Tribe Rutelini: 8 subtribes, 93 genera, and 994 species  
(*Areodina*, *Desmonychina*, *Didrepanephorina*, *Heterosternina*, *Lasiocalina*,  
*Orcytomorphina*, *Parastasiina*, *Rutelina*)

# Classification of the Rutelinae

- Since Blanchard (1851) the group has been referred to as a subfamily of Scarabaeidae, but some workers regard the group as a family or as a subfamily of Melolonthidae. We follow Machatschke (1972) and Lawrence and Newton (1995) and regard the Rutelinae as a subfamily of the Scarabaeidae.
- Tribal classification of the subfamily is stable, but some tribes may be paraphyletic (i.e., Rutelini [see Jameson 1998]).
- The ruteline tribe Anomalini is occasionally regarded as a subfamily of Scarabaeidae (i.e., Potts 1974, 1977a, 1977b) or a subfamily of Melolonthidae (i.e., Sabatinelli 1991).
- The genus *Hoplia* and its congeners have occasionally been included as a tribe (Hoplioni) and included the Rutelinae (i.e., Baraud 1985).
- World Tribes:
  - Anomalini
  - Anoplognathini
  - Geniatini
  - Rutelini
  - Anatistini (previously Spodochlamyini)
  - Adoretini
  - Alvarengiini

# Relationships of the Rutelinae



# Dynastinae and Rutelinae

*Strehlia* Frey, 1969

Rutelinae

Rutelini: Parastasiina



*Chalcasthenes* Arrow, 1937

Dynastinae

Oryctoderini



# Dynastinae and Rutelinae

Endrödi 1971, page 208:

*“Chalcasthenes divinus is the only member of the Oryctoderini with a well-developed head horn, unusual metallic sheen, and peculiar form of the claws that are split and similar to some Rutelinae.”*

*“...the form of the claws is shared with some Rutelinae and is proof that the two subfamilies are extraordinarily close...”*

*“...this character overlap occasionally causes classification conflicts.”*

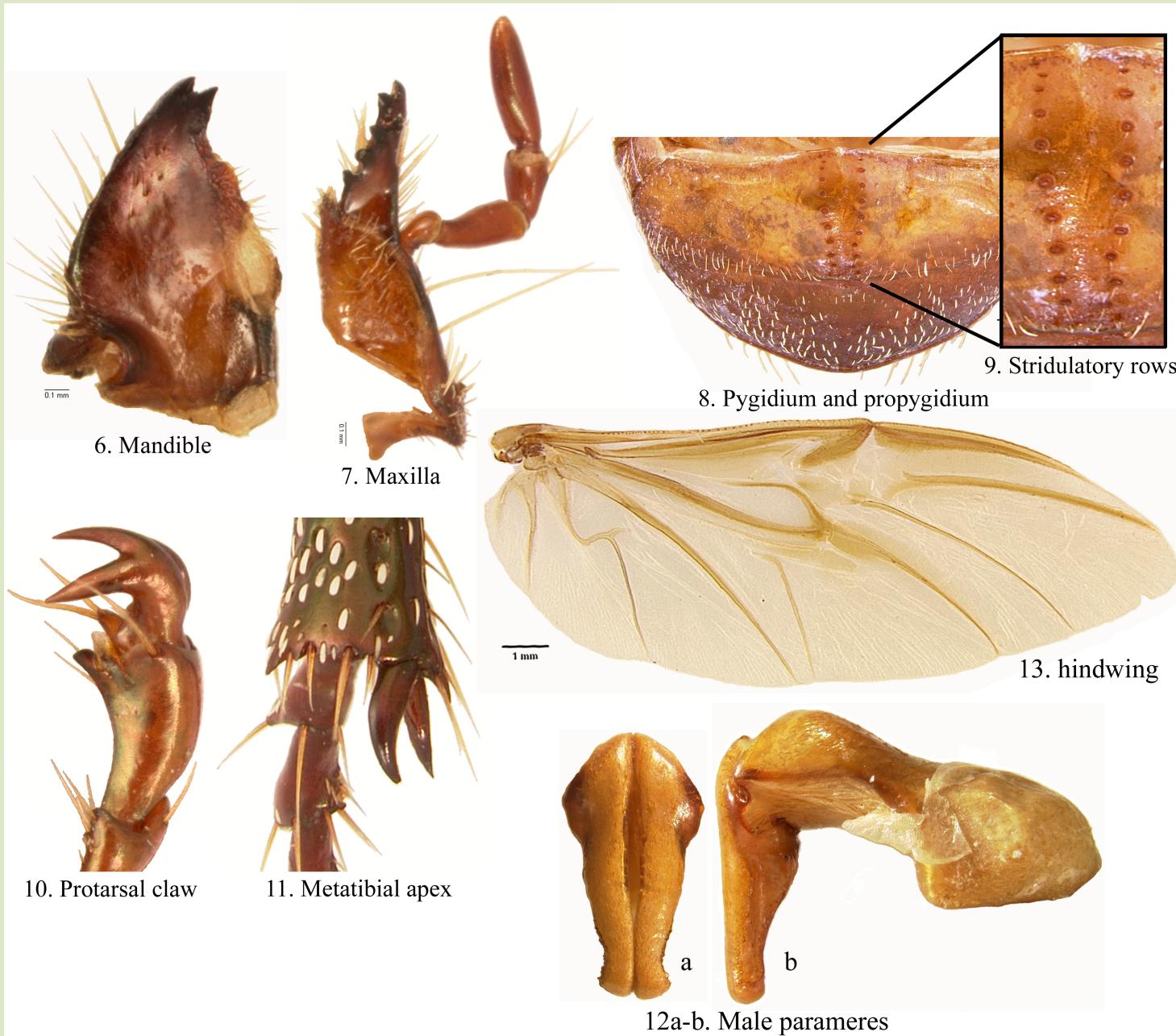
*Chalcasthenes*

Dynastinae

Oryctoderini



# Shared Characters



# Dynastinae and Rutelinae

*Valid Name*



*Chalcasthenes* Arrow, 1937

Dynastinae

Oryctoderini

An example of mistaken classification  
that has gone undetected for decades.



# Transferred from Rutelinae to Dynastinae



*Peltonotus* (southeast Asia)



*Acrobolbia* (Peru)

# Characters for Dynastinae and Rutelinae

Character	State in Dynastinae	State in Rutelinae
Fifth meso- and metatarsomeres	Apices entire (not split), claws not independently movable	Apices with a medial, longitudinal slit that allows the claws to move independently
Unguitractor plate	Cylindrical (at least at the base)	Laterally flattened
Inner apex of the metatarsomeres	Truncate (not posteriorly produced)	Posteriorly produced

# Transferred from Melolonthinae to Rutelinae

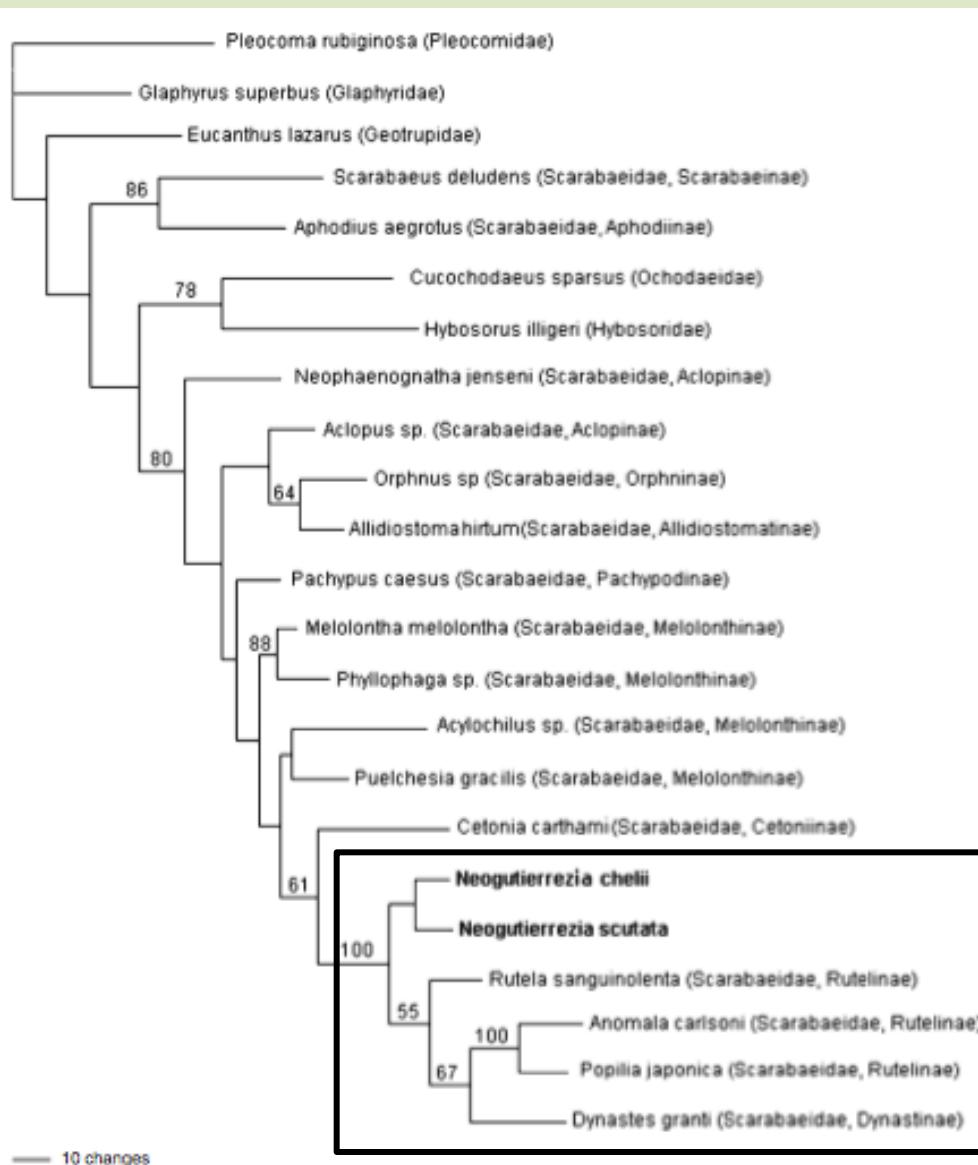
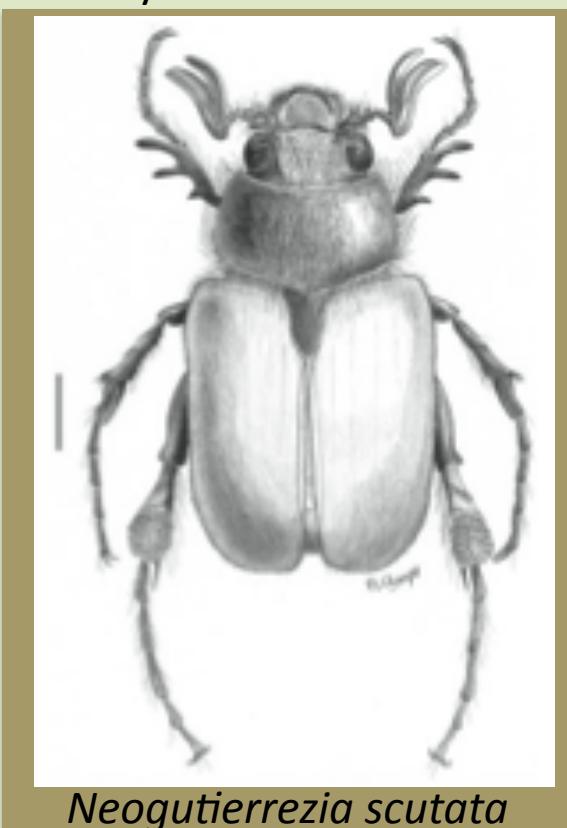


Fig. 1. Single most parsimonious tree based on molecular data from 28S D2-D3 regions showing the phylogenetic relationships of the genus *Neogutierrezia*. Maximum parsimony bootstrap values are indicated above nodes.

Results of the molecular parsimony analysis provide support that the genus *Neogutierrezia* is closely related to members of the Rutelinae. The genus was transferred from Melolonthinae: Pachydemini to Rutelinae.



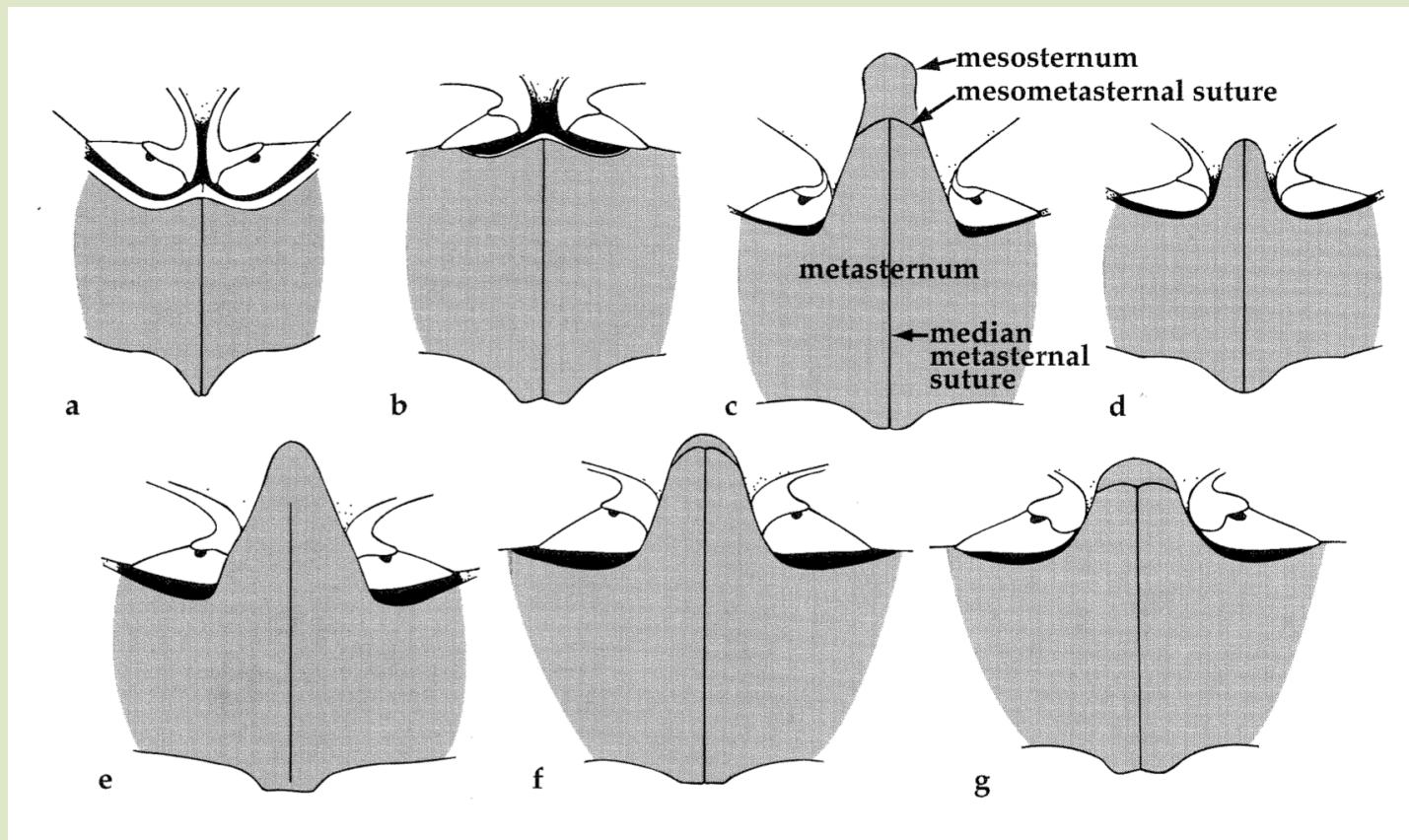
*Neogutierrezia scutata*

# **You call it Dynastinae, I call it Rutelinae.**

## **What does it Matter?**

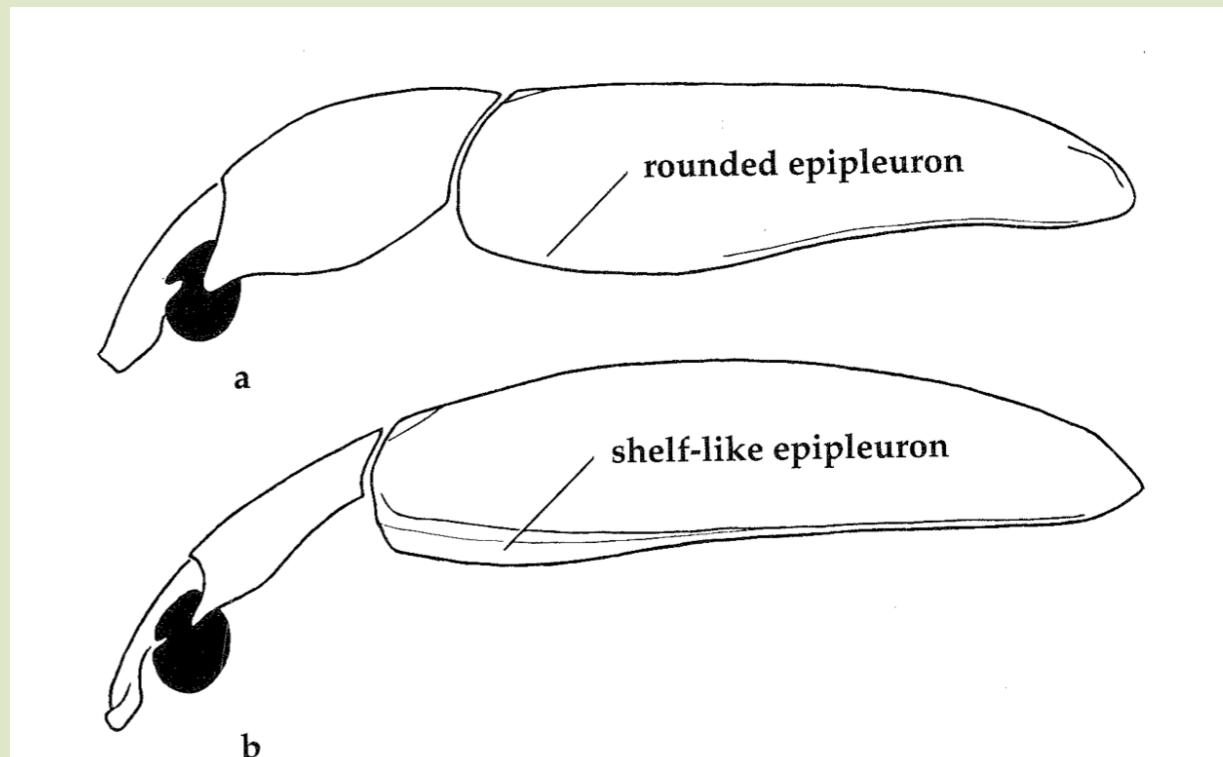
1. The lack of circumscription of higher-level taxa based on shared, derived character states creates a disconnect that results in classification problems and does not allow for predictions based on evolutionary relationships.
2. Classification errors prevent retrieval of biodiversity data and cause measures of biodiversity to be overestimated.

# Additional Rutelinae Characters



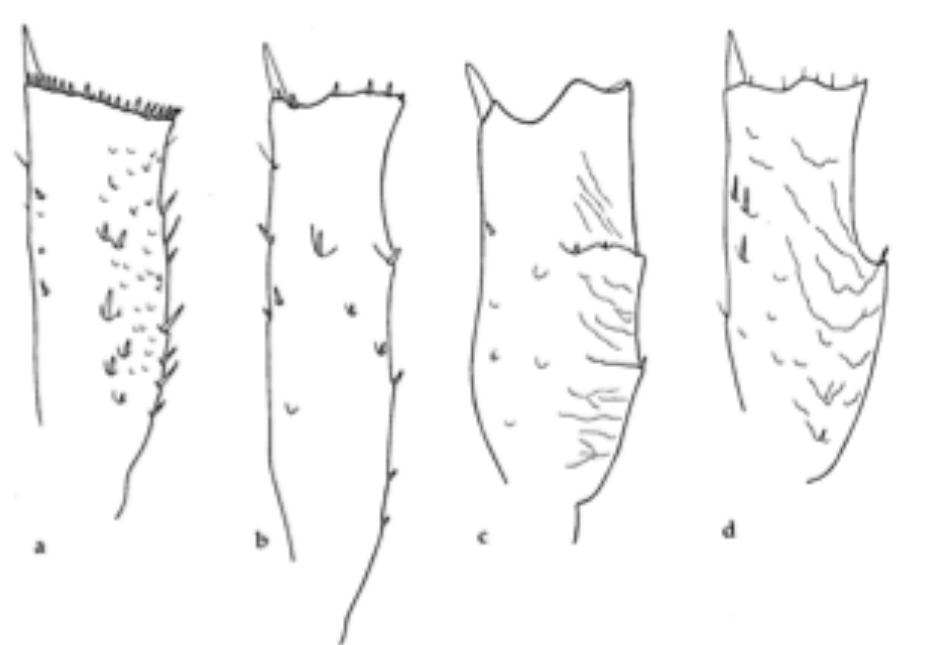
Ventral view of the metasternum in relation to the mesometasternal suture and base of the mesocoxae

# Additional Rutelinae Characters

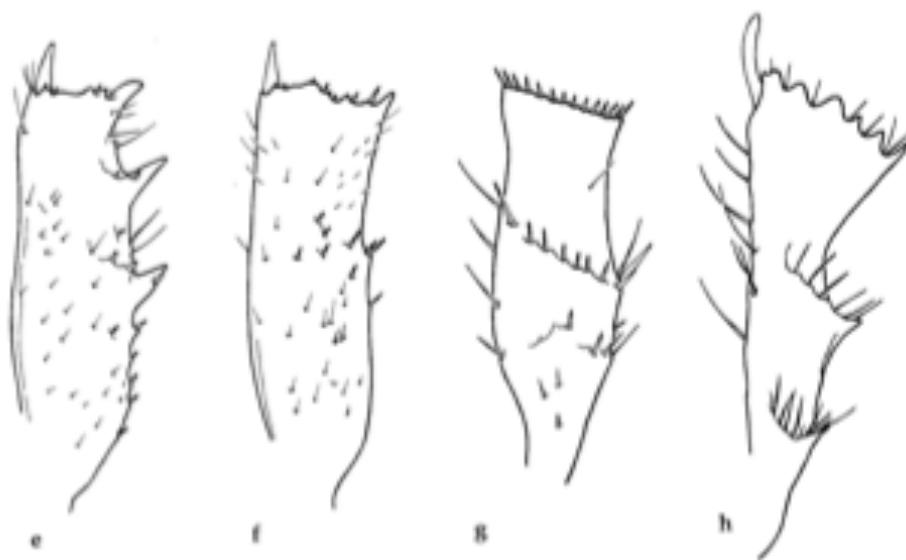


Lateral view of the thorax and abdomen showing the elytral epipleuron with a shelf-like, horizontal ridge (b) or with a rounded epipleuron (a)

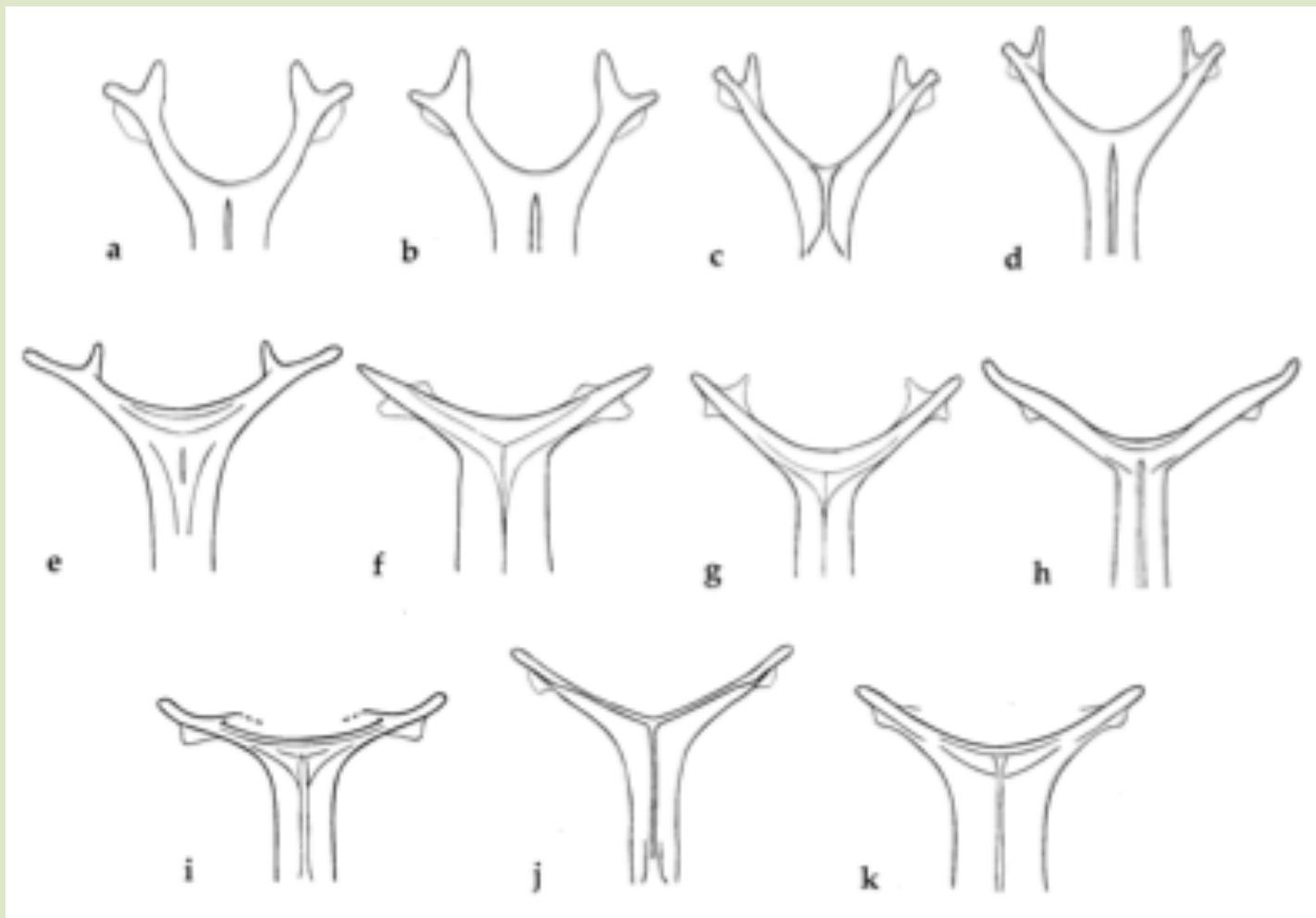
# Additional Rutelinae Characters



Ventral view of metatibia showing form of apex (with or without many spinose setae, with or without corbel, with or without many hairlike setae)

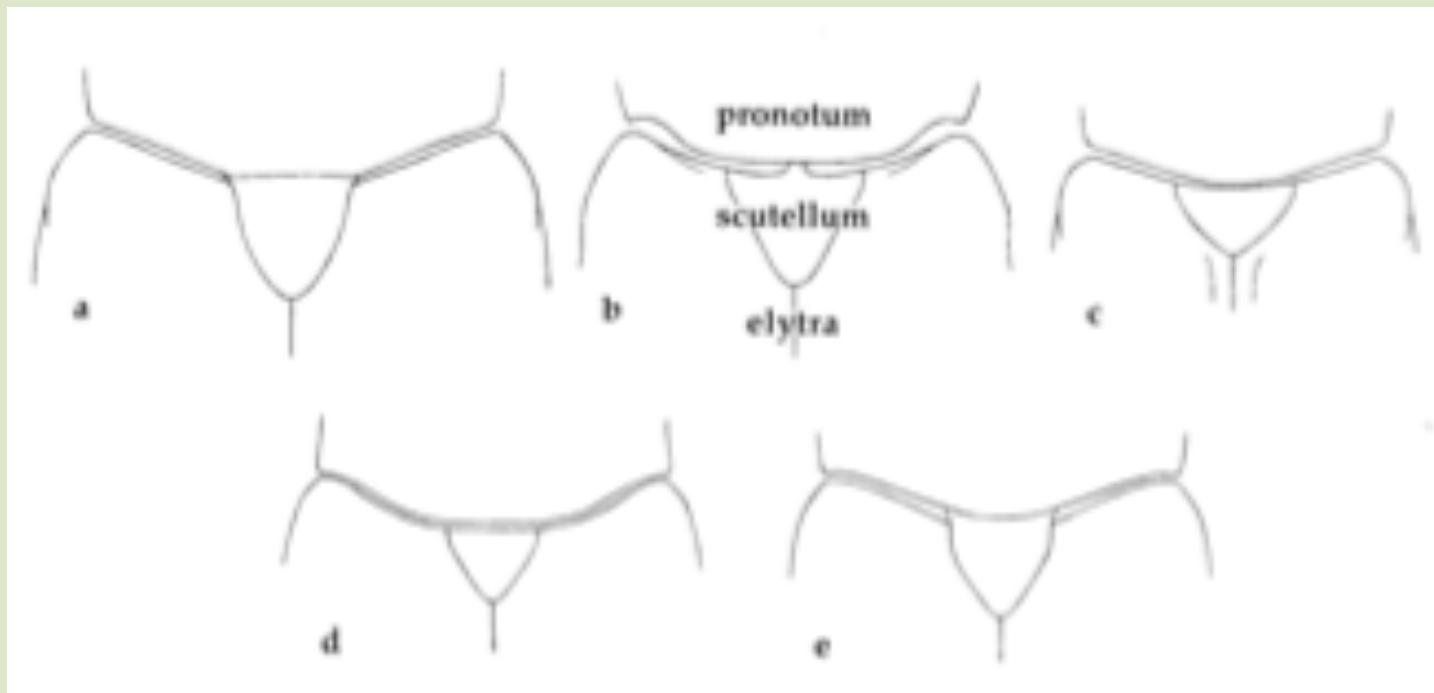


# Additional Rutelinae Characters



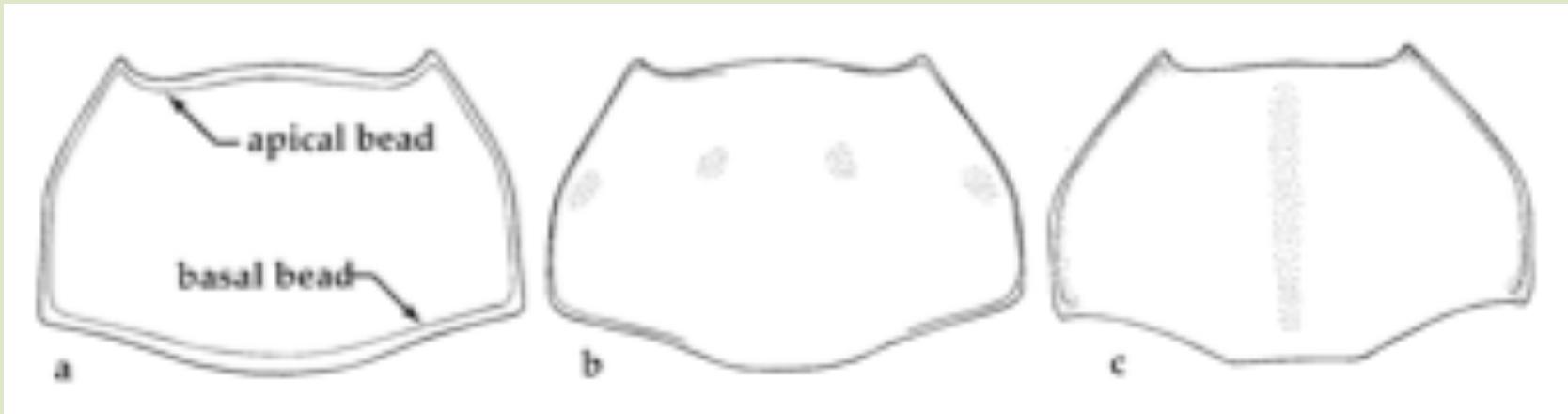
Caudal view of the metendosternite (all Rutelinae except the last one (Dynastinae: Cyclocephalini))

# Additional Rutelinae Characters



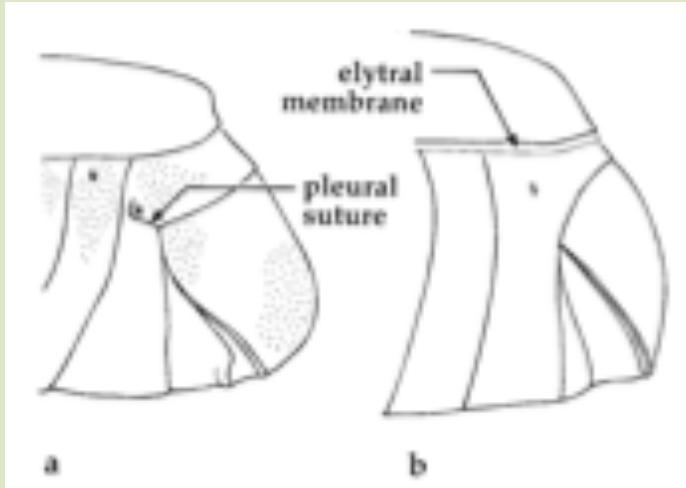
Dorsal view of pronotal, elytral, and scutellar base showing form of pronotal base and form of scutellum. Note also if the scutellar base is depressed below the plane of the elytra (c and d), with a medial, planar extension and depressed sides (b), or planar (e).

