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PHYLOGENETIC REVISION OF THE GENUS ARENIVAGA (REHN) (BLATTODEA: CORYDIIDAE), WITH DESCRIPTIONS OF NEW SPECIES, A KEY TO THE MALES, AND AN INVESTIGATION OF ITS ECOLOGICAL NICHE

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by

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B.A., History, Grinnell College, 1987
M.A. (cum laude), Education, Chapman University, 1998

DISSERTATION

Submitted in Partial Fulfillment of the
Requirements for the Degree of

Doctor of Philosophy

Biology

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ACKNOWLEDGMENTS

This work was originally intended as a small, 9-species-genus revision. It has turned into an epic exploration of the largest endemic cockroach group in the United States. This challenge was taken on by a systematic novice motivated entirely by her love for the taxon, who was fortunate enough to be admitted to a beetle systematics lab, as there are no cockroach systematic labs in the United States. I hope my work might stimulate study of the world's desert cockroaches and cockroaches in general. I also hope some future lover of cockroaches will look at this group again before another century passes; they are well worth the great demands they make.

I wish to express my gratitude to my advisor, Dr. Kelly Miller. His encouragement of my work on the lowly cockroach, and patience with my shortcomings, have been great. I also want to thank my committee Dr. Lowrey, Dr. Witt, and Dr. Ware for their time and efforts on my behalf as well as my collaborator Dr. Giermakowski.

I suffered considerable personal losses during the research and writing of this dissertation and the following people have been not only helpful colleagues but true friends through thick and thin: Dr. Sandy Brantley, Dr. Dave Lightfoot, Lorraine McInnes, Karen Wright, Cathy Osborn, Rachael Mallis, Jason Bengtson, Mike Ver Hagen, Dr. Julie McIntyre, Dr. Kristen Vanderbilt, and Phil Tonne. My petsitter, Trisha D'Angelo Pillars has been a friend and a blessing to me and my pets.

The inter-library loan service and the Molecular Biological Facility at UNM have been hugely valuable assets to my work on *Arenivaga*. The Visionary Digital photographic system designed by Roy Larimar has been a priceless workhorse for me and produced many of the wonderful photographs in this dissertation. I am particularly grateful to all the loaning institutions, especially those that allowed me to do destructive sampling in an effort to obtain DNA from old museum specimens, and to Dr. David Furth (USNM) and Jason Weintraub (ANSP) for their generous loan of *Arenivaga* holotypes.

My work has been supported by grants from AMNH (Roosevelt Grant), ANSP (Jessup Fellowship), and USNMNH (Short-term Visitor Grant). I also received support from the Office of Graduate Studies at UNM (RPT Grant). I thank all these funding sources for their generous support. Karen Wright generously let me tag along during her summer fieldwork one summer when she was flush with grant support and I was not; this allowed me to obtain fresh *Arenivaga* specimens and discover a new genus.

Finally I want to offer my deepest thanks to my family and ex-husband. Their support and unflagging belief in me never fails to amaze me. I hope this dissertation serves as some small evidence that their faith was not misplaced.

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ABSTRACT

The cockroach genus *Arenivaga* is revised. Forty-eight *Arenivaga* species are recognized with nine previously known species and 39 described as new including the following: *A. pagana* **sp. n.**, *A. grandiscanyonensis* **sp. n.**, *A. haringtoni* **sp. n.**, *A. hopkinsorum* **sp. n.**, *A. umbratilis* **sp. n.**, *A. tenax* **sp. n.**, *A. impensa* **sp. n.**, *A. trypheros* **sp. n.**, *A. darwini* **sp. n.**, *A. nalepae* **sp. n.**, *A. sequoia* **sp. n.**, *A. mckittrickae* **sp. n.**, *A. gaiophanes* **sp. n.**, *A. belli* **sp. n.**, *A. estelleae* **sp. n.**, *A. delicata* **sp. n.**, *A. mortisvallisensis* **sp. n.**, *A. milleri* **sp. n.**, *A. pratchetti* **sp. n.**, *A. gumperzae* **sp. n.**, *A. rothi* **sp. n.**, *A. ricei* **sp. n.**, *A. adamsi* **sp. n.**, *A. nicklei* **sp. n.**, *A. akanthikos* **sp. n.**, *A. moctezuma* **sp. n.**, *A. paradoxa* **sp. n.**, *A. apaeninsula* **sp. n.**, *A. hebardi* **sp. n.**, *A. dnopheros* **sp. n.**, *A. aquila* **sp. n.**, *A. florilega* **sp. n.**, *A. galeana* **sp. n.**, *A. gurneyi* **sp. n.**, *A. pumila* **sp. n.**, *A. hypogaios* **sp. n.**, *A. diaphana* **sp. n.**, *A. nocturna* **sp. n.**, *A. alichenas*

sp. n. All species are described or redescribed, major morphological features are illustrated, distributions are characterized, and the biology of the species is reviewed. A neotype series is designated for *A. investigata* Friauf & Edney.

The phylogenetic relationships between 24 species of the Corydiid cockroach genus *Arenivaga* were investigated using morphological and molecular data. The molecular dataset included the following markers: the nuclear gene histone III (H3), the mitochondrial ribosomal RNA gene 12S (12S), and the mitochondrial cytochrome c oxidase I gene (CO1). The phylogenetic relationships of these 24 species were then explored using three optimality criteria: parsimony, maximum likelihood and Bayesian analyses. The putative sister genus *Eremoblatta* and more distantly related *Blatta orientalis* were used as outgroups. A partitioned Bremer analysis was performed to provide some insight into which portions of the data provided the most evolutionary insight into this unusual group of insects. All analyses confirm the genus is monophyletic. Several relationships within the genus are recovered with strong support. Both the parsimony and likelihood estimations fail to provide good resolution along the backbone of the generic tree, whereas the Bayesian estimation resolves most nodes. Most of the strongly supported relationships are reinforced by both geographical distribution and genital morphology.

The relative contributions of 23 ecological variables to the niche of the genus *Arenivaga* were examined. This analysis revealed that more than 95% of their ecological niche could be described by eight variables: soil, isothermality, minimum temperature of the coldest month, mean temperature of the driest quarter, annual precipitation, precipitation of the driest month, precipitation of the wettest quarter and ground cover.

These eight variables with respect to their relative contributions to the niche of the genus as a whole as well as the individual niches of 27 species in the genus were then examined. This revealed the similarity of niche composition of most of the species, as well as how varied the niches were of several species. A species dendrogram built from similarity of contribution of the eight variables to niche composition was compared to a phylogeny of the genus, but few similarities in topology were found. This analysis revealed that soil is the most important contributor to these species' niches, followed by precipitation of the driest month, and finally, precipitation of the wettest quarter. It also confirmed that the majority of *Arenivaga* species have niches comprised of similar, but not identical, proportions of as few as four, and as many as eight ecological variables. Currently there is no evidence to support niche conservatism between closely related species, indicating that adapting to new and variable niches is one of the drivers of speciation in this genus.

INTRODUCTION

This document comprises three papers prepared for publication in professional, peer-reviewed journals produced in partial fulfillment of a PhD. Degree in Biology at the University of New Mexico. The first chapter is a revision of the genus *Arenivaga* (Blattodea, Corydiidae), an unusual group of desert cockroaches that are found in the American Southwest, Florida, and Mexico. This genus has not been revised since 1920 and this research produced an astounding 39 new species, as well as descriptions and distribution maps for all 48 species in the genus. In addition, a comprehensive, illustrated key to the genus was created. This first chapter has already been published in Zookeys (Hopkins, 2014). ZooKeys 384: 1–256 (2014) doi: 10.3897/zookeys.384.6197

The second chapter is the first phylogeny ever produced for the genus. This paper details the first morphological character matrix for *Arenivaga*, in addition to the efforts made to obtain molecular character data. The data obtained was concatenated and used in parsimony, likelihood, and Bayesian phylogenetic analyses. Complete data could only be obtained for 24 of the 48 species, but monophyly of the genus is tentatively established, and the putative sister genus, *Eremoblatta*, is confirmed. Several clades are recovered consistently across all optimality criterion, as is a basal species in the genus, interesting in that it contains a morphological character intermediate to *Arenivaga* and *Eremoblatta*. This paper is currently under review.

Finally, the third chapter presents an assessment of the ecological niche of *Arenivaga* and of 27 species within the genus for which there was adequate sampling data. This analysis used data for 23 biotic and abiotic variables gathered from BioClim (http://worldclim.org/bioclim) (Hijmans et al., 2005; Busby, 1991), the Harmonized

World Soil Database (HWSD) (FAO et al., 2012), vector ruggedness measure or VRM (Hobson, 1972; Sappington et al., 2007), a measure of altitude (digital elevation model or DEM), and the Global Land Cover 2000 (GLC2000) database (Latifovic et al, 2003; 2004). A MaxEnt model revealed that eight of the 23 variables examined account for more than 95% of the ecological contributions to the niche of *Arenivaga* and the 27 examined species. Nonparametric multidimensional scaling analysis was used to portray in two dimensions the impact of the selected eight variables on individual species' distributions and evaluated the overlap of variable importance between species based on this ordination. These analyses contributed to the conclusion that *Arenivaga* species do not have highly conserved niches, but rather evolving ones, and are highly adaptive organisms. This paper is currently under review.

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A revision of the genus *Arenivaga* (Rehn) (Blattodea, Corydiidae), with descriptions of new species and key to the males of the genus

by

Heidi Hopkins

Abstract

The cockroach genus *Arenivaga* is revised. Forty-eight *Arenivaga* species are recognized with nine previously known species and 39 described as new including the following: *A. pagana* **sp. n.**, *A. grandiscanyonensis* **sp. n.**, *A. haringtoni* **sp. n.**, *A. hopkinsorum* **sp. n.**, *A. umbratilis* **sp. n.**, *A. tenax* **sp. n.**, *A. impensa* **sp. n.**, *A. trypheros* **sp. n.**, *A. darwini* **sp. n.**, *A. nalepae* **sp. n.**, *A. sequoia* **sp. n.**, *A. mckittrickae* **sp. n.**, *A. gaiophanes* **sp. n.**, *A. belli* **sp. n.**, *A. estelleae* **sp. n.**, *A. delicata* **sp. n.**, *A. mortisvallisensis* **sp. n.**, *A. milleri* **sp. n.**, *A. pratchetti* **sp. n.**, *A. gumperzae* **sp. n.**, *A. rothi* **sp. n.**, *A. ricei* **sp. n.**, *A. adamsi* **sp. n.**, *A. nicklei* **sp. n.**, *A. akanthikos* **sp. n.**, *A. moctezuma* **sp. n.**, *A. paradoxa* **sp. n.**, *A. apaeninsula* **sp. n.**, *A. hebardi* **sp. n.**, *A. dnopheros* **sp. n.**, *A. aquila* **sp. n.**, *A. florilega* **sp. n.**, *A. galeana* **sp. n.**, *A. gurneyi* **sp. n.**, *A. pumila* **sp. n.**, *A. hypogaios* **sp. n.**, *A. diaphana* **sp. n.**, *A. nocturna* **sp. n.**, *A. alichenas* **sp. n.** All species are described or redescribed, major morphological features are illustrated, distributions are characterized, and the biology of the species is reviewed. A neotype series is designated for *A. investigata* Friauf & Edney.

Introduction

The genus *Arenivaga* has not been revised in nearly a century (Hebard 1920). In that time only one new species, *A. investigata* (Friauf and Edney 1969), has been described. While revisions of this genus have been started twice since 1970, nothing has been completed or published. This represents a rather large taxonomic oversight as *Arenivaga* now proves to be the most species-rich genus of native cockroaches in the United States. How have these species-rich and extraordinary animals been overlooked for so long? The reasons include the historically poor funding of systematics of "minor" insect orders, the unfortunate and inaccurate reputation held by cockroaches as disgusting animals and therefore generally not "sexy" to study, and the knowledge, among interested parties, of how very difficult *Arenivaga* are taxonomically (Hebard 1920). Even though there has been no revisionary work on the group in 93 years, *Arenivaga* has been the subject of several physiological and ecological studies (Walthall and Hartman 1981; Edney 1968; Hawke and Farley 1971a, 1971b, 1973; Cohen and Cohen 1976, 1981; Edney and McFarlane 1974; Hartman et al. 1987; Edney et al. 1974, 1978; Jackson 1983; O'Donnell 1977; 1981, 1982; Appel et al. 1983). This work has scratched the surface of the phenology and physiology of these animals and revealed a little about the amazing adaptations that allow them to succeed in some of the harshest environments on earth. Here I provide a full revision of the genus, including redescriptions of the genus and its nine known species, descriptions of 39 new species, a key to the adult males, and distribution maps for each species. Novel morphological characters are also described. A total evidence phylogenetic hypothesis and biogeographic analysis of the genus, as well as an examination of the females of the genus, will be provided in separate publications.

"…we can state definitely that the present genus (*Arenivaga*) is the most difficult genera of Blattidae found in this country" (Hebard 1920, p. 201). Having spent more than four years studying the genus, the reasons this group is so complex and challenging to understand includes: *Arenivaga* are nocturnal and subterranean making them particularly difficult to find in the field; once in collections the specimens are extremely fragile making them a challenge to handle in a laboratory setting; their external morphology provides very few diagnostic characters making species identification in most cases impossible without genitalic dissection and clearing; many species exhibit a labile morphological response to their environment making the phenotype within a species highly variable; the genus is strikingly sexually dimorphic (Figure 1) making morphological association of females with males within a species all but impossible; there is one molecular study that included *Arenivaga* (Djernaes et al. 2012) resulting in three *Arenivaga* sequences on GenBank making the DNA analysis of this genus a near complete black box from primers to protocols; finally, there is no prior phylogenetic work on the genus.

Materials and methods

Material examined

This revision is based on examination of more than 5200 adult male specimens. Often cockroaches in natural history collections are not identified to genus, or even to family. This problem is exacerbated by unevenly used classifications of Blattodea, which are not generally based in modern phylogenetic hypotheses, a problem being worked on currently (Djernaes et al. 2012; Beccaloni and Eggleton 2013). United States specimens are better represented in this monograph than Mexican specimens. Mexico represents a very diverse region for *Arenivaga*, but is less well-collected for the group than the US.

Figure 1. Sexual dimorphism in *Arenivaga*.

Primary types were borrowed to aide in redescription of the nine described species; at this time it was discovered that both the holotype and all paratypes of *A. investigata* had been destroyed by dermestids, leaving only the pins and labels behind. A neotype series is therefore designated herein. Specimens were examined from the following collections:

AMNH	American Museum of Natural History
ANSP	Academy of Natural Science, Philadelphia
ASUT	Arizona State University, Tempe
MLBM	Monte L. Bean Life Science Museum, Brigham Young University

CAS	California Academy of Science
CSCA	California State Collection of Arthropods
CSLB	California State University, Long Beach
J Cole	Jeff Cole private collection
CUIC	Cornell University Insect Collection
EMEC	Essig Museum of Entomology, California
FSCA	Florida State Collection of Arthropods
HEH	Heidi Hopkins private collection
IMNH	Idaho Museum of Natural History
LACM	Los Angeles County Museum
MCZ	Museum of Comparative Zoology, Harvard
MSB	Museum of Southwestern Biology, Albuquerque
NAUF	Northern Arizona University, Flagstaff
NVDA	Nevada Department of Agriculture
OMNH	University of Oklahoma
OSEC	Oklahoma State University
OSUC	Ohio State University Collection
PMNH	Peabody Museum of Natural History, Yale
SDMC	San Diego Natural History Museum
SEMC	University of Kansas Snow Entomological Museum Collection
TAMU	Texas A&M University
UAIC	University of Arizona Insect Collection
UCMC	University of Colorado Museum Collection

UCRC University of California, Riverside

UMMZ University of Michigan Museum of Zoology

USNM National Museum of Natural History, Smithsonian Institution

WB Warner Bill Warner private collection

Two prior researchers at the Smithsonian, Drs. Nickle and Gurney, had begun a revision of *Arenivaga* in the early 1970s. While that revision was in progress, one of the researchers passed away and the other went on to other projects; the revision was never completed and the loans were never returned. The Smithsonian assigned those loans to me if I would take on the paperwork challenge of contacting all the loaning institutions to transfer the original loans or issue me new loan papers. Most collections were excited to hear about the specimens that had been "on loan" for more than forty years, and more than happy to issue new loans with updated specimen counts. The ownership of a small minority of specimens (31) could not be determined and those are now housed in my personal collection.

Data resources

The data underpinning the analyses reported in this paper are deposited in the Global Biodiversity Information Facility, http://ipt.pensoft.net/ipt/resource.do?r=*Arenivaga*_locality_data.

