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Reevaluation of *Chalcophora angulicollis* (LeConte) and *Chalcophora virginiensis* (Drury) with a Review and Key to the North American Species of *Chalcophora* Dejean (Coleoptera: Buprestidae)

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Abstract

Chalcophora angulicollis (LeConte) and *Chalcophora virginiensis* (Drury) are shown to be valid allopatric species in the western and eastern forests of North America, respectively. The historic uncertainty regarding their status is reviewed, and new characters of the aedeagus, penultimate maxillary palpomere, and elytral serrations are utilized for their identification. This information is combined with redescriptions, diagnoses, illustrations, and a key for all species of *Chalcophora* Dejean in North America north of Mexico.

Key Words: taxonomy, metallic wood-boring beetles, Nearctic, key, coniferous forests

Chalcophora Dejean, 1833 (see Bellamy 2003 for information on the correct authorship of the genus) includes a group of common, rather large, and economically important species in North America (Bright 1987), but the status of two of these species, the western *Chalcophora angulicollis* (LeConte) and eastern *Chalcophora virginiensis* (Drury), has been confused. For 100 years, they have been repeatedly synonymized and removed from synonymy, most recently by Bright (1987) and Nelson *et al.* (2008). These most recent moves lacked any discussion of characters or detailed justification either way. This paper is an attempt to examine the morphological features of the populations involved, resolve the ambiguity of their recognition, and use the results and a review of the literature to construct a key allowing for the correct identification of all species of *Chalcophora* from North America north of Mexico (NANM).

The type species of *Chalcophora* is the Palaearctic *Buprestis mariana* L., and there are 14 (*sensu* Bright 1987) or 15 (*sensu* Nelson *et al*. 2008) currently recognized species worldwide, four or five of which occur in NANM (Bellamy 2003, 2008): *Chalcophora fortis* LeConte, *Chalcophora georgiana* (LeConte), *Chalcophora liberta* (Germar), and the problematic pair *C. angulicollis* and *C. virginiensis*. Kerremans (1909) synonymized the latter two of these North American *Chalcophora* species, proposing one transcontinental species under the oldest name, *C. virginiensis*. Casey (1914) defended the separation and diagnosed *C. angulicollis* as having proportionately more elongate elytra with no sutural spine, unlike *C. virginiensis*. However, his case was weakened by his recognition of several additional species and subspecies now synonymized under these names. After Leng (1920) synonymized the superfluous Casey names, the remaining two species were considered separate until Bright (1987), in his treatment of the buprestids of Canada and Alaska, returned them to synonymy. Bright stated he was unable to find any clear, consistent differences in either external morphology or the aedeagus and attributed the naming of numerous superfluous species to variation in sculpturing and coloration. Nelson *et al.* (2008) removed the

two species from synonymy without any explicit explanation, and a consensus on the validity of the two species has never been reached.

Material and Methods

A total of 597 specimens of *Chalcophora* were examined in the course of this study. Examination of numerous representatives of the *C. angulicollis*/*C. virginiensis* complex (239 and 215, respectively) from throughout their range (Fig. 25) was required to determine the extent of variation within species and how this relates to the species question. In addition, material examined included many specimens of the other three NANM species to better understand the morphological variation in these species and to allow for construction of diagnoses and keys. All available types were examined, although this work is a review, rather than a revision, and conclusions beyond the *C. angulicollis*/*C. virginiensis* complex are purely in support of taxonomic clarity of existing species concepts.

Label information for types is presented in the following manner – ";" for line breaks on labels and "/" separate labels. Non-type data are summarized by state or province. Full label data for all specimens can be found in Maier (2010, Appendix C).

Specimens from the following collections were examined in this study (curators listed in parentheses):

CNCI – Canadian National Collection of Insects, Ottawa, ON, Canada (Anthony E. Davies).
LSAM – Louisiana State Arthropod Museum, Louisiana State University, Baton Rouge, LA, USA (Victoria Bayless).
MTEC – Montana State Entomology Collection, Montana State University, Bozeman, MT, USA (Michael A. Ivie).
SEMC – Snow Entomology Collection, University of Kansas, Lawrence, KS, USA (Zachary H. Falin).
UASM – E.H. Strickland Entomological Museum, University of Alberta, Edmonton, Alberta, Canada (John H. Acorn).
UMSP – University of Minnesota Insect Collection, St. Paul, MN, USA (Philip J. Clausen).
USNM – National Museum of Natural History, Washington, DC, USA (Steven W. Lingafelter).
WFBM – William F. Barr Entomological Museum, University of Idaho, Moscow, ID, USA (James B. Johnson).

Morphological characters were photographed with a JVC® 3CCD KY-F750 digital camera mounted to a Leica® MS5 dissecting microscope, with a Schott® Fostec DCR 111 fiber optic illuminator and a bottomless styrofoam coffee cup as a light diffuser. The camera was attached to an IBM IntelliStation M Pro®. The images were processed using Syncroscopy Auto-montage Pro® ver. 5.03.0020 Beta and enhanced in Adobe Photoshop® CS4. Habitus images for large specimens were constructed from several stitched-together photographs.

