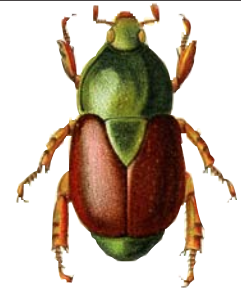


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“The Eye of the Beholder” or “They look really nice, but not very edible to me, and I have no idea what they look like to hawks, despite my name” or “Color Variation and other stuff about *Chrysina*”

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Rich Cunningham and Barney Streit showed up at my office in November 2007 to photograph *Chrysina* color forms in my collection. I tried to charge them admission, but even that threat wouldn't make them go away. Barney took photos, and then they somehow coerced me into writing this article. So, following is my attempt to provide text to meander among the large number of *Chrysina* photos that the editors have rounded-up.

Barney and Rich requested that I mainly write about *Chrysina* color forms. That's a topic that's almost as endless as the color variation itself (especially if I describe the few *Chrysina* dreams that I've had over the years – hoowah! – I've discovered some fantastic-looking new species of *Chrysina*

in dreams!). And, I could be even more verbose if there was some experimental data available on the possible selective advantages of looking like living jewelry! Oh, and besides having colorful *Chrysina* visions in dreams, I'm also quite the “Glorious” artist! Please review and enjoy (again) “my” impressionistic Crayon rendition of “Plusiotis Gloriosa,” which I generously shared with the *Scarabs* editors for Issue Number 15.

What can be said about *Chrysina* that hasn't already been said? Actually, a lot! Indisputably, species of *Chrysina* are the living jewels of the Scarabaeoidea (hence the common name “Jewel Scarabs”), and they display the most amazing variety of colors, iridescence, metallic-ness (apparently not a word), and



Dave in the lab at University of California, Riverside. Exhaustive DNA research there is finally attempting to answer the nagging question: “What is prettier - The Shirt - The Man - or The Bugs?”

**Editors’ Note: A single specimen of *Chrysina beyeri* was actually taken in one of Barney’s dung traps in Sonora.*

surface texture among the entirety of living things on this planet (no, I’m not biased...). Making them even more interesting and appealing are their wildly variable genitalia (some with spines, hooks, flanges, ridges, and even flappy-doodles), and the fact that none of them are the least bit interested in dung (not even Barney’s).*

First, some basics. There are slightly over 100 known species of *Chrysina* (most formerly known as *Plusiotis*), several as yet undescribed, all found in the New World rainforests, cloud forests, and pine-oak forests from the southwestern United States through Mexico and Central America, to Colombia and Ecuador. Most species live above 1,000 meters elevation, although there are several that occur in low-elevation forests. As is typical of ruteline scarabs (aka “Shining Leaf Chafers”), the grubs live in decaying wood, roots, and/or leaf-litter, and most adults feed on

leaves of forest trees such as oaks and pines. Adults of most species emerge during the rainy season, and are active at night.

I’ve been interested in the classification and phylogenetics of Jewel Scarabs for about 20 years. During the past 10 years, I’ve assembled a matrix of *Chrysina* DNA sequences, and I now have molecular data for about 90 species. Both morphological and molecular evidence indicated that *Chrysina*, *Plusiotis*, and *Pelidnotopsis* formed a polyphyletic “mosaic” of closely related species groups, and, therefore, in 2001 I synonymized *Plusiotis* and *Pelidnotopsis* under the older name, *Chrysina*. Despite a close morphological resemblance to *Pelidnota* and other genera in the Rutelini, *Chrysina* is clearly monophyletic and significantly divergent from its closest relatives based on evidence from three gene regions. By the way, *Pelidnota* is not monophyletic, but that’s another story!

My molecular work has shown that *Chrysina* is easily divided into species groups that usually correspond nicely with biogeographic and morphological patterns. Perhaps more interestingly, it also indicates that while many close relationships are “obvious,” there are several species that are parts of unpredicted groupings due to rather surprising examples of convergence or extreme divergence. I’ll highlight a few examples below.

Now, for all that stuff about color forms that you've been so patiently waiting for! We're all familiar with the recurring theme among many green species of *Chrysina* that a small percentage of individuals are pinkish or reddish. There has been much speculation about the "hows" and "whys" of these color variants, mainly by inebriated beetle collectors, sitting in lawn chairs (or doing the Macarena and worse "rhetorically" according to Don Thomas, *Scarabs* #24), while staring at mercury vapor lamps.