Taxonomic research in Blattodea and *Arenivaga*

Taxonomic research in Blattodea

Blattodea are a sadly understudied order of insects, but the field has benefitted greatly from a few dedicated researchers, four of whom I will mention here to create the setting in which my work was done. A masterwork of cockroach morphology (and family-level taxonomy until a very few years ago) is Evolutionary Studies of Cockroaches by Francis McKittrick (McKittrick 1964). This beautiful work, her PhD dissertation, unfortunately provides the poorest coverage of the Corydiidae (formerly Polyphagidae) (Beccaloni and Eggleton 2011). There is one drawing of the male genitalia of *A. bolliana* from a dorsal aspect, which is not useful for diagnosis in *Arenivaga*. Evolutionary Studies of Cockroaches is a family-level work and not designed for diagnosis of individual species; therefore, I do not use McKittrick's genitallic terms or abbreviations in this work, although Table 1 provides an equivalency of terms between her work and mine. Louis Roth described hundreds of new species over the course of his career but his families of specialization were Blattidae and Blattellidae and therefore also provide no reference for my work. Grandcolas (1996) is also a family-level work and has little application in my study. Table 1 provides terminological equivalency between his work and mine. Klaus-Dieter Klass produced a monumental work on cockroach genitalia (Klass 1997). This is an order-level work that examines genitalia of Blattodea and Mantodea by family. It has more coverage of Corydiidae than McKittrick's work but all drawings are again from a dorsal aspect and are therefore not helpful in this work. Corydiidae have received little attention at the subfamily and generic levels, and none at all in nearly a century. I therefore turned to the previous work on *Arenivaga* to serve as my guide in my research (see Taxonomic History below).

Table 1. Terms used to describe genital phallomeres in this study and those of McKittrick and Grandcolas. Note that the sclerites of the left phallomere are not diagnostic in *Arenivaga* so only one term is needed, and that the small central sclerite, not recognized by McKittrick, and designated as N (neoformation) by Grandcolas, is diagnostic in *Arenivaga*.

This Study	McKittrick (1964) (Fig. 110)	Grandcolas (1996) (Figs 2 and 3)
Left Phallomere	L1, L2, L4	L1, L2d, L3v, L2v
Genital Hook	L3	L3d, L2d
Right Dorsal Phallomere	R3	R3d
Right Ventral Phallomere	R1, R2	R2
Small Central Sclerite	---	N

In the interests of clarity and to create greater user-friendliness I am using full language terms for the genital phallomeres as opposed to the abbreviations favored by previous authors. For example, the genital hook is a common term used in describing the genital morphology of Blattodea, but in some families it is not particularly hooklike, and the term has been reduced to a numbered sclerite of the left phallomere (see Table 1 "Genital Hook"). In Corydiidae the genital hook is distinct, hooklike, and frequently diagnostic. For this reason I believe it is easier for the reader to understand the text and use the key if they do not have to look up which sclerite is, for example, L3d. I use standard terms indicating direction within the animal (left, right, ventral, dorsal) and provide a diagram of same to assist the reader in navigating the genitalia (see Figure 7).

Taxonomic research in Arenivaga

Other than the last species of *Arenivaga* described in 1969, (*A. investigata* Friauf and Edney 1969) no extant species had been determined by complete genitalic dissection and clearing, but rather by removal of the subgenital plate and examination and drawing in situ of the portions of the genital phallomeres so revealed (Figure 2). But when I attempted to remove subgenital plates from pinned specimens they could not be removed without damage to the plate or the specimen. I rehydrated specimens to make removal of the subgenital plate easier and to reduce damage, but in this molecular age I did not want to be adding water in any quantity to a specimen as this is known to degrade DNA and I had no way of knowing which specimens could prove vital to my future molecular analysis. Also, when I compared the completely dissected and cleared genitalia of *A. investigata* (Figure 3) to the in situ genitalia of the other eight species, I realized that there was considerable detail to the phallomeres on all sides that could not be seen from a static view of in situ genitalia. I therefore determined that *in situ* examination of *Arenivaga* genitalia would be insufficient to make species designations in most cases and it would be necessary to fully dissect and clear the holotype genitalia to ascertain true species designations. That was done, photographs of same were taken, and then drawings made from the photographs, which drawings appear in this monograph. Upon revision, the original nine species of *Arenivaga* all stand as good species.

Methods and techniques

Dissection of genitalia

Genitalia were dissected from dry specimens using a pair of microscissors to remove the entire genitalic capsule, taking care since dry specimens are very fragile. Specimens can be softened while preserving DNA by placing them for a short time in 95% ethanol after which the capsule may be cut off with less chance of damage to the specimen and less likelihood of the capsule being accidentally lost. Dissected capsules were then placed in 10% KOH solution at room temperature for three to five days to clear. There is considerable difference between specimens in the density of sclerotization

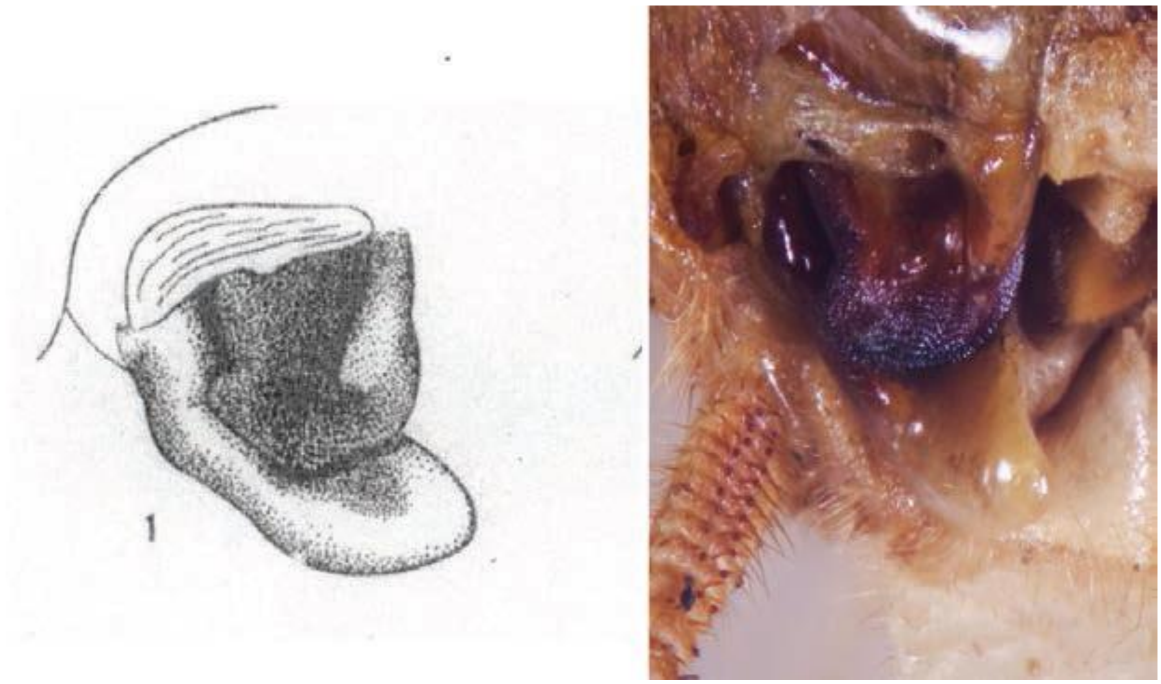


Figure 2. Hebard's drawing of genitalia of *A. bolliana* next to a photograph of same (Hebard 1920). (Drawing 1, Plate VII from Hebard 1920, used with permission of the Transactions of the American Entomological Society).

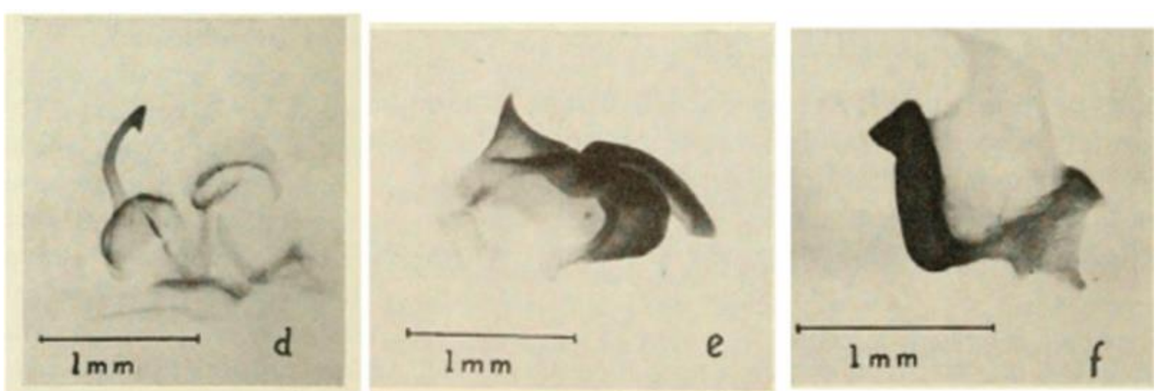


Figure 3. Photographs of the dissected and cleared genitalia provided when *A. investigata* was described (Friauf and Edney 1969). Note the extensive architecture that would be invisible if the phallomeres were left in situ. (Portions of Figure 1, Friauf and Edney 1969, used with permission of the Proceedings of the Entomological Society of Washington).

of the phallomeres, so capsules in KOH were checked beginning on the third day and then returned to solution if desired clearing was not achieved. Once cleared, the capsule was removed from the KOH solution, rinsed in DI water, and placed on a slide or watch glass. Using microdissection tools and a dissecting scope the subgenital plate was detached on one side and opened like a flap. Microtools were then used to carefully dissect away and remove sclerites other than the sub and supra genital plates, the digestive tract and rectum, muscle tissue, and other non-sclerotized material in the genitalic capsule. Remaining structures were the supra and sub genital plates, the cerci, the sclerotized genital phallomeres and genital hook (Fig. 4). Cleared genitalia were stored in a few drops of glycerin in open glass dishes pinned next to the appropriate specimen until thoroughly examined and illustrated. Then they were placed in glycerin in genitalia vials mounted on the specimen pin. On specimens dissected by previous worker the subgenital plate was left as a flap on the whole dry specimen or glued to a card attached to the pin. In both instances the subgenital plate is frequently broken off and lost or damaged. In some cases, when the genitalia were completely dissected the phallomeres were glued to a card and the card attached to the pin. These too are often broken or lost from the card. Therefore, I recurated into vials all genitalia I examined that were previously attached to a card on the specimen pin. This will provide more secure storage and preservation of vital structures.

Cleaning specimens

Many *Arenivaga* specimens are covered in dust or sand from their subterranean lifestyle, or moth scales from being captured in black light traps with Lepidoptera. They often have ant heads attached to an appendage and some specimens harbor mites.

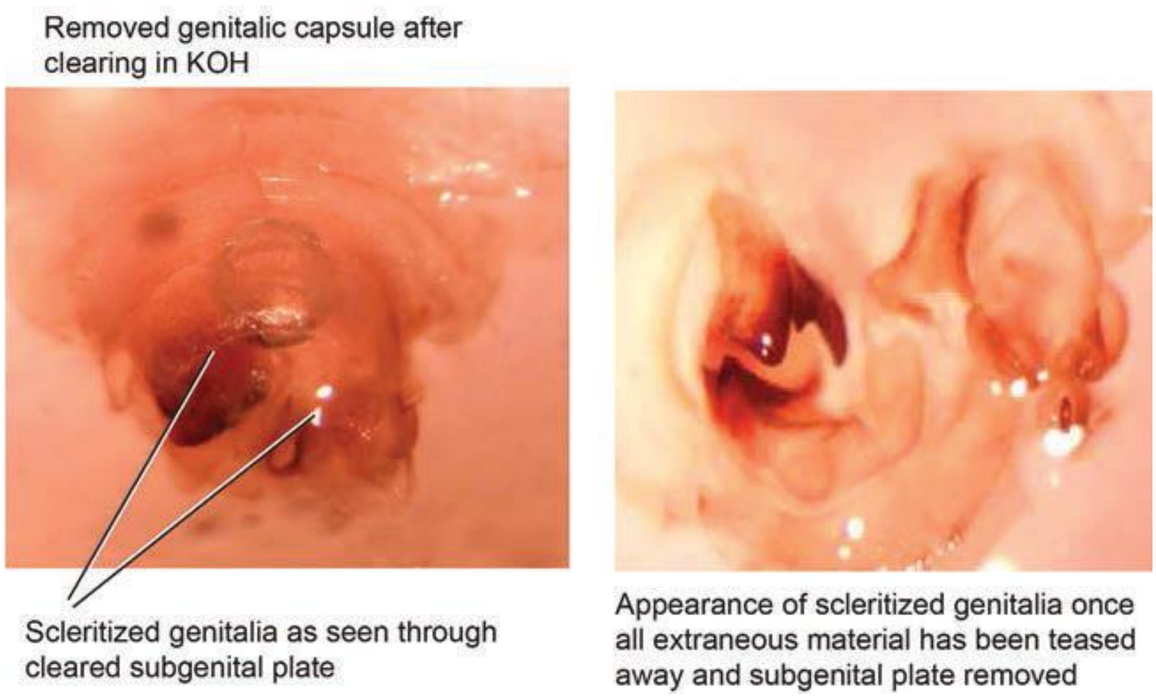


Figure 4. Photographs of cleared genitalia before and after unwanted material has been teased away.

Additionally, *Arenivaga* specimens are often greasy. Although dirty, these specimens are also too fragile to be easily thoroughly cleaned. In order to avoid damage to specimens I only cleaned holotypes, (the only specimens being photographed in most instances), and even then only cleaned the specimens to the extent that it was safe to do so.

Measurements

Measurements are provided to show the range of size within a species. The Total Length (TL), Greatest Width (GW), whole body ratio (TL/GW), Pronotal Length (PL), Pronotal Width (PW), pronotal ratio (PL/PW), maximum distance between the eyes EW), and maximum distance between the ocelli (OW) are given for the holotype. The maximum and minimum measurements of TL, GW, PL, and PW are provided for the entire species. All measurements were made with a Mitutoyo digital caliper or with a hand held micrometer used in conjunction with a Leica WILD M3C dissection microscope.

Descriptions

Descriptions in this project focus on adult males, currently the only *Arenivaga* life stage identifiable to species. In many cases, genitalic dissection and clearing are the only way to make a reliable species identification. For each species, the diagnostic genitalic feature(s) are indicated with arrow(s) on the drawing of the genitalia. Descriptions are based on the holotype (with the exception of the redescriptions of *A. erratica*, *A. grata*, *A. rehni*, and *A. tonkawa*) which could not be located in a timely manner due to extensive renovations taking place at the holding institution (ANSP). Many species of *Arenivaga* are variable in external phenotype, including size and, especially, color; such variation is included in each description.

Photographs and drawings

The dorsal and ventral habitus of all holotypes were photographed, as well as the pronotum and the anterior surface of the cranium (the face). In general, the best-preserved specimen was used for photography. All photographs were taken with a Visionary Digital BK+ light imaging system (www.visionarydigital.com, R. Larimer). The genitalia of *Arenivaga* are complexly three-dimensional in situ. Genitalia of all species were drawn using six pencil hardnesses, one white pencil and paper stumps. The drawings show the various phallomeres, and diagnostic characters are indicated with arrows. All genitalia have been drawn in ventral aspect following dissection.

Distributions

All distribution information is based on males. The type locality is provided for all species as well as a list of the label data for all specimens examined. Any illegible label data is indicated by question marks. My comments regarding label data are placed in brackets. Distribution maps are based on label data. Only rarely were latitude and longitude provided on the labels, thus each locality without these data was georeferenced using Google Earth. Coordinates were then entered into ArcGIS 10, and distribution maps produced.

Structural orientation, terminology and morphological features

Structural orientation and terminology

Orientation of the cockroach head can be particularly confusing because in insects, historically, much of the terminology is based on prognathous species. Since cockroaches are hypognathous the terminology requires some explanation. These and other descriptive adjectives (e.g. anterior, medial, etc.) are standardized here and shown in Figures 5 and 6. To preserve homology with other insect taxa, the area of the cranium with the mouthparts is the "anterior" part of the head, despite the fact that this part of the head is often directed ventrad.

The genitalia comprise three phallomeres, a small central sclerite and a genital hook, (Fig. 7). The left phallomere is rarely sclerotized to any great degree and is not drawn for most species. In a few species there are modifications to the left phallomere and in those cases the phallomere is drawn. In all drawings the right ventral phallomere has been separated from the right dorsal phallomere at the point where they articulate on the right side (Fig. 7). This was done so that the former may be rotated clockwise prior to

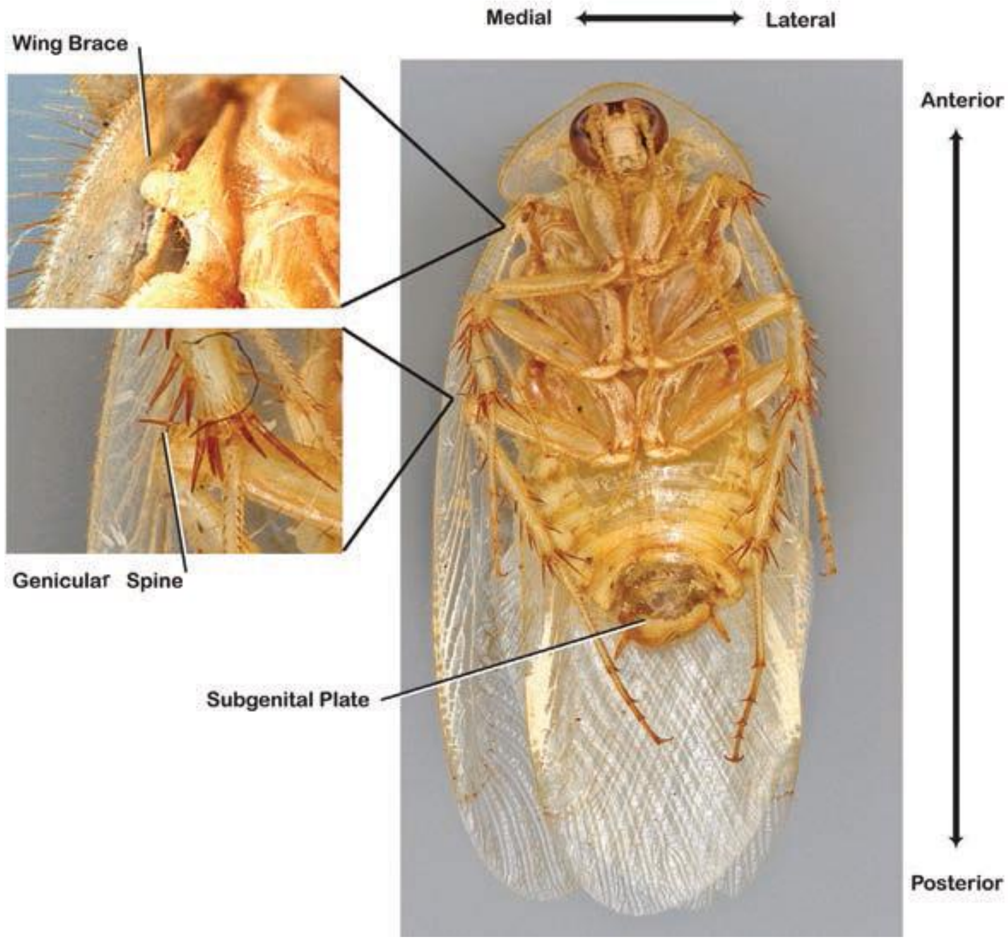


Figure 5. Labeled ventral habitus of *Arenivaga*.

