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Two new scarab beetles from the southwestern USA (Coleoptera: Scarabaeidae: Melolonthinae and Aphodiinae)

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Abstract. *Phyllophaga (Listrochelus) benwarneri* **new species** and *Cinacanthus cunninghami* **new species** (Coleoptera: Scarabaeidae) are described from dune systems in northern Arizona and extreme southern Nevada, USA. Habitus and diagnostic characters of these species are illustrated, and couplets from the respective, most recent (sub)generic keys are modified to incorporate the new species. Available habits and habitat information for each species, and a discussion of the *Phyllophaga* “senex complex” of species are provided.

Key words. *Phyllophaga*, *Cinacanthus*, *Aphodius*, taxonomy.

ZooBank registration. urn:lsid:zoobank.org:pub:6B6916E7-FE49-446F-A50A-693338A33532

Introduction

This work describes two new scarab beetles from the Southwestern USA, which are apparently restricted to dune systems in northern Arizona to extreme southern Nevada: one, an arenophilic *Cinacanthus* Schmidt species from dunes near the town of Moenkopi, Arizona, and the other, a flightless *Phyllophaga* Harris (*Listrochelus* Blanchard) “senex complex” species from unconsolidated dunes next to the town of Beaverdam, Arizona, and nearby dunes in Nevada. Both localities are known for having several precinctive species, including other flightless Scarabaeidae.

Materials and Methods

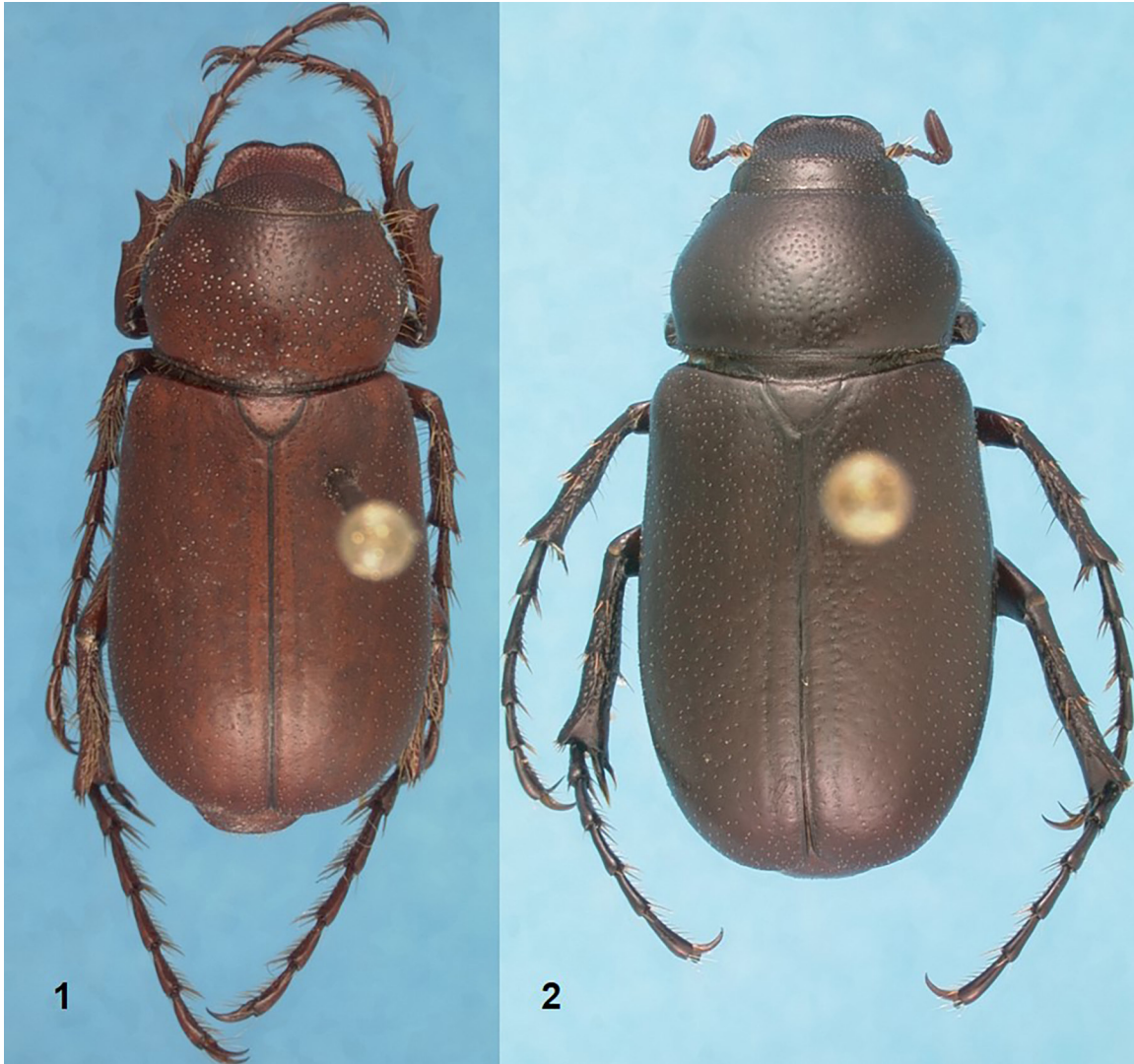
Codes for collections mentioned are (two-letter state abbreviations are the USA postal codes): ASUT = Arizona State University, Tempe, AZ; CSCA = California Dept. of Food and Agriculture, Sacramento, CA; CUIC = Cornell University, Ithaca, NY; FSCA = Florida State Collection of Arthropods, Gainesville, FL; GSPC = Gareth S. Powell, Nephi, UT; KESC = Kyle E. Schnepf, Gainesville, FL; NAUF = Northern Arizona University, Flagstaff, AZ; PESC = Paul E. Skelley, Gainesville, FL; RACC = Richard A. Cunningham, Show Low, AZ; RHMC = Ronald H. McPeak, Vancouver, WA; SEMC = University of Kansas, Lawrence, KS; UAIC = University of Arizona, Tucson, AZ; UCRC = University of California, Riverside, CA; UNSM = University of Nebraska State Museum, Lincoln, NE; USNM = National Museum of Natural History, Smithsonian Institution, Washington, DC; WBWC = William B. Warner, Chandler, AZ.