# Additional Rutelinae Characters



Dorsal view of the pronotum showing basal bead complete (a), incomplete (b), or lacking (c)

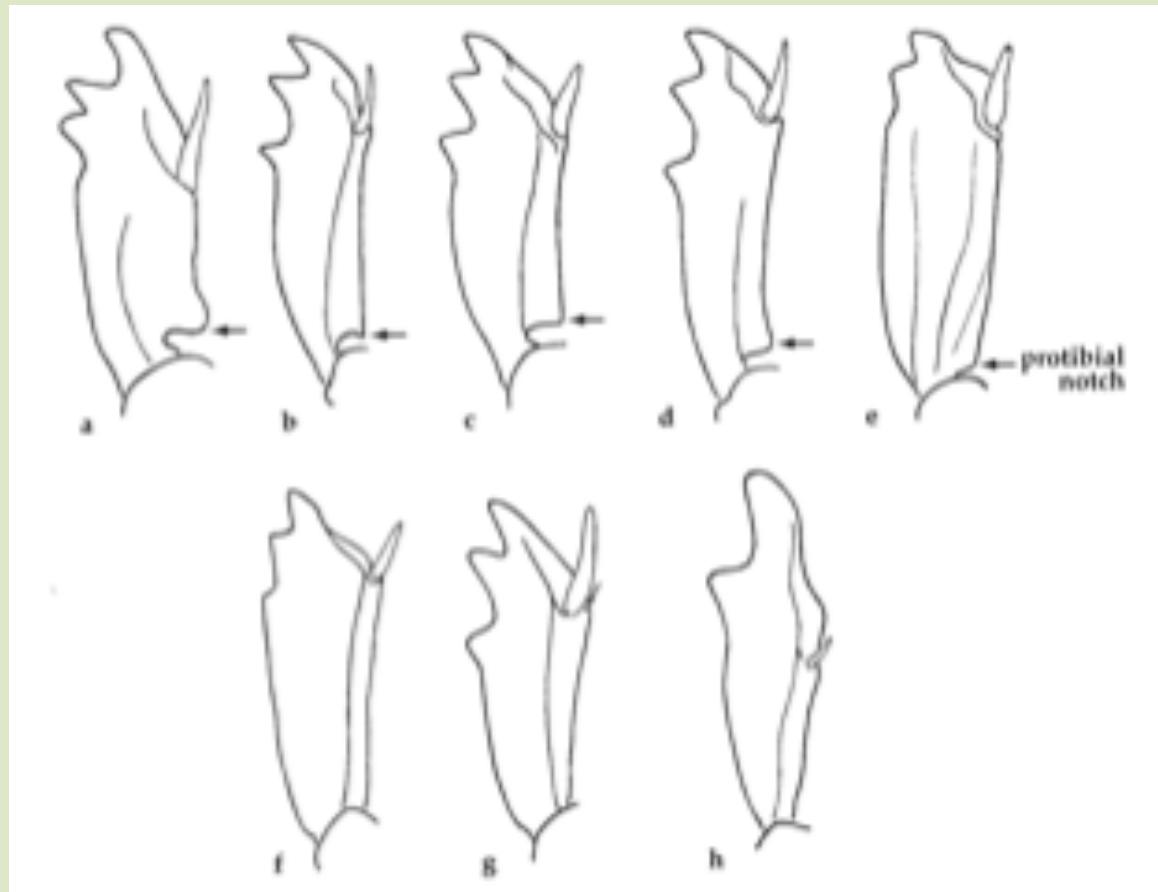
# Additional Rutelinae Characters



Lateral view of the apex of the abdomen showing elytral margin with a membranous border (b: Anomalini) or without (a: Rutelini and others).

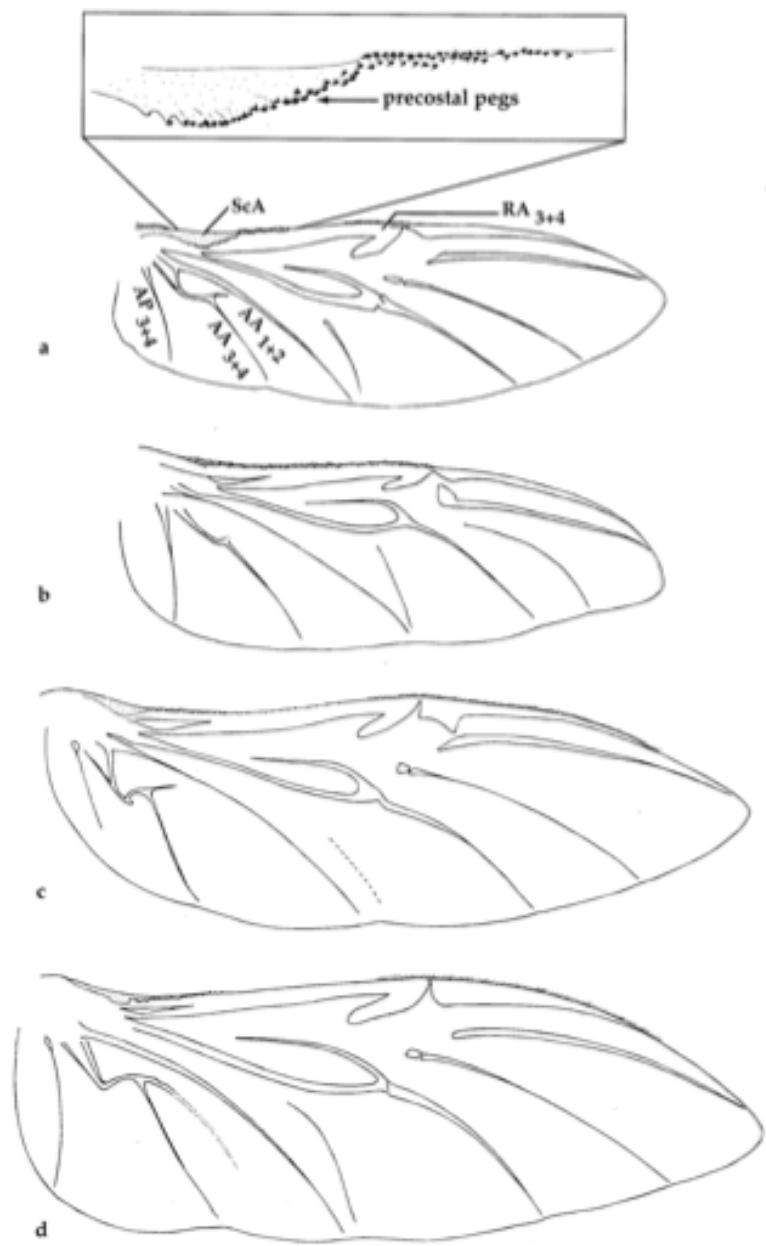
Also, pleural suture between sternite 7 and tergite 7 distinct (a: Rutelini and others) or lacking (b: Anomalini).

# Additional Rutelinae Characters



Ventral view of the right protibia showing form and the basal, protibial notch (a-e) or lacking the basal, protibial notch (f-h). All Rutelinae except e (*Cyclocephala* [Dynastinae])

# Additional Rutelinae Characters



Ventral view of the left hindwing showing venation, distribution of costal setae, and precostal pegs (inset shows location of precostal membrane and associated pegs).



*Chrysina gloriosa*



<http://thedragonflywoman.com/2010/11/12/friday5amazingazbeetles/>

# Distribution of Rutelinae

The subfamily Rutelinae includes about 235 genera and 4,197 species that are distributed worldwide. Many species remain to be described.

There are 7 tribes:

- Anatistini (previously Spodochlamyini) is found only in Central and South America.
- Anoplognathini occurs in the Australia and western Central and South America
- Geniatini is distributed in Central and South America
- Rutelini is widely distributed but is most speciose in the Neotropics
- Anomalini is widely distributed and is most speciose in the Old World
- Alvarengiini is found only in southern Brazil
- Adoretini is exclusively distributed in the Old World

# Rutelinae Literature

Casey, T. L. 1915. A review of the American species of Rutelinae, Dynastinae and Cetoniinae. Memoirs on the Coleoptera 6: 1-460.

Machatschke, J. W. 1957. Coleoptera Lamellicornia, Scarabaeidae, Rutelinae, Anomalini. Genera Insectorum, fasc. 199B: 1-219.

Machatschke, J. W. 1965. Coleoptera Lamellicornia. fam. Scarabaeidae, subfam. Rutelinae, section Rutelinae Orthochilidae. Genera Insectorum 199C:1-145.

Machatschke, J. W. 1972. Scarabaeoidea: Melolonthidae, Rutelinae. Coleopterorum Catalogus Supplementa 66(2): 363-429.

Ohaus, F. 1934. Coleoptera Lamellicornia. Fam. Scarabaeidae, Subfam. Rutelinae. Genera Insectorum, Fasc. 199A: 1-172.

Ohaus, F. 1918. Scarabaeidae: Euchirinae, Phaenomerinae, Rutelinae. Coleopterorum Catalogus pars. 66. W. Junk. Berlin.

# Rutelinae Resources

Coleop-Terra. Living Jewels. <http://www.coleop-terra.com/living-jewels/>

Frank Köhler. 2011. <http://www.koleopterologie.de/gallery/>

Kaefer der Welt - Beetles of the World. <http://www.kaefer-der-welt.de/>

Virtual-beetles. Anoplognathus, Rutelidae Australie.  
<http://www.virtual-beetles.com/rutaus.html>

Virtual-beetles. Sous-tribue Didrepanephorina (Ohaus, 1918). <http://www.virtual-beetles.com/fruhstorferia.html>

# Rutelinae Resources: Use with Caution

Soula, M. 1998. Les Coleopteres du Monde, 26.1. Antichirina 1 (Sciences Nat).

Soula, M. 2002a. Les Coleopteres du Monde, 26.2. Antichirina 2 (Hillside Books)

Soula, M. 2002b. Les Coleopteres du Monde, 26, Antichirina 3 (Hillside Books)

Soula, M. 2003. Les Coleopteres du Monde, 29, Antichirina 4 (Hillside Books)

Soula, M. 2005. Les Coleopteres du Monde, 26.3. Antichirina 5 (Hillside Books)

Soula, M. 2006. Les Coleopteres du Nouveau Monde, Rutelini 1 (Besoiro).

Soula, M. 2008. Les Coleopteres du Nouveau Monde, Rutelini 2 (Besoiro)

Soula, M. 2011. Les Coleopteres du Nouveau Monde, Geniatini 1. (Besoiro)

These publications are not peer-reviewed, contain many errors in fact and interpretation, do not provide character-based diagnoses, do not provide comprehensive keys to genera or species, and describe many new genera and species that are based on very few specimens that are not deposited in public museums (thus making repeatability intractable).

# Tribe Anomalini Streubel, 1839

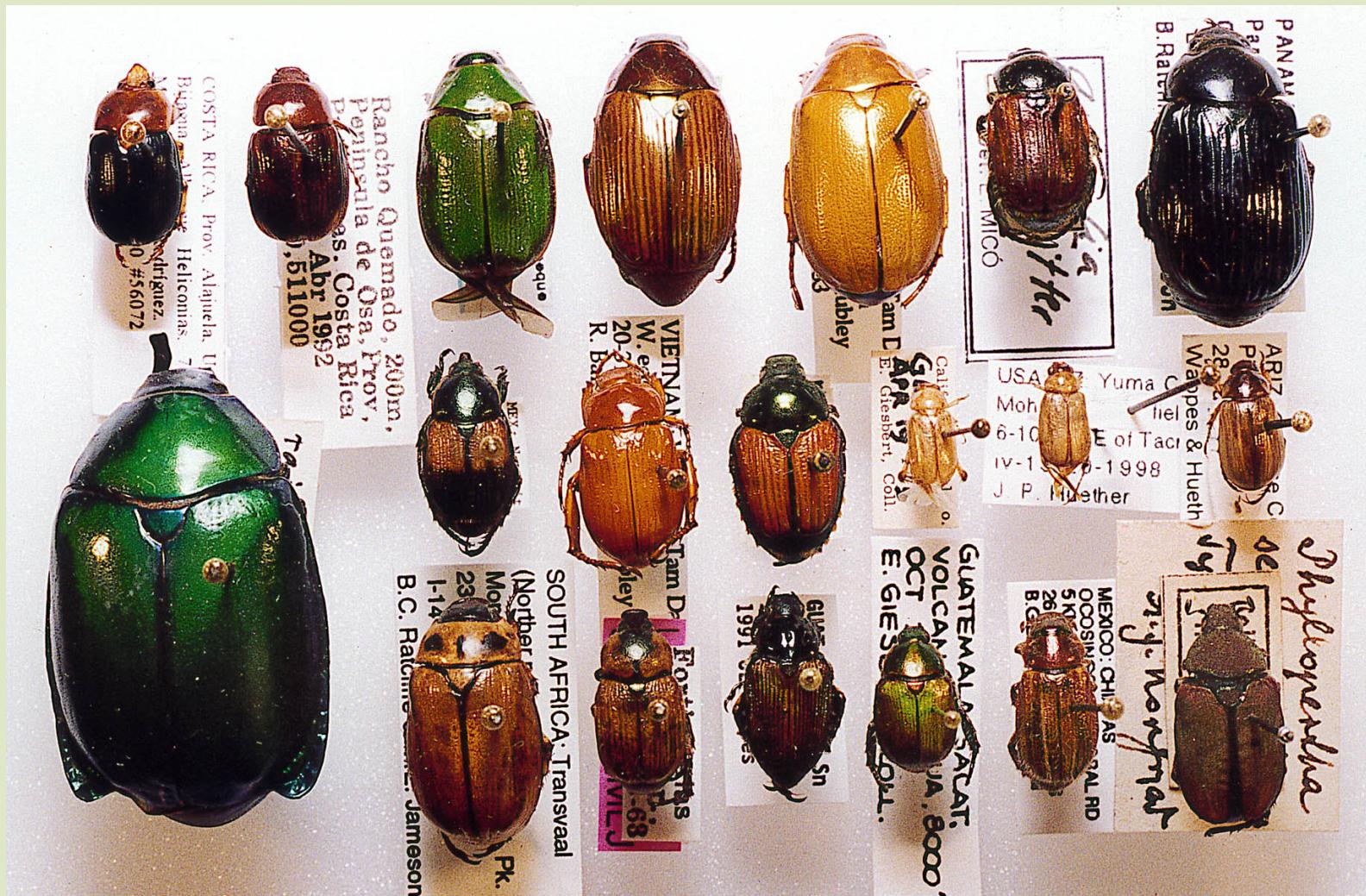


<http://www.koleopterologie.de/gallery/>

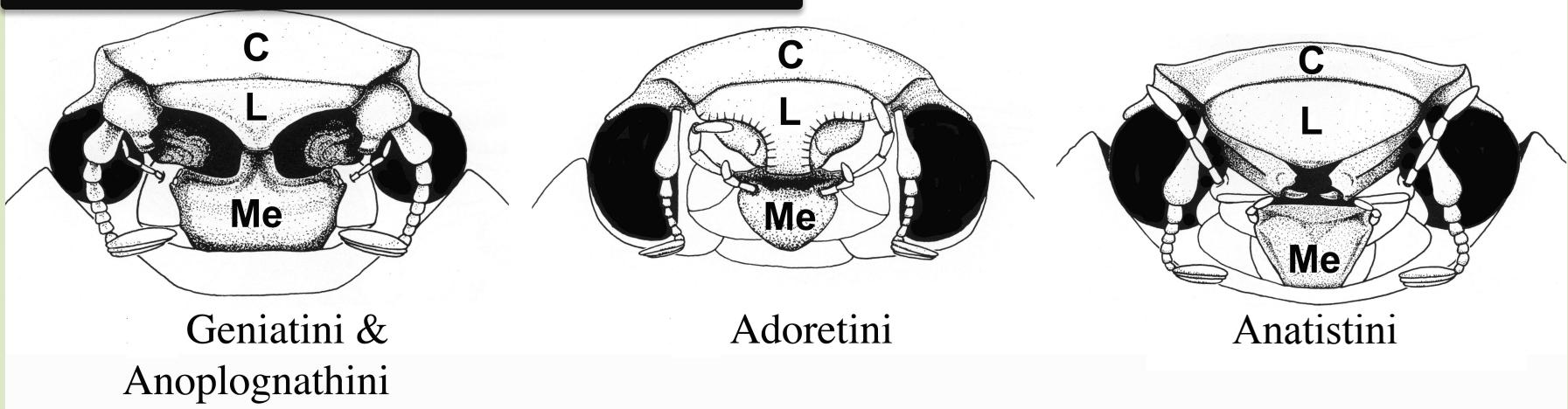
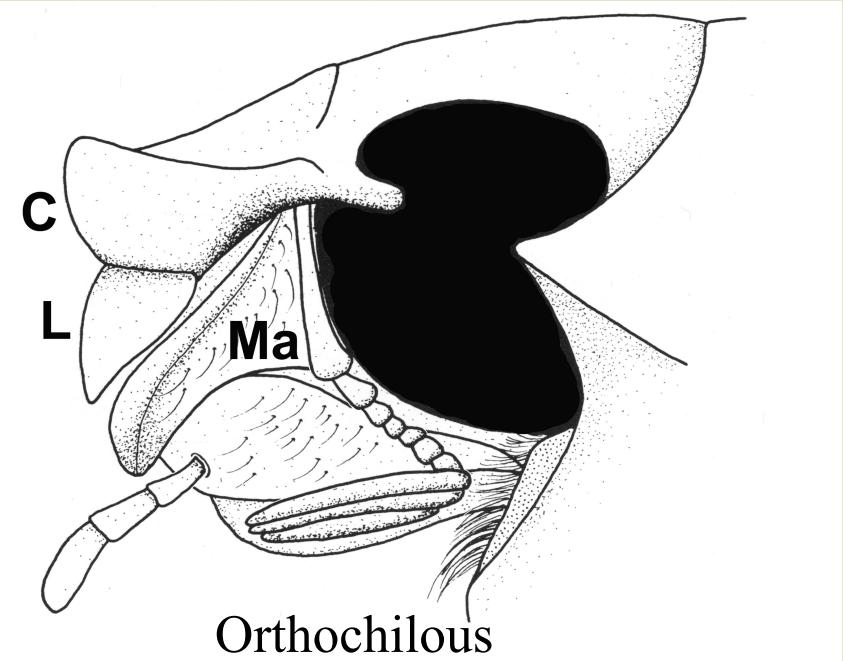
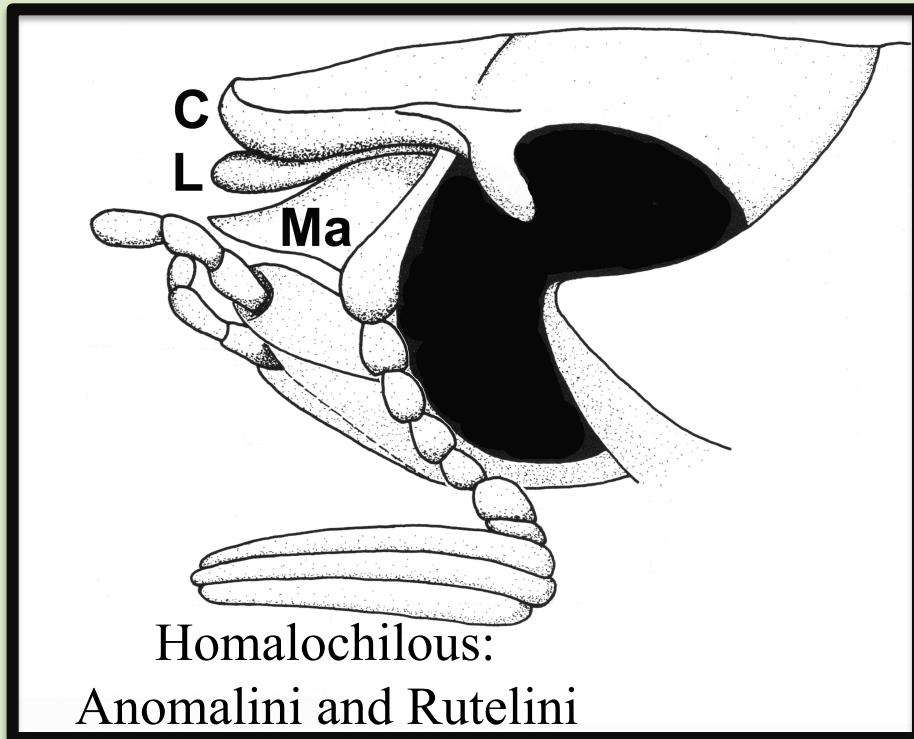
*Phyllopertha horticola*

# Species Diversity

Anomalini includes ~2,000 species world wide  
Half the number of all mammals  
Twice the number of viruses

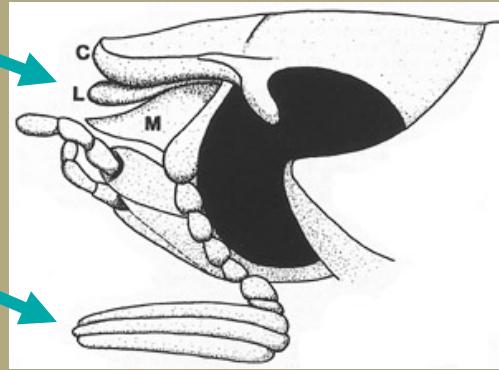


# Two Basic Ruteline Groups

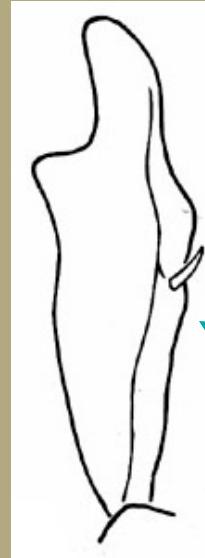


# What is an Anomaline?

- Labrum horizontal with respect to the clypeus

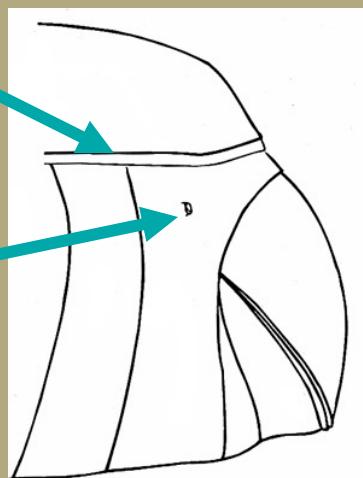


- Antenna with 9 segments

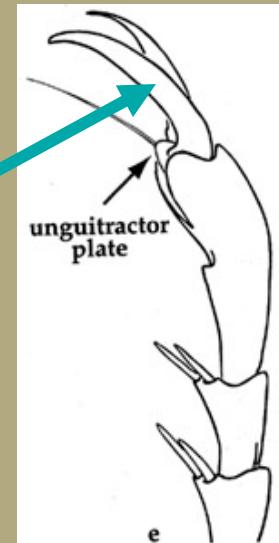


- Protibial spur located at middle of tibia

- Elytral margin with membrane
- Terminal spiracle without pleural membrane



- Hind claw always simple

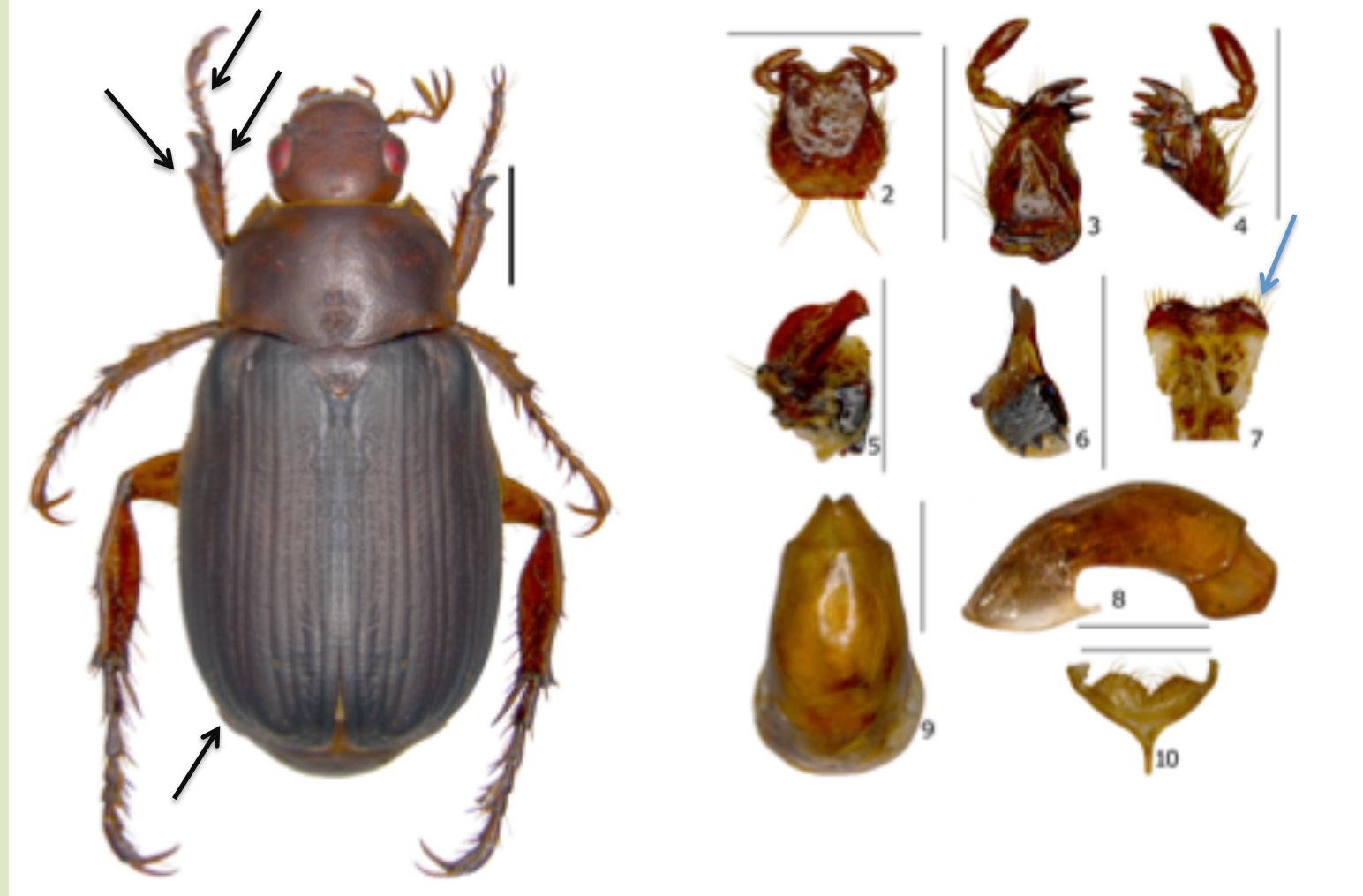


# What is an Anomaline?

- Size ranges between 5 and 40 mm
- Coloration has a wide range of tones, including metallic green, testaceous, and black.
- Labrum horizontally produced with respect to the clypeus
- Antennae with 9 segments
- Protibiae bidentate (rarely unidentate or tridentate), inner protibial spur subapical (lacking in *Leptohoplia*)
- Foretarsomeres not enlarged or densely setose ventrally
- Elytra with membranous border at lateral margin
- Terminal spiracle not positioned in pleural suture
- Distribution worldwide. In the New World, anomalines occur from southern Canada to southern South America. Species of the tribe inhabit almost every habitat except the high Andes of South America.