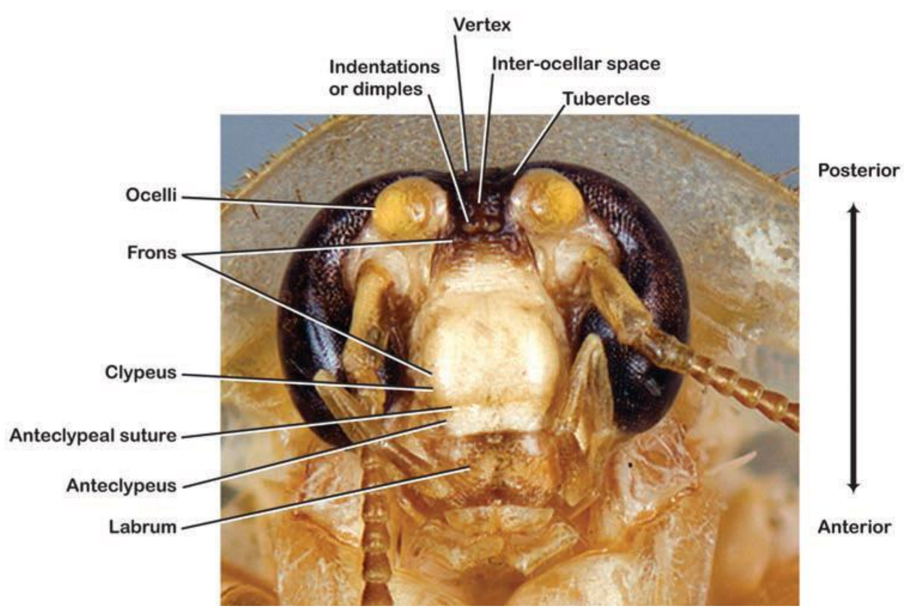


Figure 6. Labeled head of *Arenivaga*.

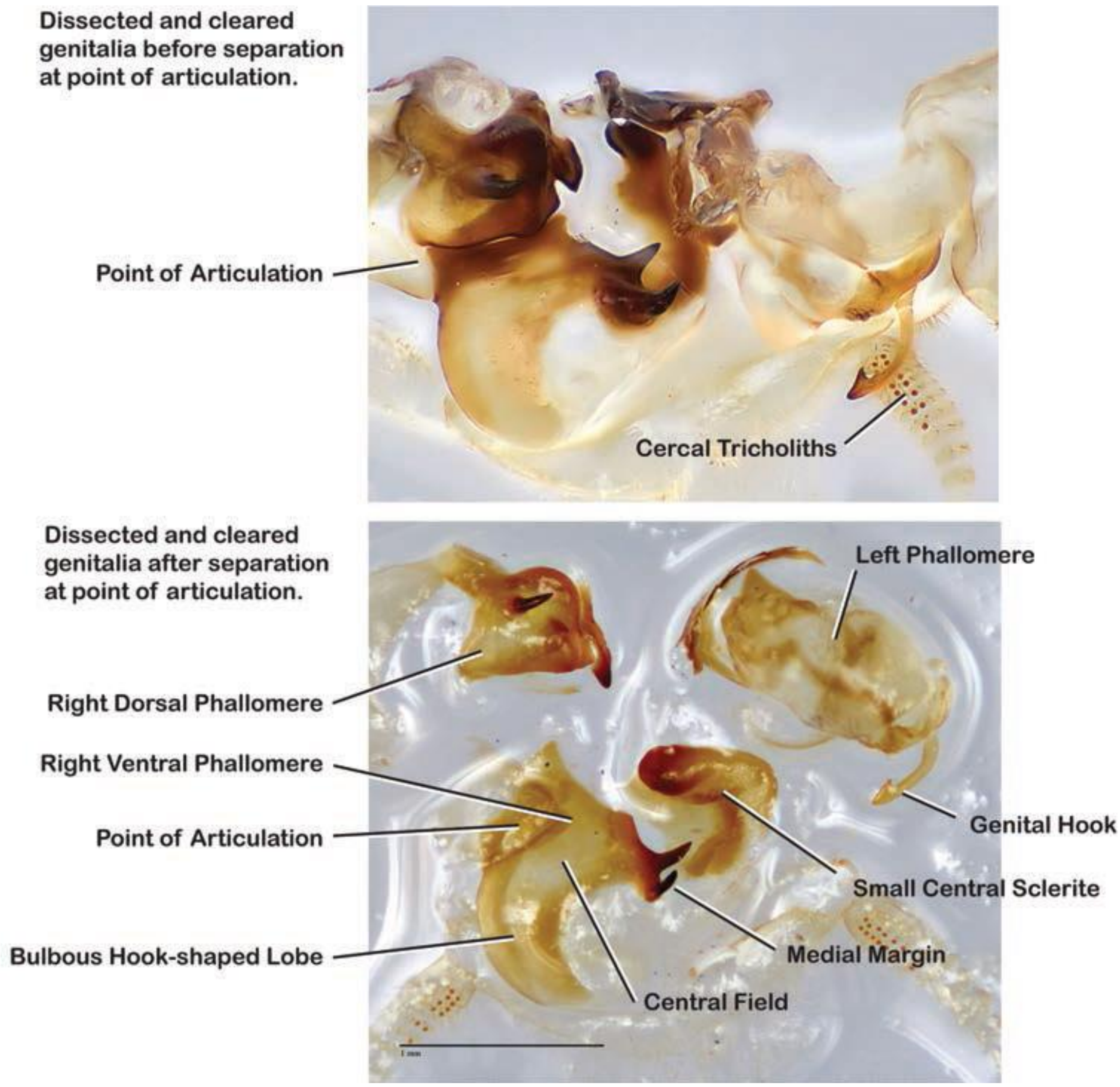


Figure 7. Labeled genitalia of *Arenivaga*.

drawing in order to show important details that are otherwise hidden. This permanent separation of the two phallomeres need not be done for species identification because the two phallomeres will open at the point of articulation sufficiently to see details.

Morphological features

Adult *Arenivaga* are strikingly sexually dimorphic (Fig. 1). Because the species taxonomy in the group is based on males, the following discussion of morphology used in the descriptions focuses on males. Males of all species are winged. They are generally gracile and small-bodied with the wings extending well beyond the end of the abdomen in most species. The animal is dorso-ventrally flattened. Although color is given for each body part for each holotype it can only rarely be relied upon for species identification. It is apparent that *Arenivaga* sequester color from their food (H. Hopkins, pers. obs.), like all cockroaches are white when teneral and don't set color for up to 24 hours after ecdysis, vary in color according to their habitat, and sequester varying amounts of uric acid which affects the appearance of color (Friauf and Edney 1969), all of which make color an unreliable character in *Arenivaga* except in a minority of species.

Head: Antennae are long and filiform, the eyes large and reniform, and the ocelli (of which there are two) are large and protruding. The size of the ocelli, distance between ocelli, and distance between the eyes are variable between species. The frons and post clypeus are joined and in most species bulging out from the face in a most unusual manner for Blattodea; in some species the area is less protruding. The clypeal suture is pronounced and the anteclypeus is flat. The labrum is broad. The coloration and indentations on the face are variable within and between species.

Pronotum: A large pronotum that covers the head like a hat or umbrella is the distinguishing character of cockroaches including *Arenivaga*. Their pronota entirely cover their heads and extend laterally, almost to the width of the body in many cases. All species' pronota are setose on the dorsal surface with a thick band of short hair along the posteroventral margin and setae of varying lengths protruding from the anterior margin. Nearly all species of *Arenivaga* have a characteristic pronotal pattern though in some it is faint or diffuse and may be impressed or not. The pattern may be surrounded by an aura of varying extent or none at all. See Figure 8 for examples of pronotal patterns

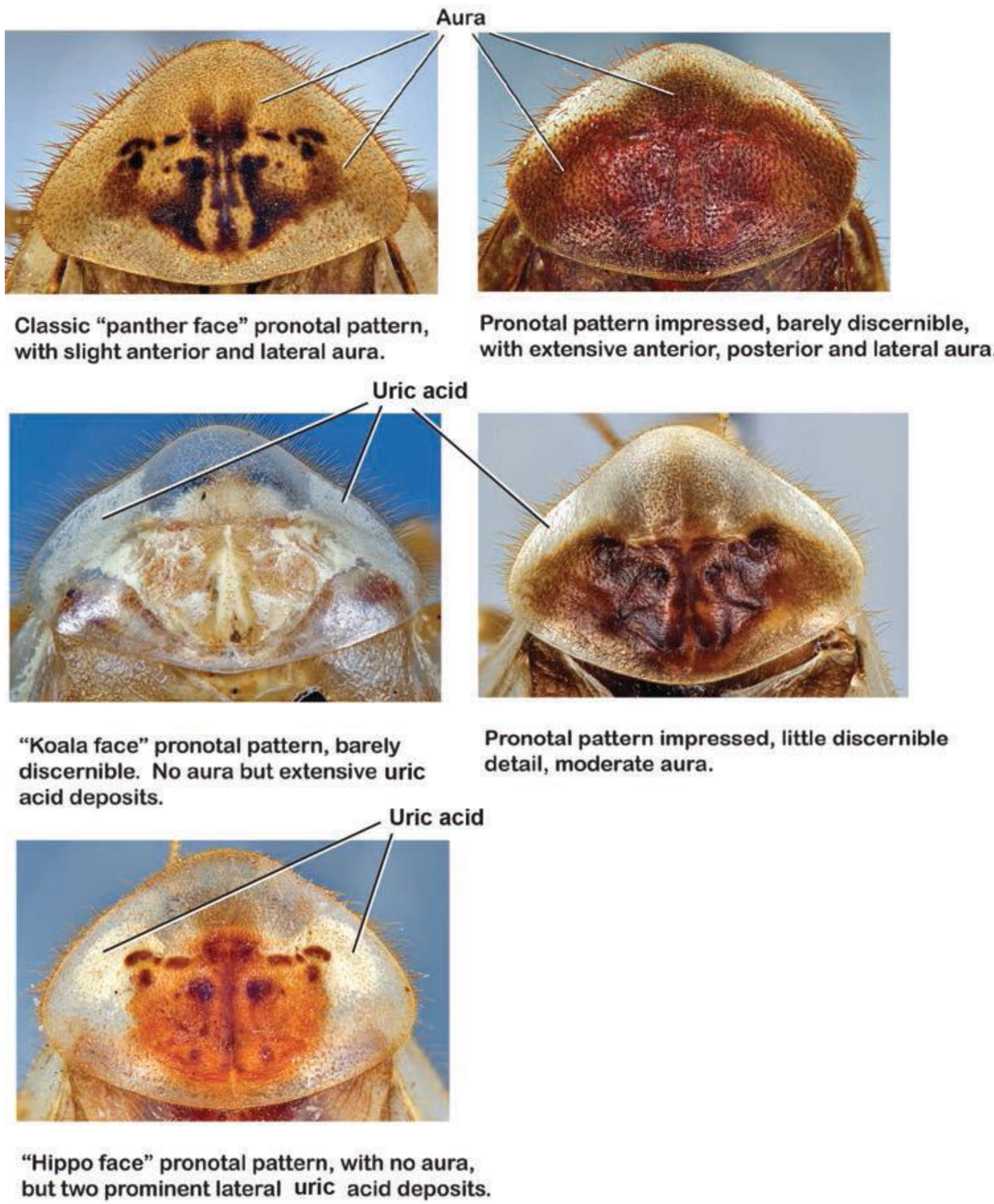


Figure 8. Examples of pronotal patterns, auras, and uric acid patches.

and auras. Pronotal aura should not be confused with patches of uric acid that are stored in the pronotum in many species. The aura radiates out from the pronotal pattern, may do so in all four directions, and is colored; uric acid patches are always located laterally on the pronotum (see Figure 8), are noncontiguous with the pronotal pattern, and are usually white though they may be a pale flesh-tone.

Body: The size range between species is considerable from tiny *A. pumila* (14.2 mm × 7.0 mm) to the largest *A. bolliana* (24.5 mm × 13.0 mm). The robustness is also wide-ranging from gracile *A. trypheros* (TL/GW 2.82) to broad *A. impensa* (TL/GW 2.16). All *Arenivaga* have two tarsal claws except for *A. darwini*, which has only one. The legs are heavily spined and genicular spines on the meso and metatibia were the defining character of the genus (Fig. 5). Some species have a wing brace, while others do not.

Forewings: The color, consistency of pigmentation (blotchiness), and degree of sheen of forewings are given in each description; most of these features are variable within species.

Genitalia: The genitalia of *Arenivaga* are complex. Variation in genitalia has been previously used to distinguish species (Rehn 1903, Caudell 1918, Hebard 1917, 1920, Friauf and Edney 1969) and it is the primary source of character information used to delimit species here. Although there is considerable variation in the genitalia across the group, in some cases the variation is subtle and species delimitation is difficult between potential species pairs. In addition to the striking variation in phallomeres, there is also variation in the genital hook and the subgenital plate (See Fig. 9). In one species, *A. rehni*, there appears an occasional rudimentary stylus on the right side of the subgenital plate in ventral view. Very occasionally there is the slightest hint of a second stylus on the left side in *A. rehni*. No other species showed evidence of styli. All close species designations (those that could be easily confused) are indicated in the individual descriptions and summarized in the Discussion section.

Subgenital plate with rounded apices.

Subgenital plate with angular apices.

Subgenital plate with pointed apices.

Figure 9. Examples of subgenital plates.

Classification

Taxonomic history

The name *Arenivaga* was first used by Rehn (1903) to circumscribe one of three subgenera of the genus Homoeogamia Burmeister, 1838. While describing a new species of Homoeogamia in 1893, Brunner placed the genus in the family Corydiidae. A year later, Saussure and Zehntner placed Homoeogamia in the subfamily Corydiinae (Saussure and Zehntner 1894). In 1903 Rehn erected three subgenera under *Homoeogamia: Homoeogamia sensu strictu*, *Arenivaga*, and *Eremoblatta*. He moved two species of *Homoeogamia* (*H. bolliana* (Saussure, 1893) and *H. apacha* (Saussure, 1893)) to the subgenus *Arenivaga*, and described one new species, *H. erratica* (Rehn 1903). Caudell (1913), recognizing seven Nearctic subfamilies of cockroaches, raised *Arenivaga* and *Eremoblatta* to genus rank and placed them in the subfamily Corydiinae. Hebard (1917), using Kirby's (1904) system of 16 cockroach subfamilies, placed *Arenivaga* in the subfamily Polyphaginae where it remained until the families Corydiidae and Polyphagidae, as well as the subfamilies Corydiinae and Polyphaginae, were recently synonymized by Beccaloni and Eggleton (2011). Hebard (1917) also described *A. rehni* Hebard 1917, and a year later, Caudell (1918) described two more species, *A. genitalis* Caudell 1918 and *A. floridensis* Caudell 1918. Hebard (1920) then revised the genus describing two new species, *A. tonkawa* Hebard, 1920 and *A. grata* Hebard, 1920. Finally, Friauf and Edney (1969) described *A. investigata* Friauf & Edney, 1969. The genus has not been revised since Hebard (1920).

Genus *Arenivaga* (Rehn, 1903)

http://species-id.net/wiki/*Arenivaga*

Figures 33–34

1903 Homoeogamia (*Arenivaga*) Rehn, Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 55, p. 188.

1913 *Arenivaga*, Caudell, Proceedings of the United States National Museum, Vol. 44, p. 605.

Type species. *Arenivaga bolliana* (Saussure) by original designation.