The cuticle of older specimens is frequently coated with greasy exudate or dust, and, since these beetles are xylophagous, they can be covered with sap and dirt. Specimens that were deemed too dirty to discern morphological characters were cleaned following the process described by Ivie (2002).

The aedeagus was extracted from relaxed specimens through the caudal opening in the abdomen, examined, and subsequently glued to a card below the specimen.

Results

The aedeagi of the western and eastern *Chalcophora* species differ consistently in proportions. In *C. virginiensis* (Figs. 15–16), the aedeagus is greater than 3.9 times as long as wide, while in *C. angulicollis* (Figs. 17–18), the aedeagus is always less than 3.3 times as long as wide. These aedeagal proportions remained constant across many individuals (*C. virginiensis* $n = 13$, *C. angulicollis* $n = 26$) sampled throughout the range of each species.

Two other characters were discovered that consistently correlate with the differing aedeagal proportions. In both cases, the characters were tested in the entire group of specimens examined ($n = 464$). First, the penultimate maxillary palpomere is cylindrical and greater than 1.7 times as long as wide in *C. virginiensis* (Fig. 12), compared to being flattened and less than 1.6 times as long as wide in *C. angulicollis* (Fig. 11). Second, in *C. virginiensis*, the lateral apical elytral margins are more strongly serrate (Fig. 6), while in *C. angulicollis* they are weakly serrate to crenulate (Fig. 7). These two external characters are diagnostic in all individuals, including females, although the latter can be difficult in some individuals of *C. virginiensis* that have the lateral apical elytral margins less strongly serrate. These character disjunctions were consistent with two allopatric distributions (Fig. 25) and are consistent with the recognition of two species, a western *C. angulicollis* and an eastern *C. virginiensis*.

Discussion

These data support the conclusion that the *Chalcophora* species recognized by Nelson *et al.* (2008) are indeed valid. In particular, the two species of interest – *C. virginiensis* and *C. angulicollis* – are distinct eastern and western species of *Chalcophora*. Several of the characters

shown to be useful to distinguish *C. virginiensis* and *C. angulicollis* are subtle, but they were consistent within and between species. Although subtle, differences in proportions of the aedeagi of western and eastern species are clear (Figs. 15–18), especially when examined together. The two external characters discussed above are diagnostic in all individuals, including females. For all three of these morphological characters, no east-west gradient was apparent.

Characters used in the past, which involved size, color, and cuticular sculpturing, should not be used to define species in this group. Within the genus *Chalcophora*, external characters such as elytral sculpturing and color vary significantly even among conspecifics. This problem with variation in *Chalcophora* is not limited to North America. In his revision of East Asian *Chalcophora*, Kurosawa (1974) discovered an inordinate number of subspecies and variations, which, as he stated, "…are not always clear-cut because of intermediate individuals."

A fairly large geographical disjunction exists between these two species in the central United States and Canada (Fig. 25). The group is apparently absent in this region, consistent with a general lack of native pines in the central Great Plains. The sole exception seen was a specimen from the artificial habitat of the Bessey District of the Nebraska National Forest of Nebraska, which consists entirely of hand-planted pines in Nebraska's Sand Hills (USFS 2013). No specimens were found from eastern South Dakota, North Dakota, and southern Saskatchewan in spite of extensive inquiries from appropriate collections. Specimens from the boreal forests of northern Canada do exist, however, and were indicated in the distribution map presented in Bright (1987) and Fig 25. Bright's (1987) specimens in the CNCI, from Fort Smith in the Northwest Territories, and specimens in the UASM from Opal, Alberta were examined on our behalf and found to clearly be *C. angulicollis* (J. Acorn, G. Hilchie, *in litt.*). *Chalcophora virginiensis* is known from east-central Saskatchewan and Manitoba eastward. This puts the dividing line in the distributions of the two species somewhere in the eastern half of the Northwest Territories, south through western Saskatchewan, and then along the 100th meridian to the Mexican border. Further collecting in this region should clarify the location of this division.

Taxonomy

In keeping with the limited goals of this paper as a review in support of identifications, rather than a revision, only the most important references are cited for each species. For complete synonymies, see Nelson *et al.* (2008) and Bellamy (2008). Nomenclature follows the established use by Nelson *et al.* (2008) and Bellamy (2008).

Key to the Species of North American *Chalcophora*

1. Protibia with one or two weak longitudinal ridges on posterior face (Fig. 13), or ridges absent; usually coppery gold to green metallic in color 2
1′. Protibia with two strong longitudinal ridges on posterior face (Fig. 14); usually shining black in color 4
2. Lateral elytral margin posteriorly smooth to weakly crenulate, never serrate (Fig. 8); aedeagus with parameres narrow, not wrapping around median lobe (Figs. 19–20); small species, 15–25 mm; northeastern North America ..... ***C. liberta*** **(Germar)**
2′. Lateral elytral margin posteriorly strongly crenulate to serrate (Figs. 9–10); aedeagus with parameres narrow, not wrapping around median lobe (Figs. 21–22) or parameres wide, wrapping around median lobe (Figs. 23–24); large species, 26–33 mm; eastern North America 3
3. Elytral apex acute, with strong spine (Fig. 9); aedeagus with parameres narrow, not wrapping around median lobe; southern United States ..... ***C. georgiana*** **(Germar)**
3′. Elytral apex truncate, with weak spine, or spine absent (Fig. 10); aedeagus with parameres wide, wrapping around median lobe (Figs. 23–24); northeastern North America..... ***C. fortis*** **LeConte**
4. Penultimate maxillary palpomere cylindrical, >1.7 times as long as wide (Fig. 12) (measured at widest point); aedeagus >3.9 times as long as wide (measured at midpoint) (Figs. 15–16); posterolateral elytral margin weakly to strongly serrate (Fig. 6); eastern North America ..... ***C. virginiensis*** **(Drury)**
4′. Penultimate maxillary palpomere flattened, <1.6 times as long as wide (Fig. 11); aedeagus <3.3 times as long as wide (Figs. 17–18); posterolateral elytral margin weakly serrate to crenulate (Fig. 7); western North America ..... ***C. angulicollis*** **(LeConte)**