# Anomaline Characteristics

*Paranomala zaragozai*, una nueva especie de Nayarit, México (Coleoptera: Melolonthidae: Rutelinae: Anomalini)



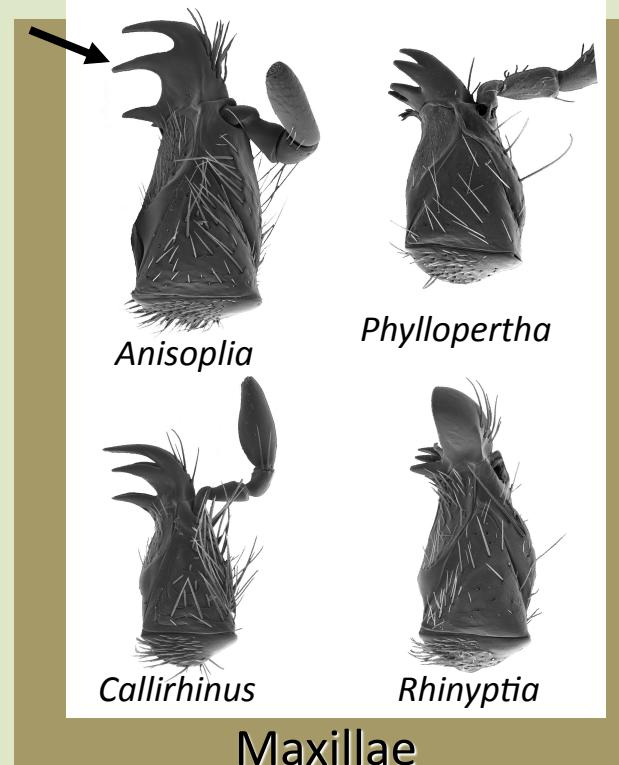
Andrés Ramírez-Ponce. 2010. *Dugesiana* 17(2): 181-185

# Characters for Anisopliina (Anomalini)

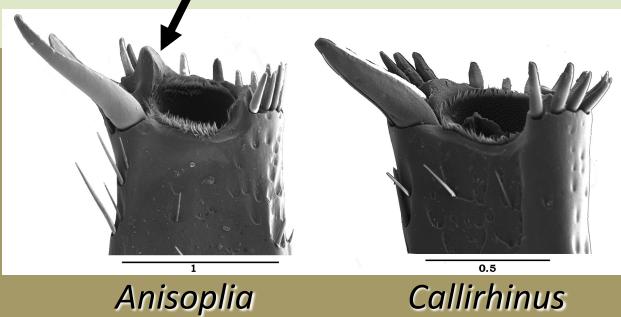


Protarsomeres

*Anthoplia*    *Anisoplia*    *Brancoplia*

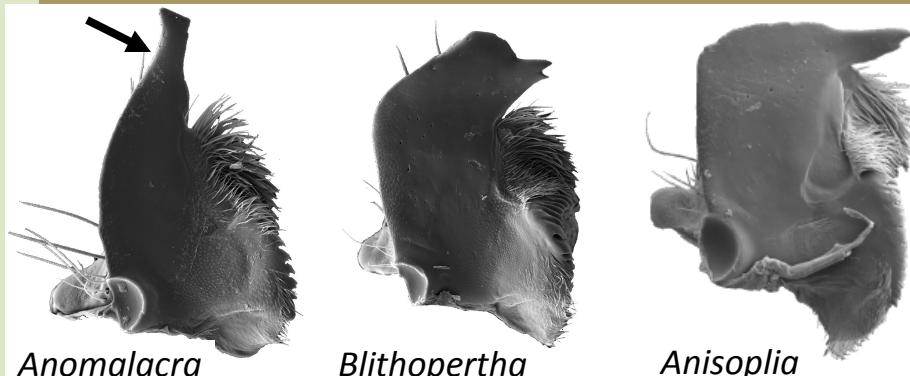


Metatibial apex

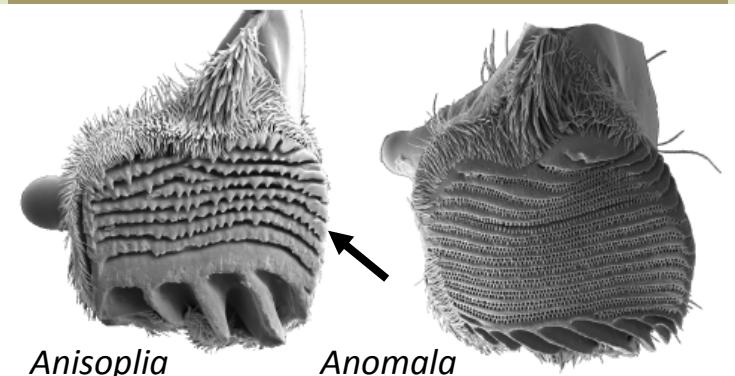


*Anisoplia*    *Callirhinus*

Maxillae



Mandibular form



Molar region

# Anomaline Characteristics



Figure 15. Head of *Chelilabia piniphaga*

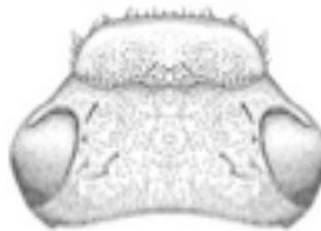


Figure 16 Head of *Anomala chrysanthae*



Figure 17. Head of *Anomalacra clypealis*

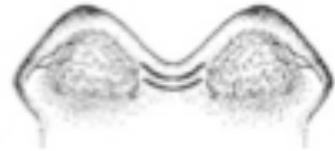


Figure 18. Labrum in ventral view of *Chelilabia piniphaga*



Figure 19. Labrum in ventral view of *Anomala chrysanthae*



Figure 20. Labrum in ventral view of *Dilophochila bolacoides*

Labrum horizontally produced with respect to the clypeus

# Anomaline Characteristics

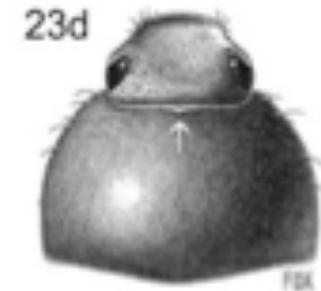
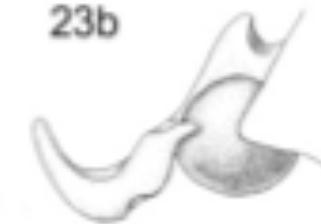
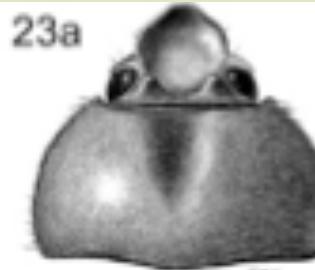
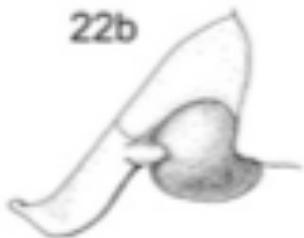
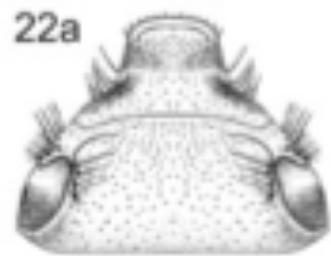


Figure 22. Head of *Callirhynus metallescens*  
a) dorsal view, b) lateral view

Figure 23a-d. Heads of: *Anomalorhina turrialbana*: 23a) male head and pronotum in dorsal view; 23b) male head in lateral view. *Anomalorhina osaensis*: 23c) male head and pronotum; 23d) female head and pronotum.

Labrum horizontally produced with respect to the clypeus. Clypeus planar with respect to frons or reflexed.

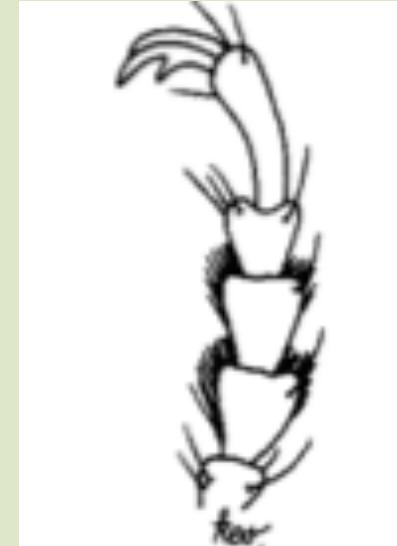
# Anomaline Characteristics



Figure 9. Foreleg in dorsal view of *Anomala chrysanthae*.



Figure 10. Foreleg in dorsal view of *Leptohoplia testaceipennis*



Foretarsi of Geniatini enlarged and densely setose ventrally.

Protibiae bidentate (rarely unidentate or tridentate), inner protibial spur subapical (lacking in *Leptohoplia*). Foretarsomeres not enlarged or densely setose ventrally.

# Anomaline Characteristics



Figure 5.  
Mesepimeron of  
*Popillia*



Figure 26. Pronotum  
in dorsal view of  
*Balanogonia freudei*



Figure 27. Pronotum  
in dorsal view of  
*Epectinaspis*  
*moreletiana*



Figure 28. Pronotum  
in dorsal view of  
*Strigoderma vestita*



Figure 29. Pronotum in  
dorsal view of  
*Yaaxkumukia*  
*ephemera*

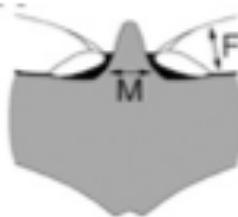


Figure 33.  
Mesosternum of  
*Popillia japonica*



Figure 34.  
Mesosternum of  
*Anomala autogramma*



Figure 35.  
Mesosternum of  
*Epectinaspis*

Form of the mesepimeron, pronotum, and mesosternum  
indicative of genera and groups.

# Anomaline Characteristics



Figure 3. Mesepimeron of *Epectinaspis*



Figure 4. Mesepimeron of *Strigoderma*

Figure 5. Mesepimeron of *Popillia*

Figure 6. Mesepimeron of *Anomala*

Form of the mesepimeron indicative of genera and groups.

# Abundance of Anomalines

University of Nebraska State Museum: 21 drawers  
United States National Museum: 45 drawers



# How many *Anomala*?

World wide: ~1,000 species

New World: ~200 species

Nearctic Realm: 48 species

Mexico: 75 species

Central America: 106 species

Costa Rica: 115 species

43% named

57% unnamed

The screenshot shows the BIMIS system interface. At the top, there's a navigation bar with icons for a magnifying glass, a tree, a leaf, and a snail, followed by the text "inventario" and "BIMIS Biodiversity Information Management System". Below the navigation bar is a horizontal menu bar with colored buttons for Reino (Kingdom), Filo (Phylum), Clase (Class), Orden (Order), Familia (Family), and Género (Genus). Under each of these main categories is a specific taxonomic rank: Animalia, Arthropoda, Insecta, Coleoptera, Scarabaeidae, and Anomala. Below the menu is a section titled "Lista de especies" (List of species) containing a grid of 20 species names, each with a blue link underlined.

Reino	Filo	Clase	Orden	Familia	Género
Animalia	Arthropoda	Insecta	Coleoptera	Scarabaeidae	Anomala

**Lista de especies**

<a href="#">amphicoma</a>	<a href="#">avata</a>	<a href="#">balteipennis</a>	<a href="#">bicollis</a>
<a href="#">calligrapha</a>	<a href="#">calvula</a>	<a href="#">chapini</a>	<a href="#">chrysina</a>
<a href="#">ciliumpressa</a>	<a href="#">ciliumpressa</a>	<a href="#">chontaleensis</a>	<a href="#">chrysanthae</a>
<a href="#">clavicornis</a>	<a href="#">collaris</a>	<a href="#">cupriventris</a>	<a href="#">discrepans</a>
<a href="#">curvilinea</a>	<a href="#">eulica</a>	<a href="#">fumiferana</a>	<a href="#">geminella</a>
<a href="#">granulifrons</a>	<a href="#">guatemalensis</a>	<a href="#">histrio</a>	<a href="#">heppi</a>
<a href="#">inconstans</a>	<a href="#">japonica</a>	<a href="#">junkanii</a>	<a href="#">keswickensis</a>
<a href="#">ludoviciana</a>	<a href="#">mexicanellus</a>	<a href="#">megalura</a>	<a href="#">minutoides</a>
<a href="#">nigra</a>	<a href="#">nitidula</a>	<a href="#">obovata</a>	<a href="#">ochracea</a>
<a href="#">pboespberga</a>	<a href="#">plutonia</a>	<a href="#">populi</a>	<a href="#">praeceps</a>
<a href="#">prasinella</a>	<a href="#">posticata</a>	<a href="#">quadrivittata</a>	<a href="#">semitecta</a>

# How many *Anomala*?

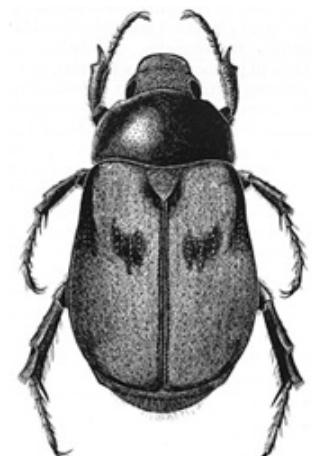
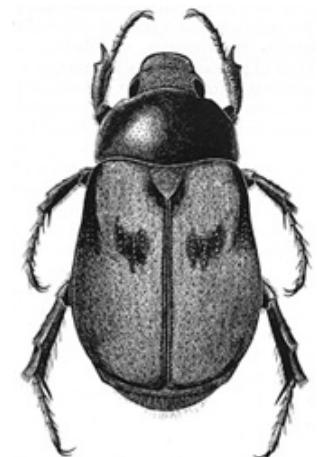
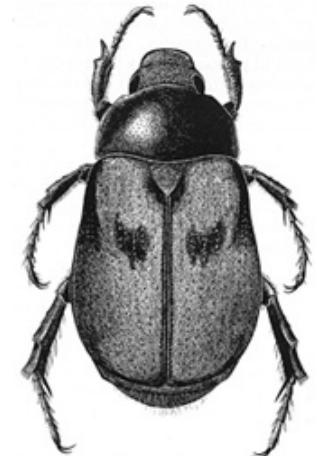
The INBio database in Costa Rica lists 115 species of *Anomala* from just this one, small country.  
50 (43%) of these species are named;  
65 (57%) are unnamed.

The screenshot shows the BIMS (Biodiversity Information Management System) interface. At the top left is the logo 'inventario' with a nature-themed icon. To the right is the 'BIMS' logo with the full name 'Biodiversity Information Management System' below it. A vertical sidebar on the right has icons for search, refresh, and navigation. Below the header is a menu bar with green buttons for 'Reino', 'Filo', 'Clase', 'Orden', 'Familia', and 'Género', each with a corresponding icon. Underneath this is a secondary row of buttons for 'Animalia', 'Arthropoda', 'Insecta', 'Coleoptera', 'Scarabaeidae', and 'Anomala'. The main content area is titled 'Lista de especies' and contains a grid of 15 species names, each with a blue link underneath:

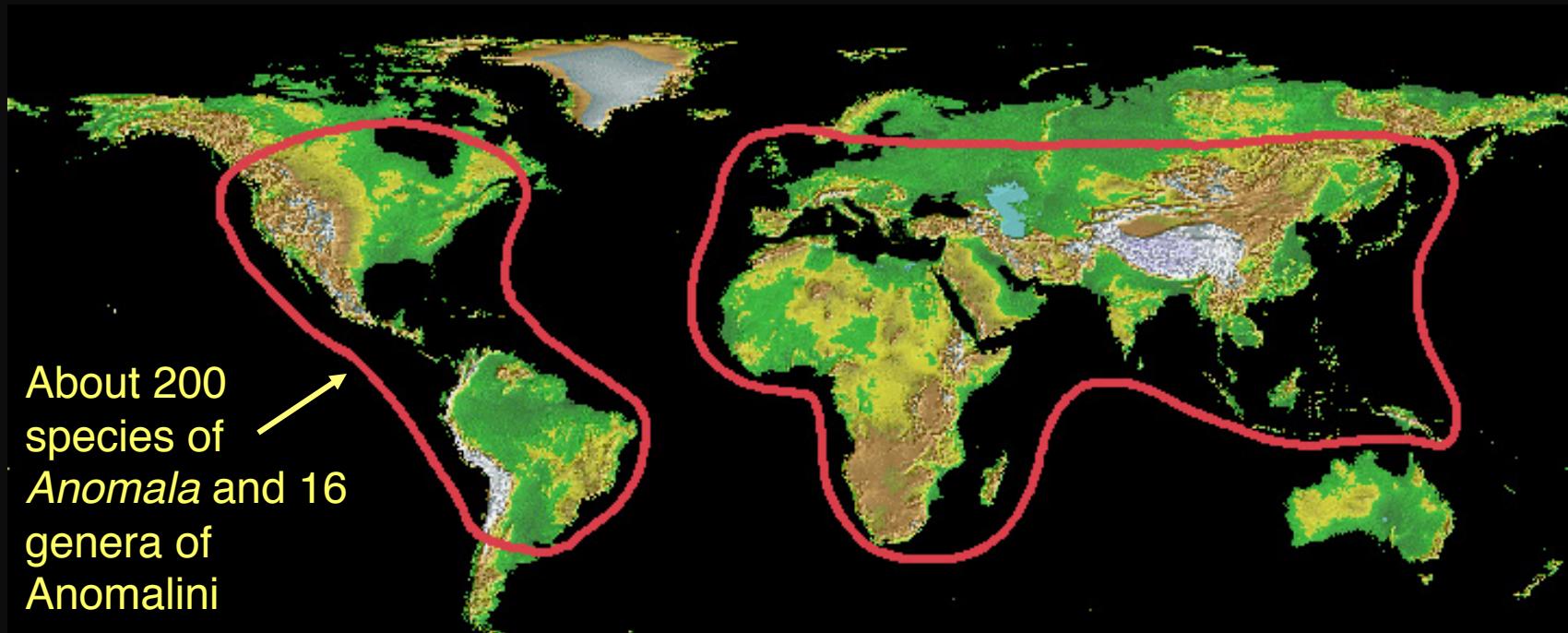
<a href="#">amphiaroma</a>	<a href="#">analis</a>	<a href="#">bulgarophylax</a>	<a href="#">buhlezi</a>
<a href="#">calligrapha</a>	<a href="#">callosota</a>	<a href="#">chapini</a>	<a href="#">chinguina</a>
<a href="#">chilensis</a>	<a href="#">chilensis</a>	<a href="#">chontalensis</a>	<a href="#">chrysanthae</a>
<a href="#">chrysomelina</a>	<a href="#">collaris</a>	<a href="#">cupriventris</a>	<a href="#">discovalis</a>
<a href="#">cucuana</a>	<a href="#">eulicra</a>	<a href="#">fumiferana</a>	<a href="#">geminella</a>
<a href="#">granulifrons</a>	<a href="#">gratiosa</a>	<a href="#">histriomella</a>	<a href="#">hoppi</a>
<a href="#">incurvatus</a>	<a href="#">japonica</a>	<a href="#">junkanii</a>	<a href="#">laevicollis</a>
<a href="#">luteola</a>	<a href="#">magrinicollis</a>	<a href="#">megala</a>	<a href="#">mimeloides</a>
<a href="#">nigra</a>	<a href="#">nubilula</a>	<a href="#">obsoleta</a>	<a href="#">ochreovestita</a>
<a href="#">obscuripes</a>	<a href="#">peltata</a>	<a href="#">populi</a>	<a href="#">praeceps</a>
<a href="#">obscurifrons</a>	<a href="#">pustulata</a>	<a href="#">populeana</a>	<a href="#">praeclensis</a>
		<a href="#">schmidti</a>	<a href="#">semitorta</a>

“We do not know, to the nearest order of magnitude, how many species there are in the world.”

--E.O. Wilson



# Diversity and Distribution

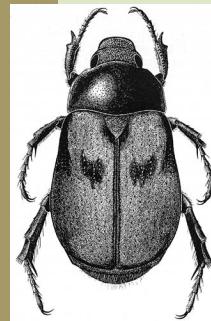


Worldwide there are about 1,000 species of  
*Anomala* and 44 genera of Anomalini

# Taxonomic Foundations

- Key to Mexican genera of Anomalini and description of 4 new genera (Morón & Nogueira 1998).

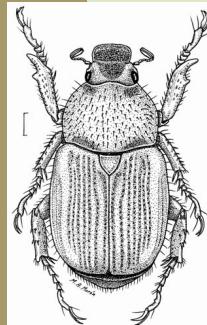
- Survey of *Anomala* north of Mexico (Potts 1977). 33 species.



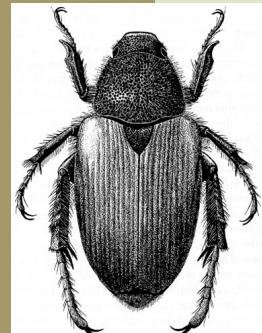
- Revision of *Dilophochila* (Morón & Howden 2001). 6 species.



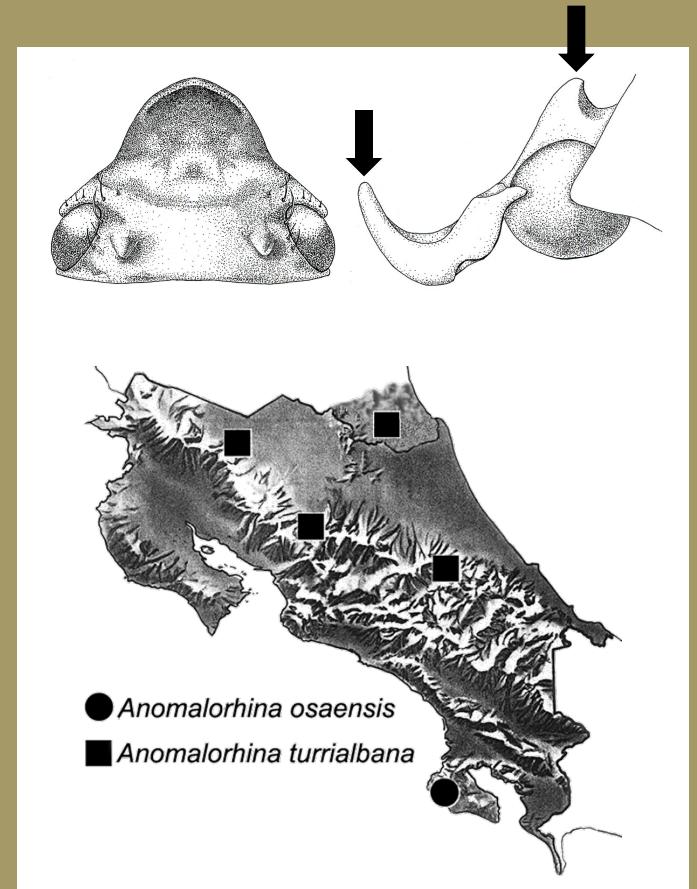
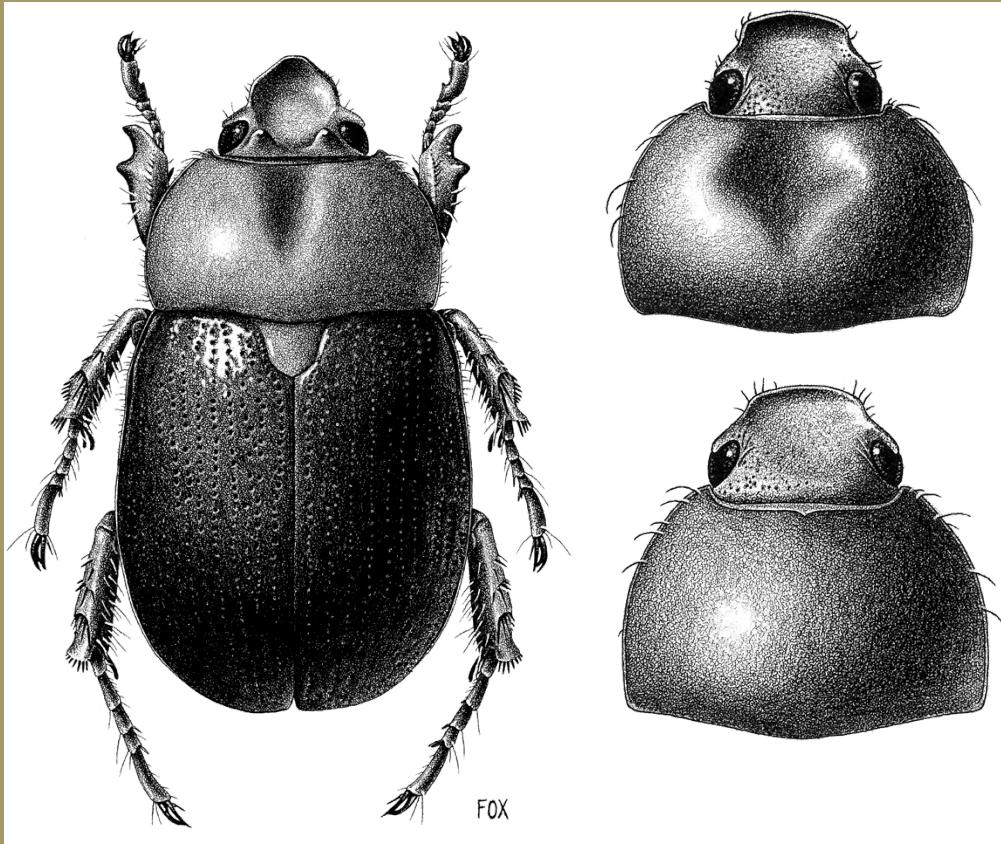
- Revision of *Epectinaspis* (Paucar 2003). 9 species.



- Revision of *Strigoderma* north of Panama (Bader 1992). 28 species.



# *Anomalorhina*

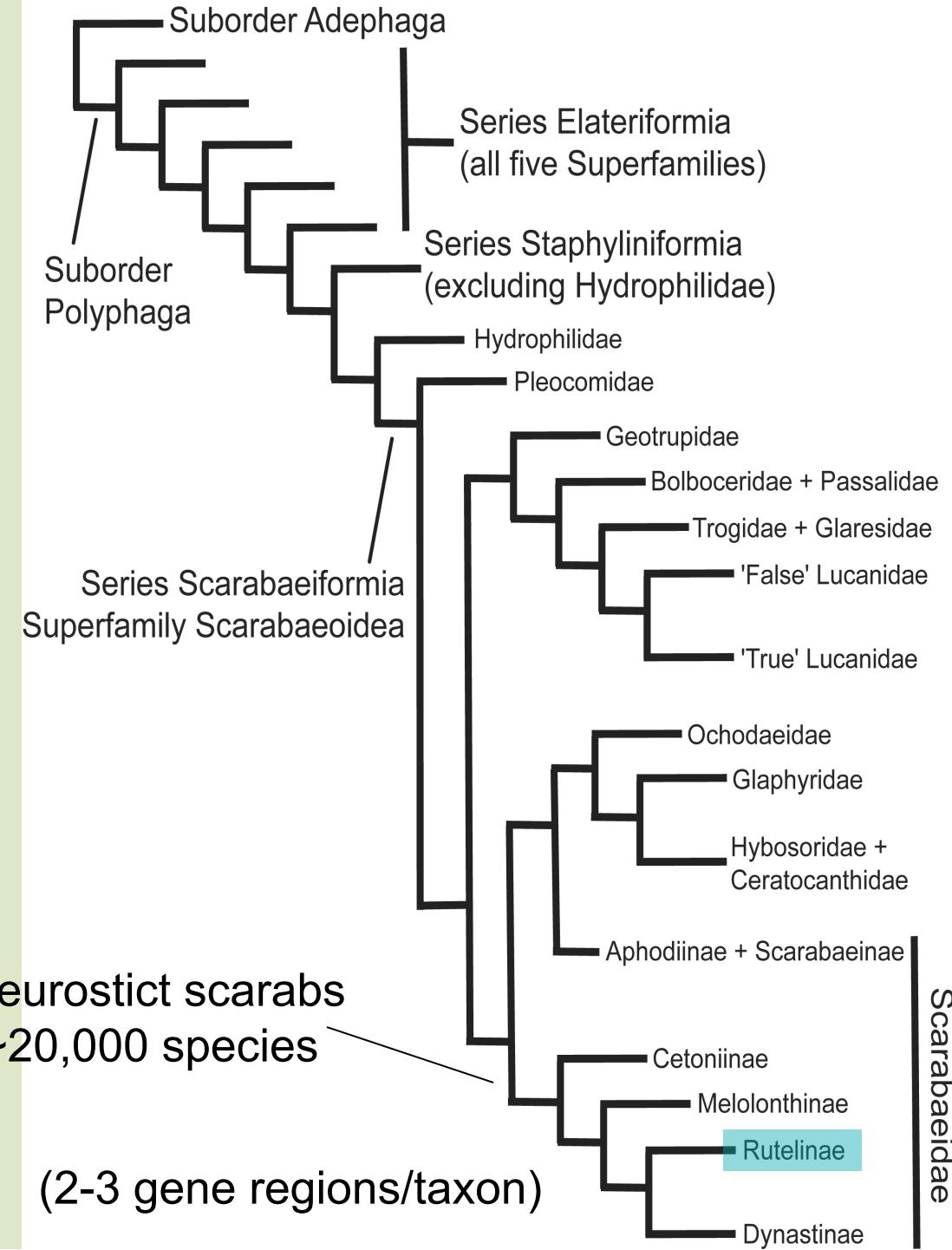


*Anomalorhina osaensis* & *Anomalorhina turrialbana*

# Classification and Phylogeny

- Blanchard (1851) first created the group name Anomalitae that included the genera.
- Bates (1886) classified the group as a subfamily of Rutelidae.
- Peringuey (1902) designated Anomalini as a tribe of Rutelinae and published a key to the tribes of Rutelinae of South Africa.
- Tribe Anomalini: 5 subtribes, ~54 genera, and ~2000 species,  
(*Anisopliina*, *Anomalina*, *Isopliina*, *Leptohopliina*, *Popilliina*)
- Classification status (tribe, subfamily, etc.) and relationships with other scarabs a matter of ongoing research.