Body measurements and terminology for appendages on *Phyllophaga* follow Warner and Morón (1992) and are rounded to the nearest 0.5 mm; for *Cinacanthus* body measurements are rounded to the nearest 0.1 mm, and taxon-specific terminology for aphodiines follows Gordon and Skelley (2007). In paratype data, letters following parenthetical paratype numbers indicate sex: m = male, f = female.

Phyllophaga (Listrochelus) benwarneri Warner, new species

Figures 1, 4, 5, 8, 10, 12–17

Diagnosis. Head lacking carina along basal margin; clypeus medially emarginate. Elytra together very convex, with humeral umbones obsolescent, apical umbones, striae and costae obsolete; metathoracic wings reduced (shorter than elytron) and nonfunctional. Meso- and metatibia slightly shorter than their respective basal three tarsomeres combined; tarsal claws on ventral edge with one row of weak serrulations in about basal half, lacking



Figures 1–2. Male dorsal habitus of *Phyllophaga* species. 1) *P. benwarneri*. 2) *P. senex*, Albuquerque, New Mexico.

larger teeth in male, with even weaker serrulations and small median tooth on both claws in female. Female pygidium with fovea at middle of about apical fifth. Male with parameres bilaterally symmetrical, fused into tube with dorsal opening; aedeagus sclerotized, tubular, apex ventrally barbed (“harpoon-like”).

Type data. Holotype male (deposited at ASUT) and allotype female labeled: “USA: AZ: Mohave Co.; dunes S of Beaver Dam; 36°54’10”, 113°56’33”W, iv.24.1998; B.C. & W.B.Warner, J.Huether; on sand at night.”

Description of holotype male. Length: 11.5 mm; widest width (about apical fourth of elytron): 5.0 mm. Body elongate, reddish-brown, convex. Head and clypeus subcontiguously punctate; clypeus about as long as rest of head with free margin biarcuate and apically moderately reflexed, medial emargination obtusely subangulate. Antennal club about as long as clypeus. Pronotum widest at about middle, about $\frac{2}{3}$ as long as elytron, slightly wider than elytra at humeri, width about 1.5 times length at midline, anterior margin weakly arcuately emarginate, posterior margin weakly convex and subparallel to anterior margin, lateral margins obtusely subangulately convex, rather remotely serrate in anterior half, fringed with long flying hairs; disc bare, moderately coarsely, but distinctly punctate, punctures mostly separated by about 1–3 times their own widths. Scutellum short and broad, apex arcuate, base about half as wide as base of elytron; disc vaguely, sparsely punctate. Elytron relatively dull (contrasting with that of female), in dorsal view sides more or less straight and weakly diverging to about



Figures 3–4. Male genitalia of *Phyllophaga* species, lateral view. 3) *P. senex*, Albuquerque, New Mexico. 4) *P. benwarneri*.