Chalcophora angulicollis (LeConte, 1857)

(Figs. 2, 7, 12, 17, 18, 25)

Buprestis angulicollis LeConte, 1857: 44.
Chalcophora oregonensis Fitch, 1858: 702 (synonymized by LeConte 1860: 190).

Figs. 1–5. *Chalcophora* species, habitus. **1)** *C. virginiensis*, Arkansas; **2)** *C. angulicollis*, Idaho; **3)** *C. liberta*, Wisconsin; **4)** *C. georgiana*, Florida; **5)** *C. fortis*, New York.

Chalcophora angulicollis montana Casey, 1909: 80 (synonymized by Kerremans 1909: 31).
Chalcophora prominens Casey, 1909: 81 (synonymized by Leng 1920: 179).
Chalcophora pallida Kerremans, 1919: 48 (synonymized by Barr 1971: 57).
For complete synonymy, see Bellamy (2008) and Westcott and Bellamy (2013).

Figs. 6–10. *Chalcophora* species, elytral apices. **6)** *C. virginiensis*; **7)** *C. angulicollis*; **8)** *C. liberta*; **9)** *C. georgiana*; **10)** *C. fortis*.

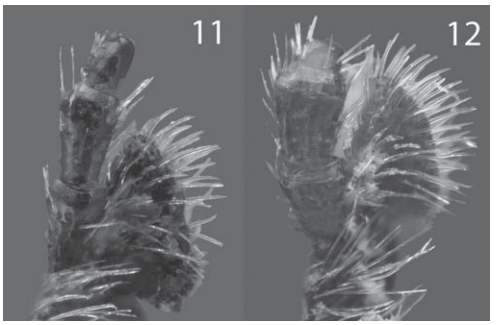
Diagnosis. This species is most similar to the eastern species *C. virginiensis*. These species both possess two strong, longitudinal ridges on the posterior face of the protibia (Fig. 14). *Chalcophora angulicollis* can be distinguished from *C. virginiensis* by the flattened shape of the penultimate maxillary palpomere, which is less than 1.6 times as long as wide (Fig. 11) and the weakly serrate or crenulate posterolateral elytral margins (Fig. 7). Additional confirmation of this species can be obtained by examining the aedeagus, which is always less than 3.3 times as long as wide (Figs. 17–18). It is the only *Chalcophora* species in western North America (Fig. 25).

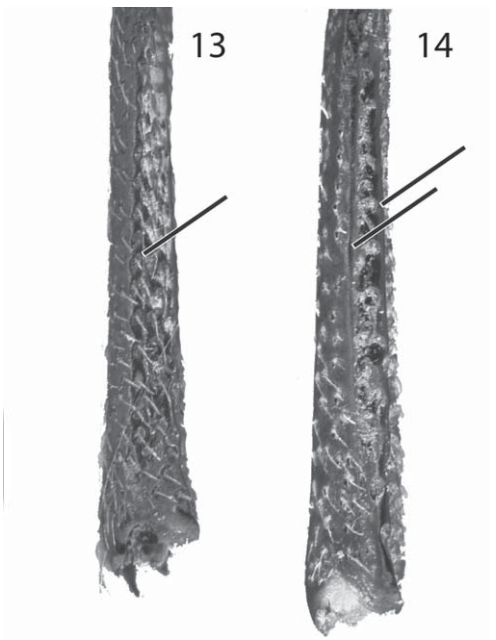
Redescription. Male. Length 20–30 mm, width 12–14 mm at widest point. Blackish, with a slight metallic copper luster; shiny bronze to copper ventrally. Head deeply incised medially, heavily punctate, sparsely setose. Penultimate maxillary palpomere flattened, 1.6 times as long as wide. Antenna dark brown, arising just inside inner margin of eye; antennomeres quadrate, with sparse setae apically. Pronotum widest in basal two-thirds; lateral borders angulate to arcuate, moderately crenulate in apical one-third; with fringe anteriorly; anterior angles acute, projecting forward around head; dorsal surface heavily sculptured, with depressed patches of dense punctation interspersed with smooth, black elevations; pronotal elevations narrow; elevation pattern variable. Protibia with broad tooth apically, two prominent longitudinal ridges, and two short apical spines. Tibiae and femora sparsely, evenly punctate and lightly setose; tibiae with tuft of setae apically; line of setae extends along the length of the tibia. Prosternal process expanded posterior to procoxae, with two longitudinal grooves. Elytra subparallel, narrowing in apical two-thirds. Elytron heavily sculptured, with depressed patches of dense punctation interspersed with smooth black elevations; elytral elevations wide; elytral sculpturing variable; posterolateral margin weakly serrate or crenulate to smooth, never strongly serrate. Elytral apex truncate to broadly rounded, with weak sutural spine or sutural spine absent. Ventrally setose; ventrites evenly punctate, posterior border smooth; apical ventrite with a deep V-shaped notch posteriorly. Aedeagus 3.3 times as long as wide; parameres wide, wrapping around median lobe, with tuft of setae apically; tegmen deeply incised medially; median lobe wide, apex acute (45°), with median ridge dorsally.