Don Thomas (in a more serious vein), Ainsley Seago, and David Robacker (2007) recently published a very interesting and detailed discussion of *Chrysina* optical physics. They explain that a slight increase in the thickness



Chrysina gloriosa from Arizona with normal coloring.



Chrysina gloriosa from the Davis Mountains of Texas with reddish coloring. Specimen courtesy of Pat Sullivan.

of layers of chitin in the cuticle causes a shift in the reflected light towards the red end of the spectrum. Thinner layers would result in a shift towards blue. Reddish-colored specimens are the most common color variants in *Chrysina*. So, I can't help but wonder (as an optical physics dodo), is there a connection between the common green-red shift in beetle cuticles and the most common form of colorblindness? Bluish or yellowish variants in *Chrysina* are known, but are not as common. I can tell you, from one of my sad experiences, that mistreating the grubs and/or pupae of *C. gloriosa* produces dwarfed, very blue beetles, with achingly thin

Editors' Note: Unless otherwise stated, all specimens are from the Dave Hawks collection.

Crypsis is the ability of an organism to avoid observation.



Chrysina gloriosa from the Patagonia Mountains of Arizona with pinkish coloring. Specimen courtesy of Rich Cunningham.

chitin layers! I have other anecdotal evidence that environmental conditions (temperature and/or humidity?) experienced during the larval or pupal stages also influence the occurrence of other *Chrysina* color forms.

An important take-home message that Thomas, Seago, and Robacker point out is that, while much is known about optical physics of the *Chrysina* cuticle and the physiology of vertebrate and invertebrate vision, the human visual perception of *Chrysina* colors may be quite different from how they are perceived by other mammals, birds, other *Chrysina*, etc. This also applies to potentially differing perceptions of the iridescence or “metallic-ness” of these beetles.

Differences between human and bird vision aside, it's reasonable that green beetles that sit on green leaves are green as a form of crypsis.* It's also pretty obvious that some of the patterning in *Chrysina* represents cryptic and/or disruptive coloration. For example, the reddish and green stripes of *C. adelaida* and *C. quetzalcoatli* make these species difficult to see among clusters of pine needles, and the irregular green and silver stripes of *C. gloriosa* make it nearly invisible when it's nestled among the foliage of its host tree, juniper. Even the pinkish or purplish legs of many *Chrysina* species seem to aid in crypsis and/or disruption among variously colored stems, branches, and petioles of host trees.



Chrysina quetzacoatli from Honduras with normal coloring.



An example of the red form of *Chrysina quetzacoatli* from Honduras.

A few species in the *C. macropus* group have the most brightly colored (and longest) legs, and these colors may be aposematic (warning colors) rather than having anything to do with crypsis, disruption, or mate recognition (discussed below). I am fortunate in having observed several green species of *Chrysina* (including a few with contrastingly colored legs) while they were “being cryptic” among leaves, pine needles, and juniper, and they are good at hiding.

Likewise, I have observed a few silver *Chrysina* on wet foliage, and they mostly look like shiny wet spots, mirroring the wet foliage on which they are sitting.

Plus, the uniformly metallic species of *Chrysina* occur in tropical forests during the rainy season when everything is wet and shiny a high percentage of the time. Contrast this observation with the fact that almost all of the several dozen *Chrysina* species that live in the “less-wet” pine-oak forests of Mexico and the southwestern United States are green and not nearly so shiny. Golden, reddish, or purplish species are more difficult to explain in terms of crypsis; although, presumably these species also somehow don’t look like food to their predators.

Of course, fancy-colored Jewel Scarabs didn’t evolve to look a certain way in order to hide from humans, or to be highly desirable as collectibles! Instead, aspects of their appearance were selected because of pressures by predators and/or as a component of mate recognition. I believe that mate recognition has little or nothing to do with it, for a few reasons:

1) *Chrysina* adults feed and mate primarily at night when “looking at each other’s nice colors” is not possible! They generally spend most daytime hours hidden in leaf litter or inactive among foliage.

2) In my experience with captive *Chrysina* of several North and Central American species, mating behavior seems to be initiated by tactile cues and pheromones. In fact, males of some species clearly are oblivious to the “good looks” of a potential mate – they will try to mate with the wrong species, the

wrong genus, or even with human fingernails!

3) Sympatric species of *Chrysina* have conspicuously different genitalia, suggesting that, once again, physical attributes rather than visual cues are important hybridization barriers.