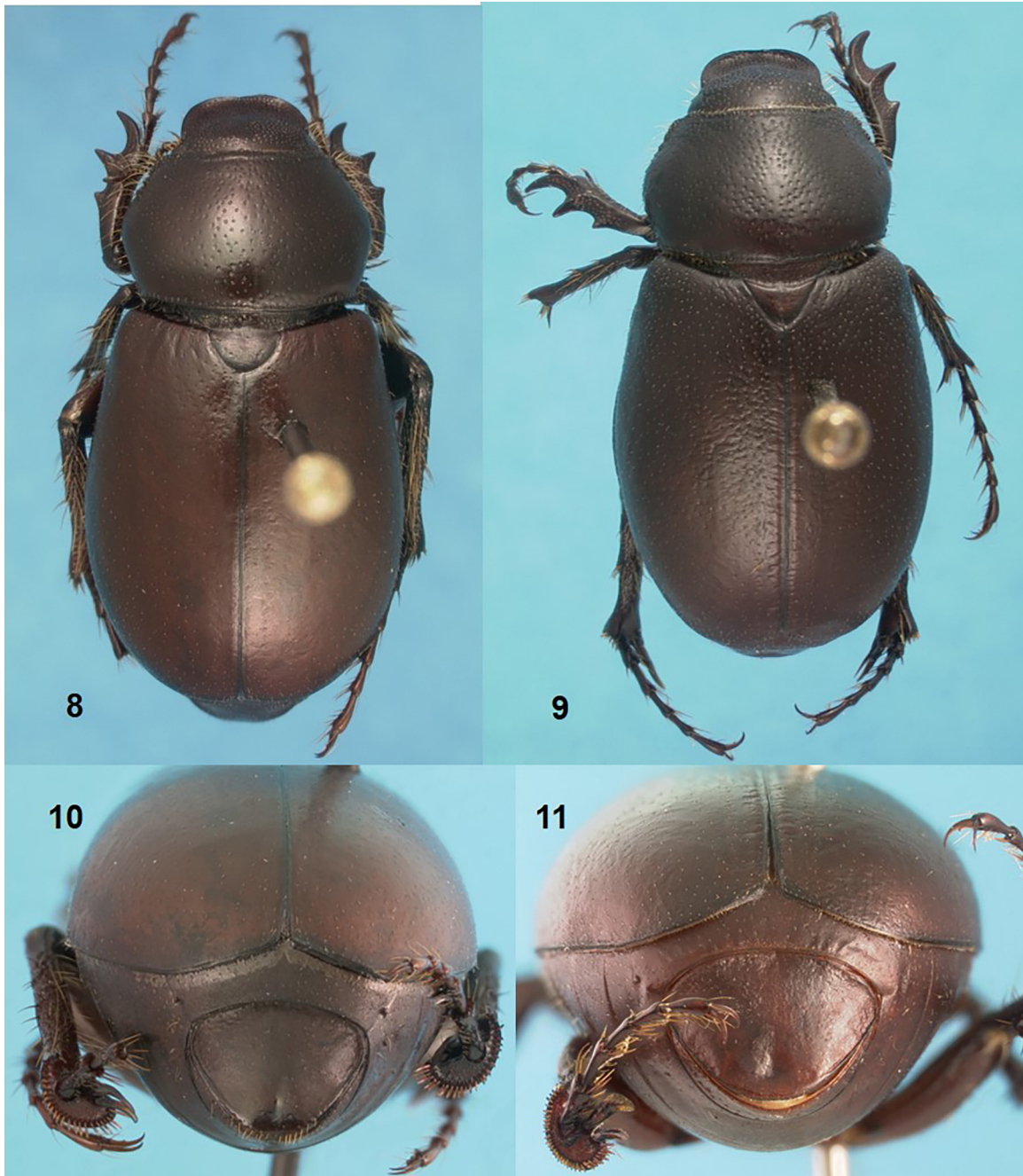
apical fourth, discal striae obsolete, sutural stria obsolescent, only vaguely indicated by slight impression or color change; disc sparsely weakly punctate, punctures much shallower and only a third or so as large as pronotal punctures, setigerous, setae mostly less than twice as long as diameter of puncture from which they emerge. Pygidium dull and sericeous as in elytron, disc sparsely punctate, punctures fine, shallow. Venter dull as in elytron; thoracic sternites with long but only moderately dense testaceous pile; abdominal ventrites with setae shorter and sparser; apex of penultimate abdominal ventrite medially narrowly and shallowly emarginated; base of apical ventrite medially transversely subtuberculate (Fig. 7). Legs long, profemur fringed on dorsal (anterior in repose) and ventral edges (meso- and metafemora primarily on dorsal edge) with long flying hairs; protibia distinctly tridentate, basal tooth at about middle; meso- and metatibia shorter than their respective basal three tarsomeres together; tarsi long (meso- and metatarsi about $\frac{3}{4}$ as long as elytron, basal four protarsomeres ending with short apicoventral mucro, this reduced in mesotarsus and nearly obsolete in metatarsus; tarsal claws with ventral edge weakly serrate in about basal half, lacking larger tooth. Genitalia with parameres (Fig. 4) fused into tube with dorsal opening, in lateral view arcuately narrowing to mucronate apex; aedeagus heavily sclerotized into tube, open dorsally, in lateral view apically weakly deflexed and arcuately narrowing to apex, with dull “harpoon-like” barb emanating from ventral edge and directed posteroventrally.

Female allotype. Length: 14.0 mm; widest width (slightly behind elytral midpoint): 7.0 mm. Similar to male but broader, more rotund, and darker in color than male, widest at about apical third of elytron; elytron oval, smoother, shiny and more convex than in male, appearing “inflated,” with punctures weak to obsolescent; pygidium flatter, with distinct medial fovea at about apical $\frac{1}{4}$; tibiae comparatively longer and more robust, protibial



Figures 5–7. Males of *Phyllophaga* species. 5) *P. benwarneri* forebody, dorsoanterior view. 6–7) *P. senex* (Albuquerque, New Mexico): 6) Forebody, dorsoanterior view. 7) Pygidium (arrow points to 6th abdominal ventrite medial process).

teeth stronger, metatibial corbels broader, tarsi less robust and comparatively shorter than in male (metatarsus about $\frac{2}{3}$ length of elytron); antennal club about half as long as clypeus. Genitalia: in ventral “in face” view inferior plates obliquely subcordiform, medially tightly abutting but not fully fused, disc irregularly convex, dorsolateral lobe concave; superior plate subhastate, lateral “wings” partially covered by inferior plates, middle half flattened except for vague longitudinal sulcus at each side of middle, lateral fourths angularly moderately deflexed, apical margin weakly emarginated at each side before deflexed portions, margin on deflexed portions weakly convex, with about 5 long erect setae on each.



Figures 8–11. Female *Phyllophaga* species dorsal and posterior habitus. **8, 10)** *P. benwarneri*. **9, 11)** *P. senex*, Albuquerque, New Mexico.

Paratypes. 419 males, 286 females with data: Same as holotype (8m, 1f); “Beaver Dam, Mohave Co., AZ, iv-23-1984, J.P.Davidson, J.M.Davidson” (2m, 2f); same except: “I-15 W side of exit at Beaverdam, iii.21.2003, W.B. & B.C. Warner” (7f); same as holotype except: “Beaverdam; N36°53'40”, W113°56'02”; iv.1.2012, night feeding & mate on *Oenothera* flowers; W.B.Warner” (47m, 66f); same except: iv.14.2015 (77m, 50f); same except: “G.S.Powell” (17m, 7f); same except: “K.E.Schnepp” (25m, 15f); same except: “iv-20-2014, feeding on *Oenothera deltoides* at night; W.B.Warner” (64m, 36f); same except: “iv.2-v.18.2012; barrier pitfall/ “fake burrow” blk. cups” (20m, 5f); same except: “1,916 ft., Beaverdam, feeding / mating on flowers + leaves of *Oenothera*, 36°53'40”N,



Figures 12–17. *Phyllophaga benwarneri* tarsal claws, lateral view. **12, 13, 14**) Male pro-, meso- and metatarsi, respectively. **15, 16, 17**) Female pro-, meso- and metatarsi, respectively.

