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12-11-2004

## Revision of the Phyllophaga of Hispaniola (Coleoptera: Scarabaeidae: Melolonthinae) – PART 2

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Woodruff, Robert E. and Sanderson, Milton W., "Revision of the Phyllophaga of Hispaniola (Coleoptera: Scarabaeidae: Melolonthinae) – PART 2" (2004). *Insecta Mundi*. 86.

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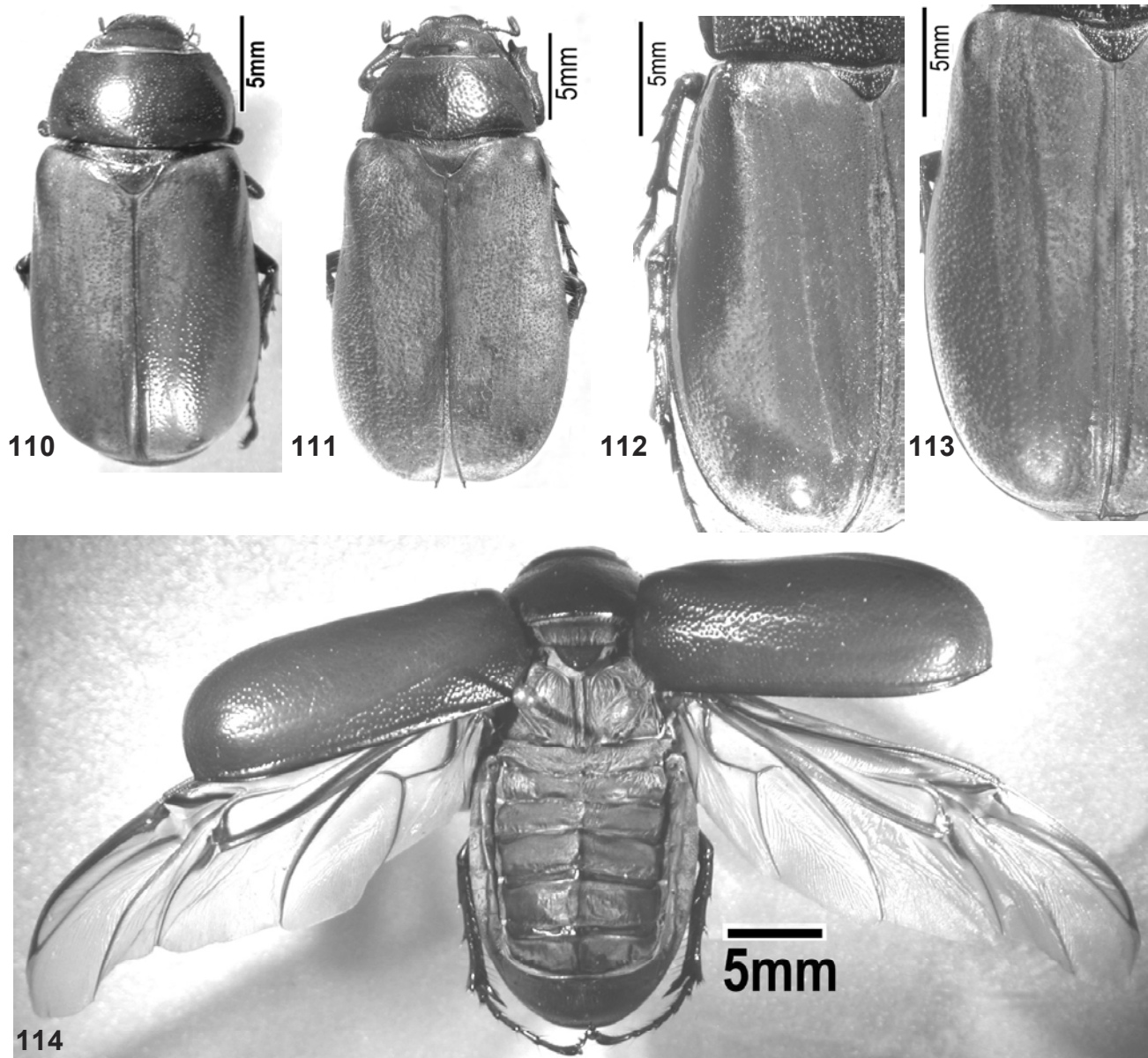


Fig. 110-114. *Phyllophaga habitus*: 110) *santachloe* Woodruff; 111) *toni* Woodruff; 112-113 *marcano* Woodruff: 112) female, note smooth shiny area above elytral margin; 113) male, note relatively uniform pruinosity in same area; 114) *kenscoffi* Wolcott, showing the well developed flying wings.

### Economic Importance

Although *Phyllophaga* adults are often pests by defoliating trees, and larvae are well known soil-inhabiting crop pests, their damage rarely has been reported as economic in Hispaniola. The published records are summarized below, but we believe their impact is much more extensive and unrecognized. Part of this is because larvae of even the common species have neither been described nor recognized. We believe that pastures, golf courses, vegetable

crops, sugarcane, and ornamental plants are frequently attacked.

Wolcott (1928a) was the first to note that Hispaniola was "...comparatively little affected by the attacks of white grubs or May beetles." He noted that it was in striking contrast to the conditions in Puerto Rico, "...where white grubs are the major pest of most agricultural crops." He mentioned the devastation to sugarcane in Puerto Rico, but not seen in Haiti (although he says it was little grown there). As one interested in biological control, he recorded a fly

(Tachinidae: *Ptilodexia harpasa* Walker) reared from Haitian grubs, later mentioning a wasp (*Tiphia* sp.) as a suspected reason for few May beetles.

Santoro (1960), in the basic economic entomology of the Dominican Republic, refers to *Phyllophaga* on 10 occasions (p. 100, 125, 156, 192, 278, 306, 328, 334, 345, 389), but the only species names used are for 2 Puerto Rican ones (p. 100, *portoricensis* and *vandinei*) and 2 from Hispaniola (p. 156, *hogardi* and *neglecta*). Most of these citations are repetitive under different crops, although twice the generic name is misspelled "*Phillophaga*". He indicated that the "Gusanos blancos de tierra or Majocás" are frequently encountered in soil around cacao, sugarcane, coffee, pineapple, peanuts, corn, citrus, etc. However, he also said that *Phyllophaga* in general are not a "notable plaga", because of effective controls. He emphasized biological control (listing several predators and parasites) over the use of the insecticides Aldrin and BHC.

The most recent treatment, entitled "Crop pests of the Caribbean" by Schmutterer (1990), listed 2 species (p. 86, *plaei* [= *portoricensis* Smyth] and *hogardi* (Blanch.)) from the Dominican Republic. In general he stated that *Phyllophaga* adults are polyphagous [some are very host specific] and small plants may be almost defoliated of sugarcane, cassava, coffee, flamboyant, casuarina, coconut, cocoa, bamboo, breadfruit, mango, and numerous other plants. He listed larvae as attacking roots of sugarcane, citrus, pigeon pea, cassava, sweet potato, cocoa, coffee, strawberry, pineapple, bean, groundnut, and tobacco, and stated that "...they may kill the damaged plants or reduce their growth and yield.... or may rot owing to infection by secondary organisms such as bacteria and fungi." *Phyllophaga hogardi* is shown on Plate 48. The most interesting report (p. 451) is that "White grubs may cause considerable damage to strawberries in the Constanza Valley. One larva is sufficient to kill a plant. A poor stand of strawberry fields (Plate 278) is often the result of the feeding activity of this pest." It is possible that *rex*, n. sp., or other species rare in collections known from this locality, is responsible for this damage.

We believe far more damage occurs in Hispaniola than has been reported. The economic literature is so voluminous that we cannot review it here, and there is an extensive World bibliography (Pike, et al., 1976). We list here some references on Caribbean Islands where they are noted as serious pests: **Puerto Rico** (Smyth, 1917; Wolcott, 1933, 1948, 1955), **Cuba** (Vandine and Christensen, 1932; Garcia-Vidal, 1975, 1978), **Guadeloupe** (Chalumeau 1983, 1985; Gruner, 1969), **Jamaica** (Frank and Bennett, 1970). In

addition, literature as a sugarcane pest is extensive: Aragón and Morón, 1993; Box, 1953; Cherry, 1984, 1985; Gordon and Anderson, 1981; Sosa, 1984; Wade, 1951.

In other Neotropical areas, much recent attention has been placed on these pests. In Central America, where they are called "gallina ciega" or "ronrones", several major papers have been published (King, 1984; King and Saunders, 1979; Cano, Monzón, and Schuster, 2000). The Mexican fauna has been extensively studied by Morón (1986, 1993, 1997), and new species are continuing to be described. They are sometimes referred to as ronrones de Mayo, escarabajos de Mayo, and May or June beetles.

### Control

Since this treatise is primarily a taxonomic one, little will be said about chemical or biological control, except to cite significant references. In the past, use of chemicals such as BHC, Dieldrin, Aldrin, Heptachlor, Lindane, and DDT were used for larval control, but soil insects are notoriously difficult to kill. Most of these chemical are no longer available or recommended because of their toxicity to vertebrates or potential contamination of groundwater. Much of our knowledge of *Phyllophaga* in the Caribbean is the result of numerous studies by Wolcott (1928-1955) in Puerto Rico. He realized very early that biological control was the only means likely to succeed. Because Hispaniola had many *Phyllophaga*, and they were not reported to be serious pests, he searched there for predators and parasites (much of this unpublished). Further studies are warranted, to assess economic damage and biological control agents in Hispaniola.

Woodruff and Beck (1989) summarized the biological control literature and listed the many organisms involved (see that reference for details). The list includes many parasitic Diptera (Pyrgotidae, Tachinidae, Sarcophagidae, Bombyliidae, Asilidae, Tabanidae), and Hymenoptera (Tiphidae, Scoliidae, Ichneumonidae, Pelecinidae). Predators include Carabidae and Elateridae (especially the genus *Pyrophorus*, whose larvae disrupted rearing operations of *Phyllophaga bruneri* Chapin in Florida), and many birds, lizards, and especially the giant Surinam toad (*Bufo marinus* L.). Wolcott considered it the most successful control agent in Puerto Rico, possibly causing extinction of a localized species of *Phyllophaga*. Many other organisms play some role, such as mites (Crocker, et al., 1992), many kinds of parasitic worms (Nematoda, Eugregarina, Helminthidae), including intermediate hosts for parasites of swine and

other vertebrates. Protozoa, milky disease, and green muscardine fungus have been used with some success, using commercial formulations.

### Generic Considerations

Sanderson (1951) discussed the history of the generic names applied to this group, and concluded that all should be in the genus *Phyllophaga* Harris (1827), in the process reducing *Cnemarachis* Saylor (1942) to subgeneric status. This has been followed by most recent workers, including the New World checklist by Evans (2003). Glasgow (1916) established the current usage of *Phyllophaga*, and that reference should be consulted for details.

Saylor (1942: 159) described the genus *Cnemarachis*, with genotype *Lachnosterna vandinei* Smyth, indicating that it "...includes nearly all the described West Indian species formerly placed in *Phyllophaga*." However, he did not list any of the species, except for the genotype. He characterized the genus thusly: "Either middle or hind tibiae or usually both, of both sexes, with an incomplete carina; lateral margins of the middle and hind tibiae usually with obviously serrate edges or with one to several moderately large to large spines; only rarely do the tibiae lack such carinae or spines or teeth." His other genus *Clemora* was based on the same characters, plus the tarsal claws were cleft (as seen here in several species; e.g., *fossoria*). All of Saylor's generic characteristics have been found on continental species, leading to suppression of both names.

By nearly doubling the number of species from Hispaniola in this paper, we have better established values and variability of characters and their states. We believe they all belong in the genus *Phyllophaga*, with species groups and subgenera of secondary importance. It can be expected that additional species will assist in evaluating genera. As Arrow (1938) stated: "Those who see the advantage of multiplication of generic names may perhaps discover some diagnostic feature by which the retention of one or both these names may be rendered possible. Such attempts seem to me, however, to only be resisting an inevitable process. As more and more species of any group become known, previous apparent gaps in the series necessarily become filled, and the disappearance of many genera is as natural as their erection at an earlier date, when the known species were fewer."

The generic name *Ancylonycha* (Dejean, 1833) was used originally for the 2 earliest Hispaniolan species described: *neglecta* and *hogardi* Blanchard (1850). This name, and its synonym *Holotrichia*

(Hope, 1837), are still used for Old World relatives. However, Saylor (1942: 165) indicated that "...the genus *Ancylonycha* cannot be separated in toto from the continental American genus *Phyllophaga* on other than geographical grounds, though many of the species placed by various authors in the genus *Holotrichia* are at least subgenerically differentiated."

Morón (1997: 229) estimated that there were more than 500 species of *Phyllophaga* in the American continents, of which 250 inhabited Mexico. He earlier (1986) separated these into 8 subgenera and 37 species groups. Various attempts have been made to assign generic names to some of these groups, but often they were based on taxa from a limited geographic area, utilized too few taxa, or emphasized certain variable morphological characters. Because the genus is so large, there will probably be future efforts to divide it into more and more genera. We believe that retention of the genus name *Phyllophaga* for the entire assemblage is the most practical and preferable way to deal with the group. Only a World revision could properly clarify this issue. Cladistical analysis, based on a small portion of the relevant taxa, is futile.

Most previous efforts to assign generic names to various groups have proven untenable or ill advised. Even if cladistics may better show relationships, the creation of many genera would obscure, rather than clarify these relationships. Subgeneric or species group names provide the best way to do this, without the attendant problems with the binomial (including homonymy). A recent paper (Coca-Abia, 2002) attempts to resurrect the old name *Trichesthes* (Erichson, 1847) for a group of species related to the North American *P. tristis* (Fabricius), basing it on a cladistical analysis. Her choice of characters and limited data matrix does little to justify her conclusions, leading Evans (2003) to keep it as a synonym of *Phyllophaga* and stating "...this action was not strongly supported due to the poor taxon sampling within *Phyllophaga* in the analysis." Cladistics may be a great tool to elucidate relationships, but that can still be done with species groups, without affecting the binomial. We believe that genera are subjective, and that using *Phyllophaga* for this entire assemblage places close relatives together and provides less confusion and greater nomenclatural stability.