Distribution. The genus *Arenivaga* is found in central Florida and from Texas to

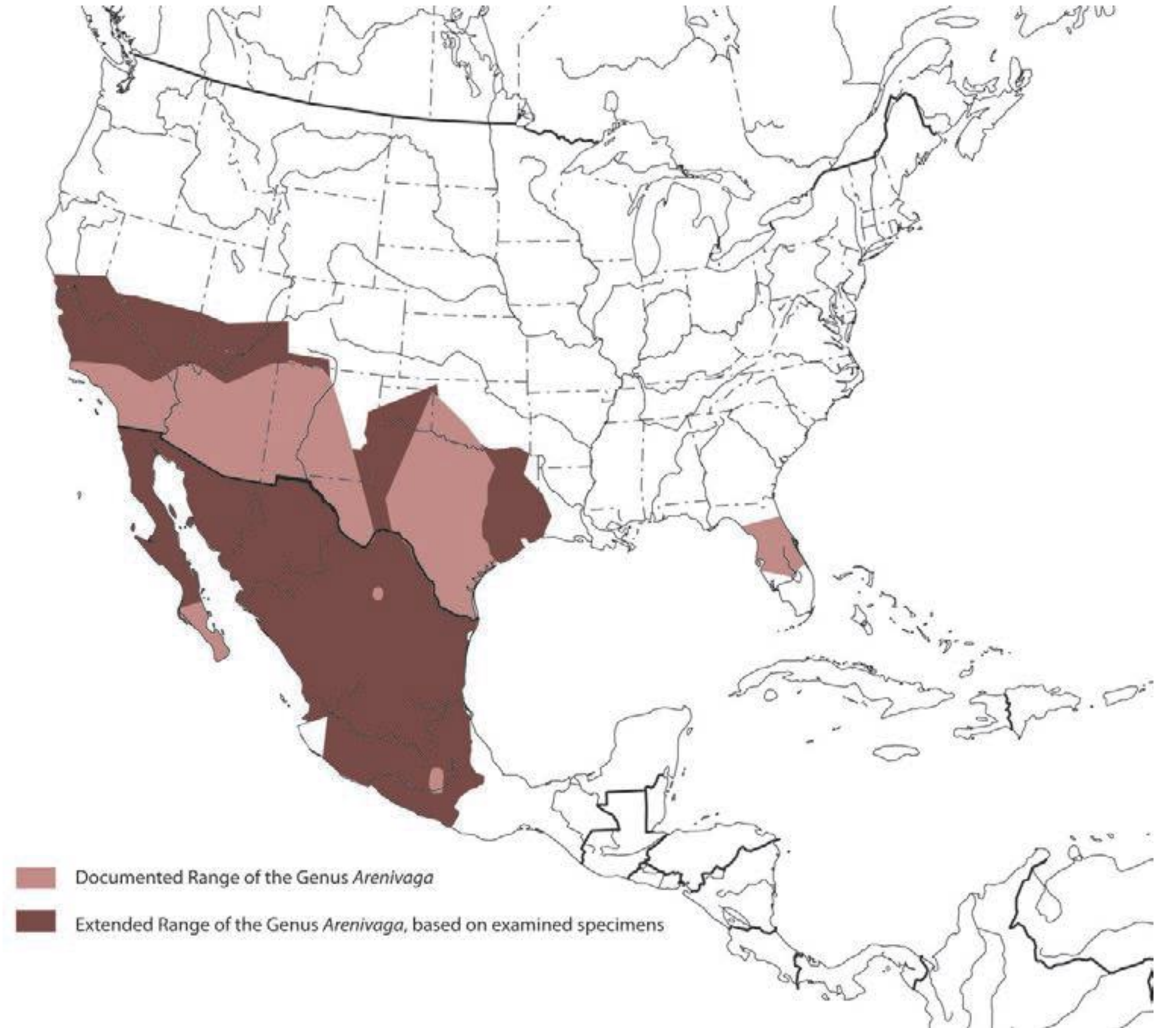


Figure 10. Previously documented and extended range of the genus *Arenivaga*.

California south into Mexico. They occur from about 39°N south to about 18°N (See Fig. 10).

Diagnosis. Until now, *Arenivaga* were diagnosed from other Corydiid genera by the presence of cercal tricholiths (Fig. 7) and genicular spines on the meta- and mesothoracic legs (Fig. 5). The sister genus *Eremoblatta*, has cercal tricholiths but no genicular spines on the legs. A new species described in this work (*A. diaphana*) has polymorphic genicular spines, the majority of specimens studied having no genicular spines but two specimens were found with the characteristic *Arenivaga* genicular spine distribution.

This undermines the character that until now separated *Arenivaga* from *Eremoblatta*. A gestalt of the phenotype of both sexes of the two genera allow easy determination between the two. But without some familiarity with both genera, or examples of both genera side by side, this method of determination is difficult. Generally speaking, *Eremoblatta* are smaller than *Arenivaga* and have pronota of consistent size with no pattern; the wings of the males are consistently glossy and wrinkled, and the females are considerably more hirsute than *Arenivaga* females. *Eremoblatta* do not appear to show intraspecific phenotypic variability due to variation in environment as do many *Arenivaga* species. The vast majority of *Arenivaga* specimens possess genicular spines on the meta- and mesothoracic legs, and the majority of specimens that lack genicular spines will be *Eremoblatta*. Genitalia provide a clear distinction as *Arenivaga* has a single-pronged genital hook and *Eremoblatta*'s is double-pronged.

Description. Male. Measurements. Holotype TL = 24.6 mm, GW = 13.0 mm, PW = 8.64 mm, PL = 5.60 mm, TL/GW =1.89, PL/PW = 0.65. EW = 0.40 mm; OW = 0.60 mm. Among paratypes range of TL 20.1–30.7 mm; range of GW 9.6–15.3 mm; range of PW 7.25–10.10 mm; range of PL 4.74–6.17 mm.

Head. Two ocelli large, ovoid and protruding; vertex flat, variable in color and width, most species with small ridges between apices of eyes that extend onto ocellar tubercles; interocellar space concave, of varying width, concavity depth and color. Frons color variable, tectiform, concave and/or with fine horizontal corrugations; margined on each side by ridges extending from medial margins of ocelli laterally to margins of clypeus with long or very long setae. Anterior portion of frons of variable color, bulbous to very bulbous in most species; clypeal suture with two proximal setae demarcating anteclypeus; labrum wide. Eyes large and reniform, medially emarginate, dark brown in life but color various in dried specimens. Antennae long, delicate and filiform, arising from medial emargination of eyes; antennomere number variable from ~53–67, though determination is made difficult by frequency of broken antennae on specimens.

Pronotum. Pronotum elliptical, variable in size, anterior margin convex, extending anteriorly over head; broad anterior margin translucent, waxy light brown. Setae of variable length along anterior margin; pale short dense setae projecting from ventral side of posterior margin; dorsal surface of pronotum covered with short setae; pronotal pattern may be impressed into surface or not, well demarcated or not, widely variable in color even within some species, with varying extent of aura; the pattern itself varies across the group and takes on certain distinctive appearances including semblance of "panther" or "hippo" faces, and, more rarely, a "koala" face pattern (Fig. 8).

Body. Abdomen and legs dorso-ventrally flattened; all legs heavily spinous and setose. Legs and body varying in color, often within a species; white deposits of uric acid visible through exoskeleton throughout body, legs, pronotum, and wing venation. Sternites rounded and setose laterally in most species. Wing brace (Fig. 5) may be present or absent but is consistent within each species. Tarsi with tarsomere I length equal to length of II-V combined; tarsomere IV shortest; with genicular spines on meso and metalegs (but see Diagnosis, above). Two tarsal claws present in all species but one. Subgenital plate asymmetrical with posterior edge emarginated, apices variable in shape; setose along posterior edge and posterior half of dorsal and ventral surfaces.

Forewings. Wings extended beyond abdominal apex to varying degrees; veins distinctly raised above surface anteriorly and laterally, becoming increasingly embedded in surface posteriorly and centrally; color ranges from pale clear golden tan to very dark brown; blotchiness absent in some species, consistent in others, variable in others; surface ranges from opaque to semi-opaque to translucent, and from matte to shiny; with variable length setae on anterior lateral edges decreasing to uniformly small posteriorly.

Genitalia. Distinctive and highly sculptural, the genitalia of *Arenivaga* distinguish and delimit species. This revision names and describes four phallomeres, though alternate interpretations of the limits of these structures are possible. While the structures are easy to homologize between species of the genus and close relatives, they are extremely difficult to homologize with the genitalia of other cockroach families or with a “generic” cockroach and no such analysis is attempted here. The phallomeres used in this revision are the right dorsal phallomere, the right ventral phallomere, the small central sclerite, and the left phallomere which includes the genital hook (Fig. 7). The two right phallomeres are hinged together on the lateral side of the animal but are disarticulated here prior to drawing so that as much detail as possible may be shown (Fig. 7).

Habitat and natural history. *Arenivaga*, Latin for “sand runner”, are found in the American southwest, Mexico, and Florida (Fig. 10). Females and nymphs are subterranean in sandy, dune habitats, feeding on mycorrhizal fungi, leaf detritus of desert shrubs, and the seeds collected by the mammals whose burrows they cohabit (Cohen and Cohen 1976, Hawke and Farley 1973). Their cryptic life history has never been fully documented although their adaptations for life in the desert are well-studied (Walthall and Hartman 1981, Edney 1968, Hawke and Farley 1971a, 1971b, 1973, Cohen and Cohen 1976, 1981, Edney and McFarlane 1974, Hartman et al. 1987, Edney et al. 1974, 1978, Jackson 1983, O'Donnell 1977, 1981, 1982, Appel et al. 1983). Mature males, the only winged form, live most of their short lives above-ground (Appel et al. 1983). Females are most active near and at the surface during summer, which is most likely the mating season. Mature females "swim" to the surface after dark when the first few centimeters of sand have cooled. There, they wander the surface of the sand, presumably attracting males using pheromones (Hawke and Farley 1973). Courtship has never been observed, but mating proceeds in the typical end-to-end manner found in other Blattodea (Figure 11).

Figure 11. *Arenivaga* pair in copula.

Species treatments

Arenivaga adamsi sp. n.

http://zoobank.org/0FCD7D02-CD7F-41B9-82D3-2AD1F0B5F3E9

http://species-id.net/wiki/*Arenivaga_adamsi*

Figures 12–14

Type locality. MEXICO, Sonora, Arroyo Cuchujaqui.

Material examined. Holotype: ♂ in EMEC labeled "Arroyo Cuchujaqui, 7 mi. SE Alamos, Son., Mex. VI-19-63, Collr: W. A. Foster" "HOLOTYPE *Arenivaga adamsi* Hopkins, 2012" [red label with black border].

Paratypes (32): MEXICO: Sonora,Nogales, 6/1/1966, alive with fruit on truck (1, USNM); Sonora, Guaymas area, Ejido Buenos Aires, citrus, 5/22/2004, 27.59.093N 110.57.437W, SIB 2004.0040 (1, UAIC); Sonora, Guaymas area, Nacapule Canyon, 5/27/2003, 28.01N 111.03W, SIB 2003.0027, Blue Tag 9000 (2, UAIC), Sonora, Guaymas area, SW bajada of Aguaje Mts., 5/19/2003, 28.001N 111.06W, SIB 2003.0004, Blue Tag 9000 (1, UAIC); Sonora, Guaymas area, Nacapule Canyon, 5/21/2004, 28.01N 111.03W, SIB 2004.0039 (1, UAIC); Sonora, Guaymas, 11/23/1969, Vars & Clifford (1, USNM); Sonora, Guaymas, 6/21/1962, AE Michelbacher (1, EMEC); Sonora, Guaymas, 7/23/1959, HE Evans (1, CUIC); Sonora, Navajoa, 6/24/1962, AE Michelbacher (1, EMEC); Sonora, Navajoa, 8/3/1952, C & P Vaurie (1, AMNH); Sonora, Navajoa, 8/18/1962, AE Michelbacher (1, EMEC); Sonora, Navajoa, 7/18/1972, J & MA Chemsak,A & M Michelbacher, at light (1, EMEC); Sonora, Arroyo Cuchujaqui,7 mi SE of Alamos, 6/19/1963, WA Foster (2, EMEC); Sonora, Alamos, 7/25-8/7/1953, Fred S. Truxal (4, LACM); Sonora, Cocorit, 6/11/1961, Menke & Stange (1, LACM); Sonora, 1.5 mi S of Presa de Mocuzari, 11/25/1967, R Rice, in rock pile (1, UAIC); Sinaloa, Baviri (playa) W of Los Mochis, 9/8/1986, Faulkner & Bloomfield (2, SDMC); Sinaloa, Los Mochis, 6/26/1962, AE Michelbacher (1, EMEC); Sinaloa, Los Mochis, 7/8/1922, CT Dodds, [Entire body missing] (1, CAS); Sonora, W side of Mazatan, 6/17/2012, N29.0017 W110.0863, 550 m, TR VanDevender & AL Reina-G, mesquite bosque, foothills thorn scrub on slopes (1, HEH); Sonora, W side of Mazatan, 8/13/12, 29.00472N 110.14806W, 550 m, TR VanDevender & J. Palling (3, HEH); Sonora, 6 mi. NNW of C. Obregon, 6/2/1954, AA Alcorn (1, SEMC). USA: AZ, Cochise Co., Douglas, 7/22-25/1969, VD Roth (1, SWRS); AZ, Cochise Co. 28 mi E Douglas, Guadalupe Canyon, 6/24/1970 (1, SWRS). All paratypes labeled "Paratype *Arenivaga adamsi* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named in honor and fond remembrance of Douglas Adams, whose writing makes me laugh, and who loved and respected all life on this planet.

Distribution. This species is found in central Sonora and northern Sinaloa Mexico and southeastern Arizona. See Fig. 14.

Diagnosis. *A. adamsi* may be confused with *A. moctezuma* but can be distinguished by the single large spine on the posterior end of the medial margin of the right dorsal phallomere. See Figs 11 and 104.

Description. Male. Measurements. Holotype TL = 17.5 mm, GW = 9.0 mm, PW = 6.13 mm, PL = 4.33 mm, TL/GW = 1.94, PL/PW = 0.71. EW = 0.30 mm; OW = 0.30 mm. Among paratypes range of TL 15.8–20.7 mm; range of GW 7.3–10.3 mm; range of PW 5.47–6.33 mm; range of PL 3.60–4.57 mm.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm); vertex dark brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space concave, medium brown. Frons translucent peach-brown, unusually wide, posterior concave; anterior portion of frons bulbous and translucent peach-brown; translucent peach-brown smooth anteclypeus. See Fig. 12d.

Pronotum. Pronotum translucent waxy beige; dorsal surface of pronotum with short orange-brown setae that are thicker and longer laterally; pronotal pattern orange-brown or red-brown “panther face”, with scattered maculations of same color as pattern; discernible detail within pattern variable; slight aura. See Fig. 12c.

Body. Wing brace present. Two tarsal claws present. Legs and body light orange-brown; many specimens with brown maculations laterally on each sternite; subgenital plate light orange-brown; asymmetrical with rounded apices. See Fig. 12b.

Forewings. Wings extended well beyond abdominal apex (up to 40% of wing length); blotchy medium to dark brown depending on specimen; surface matte and opaque. See Fig. 12a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, long, bulbous hook-shaped lobe, articulated with right ventral phallomere on lateral side; medial side of lobe deeply emarginated from medial edge of remainder of phallomere; central field shallow, cupped, lightly sclerotized; medial margin more heavily sclerotized, smooth, with long posterior projecting spine. Small central sclerite punctate, with large shagreened, rugose, medially projecting bilobed bulge; right ventral phallomere extends from articulation to form shagreened rounded structure, with prominent medially projecting spine located posteriorly; attached anteriorly is mildly dorsally projecting flanged smooth concave arm, that extends only slightly beyond depth of rest of phallomere, apex punctate. Folded anterior portion of left phallomere dramatically modified with sclerotized anterior wall and posteriorly projecting setose spine located ventrally. Genital hook with short extension to pointed head with moderate hook; arm smoothly curved. See Fig. 13.

Habitat and natural history. All life history elements remain unobserved.