113°56'02"W, 1-April-2012, at night, R.A.Cunningham + W.B.Warner" (42m, 29f), same except: "36°53'41"N, 113°55'55"W, 1-4/April/2012, black cup pitfall traps" (1m, 1f); same except: "Beaver Dam nr jct Hwy 15 & Hwy 91, Elev. 2000' 36 53.703N, 113 56.002W, on *Oenothera*, 4/5/2013 to 4/7/2013; R.H.McPeak" (38m, 28f); "USA: AZ; Mohave Co., 1880 ft., Littlefield Sand Dunes, I-15, 0.2 mi. S. of County Rd. 3454, 36°53'32"N, 113°55'55"W, 26-IV-2003, R.A.Cunningham" (14m, 4f); "USA: NV: Clark Co., 0.4 mi. W. jct. of I-15 & Hwy. 169; 3640'16"N, 114°31'49"W; May 31, 2012; dune, night; R.A.Cunningham" (1f); same except: "April 12, 2015, K.E.Schnepp" (1m); "USA: NV: Clark Co., St. Thomas Gap dunes, 36.4100°, -114.0904°; 30-IV-2018; M.A.Johnston" (1m, 1f) "USA: NV: Clark Co., Hwy. 167, nr. Echo Wash bridge, 450m, pitf. in open, DP5; 36°18'35"N, 114°29'21"W; 21.iv.2008; Suazo & Ibarra" (1f); USA: NV: Clark Co., Hwy. 167, NE jct. Valley of Fire Hwy., 465m, pitf. under shrub, GYP1; 36°26'24"N, 114°25'36"W; 21.iv.2008; Suazo & Ibarra" (1m, 1f); same except: "GYP2; 36°26'26"N,



Figures 18–19. Male *Phyllophaga senex*, Monahans Sand Dunes near Kermit, Texas. **18)** Dorsal habitus. **19)** genitalia, lateral view.

114°25'31"W" (5m); same except: "pitf. in open" (1m, 2f); same except: "GYP3; 36°26'24"N, 114°25'31"W" (1m, 5f); same except: "pitf. under shrub" (19m, 13f); "USA: NV: Clark Co., Hwy. 167, W jct. Rt. 12; 430m; pitfall in open GYP4; 36°26'17"N, 114°24'46"W; 21.iv.2008; Suazo & Ibarra" (2m, 5f); same except: "pitfall under shrub" (8m, 1f); same except: "GYP5; 36°26'17"N, 114°24'43"W" (19m, 2f); same except: "pitfall in open" (6m, 3f).

Specimens are deposited in all of the collections mentioned in the Materials and Methods.

Variation. Males: Length 10.0–13.0 mm, widest width 4.5–6.0 mm. Females: Length 11.0–15.5 mm, widest width 5.0–7.5 mm. Variation other than in size primarily in slight body proportion differences. In males, mediobasal area of last abdominal ventrite varying from roughened transverse umbo to more or less distinct tubercle. Female superior genital plate medioapically with shallow and narrow emargination in some specimens; color variable but usually darker than males.

Etymology. I name this species in honor of my son, Benjamin C. Warner, who as an adolescent collected the first specimen of the holotype series as it was sitting on bare sand. He presented it to me, then proceeded to collect five additional specimens, excitedly calling out each capture, while both the frustrated author and fellow frustrated collector Jeff Huether frantically searched the same small area for over 30 minutes before finally finding a few specimens. He continues to frustrate me in such pleasant ways to this day.

Habits and habitat. The holotype series was collected as they sat or walked on bare sand at night on low, unconsolidated dunes immediately southwest of Beaverdam, Arizona. Subsequent trips to the area yielded specimens in

similar situations, as well as many specimens collected while they fed on sand verbena (*Abronia* sp., Nyctaginaceae) or much more commonly *Oenothera deltoides* Torrey and Fremont (Onagraceae). Two large series collected by the author and R. A. Cunningham on the same dunes a few hundred yards away on April 1, 2012 and April 20, 2014, another by the author, K. E. Schnepf and G. S. Powell on April 14, 2015, as well as another series of 66 taken April 5–7, 2013, by R. H. McPeak, were taken at night nearly entirely while the specimens fed on *Oenothera* (mostly flowers, but occasionally on bracts or leaves), or were mating on the same plants. Additional specimens were collected in barrier pitfall samples set the day after the 2012 series was collected, as well as in pitfall traps or “headlamping” at night on blow sands in nearby Nevada localities in an arc ending in the Moapa Valley/Valley of Fire area.

Beaverdam is adjacent to Littlefield, Arizona, both small, unincorporated towns located near the confluence of Beaverdam Creek and the Virgin River in the extreme northwestern corner of the state about 13 km northeast of Mesquite, Nevada. The type locality is on the bluff that borders the southwest edge of the Beaverdam Creek flood plain, a riparian area that cuts through the Mojave Desert biotype from which most of the type series was collected (mostly from the rim of the bluff to approximately 300 meters southwest of the rim). Primary perennial plants at the site are *Larrea tridentata* (de Candolle) Coville, *Ambrosia dumosa* (A. Gray) Payne and *Ephedra* species; scattered *Yucca brevifolia* Engelm. dot the surrounding desert. The riparian area immediately adjacent to the type locality is dominated by cottonwood (*Populus fremontii* S. Watson), willow (*Salix* species), desert willow (*Chilopsis linearis* (Cavanilles) Sweet), seep willow (*Baccharis glutinosa* (Ruiz and Pavón) Persoon) and desert shrubs, although specimens of *P. benwarneri* have only been found on the dry blow sands on the bluffs above the flood plain, and in similar habitats to the southwest. Other precinctive scarab beetles known from the same habitats in those locations include the flightless *Diplotaxis robertmarki* Davidson and Davidson and *Aegialia knighti* Gordon and Rust, as well as *Diplotaxis coenonychoides* Davidson and Davidson (which flies and also occurs in a few nearby dunes in southwestern Utah). The same dune system is the type locality of the precinctive meloid beetle *Lytta arizonica* Selander, and is the habitat of two undescribed *Trigonoscuta* species (Curculionidae: Entiminae; C. W. O'Brien, pers. comm.).