### Phylogeny and Species Groups

Because this study is primarily a descriptive one, little effort has been made to determine phylogenies or to use cladistics for analysis (see reference above). I recall reading that we don't know any phylogenies,

and we never will (Blackwelder, 1967). Because of the paucity of insect fossils (none for *Phyllophaga*) this axiom is undoubtedly true. However, the search for these relationships can add much to our bank of knowledge in zoogeography, ecology, behavior, and systematics. In that regard, and with time and space restrictions, we have organized below the Hispaniolan species into "groups", based on similarities (and our extensive experience with the genus).

The groups are arbitrarily named on the basis of the older or more common species. We have tried to group them by genitalic type, but the difficulty in homologizing or even describing such complicated structures precludes this. In addition, the results would be different if male or female genitalia were used. There is no character or group of characters that seem to be adequate for clearly defining these groups, and it is not implied that all are natural, although we hope some are. At this stage in our knowledge, they are useful primarily for sorting purposes.

**1. "hogardi" group.** Medium to large (L. 17-30mm), characterized by a large spine at elytral sutural tip, and genitalic parameres fused or nearly so. It includes *hogardi*, *eladio*, *marcano*, *toni*, *permagna*, *romana*, *leptospica*, and *baoruco*; *cano* belongs here but has the elytral spine obsolete.

**2. "garrota" group.** Medium to large (L. 14-22), characterized by exceptionally large male antennal club (with 3+ to 4 lamellae), aedeagus a simple tube generally unmodified, high altitude (to 3000 m), females unknown. It includes *garrota*, *probaporra*, and *costura*. Possibly includes *carnegie* and *dauidsoni* which are somewhat bicolored with different genitalic types.

**3. "mali" group.** Medium to large (L. 15-24 mm), characterized by ferruginous pruinosity, genitalia complicated and relatively large, the aedeagus with lateral and dorsal processes (often pointed) flexible at base. It includes *mali*, *neglecta*, *barrosa*, *haitiensis*, and *rustica*.

**4. "kenscoffi" group.** Large (L. 20-25 mm), brown, bulky, glabrous, shiny (rarely vague pruinosity), no elytral spine, the aedeagus 3 pronged as in the *mali* group. It includes *kenscoffi*, *jimenezi*, and *santachloe*.

**5. "fossoria" group.** Small to medium (L. 8-14 mm), antennal club long, often hairy, tarsal claws cleft, genital parameres with setae on lateral area. It

includes *fossoria*, *nunezi*, *androw*, *aliada*, *approxima* and n. sp. near *fossoria*. On the basis of some characters, *esquinada* belong here also.

**6. "recorta" group.** Medium (L. 17.5-21 mm), light yellow-brown, glabrous, shiny, aedeagus with heavy plates and saw-like projections, the female genitalia with enlarged triangular median plate covering inferior plate base. Includes the sister species *recorta* and *larimar*.

**7. "imprima" group.** Small to medium (L. 8-12 mm, first 4 spp.; 13.5-16 mm, last 2), mostly pruinose, glabrous, pygidium shiny in center and pruinose at sides (Fig. 374-375). It includes *imprima*, *cartaba*, *latiungula*, *panicula*, *mella* and *espina*. The latter 2 are larger and with peculiar aedeagus, but their habitus is similar to others of the *imprima* group.

**8. "audanti" group.** Small (L. 8-13 mm), brown, shiny, non-pruinose, strongly punctate, genital capsule short, tarsal claws with minimal notch (space) between median tooth and base. It includes *audanti*, *pedernales*, and *aceitillar*.

**9. "jaragua" group.** Medium (L. 16-18 mm), light brown, head, pronotum and parts of elytra shiny, elytra lightly pruinose. It includes *jaragua* and *alcoa* whose habitus' are similar (Fig. 86, 63), but the genitalia are of drastically different types (Fig. 384-385, 124-131).

There are 6 remaining species that appear to be so distinct that they do not fit into the above groups, and we prefer not to assign group names to them at this time. They are *bonfils*, *minutissima*, *ortizi*, *pseudocalcaris*, *rawlinsi*, and *rex*.

### Zoogeography

The present distribution of Hispaniolan *Phyllophaga* is the result of many past geological events. Because all 48 known species (and there are probably more) are found nowhere else (precinctive, endemic), their origins and dispersal routes should provide important clues for the entire Caribbean. By their similarities and occurrence on opposite sides of the Enriquillo basin (Cul-de-Sac), many of these are "sister species", and appear to reflect the "north and south island" concept (see Schwartz, 1980, 1989). Based on our current knowledge, 15 species are restricted to the "south island", with 23 species restricted to the "north". The most common lowland species are more widespread (including *hogardi* and *mali*). How each

of the species got there, and determining their nearest relatives elsewhere, would be worthy of a much more extensive treatment than can be afforded here. The following remarks are made as only a brief introduction.

Except for *Phyllophaga*, there is probably no other group of insects that has so many species unique to a single island, but which reflects the geology so well. Recent studies (Liebherr, 1988; Donnelly, 1988, 1989; Woods, 1989) shed some light on the zoogeography of the area, but deal primarily with the entire Caribbean. Sourakov (1996, 1999) studied the butterfly genus *Calisto*, which is primarily Hispaniolan, finding "sister species" on each paleo island. He indicated that the 56 taxa in the West Indies (Satyridae: Satyrinae: Pronophilini) are related to other tribal members from the high Andes of South America.

There are no known fossils of *Phyllophaga* from the Caribbean, although an exceptional record of other scarab beetles and other insects occurs in Dominican amber (Pérez-Gelabert, 1999; Poinar and Poinar, 1999; Woodruff, unpub.). These deposits are considered Miocene in age. The discovery of the relictual beetle family Brachypsectridae in Dominican amber was exciting, but it was exceeded by the recent discovery of a living new species at Cabo Rojo (south island) (Woodruff, 2004). Of greater antiquity, fossil trees have been discovered in the volcanic Larimar deposit (Woodruff, 1986; unpub.; Woodruff and Fritsch, 1989) which is considered Cretaceous (De León, 1989). Four of the new species described herein are from that site, which suggests their possible age and origin.

This volcanic deposit in the Dominican Republic may be contemporaneous with the origin of the microtektites and shocked quartz found nearby in Haiti (Hildebrand and Boynton, 1991). Those are believed to be additional evidence for a giant meteorite (Chicxulub site) which hit off Yucatan, apparently ending the Cretaceous (about 65 million years ago). Donnelly (1988) indicated that the Greater Antilles started emerging 105 million years ago, with a rapid increase in size about 80 million years ago. Their exact size and position during subsequent geological periods has been the subject of considerable debate. However, most agree that the Caribbean plate has moved many times and the individual islands occupied different positions from today.

Perfit and Williams (1989: 102, Fig. 6) showed one scenario, which includes 3 "Hispaniola" islands in the mid-Eocene, but only 2 by the late Miocene-Pliocene. The "south island" presumably maintained its identi-

ty until the Pleistocene, when it made contact with the "north island". The subduction of the plate of the "south island" was responsible (along with lowering sea level) for forming the Enriquillo basin, and trapping the salt lake Enriquillo (now 40 meters below sea level). How the current population of crocodiles became trapped here is open to speculation.

There are two basic theories used to explain current geographic distributions, in relation to past geological events. They are **vicariance**, believed to be the transfer of continental faunas as units from mainland to islands, and **dispersal**, which implies movement of taxa in this case over water gaps. These theories are not necessarily mutually exclusive, and we believe both may have been involved with *Phyllophaga*. We believe that the strongest evidence for vicariance is the occurrence of several "sister species" on the 2 "islands". If we agree that the 2 have been contiguous since the Pleistocene, we would not expect these distribution patterns to be so rigid, unless the species were distinct already. Most of the "sister species" occur in the mountains, often above 2500 ft. Even though the Enriquillo basin is only a relatively narrow barrier, there seems to be almost no crossing over. Dispersal seems not to have taken place, except for species occupying lowland and coastal areas.

The species of the lowlands are more widely distributed, adapt to varying soils and climate, occur in large numbers, and seem to show a few relationships (similarities) to species of other islands. That is what would be expected for potential dispersal species. For example, *mali* is widespread, common at sea level and at 3300 ft, and similar to several Puerto Rican species. It also has "sister species" (possibly *haitiensis*, *rustica*, and *barrosa*) which are rare and localized. One of the unique small species (*pseudocalcaris*) occurs only on the north coast, often by the thousands, and is similar in habitus to a Cuban species group ("*suturalis*"). We believe that these may be examples of species which employed dispersal methods to arrive in Hispaniola. Agriculture and other human activities also undoubtedly play a role in moving soil, plants, and insects. This is most likely with the common species associated with sugarcane.

However, most of the entire Hispaniolan fauna of 48 species appears to have evolved on the "north or south" islands, and maintained their identity since contact. Thus, their present distributions are the result of vicariance events from possibly a Central American source. Almost every island in the Caribbean has a completely endemic fauna of *Phyllophaga*, another important reason for their continued study. Morón (1997: 229) estimated there were over 500

species of *Phyllophaga*, with 250 species in Mexico, and more than 100 in the U.S. In Florida there are 54, with 2 adventive from Cuba and the Bahamas (Woodruff and Beck, 1989). Cuba probably has more species (perhaps 75) than Hispaniola, partially the result of greater land area, and Puerto Rico has fewer. However, we believe that there may be nearly 200 species in the Antilles. Because relatively few species have reached South America (and mostly in the north), the group appears to have had its origin in Mexico or Central America.

Other insect groups have perhaps had different means of moving into the Caribbean. Howden (1996: 1514) suggested that, in the burrowing scarab genus *Neothyreus*, there were 3 fairly lengthy over-water dispersals: 1) over the Panamanian water gap in the Miocene; 2) over the Bahama Passage in the Pleistocene; and 3) over water in the Pleistocene to Grenada and St. Vincent from Tobago or Trinidad. Matthews (1966) studied the dung beetles of the Caribbean and concluded that "...this fauna is a greatly reduced sample of the North or Central American fauna of the distant past, perhaps of the Miocene or Pliocene, just after the establishment of the Panamanian 'bridge', when invasion by South American elements was just beginning....the unquestionably high degree of endemicity of the Greater Antillean scarabaeine fauna is a reflection, not of special insular evolution, but of the continued survival of an ancient fauna for which these islands have become a refuge. This survival would not have been possible if the Scarabaeinae were capable of rapid over water dispersal..." A thorough analysis of our distribution data (not possible here) would be a worthwhile endeavor to assist in understanding the zoogeography of this important part of the Caribbean.

A recent website (see below) has an excellent resumé of the geology, and I briefly paraphrase portions here: Hispaniola was formed 10 million years ago, when 2 "paleo-islands" collided. The southern island originated as a part of Pangaea near the present Yucatan peninsula, and moved along the fault line between the Caribbean and North American plate. The collision created 2 mountain ranges over 2000 m high with a marine channel between. During glaciation water level dropped, and about 18,000 years ago sea level was 100 m below current levels. During glacier melting sea level rose again and about 6,000 years ago it had filled the valley, including the Neiba Valley, and forming a bay 85 km long and 15 km wide. It existed for nearly 1,200 years, until the Rio Yaque del Sur deposited sufficient mountain silt, closing the mouth of the bay and creating a

landlocked salt lake. Eventually the river's flushing converted it to fresh water. Dolphins and manatee historically inhabited the lake which was about 15 m above sea level when Columbus arrived 500 years ago. Lago Enriquillo's surface dropped 60 meters to 45 m below sea level in less than half a millenium. Its salinity rose from 36 ppt (1983) to 110 ppt (2003) and decreased in size from 280 km<sup>2</sup> (1968) to 160 km<sup>2</sup> (2004). [[http://www.globalnature.org/docs/01\\_vorlage\\_news\\_neu.asp?id=11093&domid=1011&sp=E&addlastid=&m1=11089&m2=11093](http://www.globalnature.org/docs/01_vorlage_news_neu.asp?id=11093&domid=1011&sp=E&addlastid=&m1=11089&m2=11093)]

### Behavior and Sex

Most adult *Phyllophaga* are nocturnal, emerge in early evening, fly to host trees where they feed and mate during the night, returning to cover during early morning hours. In Hispaniola there is at least 1 (and maybe more) exception. Prof. Eugenio Marcano collected a good series of *garrota* at La Pirámide, "capturado en el dia en vuelo 12-3 p.m.", at over 2200 meters elevation. Other specimens have been taken in Malaise traps at high altitudes (although time of day not recorded), some perhaps collected in daytime. We believe that the "*garrota* group" (including *probaporra* and *costura*) may all be diurnal. They are known only from males, with enlarged antennal lamellae containing obvious receptors (Fig. 10-12), and from high altitudes. In these cases we believe females may be flightless, the males being adapted to locate them during the warmer daylight hours (where night temperatures make flight difficult). Under normal warmer conditions, the sexes congregate together on host trees, facilitating mate location. The noticeable receptors on the antennae of other species may also reflect a more diurnal activity period. Most have been rarely collected.

Because of the often bizarre and varied modifications of the genitalia, taxonomists are able to distinguish closely related species (for which we are thankful). However, little information is available on how these parts actually fit together and function. One of the most intriguing aspects of their behavior involves the mating process itself. Unfortunately, few original observations were made during this study, and we can touch only briefly on it here. We were extremely fortunate to retrieve a feeding female (*mella*) which was carrying the male genital capsule attached to her (the unfortunate male may have been eaten by a predator). The relationships of the genitalia can be seen readily (Fig. 495-500), and it does not involve the male parameres (only the aedeagus). At least in this

case, the old theory of “lock and key” mechanism (Shapiro and Porter, 1989) does not seem to apply. However, it may be exceptional, because the female of this species has a unique moveable process (“ice-tongs”) which appears to have held the male organ in place. The elaborate parameres may be merely “can-openers”, as my colleague Paul Skelley coined them. They may function in eliciting cooperation of the female, but the aedeagus may be the only part inserted between the simplified female genital plates. Some of these are flexible and not fused, while others are rigid, fused, and heavily sclerotized. Their form would dictate or permit the inclusion/exclusion of specific male parts, but not likely the parameres.