Female. Generally larger; last ventrite rounded posteriorly, notch absent.

Variation. The extraordinary amount of variation within this and the following species has been the cause of many problems with the taxonomy of the genus. *Chalcophora angulicollis* and most other species in the genus vary considerably in body shape, color, size, and amount of cuticular sculpturing.

Type Material Examined. *Chalcophora prominens* HOLOTYPE – "Fla.; CASEY; bequest; 1925/ TYPE USNM/ 35737/ *prominens* Csy/ "'Fla.' locality for *prominens* probably erroneous. See Casey. Mem. 5, p. 355"" (USNM). *C. angulicollis* ssp. *montana* – "Boulder; Co. Col./ CASEY; bequest; 1925/ TYPE USNM; 35735/ montana/ LECTOTYPE; *Chalcophora*; *angulicollis*; *montana* Casey; 1989; C.L. BELLAMY" (USNM). "Boulder; Co. Col./ CASEY; bequest; 1925/ *montana* – 2; PARATYPE USNM; 35735/ PARALECTOTYPE; *Chalcophora*; *angulicollis*; *montana* Casey; 1989; C.L. BELLAMY" (USNM). HOLOTYPE: *C. virginiensis* ssp. *antennalis* – "Idaho/





Figs. 11–14. *Chalcophora* species. **11)** *C. angulicollis*, maxillary palpus; **12)** *C. virginiensis*, maxillary palpus; **13)** *C. fortis*, protibia, posterior face; **14)** *C. angulicollis*, protibia, posterior face.

CASEY; bequest; 1925/ TYPE USNM; 35734/ antennalis Csy." (USNM).

Other Material Examined. 240 specimens (Fig. 25, see Maier 2010, Appendix C).

Notes. In the original description, LeConte (1857) distinguished this species from the eastern species by its larger size, more angular pronotal margins, and wider dilations of the second and third elytral costae. While we have recognized this as a valid species, the characters given in the original description are inadequate for the identification of this species, since they vary greatly between individuals. Characters given in the key will consistently separate *C. angulicollis* from *C. virginiensis*.

Benoit (1963) indicated that C. A. Frost collected several *C. angulicollis* from Québec and Ontario in eastern Canada. However, based on the characters Benoit used for both *C. virginiensis* and *C. angulicollis*, which included size, width of sculpturing, and pronotal shape, it is unlikely these specimens are *C. angulicollis*. Specimens examined from Québec, Saskatchewan, and Ontario indicate Ontario is within the range of *C. virginiensis*, not *C. angulicollis*. Records of this species from Texas (Nelson *et al.* 2008) were based on a misidentification of *C. virginiensis* (Westcott and Bellamy 2013).

Casey's (1909) Florida type and record for *C. prominens* was apparently the result of a mislabeled specimen (Casey 1914). It belongs to *C. angulicollis*.

Host Records. Various Pinaceae, including *Pinus ponderosa* Douglas ex C. Lawson, *Pinus contorta* Douglas ex Loudon, *Pseudotsuga menziesii* (Mirbel) Franco, *Abies grandis* (Douglas ex D. Don) Lindley, and *Abies concolor* (Gordon and Glend.) Lindley ex Hildebrand (Barr 1971). A recent additional record for "*Pinus chihuahuae*" [sic] (Westcott and Bellamy 2013) apparently refers to *Pinus leiophylla chihuahuana* (Engelmann) G. R. Shaw.