Relationships. *Phyllophaga benwarneri* is a member of the *Phyllophaga* (*Listrochelus*) *senex* (Horn) lineage, and forms the western-most population of that “superspecies.” The *Phyllophaga senex* complex species share similar male genital structure, tarsal claws with only weakly serrate ventral edge, and female pygidial fovea. Both sexes of *P. benwarneri*, however, are flightless, differ in surface sculpture, have much hairier legs, a distinctly biarcuate clypeal margin, and more strongly developed pronotal marginal beading than other members of the *senex* complex. Females of *P. benwarneri* may be distinguished from those of other taxa in the *P. senex* complex by their more strongly basally constricted pronotum and elytra, longer legs, wider head with larger, more prominent labrum and longer clypeus, nearly semicircular (vs. triangular) scutellum, elytron with flat sutural interval, and smoother, more finely punctate dorsum (e.g. compare Fig. 8 and 9).

Additionally, *P. benwarneri* is ecologically, altitudinally and geographically isolated from nearest known populations of other *senex* complex phenotypes by several mountain ranges and the Colorado and Virgin Rivers (including the Grand Canyon). Interestingly, this pattern follows a similar situation with *Diplotaxis robertmarki* vs. *Diplotaxis brachyptera* Vaurie, *D. robertmarki* being a distinctive species sympatric with *P. benwarneri*, and its putative “mother taxon,” *D. brachyptera*, having a somewhat similar (though generally in higher altitude locations) and wider discontinuous distribution to that of *P. senex* (sensu lato), with isolated populations of both the latter species demonstrating mild to moderate character shifts across their ranges.

The *Phyllophaga* “senex complex.” The *Phyllophaga senex* complex species share similar male genital structure, tarsal claws with only weakly serrate ventral edge, male 6th abdominal ventrite with small prominent central lobe (Fig. 7, arrow) and female pygidial fovea. *Phyllophaga senex* (sensu lato) comprises several phenotypically distinct populations, most of which have males with functional flight wings and females that are flightless. The type locality of *P. senex* is the “Llano Estacado,” a large flat mesa running along much of the Texas-New Mexico border. “Typical” specimens of *P. senex* in and around the Llano Estacado tend to be somewhat lighter in color and are often smaller (e.g. Fig. 18–19, a specimen from the Monahans dune system near Kermit, Texas) than more western and northern populations. Some southern Texas and New Mexico populations are uniformly even smaller and paler. Additional collecting is needed to further elucidate taxonomic limits and taxonomic status of the other populations within this complex.

Applicable couplets from the Saylor's (1940, p. 68) key to US *Listrochelus* males are here modified below to include males of *P. benwarneri*:

- 40(39).** Pygidium very convex, densely and coarsely punctate and shining, with short procumbent hair; sixth abdominal ventrite plane (genitalia fig. 6, k–n) *Phyllophaga scuticeps* (Bates)
 — Pygidium plane, very sparsely and finely punctate, with minute hair, surface subopaque; sixth abdominal ventrite with a short and truncate lobe at middle (fig. 2, b [also Fig. 7 herein]) **41**
- 41(40).** Flight wings functional (longer than elytra and folded beneath them); pronotum with anterior and posterior marginal beading weak; scutellum subtriangular; mesotibia with few setae mostly $\frac{1}{5}$ or less as long as mesotibia *Phyllophaga senex* (Horn)
 — Flight wings reduced, non-functional; pronotum with anterior and posterior marginal beading distinct, delimited by row of round punctures within; scutellum subsemicircular; mesotibia with moderately dense brush of setae mostly $\frac{1}{4}$ to $\frac{1}{3}$ as long as mesotibia . . . *Phyllophaga benwarneri* Warner, n. sp.

Remarks. Saylor (1940) misidentified females of a different species as the female of *P. senex*, because his description mentions a prominent transverse ridge on the occiput, a character that is not present in specimens of *P. senex*. Also, although describing the female tarsal claws as having a triangular tooth at middle in the species account (p. 115), Saylor separates *P. senex* out at the beginning of his key to females (1940, p. 68) as having tarsal claws "...lacking any intercalated larger teeth." All female specimens of the "senex complex" examined are unique amongst USA *Listrochelus* in being flightless, with metathoracic wings shorter than the elytra. Additionally they lack a transverse ridge on the occiput, have a flat pygidium with medioapical fovea, and have all tarsal claws ventrally adorned with a slightly submedian triangular tooth and very weak serrations proximal to the tooth (e.g. Fig. 15–17); the serrations are usually obsolete distal to the tooth. Females of *P. benwarneri* may be distinguished from those of other members of the complex by having the scutellum nearly semicircular rather than triangular, and in having the clypeus biarcuate.

Sanderson (1958) tentatively determined two females of a dark brown form from "Flagstaff, Arizona" (probably a sandy locality at lower elevations nearby) as *Phyllophaga epigaea* Wickham; I examined these specimens and they are essentially identical to females of *P. senex* populations near Albuquerque, New Mexico (Fig. 9, 11). The unusual facies of *P. senex* complex females indeed give them an appearance more similar to that of females belonging to the subgenus *Eugastra* than to other *Listrochelus*, the similarities apparently the result of parallelisms for flightlessness. The weak tarsal claw serrations may be easily overlooked, and this coupled with the unusual gestalt probably led to Saylor's (1940) and Sanderson's (1958) misidentifications.