# Phylogeny of scarabaeoids based on molecular data

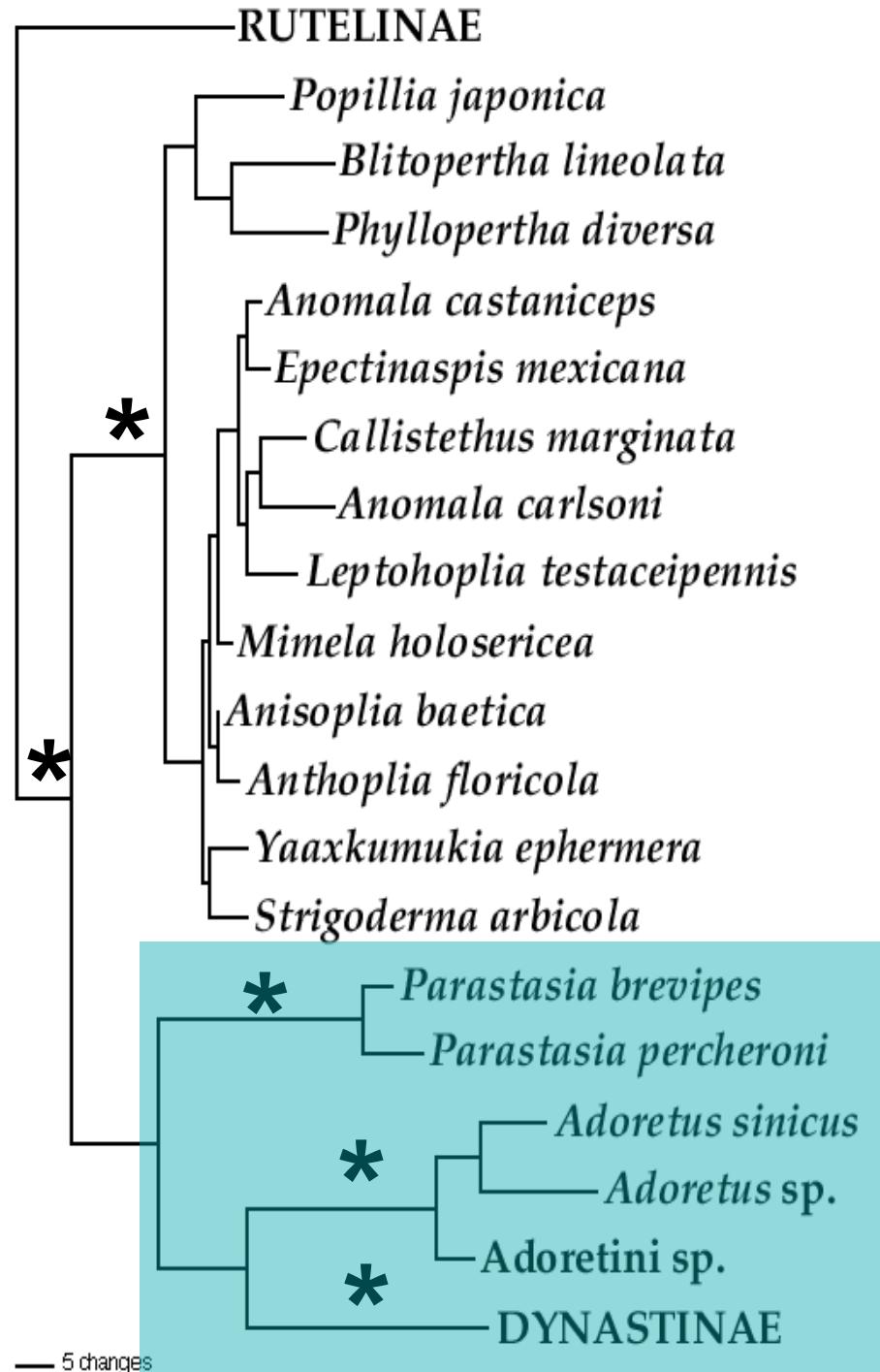


## Sister Group to the Anomalini Clade?

1 of 26 equally  
parsimonious trees

\*indicates high bootstrap  
support (+82%)

## The Dynastinae

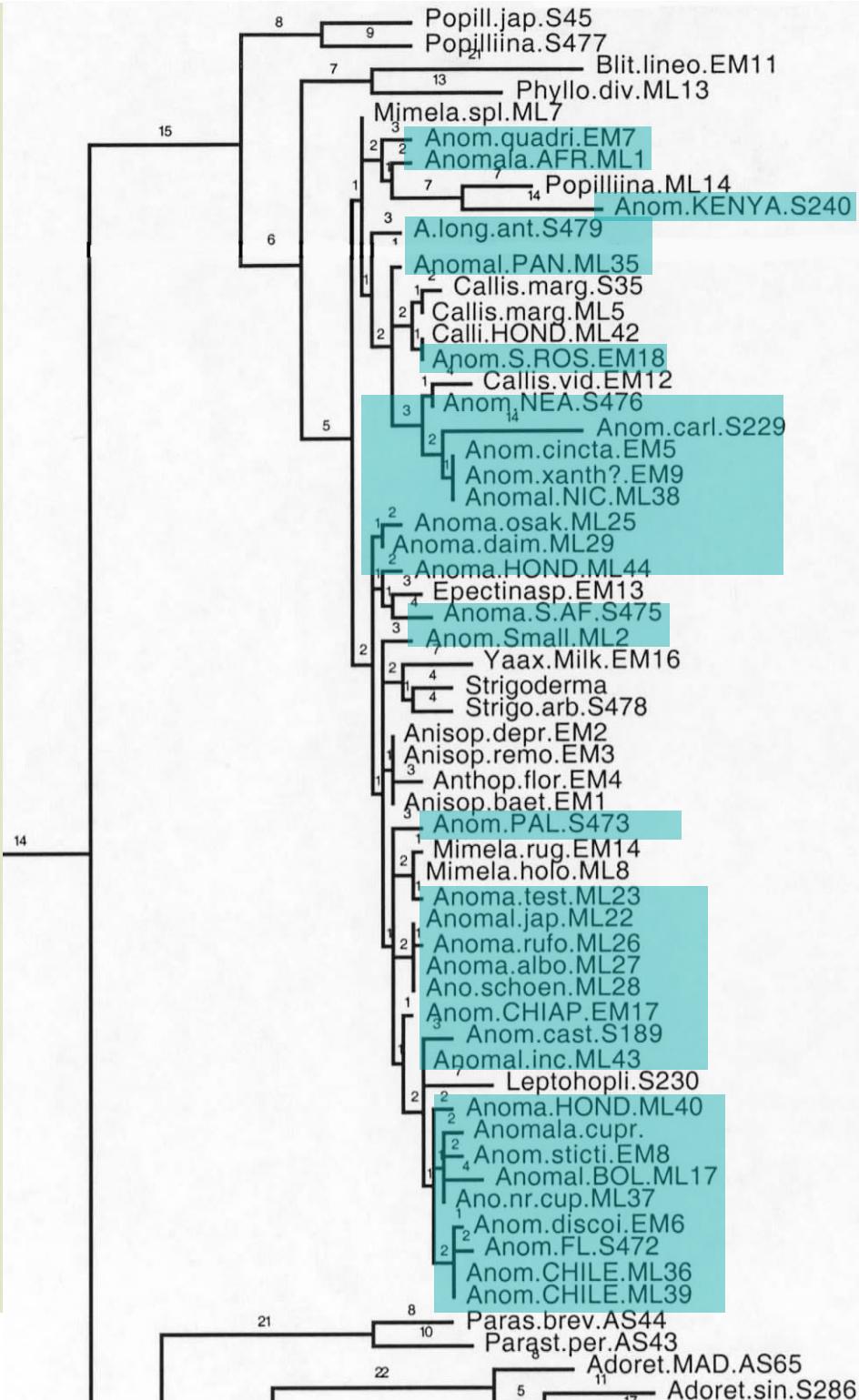


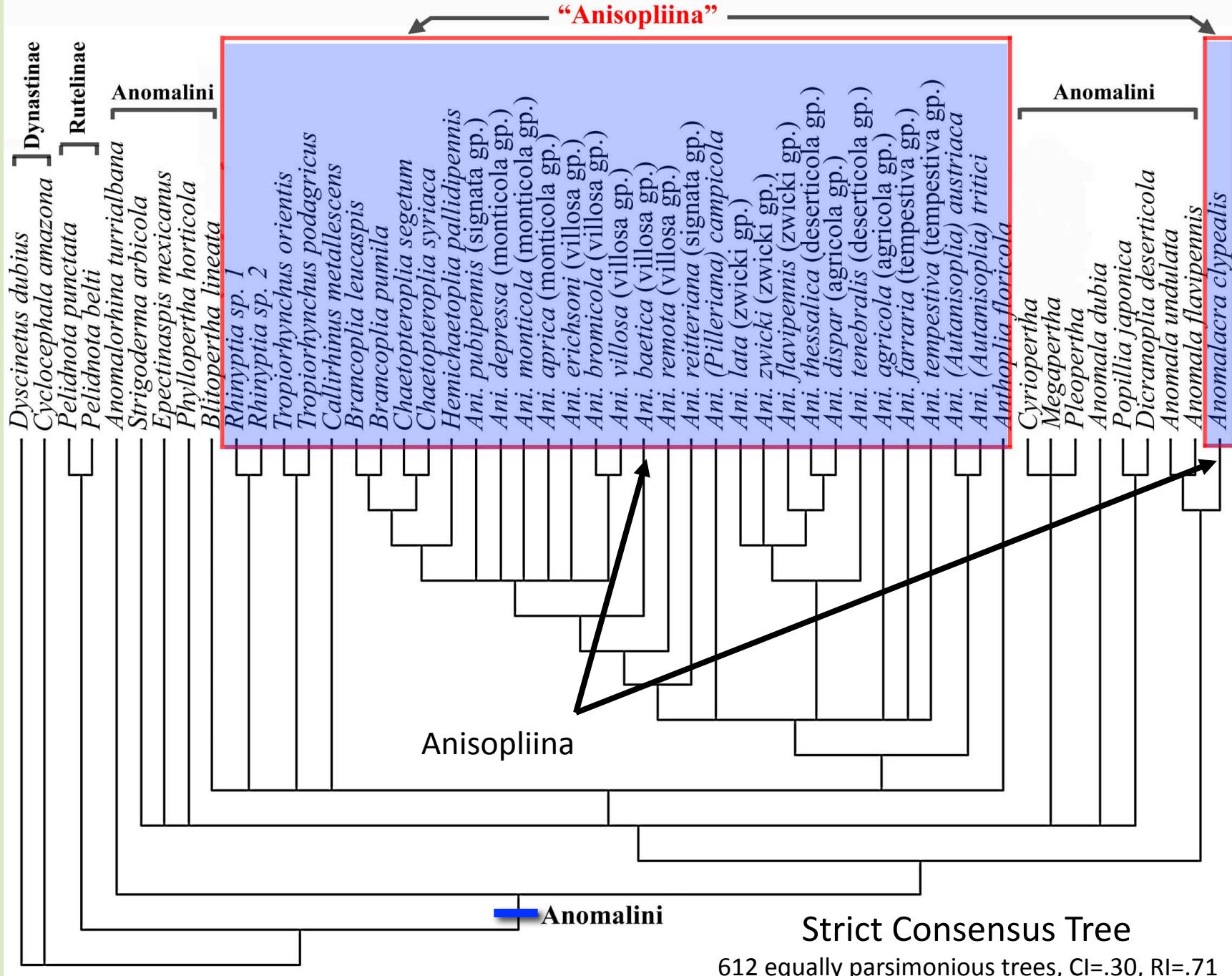
# Anomalini Clade

79 species

3 gene regions  
(1550 base pairs)

Based on Hawks, Mico, and Jameson in prep.





# Recent Literature

Ramírez-Ponce, A. & Morón, M.A. 2009. Relaciones filogenéticas del género *Anomala* Samouelle (Coleoptera: Melolonthidae: Rutelinae: Anomalini). Revista Mexicana de Biodiversidad 80: 357-394.

Morón, M.A. and G. Nogueira.1999. Adiciones y actualizaciones en los Anomalini (Coleoptera: Melolonthidae: Rutelinae) de la Zona de Transicion Mexicana (I). Folia Entomológica Mexicana 103: 15-54.

## Anomalini



<http://www.koleopterologie.de/gallery/>

*Anisoplia zwicki*

## Anomalini



<http://www.koleopterologie.de/gallery/>

*Anomala dubia*

## Anomalini



<http://www.koleopterologie.de/gallery/>

*Blitopertha campestris*

## Anomalini



<http://www.koleopterologie.de/gallery/>

*Chaetopteroplia segetum*

## Anomalini



<http://carn.ua.es/CIBIO/es/colecciones/tipos.htm>

Cañada Talcuán  
Unión Juarez, CHIAPAS  
(MEXICO) 7-4-2002  
Leg.: E. Galante

HOLOTYPE  
*Yaaxkumukia conabioi*  
Micó, Gómez &  
Galante, 2005

*Yaaxkumukia conabioi* Micó, Gómez & Galante 2005

## Anomalini



<http://www.biodiversity-georgia.net/gallery.php?taxon=Anomala%20abchasica>

*Anomala abchasica*, color variations (Europe)

## Anomalini



<http://bugguide.net/node/view/402333/bgimage>

*Anomala marginata*

## Anomalini



<http://www.unl.edu/museum/research/entomology/Scarabs-for-Kids/images/pics/album/index.html>

*Strigoderma arbicola* (Fabricius)

# Tribe Anoplognathini MacLeay, 1819



[http://www.oocities.org/brisbane\\_scarabs/Rutelinae.htm](http://www.oocities.org/brisbane_scarabs/Rutelinae.htm)

*Anoplognathus* sp. Australia

# Species Diversity



Scarabaeidae: *Platycelia humeralis*, Honduras  
<http://www.allaboutbeetles.co.uk/show/english/projects/honduras.aspx> © 2007

5 subtribes:  
Anoplognathina,  
Brachysternina,  
Phalangogonina,  
Platyceoliina,  
Schizognathina

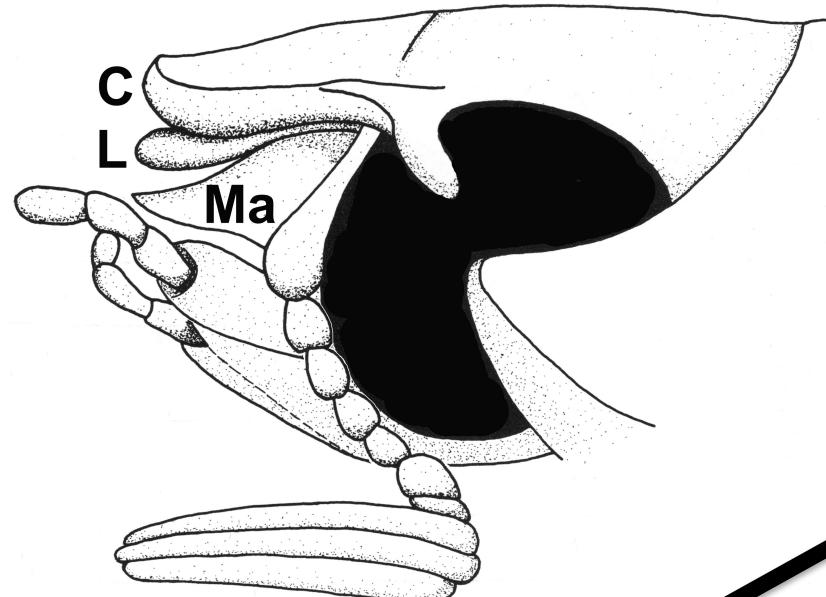
25 genera

202 species

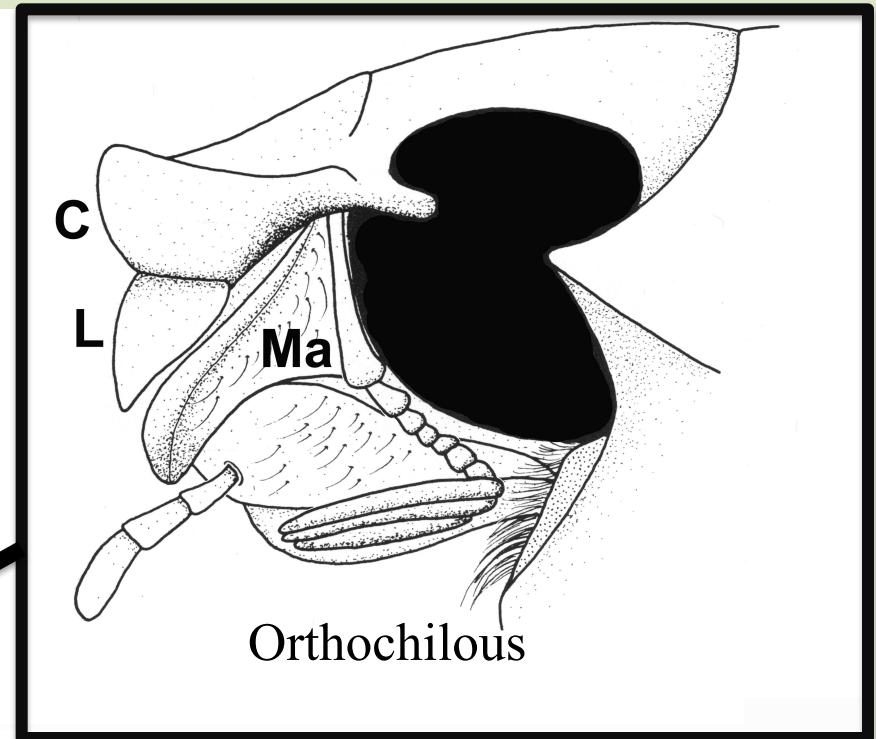
# What is an Anoplognathine?

- Form elongate oval, size *generally* about 15-25 mm
- Labrum vertically produced with respect to the clypeus; clypeus and mentum often with apicomедial projections.
- Antennae with 9 or 10 segments.
- Protarsomeres not dorsoventrally flattened and expanded apically; protarsus with claw usually enlarged and often split in males, usually with medial tooth in females.
- Elytral margin chitinous or membranous.
- The tribe Anoplognathini is endemic to the Australian and Neotropical realms.

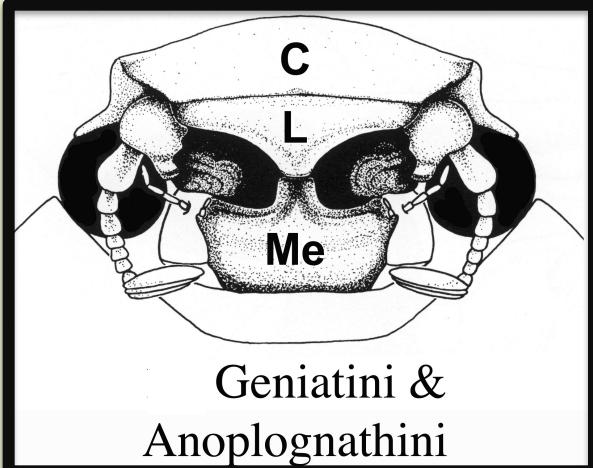
# Two Basic Ruteline Groups



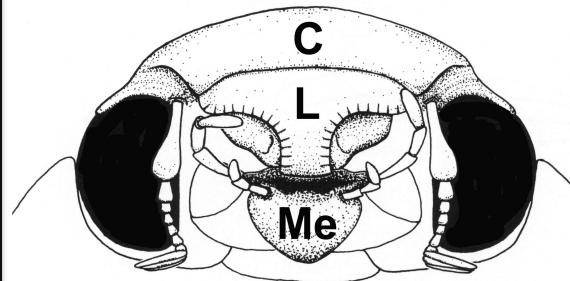
Homalochilous:  
Anomalini and Rutelini



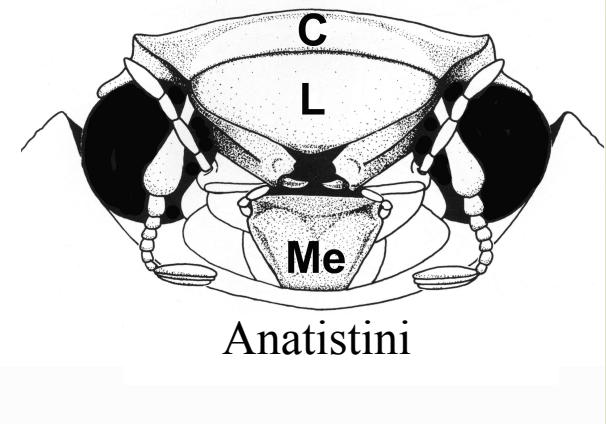
Orthochilous



Geniatini &  
Anoplognathini



Adoretini



Anatistini

# Anoplognathine Characteristics



Fig. 2. *Platynoelia grandicula* mouthparts.



Fig. 3. *Platynoelia chrysotina* mouthparts.

Smith 2003

Labrum vertically produced with respect to the clypeus; clypeus and mentum often with apicomедial projections.

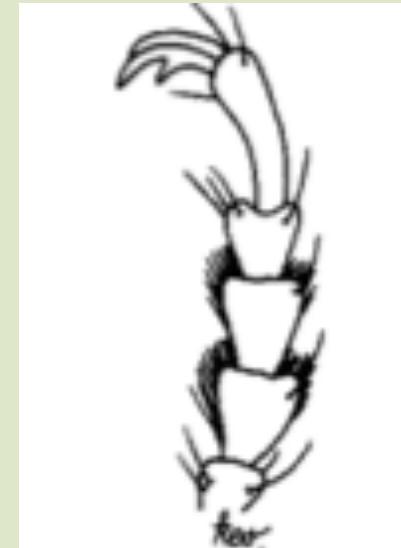
# Anoplognathine Characteristics



Figure 9. Foreleg in dorsal view of *Anomala chrysanthae*.



Figure 10. Foreleg in dorsal view of *Leptohoplia testaceipennis*



Foretarsi of Geniatini enlarged and densely setose ventrally.

Protarsomeres not dorsoventrally flattened and expanded apically; protarsus with claw usually enlarged and often split in males, usually with medial tooth in females.

# Anoplognathine Characteristics

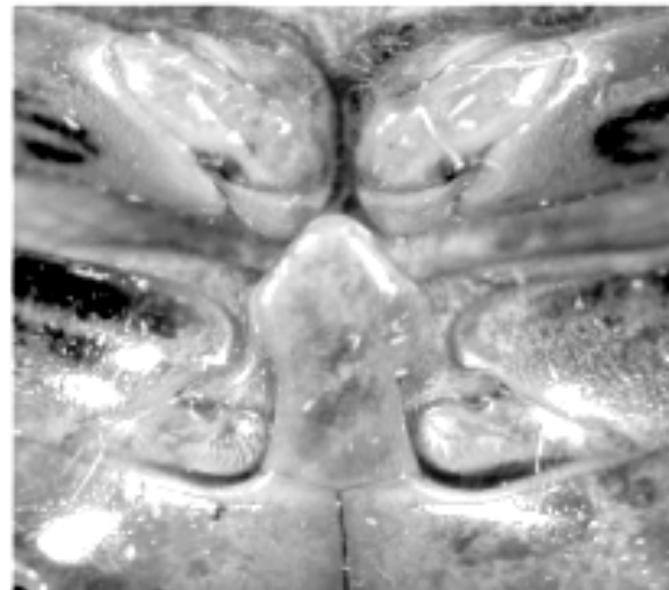


Fig. 7. *Platycocelia mesostemalis* mesothoracic process.

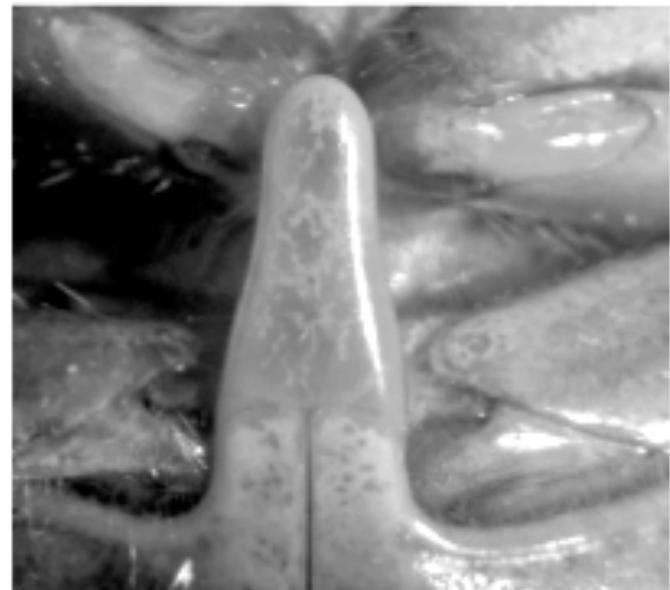


Fig. 8. *Platycocelia grandicula* mesothoracic process.

Smith 2003

Form of the mesothoracic process.

# Anoplognathine Characteristics

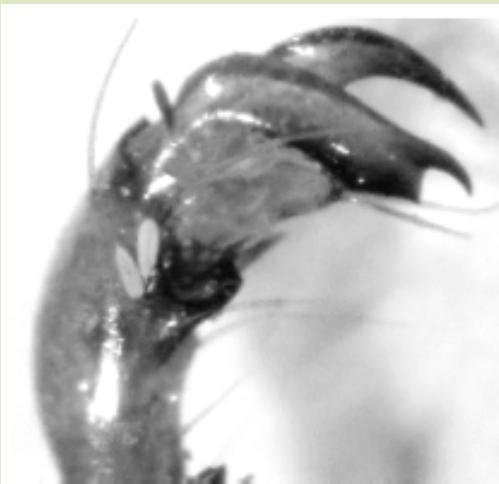


Fig. 11. *Platycocelia alternans* male protarsal claw.



Fig. 12. *Platycocelia valida* male protarsal claw.

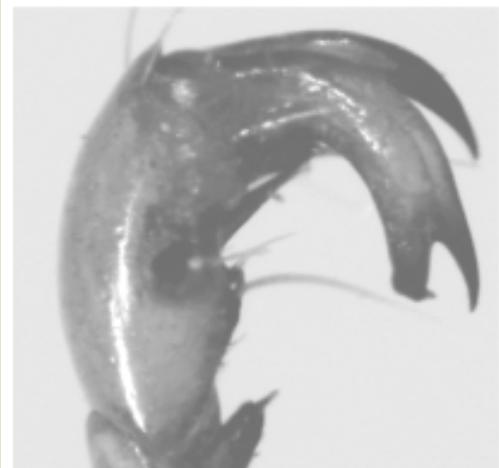


Fig. 13. *Platycocelia grandicula* male protarsal claw.

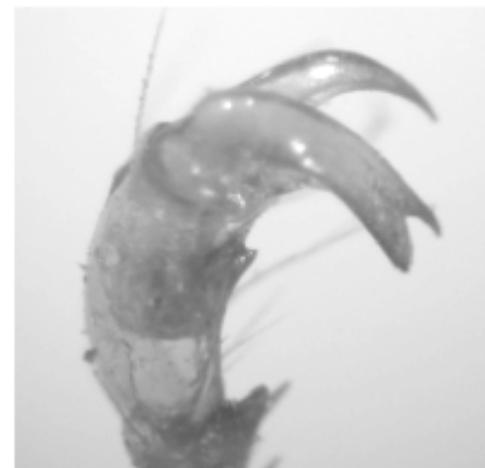


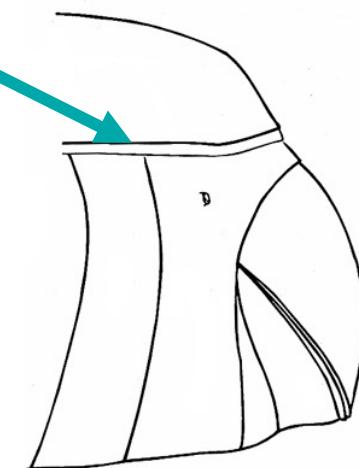
Fig. 14. *Platycocelia chrysotina* male protarsal claw.

Smith 2003

protarsus with claw usually enlarged and often split in males, usually with medial tooth in females.

# Anoplognathine Characteristics

Elytral margin  
with membrane



Elytral margin chitinous or membranous

# Anoplognathine Characteristics



Labrum not produced beyond apex of clypeus



<http://insectophilia.livejournal.com/153600.html>

Dorsal surface often highly convex

# Distribution

The five subtribes are distributed as follows:  
Anoplognathina (Australia and New Guinea),  
Schizognathina (Australia), Brachysternina  
(Chile, Argentina), Phalangogoniina (México  
and Central America), and Platycoeliina  
(Neotropics, mainly in the Andes Mountains  
and montaine areas of Central America).

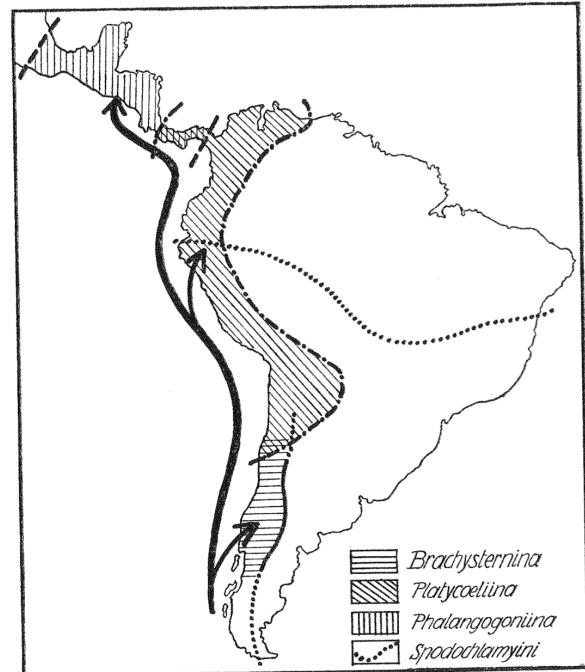


Fig. 20.

Verbreitung der südamerikanischen *Anoplognathini* und *Spodochlamyini*.