As already suggested, some species may have brightly colored legs and/or tarsi to warn predators that they are harmful in some way. Many species of *Chrysina* have needle-sharp tarsal claws that they viciously stab into your fingers (sometimes drawing blood) if not handled carefully. I can easily imagine some *Chrysina* species injuring an inexperienced or unlucky bird, squirrel, or monkey that thinks it has found a tasty, crunchy, beetle treat! Some *Chrysina* species are more vicious than others, and, not surprisingly, these are the ones with the most strikingly colored legs and/or tarsi.

For example, consider six species in the *C. macropus* species group: [*C. macropus*, *C. modesta*], [*C. triumphalis*, *C. prototolica*], [*C. karschi*, and *C. cavei*]. All are typically green, but with varying characteristics of leg coloration and enlargement of the hind legs in the males. In terms of gestalt, one would expect that *C. macropus* and *C. triumphalis* are closest relatives, and, likewise, *C. prototolica* and *C. karschi* appear to be very similar and must be close relatives. Nope! Both molecular data as well as subtle morphological features indicate that this group



The normal green form of *Chrysina modesta* from Mexico, courtesy of Rich Cunningham.



The pinkish form of *Chrysina modesta* from Mexico, courtesy of Rich Cunningham.



The gray form of *Chrysina modesta* from Mexico, courtesy of Rich Cunningham.



The normal green form of *Chrysina cavei* from Honduras.

of six species is comprised of three species-pairs (indicated above by brackets), each consisting of one species with enlarged, brightly colored hindlegs and tarsi, and the other with little or no hindleg enlargement in males and not very strikingly colored legs and tarsi. What else distinguishes the members of these pairs? The ones with enlarged, brightly colored legs are painful pinchers!!

So, do the striking colors of the legs and tarsi serve as warning colors? I believe so. Basically, speciation in this group of *Chrysina* has proceeded in two directions, both obviously very successful. *C. modesta*, *C. prototolica*, and *C. karschi* are typical of most *Chrysina* in that they are cryptic among foliage at both distant and close ranges, and they rely mostly



The pinkish form of *Chrysina cavei* from Honduras.

or entirely on their camouflage as protection from predators. *C. macropus*, *C. triumphalis*, and *C. cavei* presumably rely on their green bodies for crypsis, but, if discovered by a predator at close range, then their bright legs advertise the painful pinch that the predator will receive if it attacks the beetle. Do males with enlarged, pinching hind legs also use this tactic in competition for mates? I used to think so, but I'm really not sure!

So, how do the females with brightly colored legs benefit without having enlarged, pinching hindlegs? Possibly by mimicking the males! As is similar with other mimicry pairs or complexes, if a predator first has a painful experience with a pinching male *Chrysina*, then presumably remembering the "big green beetle with red legs and blue tarsi" will prevent the predator from testing a female with this same color pattern.

Interestingly, there may be selective pressure against color variants among aposematic *Chrysina* species, since pinkish individuals are very rare. In the non-aposematic *C. karschi*, pink, orange, and other color forms are fairly common. Likewise, pinkish, purplish, and brownish color variants are common in *C. modesta*. Despite excellent camouflage in *C. karschi*, Ron Cave and I learned of a pair of Resplendent Quetzals in Honduras that had developed quite the search image, and was harvesting

C. karschi adults from oak foliage and feeding them to their chicks!

Clearly, in this article, I've barely "scratched the surface of the cuticle" in terms of the amazing array of *Chrysina* color variants that Barney took pictures of! So, I'm hereby forewarning you that all subsequent issues of *Scarabs* will be renamed *The Chrysina Chronicles*. OK, not really.... But there will be at least a couple additional *Chrysina* installments so that we can cover all your favorite photos and stories celebrating variety being the spice of life, or something.

By the way, how many of you believe that a *Chrysina beyeri* found its way into one of Barney's dung traps on its own accord? I think it was pushed! Or else Barney had the dung trap sitting directly under the MV lamp! Truly despicable!!

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The normal green form.



The green form with pink legs and clypeus.



The green-purple form.

Examples of *Chrysina karschi*, all from Honduras



The pink form.



The orange form.



A teneral gold form.

More *Chrysina* Notes and Photos

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In the search for more beetles in Cusuco, Dave Hawks and I trekked upwards to a clearing at about 1,800 meters, where it was bitterly cold (11° C) and windy. Our feet and pants were wet from the rain-soaked ground and vegetation. Even with several layers of clothing, I'm extremely intolerant of cold weather (I have the reputation of wearing a thick jacket on Roatan island.). To keep our hands warm and our feet somewhat dry, we sat in front of the warm exhaust from our generator. It was such a long, cold, and frustrating night. We saw very few beetles.