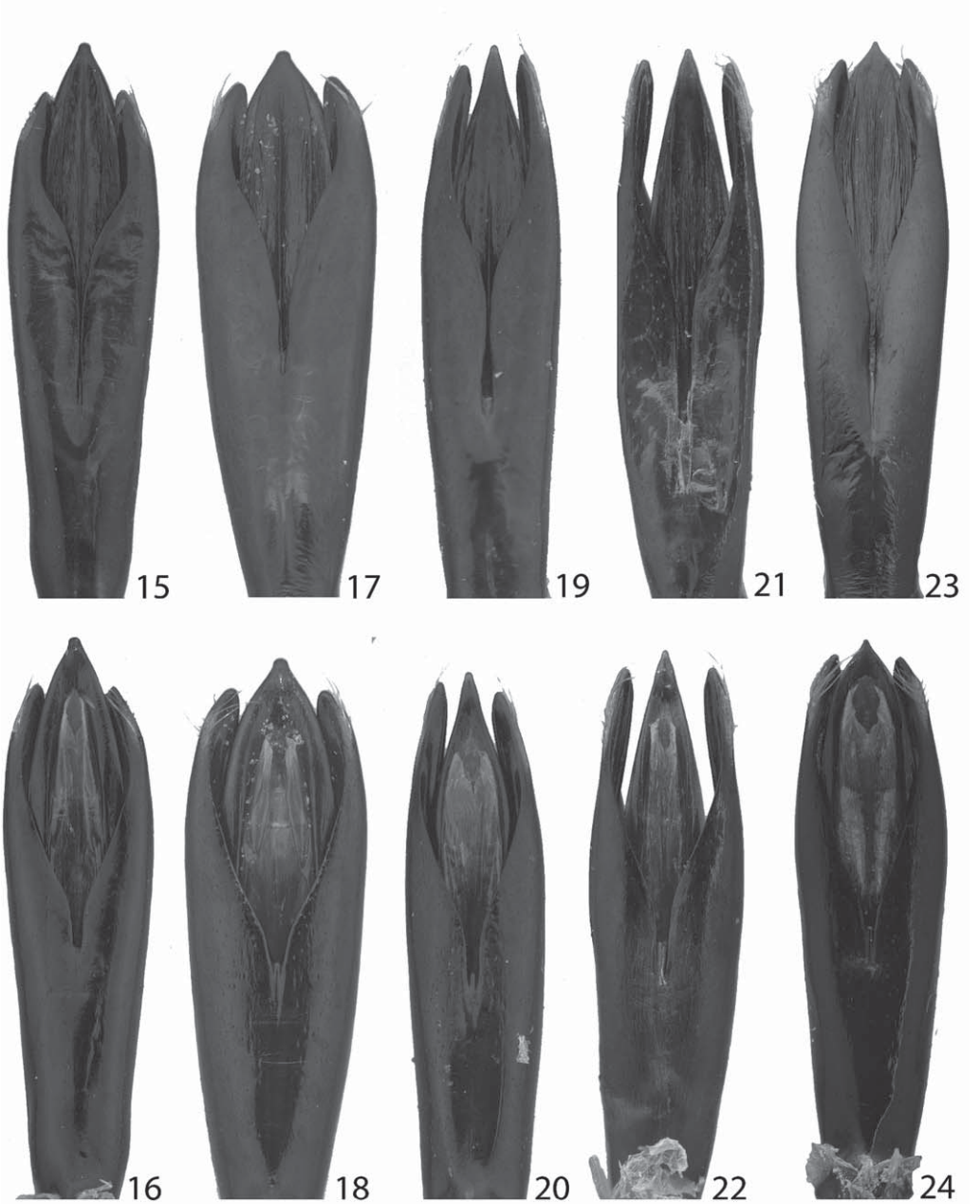
Recorded Distribution. CANADA: Alberta, British Columbia, Northwest Territories. **USA:** Arizona, California, Colorado, Idaho, Montana, Nebraska, New Mexico, Oregon, South Dakota, Washington, Wyoming. Outside NANM: Japan, Europe (interceptions). The Nebraska record is from a planted forest in the Great Plains and probably represents an introduction beyond the native range.

Chalcophora fortis LeConte, 1860
(Figs. 5, 10, 11, 23, 24)

Chalcophora fortis LeConte, 1860: 191.
Chalcophora laurentica Casey, 1909: 82 (synonymized by Leng 1920: 179).
Chalcophora cupreola Casey, 1914: 360 (synonymized by Leng 1920: 179).
For complete synonymy, see Bellamy (2008).

Diagnosis. The largest of the North American *Chalcophora* (26–33 mm), this coppery green species is easily distinguished from all other species by the single weak, longitudinal ridge present on the posterior face of the protibia (Fig. 13) as well as by the shape of the aedeagus. The parameres of the aedeagus are wide, wrapping around the median lobe (Figs. 23–24).

Redescription. Male. Length 26–33 mm, width 12–16 mm at widest point. Blackish, with metallic green-copper luster dorsally; shiny bronze



Figs. 15–24. *Chalcophora* species, male genitalia, dorsal view (top row), ventral view (bottom row). **15–16)** *C. virginiensis*; **17–18)** *C. angulicollis*; **19–20)** *C. liberta*; **21–22)** *C. georgiana*; **23–24)** *C. fortis.*

to metallic green ventrally. Head deeply incised medially, heavily punctate, sparsely setose. Antenna dark brown; arising just inside inner margin of eye; antennomeres with sparse setae apically. Pronotum widest in basal two-thirds; lateral borders subparallel, heavily crenulate in apical one-third; with fringe anteriorly; anterior angles acute, projecting forward around head; dorsal surface heavily sculptured, with depressed patches of dense punctation interspersed with smooth, black elevations; pronotal elevations narrow; elevation pattern variable. Protibia with

Fig. 25. Distribution map of *Chalcophora angulicollis* and *Chalcophora virginiensis* in North America, indicating the disjunction between the two populations. Circles approximate localities of specimens examined; squares centered in state/provinces are literature records not represented by specimens examined. The grey shaded area indicates forest cover in North America (adapted from Global Forest Watch 2013).