As mentioned earlier, Smith (1889) was the first to use these structures for identification in *Phyllophaga*. The use of genitalia for taxonomic studies in Coleoptera was reviewed by Nichols (1986). Woodruff and Beck (1989) illustrated the genitalia of the 54 Florida species with over 400 SEM photographs. But, the exact nature of the mating behavior is relatively unknown and begs for additional studies. Eberhard (1987, 1990, et seq.) has suggested that female choice may be far more relevant than the elaborate male organ (see our new species *rex*, Fig. 667). Could it be that the cleft claws of some species may be an adaptation for holding on to hairs during copulation? We have many more questions than answers.

### Host Plants

Adult *Phyllophaga* feed on foliage of both broad leaved trees and conifers. Since most specimens have been collected at lights or in light traps, little information is available on actual feeding hosts. We have no specific Hispaniolan records of feeding on conifers, but we suspect that many of the higher altitude species (e.g., *aceitillar*, *alcoa*, *androw*, *carnegie*, *davidsoni*, *rex*) feed on pine or *Podocarpus* which are more common there. Those that feed on broad leaved trees are rarely host specific, but often prefer certain tree species and these may be favorites for several Scarabaeidae (pers. observ.). An example is the genus *Inga* which is a good host throughout the Caribbean and Central America. In the DR, *Rutela dorcyi* (Olivier) and one of our new species (*santachloe*) were more common on this host; the latter rarely found on citrus nearby.

Other recorded hosts for Hispaniolan species are listed here under each species: *aliada* [*Miconia azuensis* Urb. and Ekman (*assuaensis* on label) and *Tetrazygia* sp.]; *approxima* [*Trema lamarkianum* (Schult.) Blume; and *Spondias cytherea* Sonn. (*dulcis*

on label)]; *jimenezi* [*Byrsonima* (*Brysonia* on label) *crassifolia* (L.) HBK; *Cupania glabra* Sw., *Echites umbellata* Jacq., *Miconia rubiginosa* (Bonpl.) DC; *Psidium guajava* L. (*guayava* on label)]. In addition they are periodic pests on the foliage of the following commercial crops: citrus, coffee, cacao, sugarcane, tobacco, mango, papaya, flamboyant and many other ornamental and nursery trees. Significant data on host plants and possible specificity would be an excellent project for a collaborative effort between local botanists and entomologists. We had little opportunity to properly collect botanical samples for later identification.

Larval hosts are probably not specific, except roots of certain grasses (especially pastures, lawns, and golf courses) seem to be preferred. They appear to be able to subsist, in some cases at least, on rich organic contents of the soil without roots being present. They are not common in rocky or sandy soils, but prefer rich organic or lateritic soils. They do attack almost any kind of root crop on occasion, especially sugarcane, citrus, pigeon pea, cassava, sweet potato, cocoa, coffee, strawberry, pineapple, bean, groundnut, and tobacco.

### Immatures (Fig. 115-118)

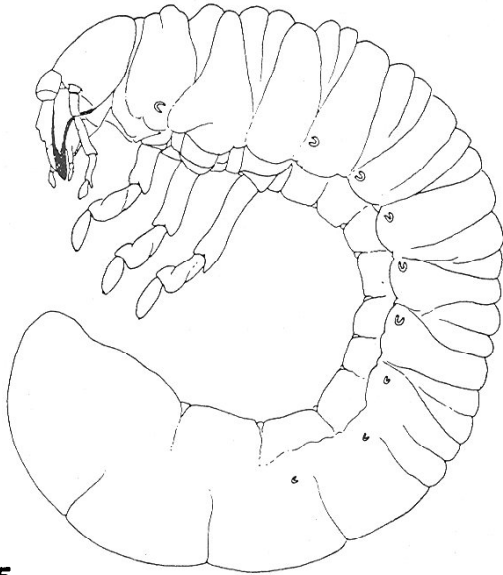
Basically there have been no studies on larvae or pupae of Hispaniolan *Phyllophaga*, even though the grubs (gusanos blancos, majocá, or gallina ciega) are the most damaging stage. Good taxonomic characters are present on the mouthparts and last ventral abdominal segment, and the larvae are relatively easy to rear. We have no knowledge of the length of life cycle, but most may be annual (occasionally 2 to 4 years in colder continental areas). References on larvae of continental species include Ritcher (1966), Böving (1942b), Cherry (1984, 1985), King (1984), Morón (1993), Sosa (1984), and Woodruff and Beck (1989). We have illustrated here the characters of a Cuban species introduced into Florida (Fig. 115-118). It is in the same subgenus (*Cnemarachis*) and should assist in learning the nomenclature for larvae found in Hispaniola.

The only papers dealing with larvae of Caribbean species are Böving (1942a), from Guadeloupe (Gruner, 1969, et seq.), and Puerto Rico (Wolcott, 1948). Undoubtedly Wolcott reared several Haitian species during his studies of biological control agents, but these were never published. As a consequence, we have no larvae correctly associated with any of the 48 Hispaniolan species. Because they are of great economic importance to commercial crops, a special

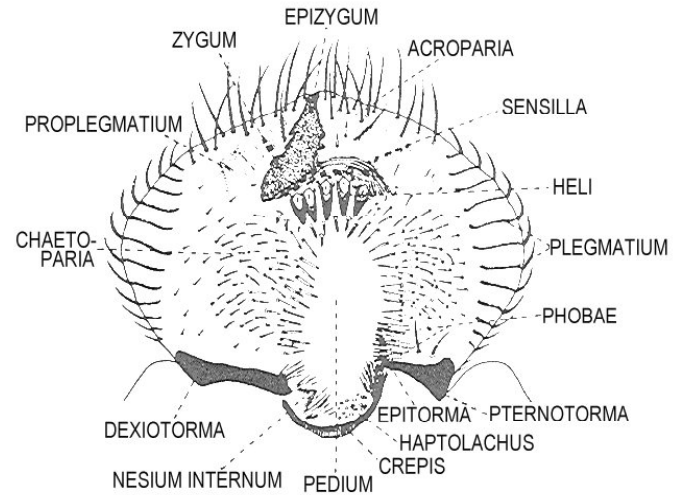


## Larval Morphological Characters of *Phyllophaga bruneri* Chapin

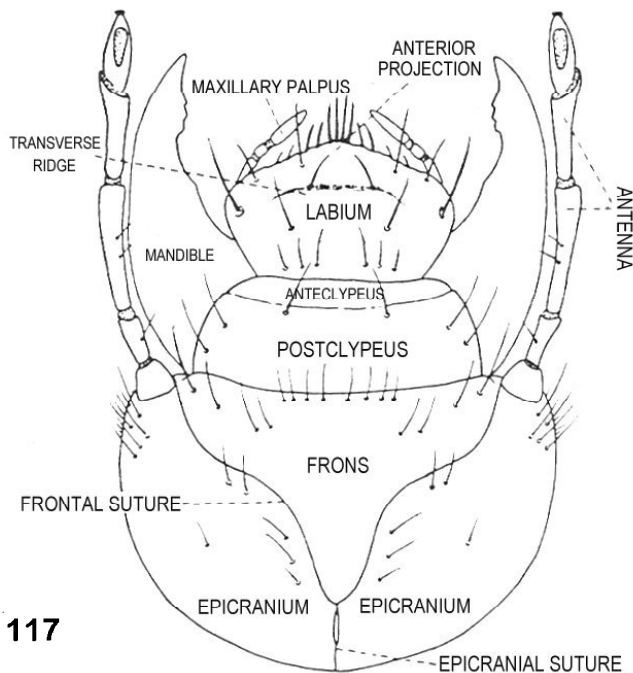
(A Cuban species in the subgenus *Cnemarachis* is illustrated for lack of Hispaniolan material)



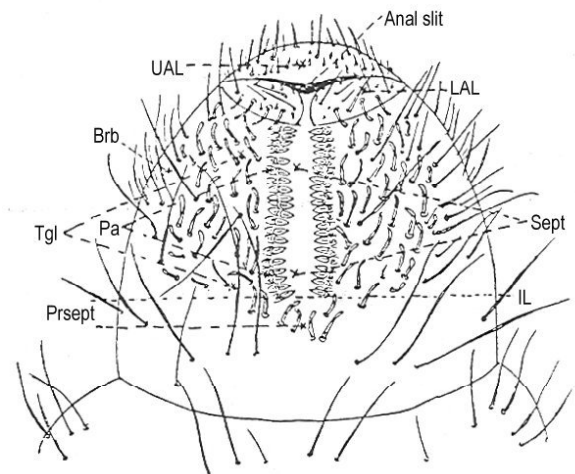
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118

Fig. 115-118. Larval morphological characters. 115) Typical larva, 3<sup>rd</sup> instar; 116) Epipharynx (upper lip), 3<sup>rd</sup> instar; 117) Head of 3<sup>rd</sup> instar larva; parts labeled; 118) Diagrammatic ventral 10<sup>th</sup> abdominal segment with raster: brb=barbula, LAL=lower anal lip, Pa=palidium, Prsept=preseptular setae, Sept=septula, Tgl=tegillum, UVA=upper anal lip. (After Böving, 1942).

effort should be made to study these larvae. Correct identification to species is absolutely essential in any control program, be it chemical or biological.

Böving (1942a: 170) indicated that he had seen larvae of *Cnemerachis neglecta* (Blanchard) from Santa Rita, Puerto Rico, but stated that it "...is so similar to that of *C. vandinei* (Smyth) that I have been unable to separate them." Since *neglecta* appears to be endemic to Hispaniola, and I have been unable to find any other reference to its occurrence in Puerto Rico, I believe these represent misidentifications. He mentions no other Hispaniolan larval specimens.

#### Species Treatments (alphabetically)

##### *Phyllophaga aceitillar* Woodruff, **new species** (Fig. 119-123)

**Holotype male.** DOMINICAN REPUBLIC: Prov. Pedernales, Sierra de Baoruco, Aceitillar, 23.6km. NE Pedernales, 18-09-23N, 71-34-09W, 1560M, 14 June 2003, C. Young, J. Rawlins, C Nuñez, R. Davidson, P. Acevedo, M de la Cruz, open pine forest with grassland, UV light, Sample 42112, Carnegie Museum Specimen Number CMNH -309-197 [CMNH].

**General description** (Fig. 62, habitus): Medium sized (L. 13 mm, W. 6 mm), shiny, uniformly chestnut brown, somewhat convex, nearly glabrous dorsally, except inconspicuous, fine, golden setae on elytral surface and margin, and margins of pronotum. Male genitalia simple, parameres similar to those of other related species, but with U- or V-shaped aedeagal tip (caudally) distinctive (Fig. 122-123).

**Head.** Clypeus emarginate, anterior angles rounded, strongly reflexed; posterior angles slightly convergent; venter with long, golden, curved setae; surface densely punctate, many punctures coalescing, especially medially. Eye canthus with 11 long, straight setae (about length of those on clypeal venter). Frontal suture deeply impressed, forming wavy line. Frons longer than clypeus, punctures more distinct than on clypeus, slightly depressed medially where punctures denser and coalescent, remainder separated by 1 to 2 diameters, but denser at junction of clypeus and eye canthus. **Antenna** 9-segmented, club 3-segmented, club as long as 5 preceding antennomeres, 6 very small, barely produced before club, 3 and 4 more elongate than others. Club yellowish, matte, with micro-receptors apparently evenly distributed.

**Pronotum.** Somewhat convex, shiny, lateral angles prominent, front angles barely produced, posterior angles not produced. Lateral margin slightly crenulate near anterior angle, from which arise numerous long, curved, golden setae (about length of those in eye canthus), extending also along entire posterior margin. Surface noticeably punctate with shallow, fine, scattered (most separated by 3-5 diameters), punctures slightly denser near anterior pronotal angles.

**Scutellum.** Shiny as elytra, densely punctate in more than one row, arranged in V-shaped pattern on lateral thirds, leaving another V-shaped impunctate area centrally. Otherwise unremarkable.

**Elytra.** Appearing shiny, glabrous, but with fine, short, golden setae arranged in irregular lines, plus a few more in humeral area, and some on elytral margin. Punctures noticeable, but fine and sparse; single row (somewhat darker) linearly arranged, defining a sutural costa, which is more convex, but depressed toward suture. Elytral tip regular, not produced or spine-like.

**Pygidium.** Triangular, broader at base, apex truncate, glabrous, except normal apical marginal fringe of golden setae; slightly convex, shiny, punctures shallower but about same density as elytra. Marginal carina extending entire circumference. No noticeable pruinose areas on surface or surrounding.

**Legs.** Relatively long, especially tarsi, all claws with sharp tooth at tip, middle tooth reduced, not cleft. Anterior tibia tridentate, lower tooth about equally developed; spur narrow, long, acuminate, sharp. Anterior tarsal claw with middle tooth behind center, short, broad, pointed to middle; base of claw broad, forming narrow notch before central tooth. Protarsal segments not as long as those on metatarsus; segments 2-3-4 subequal in length.

Meso- and metatibia with longitudinal carina and spinose notches on inner and outer surfaces at incomplete transverse carina. Metatibial spurs long, nearly straight, narrow, sharp; inner spur about 1.5X longer and outer spur shorter than first tarsal segment; both flattened on inner face and slightly concave. Metatibial apical spinule composed of 12 fine spines. Mesotarsal segments 1-2-3 about equal, 4<sup>th</sup> shorter. Metatarsal segments 2-3-4 gradually shorter; 2 unusually long, nearly double length of 4, 5 subequal to 3.