The gold form of
Chrysina pastori
HONDURAS: Cortés
Parque Nacional
Cusuco
1,450 m
4 June 1998

Alone one June night in Cusuco National Park, I was tending to three of the lights my colleagues and I had put out to attract *Chrysina*. Dave Hawks and Guy Bruyera had headed up the mountain to collect at a higher elevation site. It was a terrific night for beetles. I witnessed 200 to 300 of them, mostly *C. karschi* with a few *C. pastori* and *C. quetzalcoatli* mixed in, come pouring down from the sky within an hour starting about 9:00 PM. I was frantically running between the lights picking up handfuls of beetles. The sharp leg spines and claws of multiple beetles grasped tightly in my hands caused excruciating pain. I barely had time to record the sex of each one before I threw it in the bucket. Never before and never afterwards did I see such a rain of jewel scarabs.

In Güisayote Biological Reserve lots of moths were attracted to our lights in July. They were everywhere. Some managed to get underneath my eyeglasses. Some even flew up my nose and into my mouth. As long as scarabs are coming I didn't really mind the nuisance, but one night a nasty little noctuid found its way into my ear canal and wiggled its way almost to my eardrum. I tried and tried to dig it out, but I just couldn't get to it. Surprisingly there was no pain, just a constant fluttering of wings. After a sleepless night, I went down to the town of Ocotepeque and saw a doctor, who was able to flush it out but not easily. Lesson learned: toilet paper in the ears!



The normal form of *Chrysina quetzalcoatli*
 HONDURAS: Cortés
 Parque Nacional Cusuco
 1,450 m 22 July 1998



The green form of *Chrysina quetzalcoatli*
 HONDURAS: Cortés
 Parque Nacional Cusuco
 1,450 m 22 July 1998



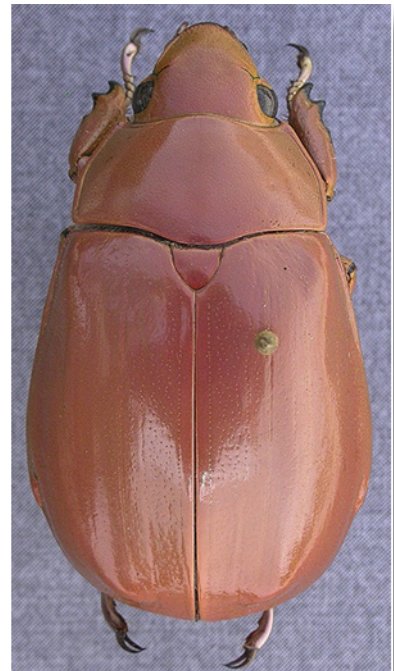
The purple form of *Chrysina quetzalcoatli*
 HONDURAS: Intibucá
 Sierra de Montecillos
 El Aguila Otoro 1,750 m
 30 August 2000



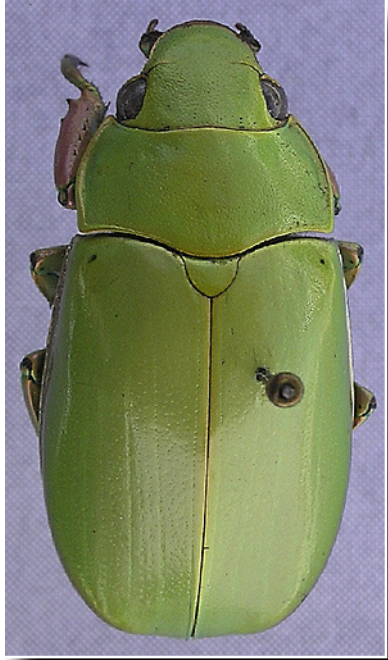
The normal green form of *Chrysina karschi*
 HONDURAS: Yoro
 Sinaí 1,410 m
 4 June 2002



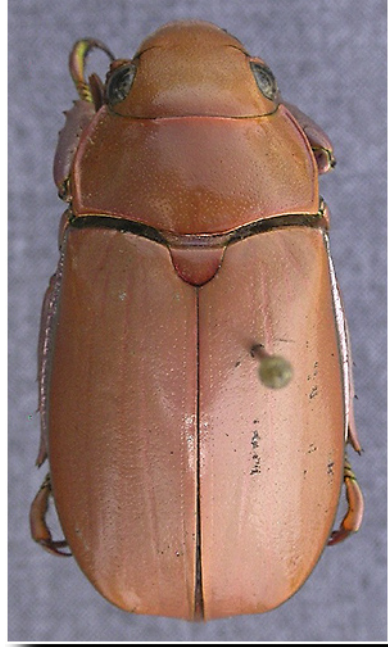
The brown form of *Chrysina karschi*
 HONDURAS: Cortés
 Parque Nacional Cusuco 1,450 m
 4 July 1997