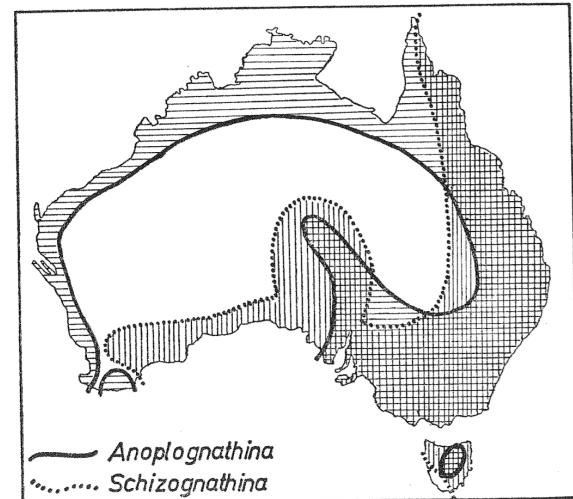


Fig. 21.

Uebersicht über die Verbreitung der australischen *Anoplognathini*.

## Anoplognathini



Fig. 41. *Platycocelia inflata* female.

Smith 2003

## Anoplognathini



*Phalangogonia hawksi* Smith. Photo by Andrew Smith.

[http://www.unl.edu/museum/research/entomology/  
Guide/Scarabaeoidea/Scarabaeidae/Rutelinae/  
Rutelinae-Tribes/Anoplognathini/Anoplognathini-  
generic-%20pages/Phalangogonia/Phalangogonia.html](http://www.unl.edu/museum/research/entomology/Guide/Scarabaeoidea/Scarabaeidae/Rutelinae/Rutelinae-Tribes/Anoplognathini/Anoplognathini-generic-%20pages/Phalangogonia/Phalangogonia.html)

## Anoplognathini



[http://www.sciencentre.qm.qld.gov.au/Find-out-about/Animals-of-Queensland/Insects/Beetles/Common-species/  
Christmas-Beetles](http://www.sciencentre.qm.qld.gov.au/Find-out-about/Animals-of-Queensland/Insects/Beetles/Common-species/Christmas-Beetles)

*Anoplognathus porosus*, Australia

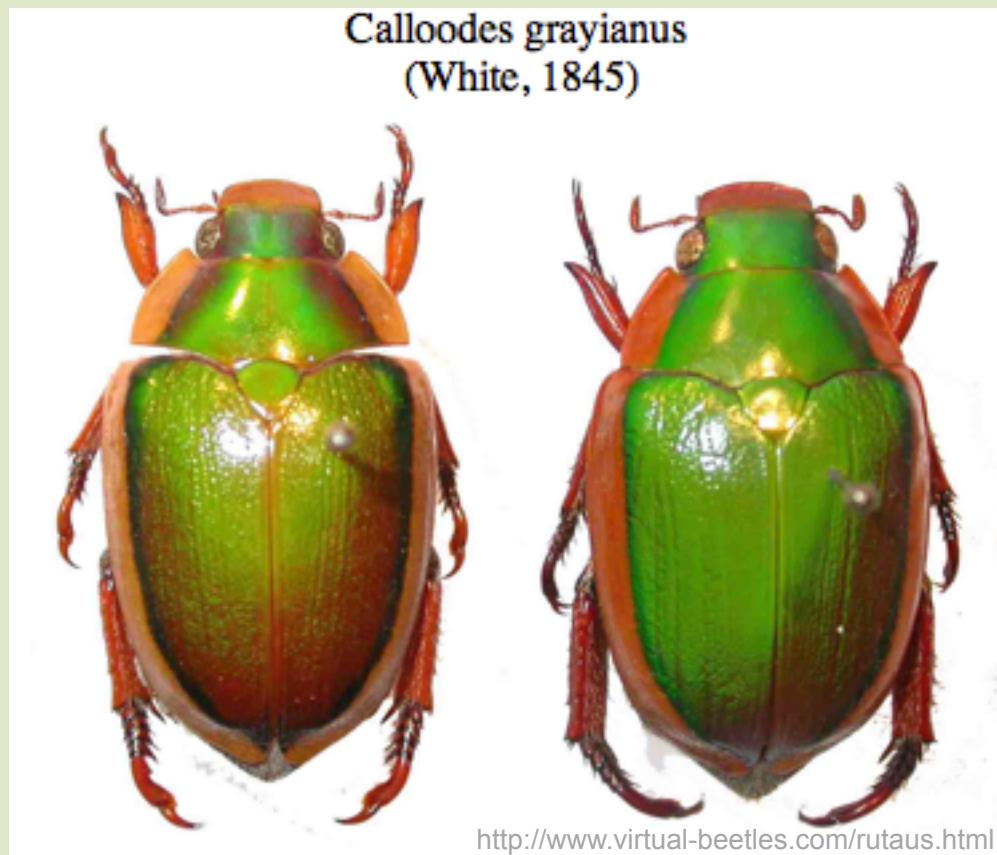
## Anoplognathini



[http://www.scienccentre.qm.qld.gov.au/Find+out/about/Animals+of+Queensland/Insects/Beetles/Common+species/  
Christmas+Beetles](http://www.scienccentre.qm.qld.gov.au/Find+out/about/Animals+of+Queensland/Insects/Beetles/Common+species/Christmas+Beetles)

*Anoplognathus viriditarsis*, Australia

## Anoplognathini



## Anoplognathini

**Anoplostethus laetus**  
(Rothschild & Jordan, 1894)



<http://www.virtual-beetles.com/rutaus.html>

## Anoplognathini

**Repsimus manicatus manicatus**  
(Swartz, 1817)



<http://www.virtual-beetles.com/rutaus.html>

## Anoplognathini



<http://www.flickr.com/photos/rainforests/5556796539/>

*Platycoelia* sp. from Ecuador

## Anoplognathini



<http://www.unl.edu/museum/research/entomology/Scarabs-for-Kids/images/pics/album/index.html>

*Brachysternus prasinus*, Chile

# Classification and Phylogeny

- MacLeay (1819) created the Anoplognathidae, but it had a very different composition from the current concept – it consisted of the modern Anoplognathini, Geniatini, and *Apogonia* Kirby (a Melolonthinae genus)
- Burmeister (1844) classified the Anoplognathini in the modern sense (all of the taxa currently considered to be in the group and that were known at the time)
- Ohaus (1904a, 1904b, 1905, 1918) divided the tribe into the five currently recognized subtribes: Anoplognathina, Schizognathina, Brachysternina, Phalangogoniina, and Platycoeliina.
- All three of the Neotropical subtribes have recently been revised (Brachysternina by Jameson and Smith [2002], Ratcliffe and Ocampo [2002], and Smith [2002]; Phalangogoniina by Smith and Morón [2003]; and Platycoeliina by Smith [2003]).
- Tribe Anoplognathini: 5 subtribes, 25 genera, and 202 species  
(Anoplognathina, Brachysternina, Phalangogonina, Platyceoliina, Schizognathina)
- Relationships of the Anoplognathini to other ruteline tribes (sister group relationships) and relationships of genera within the tribe and require further investigation.

# Phylogeny

- Preliminary phylogenetic research on the tribe Anoplognathini supports the monophyly of the Neotropical subtribes of Anoplognathini (Brachysternina, Phalangogoniina, Platycoeliina), but not the Australian subtribes (Anoplognathina, Schizognathina) (Smith in prep.).
- Preliminary molecular results of the phytophagous scarabs place serious doubt on the monophyly of the tribe Anoplognathini. The Brachysternina and the Australian taxa form a monophyletic clade, but the Phalangogoniina and Platycoeliina are quite divergent and will probably need to be reclassified within the Rutelinae (Smith in prep.).

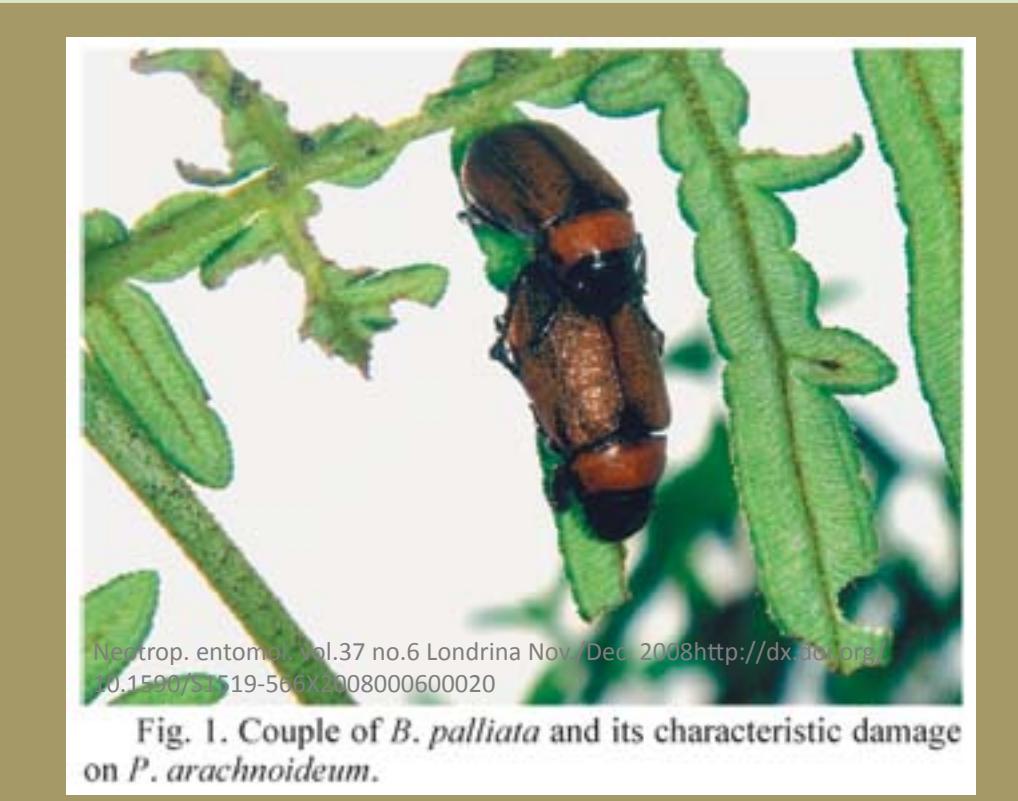
# Resources

Smith, A.B.T. 2003. A Monographic Revision of the Genus *Platycoelia* Dejean (Coleoptera: Scarabaeidae: Rutelinae: Anoplognathini). Bulletin of the University of Nebraska State Museum 15: 1-209.

Carne, P. B. 1958. A review of the Australian Rutelinae (Coleoptera: Scarabaeidae). Australian Journal of Zoology 6(2): 162- 240.

Smith, A B.T. 2008. Checklist of the Anoplognathini (Scarabaeidae: Rutelinae). (URL: <http://www-museum.unl.edu/research/entomology/Guide/Scarabaeoidea/Scarabaeidae/Rutelinae/Rutelinae-Tribes/Anoplognathini/Anoplognathini-Catalog/AnoplognathiniC.html>). In, B.C. Ratcliffe and M.L. Jameson (eds.), Generic Guide to New World Scarab Beetles (URL: <http://www-museum.unl.edu/research/entomology/Guide/index4.htm>).

# Tribe Geniatini Burmeister, 1844

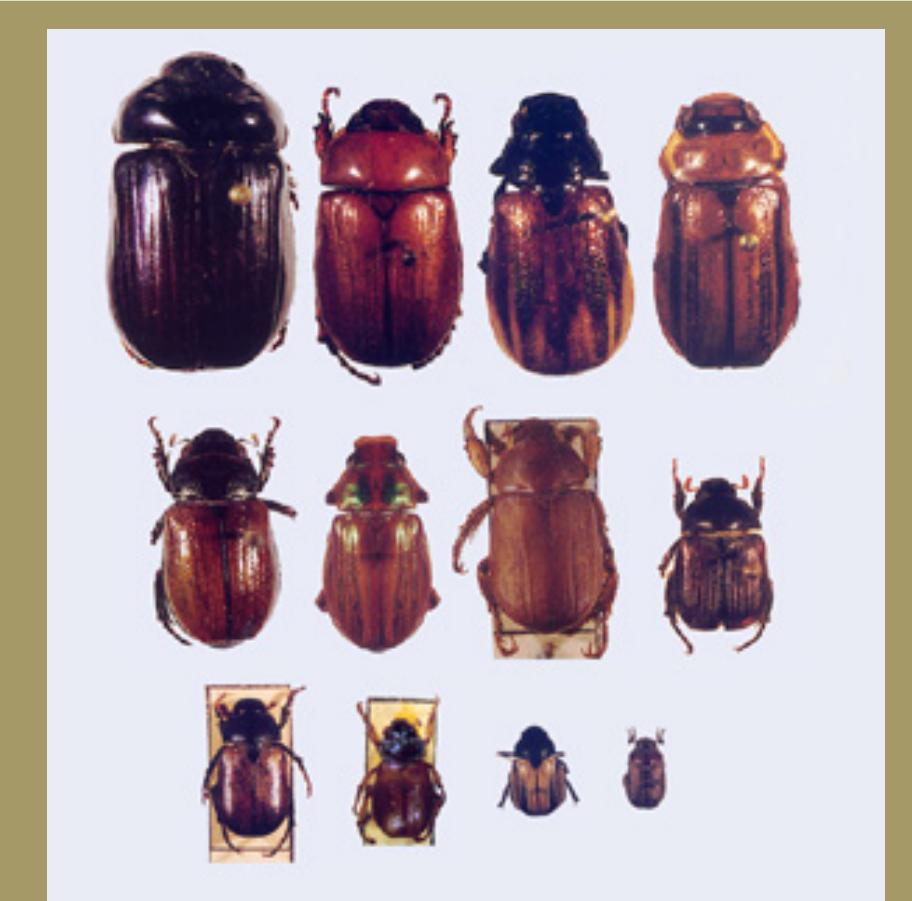


Neotrop. entomol. vol.37 no.6 Londrina Nov./Dec. 2008 [http://dx.doi.org/  
10.1590/S1519-566X2008000600020](http://dx.doi.org/10.1590/S1519-566X2008000600020)

Fig. 1. Couple of *B. palliata* and its characteristic damage  
on *P. arachnoideum*.

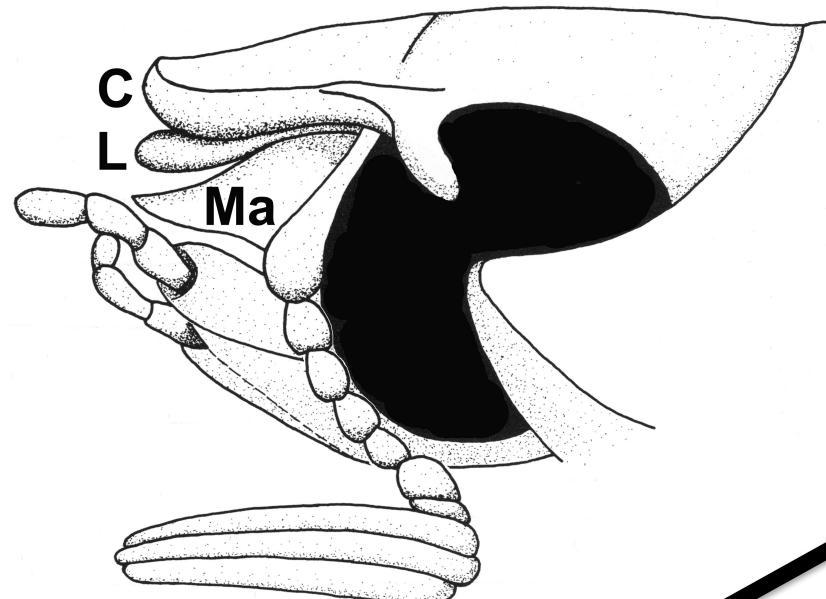
*Bolax palliata* feeds on bracken fern

# Species Diversity

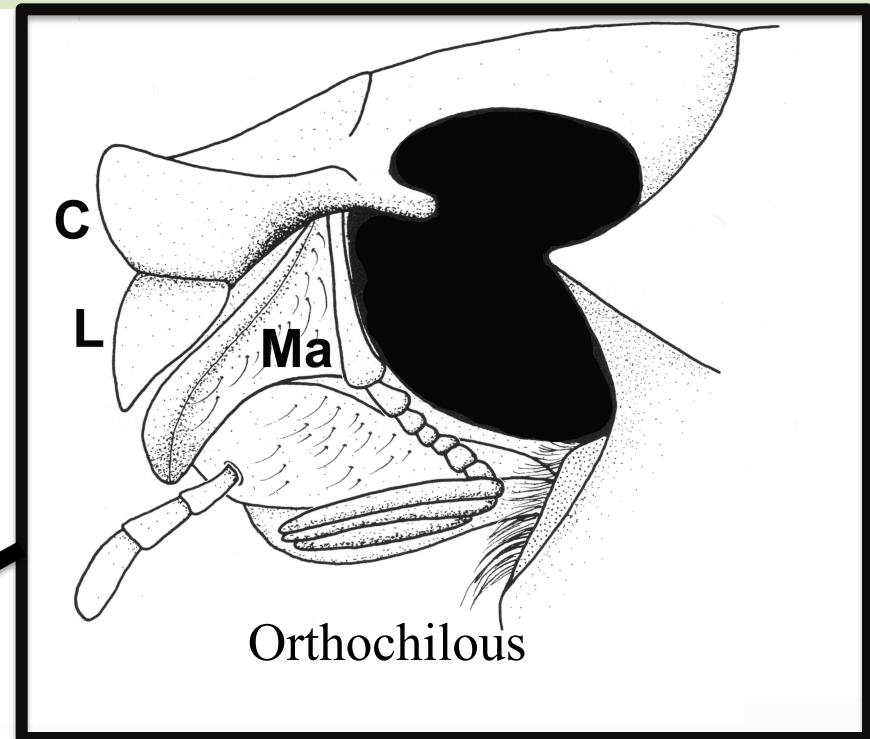


Tribe Geniatini: 13 genera, 327 species

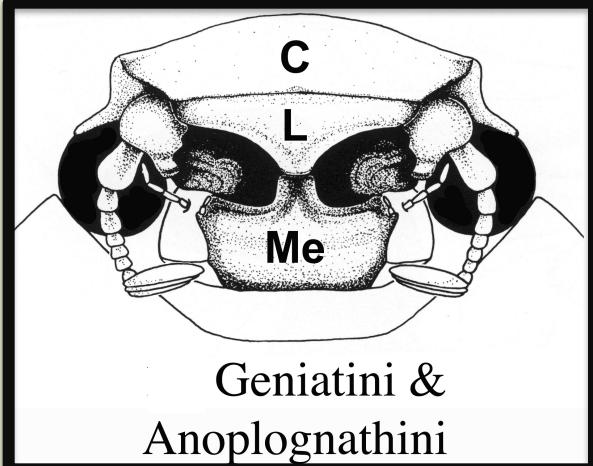
# Two Basic Ruteline Groups



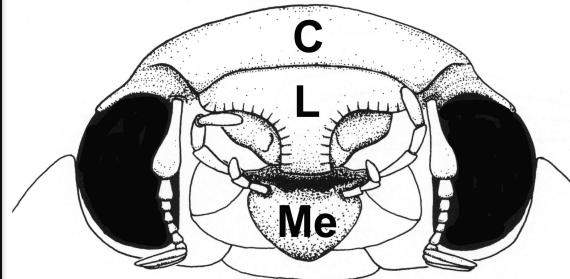
Homalochilous:  
Anomalini and Rutelini



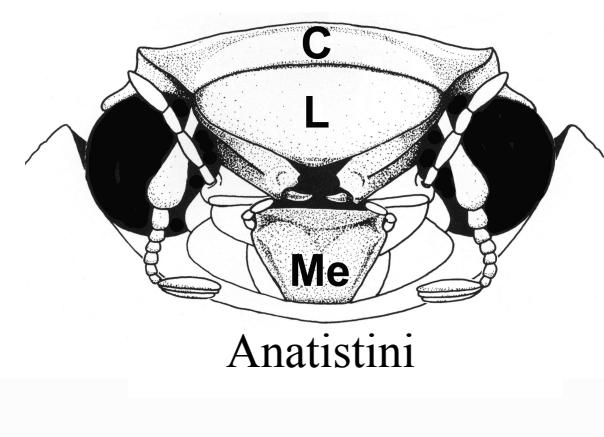
Orthochilous



Geniatini &  
Anoplognathini

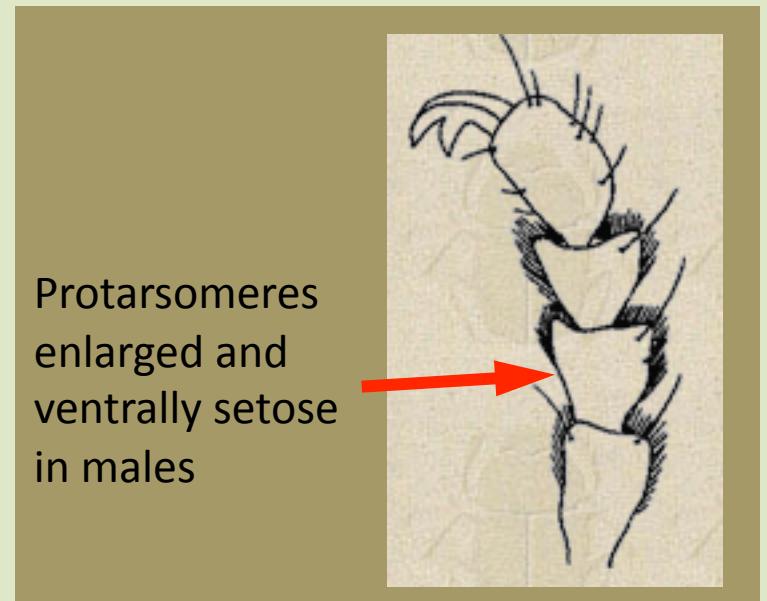
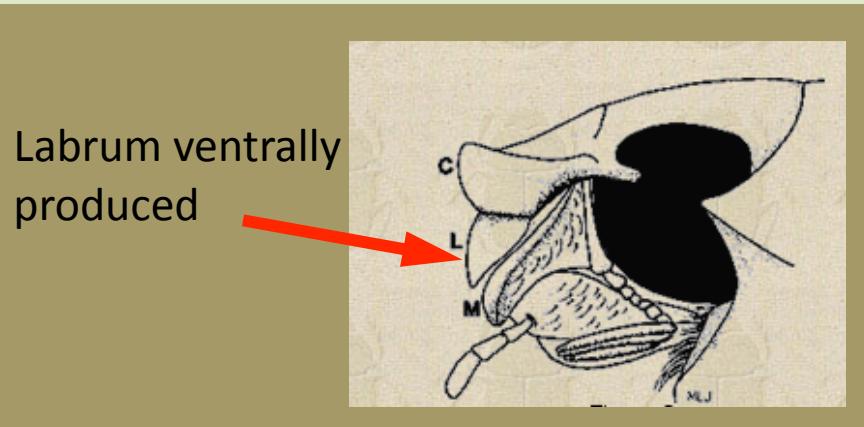


Adoretini

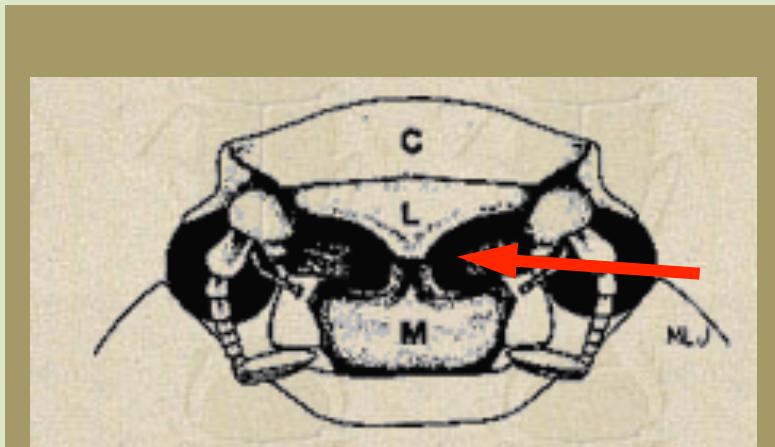


Anatistini

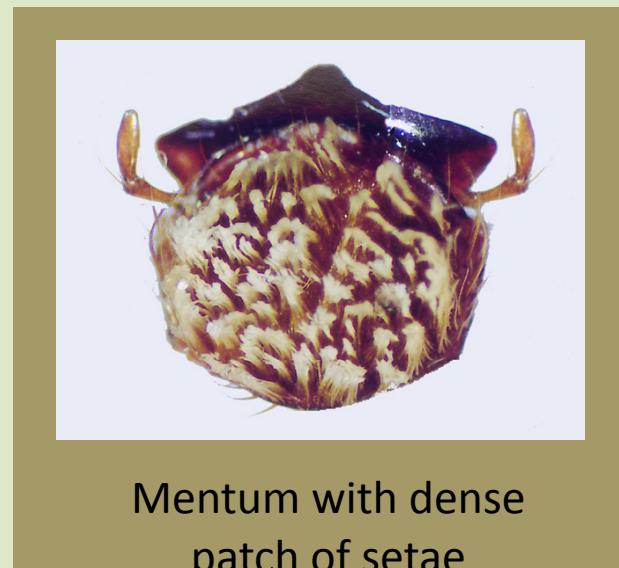
# What is a Geniatine?



*Geniates* is Greek for “bearded”



Labrum and mentum with apicomедial projections

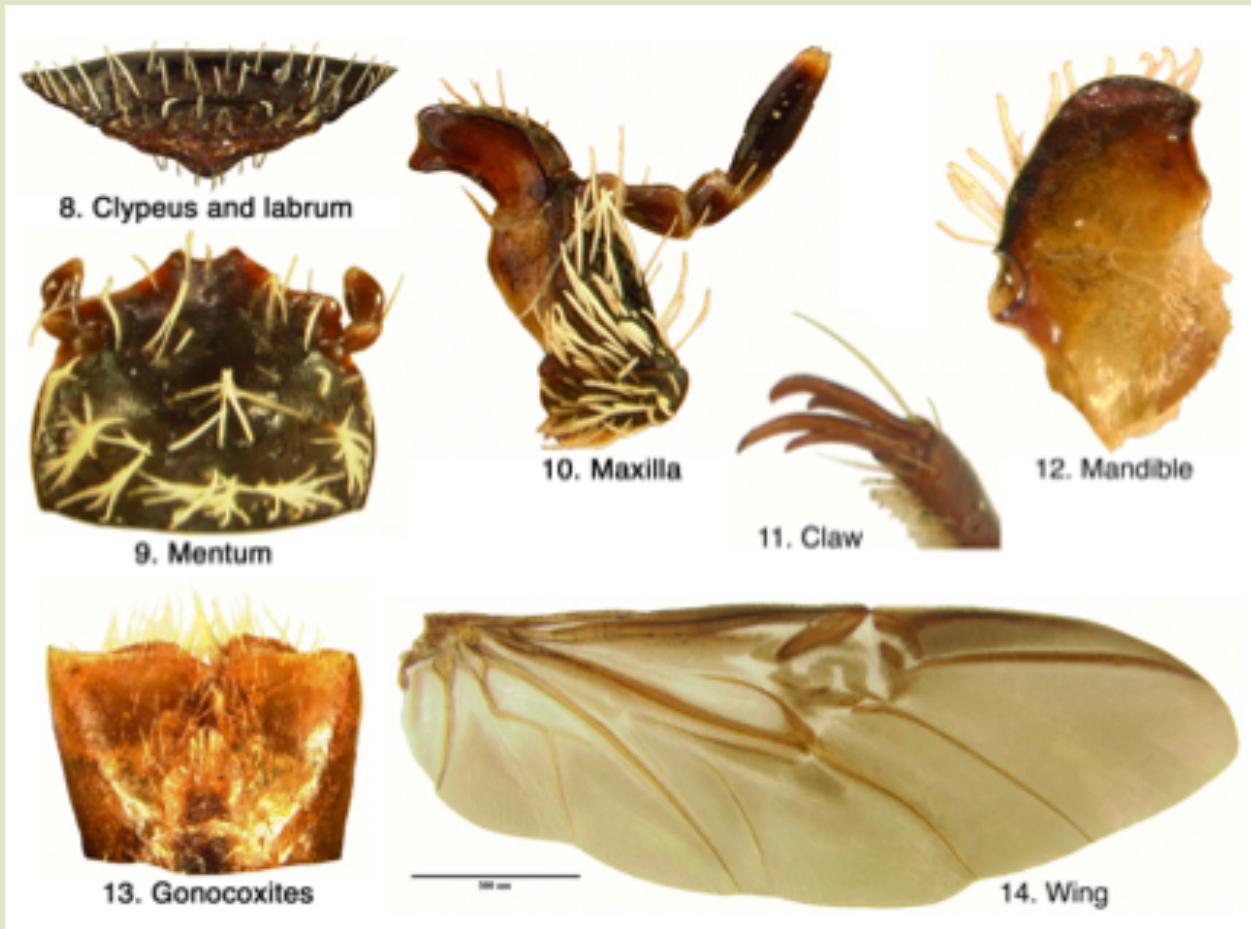


Mentum with dense patch of setae

# What is a Geniatine?

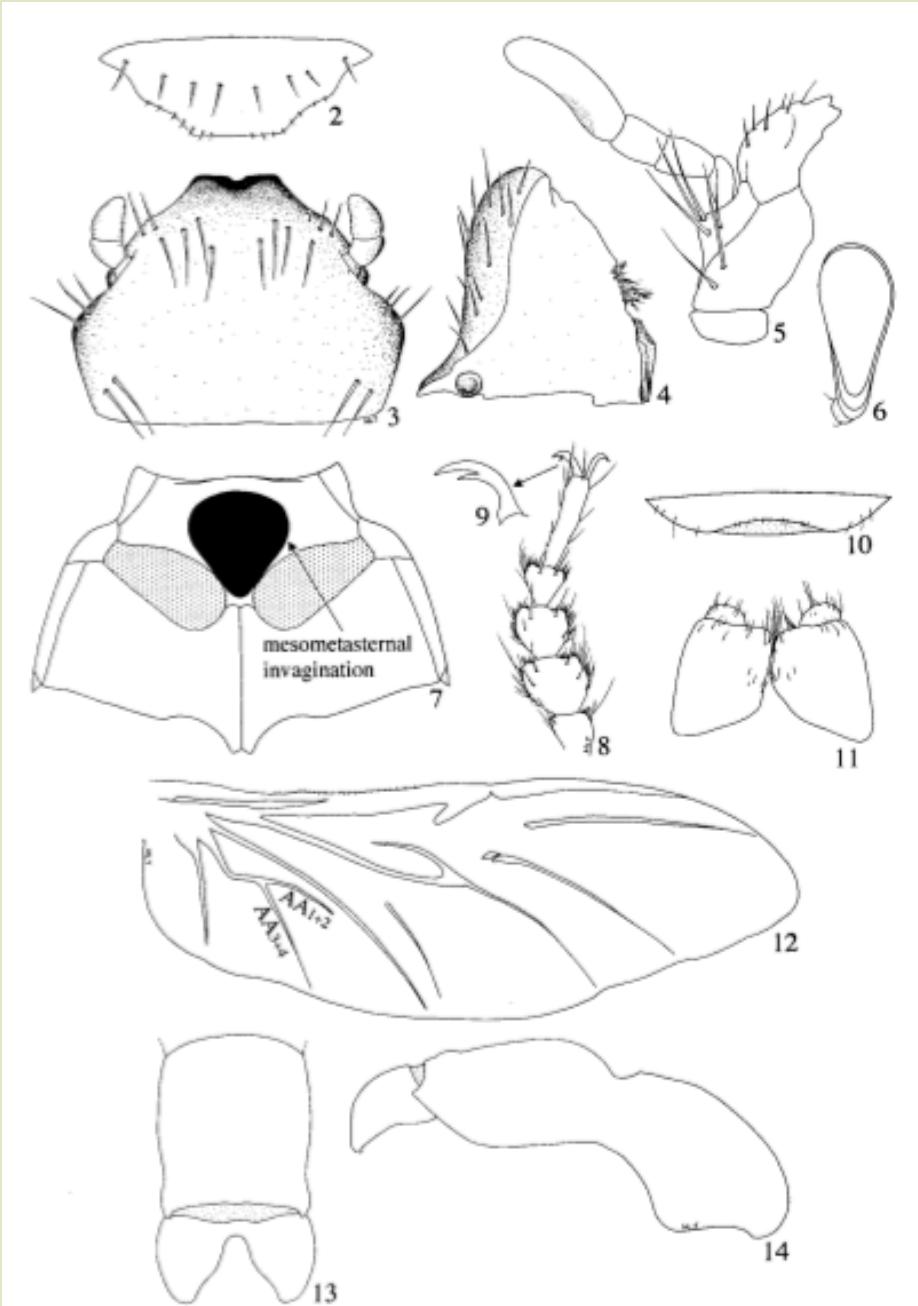
- Form elongate oval, size 5 mm to about 30 mm.
- Labrum vertically produced with respect to the clypeus
- Clypeus and mentum with apicomедial projections
- Antennae with 9 or 10 segments
- Protibiae tridentate (bidentate in *Microchilus*), inner protibial spur apical; foretarsomeres usually enlarged in males and/or females and densely setose ventrally (except in *Geniatosoma*)
- Elytral margin chitinous or membranous
- Terminal spiracle positioned in pleural suture
- Tribe Geniatini: 13 genera, 327 species
- Distributed in New World only