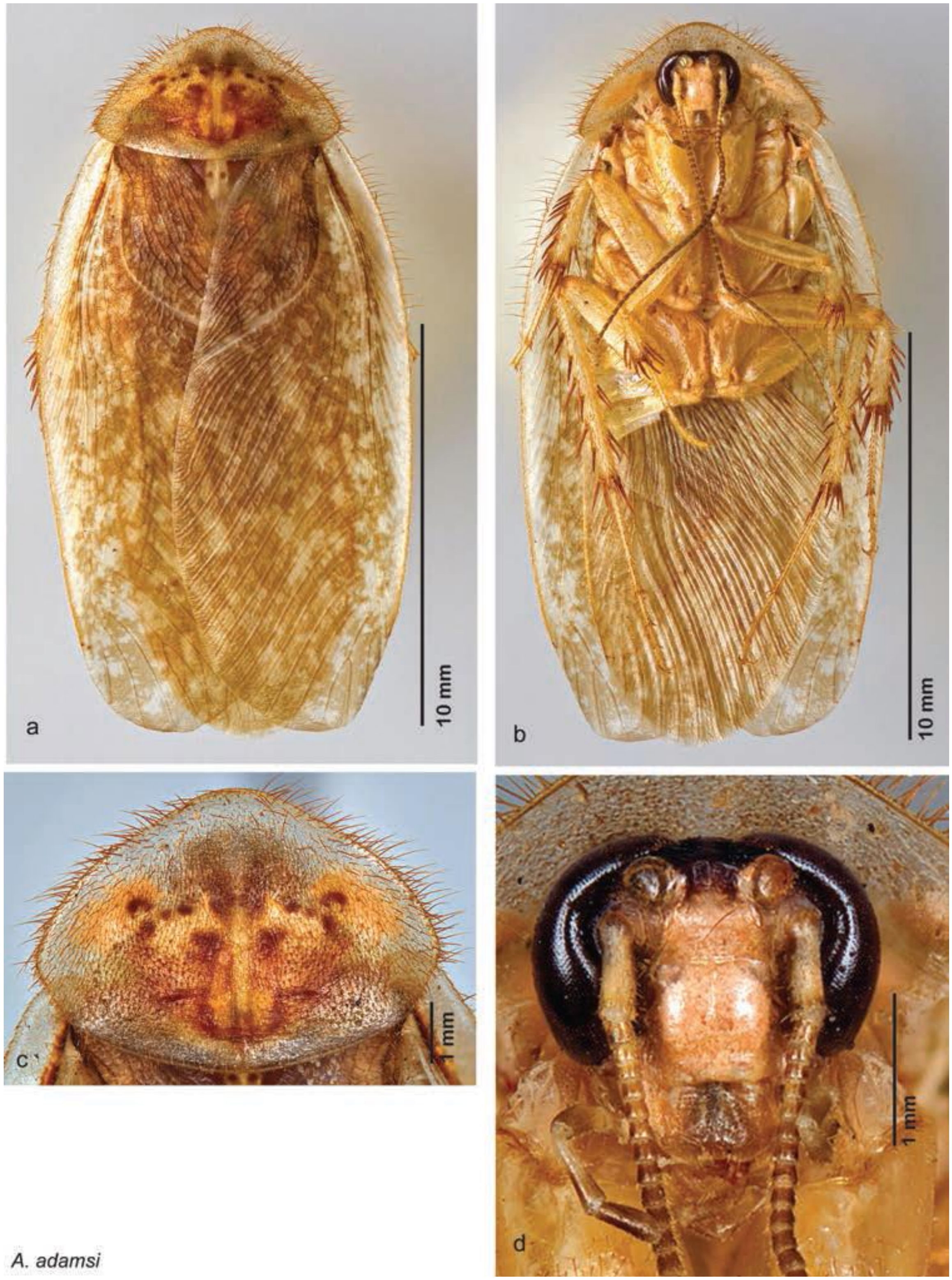


Figure 12. *A. adamsi*, a dorsal habitus b ventral habitus c pronotum d head.

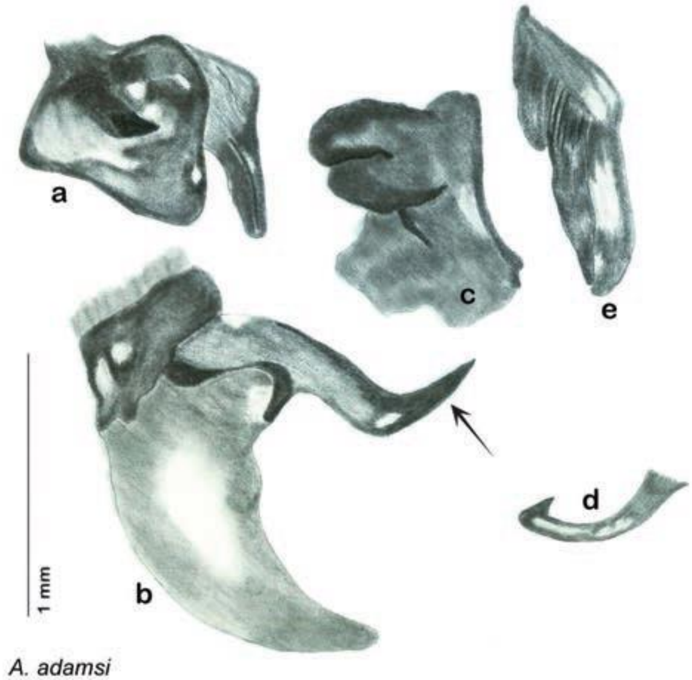


Figure 13. *A. adamsi*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook e left phallomere. Arrow(s) indicate diagnostic characters (see text).

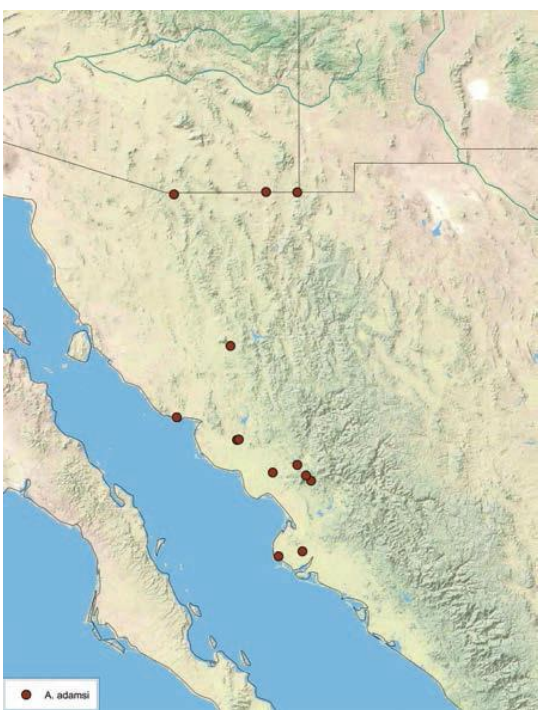


Figure 14. *A. adamsi*, distribution.

***Arenivaga akanthikos* sp. n.**

http://zoobank.org/7ED6E664-C9A5-4BEA-A5C7-EDDAF4284DA7

http://species-id.net/wiki/*Arenivaga_akanthikos*

Figures 15–17

Type locality. MEXICO, Sonora, 8 km W of Carbo.

Material examined. Holotype: ♂ in UAIC labeled "8 km. W. of Carbo, Son. Mex. 5-X-60, at light, Wm. W. Gibson Collector" "HOLOTYPE *Arenivaga akanthikos* Hopkins, 2012" [red label with black border].

Paratypes (1): MEXICO: Sonora, 8 mi W of Caborca, 3/20/1980, CE Griswold (1, EMEC). All paratypes labeled "Paratype *Arenivaga akanthikos* Hopkins 2012" [blue label with black border].

Etymology. The name is an adjective in the nominative singular. This species is named from the Greek meaning thorny because of the amazing number of thorns present on its genitalia.

Distribution. This species is found in the northwest part of Sonora, Mexico. See Fig. 17.

Diagnosis. *A. akanthikos* can be distinguished by its having three spines on right dorsal phallomere, one on the right ventral phallomere, one on the small central sclerite, and one on the left phallomere. See Fig. 16.

Description. Male. Measurements. Holotype TL = 18.3 mm, GW = 8.1 mm, PW = 5.84 mm, PL = 4.20 mm, TL/GW = 2.26, PL/PW = 0.72. EW = 0.25 mm; OW = 0.30 mm. No notable difference in size among paratypes.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm); vertex dark brown with small ridges in rays around upper apex of eyes and extending onto ocellar tubercles;

interocellar space concave, dark brown, with two small round indentations. Frons waxy white with brown edges near ocelli; posterior concave with occasional long setae; bound on either side by ridges extending from inner apex of ocelli outwards to lateral edges of clypeus. Anterior portion of frons bulbous and waxy white; clypeal suture with two proximal setae, demarcates waxy white smooth anteclypeus. See Fig. 15d.

Pronotum. Pronotum average in size for genus; translucent waxy beige; variable length orange-brown setae along anterior margin; setae on dorsal surface of pronotum thicker and longer laterally; pronotal pattern dark orange-brown “panther face”, not impressed, detail discernible; small lateral and anterior aura. See Fig. 15c.

Body. Wing brace present. Legs and body light brown; one specimen with brown maculations laterally on each sternite; subgenital plate light brown with rounded apices. See Fig. 15b.

Forewings. Wings extended well beyond abdominal apex (~35% of wing length); blotchy medium to dark brown; surface matte and opaque. See Fig. 15a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, unusually curved, bulbous hook-shaped lobe, articulated with right ventral phallomere on lateral side; medial side of lobe deeply emarginated from medial edge of remainder of phallomere; central field shallow, cupped, lightly sclerotized; medial margin more heavily sclerotized, smooth, with long posterior projecting spine and two medially projecting spines located on anterior third of medial margin. Small central sclerite concave, punctate, with large shagreened medially projecting wide upside down V-shape on ventral edge, point of which extends into small spine; right ventral phallomere extends from articulation to form shagreened rounded structure, with prominent medially projecting spine located posteriorly; attached anteriorly is flanged punctate concave arm that extends slightly beyond depth of rest of phallomere, edge shagreened. Folded anterior portion of left phallomere dramatically modified with sclerotized anterior wall and posteriorly projecting smooth spine located ventrally. Genital hook with short extension to pointed head with short hook. See Fig. 16.

Habitat and natural history. All life history elements remain unobserved.

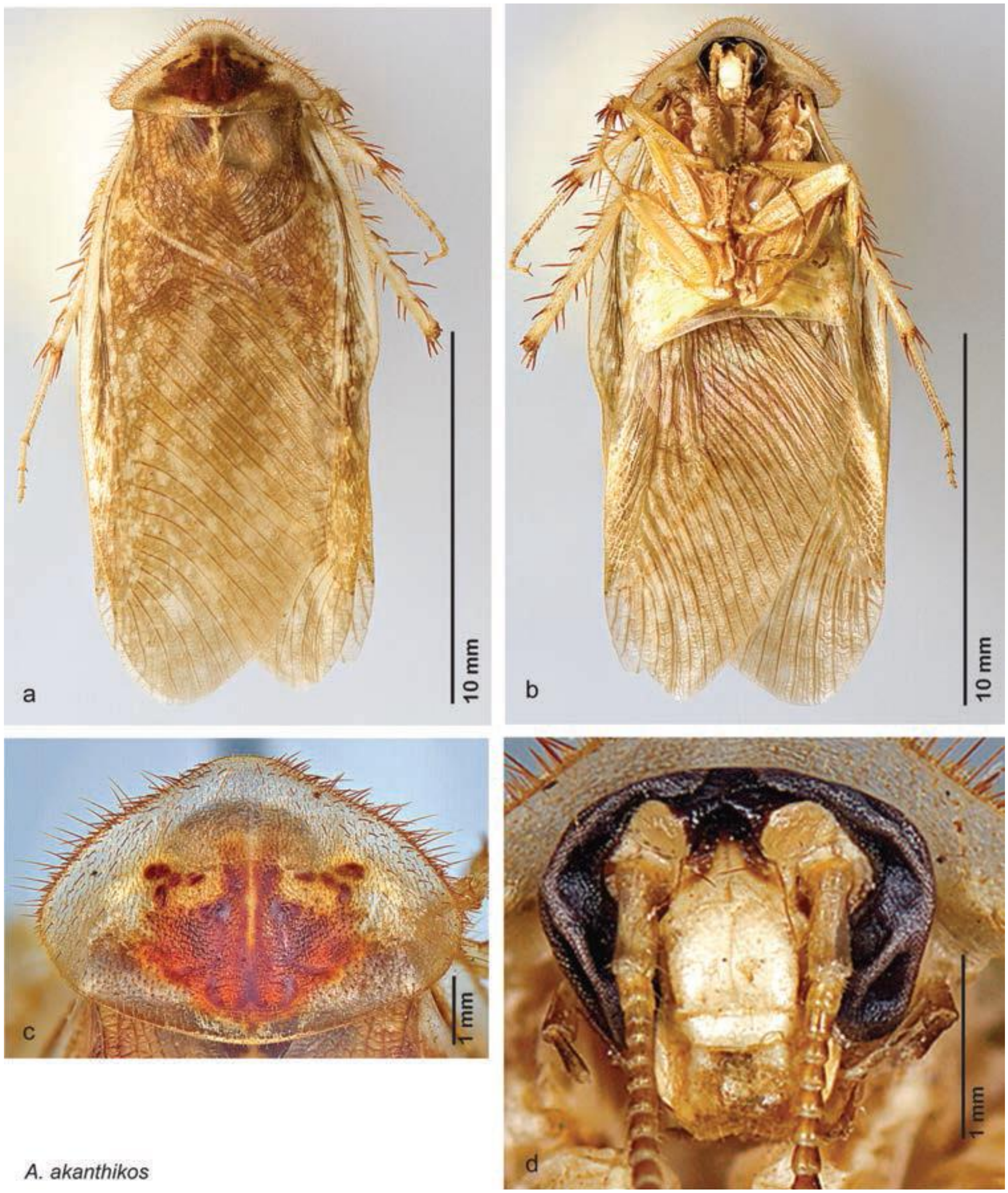


Figure 15. *A. akanthikos*, a dorsal habitus b ventral habitus c pronotum d head.

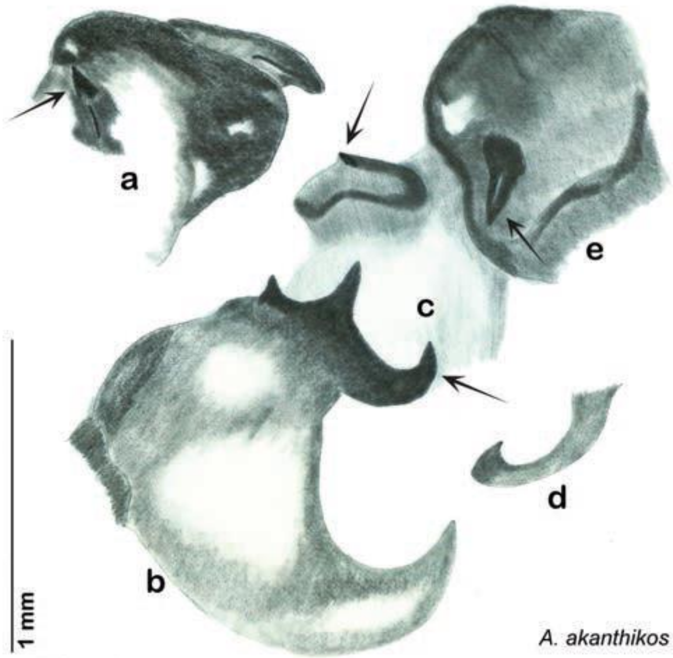


Figure 16. *A. akanthikos*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook e left phallomere. Arrow(s) indicate diagnostic characters (see text).

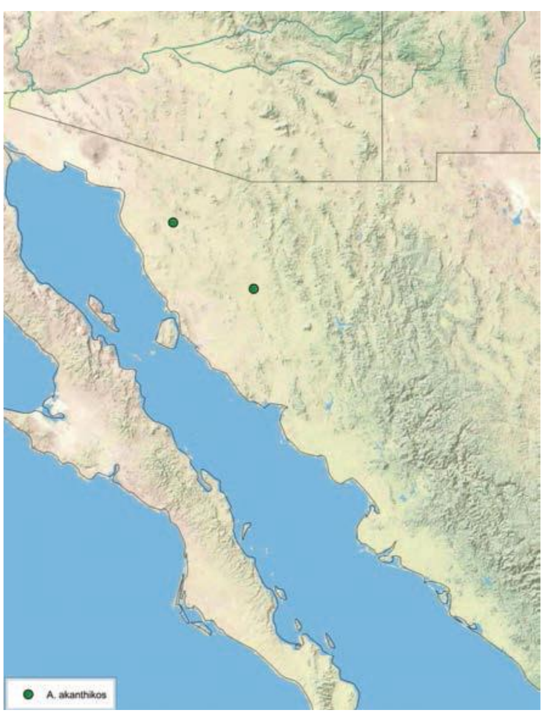


Figure 17. *A. akanthikos*, distribution.

***Arenivaga alichenas* sp. n.**

http://zoobank.org/CD31B67A-EF22-4F49-A50B-2B978ABB63E9

http://species-id.net/wiki/*Arenivaga_alichenas*

Figures 18–20

Type locality. MEXICO, BC, hills S of Laguna el Rosario.

Material examined. Holotype: ♂ in USNM labeled "MEXICO: Baja Calif., hills S of Laguna El Rosario 5-VIII-1973, leg. L.J. Oraak, ?.?. Simpson, ex. Lichen, bee collecting notes of L.J. Oraak (LJO-1076)" "HOLOTYPE *Arenivaga alichenas* Hopkins, 2012" [red label with black border].

Paratypes (1): MEXICO: BC, Valle de la Trinidad, 7/?/1927, LM Muey (1, SDMC). All paratypes labeled "Paratype *Arenivaga alichenas* Hopkins 2012" [blue label with black border].

Etymology. This species is named from the Latin meaning "from lichen" because the holotype was taken from lichen.

Distribution. This species is found in western and north-central Baja California Norte, Mexico. See Fig. 20.

Diagnosis. *A. alichenas* may be diagnosed by very narrow hook-shaped lobe on the right dorsal phallomere and the sclerotized edge of the anterior portion of the small central sclerite. See Fig. 19.

Description. Male. Measurements. Holotype TL = 14.3 mm, GW = 7.2 mm, PW = 5.00 mm, PL = 3.55 mm, TL/GW = 1.97, PL/PW = 0.71. EW = 0.70 mm; OW = 0.45 mm. No notable difference in measurements among paratypes.