Evans and Smith (2020) follow Rivera-Gasparín and Morón's (2017) elevation of *Listrochelus* to generic status while maintaining as *Phyllophaga* subgenera other taxa scattered paraphyletically and polyphyletically in several more basal nodes than *Listrochelus*. Because there has yet to be a more comprehensive phylogeny of the New-World Rhizotrogini that includes a high level of taxon sampling, including many structurally similar Old-World groups and genetic sequencing data, I agree with recent authors such as Guzmán-Vásquez and Martínez-Martínez (2020) and Hernández-Cruz et al. (2019) and believe that it is premature to elevate *Phyllophaga* subgenera "piece-meal" and paraphyletically without a comprehensive analysis. Thus I am here retaining *Listrochelus* as a subgenus of *Phyllophaga*.

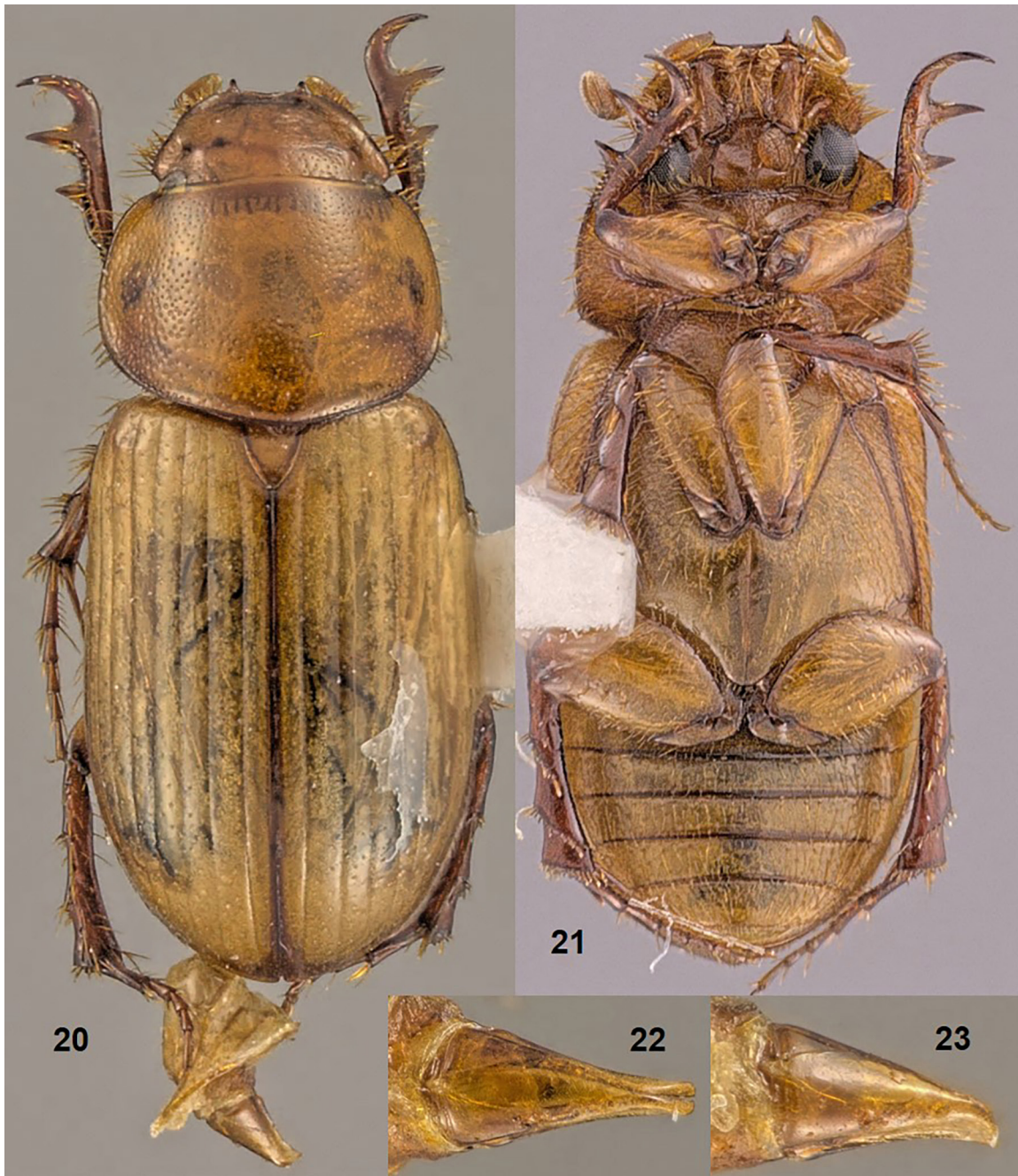
Cinacanthus cunninghami Warner, new species

Figures 20–28

Diagnosis. Elytral and clypeal discs lacking long setae; pronotum with posterolateral angles obsolete; protibia with ramus unusually narrow, teeth unusually long and narrow.