**Abdomen.** Ventrally, color nearly as in dorsum. Ultimate sternite transversely grooved, slightly de-

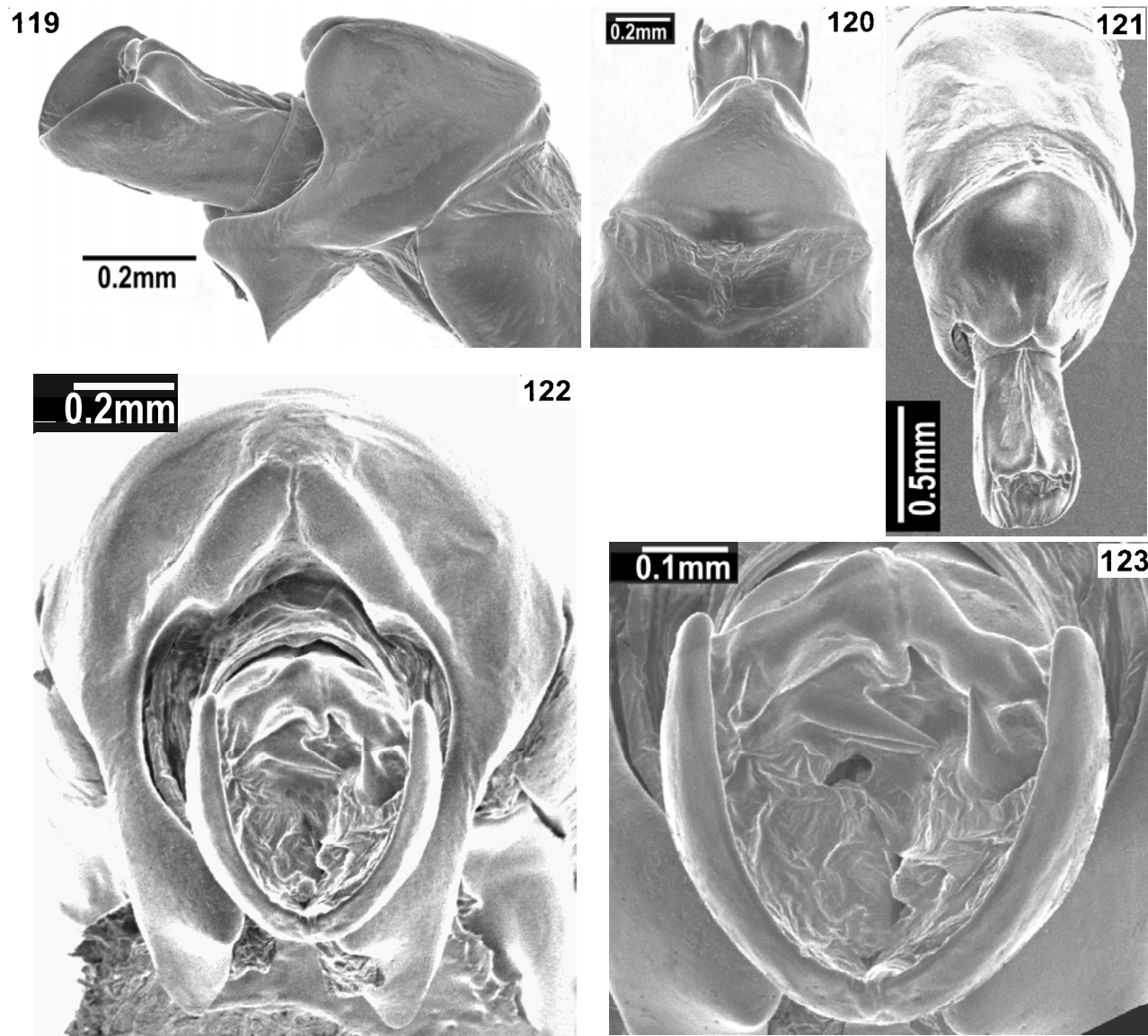


Fig. 119-123. *Phyllophaga aceitillar* Woodruff. Male genitalia: 119) lateral; 120) dorsal; 121) dorso/caudal; 122) caudal; 123) aedeagal tip, caudal.

pressed medially; about 10 long setae on each side, arranged in a line parallel to apical margin. Abdomen appearing nearly glabrous, although few fine setae scattered on most segments laterally. Punctate as in pygidium. Lateral pruinose patch (which occurs in many species) on penultimate sternite weakly defined, accompanied by a few long setae.

**Genitalia** (Fig. 119-123). Of simplified type, with aedeagus heavily sclerotized, but not greatly modified. Parameres of the *imprima* type, projecting sharply backwards in pointed tip (lateral); broader than many in this group; upper part hood-like, narrowed centrally and emarginate, but without large bulbous projec-

tions beneath (as in the similar *davidsoni*). Aedeagus caudally with U-shape, top weakly sclerotized; 2 large, broad, dark colored hooks recessed deep inside. **Female.** Unknown.

**Specimens examined.** Holotype and 23 paratypes (all DOMINICAN REPUBLIC): ( 21) same data as holotype; (1) Prov. Pedernales, 37 km N. Cabo Rojo, 18-09N, 71-35W, 11-VII-1987, R.H. Davidson, J. Rawlins, 1560 m; (1) same, but 25-IX-1991, Rawlins, Davidson, Young, Thompson, grassland with pine. Paratypes deposited in CMNH, FSCA, MHND.

**Ecology.** Apparently a high altitude species; most were collected at 1560 m elevation. I collected none at many stations below this. Labels indicate that most were taken at UV light (sample 42112), but 5 were collected in Malaise traps (sample 42182). Vegetation at this locality is primarily pine and open grassland (“acetillo”), as labels indicate. Specimens were taken in June (22), July (1), and September (1). The absence of females, coupled with the noticeable receptors on the male antennae, suggests that females may be flightless.

The area near the type locality was heavily mined for Bauxite for many years (none recent) and open scars of the operation still have little vegetation. The soil is bright red with sentinel pillars of limestone which were left standing after loose Bauxite was removed. Although a part of Parque Nacional Jaragua, this area and most of the lower parts of this road (where many interesting and endemic insects have been collected in the past) are being heavily invaded by Haitian and Dominican squatters, resulting in much of the land being cleared for crops. It is an extremely important habitat that requires immediate attention of conservationists.

**Comparisons:** The closest relative would seem to be *davidsoni* (compare genitalia Fig. 119 vs 255). It is exceptionally shiny, but somewhat similar to the smaller *pedernales* (genitalia Fig. 584) which occurs along the same road at slightly lower elevations down to sea level at Cabo Rojo.

**Etymology:** The name *aceitillar* is from the type locality with the same name. Aceitillar is located on the road north of Cabo Rojo (constructed by Alcoa for Bauxite mining) from about kilometer 33 to 37 north of Cabo Rojo. The labels for most of the type series give the longitude/latitude as 18-09-23N, 71-34-09W, and 23.6 km NE of Pedernales at 1560 m elevation. Two additional older specimens bear the label 37km N. of Cabo Rojo, 18-19N, 71-35W. They probably represent the same locality, with less precise measuring equipment. At present it is about as far as one can drive, because the road is impassable to Las Abejas at higher elevation. My notes from collecting near this locality indicate km 33 at 4200 ft is in the Parque Nacional Jaragua, by a ranger station near the road.

My good friend José Marcano has provided the following information: The locality is apparently named for a common grass called “acetillo”; *aceitillar*= the place where *acetillo* grows. It is also called “acetilla, espartillo, and maicote (Creole)” and is *Andropogon*

*gracilis* var. *firmior* Hitch. It is native to the West Indies and Florida.

*Phyllophaga alcoa* Woodruff, **new species**  
(Fig. 63, 124-135)

**Holotype male.** DOMINICAN REPUBLIC: Prov. Pedernales, 17 km N. Cabo Rojo, 255 m, 18-04N, 71-38W, 21-X-1991, R. Davidson, C. Young, S. Thompson, J. Rawlins, dry deciduous forest, CMNH Specimen Number 305,459 [CMNH].

**General description** (Habitus, Fig. 63). Medium sized (L. 18, W. 8 mm), tan, head and pronotum shiny, elytra pruinose, except for shiny humeral angles (appearing rubbed). Male and female genitalia of unique type (Fig. 124-135).

**Head.** Clypeus glabrous, shiny, emarginate, margin reflexed, densely punctate medially, with 2 small, bare, diagonal areas but otherwise punctures less than their diameter apart; posterior angles rounded, barely constricted at frontal suture; frons twice length of clypeus, frontal suture slightly curved but not emarginate medially, noticeably impressed, frons punctures less dense than clypeus, some coalescing, often separated by their diameter; posterior band lightly punctate on posterior, with impunctate band in front of them. **Antenna** 9-segmented, club 3-segmented; antennomere 3 longer and narrower than 4, 5, or 6; club ovate, length equal to previous 5 antennomeres, no noticeable receptors at 20X, club yellowish.

**Pronotum.** Surface glabrous, except lateral margins with long, curved, golden setae, which continue partially around posterior margin, but becoming smaller toward center; punctures larger but less dense than clypeus and frons, often separated by 2 to 3 diameters; lateral pronotal margin slightly crenulate, pronotum widest near middle at lateral angle; anterior angles obtuse, posterior angles rounded, surface shiny, dark chocolate brown.

**Scutellum.** Impunctate in center with 8-9 punctures on each side similar to pronotum, posterior slightly depressed.

**Elytra.** Surface pruinose except for V-shaped shiny area on basal third, behind scutellum and humeral angles; pruinosity appearing dull, although iridescent in lateral view; punctation shallower than pronotum, separated 2-3 diameters, no setaceous punc-

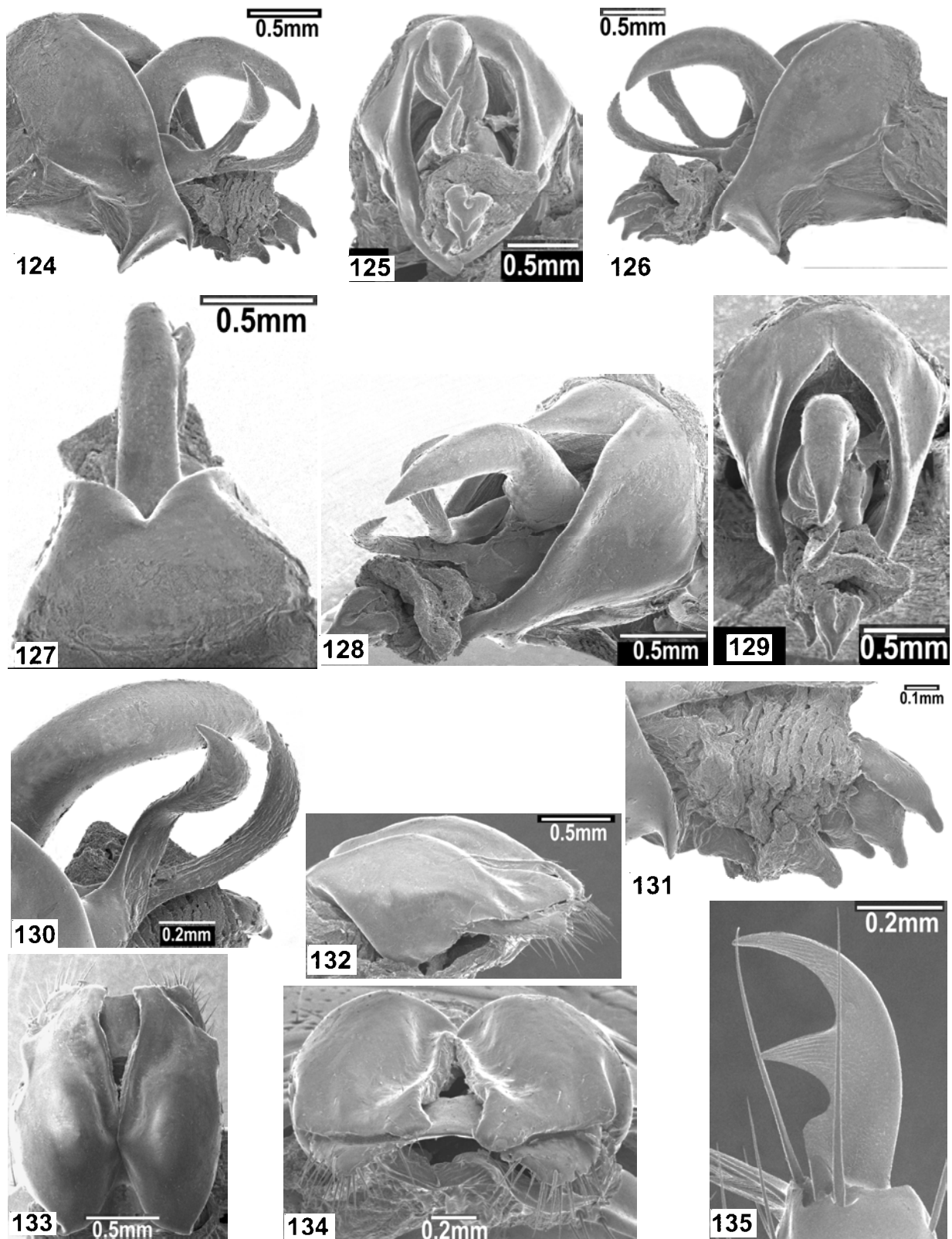


Fig. 124-135. *Phyllophaga alcoa* Woodruff. 124-131 Male genitalia: 124) left lateral; 125) caudo/ventral; 126) right lateral; 127) dorsal; 128) caudo/lateral; 129) caudo/dorsal; 130) aedeagal tip; 131) papillose area of lower aedeagal tip; 132-134 female genitalia: 132) lateral; 133) ventral; 134) caudal; 135) protarsal claw, female.

tures; elytral margin barely raised, suture well defined by weakly convex costae with a few scattered punctures. Elytra terminating in obtuse angle with no spine.

**Legs.** Protibiae tridentate, spur sharply pointed, and barely reaching base of first tarsal segment, protarsal segments 1-4 subequal in length, fifth 1.5X longer than previous segments. Protarsal claws with middle tooth central, triangular, acute, but not sharply pointed, terminal tooth sickle-shaped (Fig. 135, female). Mesotibia with longitudinal carina well developed; transverse carina incomplete, marked by 2 sets of large spines forming outside, and a large spine opposite 2 middle spines, but on inside. Mesotibial spurs elongate and sharp pointed, narrow and acuminate; inner spur 3/4 length of outer. Mesotarsal segments similar to anterior ones. Metatibial apical spurs similar to mesotibia, long spur broader, inner surface noticeably concave, shorter spur 2/3 length, narrower; neither sharp pointed as on mesotibia; apical fringe of 27 spines (more than most species). Metatarsal segments 1-4 becoming gradually shorter, fifth 1/4 longer than 4, tarsal claws with teeth similar to protarsi, except central tooth somewhat sharper pointed.

**Pygidium.** Surface pruinose as elytra, punctures scattered, surface glabrous except for terminal fringe.

**Abdomen.** Venter with setae on each segment, but scattered, more numerous laterally in slightly pruinose patch on penultimate sternite; ultimate sternite with slight longitudinal depression in middle.

**Male genitalia** (Fig. 124-13). Asymmetrical, parameres broadly truncate at bottom, with slight tooth at anterior tip. Aedeagus with a large, curved, dorsal hook, and 2 lateral "parameres" projecting upward, covered with microsetae (Fig. 130); left one with angular curve, noticeably different from right smooth curved one (appearing as if they may be capable of twisting together). Tip of aedeagus below with a group of 4 papillose projections (Fig. 131), unique within the genus. In dorsal view, phallobase notched, angle somewhat acute.