Head. Two ocelli large, ovoid and protruding (0.30 × 0.20 mm); vertex medium brown, with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space deeply concave, medium brown, lighter medially. Frons waxy white, concave; anterior portion of frons waxy white, bulbous; light brown anteclypeus. See Fig. 18d.

Pronotum. Pronotum small; translucent waxy beige with fine dark brown margin; dorsal surface of pronotum covered with dense golden brown setae, could be called furry; pronotal pattern dark orange-brown "panther face" with medium to dark brown aura; detail impressed. See Fig. 18c.

Body. Wing brace present. Legs and body light brown; subgenital plate dissected and cleared with angular apices. See Fig. 18b.

Forewings. Wings extended beyond abdominal apex (up to ~30% of total wing length); no blotchiness, medium to dark brown; surface translucent, with slight sheen. See Fig. 18a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized narrow hook-shaped lobe, articulated with right ventral phallomere on lateral side; central field broad, lightly sclerotized, punctate; medial margin heavily sclerotized, shagreened with straight toothed edge. Small central sclerite concave, with punctate crescent shape with more sclerotized margins anteriorly; anterior rounded point curves back on itself; posterior margin attached to dorsal side of right dorsal phallomere. Right ventral phallomere extends from articulation to form flattened smooth lobe, increasingly punctate and sclerotized anteriorly; after narrow gap, wide rounded concave shagreened arm extending to depth of rest of phallomere. Folded anterior portion of left phallomere narrow, setose, otherwise unmodified. Genital hook with long extension to pointed head with slight concavity on short hook; arm smoothly curved. See Fig. 19.

Habitat and natural history. All life history elements remain unobserved.

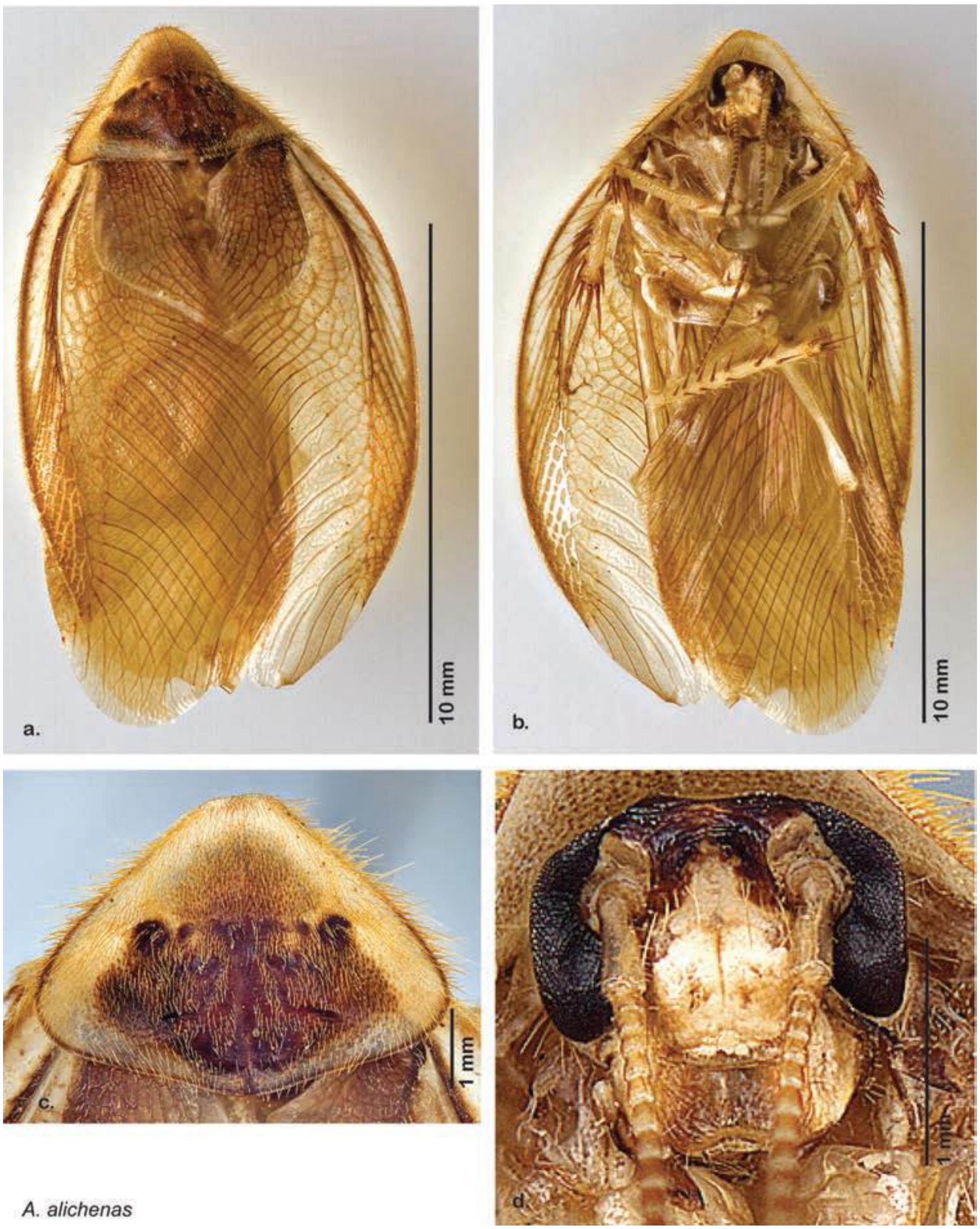


Figure 18. *A. alichenas*, a dorsal habitus b ventral habitus c pronotum d head.

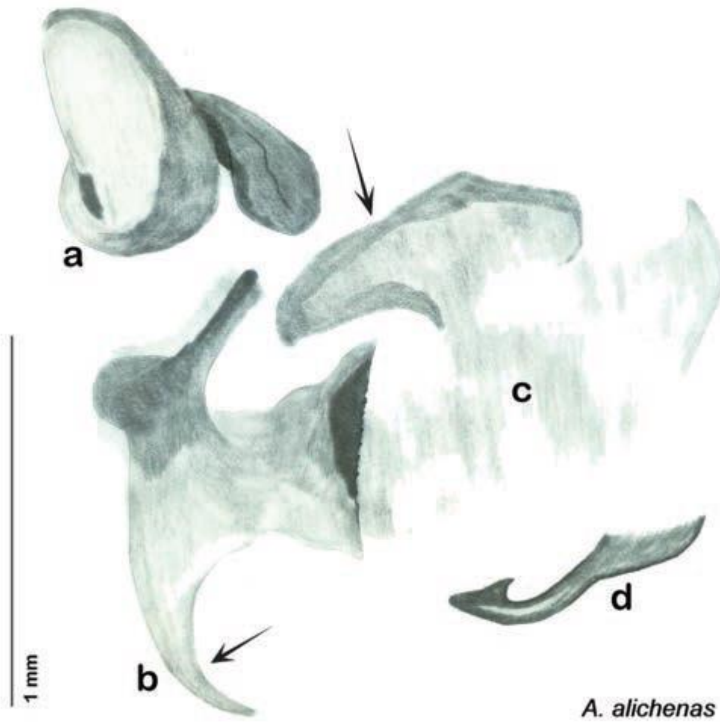


Figure 19. *A. alichenas*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 20. *A. alichenas*, distribution.

Arenivaga apacha (Saussure)

http://species-id.net/wiki/*Arenivaga_apacha*

Figures 21–23

1893 [*Homoeogamia*] *apacha* Saussure, Revue Suisse de Zoologie, I, Fasc. 2, p.296. [Chihuahua, Mexico.]

1894 *Homoeogamia apacha*, Saussure and Zehntner, Biol. Cent.-Amer., Orthopt., I, pp. 107–108. [Chihuahua, Mexico.]

1903 *Homoeogamia* (*Arenivaga*) *apacha* Rehn, Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 55, p. 188.

1905 *Homoeogamia* (*Arenivaga*) *apacha* infuscata Caudell, Proceedings of the US National Museum, Vol. 28, pp. 462-463. [Phoenix, Arizona.]

1917 *Arenivaga apacha* (Saussure) Hebard, Memoirs of the American Entomological Society, No. 2, pp. 236–239.

1920 *Arenivaga apacha* (Saussure), Transactions of the American Entomological Society, Vol. 46, pp. 213–214.

Material examined (343). USA: AZ, Chiricahua Mts., 8/21/1962, D.J. & J.N.Knull (1, OSUC); AZ, Chiricahua Mts., 9/4/1962, D.J. & J.N.Knull (1, OSUC); AZ, Chiricahua Mts., 7/9/1959, D.J. & J.N.Knull (1, OSUC); AZ, Chiricahua Mts., 7/17/1957, D.J. & J.N.Knull (1, OSUC); AZ, Chiricahua Mts., 7/22/1957, D.J. & J.N.Knull (1, OSUC); AZ, Chiricahua Mts., 8/2/1952, D.J. & J.N.Knull (1, OSUC); AZ, Chiricahua Mts., 7/19/1952, D.J. & J.N.Knull (2, OSUC); AZ, Fish Creek, Tonto NF, 5/9-10/1918, J.C.Bradley (1, ANSP); AZ, Gila Co., Tonto Natural Bridge SP, 9/11/2010, 34.19.16N 111.27.24, Warner & Smith, UVBL lights, (1, WB Warner); AZ, Pima Co., 7/27/1927, R.H.Beamer

(1, ANSP); AZ, Globe, 6/19/1957, Butler & Werner, at light (3, UAIC); AZ, Globe, 6/2/1935, Parker (1, UCRC); AZ, Pima Co., Santa Rita Mts., Box Canyon, 7/21/1995, Olson,Hall et al. (1, UAIC); AZ, Pima Co., Santa Rita Mts., Box Canyon, 7/9/1976, D.Whitman #581 (1, EMEC); AZ, Pima Co., Rincon Mts., Mack Burn Site, 6/30/1995, Pitfall 5, Pitfall 2 (2, UAIC); AZ, Pima Co., Rincon Mts., Mack Burn Site, 8/12/1995, Pitfall 11 (2, UAIC); AZ, Pima Co., 8 mi. N of Vail, 6/26/1962, F.Werner, UV Light trap (1, UAIC); AZ, Pima Co., 8 mi. N of Vail, 8/30/1962, Werner & Nutting, UV Light trap (1, UAIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/8/1974, 5000', E.R.Hoebeke (1, CUIC); AZ, Cochise Co., Chiricahua Mts., Silver Creek Wash, 0.7 mi. W of Portal, 8/2/1966, 4870', R.G.Beard, UV Light trap (2, CUIC); AZ, Cochise Co., Guadalupe Canyon in wash at entry into canyon, 8/4/1966, 4200', R.G.Beard, UV Light trap (1, CUIC); AZ, Cochise Co., Pyeatt's Ranch, 6/29/1953, 6000', A & H Dietrich (3, CUIC); AZ, Cochise Co., Portal, 8/22/1959, 5000', H.E.Evans, at light (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 6/25/1974, 5000', E.R.Hoebeke (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/24/1974, 5000', E.R.Hoebeke (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 6/28/1974, 5000', T.L.McCabe (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/8/1974, 5000', T.L.McCabe (2, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 6/25/1974, 5000', T.L.McCabe (2, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/13/1974, 5000', E.R.Hoebeke (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/7/1974, 5000', E.R.Hoebeke (2, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/7/1974, 5000', T.L.McCabe (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 6/20/1974, 5000', T.L.McCabe (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/4/1974, 5000’, T.L.McCabe (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/21/1974, 5000’, T.L.McCabe, (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/5/1974, 5000’, T.L.McCabe (6, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/8/1974, 5000’, E.R.Hoebeke (2, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/12/1974, 5400’, E.R.Hoebeke (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/4/1974, 5000’, E.R.Hoebeke (1, CUIC); AZ, Graham Co., Noon Creek, Graham Mts., 7/8/1965, Werner & Butler (7, UAIC); AZ, Cave Creek, 8/22/1926, W.W.Jones (1, UAIC); AZ, Noon Creek, Mt. Graham, 7/28/1954, F.G.Werner, light (1, UAIC); AZ, Cochise Co., SWRS, Chiricahua Mts. 4 mi. W of Portal, 6/24/1956, O.L.Cartwright (1, UAIC); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 8/5/1949, 3500’, G.M.Bradt (1, AMNH); AZ, Huachuca Mts., 7/8/1932, J.D.Beamer (1, SEMC); AZ, Cochise Co., Carr Canyon, Huachuca Mts., 6/3/1952, Cazier,Gertsch & Schrammel (1, AMNH); AZ, Cochise Co., Paradise, Chiricahua Mts., 7/3/1954, Cazier & Gertsch (1, AMNH); AZ, Chiricahua Mts., 7/8/1932, R.H.Beamer (2, SEMC); AZ, Graham Co., Wet Canyon, Graham Mts., 9/14/1950, 6000’-6500’, Gertsch & Cazier (1, AMNH); AZ, Cochise Co., Portal, 6/1/1952, Cazier,Gertsch & Schrammel (2, AMNH); AZ, Cochise Co., SWRS 5 mi. W of Portal, 6/19/1957, 5400’, M.Statham (1, AMNH); AZ, Cochise Co., SWRS 5 mi. W of Portal, 5/15/1956, 5400’, M.Statham (1, AMNH); AZ, Cochise Co., SWRS 5 mi. W of Portal, 7/19/1955, 5400’, W.J.Gertsch (1, AMNH); AZ, Cochise Co., SWRS 5 mi. W of Portal, 5/3/1956, 5400’, M.Statham (1, AMNH); AZ, Cochise Co., SWRS 5 mi. W of Portal, 7/7/1956, 5400’, C & M Cazier (1, AMNH); AZ, Cochise Co., Palmerlee, Miller Canyon, 6/29/1950, R.F.Smith (2, AMNH); AZ, Cochise Co., Tombstone, 8/?/1975, GSF

(1, SDMC); AZ, Cochise Co., 2 mi. E of Portal, 7/15/1955, E.Ordway (1, AMNH); AZ, Gila Co., Globe, 7/16-17/1948, 3600', Werner & Nutting, at light, mesquite-cholla (1, UAIC); AZ, Cochise Co., SWRS Cave Creek Canyon, Chiricahua Mts., 6/13/1938, 5400', Burns & Burns (1, EMEC); AZ, Benson, 7/4/1947, E.R.Tinkham (2, USNM); AZ, Huachuca Mts., Catal. No. 28, Brooklyn Museum Colln. 1929 (1, LACM); AZ, Bowie, 7/14/1917, Wheeler (2, UMMZ); AZ, Santa Rita Mts., 7/10/1950, H.O.Wright (1, SEMC); AZ, Gila Co., White Mts., 5/16/1925, 6000', O.C.Poling (1, UMMZ); AZ, Cochise Co., 10 mi. E of Sierra Vista, 8/8/1977, Allen & Duffy, collected at blacklight (1, CSCA); AZ, Yuma Co., Wellton, 3/3/1925, O.C.Poling (2, UMMZ); AZ, C.U.Lot 34, Cornell U. Lot 677 Sub.10 (1, CUIC); AZ, Cochise Stronghold, Dragoon Mts., 7/16/1958, C.W.O'Brien (4, UAIC); AZ, Cochise Co., Cochise Stronghold, 6/29/1969, L.S.Hawkins (1, CSCA); AZ, Pima Co., Madera Canyon, Santa Rita Mts., 8/9-20/1978, DKF (1, SDMC); AZ, Santa Rita Mts., 7/9/1947, L.D.Beamer (1, SEMC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/25/1959, 4880', J.C.Franclemont (1, CUIC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/14/1959, 4880', J.C.Franclemont (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/3/1974, 5000', E.R.Hoebeke (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/2/1974, 5000', T.L.McCabe (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 8/9/1974, 5000', T.L.McCabe (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 6/24/1974, 5000', E.R.Hoebeke (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 6/23/1974, 5000', E.R.Hoebeke (2, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/4/1974, 5000', E.R.Hoebeke (4, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/5/1974, 5000', E.R.Hoebeke (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 7/16/1974, 5000', E.R.Hoebeke (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 6/27/1974, 5000', E.R.Hoebeke (1, CUIC); AZ, 8 mi. N of Vail, 8/7/1966, F.Werner family, UV trap (1, UAIC); AZ, Pima Co., Catalina Mts. Y camp N side, 7/20/1961, at light (1, FSCA); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 8/3/1974, 5000', T.L.McCabe (1, CUIC); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 6/22/1974, 5000', E.R.Hoebeke (1, CUIC); AZ, Gila Co., White Mts., 7/12/1935, 7000', O.C.Poling (8, UMMZ); AZ, Gila-Pinal Co., Miami, Pinal Mts., 5/18-25/1925, 5000', O.C.Poling (6, UMMZ); AZ, Cochise Co., Miller Canyon, Huachuca Mts., 8/13/1974, 5000', E.R.Hoebeke (1, CUIC); AZ, Gila Co., Globe, 7/12/1925, C.J.Alden (2, UMMZ); AZ, Gila Co., White Mts., 7/11/1925, 6000', O.C.Poling (1, UMMZ); AZ, Gila Co., White Mts., 6/27/1925, 7000', O.C.Poling (1, UMMZ); AZ, Madera Canyon, Santa Rita Mts., 7/8/1970, W.E & C.A.Triplehorn (1, OSUC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/4/1980, R.H.Crandall (2, LACM); AZ, Cochise Co., 1 mi. S of Portal, 7/17/1965, 4800', Davidson,Davidson & Cazier, at light (1, ASU); AZ, Cochise Co., W side of Wilcox Dry Gulch near Cochise, 9/2/1991, 4200', Miller & Sta???, (1, FSCA); AZ, Cochise Co., SWRS 5 mi. SW of Portal, 5/23/1979, 5300', W.B.Warner, at light (1, ASUT); AZ, Cochise Co., SWRS 5 mi. SW of Portal, 7/2/1979, 5300', W.B.Warner, at light (1, ASUT); AZ, Yavapai Co., Prescott, 7/15/1984, C.R.Ash, (1, UAIC); AZ, Yavapai Co., Prescott, 7/?/1985, D.Tuttle, (1, UAIC); AZ, Yavapai Co., Prescott, 7/?/1987, D.Tuttle, (3, UAIC); AZ, Yavapai Co., Prescott, 6/15/1986, D.Tuttle, (2, UAIC); AZ, Yavapai Co., Prescott, 7/28/1984, C.R.Ash, at light (1, UAIC); AZ, Yavapai Co., Montezuma Castle NM, 5/25/1993, S.W.Fondriest, black light trap, site 12, round blue label (1, NAUF); AZ, Yavapai Co., Montezuma Well