broad tooth apically, lacking prominent longitudinal ridges posteriorly or with one very weak ridge, with two short apical spines. Tibia and femora sparsely, evenly punctate and lightly setose; tibiae with tuft of setae apically; line of setae extends along the length of the tibia. Prosternal process expanded posterior to procoxae, with two longitudinal grooves. Elytra subparallel, narrowing in apical one-third. Elytron heavily sculptured, with depressed patches of dense punctation interspersed with smooth black elevations; elytral elevations narrow; elytral sculpturing variable; posterolateral border weakly to strongly serrate. Elytral apex trunate to broadly rounded, with weak sutural spine or sutural spine absent. Ventrally setose; ventrites evenly punctate, posterior border smooth; apical ventrite with deep V-shaped notch posteriorly. Aedeagus with parameres wide, wrapping around median lobe, with tuft of setae apically; tegmen deeply incised medially; median lobe wide, apex acute (approximately 70°), with two lateral ridges dorsally.

Female. Generally larger; last ventrite rounded posteriorly, notch absent.

Variation. Compared to other species in the genus, *C. fortis* displays very little variation. The

size, color, and density of setae ventrally vary only slightly, though sculpturing patterns vary considerably from individual to individual.

Type Material Examined. *Chalcophora laurentica* – "Ont./ CASEY; bequest; 1925/ TYPE USNM; 35739/ laurentica; Csy./ LECTOTYPE; CHALCOPHORA; laurentica ♂; Casey; 1989; C.L. Bellamy" (USNM). "Ont./ CASEY; bequest; 1925 / TYPE USNM; 35739 / laurentica – 2; Csy. / PARA-LECTOTYPE; CHALCOPHORA; laurentica; Casey; 1989; C.L. Bellamy" (USNM). "Ont. / CASEY; bequest; 1925 / TYPE USNM; 35739 / laurentica –- 3; Csy. / PARA-LECTOTYPE; CHALCOPHORA; laurentica; Casey; 1989; C.L. Bellamy" (USNM).

HOLOTYPE: *C. cupreola* – "Kas. / CASEY; bequest; 1925 / TYPE USNM; 35740 / cupreola Csy." (USNM).

Other Material Examined. 23 specimens (see Maier 2010, Appendix C).

Notes. *Chalcophora fortis* appears to be a very distinct species, with a range restricted to northern and eastern North America.

Host Records. *Pinus strobus* L. (Nelson *et al.* 2008).

Distribution. CANADA: Ontario, Manitoba, New Brunswick, Quebec. **USA:** Connecticut, Iowa, Kansas, Maine, Massachusetts, Michigan, Minnesota, Nebraska, New Hampshire, New Jersey, New York, Pennsylvania, Vermont, Wisconsin.

Chalcophora georgiana (LeConte, 1857)
(Figs. 4, 9, 21, 22)

Buprestis liberta (not Germar, misidentification); Laporte and Gory 1836: 11 (Sometimes treated as a primary junior homonym of *Buprestis liberta* Germar, 1824, see Bellamy 2008).

Buprestis georgiana LeConte, 1857: 191 (Replacement name for *Buprestis liberta* Laporte and Gory 1836: 11).

Chalcophora iridescens Casey, 1909: 82 (synonymized by Casey 1914).

For complete synonymy, see Bellamy (2008).

Diagnosis. This coppery green species can be easily separated from all other species of NANM *Chalcophora* by the acute elytral apex, with a strong sutural spine (Fig. 9), and aedeagus with narrow parameres which do not wrap around the median lobe (Figs. 21–22). This species is distributed throughout southeastern North America.

Redescription. Male. Length 20–29 mm, width 10–14 mm at widest point. Metallic copper to light metallic green dorsally; ventrally shiny bronze to metallic green. Head deeply incised medially, heavily punctate, sparsely setose. Antenna cupreous; arising just inside inner margin of eye; antennomeres with sparse setae apically. Pronotum widest at base; lateral borders subparallel; with fringe anteriorly; anterior angles acute, projecting forward around head; dorsal surface heavily sculptured, with depressed patches of very dense, convergent punctation interspersed with smooth, coppery elevations; pronotal elevations wide; elevation pattern variable. Protibia with broad tooth apically, lacking prominent longitudinal ridges posteriorly or with two very weak ridges; with two short apical spines. Tibiae and femora sparsely, evenly punctate and lightly setose, with tuft of setae apically, line of setae extends along length of tibia. Prosternal process expanded posterior to procoxae, with two longitudinal grooves. Elytra subparallel, narrowing in apical one-third. Elytron heavily sculptured, with shallowly depressed patches of dense punctation interspersed with smooth coppery elevations; elytral elevations wide, shallow; elytral sculpturing variable; posterolateral border crenulate to weakly serrate. Elytral apex acute, with prominent sutural spine. Ventrally setose; ventrites evenly punctate, posterior border smooth; apical ventrite with deep V-shaped notch posteriorly. Aedeagus with parameres narrow, not wrapping around median lobe, with tuft of setae apically; tegmen deeply incised medially; median lobe narrow, apex strongly acute (20°), with two lateral ridges dorsally.

Female. Generally larger; last ventrite rounded posteriorly, notch absent.