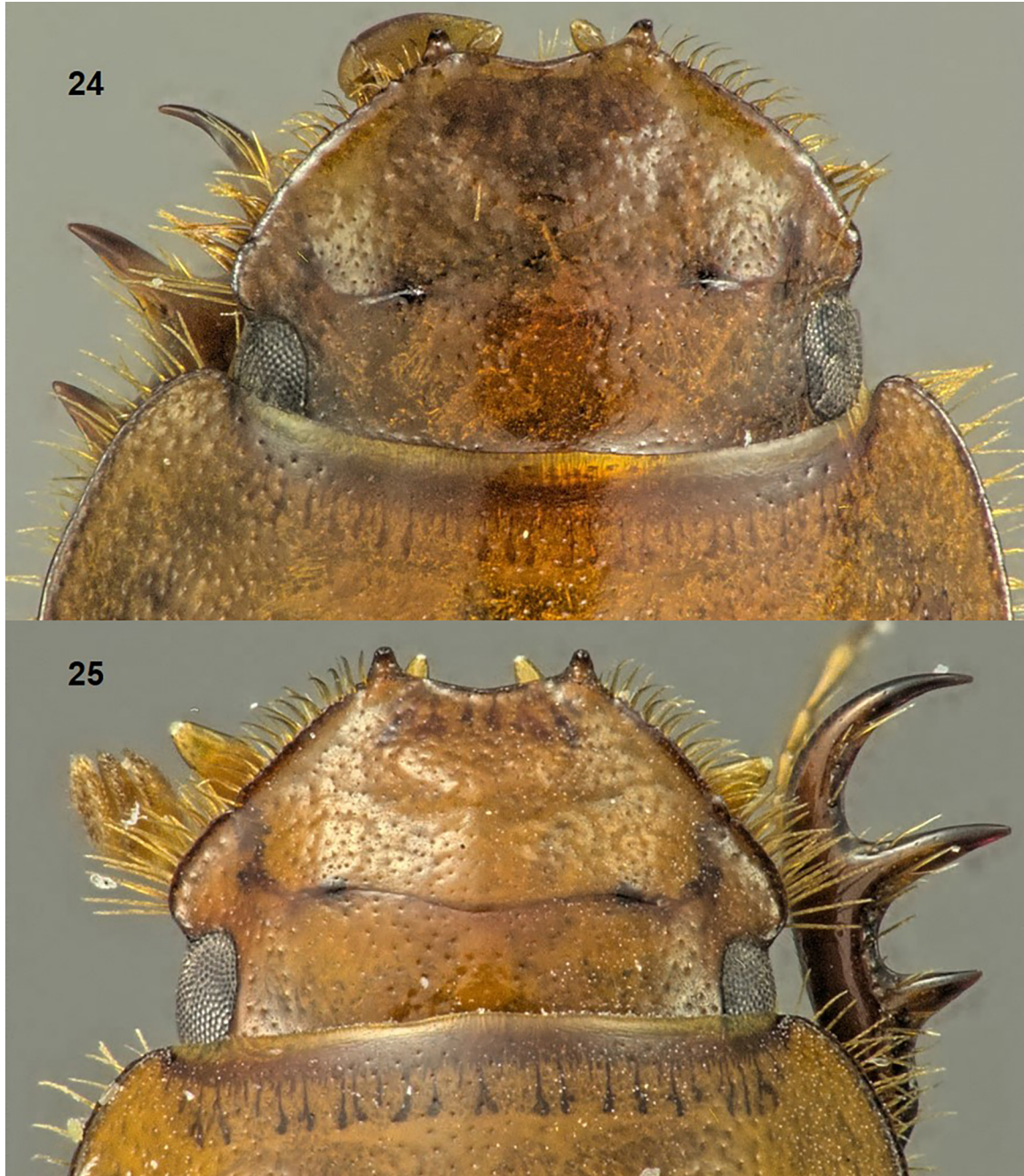
Type data. Holotype male (deposited at ASUT) and allotype female labeled: "USA: AZ: Coconino Co., dune 1.5 mi. WSW of Moenkopi; 36°05'56"N, 111°12'03", May 4, 2013, W.B. Warner & R.A. Cunningham".

Description of holotype male. Length: 5.5 mm; widest width (about apical $\frac{3}{5}$ of elytron): 2.5 mm. Body (Fig. 20) elongate-subpyriform, body and legs light reddish-brown, elytra testaceous, integument subtransparent, flight wings visible through elytra. Head (Fig. 24) subtrapezoidal, with free margins weakly convex and fimbriate, genae prominent from eyes but continuous with lateral margins of clypeus which are weakly irregularly serrate-crenulate, apex emarginated, at each side of emargination with distinct narrow tooth arising from beneath



Figures 20–23. *Cinacanthus cunninghami*. 20) Male dorsal habitus. 21) Female ventral habitus. 22) Male genitalia, dorsal view of parameres. 23) Lateral view of parameres.

margin, tooth reflexed and extending anterodorsally; clypeofrontal suture bisinuate, front and upper clypeus finely, sparsely punctured similar to anteromedial area of pronotum, medially mostly impunctate, apical half of clypeus obscurely tuberculate-punctate, epistome between clypeal teeth with weak semicircular depression covering nearly half clypeal length; in dorsal view, eye small, about $\frac{1}{2}$ of dorsal interocular width. Pronotum broad (length about $\frac{4}{5}$ width), laterally explanate with fimbriate margin, widest slightly anterior to middle, posterior margin vaguely obtusely angulate, but very broadly rounded, marginal bead fine but distinct on lateral margins, obsolescent between humeri and obsolete on anterior margin, posterior angles nearly obsolete, anterior angles



Figures 24–25. *Cinacanthus cunninghami* dorsal views of head. 24) Male. 25) Female.

rounded, disc in middle third moderately punctate, punctures round, mostly separated by about 1–3 times their own diameters, punctures increasing in size and density laterally, posterolaterally pronotum slightly depressed and punctures becoming even larger, elongate-subocellate and often subconfluent in longitudinal series (Fig. 26). Scutellum narrower than elytral sutural and second intervals taken together at elytral midpoint, slightly longer than wide, lateral margins convex to acutely angulate apex, disc very sparsely minutely punctate. Elytron about 2.3 times as long as pronotum, with 6 distinct, subequidistant striae between humerus and suture, striae finely punctate, punctures mostly separated by about 2–4 times their own diameters; intervals weakly convex, sparsely vaguely punctate, punctures irregular in size and placement, but mostly smaller than pronotal



Figure 26. *Cinacanthus cunninghami* male, dorsolateral view of head and pronotum.

punctures; posterolaterally punctures setigerous, setae short, erect. Venter (Fig. 21) with metasternite in middle third somewhat coarsely, sparsely punctate, setigerously punctate in lateral thirds, with broad shiny impunctate subtriangular area along posterior margin at each side, metasternal midline impressed; abdominal ventrites sparsely setigerously punctate. Legs delicate and narrow, protibia tridentate, teeth unusually long and narrow, basal tooth at about basal third of tibia, apical tooth evenly curving outward from middle tooth; spur obsolescent, minute and appressed to tibia, extending to about basal third of first protarsomere; meso- and metafemur with anteroventral sixth or so (i.e. area along posterior margin of normally “ventral” face in repose) in basal two thirds with setigerously and subcontiguously punctulate patch, this area declivous and flattened, setae in patch subdecumbent, golden (Fig. 27); anterior femoral face at about ventral third with single line of darkened coarse setae in about distal $\frac{2}{3}$; metatibia subequal in length to metatarsus. Genitalia (Fig. 22–23) with parameres unadorned and subtriangular in lateral view, similar to those of other *Cinacanthus* species.