**Allotype female.** Data same as holotype, except CMNH Specimen number 308,120 [CMNH]. Nearly identical to male, except frons somewhat more densely punctate medially, pronotum more shining, surface of elytra similar to male, non-pruinose areas somewhat more extensive and including posterior

tumulosity; terminal sternite without central depression and slightly more convex. Metatibial apical inner spur somewhat more spatulate-shaped, broader near tip than base; apical fringe of 33 spines (27 in holotype). **Female genitalia** distinctive (Fig. 132-134), elongate, inferior plates joined in center, ventrally convex, terminus projecting into a truncate lobe. Superior plates extending beyond inferior plates, center (viewed ventrally) with smooth arc to obtuse angulate tips containing 16-18 setae.

**Specimens examined:** Only the holotype and allotype are known. Several collectors, including myself, have collected near the type locality, but no other specimens have been found.

**Ecology.** The type locality is on the road from Cabo Rojo north to Aceitillar and Las Abejas, which is well marked with kilometer posts and which provides easy access for collectors. There is little legal habitation along this road. It is sometimes referred to as the "Mercedes" road, although that is the only town, a short distance to the west, accessed at about km 21 (1200 ft). The road was constructed by Alcoa (Aluminum Company of America; for whom this species named), to access bauxite mining areas higher up. The entire area along the road is rapidly being modified with illegal clearing by squatters (both Haitian and Dominican), even though it is a part of the Parque Nacional Jaragua.

The habitat at kilometer 17 is labeled as "dry deciduous forest" at an altitude of 255 meters. Habitats below this are much drier and desert-like; above gradually elevated through moist tropical forest to pure pine forest. *P. alcoa* appears to occupy a narrow habitat or a specific adult host tree, since only a single pair has been collected. The same area is inhabited by a huge land iguana (*Cyclura*), as well as the endemic mammal *Solenodon*.

The area along this road, transecting most habitats from sea level to 5000 feet, is of great endemism, and a special effort should be made to protect its interesting fauna and flora for future generations. One of 5 new species which are endemic to the "South Island", *alcoa* (including *davidsoni*, *jaragua*, *pedernales*, and *aceitillar*) is known only from this small portion of the Baoruco Mountains.

**Comparisons.** Superficially *alcoa* is similar to *jaragua* in its coloration and the extent of glabrous and shiny areas (on a pruinose base) on the pronotum and elytra. It is slightly larger (L. 18 vs. 15 mm), has less swollen elytra posteriorly; but few specimens are

known. The 2 appear to be "sister species" by external characters, but the male and female genitalia are drastically different (compare Fig. 124-134 vs. 384-389). The female of *alcoa* has 16-18 setae on each projection of the superior plates, whereas *jaragua* has only 8. Although data are lacking on altitudes, *jaragua* appears to be a species of lower elevations.

**Etymology.** I take great pleasure in naming this species for Alcoa (Aluminum Company of America), who not only built the road which accesses the type locality and other collecting sites, but has graciously provided accommodations and assistance for an untold number of naturalists over nearly half a century. The staff of Alcoa and Ideal Dominicana (their successor), from managers, engineers, and guards to the "empleadas", have always been extremely courteous and helpful in many ways. I personally wish to thank the two companies and Ramon Cáceres who made most of our collecting possible, as well as Rafael Reyes and Hans Leiter (our residence hosts).

*Phyllophaga aliada* Sanderson  
(Fig. 64, 136-148)

*Phyllophaga aliada* Sanderson (1951: 279-280; fig. 59).

**Holotype** (examined). Female [MCZC type 30517, examined]: Mt. Basil, N. Haiti, to [struck out] 4700 ft, Sept. 9, 1934, [P.J.] Darlington. Because the male was previously unrecognized, the allotype male is described below.

**Allotype male** (here designated). DOMINICAN REPUBLIC: Prov. La Vega, La Ciénega de Manabao, Parque Nacional Armando Bermudez, headquarters, 3000 ft, R.E. Woodruff, 3-5-VII-1999, night on *Tetrazygia* sp. [FSCA].

**General description, male allotype.** Medium sized (L. 14, W. 6 mm), similar to female, but narrower, subparallel, posterior tibial spurs longer and less flattened. All claws cleft. Antennal club much larger, nearly as long as width of clypeus and longer than previous 5 antennomeres. Color generally light yellow, but not translucent (compared to *approxima* n. sp.), head and pronotum more reddish-brown. Dorsum appearing dull, matte, but iridescent in diagonal lighting. Genitalia distinctive (Fig. 136-140), similar to *approxima* (see description below).

**Head** (Fig. 144, female). Color orange-brown, slightly darker than elytra. Clypeus emarginate, anteriorly rounded, posterior angles diverging, until sharp angle to frontal suture, clypeal margin reflexed, surface evenly punctured, punctures about a diameter apart, frontal suture deeply impressed, emarginate in the middle. Frons less densely punctured than clypeus, punctures larger, separated mostly by 2 diameters, posterior band impunctate except near the lateral base, center of both frons and clypeus somewhat depressed longitudinally, that weak depression continuing on pronotum. **Antenna** orange, 9-segmented, club 3-segmented, elongate, longer than previous 5 antennomeres, 3 and 4 cylindrical and subequal, division weakly marked (Fig. 146), club with noticeable receptors (in both sexes) (Fig. 147).

**Pronotum.** Anterior pronotal margin wide and impunctate, anterior angles slightly obtuse, posterior angles smoothly rounded, sides slightly convergent from near middle to basal angles, base wider than apex, few long setae on lateral margin, not continuing to the posterior margin, punctation denser in spots but less so in central third, denser at anterior angles.

**Scutellum.** Punctate in a V-shaped pattern, with approximately 3 rows on each side with a V-shaped smooth area in middle anteriorly.

**Elytra.** Surface slightly pruinose, appearing dull, mostly coppery-orange, darker at apical declivity below tumosity and extending short distance up suture. Lateral marginal setae few and not obvious; elytra with few scattered setae only, punctation fairly uniform, except sutural striae which have few scattered punctures. Elytral suture without terminal spine. Elytral margin barely raised laterally.

**Pygidium.** Convex, shining, glabrous except for terminal fringe, irregularly punctate, some punctures coalescing to form longitudinal rugosities, apex slightly truncate.

**Legs.** Protibia tridentate, basal tooth fairly developed, middle tooth somewhat rounded but nearer proximal than basal, spur reaching beyond base of first tarsal segment. First protarsal segment shortest, next 3 subequal, fifth 1.25X longer; claw cleft, middle tooth broader and shorter than apical one (Fig. 148). Mesotibia with longitudinal carina not obvious, no transverse diagonal band of setae, but clusters on outer face as normal; inner apical spur shorter, dagger-like, both spurs shorter than first tarsal seg-

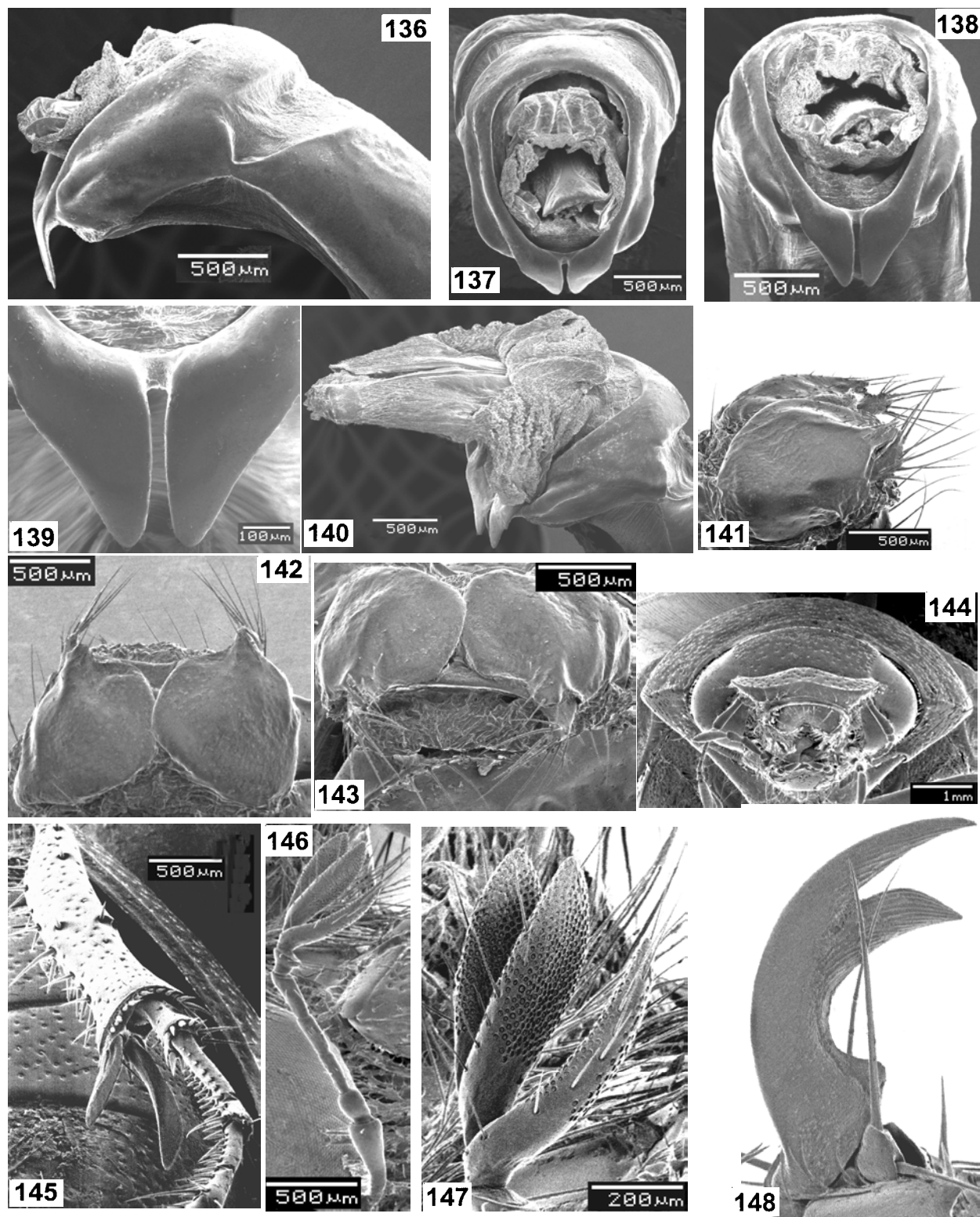


Fig. 136-148. *Phyllophaga aliada* Sanderson. 136-140 Male genitalia: 136) lateral; 137) caudal; 138) ventral; 139) paramere tips; 140) aedeagus extended (lateral); 141-143 female genitalia: 141) lateral; 142) ventral; 143) dorsal; 144-148 female: 144) head; 145) metatibial apex; 146) antenna; 147) antennal club; 148) tarsal claws.



ment. Mesotarsal segments progressively shorter, with 5 and 1 about equal, spurs cleft as protarsi. Metatibia as in mesotibia, inner spur about 2X length of first tarsal segment, spur curved inward and machete-like; outer spur about equal to first tarsal segment; longitudinal carina on metatibia suggested by long row of stiff spines, but not carinate or darkened; dorsal tibial notch obvious, external angle produced with longer spines; apical fringe of 11-12 spinules (female with 16). Second metatarsal segment unusually elongated, nearly 2X longer than first, 2-4 progressively shorter until fifth which is subequal to 2nd; tarsal claws cleft as protarsi, but middle tooth broader and equal in length to apical tooth. Metatarsal segments 2-4 containing 2 rows of sharp, stiff spines on their inner surface (Fig. 145).

**Abdomen.** Venter pale yellow, convex, somewhat translucent, barely pruinose in patch on sides of penultimate sternite, otherwise shiny; sutures well marked.

**Male genitalia** (Fig. 136-140). Relatively simplified, the aedeagus normally recessed. Paramere tips turned abruptly backward, fused medially only at base; labia nearly triangular, flattened on face; laterally a smoothly rounded convexity. Phallobase evenly rounded dorsally, not notched. Aedeagus poorly sclerotized, harder central piece caudally as an inverted "shovel", surrounded by several groups or clusters of spinose areas imbedded in flexible tissues (Fig. 140).

**Female** (Fig. 141-148). Similar to male, except antennal club shorter, ovate, receptors not uniformly covering lamellae (Fig. 147). Metatibial spinule with 16 spines (11-12 on male). **Female genitalia** distinctive (Fig. 141-143); inferior plates not fused, with teat-like projection apically, terminating in cluster of about 4 long setae; superior plates fused and evenly curved medially; apically with cluster of 8 extremely long setae on terminal projections (Fig. 142).

**Specimens examined.** In addition to the holotype female from Haiti and the allotype male from Dominican Republic, I have seen 67 additional specimens (all DOMINICAN REPUBLIC, **new country records**) as follows: (16) same data as allotype [all FSCA]. **Prov. La Vega:** (1) La Ciénega de Manabao, Pk. Hdqtrs. [Parque Nacional Armando Bermudez], 20-21-IV-2000, R. E. Woodruff, T. J. Henry, 3000 ft, black-light trap [FSCA]; (3) Valle Nuevo, 6-V-1959, Sanderson and Farr, R59-9[1], feeding on *Miconia assuaensis* [INHS]; (1) Constanza, 10-V-1972, J. and S. Klapper-

ich, 1250 m [NHMB]. **Prov. Monseñor Nouel:** (3) 1km E. Paso Alto de Casabito, 7km NW La Ceiba, 19-02N, 70-29W, 28-VII-1992, 1130 m, cloud forest, J. Davidson, J. Rawlins, C. Young, S. Thompson [CMNH]. **Prov. San Juan:** (40) Sierra de Neiba, 9.4km SSW El Cercado, 18-39-18N, 71-32-51W, 1973m, 22-VI-2003, Sample 32242, R. Davidson, C. Nuñez, C. Young, J. Rawlins, P. Acevedo, M. de la Cruz, meadow near mature pine forest, hand collected [CMNH]. **Prov. Elias Piña:** (1) 9.0km WSW Hondo Valle, 18-41-34N, 71-46-52W, 1843 m, 25-VI-2003, Sample 31312, R. Davidson, C. Nuñez, C. Young, J. Rawlins, P. Acevedo, M. de la Cruz, disturbed montane woodland with pine, UV light [CMNH]; (1) same, except 9.3km WSW, 18-41-31N, 71-47-03W, Sample 31112 [CMNH]. **Prov. Independencia:** (1) Sierra de Neiba near crest, 5.5km NNW Angel Feliz, 18-41N, 71-47W, 1750 m, 21-22-VII-1992, J. Rawlins, S. Thompson, C. Young, R. Davidson, dense cloud forest [CMNH].