Variation. When compared to other species in the genus, *C. georgiana* displays very little variation. The size, color, and density of setae ventrally vary only slightly, though sculpturing patterns vary considerably from individual to individual.

Type Material Examined. HOLOTYPE: *C. iridescens* – "CASEY; bequest; 1925 / TYPE USNM; 35733 / iridescens Csy. CASEY determ.; georgiana -12" (USNM).

Other Material Examined. 23 specimens (see Maier 2010, Appendix C).

Notes. While Kerremans (1909) pointed out certain affinities of *C. georgiana* to *C. liberta*, to the point of considering synonymizing the two, *C. georgiana* appears to be a well-defined species. Externally, this species can closely resemble the *C. virginiensis/C. angulicollis* complex, however, the male genitalia share the character of thin parameres, which do not wrap around the median lobe, with *C. liberta*.

Host Records. *Pinus caribea* Morelet, *Pinus echinata* Miller, *Pinus palustris* Miller, *Pinus taeda* L. (Nelson *et al.* 2008).

Recorded Distribution. USA: Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, Pennsylvania, South Carolina, Virginia.

Chalcophora liberta (Germar, 1824)
(Figs. 3, 8, 19, 20)

Buprestis liberta Germar, 1824: 38.
Buprestis borealis Laporte and Gory, 1836: 13 (synonymized by LeConte 1860: 191).
Chalcophora parviceps Casey, 1909: 83 (synonymized by Leng 1920: 197).
For complete synonymy, see Bellamy (2008).

Diagnosis. This, the smallest North American species of *Chalcophora* (length 15–25 mm), may be readily distinguished from other *Chalcophora* by its truncate or rounded elytral apices, without a sutural spine (Fig. 8), small size, and usually bright metallic, orange-green color (see variation below).

Redescription. Male. Length 15–25 mm, width 6–10 mm at widest point. Brilliant orange-copper to metallic green dorsally; ventrally shiny bronze to metallic green; occasionally dull black. Head deeply incised medially, heavily punctate, sparsely setose. Antenna dark brown; arising just inside inner margin of eye; antennomeres quadrate, with sparse setae apically. Pronotum widest in basal half; lateral borders arcuate; with fringe anteriorly; anterior angles acute, projecting forward around head; dorsal surface heavily sculptured, with depressed patches of very dense, convergent punctation interspersed with smooth, black elevations; pronotal elevations narrow; elevation pattern variable. Protibia with broad tooth apically, lacking prominent longitudinal ridges posteriorly or with two very weak ridges; with two short apical spines. Tibiae and femora sparsely, evenly punctate and lightly setose, with tuft of setae apically, line of setae extends along the length of the tibia. Prosternal process expanded posterior to procoxae, with two longitudinal grooves. Elytra subparallel, narrowing in apical two-thirds. Elytron heavily sculptured, with depressed patches of very dense, convergent punctation interspersed with smooth, black elevations; elytral elevations narrow; elytral sculpturing variable; lateral border smooth to weakly crenulate posteriorly, never serrate. Elytral apex truncate to broadly rounded, without sutural spine. Ventrally setose; ventrites evenly punctate, posterior border smooth; apical ventrite with a deep V-shaped notch posteriorly. Aedeagus with paramere narrow, not wrapping around median lobe, with tuft of setae apically; tegmen deeply incised medially; median lobe narrow, apex strongly acute (approximately 20°), with single ridge dorsally.

Female. Generally larger; last ventrite rounded posteriorly, notch absent.

Variation. The color and luster of this species can vary from brilliant metallic coppery orange to dull black. Additionally, there is an enormous amount of variation in size, the amount of sculpturing on the elytra and pronotum, and the density of setae ventrally.

Type Material Examined. HOLOTYPE: *C. parviceps* – "N.Y; T.B.A./ CASEY; Bequest; 1925/ TYPE USNM; 35741/ parviceps; Csy." (USNM).

Other Material Examined. 52 specimens (see Maier 2010, Appendix C).

Notes. *Chalcophora liberta* is the smallest *Chalcophora* in the Nearctic Region, and is distinctive when compared to other members of the genus. However, small *C. virginiensis* are often found in collections misidentified as *C. liberta*. *Chalcophora liberta* is generally a northern species, and the few records of *C. liberta* from the southeastern United States (Florida, North Carolina) were found to be misidentified, small *C.virginiensis*. Therefore, identification based on size alone is not appropriate for this species.

Host Records. *Pinus resinosa* Aiton, *P. strobus* (Nelson *et al.* 2008).

Recorded Distribution. CANADA: Manitoba, Ontario, Québec. **USA:** Alabama, Connecticut, Indiana, Maine, Massachusetts, Michigan, Minnesota, New Hampshire, New York, Pennsylvania, Texas, West Virginia, Wisconsin.