# Geniatine Characteristics



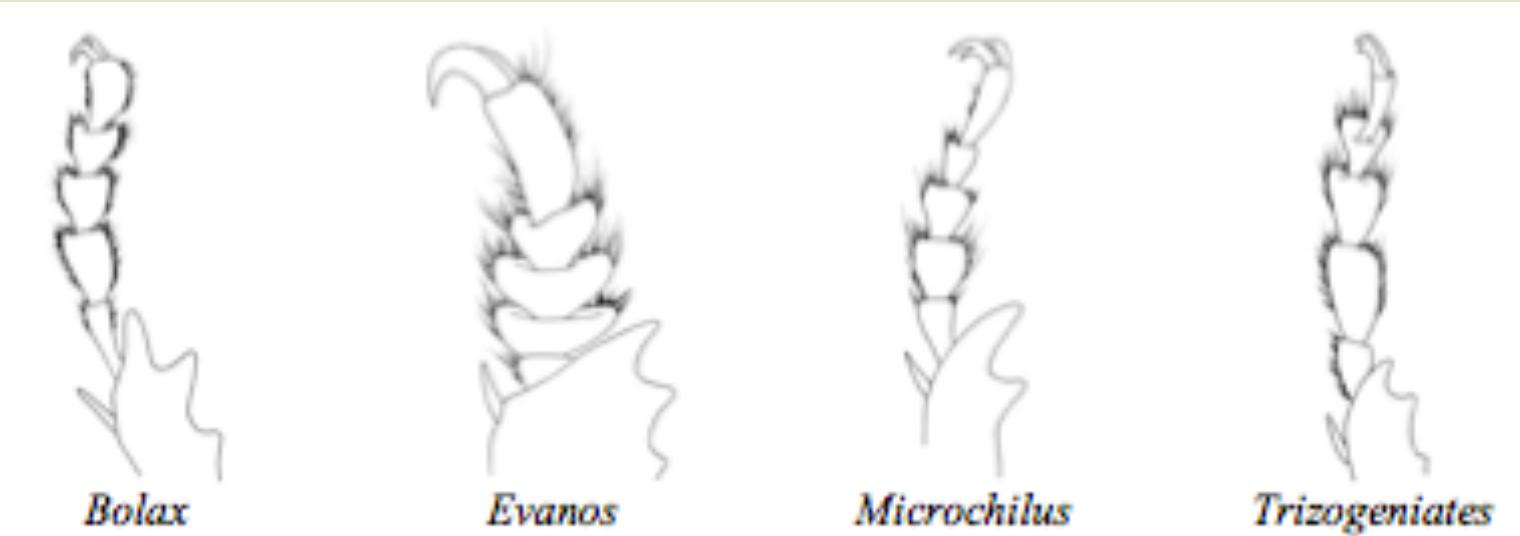
*Microchilus* species

# Geniatine Characteristics



*Xenogeniates*

# Geniatine Characteristics



Protibiae tridentate (bidentate in *Microchilus*), inner protibial spur apical; foretarsomeres usually enlarged in males and/or females and densely setose ventrally (except in *Geniatosoma*)

# Geniatine Characteristics



*Mimogeniates margaridae*



*Rhizogeniates antennatus*



*Rhizogeniates carbonarius*

Mentum usually with apicomедial projections, but there are exceptions

# Geniatine Characteristics

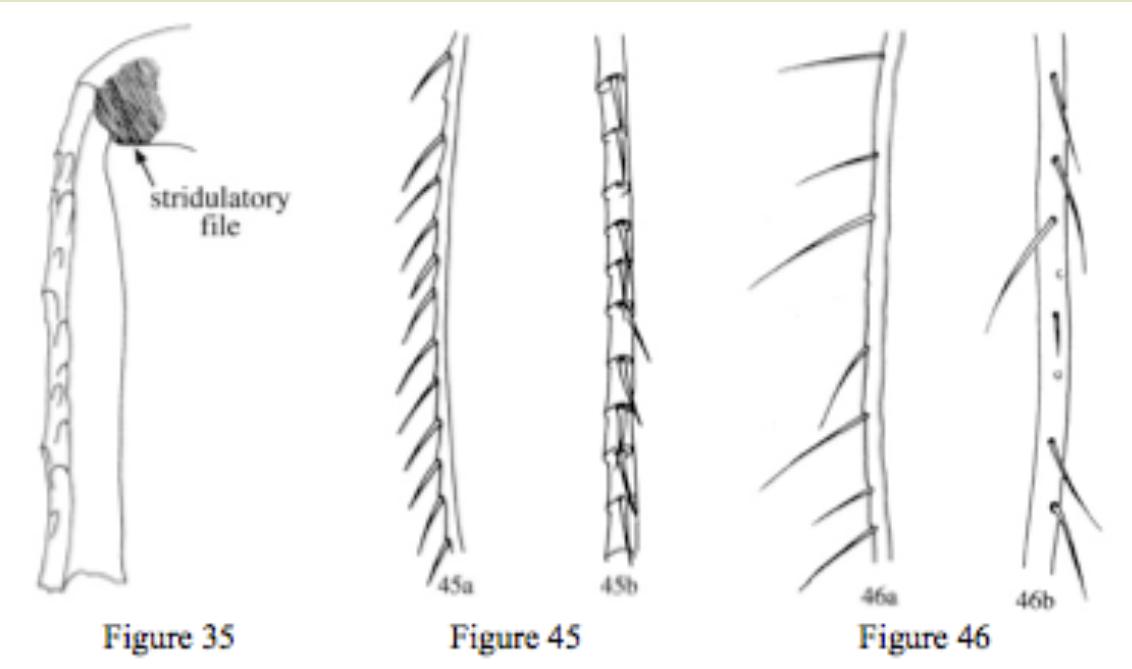


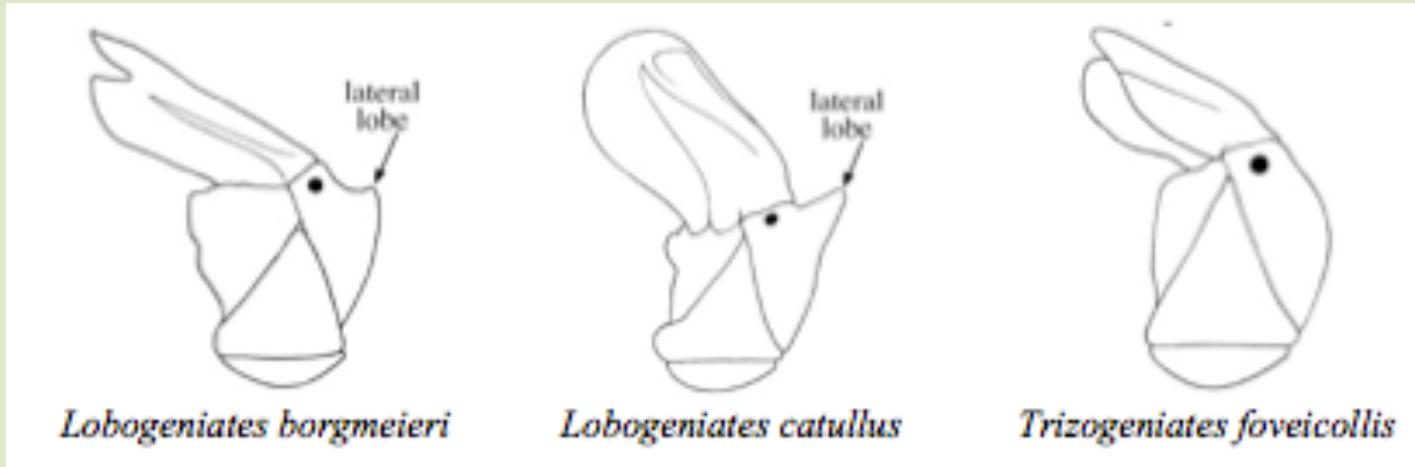
Figure 35

Figure 45

Figure 46

Elytral margin chitinous or membranous. *Trizogeniates* with stridulatory setae.

# Geniatine Characteristics

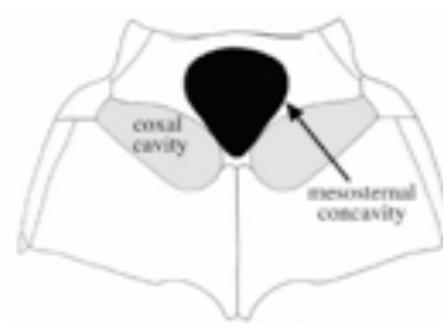


Form of the stipes characteristic for Lobogeniates (with lateral lobe)

# Geniatine Characteristics



*Bolax magna*  
Figure 51



*Xenogeniates martinezii*  
Figure 52

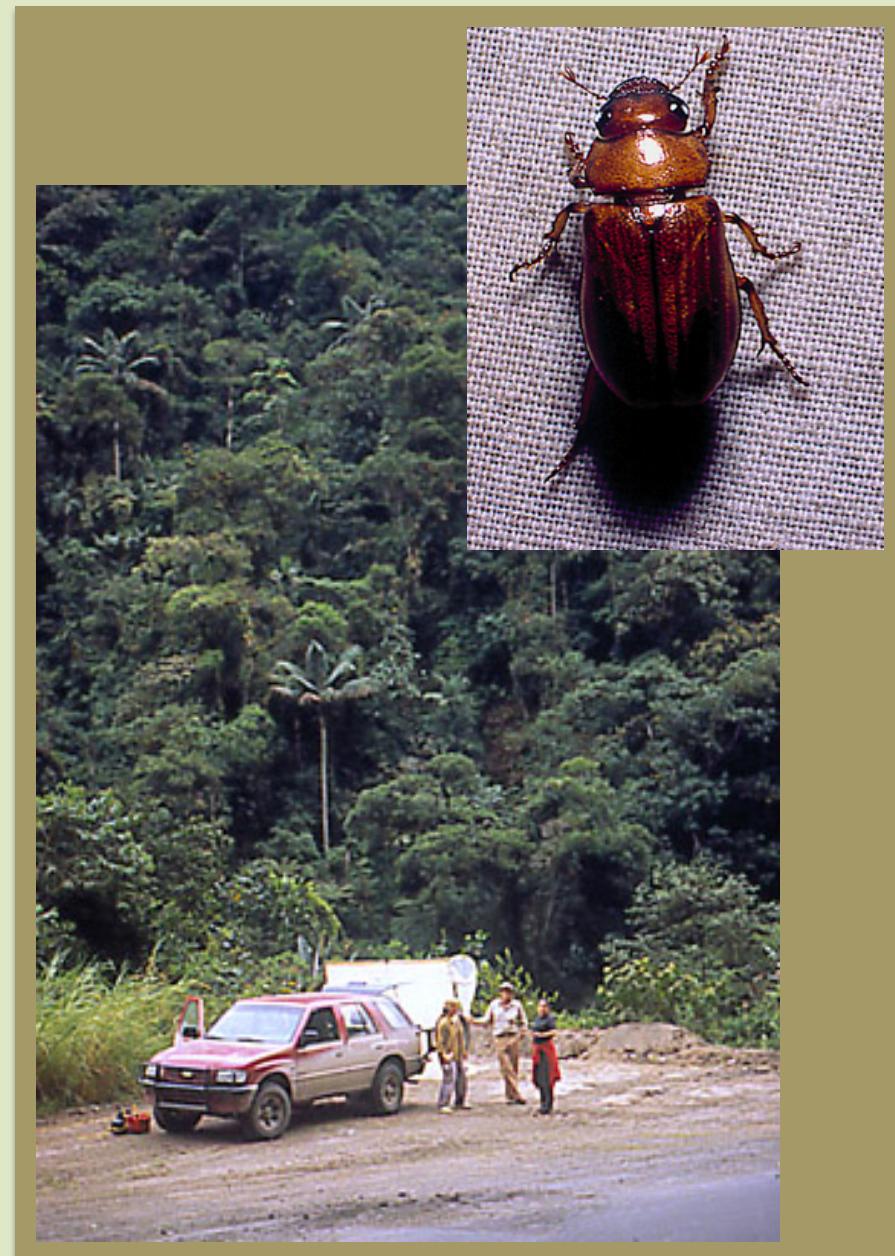
Mesosternal concavity present in *Xenogeniates*

# Distribution and Biology

Neotropical distribution (Mexico to northern Argentina and Brazil). Only one species is known from Chile (*Geniates leptopus* Ohaus).

## Ecology:

- Inhabit forests from sea level to 2000 meters
- Adults are leaf-feeders
- Larvae are unknown
- Collected at lights



# Classification and Phylogeny

- Burmeister (1844) created the group name "Geniatidae" that included the genera *Bolax*, *Leucothyreus*, *Evanos*, and *Geniates*.
- Ohaus (1918) designated the Geniatini as a tribe within the Rutelinae.
- This group is poorly known taxonomically. Revisions and keys to species are needed in all the genera, and the taxonomic position of some genera and species needs clarification.
- Phylogeny of the group, sister group relationships, and relationships of genera require investigation.

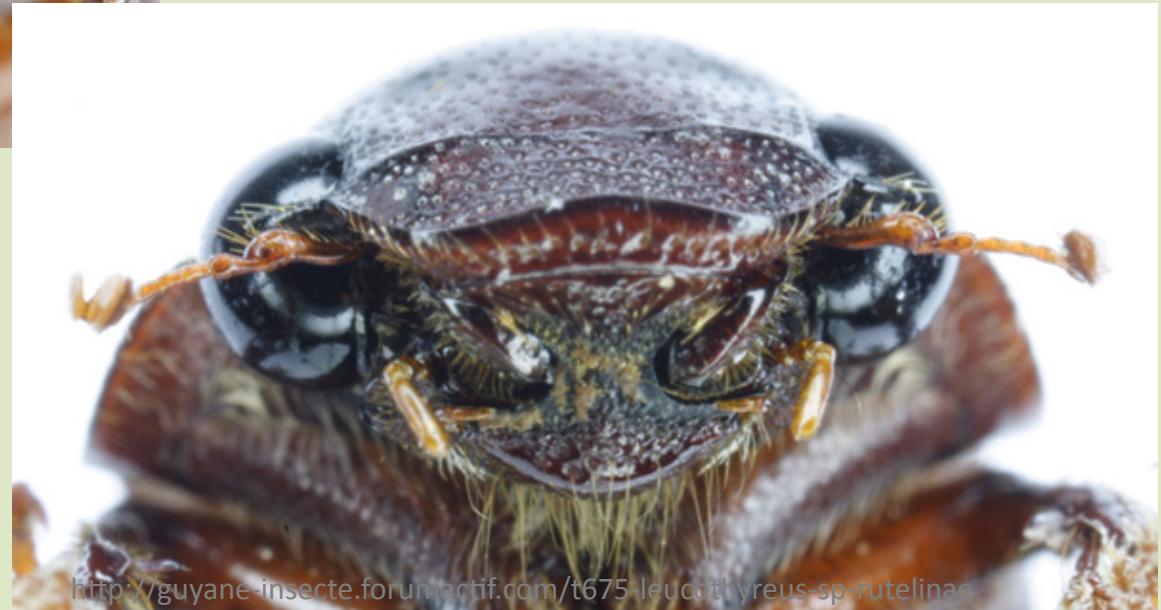
## Geniatini



<http://guyane-insecte.forumactif.com/t675-leucothyreus-sp-rutelinae>

*Leucothyreus* sp. from Guyane

## Geniatini



<http://guyane-insecte.forumactif.com/t675-leucothyreus-sp-rutelinae>

*Leucothyreus* sp. from Guyane

## **Geniatini**



*Trizogeniates foveicollis*

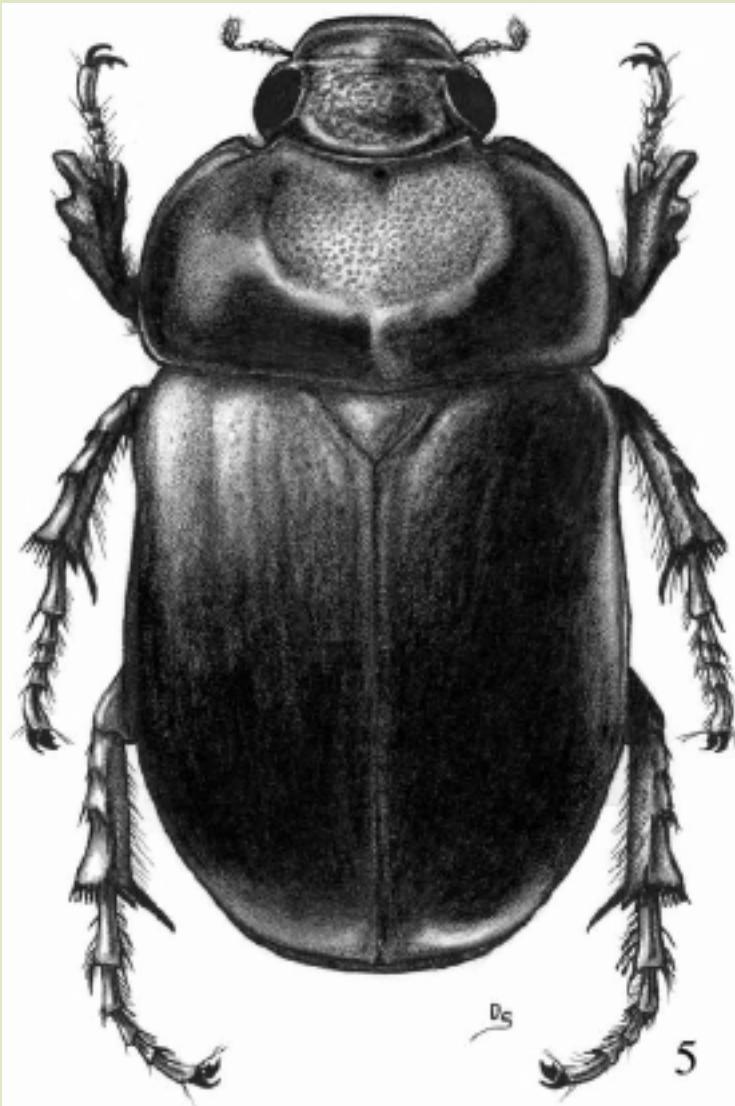
## Geniatini



<http://ntsavanna.com/a-plague-of-beetles/>

*Bolax magnus*, Panama

## Geniatini



*Geniatosoma nigrum* (male)

# Resources

Jameson, M.L. and S.J. Hawkins. 2005. Synopsis of the genera of Geniatini (Coleoptera: Scarabaeidae: Rutelinae) with an annotated catalog of species. Zootaxa 874: 1-76.

Jameson and Villatoro. 2006. Annotated Catalog of the Geniatini (Scarabaeidae: Rutelinae). URL:

<http://www-museum.unl.edu/research/entomology/Guide/Scarabaeoidea/Scarabaeidae/Rutelinae/Rutelinae-Tribes/Geniatini/Geniatini-Catalog/GeniatiniC.html>. In, B.C. Ratcliffe and M.L. Jameson (eds.), Generic Guide to New World Scarab Beetles (URL:

<http://www-museum.unl.edu/research/entomology/Guide/index4.htm>).

Villatoro, K. 2002. Revisión del género neotropical *Trizogeniates* Ohaus (Coleoptera: Scarabaeidae: Rutelinae: Geniatini). Entomotropica 17: 225-294.

# Tribe Anatistini Lacordaire, 1856

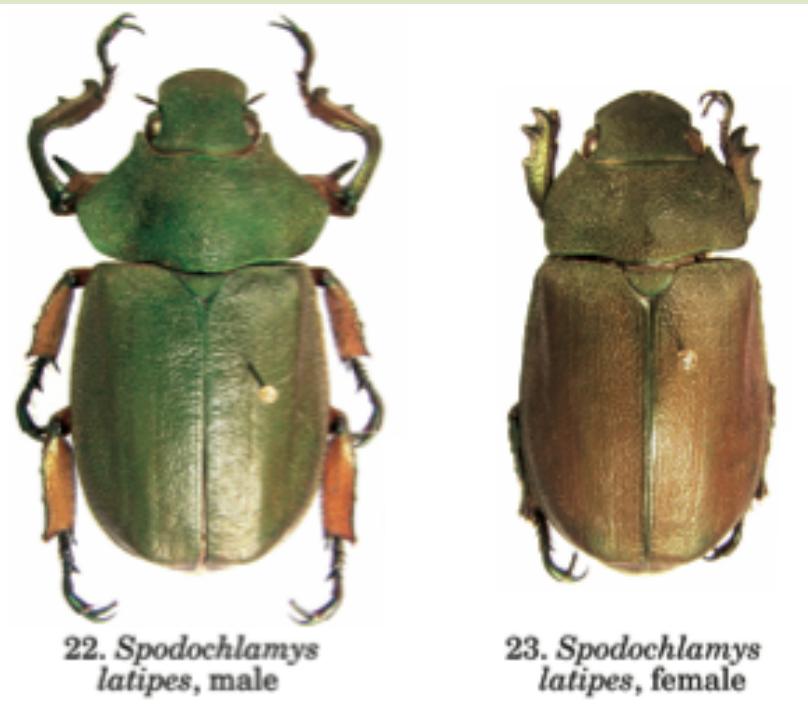


<http://www.insecte.org/forum/viewtopic.php?f=1&t=52573>

*Spodochlamys latipes*, Ecuador

# Species Diversity

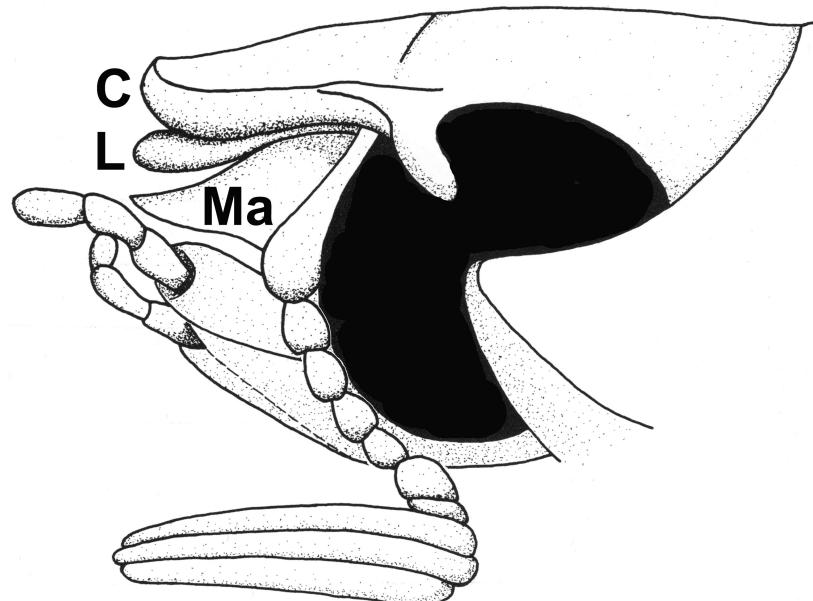
- The tribe includes 21 species and 4 genera.
- Size ranges from 20-50 mm.
- Species in the group are restricted to forested regions from Honduras in the north to Mato Grosso, Brazil in the south.
- The highest area of diversity for the group is Colombia with 45% of the species.



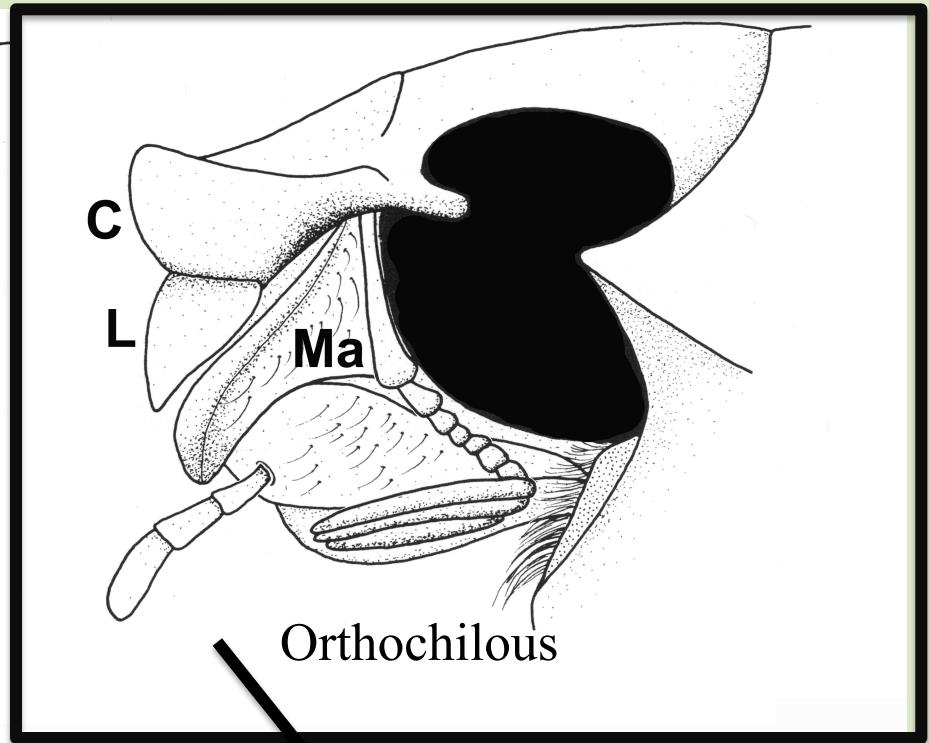
22. *Spodochlamys latipes*, male

23. *Spodochlamys latipes*, female

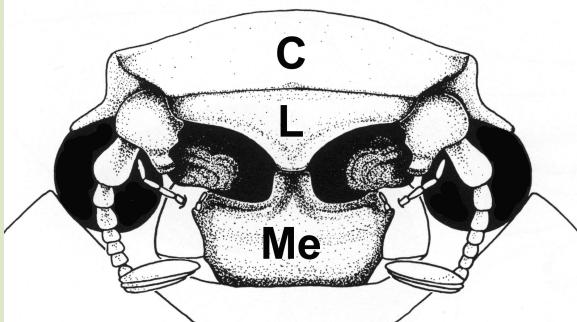
# Two Basic Ruteline Groups



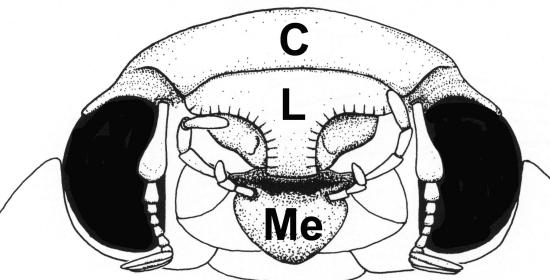
Homalochilous:  
Anomalini and Rutelini



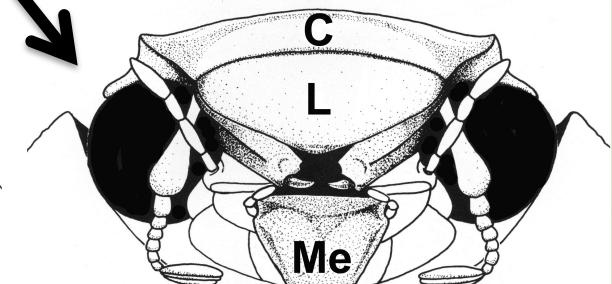
Orthochilous



Geniatini &  
Anoplognathini



Adoretini

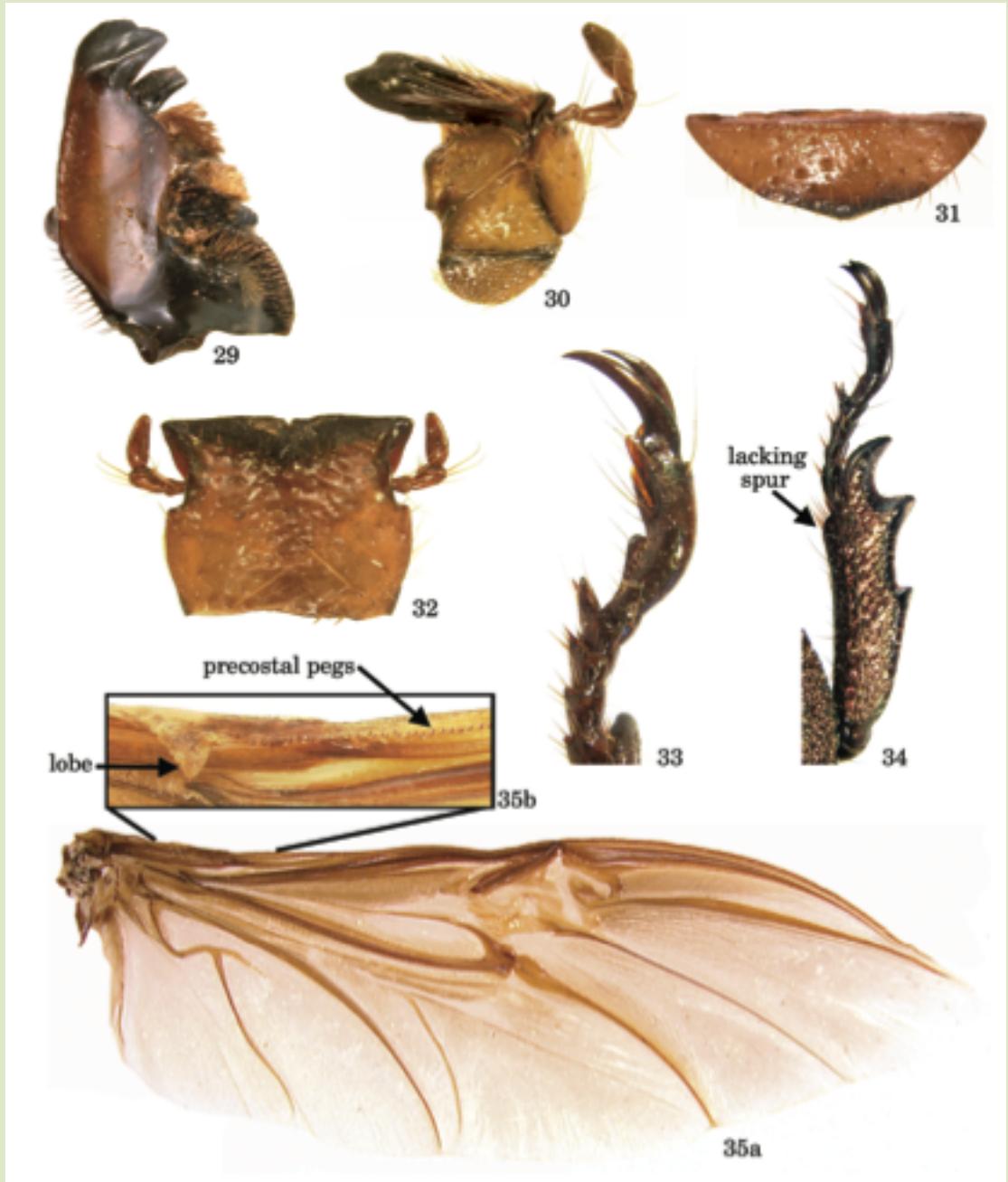


Anatistini

# What is an Anatistine?

- Labrum vertically and ventrally produced with respect to the clypeus and somewhat fused to the clypeus
- Labrum with apex weakly triangulate, lacking apical projection that overhangs the mentum (Adoretini possess a median, apical projection)
- Mentum lacking median, apical tooth or projection (Geniatini and Anoplognathini with median, apical tooth).
- Protarsomeres of males and/or females more or less cylindrical and lacking dense, ventral pilosity (protarsomeres of males and/or females dorsoventrally flattened, enlarged, and densely pilose ventrally in the tribe Geniatini; form of protarsomeres is shared with Anoplognathini, Adoretini, Rutelini, and Anomalini).
- Protibia lacking apical spur (spur present in all other Rutelinae).
- Margin of elytra with membranous border (membranous border lacking in Rutelini and Adoretini; form of elytral margin shared with Anomalini, Geniatini, and some Anoplognathini).