Female allotype. Length: 6.6 mm; widest width (slightly behind elytral midpoint): 2.5 mm. Very similar to male, differing primarily in secondary sexual characteristics: Clypeus with outer lateral margins less convex to nearly straight (Fig. 25), protibial spur more prominent and visible, though tiny, extending to about middle of first protarsomere, protibia usually less bowed; metafemur in anteroventral fifth (i.e. near posterior edge of visible face in repose) simply punctate, with scattered hairs (Fig. 28), not flattened and declivous.

Paratypes. 9 males, 5 females with data: Same as holotype (4m, 2F); same except “iv.4–5.2013” (1m); same except: “dunes at night, April 20, 2012, W.B.Warner, J.P.Gruber” (1m, 2f); same except: “April 24, 2014, on dunes-night & UV light, W.B.Warner” (2m, 1f); same except: “Hwy.264, 2.1 rd. mi. SE Moenkopi; 11 August 1992; R. A. Cunningham, collector; in sand dunes, MV & BL” (1m).

Specimens are deposited in the following collections: ASUT, CSCA, FSCA, RACC, UAIC, WBWC.



Figures 27–28. *Cinacanthus cunninghami* ventral views of mesofemora. 27) Male (arrows indicating setal tufts). 28) Female, setal tufts lacking.

Variation. Males: Length 5.2–6.3 mm, widest width 2.4–2.9 mm. Females: Length 5.8–6.7 mm, widest width 2.6–2.9 mm. Other than variation in size, muting of setal length through wear, and vague color differences, the paratypes are remarkably uniform. Some females have one or both protibial spurs missing (lost; socket present); some males have a tiny, almost setiform protibial spur on one or both sides, spur being less than half size of female spur.

Etymology. I am pleased to name this species after Richard A. Cunningham of Show Low, Arizona, good friend and master scarab collector who captured the first known specimen of this species.

Habits and Habitat. The type series was collected on small dunes south of Moenkopi Creek; however, the dunes are not riparian, instead consisting of “spill-over” into the canyon from larger wind-blown dunes on the mesa above where this species probably also occurs. Primary perennial plants bordering the mostly bare dune are *Atriplex*, *Artemisia*, and *Ephedra* species. I observed a few specimens flying very rapidly (for an aphodiine)

approximately 15 cm above the surface of open sand of the consolidated dune at dusk. I knocked one specimen by hand onto a blacklight sheet as it flew by before dark, but it did not appear to be attracted to the light. Other specimens were collected at blacklights after dark, and some specimens were collected in black pitfall traps (empty, simulating rodent burrows) set shortly before dusk and picked up after dark. No specimens were seen on the hardpan surrounding the dune. Given this, its unusual gracile tibial form, light pigmentation and subtransparent elytra, *C. cunninghami* is apparently a true arenophile.

Based on known habits of other *Cinacanthus* species, this species is expected to be an inquiline of kangaroo rats (*Dipodomys* species) or other burrowing rodents whose burrows are common at the type locality. Other aphodiine species collected with *C. cunninghami* using the same methods were *Cinacanthus* near *ulkei* Gordon, *Tetraclypeoides moquinus* (Fall), and *Dellacasiellus* near *milleri* Gordon and Skelley.

Relationships. *Cinacanthus cunninghami* phenotypically appears to be intermediate between *C. militaris* (LeConte), *C. hirsutus* (Brown) and *C. coquillettii* (Linell): It has the pronotum laterally explanate and posterolateral pronotal punctures enlarged vaguely similar to those of *C. coquillettii*, but lacks the short clypeal hair of that species. Although vaguely similar in general facies, specimens of *C. hirsutus* are darker, more coarsely punctate, and have thicker protibiae, distinctly setose elytra, and pronotal margins that are usually obviously crenulate. The only other *Cinacanthus* species with adults that have gracile protibiae is *C. militaris*, though even in that species the tibiae are noticeably thicker than those of *C. cunninghami*. Additionally, specimens of *C. militaris* has a more quadrate pronotum with finer punctures.

Cinacanthus cunninghami keys as far as *C. crenicollis* (Fall) in Gordon and Skelley's (2007) key to *Cinacanthus*; but has a different pronotal shape. The applicable couplet may be modified to accept this species as follows:

- 4(3). Pronotal punctures comparatively small laterally in basal $\frac{3}{4}$, 3–6 times as large as punctures on vertex; pronotum normally convex, posterior angles various **4a**
 — Pronotal punctures large laterally in basal $\frac{4}{3}$, 8–10 times as large as punctures on vertex (Fig. 931–932); pronotum strongly convex, posterior angles obscure, oblique, broadly rounded; pronotum not quadrate **5**
- 4a(4). Protibia with width of ramus between teeth narrow, equivalent to distinctly less than half distance between apices of clypeal teeth; pronotum subpentagonal, laterally explanate, basolateral margins oblique, with posterior angles broadly rounded, subobsolescent ***C. cunninghami* Warner, n. sp.**
 — Protibia with width of ramus between teeth moderately wide, equivalent to about half distance between apices of clypeal teeth; pronotum subquadrate, only weakly explanate laterally, with posterior angles more narrowly rounded and distinct ***C. crenicollis* (Fall)**

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