NM, 7/13/1993, S.W.Fondriest, black light trap, site 10, round blue label (1, NAUF); AZ, Greenlee Co., Eagle Creek, 7/1/1977, 3700’, (1, ASUT); AZ, Mescal, 7/28/1927, L.A.Anderson, (1, ANSP); AZ, Huachuca, Kunze, (1, ANSP); AZ, Huachuca Mts., 7/8/1932, R.H.Beamer, (2, ANSP); AZ, Santa Rita Mts., 7/29/1979, R.H.Crandall, (2, LACM); AZ, Chiricahua Mts., 7/8/1932, R.H.Beamer, (1, ANSP); AZ, Santa Rita Mts., 8/29/1924, C.T.Vorhies, (1, ANSP); AZ, Santa Rita Mts., 6/16/1926, 4000’, C.T.Vorhies, (1, ANSP); AZ, Santa Rita Mts., 10/?/1936, Bryant, (1, UCRC); AZ, Santa Rita Mts., 6/21/1936, R.A.Flock, (1, ANSP); AZ, Pima Co., Sycamore Canyon, Santa Rita Mts., 7/8/1981, J.C.S?????, light trap (3, UAIC); AZ, Pima Co., Sycamore Canyon, Santa Rita Mts., 7/22/1981, J.C.Burne, (2, UAIC); AZ, Madera Canyon, Santa Rita Mts., 7/27/1947, L.M.Martin, (1, HEH); AZ, Cochise Co., Chiricahua Mts. 5 mi. W of Portal, 6/15/1959, 5400’, L.A.Stange, (3, LACM); AZ, Cochise Co., Chiricahua Mts. South Fork, Cave Creek Camp, 5/20/1966, L.M.Martin, (2, LACM); AZ, Cochise Co., 5 mi. W of Portal, 6/6/1959, L.A.Stange, (1, LACM); AZ, Cochise Co., San Bernardino Ranch 13 mi. E of Douglas, 6/12/1959, L.A.Stange, (6, LACM); AZ, Cochise Co., 2 mi. E of Portal, 1/17/1959, L.A.Stange, (1, LACM); AZ, Gila Co., E.Verde River, 7 mi. N of Payson, 10/26/1959, Truxal & Martin, (1, LACM); AZ, Pinal Co., Oak Flat Cpgd. off US60, 9/18/2010, 33.18.28N 111.03.10W, , Warner & Gruber, Bill Warner, head lamp and UV light, (2, HEH); AZ, Cochise Co., SWRS Chiricahua Mts., 6/27/1960, 5400’, M.Cazier, (1, ASUT); AZ, Cochise Co., SWRS, 6/33/1993, L.R.Davis,Jr., (1, FSCA); AZ, Cochise Co., SWRS Chiricahua Mts., 5 mi. SW of Portal, 8/16-20/2000, 31.54.02N 109.13.39W, 5400’, M.J.Yoder, at lights (1, TAMU); AZ, Santa Rita Mts., 7/7/????, genitalia figured H1920 (1, ANSP); AZ, Santa Rita Mts., 7/17/1932, R.H.Beamer, (1, ANSP); AZ, Madera

Canyon, Santa Rita Mts., 5/5/1948, L.M.Martin, (1, LACM); AZ, Madera Canyon, Santa Rita Mts., 8/14/1949, L.M.Martin, (1, LACM); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 6/22/1955, 5800', L.M.Martin, (1, LACM); AZ, Madera Canyon, Santa Rita Mts., 8/20/1953, R.J.Ford, (1, LACM); AZ, Box Canyon, Santa Rita Mts., 8/25/1949, L.M.Martin, (1, LACM); AZ, Madera Canyon, Santa Rita Mts., 8/7/1952, Kirkwood & Reid, (1, LACM); AZ, Madera Canyon, Santa Rita Mts., 8/18/1949, L.M.Martin, (1, LACM); AZ, Santa Rita Mts., 10/6/????, Univ. of Kan Lot 968 (2, ANSP); AZ, Madera Canyon, Santa Rita Mts., 7/27/1947, L.M.Martin, (1, LACM); AZ, Madera Canyon, Santa Rita Mts., 8/7/1947, L.M.Martin, (2, LACM); AZ, Madera Canyon, Santa Rita Mts., 9/2/1952, L.M.Martin, (1, LACM); AZ, Madera Canyon, Santa Rita Mts., 9/2/1953, L.Martin, (1, LACM); AZ, SWRS 5 mi. W of Portal, Chiricahua Mts., 6/7/1947, 5400', J.W.Green, (1, CAS); AZ, Cochise Co., Huachuca Mts., floor of Carr Canyon, 8/8-9/1952, 5400', Leech & Green, (1, CAS); AZ, Sawmill Canyon, Hualapai Mts., 9/10/1919, O.C.Poling, (2, ANSP); AZ, Madera Canyon, Santa Rita Mts., 7/26/1955, F.X.Williams, (2, CAS); AZ, Pima Co., 7/27/1927, R.H.Beamer, (1, ANSP); AZ, Peppersauce Canyon, Santa Catalina Mts., 8/10/1924, J.O.Martin, (1, CAS); AZ, Peppersauce Canyon, Santa Catalina Mts., 8/15/1924, E.P.VanDuzee, (4, CAS); AZ, Chiricahua Mts., 7/4/1940, L.A.Liporsky, (1, ANSP); AZ, Prescott, 8/21/1917, J.A.Kusche, (1, ANSP); AZ, Santa Rita Mts., E.A.Schwarz, (2, USNM); AZ, Carr Canyon, Huachuca Mts., 8/9/1940, E.S.Ross, (2, CAS); AZ, Portal, 6/17/1956, O.L.Cartwright, (1, USNM); AZ, Ft.Grant, H.G.Hubbard, (2, USNM); AZ, Globe, 8/6/1959, J.Helfer, (1, USNM); AZ, Globe, 8/12/1958, D.K.Duncan, (1, USNM); AZ, Madera Canyon, Santa Rita Mts., 6/17/1898, E.A.Schwarz, (1, USNM); AZ, Huachuca

Mts., (1, USNM); AZ, Benson, (1, HEH); AZ, Santa Rita Mts., 7/26/1925, (1, USNM); AZ, Oracle, (1, USNM); AZ, Pima Co., Stratton, Santa Catalina Mts., 7/27/1917, 6-7000', Wheeler, (1, USNM); AZ, Huachuca Mts., (2, USNM); AZ, Yavapai Co., Bloody Basin, 9/18/1947, F.H.Parker, (1, HEH); AZ, Yavapai Co., 4 mi. N of Granite Dells, 7/12/1970, L.M.Martin, (3, LACM); AZ, Yavapai Co., Yarnell, Weaver Mts., 6/10/1937, L.K.Gloyd, 110, taken at light (1, UMMZ); AZ, Oracle, 6/16/1967, R.Rice, under stone (3, UAIC); AZ, Bisbee, 10/15/1959, J.M.Kraft, (1, ASUT); AZ, Cochise Co., Portal, 6/18/1964, 4700', Mortenson & Cazier, at light (1, ASUT); AZ, Catalina Mts., ?/?/1917, 5500', Cornell U. Lot 892 Sub. 146 (1, CUIC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/10-26/1964, 5100', D.R.Davis, (1, USNM); AZ, Pima Co., Madera Canyon, Santa Rita Mts., 5/16/1963, 4400', J.G.Franclemont, (1, CUIC); AZ, Chiricahua Mts., 7/20/1953, D.J. & J.N. Knull, (1, FSCA); AZ, Madera Canyon, Santa Rita Mts., 6/18-23/1962, 5000', F.Werner, UV light trap (1, UAIC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/4/1979, R.H.Crandall, (1, LACM); AZ, Gila Co., Payson, 7/30/1988, 5000', C.D.Ferris, (1, FSCA); AZ, Cochise Co., Portal, 6/16/1964, 4700', Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 7/3/1964, 4700', Puckle,Mortenson & Cazier, at light (4, ASUT); AZ, Cochise Co., Portal, 6/7/1964, 4700', Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., 1 mi. S of Portal, 7/31/1965, 4800', Davidson,Davidson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 7/2/1964, 4700', Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Chiricahua Mts., 6/27/1949, D.J. & J.N. Knull, (3, OSUC); AZ, Chiricahua Mts., 7/5/1949, D.J. & J.N. Knull, (1, FSCA); AZ, Chiricahua Mts., 7/9/1959, D.J. & J.N. Knull, (2, FSCA); AZ, Chiricahua Mts., 7/23/1959, D.J. & J.N. Knull, (1, OSUC); AZ, Prescott, 8/22/1917, O.C.Poling, (1, ANSP); AZ, Prescott, 7/14/1904, Kunze, genitalia figured H1920 (1, ANSP); AZ, Prescott, 7/18/1904, Kunze, (2, ANSP); AZ, Chiricahua Mts., 6/15/1939, D.J. & J.N. Knull, (1, OSUC); AZ, Chiricahua Mts., 6/27/1949, D.J. & J.N. Knull, (2, OSUC); AZ, Santa Cruz Co., Sycamore Canyon, 7/3/1974, D.G.Marqua, (1, LACM); AZ, Cochise Co., South Fork, Cave Creek, Chiricahua Mts., 6/1/1964, 5000', Puckle,Mortenson & Cazier, (1, ASUT); AZ, Stewart For.Camp, Cave Creek Canyon, Chiricahua Mts., 9/13-14/1952, B.Malkin, (1, USNM); AZ, Carr Canyon, Huachuca Mts., 2/25-28/1964, R.F.Sternitsky, (2, PMNH); AZ, Cochise Co., Ramsey Canyon, Huachuca Mts., 9/3/1964, R.F.Sternitsky, (1, PMNH); AZ, Miller Canyon, Huachuca Mts., 6/24/1980, C.A.Olson, (1, UAIC); AZ, Miller Canyon at Tombstone, Huachuca Mts., 6/6/1964, 5800', J.Burger, (1, UAIC); AZ, Cochise Co., 9 mi. S of MacNeal, 8/30/1958, D.D.Linsdale, (2, FSCA); AZ, Huachuca Mts., 7/20/1937, D.J. & J.N. Knull, (2, OSUC); AZ, Montezuma Pass, Huachuca Mts., 7/6/1956, 6600', O.L.Cartwright, (1, USNM); AZ, Huachuca Mts., 8/19/1950, D.J. & J.N. Knull, (2, OSUC); AZ, Pima Co., Santa Rita Mts. N end, Rosemont area, McCleary Canyon, 7/15/1975, 5200', Busacca & Olson, Anamax Mine Inventory, UV light (3, UAIC); AZ, Pima Co., Santa Rita Mts. N end, Rosemont area, Barrel Canyon, 9/10/1975, 4600', Busacca & Olson, Anamax Mine Inventory, UV light (1, UAIC); AZ, Pima Co., Florida Canyon, Santa Rita Mts., 5/20/1978, M.W.Hetz, (1, UAIC); AZ, Cochise Co., Portal, 8/29-9/3/1974, J.D.Pinto, (1, UCRC); AZ, Oracle, (1, ANSP); AZ, Graham Co., Dripping Spring, Whitlock Mts., 8/5/1976, D.G.Chandler, *Arenivaga* sp. Det. D.G.Chandler (1, UAIC); AZ, Graham Mts., Noon Creek, 8/1/1957, G.D.Butler, (4, UAIC); AZ, Cochise Co., Portal, 6/27/1963, A.Raske, (1, EMEC); AZ, Cochise Co., Cave Creek Ranch, Portal, 8/1-3/1972, E.G.Linsley, (1, EMEC); AZ, Bog

Springs Cpgd., Madera Canyon, Santa Rita Mts., 8/1-3/1975, Menke & Pulawski, (3, USNM); AZ, Pima Co., Bog Springs Cpgd., Madera Canyon, 7/10/1976, Doug Whitman, #575, black light (2, EMEC); AZ, Palmerlee, Banks, *erratica* (1, MCZ); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/4/1979, R.H.Crandall, (1, LACM); AZ, San Bernardino Ranch 20 mi. E of Douglas, 7/7/1947, E.R.Tinkham, E.R.T., at light, (2, HEH); AZ, Maricopa Co., Wickenberg, 6/14/1963, J Doyen, (1, EMEC); AZ, Maricopa Co., Wickenberg, 8/20/1938, DJ & JN Knull, (1, OSUC); AZ, Cochise Co., Guadalupe Canyon 29 mi. E of Douglas, 8/15-16/1972, J Doyen, Black light trap (2, EMEC); AZ, Cochise Co., Chihuahua Mts. Tex Canyon, 9/8/1927, 5-600 ft., JA Kusche, (1, CAS); NM, Hidalgo Co., Cienega Lake,12.2 mi. N of jct. Portal Rd. & Hwy. 80, 8/9/1973, SI & SL Frommer, UV light, 7.20-10.30 pm (1, UCRC); NM, Cave Creek, 7/3/1947, H.S.Wallace, (2, SEMC); NM, Hidalgo Co., Cienaga Ranch nr. Rodeo, 7/12/1948, C & P Vaurie, (1, AMNH); NM, Hidalgo Co., Pelencio Mts., 7/23/1981, Olson & Thomas, (1, UAIC); AZ, Pima Co., Mt. Lemmon RA, Catalina Hwy. milepost 11.3, 6/11/2012, 32 22 21.0, 110 41 40.2, 5840 ft., DB Weissman, pine forest and shrubs (2, HEH); AZ, Mohave Co., Hualapai Mt. Rd. E of Kingman, milepost 12.5, 6/13/2012, 35 05 26.9, 113 52 17.8, 6000 ft., DB Weissman, pines, (1, HEH); AZ, Chiricahua Mts., Cave Creek Cnyn., Stewart Campground, 8/7/1974, GH Nelson, (1, FSAC); NM, Virden, 6/26/1963, R Enzie, (1, NMSU); AZ, Cochise Co., Tex. Can., 10/24/1958, 4600’, G & A Ferguson, (1, FSAC); AZ, Cochise Co., Tex. Can., 10/5/1960, GR Ferguson, (1, FSAC); AZ, Cochise Co., nr. Double Adobe, 6/28/1977, S McCleve, lite (1, FSAC); AZ, Cochise Co., near Fairbanks, 6/29/1973, S McCleve, lite (1, FSAC); AZ, Cochise Co., San Pedro R, nr. Fairbanks, 6/29/1973, S McCleve, lite (1, FSAC); AZ, Cochise Co., SWRS 5 mi W

Portal, 5/2/1967, 5400’, VD Roth, (1, SWRS); AZ, Cochise Co., SWRS 5 mi W Portal, 7/8/1964, VD Roth, *Arenivaga* infuscata (Caud) (1, SWRS); AZ, Cochise Co., SWRS 5 mi W Portal, 5/23/1964, VD Roth, (1, SWRS); AZ, SWRS, 5/12/1956, (1, SWRS). Determiner label *Arenivaga apacha* Hopkins 2011” [white label with black border].

Distribution. *A. apacha* is found in in the entire southeastern portion of Arizona and northwestwards from there. The appearance on the map that the distribution ends at the Mexican and New Mexican borders is without doubt a collection artifact. See Fig. 23.

Diagnosis. *A. apacha* may be diagnosed by forward and backward facing spines, one on each end of the medial margin of the right dorsal phallomere. There is also a prominent spine on the right ventral phallomere. See Fig. 22.

Description. Male. NB: Ventral surface of holotype shellacked. Measurements. Holotype TL = 20.9 mm, GW = 9.7 mm, PW = 6.07 mm, PL = 4.27 mm, TL/GW = 2.15, PL/PW = 0.70. EW = 0.40 mm; OW = 0.40 mm. Among paratypes range of TL 16.7–23.0 mm; range of GW 7.3–10.4 mm; range of PW 5.06–6.30 mm; range of PL 3.98–4.90 mm.

Head. Two ocelli large, ovoid and protruding (0.35 × 0.25 mm); vertex medium brown, with small ridges between apices of eyes and extending onto ocellar tubercles; interocellar space concave, medium brown. Frons light brown, concave with occasional very long setae; bound on either side by ridges extending from inner apex of ocelli outwards to lateral edges of clypeus. Anterior portion of frons light brown, bulbous; clypeal suture demarcates light brown anteclypeus. See Fig. 21d.