# Anatistine Characteristics



# Anatistine Characteristics



61. *Anatista macrophylla*

62. *Spodochlamys caesarea*, male

63. *Spodochlamys caesarea*, female

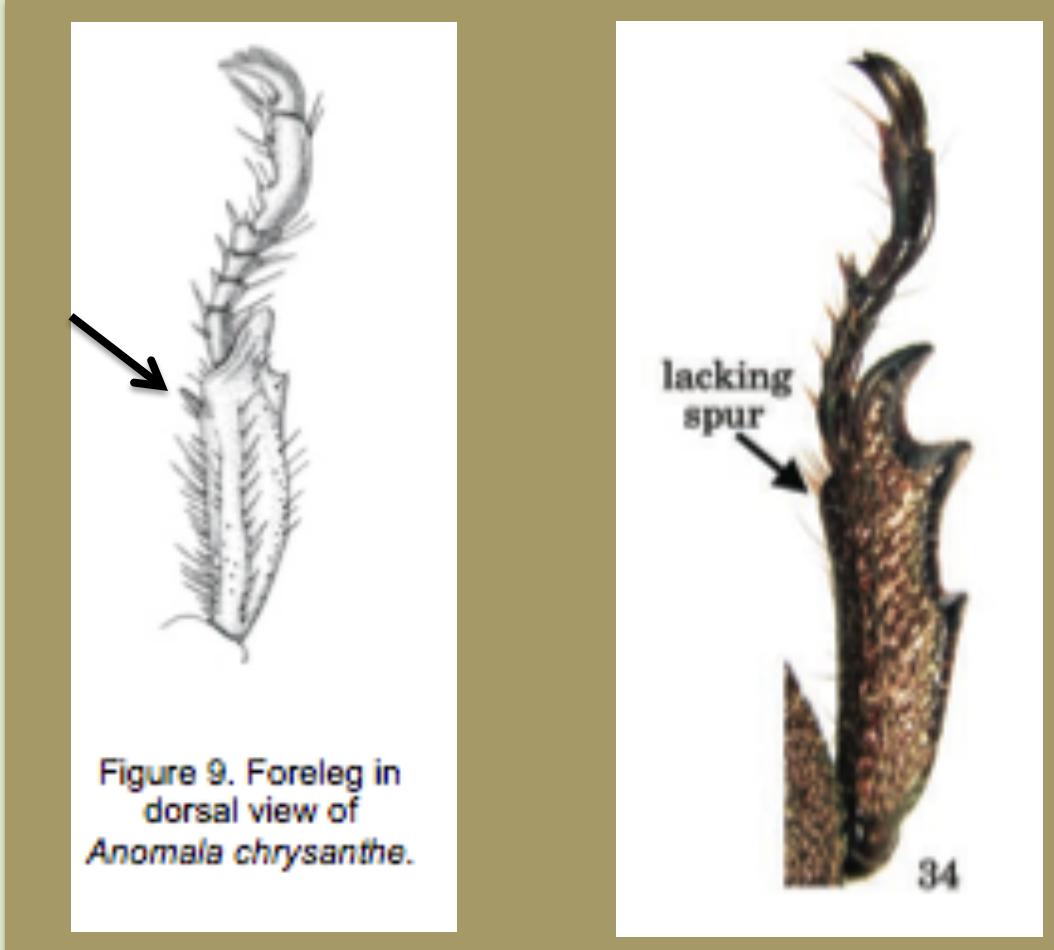


64. *Spodochlamys cupreola*

65. *Spodochlamys gigas*

Labrum vertically and ventrally produced with respect to the clypeus and somewhat fused to the clypeus. Labrum with apex weakly triangulate, lacking apical projection that overhangs the mentum (Adoretini possess a median, apical projection). Mentum lacking median, apical tooth or projection (Geniatini and Anoplognathini with median, apical tooth).

# Anatistine Characteristics

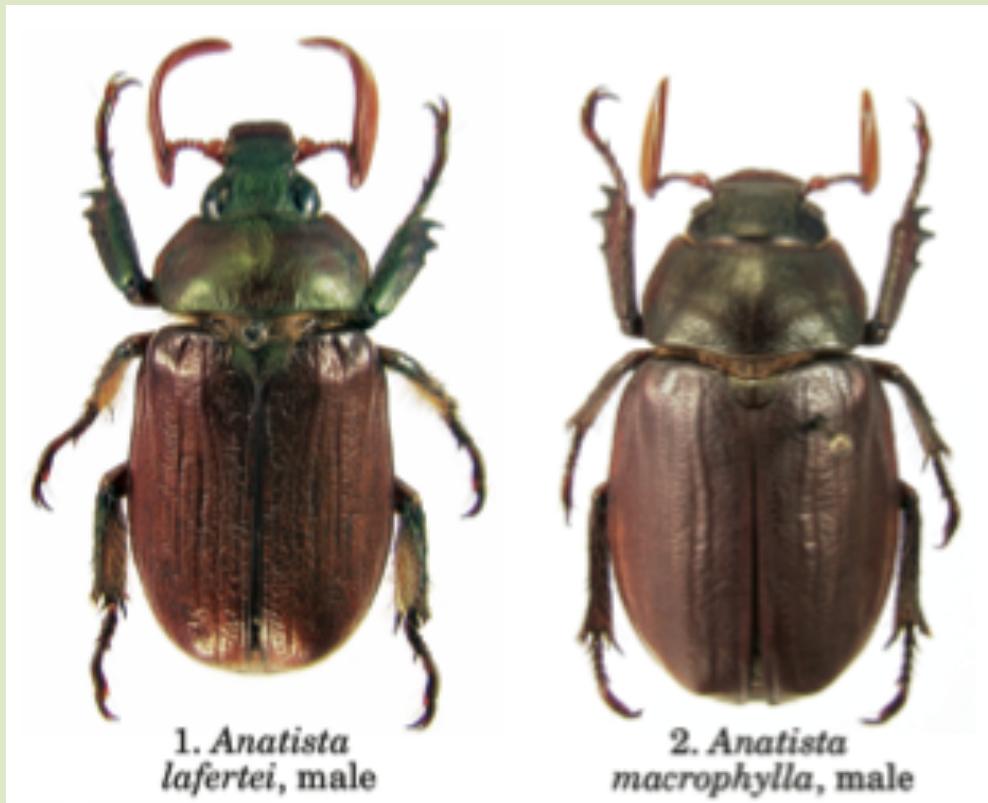


Protibia lacking apical spur (spur present in all other Rutelinae). Protarsomeres of males and/or females more or less cylindrical and lacking dense, ventral pilosity (protarsomeres of males and/or females dorsoventrally flattened, enlarged, and densely pilose ventrally in the tribe Geniatini; form of protarsomeres is shared with Anoplognathini, Adoretini, Rutelini, and Anomalini).

# Classification and Phylogeny

- Lacordaire (1856) created the subtribe “Anatistides” for the genus *Anatista* and placed it at the beginning of the Rutelinae.
- Ohaus (1905) placed the genus *Anatista* in the Anatistini (as Spodochlamyini) based on what he viewed as a shared form of the antennae, mouthparts, and clypeus. Although Ohaus was aware of Lacordaire’s work, he abandoned use of the “Anatistides”.
- The family group name Anatistini pre-dates the family group name Spodochlamyini (Smith 2006), and it has nomenclatural priority.
- The group is assumed to be monophyletic based on many characters.
- Sister group relationships have not been analyzed, but based on the form of the labrum, Machatschke (1965) hypothesized that the Anatistini (as Spodochlamyini) evolved from the lineage that included the subtribe Brachysternina (Rutelinae: Anop- lognathini)
- Additional comparative analyses and phylogenetic analyses are necessary in order to understand evolutionary relationships, adaptation, and classification of ruteline tribes, including the Anatistini.

## Anatistini



1. *Anatista  
lafertei*, male

2. *Anatista  
macrophylla*, male

## Anatistini



9. *Spodochlamys*  
*flavofemorata*, female



10. *Spodochlamys*  
*gigas*, male



11. *Spodochlamys*  
*iheringi*, male



12. *Spodochlamys*  
*iheringi*, female



13. *Spodochlamys*  
*letiranti*, female



14. *Spodochlamys*  
*marahuaca*, male



15. *Spodochlamys*  
*neblina*, male



16. *Spodochlamys*  
*neitai*, male

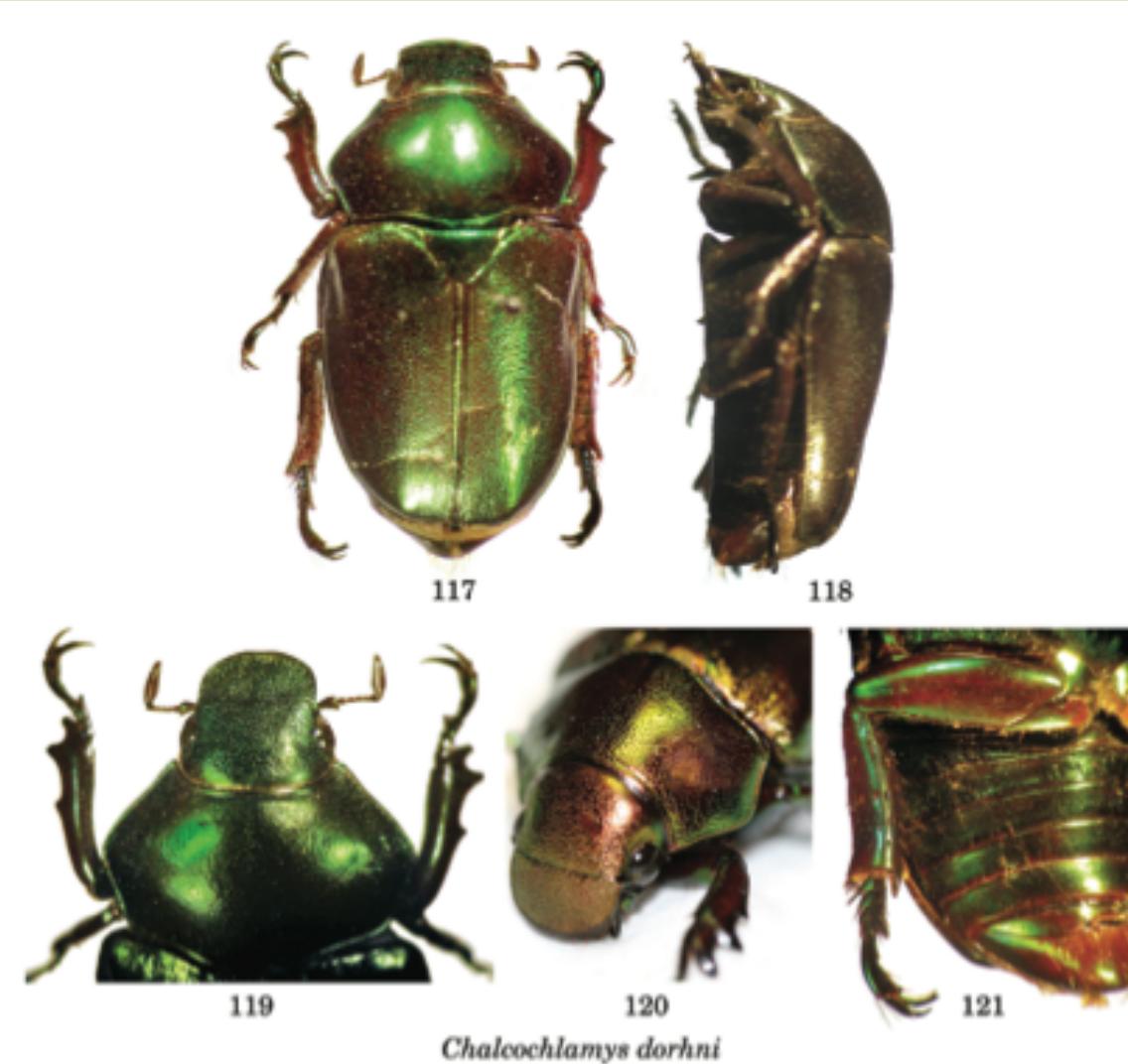


17. *Spodochlamys*  
*soulai*, male

## Anatistini



## Anatistini



## Anatistini

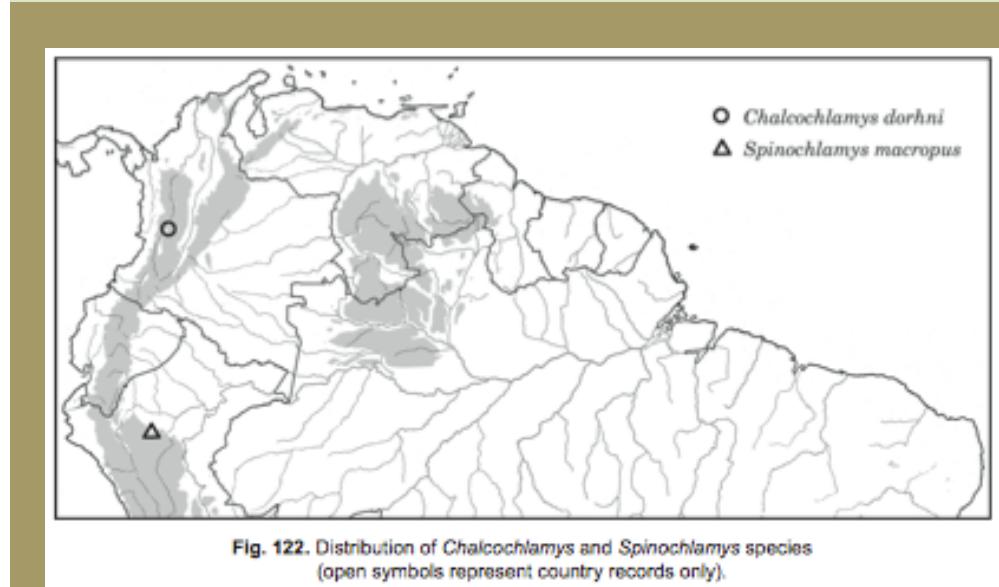


Fig. 122. Distribution of *Chalcochlamys* and *Spinochlamys* species  
(open symbols represent country records only).

# Resources

Jameson, M.L. and Ratcliffe, B.C. 2011. The Neotropical Scarab Beetle Tribe Anatistini (Coleoptera: Scarabaeidae: Rutelinae). *Bulletin of the University of Nebraska State Museum* 26: 1-100.

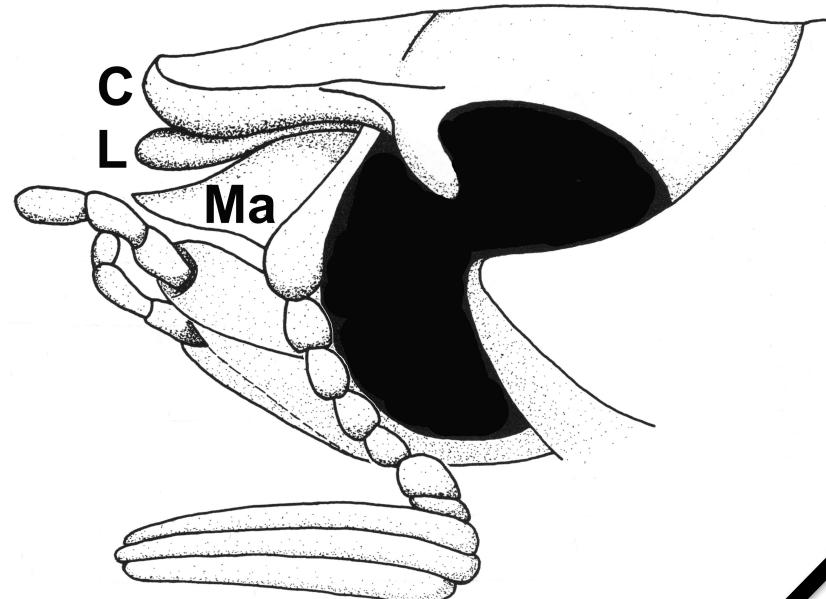
# Tribe Adoretini Burmeister, 1844



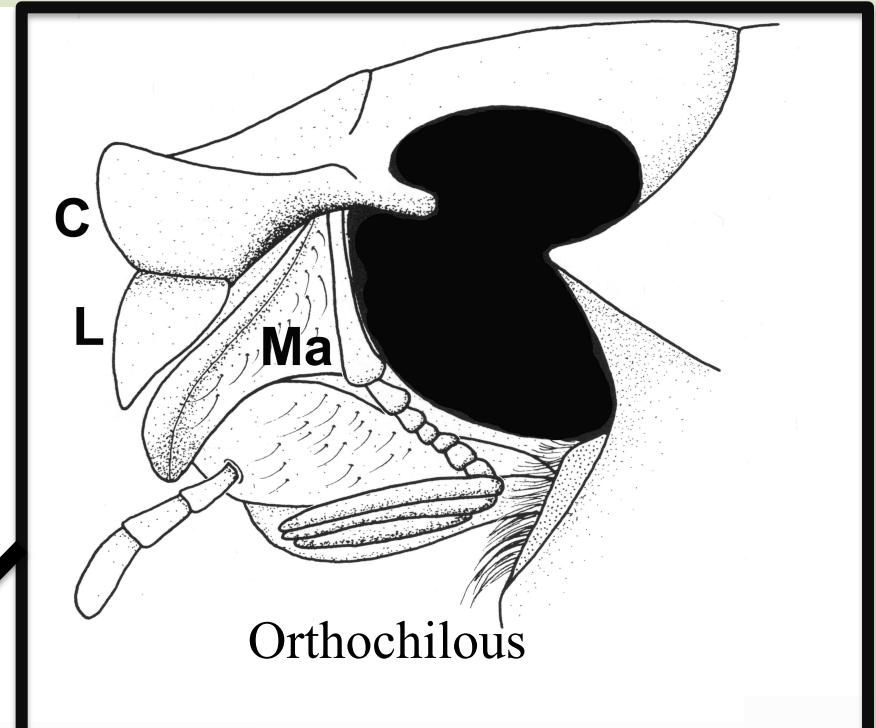
<http://everythingbutthaidragonflies.blogspot.com/2011/05/beetle-1.html>

*Adoretus compressus* (Weber, 1801)

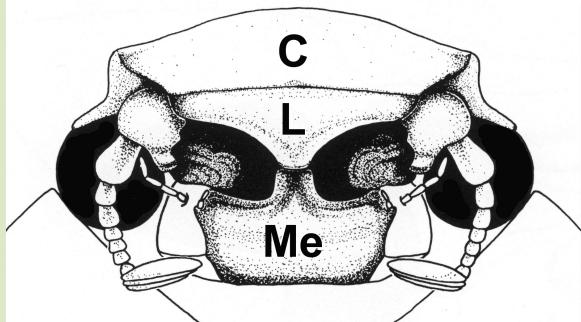
# Two Basic Ruteline Groups



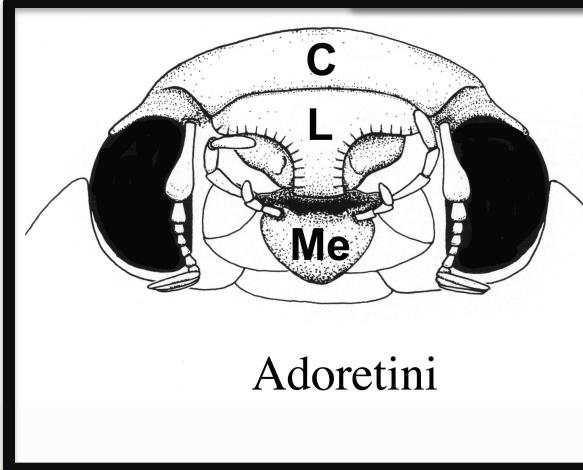
Homalochilous:  
Anomalini and Rutelini



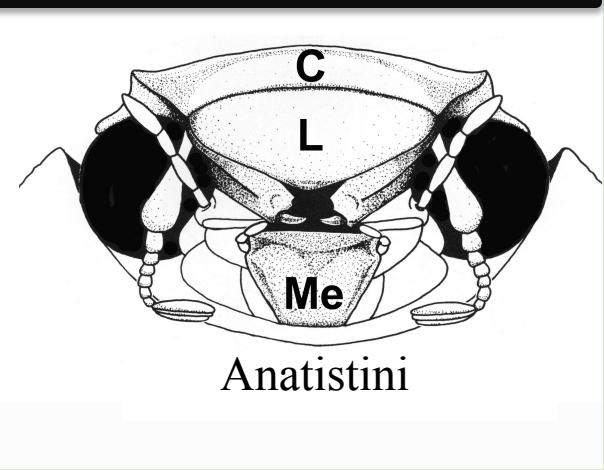
Orthochilous



Geniatini &  
Anoplognathini



Adoretini



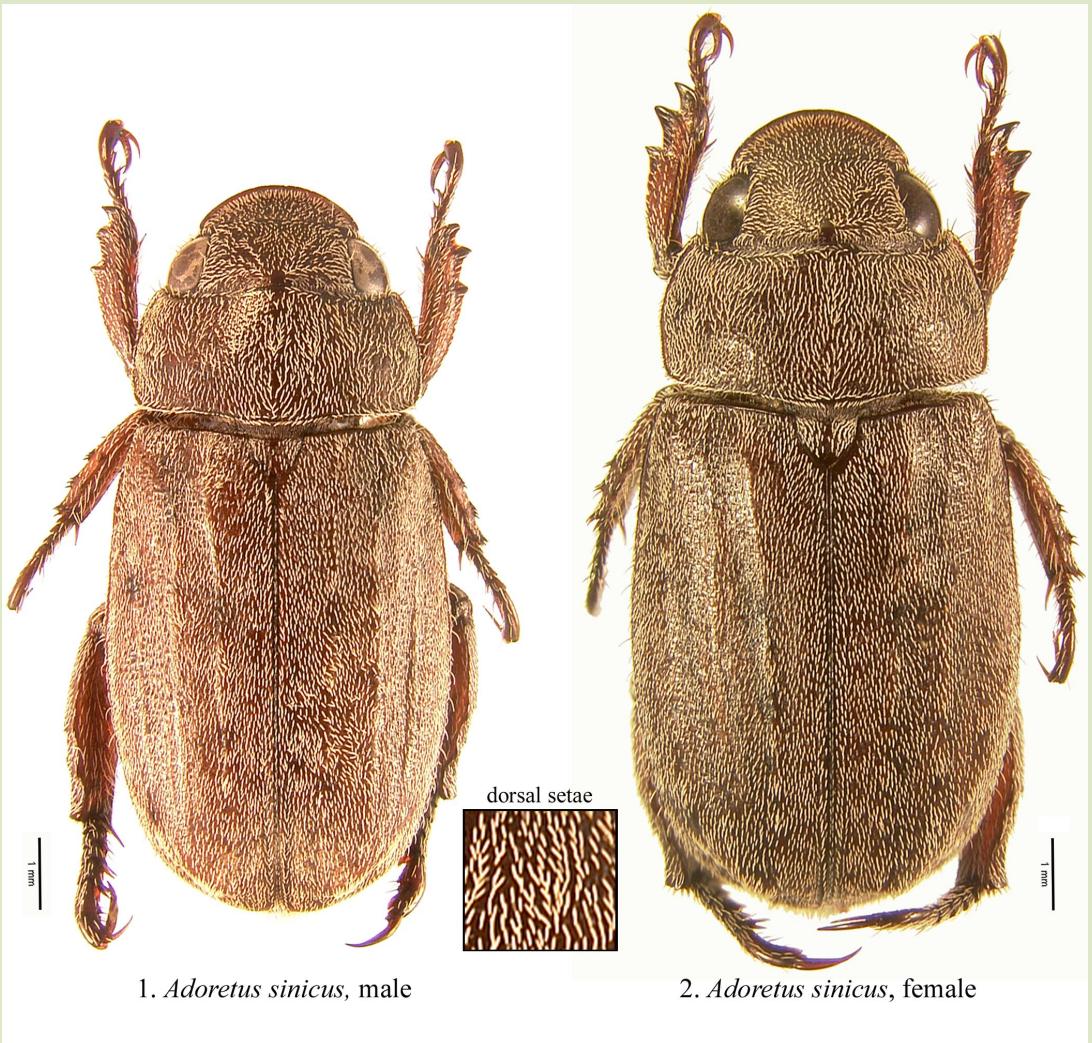
Anatistini

# What is an Adoretine?

- Includes 5 subtribes, 26 genera, and ~500 species  
(*Adoretina*, *Adorrhinyptina*, *Pachyrhinadoretina*, *Prodoretina*, *Trigonostomusina*)
- Size ranges from 5-25 mm.
- Distributed in the Old World with introductions to Australia, Hawaii, and several other regions.
- There are few resources for identification of species. Identification of adult and larval Adoretini is problematic and no systematists have a broad knowledge of the world Adoretini fauna. Other than scattered and older regional works, there are few resources for identification of species or genera.
- Based on limited biological information, adults are herbivore generalists and are known to feed on a wide variety of plants. Larvae are associated with roots and, depending on the species, feed on living or non-living plant tissues
- The group includes species that are of concern as invasive species.
- Phylogenetic data provide evidence that the tribe is sister to the Dynastinae

# Chinese Rose Beetle

The adult Chinese rose beetle has been reported to feed on over 250 species and approximately 56 families of plants or on over 500 plant species. Host plants include many economically important plants.



# Adoretines of Biosecurity Concern



Feeding damage by *Adoretus* sp.