**Taxonomic notes.** This species was originally described from a unique female. Retrospectively, Sanderson and I agree that perhaps the species name should have been established on the basis of males, because their genitalia are more distinctive. Actually, some of our specimens were labeled as a new species, and Sanderson gave them the manuscript name "*cuparia*" many years ago. During the present study they were so considered, until the holotype of *aliada* was borrowed from the Museum of Comparative Zoology. The female genitalia are preserved in a glycerine vial and are somewhat cleared. Because the tissues that connect the superior and inferior plates are flexible, they did appear different from our specimens. However, when the inferior plates were positioned as our fresh material, they were obviously the same as in Fig. 142. We therefore avoided the unnecessary description of a synonym and have firmly established the association of the sexes; especially important in *Phyllophaga*.

Some may question the description of an allotype, especially many years after the original description and by subsequent authors. However, the original description of the term "allotype" clearly includes this provision (see earlier discussion on this topic in Methods and Materials; and Fernald, 1939).

**Comparisons.** In external and genitalic characters it is most similar to *approxima* (compare Fig. 136-143 vs. 167-177). Externally *aliada* is matte, opaque, while *approxima* is shiny, translucent.

*Phyllophaga androw* Woodruff, **new species**  
(Fig. 65, 149-166)

**Holotype male.** DOMINICAN REPUBLIC: Prov. San Juan, Sierra de Neiba, 9.4km SSW El Cercado, 18-39-18N, 71-32-51W, 1973 m, 22-VI-2003, R. Davidson, C Nuñez, C. Young, J. Rawlins, P. Acevedo, M. de la Cruz, sample 32212, meadow near mature pine forest, UV light, CMNH specimen number 307,025 [CMNH].

**General description** (Habitus, Fig. 65). Medium sized (L. 12, W. 6 mm), base color light orange-brown, with darker area in pronotum and posterior portions of suture and elytral apical declivity; head nearly black. Color similar to *fossoria*, but vestiture denser and obvious.

**Head.** Color nearly black, except lighter clypeus. Clypeus one-third length of frons, almost quadrate, sides nearly parallel, smoothly emarginate; margin highly reflexed; surface densely punctate, punctures more numerous medially, frontal suture slightly impressed, emarginate medially, diminished at sides, some clypeal punctures setiferous, frons noticeably hirsute with long, posteriorly curved reddish setae, posterior band impunctate, exceptionally dark, nearly black; punctation of frons dense, coarse, coalescing in lateral thirds, basal band projecting forward in the middle, slightly raised. Eye canthus carinate, with 8 long curved setae. **Antenna** (similar to Fig. 164) orange-brown, segments 2, 3, 4 progressively shorter, club 3 segmented, lamellae flattened, receptors noticeable at 20X, longer than preceding 5 antennomeres.

**Pronotum.** (Fig. 65). Vestiture hirsute, dense setae longest in anterior center and lateral and posterior margins, but covering disc also. Lateral margin noticeable crenulate at setal insertions. Punctation coarse, denser at anterior angles. Pronotum widest at rounded, near medial, lateral angles; anterior and posterior angles not projecting or acute, posterior more rounded. Color orange-brown, with weakly defined darker band in center disc. Posterior marginal line raised.

**Scutellum.** Surface slightly alutaceous, punctures shallow, scattered, a few setiferous with straight short setae.

**Elytra.** Dorsally somewhat flattened, orange-brown, with a darker chevron pattern near elytral apices,

extending up suture and sutural striae. Noticeably hirsute, more densely so at humeral angles and on lateral margins. Sutural apices not projected into a point, marginal line barely reflexed.

**Pygidium.** Convex, hirsute, slightly alutaceous, punctures nearly evenly spaced, separated by 1-2 diameters, nearly all setiferous, margin reflexed with terminal fringe; apex slightly truncate.

**Legs.** Protibiae tridentate, basal tooth weakly projecting, middle tooth nearer proximal than basal; apical spur not reaching base of first tarsal segment, short and not finely pointed. Protarsal segments 1-4 subequal, fifth 1.25X longer; claws cleft (Fig. 166), lower tooth shorter and broader than apical. Mesotibia with longitudinal carina obvious, diagonal band of 7-8 stiff setae located about one-third length from apex; terminal spurs nearly equal in length, inner longer. Mesotarsal segments 1, 2, 5 subequal, 3 and 4 progressively shorter; claw cleft as protarsi. Metatibia with transverse carina well marked (Fig. 17, 19), setae as on mesotibia; inner apical spur longer and slightly broader, both spurs longer than first tarsal segment. First metatarsal segment reduced, next 3 progressively shorter to 5th which is subequal to second; claws cleft as on protarsi.

**Abdomen.** Ventral surface with microsetae on 3 sternites; penultimate sternite with elongate setae similar to pygidium; terminal sternite with similar but shorter setae.

**Male genitalia** (Fig. 149-157). Extremely similar to *fossoria* (Fig. 288-298), but differs in minor details, lateral projection of aedeagus more "hand-like". The long, saw-like projection from the aedeagal tip (Fig. 152) is also found in *fossoria*, but it is difficult to dissect. Often when genitalic differences are minor, there are excellent external characters for separation. In this case *androw* is extremely hirsute, especially on pronotum, whereas *fossoria* has pronotal disc glabrous.

**Allotype female.** Data same as holotype, except Salcedo's Caseta, 7.8 km SSW El Cercado, 18-39-56N, 71-31-57W, 19-VI-2003, sample 30042, 1659 m, hand collected [CMNH]. Length 12 mm. Similar to holotype in most respects, including fuscous pattern. Shape slightly more robust, elytra not as parallel-sided, broader (6.5 mm at widest). **Female genitalia** (Fig. 158-160) with inferior and superior plates connected at apex laterally (as in *fossoria*), inferior plates

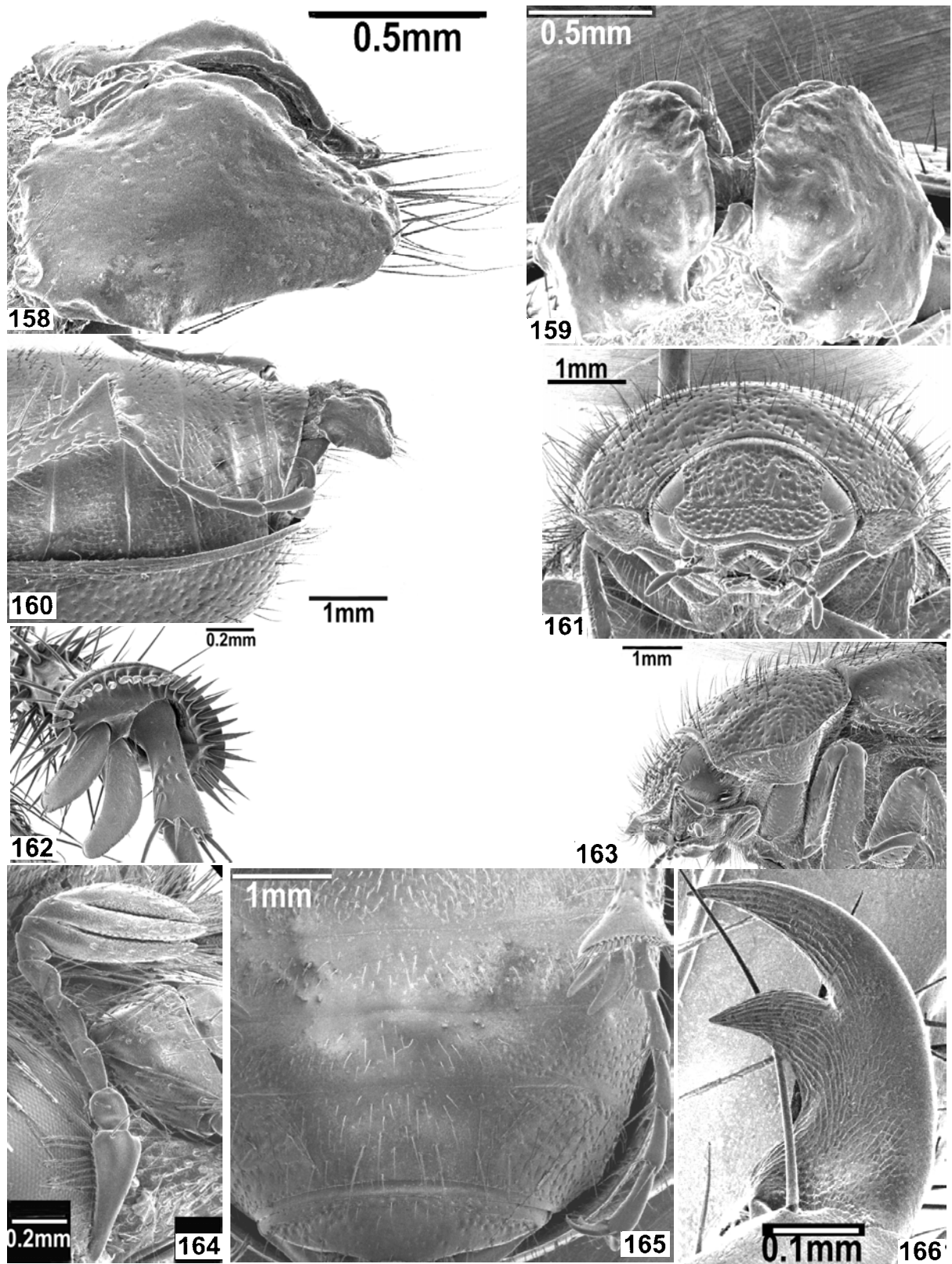


Fig. 158-166. *Phyllophaga androw* Woodruff. Female. 158) genitalia, lateral; 159) genitalia, ventral; 160) abdomen, lateral, genitalia extruded; 161) head, frontal; 162) metatibial apex; 163) head and pronotum, lateral; 164) antenna; 165) abdomen, ventral; 166) metatarsal claw, lateral.

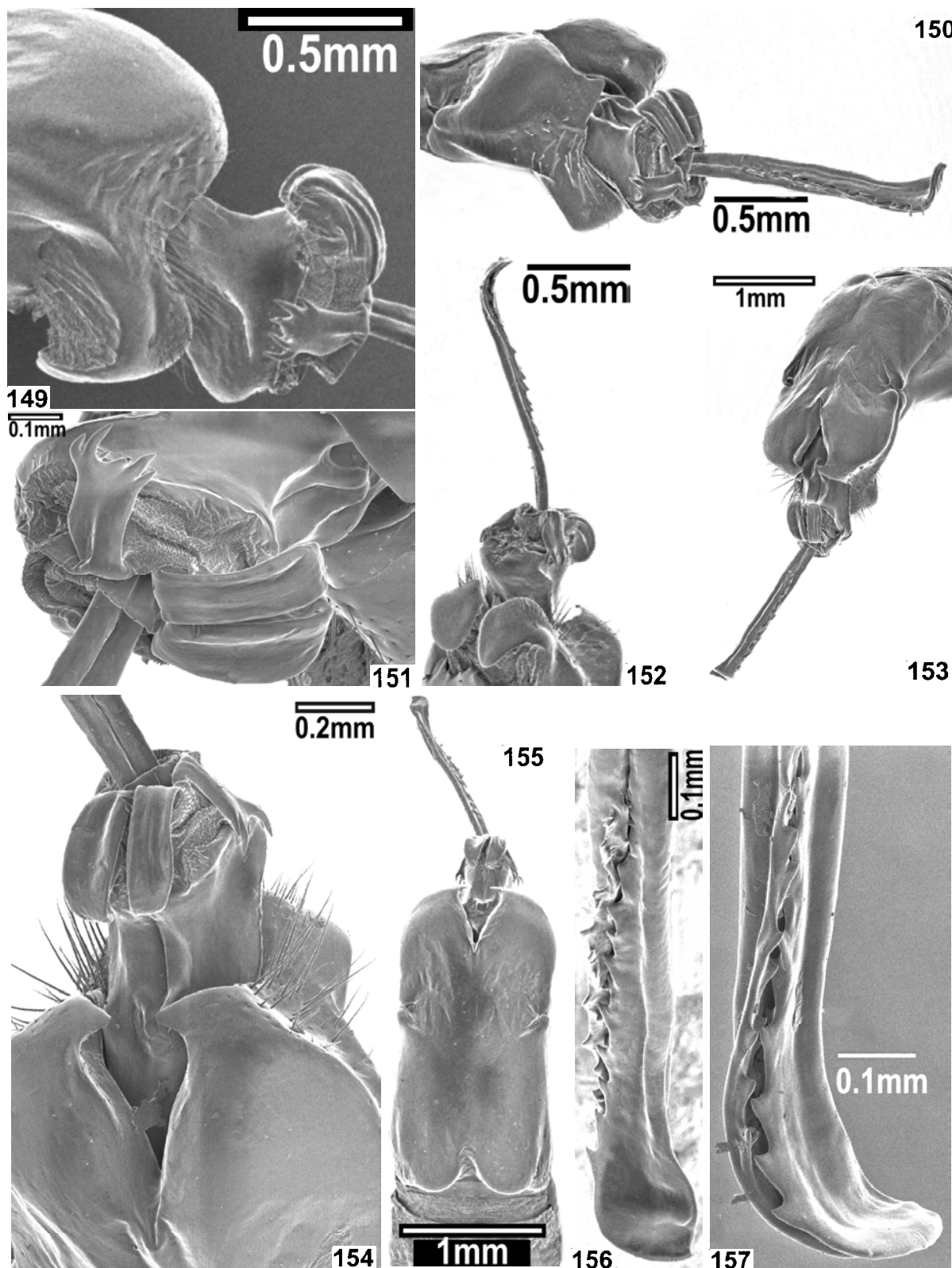


Fig. 149-157. *Phyllophaga androw* Woodruff. Male genitalia: 149) lateral (aedeagal tip cut off); 150) caudo/lateral with tip included; 151) aedeagal tip with "hand"; 152) ventral, aedeagal tip; 153) caudo/dorsal; 154) dorsal, paramere tip and aedeagal base; 155) dorsal, entire; 156-157) tip of aedeagal extension.

convex medially, with a carina paralleling division. A weakly sclerotized triangular plate divides base, superior plates with about 13 terminal setae on each projection. Pygidium more flattened than in holotype, punctation of head and frons somewhat denser, appearing more rugulose, antennal club (Fig. 164) ovate in outline, shorter than preceding 5 segments. Metatibial spurs much broader and spatulate-shaped, terminal fringe composed of about 33 spines (about 21 on male). A single female is known.