Chalcophora virginiensis (Drury, 1770)
(Figs. 1, 6, 13, 15, 16, 25)

Buprestis virginiensis Drury, 1770: 88.
Buprestis cupreomaculata Goeze, 1777: 596 (synonymized by Saunders 1870: 34).
Buprestis virginica Gmelin, 1790: 1940 (synonymized by LeConte 1860: 191).
Chalcophora novaeboracensis Fitch, 1858: 701 (synonymized by LeConte 1860: 191).
Chalcophora virginiensis var. *immaculata* Fitch, 1858: 700.
Chalcophora lacustris LeConte, 1860: 190 (synonymized by Wellso *et al*. 1976: 6).
Chalcophora lacustris brevicollis Casey, 1909: 79 (synonymized by Kerremans 1909: 29).
Chalcophora virginiensis obliterata Casey, 1909: 78 (synonymized by Kerremans 1909: 26).
Chalcophora melanotum Muttkowski, 1910: 135 (synonymized by Leng 1920: 179).
Chalcophora mariana filigriana Obenberger, 1913: 28 (synonymized by Bílý 1981: 348).
Chalcophora ingens Casey, 1914: 360 (synonymized by Leng 1920: 179).
For complete synonymy, see Bellamy (2008), Hansen *et al*. (2012), and Westcott and Bellamy (2013).

Diagnosis. This species is most similar to the western species *C. angulicollis*. These species both possess two strong, longitudinal ridges on

the posterior face of the protibia. *Chalcophora virginiensis* can be distinguished from *C. angulicollis* by the rounded shape of the penultimate maxillary palpomere, which is at least 1.7 times as long as wide (Fig. 12), and the usually strongly serrate elytral margins (Fig. 6). Additional confirmation of this species can be obtained by examining the aedeagus, which is always greater than 3.9 times as long as wide (Figs. 15–16).

Redescription. Male. Length 18–30 mm, width 11–14 mm at widest point. Blackish, with a slight metallic copper luster; ventrally shining bronze to copper. Head deeply incised medially, heavily punctate, sparsely setose. Penultimate maxillary palpomere cylindrical, 1.7–1.8 times as long as wide. Antenna dark brown; arising just inside inner margin of eye; antennomeres quadrate, with sparse setae apically. Pronotum widest in basal two-thirds; lateral borders arcuate, moderately crenulate on apical one-third; with fringe anteriorly; anterior angles acute, projecting forward around head; dorsal surface heavily sculptured, with depressed patches of dense punctation interspersed with smooth, black elevations; pronotal elevations narrow; elevation pattern variable. Protibia with broad tooth apically; with two prominent, longitudinal ridges; with two short apical spines. Tibiae and femora sparsely, evenly punctate and lightly setose, with tuft of setae apically, line of setae extends along the length of the tibia. Prosternal process expanded posterior to procoxae, with two longitudinal grooves. Elytra subparallel, narrowing in apical two-thirds. Elytron heavily sculptured, with depressed patches of dense punctation interspersed with smooth black elevations; elytral elevations wide; elytral sculpturing variable; lateral border weakly to strongly serrate posteriorly. Elytral apex trunate to broadly rounded, with weak sutural spine or sutural spine absent. Ventrally setose; ventrites evenly punctate, posterior border smooth; apical ventrite with deep V-shaped notch posteriorly. Aedeagus four times as long as wide; parameres wrapping around median lobe, with tuft of setae apically; tegmen deeply incised medially; median lobe wide, apex acute (approximately 45°), with median ridge dorsally.

Female. Generally larger; last ventrite rounded posteriorly, notch absent.

Variation. The characters used in the diagnosis vary little within the species; the genitalia have consistent proportions, the penultimate maxillary palpomere is always cylindrical in this species, and the posterior face of the protibia always has strong ridges. The serration of the elytra varies slightly, but still remains a good character for identification.

Type Material Examined. HOLOTYPE: *C. virginiensis* ssp. *obliterata* – "Fla./ CASEY; bequest; 1925/ TYPE USNM; 35731/ obliterata Csy." (USNM). HOLOTYPE: *C. lacustris* ssp. *brevicollis* – "Mass./ CASEY; bequest; 1925/ TYPE USNM; 35732/ brevicollis Csy." (USNM). HOLOTYPE: *C. ingens* – "CASEY; bequest; 1925/ TYPE USNM; 35736/ ingens Csy." (USNM).

Other Material Examined. 232 specimens (see Maier 2010, Appendix C).

Notes. The variation in external characters in *C. virginiensis* is similar to that of *C. angulicollis*, and some of the characters used in the old species definitions are shared between the two, so that there are many *C. virginiensis* that closely resemble *C. angulicollis*. In fact, one synonym, *C. lacustris*, was named simply as an eastern species which displayed many external characters of *C. angulicollis*. Specimens collected in Japan and Europe are presumably specimens that have been transported through the movement of wood across oceans.

Host Records. *Larix laricina* (Du Roi) K. Koch (Pinaceae) (from specimen labels), *P. echinata, P. palustris*, *P. resinosa, Pinus rigida* Miller, *P. strobus, P. taeda, Pinus virginiana* Miller, *Taxodium distichum* (L.) Richard (Cupressaceae) (Bright 1987; Nelson *et al.* 2008).

Recorded Distribution. CANADA: Manitoba, New Brunswick, Saskatchewan. **USA**: Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Hampshire, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Texas, Virginia, District of Columbia, West Virginia, Wisconsin. Outside NANM: Japan, Europe. Records from Mexico and Central America are based on misidentifications (Westcott and Bellamy 2013).

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