Table 1. *Adoretus* species of Biosecurity Concern

Species	Host Plants	Distribution	References
<i>Adoretus bicolor</i>	Grapevine foliage and fruit, groundnut	ASIA: India	Ahmed et al. 1978; Kapadia et al. 2006
<i>Adoretus caliginosus</i>	Cotton	ASIA: Pakistan	Mahar et al. 1977
<i>Adoretus compressus</i> (Rose beetle)	Lychee	AFRICA: Cape Province. ASIA: India, Sri Lanka, Malaysia, Mauritius, Thailand, AUSTRALASIA: Borneo, Java, Papua New Guinea, Sumatra	Commonwealth of Australia 2003; Machatschke 1974
<i>Adoretus hirsutus</i> (White root grub)	Lychee	ASIA: China, Taiwan	Commonwealth of Australia 2003; Machatschke 1974
<i>Adoretus ranunculus</i>	Cocoa	ASIA: Philippines	Caballero et al. 1987
<i>Adoretus sinicus</i> (Chinese rose beetle, Oriental rose beetle)	Over 250 species in 56 plant families including major crops, turf grass, and ornamentals.	ASIA: China, Indonesia, Java, Japan, Kampuchea, Korea, Malaysia, Taiwan, Thailand, Timor, Vietnam. PACIFIC ISLANDS: Hawaiian Islands, Mariana Islands, Caroline Islands.	Ohaus 1935; Habbeck 1964; Machatschke 1965, 1974; Fang et al. 1985; Commonwealth of Australia 2003; Smith 2004
<i>Adoretus tessellatus</i> (Chestnut brown chafer or Brown chafer)	186 species in 42 plant families.	ASIA: China, Japan, Taiwan	Commonwealth of Australia 2003; DongWoon et al. 1997; Machatschke 1974
<i>Adoretus versutus</i> (Rose beetle or Indian rose beetle)	Cacao, coffee, rose, vegetables, ornamentals	ASIA: Chagos Archipelago, India, Indonesia, Pakistan, Sri Lanka. AFRICA: Madagascar, Mauritius, Réunion, St. Helena, Seychelles. AUSTRALASIA and PACIFIC ISLANDS: Cook Islands, Fiji, Java, Kiribati, Mariana Islands, Niue, Samoa, Tonga, Tuvalu, Wallis Islands, AUSTRALIA.	Ohaus 1935; Machatschke 1965, 1974; Watt 1986; Tsutsumi et al. 1993; Beaudoin et al. 1994; Commonwealth of Australia 2003; Aberle et al. 2004; Smith 2004

## Adoretini

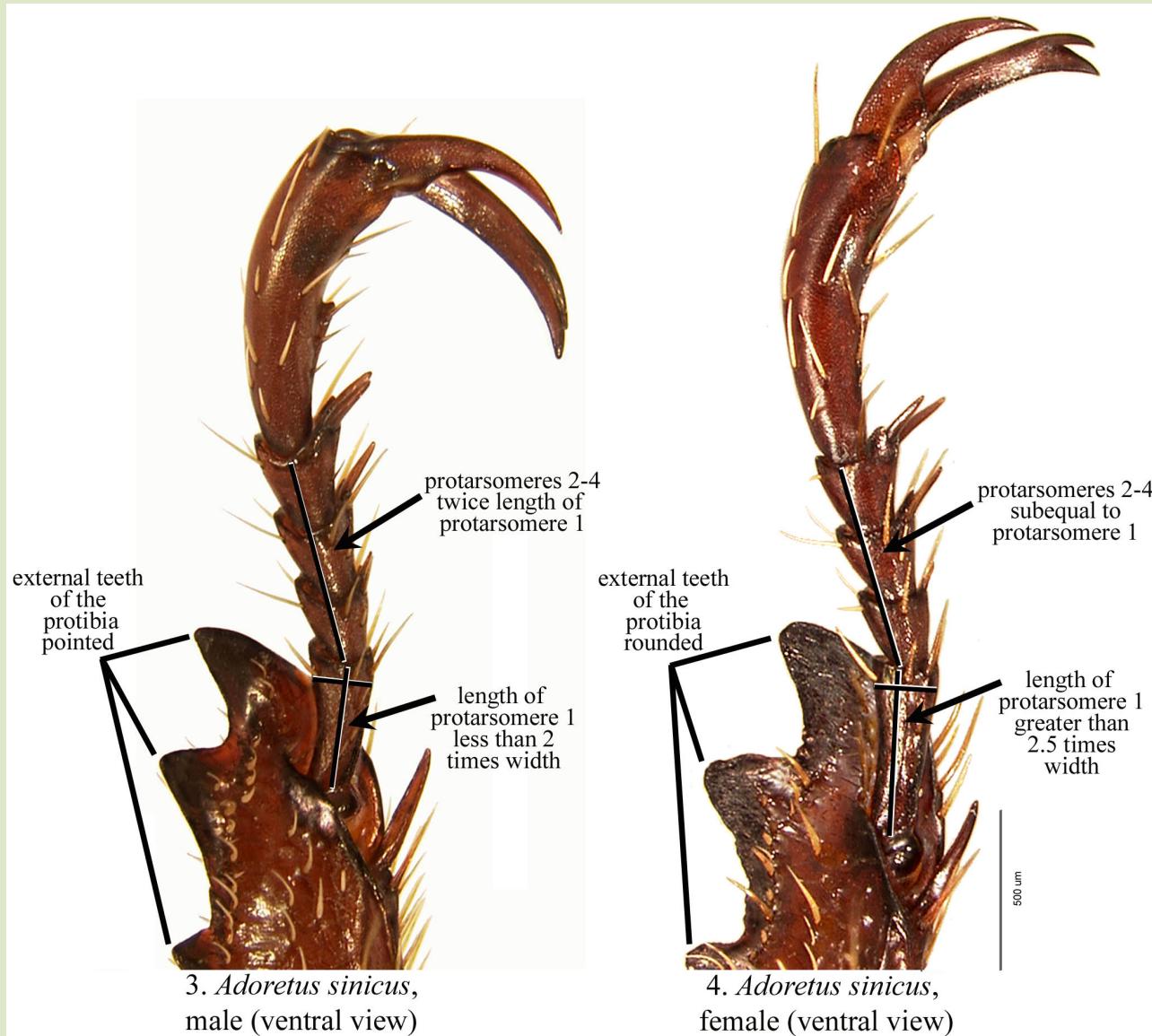


Scarabaeidae  
*Adoretus* sp

<http://www.padil.gov.au/maf-border/Pest/Man/140400/30269>

Labrum vertically and ventrally produced with respect to the clypeus and somewhat fused to the clypeus. Body with thickened, scale-like setae

## Adoretini



## Adoretini

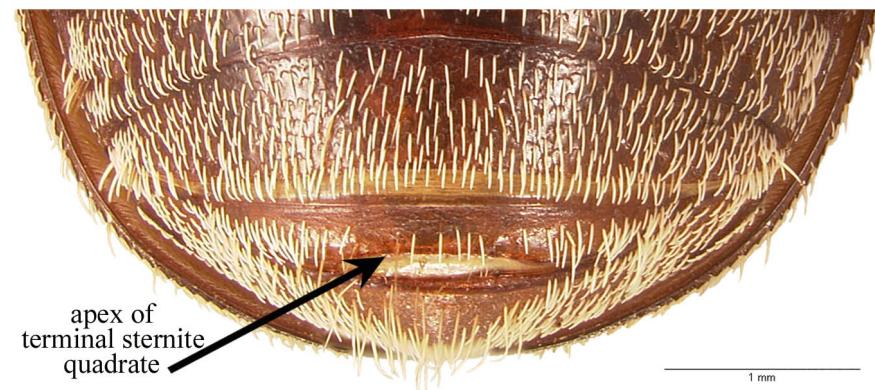


10. *Adoretus sinicus*  
male genitalia      11. *Adoretus tenuimaculatus*  
male genitalia

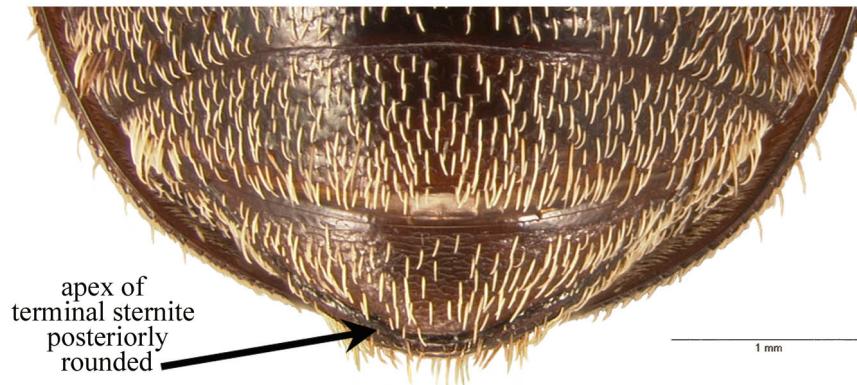


12. *Adoretus sinicus*,  
dorsal view      13. *Adoretus tenuimaculatus*,  
dorsal view

## Adoretini



5. *Adoretus sinicus*, male



6. *Adoretus sinicus*, female

## Adoretini



<http://www.biodiversityexplorer.org/beetles/scarabaeidae/rutelinae/>

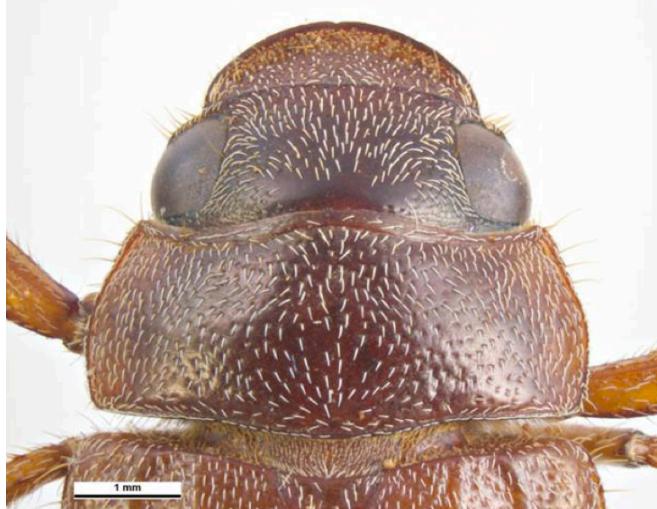
*Adoretus ictericus*, South Africa

## Adoretini



<http://www.padil.gov.au/pests-and-diseases/Pest/Main/135985/7327#>

*Adoretus versutus* Harold



## **Adoretini**



<http://www.plantwise.org/?dsid=3283&loadmodule=plantwisedatasheet&page=4270&site=234>

*Adoretus versutus*

## **Adoretini**



<http://www.galerie-insecte.org/galerie/el-38624.htm>

***Adoretus* sp., Irian Jaya**

Tribe  
**Alvarengiini**  
Frey, 1975



*Ottokellaria* sp.

# Alvarengiini

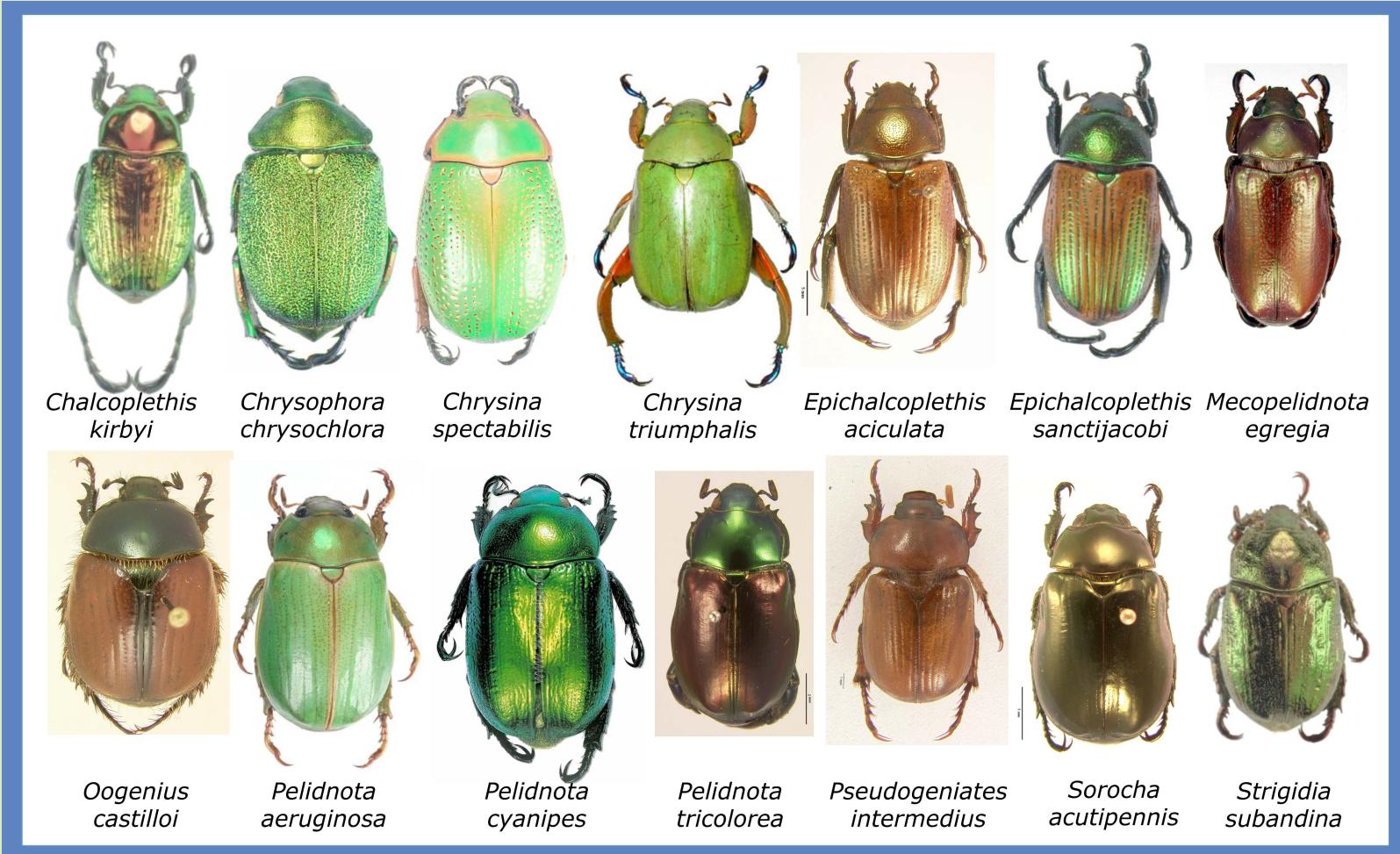
- Tribe Alvarengiini: 3 genera, 3 species
- Distributed in southern Brazil
- Little known about this group, and the taxonomy is greatly confused. Comparative morphology and phylogenetic analyses are needed to understand the relationships of this group to other scarabs. It is possible that this group is more closely related to melolonthines or is a basal Rutelinae.
- Includes *Pachylus*, *Ottokellaria*, and *Alvarengius*.

# Tribe Rutelini MacLeay, 1819



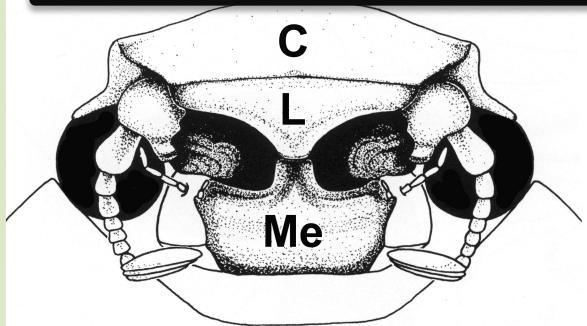
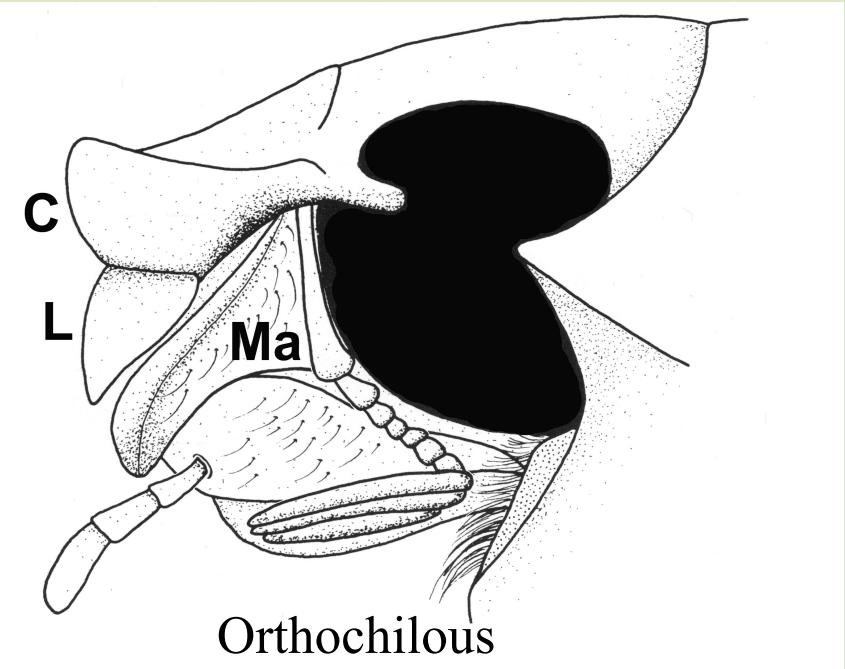
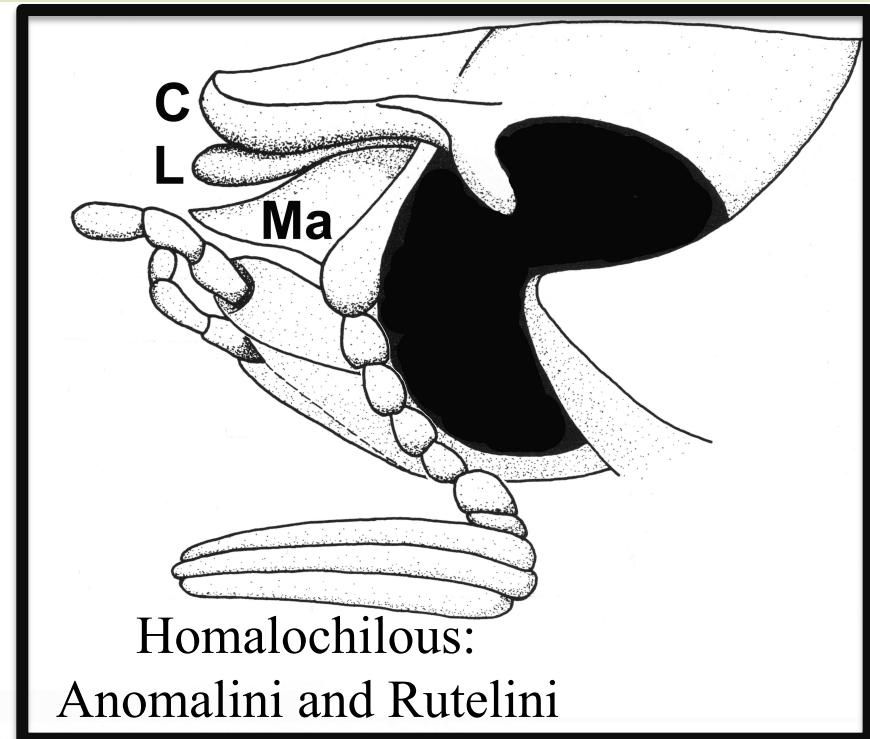
Silver Jewel Scarab (*Chrysina chrysargyrea*), Costa Rica

# Species Diversity

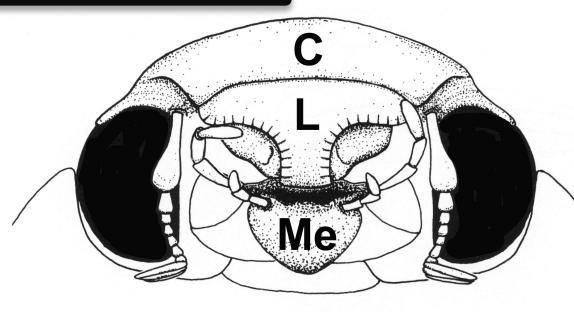


994 species, 93 genera, and 8 subtribes (Areodina, Desmonychina, Didrepanephorina, Heterosternina, Lasiocalina, Orcytomorphina, Parastasiina, Rutelina). Most subtribes are probably paraphyletic. The subtribe Pelidnotina (above) is paraphyletic and many genera are paraphyletic.

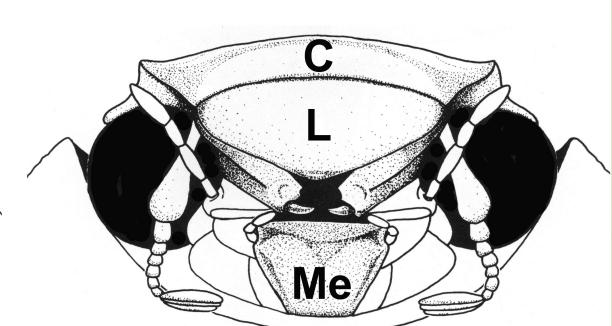
# Two Basic Ruteline Groups



Geniatini &  
Anoplognathini



Adoretini

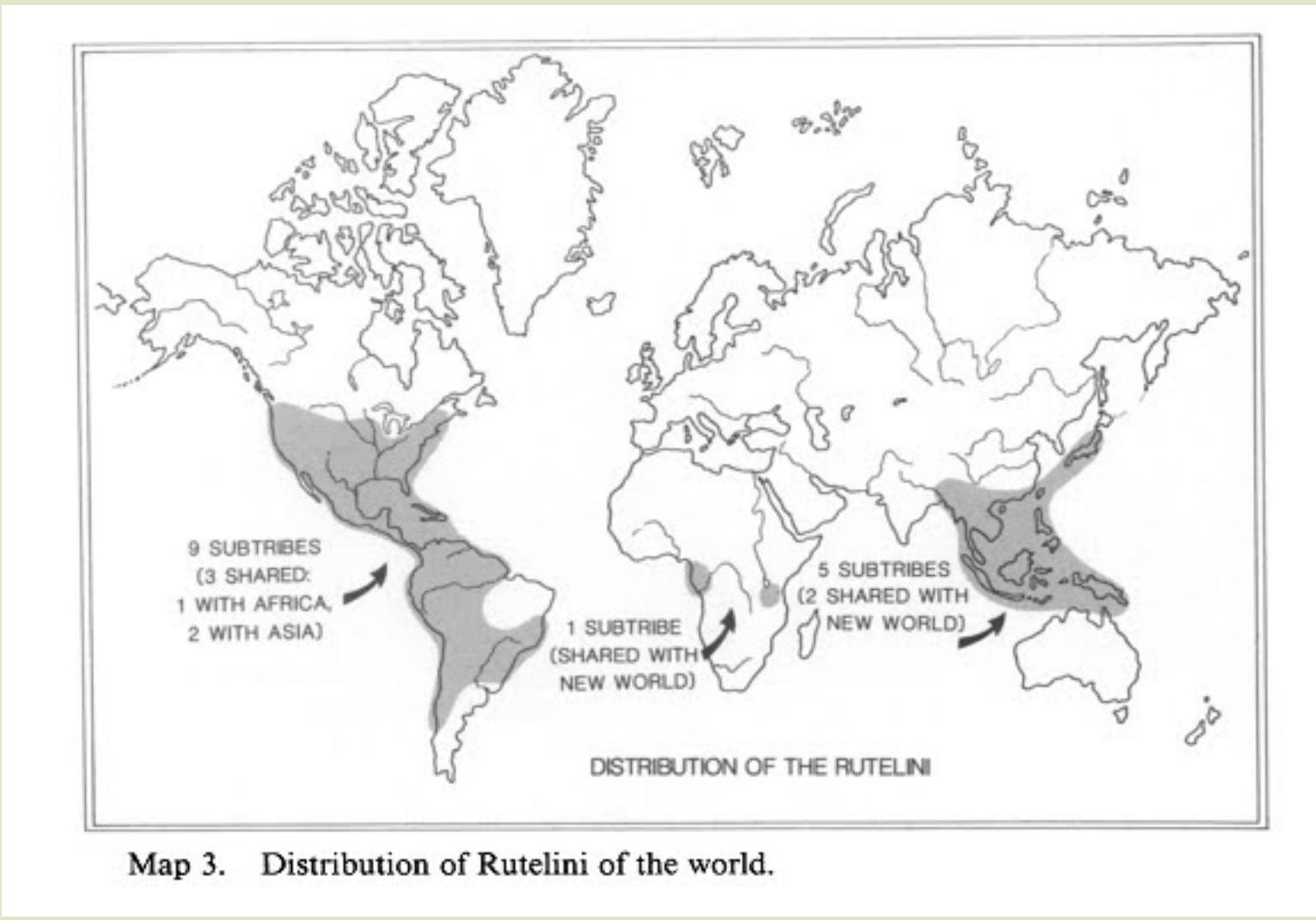


Anatistini

# What is a Rutelini?

- Labrum horizontally produced with respect to the clypeus.
- Antennae with 10 segments (8 or 9 in *Parachrysina*).
- Protibiae tridentate, inner protibial spur apical; foretarsomeres not enlarged or densely setose ventrally.
- Elytral margin entirely chitinous.
- Terminal spiracle positioned in pleural suture.
- Distribution in New World and Old World.
- Size ranges from 5 to 50 mm.
- 994 species, 93 genera, and 8 subtribes (Areodina, Desmonychina, Didrepanephorina, Heterosternina, Lasiocalina, Orcytomorphina, Parastasiina, Rutelina). Most subtribes are probably paraphyletic. The subtribe Pelidnotina (above) is paraphyletic and many genera are paraphyletic.

# Distribution of Rutelini



The tribe Rutelini is distributed worldwide but is most speciose in the Neotropics.

# Classification and Phylogeny

- MacLeay (1819) created the “Rutelini”, including the genus *Rutela*.
- The tribe is paraphyletic. Additional research is required to understand relationships of within the Rutelinae.
- Several subtribes within the tribe are not natural groups (not monophyletic). Additional research is required to understand relationships of the genera within the Rutelinae.

# Wide Array of Forms

A wide array of morphological forms is exhibited by members of the tribe including taxa with enlarged, horn-like mandibles (*Fruhstorferia* from Asia), backward-projecting thoracic horns (*Pepperonota* from Asia), enlarged hind femora (*Heterosternus* and *Chrysina* from the New World), and strikingly-colored, metallic silver and gold beetles (*Plusiotis* from the New World).



*Kibakoganea formosana*



*Ceroplophana modiglianii*



*Peppernota harringtoni*



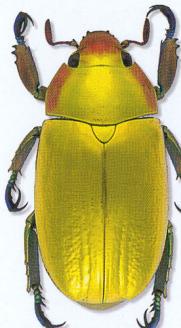
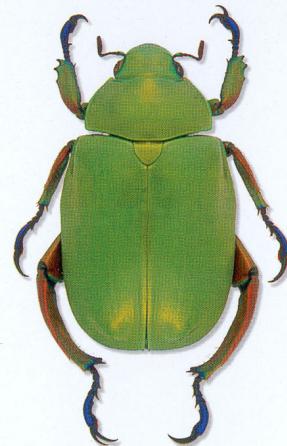
*Dicauchocephalus feae*



*Peppernota harringtoni*

# Wide Array of Forms

## *Jewel Scarabs*



*Chrysina* species

## Rutelini: Heterosternina



*Macropoidelimus mnizechi*

## Rutelini: Heterosternina



*Heterosternus oberthuri*, Panama

## Rutelini: Areodina



<http://www.graniteridgenature.com/california.html>

Punctate Bear Beetle (*Paracotalpa puncticollis*) on California Juniper

## Rutelini: “Pelidnotina”



<http://www.rutelide-dundee.com/Marc6F.htm>

*Pelidnota quadripunctata*

## Rutelini: “Antichirina”



<http://www.rutelide-dundee.com/Marc6F.htm>

*Macraspis olivieri*, Guyana

## Rutelini: “Antichirina”



*Chlorota* sp., Guyana

## Rutelini: “Antichirina”



<http://www.rutelide-dundee.com/Marc6F.htm>

*Lagochile sparsa guyanensis* Soula, Guyana

## Rutelini: “Antichirina”



<http://www.rutelide-dundee.com/Marc6F.htm>

*Antichira capucina*, Guyana

## Rutelini: “Antichirina”



<http://www.rutelide-dundee.com/Marc6F.htm>

*Pseudomacraspis affinis*, Guyana

## Rutelini: Rutelina



<http://www.rutelide-dundee.com/Marc6F.htm>

*Rutela lineola*, Guyana

## Rutelini: Didrepanephorina

*Fruhstorferia javana*  
(Kolbe, 1894)  
Java.



*Didrepanephorus yunnana* (syn. *Fruhstorferia yunnana*)  
(Ohaus, 1911)  
Chine.



<http://www.virtual-beetles.com/fruhstorferia.html>

## Rutelini: Didrepanephorina

*Masumokoganea kinabalensis* (syn. *Fruhstorferia kinabalensis*)  
(Hirasawa, 1992)  
Malaisie Shaba.



*Kibakoganea formosana*  
(Kurosawa, Kobayashi, 1975)  
Taiwan.



<http://www.virtual-beetles.com/fruhstorferia.html>

## Rutelini: Parastasiina

*Dicauchocephalus feae*  
(Gestro, 1888)  
Thailande, Myanmar.



*Dicauchocephalus fruhstorferi* (syn. *D. tetsuo*)  
(Ohaus, 1901)  
Thailande, Laos, Vietnam, Sud China.



<http://www.virtual-beetles.com/fruhstorferia.html>

## Rutelini: Parastasiina

*Peperonota harringtoni*  
(Westwood, 1847)  
Cameron Highlands.



<http://www.virtual-beetles.com/fruhstorferia.html>

## Rutelini: Parastasiina

*Ceroplophana modiglianii*  
(Gestro, 1893)  
Malaysie, Cameron Highlands.



<http://www.virtual-beetles.com/fruhstorferia.html>

## Rutelini: Parastasiina



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*Cyphelytra ochracea*, Thailand



<http://www.thaibugs.com/>

## Rutelini: Oryctomorphina



*Oryctomorphus bimaculatus* (Chile)

## Rutelini: Desmonychina



*Desmonyx humeralis*, Asia

# Resources

## *Chrysina* Gallery.

<http://www-museum.unl.edu/research/entomology/Guide/Scarabs%20Gallery/Chrysina%20Gallery/index.html>. In, B.C. Ratcliffe and M.L. Jameson (eds.), Generic Guide to New World Scarab Beetles (URL:  
<http://www-museum.unl.edu/research/entomology/Guide/index4.htm>).

## Heterosternina Gallery.

<http://www-museum.unl.edu/research/entomology/Guide/Scarabs%20Gallery/Heterosternina%20Gallery/index.html>. In, B.C. Ratcliffe and M.L. Jameson (eds.), Generic Guide to New World Scarab Beetles (URL:  
<http://www-museum.unl.edu/research/entomology/Guide/index4.htm>).