**Specimens examined.** In addition to the holotype and allotype above, I have designated 12 paratype specimens as follows: 1 male with same data as holotype and 11 males with same data as allotype [CMNH, FSCA, MNSD].

**Ecology.** Because of the noticeable receptors on the antennal lamellae, I suspect that adults are primarily diurnal (as are those of other species from high altitudes). The fact that only 2 were collected at "UV light" and 12 were hand collected adds to that supposition. Altitudes range from 1659 m at the hand collecting site, to 1973 m at the UV light collections. The latter was "meadow near mature pine forest", and the other was "pastures, pine woodland". It is probable that pine is the host plant of adults.

**Comparisons.** This species is extremely close to *fossoria*, and was not immediately recognized at first encounter. However, the locality did not coincide with known distributions of that species and closer scrutiny revealed this interesting "sister species". The Sierra de Neiba is another of the mountain ranges with several endemic plants and animals. In addition to being a slightly smaller species (av. 12 vs. 14 mm), *androw* has the entire pronotal surface noticeably hairy (Fig. 161, 163). The genitalia are similar, but distinctive (compare Fig. 149-160 with 288-304).

**Etymology.** It is with great pleasure that I name this species for Robert Androw, who greatly facilitated my work by his dedication and care in preparing and dissecting the extensive Carnegie collections, although he did not get the enjoyable benefits of the field work to collect them. His efforts not only assisted in this study, but have made these specimens both useful and aesthetic. Rarely have we seen such well-prepared material.

*Phyllophaga approxima* Woodruff and Sanderson,  
**new species**  
(Fig. 66, 167-177)

**Holotype male.** DOMINICAN REPUBLIC: Prov. La Vega, 5-7 mi S. Constanza, 5-V-1959, [M.W.] Sanderson and [T.H.] Farr, RD59-4(1), feeding on *Trema lamarkiana* [INHS].

**General description** (Habitus, Fig. 66). Medium sized (L. 13, W. 6 mm), color pale yellowish orange, integument translucent, head and pronotum slightly more orange, but not dark. All legs and abdomen somewhat translucent. Shape elongate, parallel-sided. Genitalia distinctive (Fig. 167-172).

**Head.** Clypeus smoothly rounded to truncate apex, not emarginate, half length of frons; margin reflexed, surface shallowly but noticeably punctate, denser in anterior depression but punctures separated by a diameter or more in remainder, posterior clypeal angles rounded to frontal suture; suture impressed, barely emarginate in center. Frons less densely punctate than clypeus, some punctures larger but separated by 1-2 diameters, center depressed, with denser cluster of punctures; posterior band impunctate. **Antenna** yellowish, 9-segmented, club 3-segmented, capable of being flatly compressed, club with noticeable receptors, lamellae as long as previous 5 antennomeres; antennomere 3 and 4 subequal in length, narrow, 5 broader but nearly equal in length, 6 short and barely expanded.

**Pronotum.** About 1.75X wider than long, color somewhat orange compared to elytra; surface glabrous, shiny. Anterior angles bluntly rounded; pronotum widest at lateral angles, but not noticeably angulate; posterior angles subquadrate. Punctation denser at sides, forming a slight longitudinal impression on disc, marginal setae scattered, fine, not extending on posterior margin, which is indicated by row of depressed punctures, margin carinate.

**Scutellum.** Punctures smaller and denser than those on elytra, in a V-shaped pattern, some coalescing with a V-shaped impunctate area in center.

**Elytra.** Color pale yellow, translucent, shiny, not pruinose; surface densely, shallowly punctate, punctures usually separated by a diameter, but some coalescing below humeral angles; elytral margin barely reflexed, weakly so in posterior third; sutural carina and costae barely noticeable near scutellum

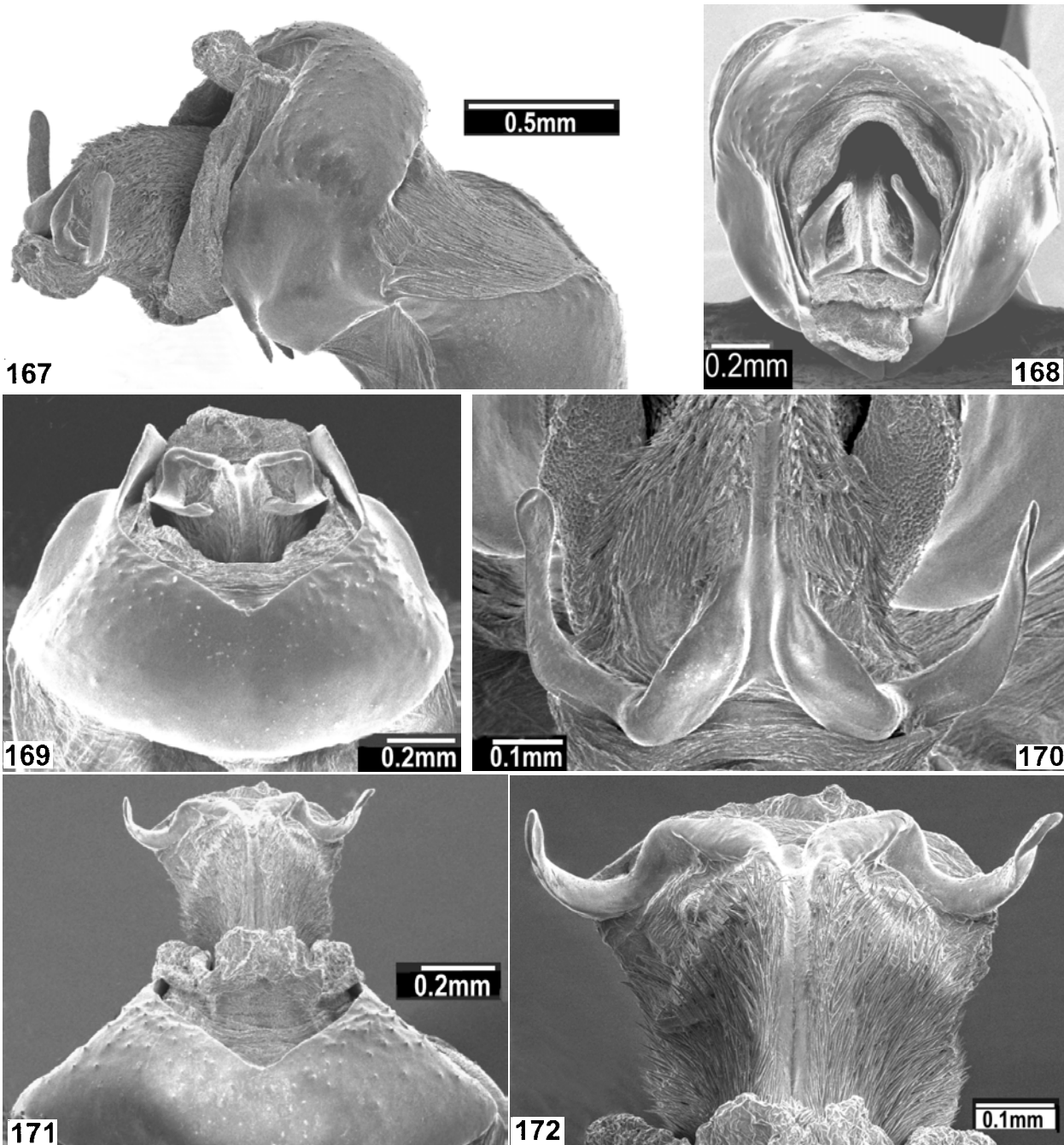


Fig. 167-172. *Phyllophaga approxima* Woodruff and Sanderson. Male genitalia: 167) lateral; 168) caudal; 169) dorsal; 170) aedeagal tip, caudal; 171) aedeagus extruded, dorsal; 172) aedeagal tip enlarged, dorsal.

but better developed throughout, punctate similar to elytra, sutural apex without spine, obtusely rounded.

**Pygidium.** Surface nearly glabrous, except for marginal fringe, but scattered short, pale setae present; densely, coarsely punctate, many punctures coalescing, appearing longitudinally wrinkled; apex somewhat truncate.

**Legs.** Protibiae tridentate, basal tooth weakly projecting, middle tooth nearer proximal than basal; tibial spur long, acuminate, and dagger-like, projecting beyond base of first tarsal segment. Protarsi long, segments 2, 3, and 4 subequal, fifth 1.25X longer; claw distinctly cleft, lower tooth shorter and broader than upper (Fig. 166, female). Mesotibial spurs sharp, dagger-like, inner spur 1.25X longer than outer spur;

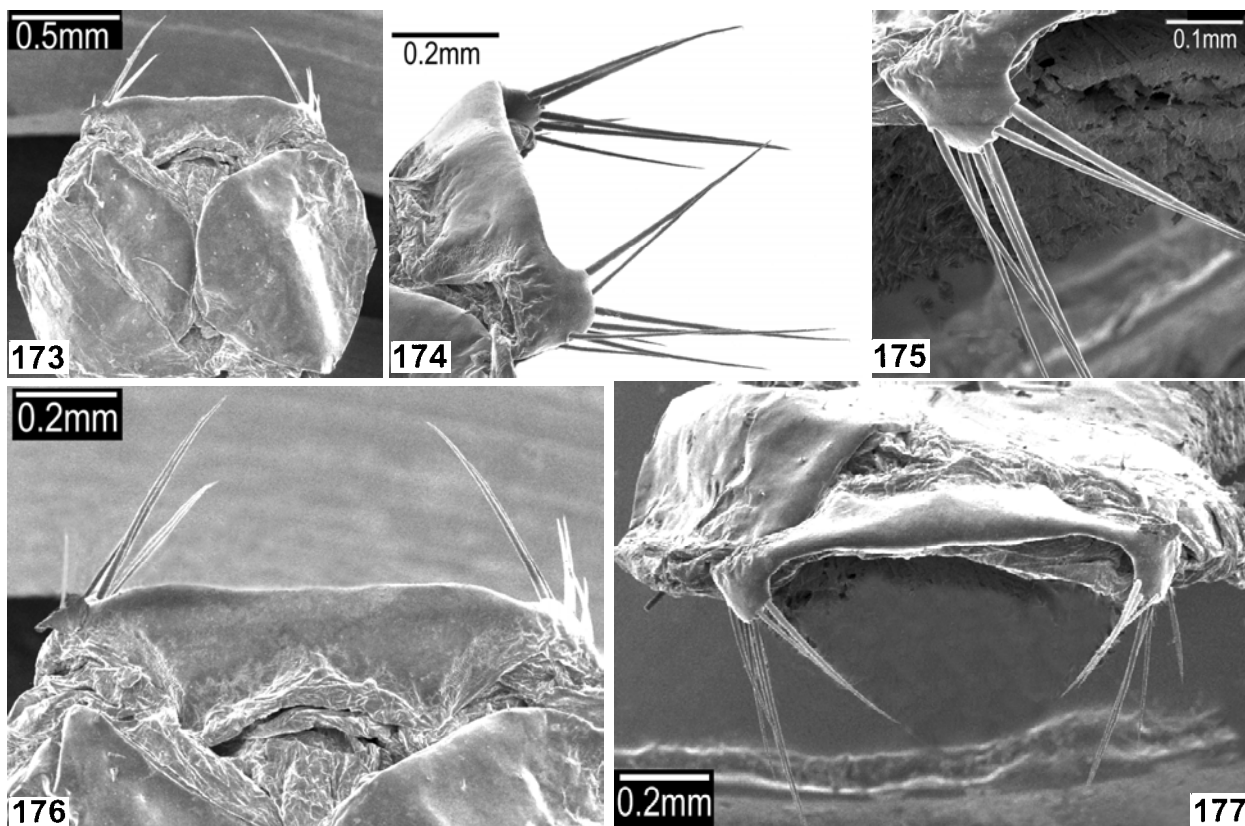


Fig. 173-177. *Phyllophaga approxima* Woodruff and Sanderson. Female genitalia: 173) ventral; 174) diagonal/lateral; 175) enlarged tip of right superior plate, ventral; 176) superior plate, ventral; 177) dorso/caudal.

diagonal transverse band of setae one-third distance from apex, longitudinal carina not noticeable. Mesotarsal claws as in protarsi, tarsal segments 2, 3, and 4 progressively shorter, with 5 subequal to 1, claws nearly identical to protarsi. Metatibia curved dorsally, longitudinal carina not noticeable, but transverse carina marked by patch of setae as in mesotibia; inner apical spur long, narrow, sharply pointed, equal in length to first tarsal segment, outer spur 1.3X longer than first tarsal segment, narrow, pointed; apical fringe of 14 spinules (some shorter than others). Metatarsal segments 1 and 4 subequal in length, 2 longest, 3 and 5 subequal, all with long sharp setae on the inner face, claw similar to anterior but middle tooth broader and longer.

**Abdomen.** Ventral surface glabrous except for large cluster of setae on pruinose patch of penultimate sternite, setae somewhat shorter in center, ultimate sternite with long setae on posterior margin similar to fringe on pygidium.

**Genitalia, male** (Fig. 167-172). Generally similar to *aliada*, but phallobase dorsally broadly notched, and

aedeagal tip with 2 ram-like horns, the area behind them covered with spinose setae. Caudo/lateral area of parameres carinate and flange-like. Dorsum of phallobase with numerous bumps (possible vestiges of setal bases).