The pink form of *Chrysina karschi*
 HONDURAS: Cortés
 Parque Nacional Cusuco
 Orión 1,500 m
 24 July 2002



The green form of *Chrysina bruyei*
HONDURAS: El Paraíso
8.3 km SE Capire 675 m
24 May 2002



The pink form of *Chrysina bruyei*
HONDURAS: El Paraíso
5.3 km N Cifuentes 1,200 m
13 June 1999



The green form of *Chrysina cusuquensis*
HONDURAS: Cortés
Parque Nacional Cusuco 1,450 m
25 June 1998



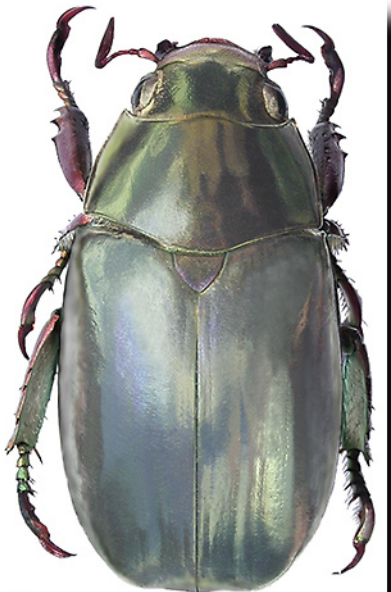
The pink form of *Chrysina cusuquensis*
HONDURAS: Cortés
Parque Nacional Cusuco 1,450 m
22 July 1998



The green form of a *Chrysina*
new species
HONDURAS: Ocotepeque
Reserva Biológica Guisayote
1,800 m 16 September 1998



The red form of a *Chrysina*
new species
HONDURAS: Ocotepeque
Reserva Biológica Guisayote
1,800 m 16 August 1998



The normal form of *Chrysina*
strasseni



The gold form of *Chrysina*
strasseni
HONDURAS: Yoro
Parque Nacional Pico Pijol
Linda Vista 1450 m
8 June 2007

In Past Years - VIII - Bernard Benesh

by Henry F. Howden

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Bernard Benesh.



Oscar Cartwright (standing) in his office with Henry Howden at the Smithsonian Institution, July 1976. Photo by Brett Ratcliffe.

Anne and I knew of Bernard Benesh when we moved to Tennessee, but had never met him. Henry Dybas had told us about Bernard; that he had worked in the Chicago steel mills, but had to retire early because of a bad back or severe arthritis (I don't remember which). He moved to Burville on the Cumberland Plateau in central Tennessee because he could live there for very little; he did not have much of a pension.

We wrote him and were asked to visit, at the same time he sent along a map on how to find his house. We arrived in early March in the middle of an ice storm. Burville was not a town or if it was we never saw it. His map took us on some very bad dirt tracts, and after asking in several places we wound up walking the last half mile, arriving at a small clapboard house in the forest. It had a covered front porch, Bernard was standing there and his first words to us were "Veres de beer?". On subsequent visits we always brought beer.

His living conditions were fairly primitive: water had to be hand pumped, a wood stove furnished the heat, and the "out house" consisted of a board nailed between two trees. We later found that, in the summer, he opened the windows on one

side of the house (no screens) and used the house as a big malaise trap! Despite this he had a well-maintained collection of lucanids (most of his collection was already in Chicago). He did his own drawings and was still productive.

He told us that he had an invitation to visit Oscar Cartwright who, at the time, was living in Clemson, South Carolina. So, in mid summer he set out with a back pack and started walking. We don't know what route he took, but it took him about a week to get to Clemson, camping all the way up and over the Smoky Mountains.

His arrival at the Cartwright house, unshaven and in need of clean cloths, was unexpected, particularly by Marie Cartwright, who had not been told of the invitation. To make the situation worse, Marie was in the middle of giving a tea party to some of Clemson's elite. Bernard was not bothered, he simply sat down and made himself at home.

We never found out the details, but Cartwright never heard the end of it! When Bernard arrived back in Burville, he told us that he had a "good" visit. That's all we know.