**Allotype female.** (Genitalia Fig. 173-177). Data same as holotype [INHS]. Generally similar to male in most respects, slightly wider posteriorly. Antennal club ovate, lamellae not flat or compactable, much shorter than previous 5 segments. Metatibial inner spur more curved, slightly broader. Apex of metatibia with more (about 16) setae in fringe. **Female genitalia** with 6 exceptionally long setae at lateral angles of fused superior plates; area between nearly straight, rounded to corners, no median indentation. Inferior plates not fused, convex, without carinae or depressions, apically prolonged in acute angle, but not sharp-pointed, no long setae; base at median not closed by triangular plate.

**Specimens examined.** In addition to the holotype and allotype, we have designated the following 18 paratypes (all from DOMINICAN REPUBLIC): (13)

same data as holotype, some on *Spondias dulcis* [INHS, FSCA, MCZC]. (4) Prov. La Vega, Convento, 12 km S. Constanza, 6-13-VI-1969, Flint and Gomez [USNM]. (1) Prov. San Cristobal, San Cristobal, 8-9-VI-1969, Flint and Gomez [USNM]. The latter record is questionable. Based on the known altitudinal preferences, the fact that labels were similar in printing, the same collectors, and the dates overlap, we believe that the latter specimen is likely mislabeled. Inquiries to Dr. O.L. Flint shed no light on this specimen.

**Ecology.** Adult host plant records include 2 trees: *Trema lamarckiana* (9 males, 3 females) and *Spondias dulcis* (5 males). Seasonal records extend from May 5 to June 13. Several other workers have collected in the vicinity of the 2 known localities, but further specimens were not encountered. There are no light trap collections, indicating that its rarity may be due to its sedentary habits. The noticeable receptors on lamellae of the antennal club suggest they may be more active in the daytime.

**Comparisons.** In both general appearance and genitalic features, *approxima* is nearest *aliada* Sanderson. From that species it can be separated by the shiny, non-pruinose dorsum, translucent integument, and non-emarginate clypeus. The male genitalia have the same basic shape, but *approxima* has 2 bull-like horns (Fig. 172) on the aedeagus, whereas *aliada* has the aedeagus without such horns and it projects into a tongue-like, truncate projection clothed with microsetae (Fig. 140).

**Variation.** Little variation was noted in the type series (L. 12-13.5, W. 5-6 mm). Apical fringe of metatibia in male varying from 8 to 14 spinules (20 tibiae examined). The clypeus of 1 male was more rectangular than others and one had the pronotum noticeably more convex.

**Etymology.** The name *approxima* refers to the similarity of this species to *aliada*, and other light colored species in the same size range.

*Phyllophaga audanti* Wolcott

*Phyllophaga audanti* Wolcott (1928a: 27). Sanderson (1951: 273-274; Fig. 44, 45, 71, 72). (Habitus Fig. 67, male genitalia Fig. 178-181, female genitalia Fig. 185-188.)

This small, shiny, glabrous species (L. 8-10, W. 4.5-5 mm) is relatively common in the southern

lowlands of the Dominican Republic, from Santo Domingo west to Port-au-Prince, Haiti (from which the types came). It appears to be found throughout the year, and is frequent at lights. It has potential as an economic pest; several hundred were collected near a sorghum field (13 km W. Los Tres Charcos, Prov. Pedernales) on May 22, 1985. Adults were feeding on mesquite and small herbaceous plants near the soil, which is a bright red, sticky lateritic clay. The area is a semiarid coastal plain, only a few meters above sea level, that is heavily cultivated. It is likely that larvae damage various crops grown here. Altitude records are from sea level to 475 m.

Records include the following DR Provinces: Azua, Barahona, Distrito Nacional, Independencia, Pedernales, Puerto Plata, San Juan, Santiago. Haitian records include Port-au-Prince and Petionville.

*Phyllophaga baoruco* Woodruff, **new species**  
(Fig. 68, 191-198)

**Holotype male.** DOMINICAN REPUBLIC: Prov. Barahona, Larimar Mine, nr. Filipinas, 3300 ft, 26-VI-1992, blacklight trap, P. Landolt, F. Skillman, P.E. Skelley, R.E. Woodruff [FSCA].

**General description.** (Habitus, Fig. 68). Large (L. 23, W. 7 mm). Reddish brown, anterior third shiny, glabrous, elytra pruinose, pile producing an iridescent sheen; elytral suture terminating in outward projecting spine.

**Head.** Clypeus slightly emarginate, margin reflexed, punctures coarse, rarely separated by 1 diameter, smaller and denser medially; lateral margins rounded, slightly indented at frontal suture, suture deeply impressed, especially at eye. Frons punctate similarly to clypeus; smaller, coarser, denser line of punctures above eye. Posterior band impunctate, a few punctures at posterior corners behind. **Antenna** 9-segmented, club 3-segmented; lamellae shorter than preceding 5 antennomeres, 3 and 4 subequal, elongate, 5 wider than long, slightly projecting anteriorly, 6 wider than long. Color dark orange-brown.

**Pronotum.** Wider than long, lateral angles not prominent, widest at posterior angles. Lateral margin somewhat crenulate at marginal setae. Posterior line marked by row of punctures, but weakly reflexed. Surface glabrous, shiny, reddish-brown. Punctures coarse, irregularly spaced from 1 to 4 diameters; vague indication of impunctate longitudinal line in central disc (more extensive on some specimens).



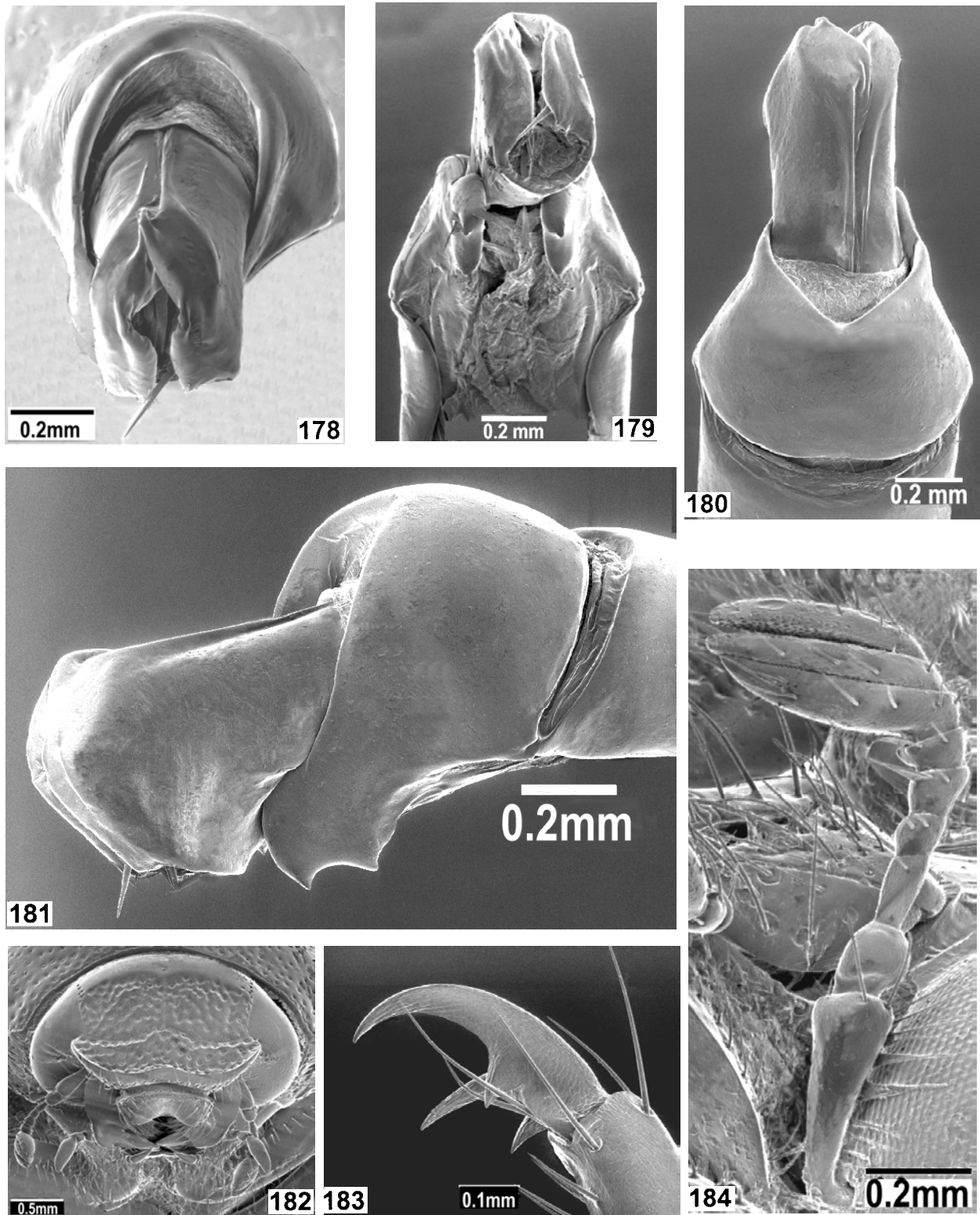


Fig. 178-184. *Phyllophaga audanti* Wolcott. Male. 178-181 genitalia: 178) caudal; 179) ventral; 180) dorsal; 181) lateral (right); 182) head, frontal; 183) protarsal claw; 184) antenna.

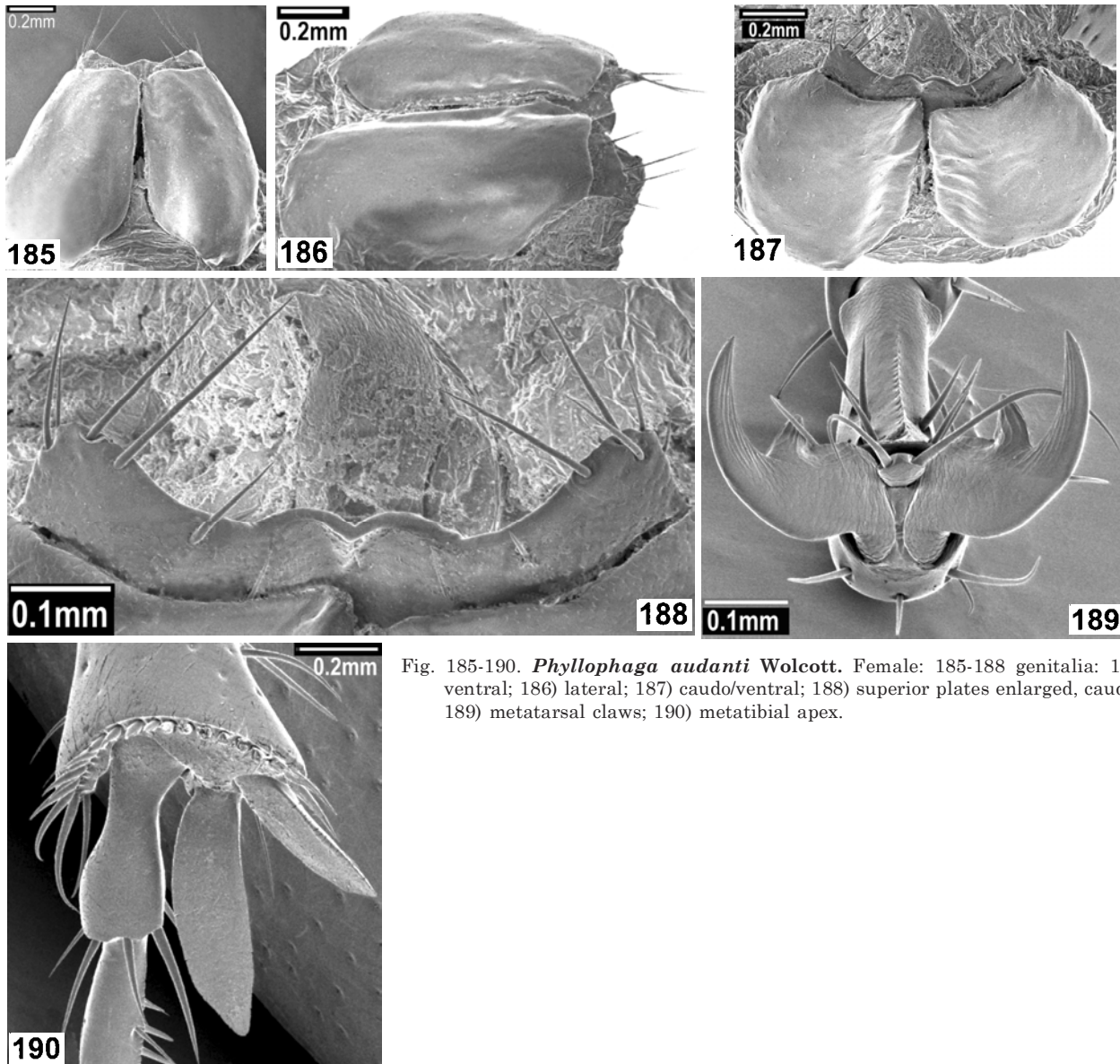


Fig. 185-190. *Phyllophaga audanti* Wolcott. Female: 185-188 genitalia: 185) ventral; 186) lateral; 187) caudo/ventral; 188) superior plates enlarged, caudal; 189) metatarsal claws; 190) metatibial apex.

Punctures denser and smaller at anterior angles, which are sharply projected and laterally reflexed. Anterior margin slightly raised and bordered posteriorly by a row of small, nearly contiguous punctures.

**Scutellum.** Shiny, glabrous, slightly convex, center impunctate, margins with fine punctures.

**Elytra.** Two elytral costae indicated by convex ridges. Surface uniformly pruinose except humeral angles and small band along basal area shining. Surface somewhat iridescent from grey-blue to reddish-brown. Punctures shallower than pronotum, fairly evenly spaced, separated mainly by 2 to 4 diameters. Elytra with scattered, short, microsetae, nearly arranged in

rows, not noticeably pubescent, nearly invisible except in lateral view. Suture barely carinate and sutural costae inconspicuous until near apical declivity. Suture internally margined with golden microsetae, terminating in sharp outwardly curved spine (similar to *hogardi*). Sutural costae slightly convex with few scattered punctures. Lateral elytral margin barely reflexed and poorly indicated on apical declivity, except by a row of microsetae.

**Pygidium.** Pruinose, but not as strongly as elytra, more alutaceous. Punctures shallow, evenly spaced on dorsum, but finer and denser toward pygidial apex. Most punctures setiferous, with fine, short, straight, golden, setae.