Pronotum. Pronotum translucent waxy beige, often only along anterior margin depending on specimen with remainder of pronotum medium orange-brown; variable length orange-brown setae along anterior margin; dorsal surface of pronotum covered with short orange-brown setae; pronotal pattern “panther face” ranging from light brown through every shade of orange-brown and brown with many shades of aura, usually extensive, depending on specimen; detail ranges from clear to indiscernible. See Fig. 21c.

Body. Wing brace present. Legs and body light orange-brown; subgenital plate light orange-brown; asymmetrical with posterior edge emarginated, rounded apices. See Fig. 21b.

Forewings. Wings extended beyond abdominal apex (up to ~40% of total wing length); dark-orange brown densely blotchy; majority of specimens with medium to dark brown or orange-brown densely blotchy wings; occasional specimens light or very dark, or with uniform coloration; surface opaque and matte. See Fig. 21a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized narrow hook-shaped lobe, articulated with right ventral phallomere on lateral side; central field broad, slightly sclerotized; medial margin heavily sclerotized, sinuous, with toothed edge; long posteriorly projecting spine and shorter anterior spine; anterior spine of varying sizes depending on specimen. Teeth along medial edge may be variously lengthened depending on specimen. Small central sclerite deeply concave, punctate, with medially projecting punctate lobe on ventral end. Right ventral phallomere extends from articulation into smooth lobe with prominent medially projecting spine at posteroventral corner; increasingly punctate and sclerotized anteriorly; after narrow gap, wide rounded concave shagreened arm extending beyond the depth of rest of phallomere. Folded anterior portion of left phallomere narrow, trifold, punctate, otherwise unmodified. Genital hook (missing from holotype) with moderate extension to pointed head with slight concavity on moderate hook; arm narrow and smoothly curved. See Fig. 22.

Habitat and natural history. *A. apacha* dig shelves in the mounds of *Dipodomys spectabilis* which they then line with materials taken from the mounds of the kangaroo rats (Cohen and Cohen 1976). They were also observed to cache seeds acquired from the rodent mounds, most particularly *Atriplex* seeds. When Cohen and Cohen measured the temperature of the cockroach shelves they were found to remain at an average of 16.5 degrees Celsius when the surrounding surface soil temperatures were as high as 60 degrees Celsius and never lower than 30 degrees Celsius. Additionally the humidity in the lined cockroach shelves was never found to be lower than 91% while that of the surrounding burrow was as low as 20%. This species of *Arenivaga* has found a way to create an ideal temperature and humidity controlled environment in an otherwise harsh climate. They also use the materials collected by the kangaroo rats for a larder.

Figure 21. *A. apacha*, a dorsal habitus b ventral habitus c pronotum d head.

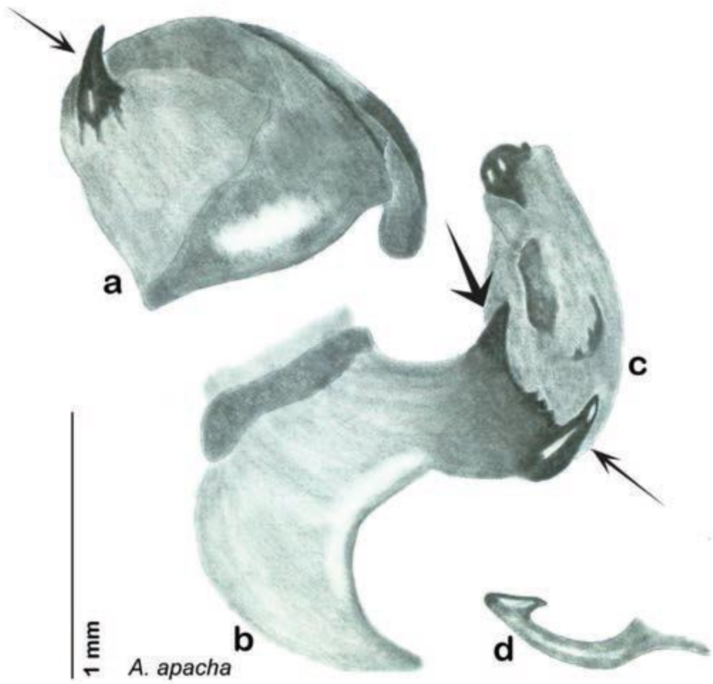


Figure 22. *A. apacha*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 23. *A. apacha*, distribution.

***Arenivaga apaeninsula* sp. n.**

http://zoobank.org/E5D8D314-BF5F-421E-98ED-FBD3DA74FE4C

http://species-id.net/wiki/*Arenivaga_apaeninsula*

Figures 24–26

Type locality. MEXICO, BCS, 7 mi SW La Paz.

Material examined. Holotype: ♂ in EMEC labeled "MEX: Baja Calif. Sur, La Paz, 7 mi. SW, VIII-2-66" "HOLOTYPE *Arenivaga apaeninsula* Hopkins, 2012" [red label with black border].

Paratypes (6): MEXICO: BCS, 7 mi SW of La Paz, 8/2/1966, Linsley,Chemsak & Hurd, at light (6, EMEC). All paratypes labeled "Paratype *Arenivaga apaeninsula* Hopkins 2012" [blue label with black border].

Etymology. This species is named from the Latin meaning "from a peninsula" because all known specimens are from La Paz, BCS, Mexico.

Distribution. This species is known only from the type locality in Baja California Sur, Mexico. See Fig. 26.

Diagnosis. *A. apaeninsula* may be distinguished by the dense brown setae on the pronotum and dark red-brown pronotal pattern with no discernible detail. Its striking pronotum and restricted range combine to make it easily diagnosed. See Figs 24c and 26.

Description. Male. Measurements. Holotype TL = 16.1 mm, GW = 7.6 mm, PW = 5.48 mm, PL = 4.17 mm, TL/GW = 2.12, PL/PW = 0.76. EW = 0.50 mm; OW = 0.55 mm. No notable size differences among paratypes.

Head. Two ocelli large, ovoid and protruding (0.35 × 0.25 mm); vertex light brown with narrow dark brown band around apex of eyes and ocelli; with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space concave, dark brown, light brown medially. Frons medium brown; posterior tectiform horizontally; anterior portion of frons bulbous, medium brown fading to light brown anteriorly; narrow light brown anteclypeus. See Fig. 24d.

Pronotum. Pronotum small, opaque waxy white; dorsal surface of pronotum with dense brown setae that are thicker and longer laterally; pronotal pattern dark red-brown "panther face", not impressed, with no discernible detail; scattered brown freckles bordering pronotal pattern; no aura. See Fig. 24c.

Body. Wing brace absent. Legs and body light brown; large dark brown maculations on ventral surface of procoxa; medium brown maculations at proximal end of meso and meta femurs, located ventrally and wrapping dorsally; scattered medium brown maculations on mesocoxa. Sternites with dark brown maculations laterally on each; subgenital plate light brown with darker border and rounded apices. See Fig. 24b.

Forewings. Wings extended well beyond abdominal apex (~30% of wing length); medium to dark brown blotches; surface opaque and matte. See Fig. 24a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, bulbous pointed lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized. Small central sclerite so slight and transparent as to be virtually non-existent, unmodified. Articulation between right phallomere dramatically modified with smooth rounded knob posteriorly extending into raised ridge and then to shagreened or toothed flange anteriorly; right ventral phallomere extends from articulation to form shagreened rounded structure; after moderate gap, wide toothed flange with central concavity and rounded apices that extends to depth of rest of phallomere. Folded anterior portion of left phallomere dramatically modified into 3D triangle with rounded edges and concave surfaces; medial surface has deep concave dimple. Genital hook a wide sweeping curve with straight arm. See Fig. 25.

Habitat and natural history. All life history elements remain unobserved.

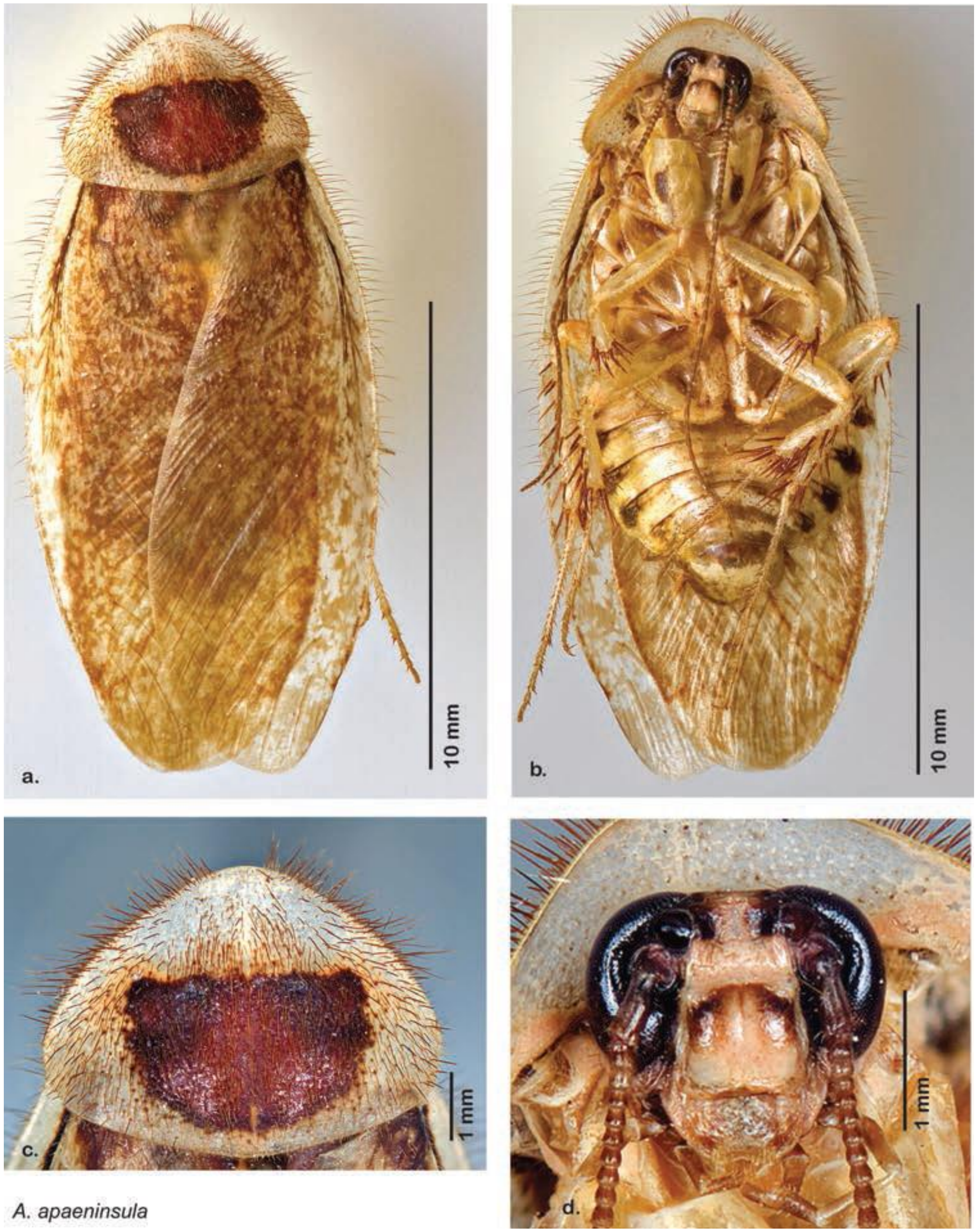


Figure 24. *A. apaeninsula*, a dorsal habitus b ventral habitus c pronotum d head.

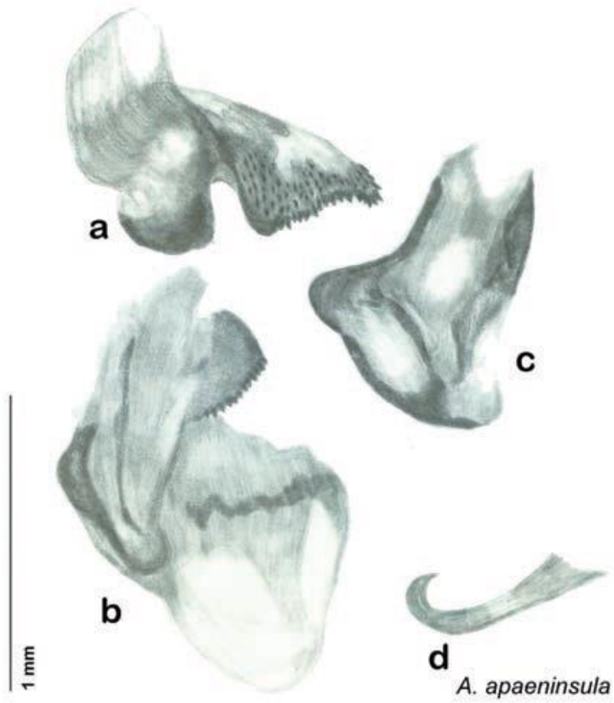


Figure 25. *A. apaeninsula*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 26. *A. apaeninsula*, distribution.

***Arenivaga aquila* sp. n.**

http://zoobank.org/31D849C4-8517-4A26-AA2E-31B2345DC052

http://species-id.net/wiki/*Arenivaga_aquila*

Figures 27–29

Type locality. MEXICO, Morelos, 7.3 mi S of Yautepec.

Material examined. Holotype: ♂ in SEMC labeled "MEXICO Morelos, 7.3 mi. S. Yautepec, 3000', 17 Aug. 1962, Ordway & Roberts, *Arenivaga* sp. nr. *bolliana* (Saussure) Det. F.W.Fisk '80" "HOLOTYPE *Arenivaga aquila* Hopkins, 2012" [red label with black border].

Paratypes (23): MEXICO: Guerrero, Xalitla, 8 km N of Mezala, 9/17-23/1982, 580 m, Powell & Chemask (1, EMEC); Guerrero, 2.1 mi. NW of Cacahuamilpa, 8/10/1980, Schaffner, Weaver & Friedlander (2, TAMU); Guerrero, 10.3 mi. S of Iguala, 7/23/1981, Bogar,Schaffner &Friedlander (2, TAMU); Guerrero, 6.2 mi. SW of Xochipala, 7/6/1987, 5670 ft., Kovarik & Schaffner (1, TAMU); Guerrero, Cacahuamilpa, 9/11/1964, B.Rotger (1, UCMC); Morelos, 7.3 mi. S of Yautepec, 7/30/1963, 3300 ft., GW Byers (6, SEMC); Morelos, Alpuvec, 8/18/1957, WW Gibson, HIERBA, Rockefeller Collection, return to Cantrell (1, UMMZ); Morelos, 6.7 mi. S of Yautepec, 7/29/1963, Naumann & Willis, *Arenivaga* nr. *bolliana* det. FW Fisk 1980, 135 (1, SEMC); Morelos, Canada de Lobo, 20 km E of Cuernavaca, 7/7/1981, EM Fisher (1, CSCA); Morelos, Barrio de las Piedras #37, Jiutepec, 7/1/1998, E Brambila, under a rock (1, FSAC); Morelos, Canada de Lobo, 9/18/1964, B.Rotger (1, UCMC); Morelos, Iguala, *Arenivaga* nr. or = *rehni* teg:miaculat. as in *grata* det. Hebard 1931 (1, ANSP); Guerrero, Coacoyula, 10/24/1942, WF Foshag (2, USNM); Morelos, Barrio de las Piedras #37, Jiutepec, 6/28/1998, J Brambila, flying

(1, FSAC); Morelos, Jojula, ?/?/1929, JJ White, Hebard Collection (1, ANSP). All paratypes labeled “Paratype *Arenivaga aquila* Hopkins 2012” [blue label with black border].

Etymology. The name is an adjective in the nominative singular. This species is named from the Latin meaning dark-colored or swarthy because of its very dark color.

Distribution. This species is found in the states of Morelos and Guerrero, Mexico. See Fig. 29.

Diagnosis. *A. aquila* may be distinguished by the small ridge projecting from the ventrolateral edge of the folded portion of the left phallomere. See Fig. 28.

Description. Male. Measurements. Holotype TL = 19.1 mm, GW = 8.4 mm, PW = 6.00 mm, PL = 4.17 mm, TL/GW = 2.27, PL/PW = 0.70. EW = 0.15 mm; OW = 0.40 mm. Among paratypes range of TL 18.0–21.5 mm; range of GW 8.2–10.1 mm; range of PW 5.60–6.74 mm; range of PL 3.94–4.59 mm.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm); vertex dark brown, with small ridges between apices of eyes and extending onto ocellar tubercles; interocellar space concave, dark brown, with two small oval indentations. Frons light brown; posterior concave; anterior portion of frons bulbous but much less so than in most species, light brown; light brown anteclypeus. See Fig. 27d.

Pronotum. Pronotum with translucent waxy beige anterior margin; aura so extensive that remainder of pronotum dark orange-brown and dark brown; pronotal pattern impressed “panther face”, difficult to discern. See Fig. 27c.

Body. Wing brace absent. Legs and body medium orange-brown; subgenital plate orange-brown; strongly asymmetrical with angular apices. See Fig. 27b.

Forewings. Wings extended well beyond abdominal apex (up to ~40% of wing length); blotchy dark brown to solid dark brown depending on specimen; surface matte and opaque. See Fig. 27a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, short, narrow, bulbous lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized, cupped; with narrow medial edge more sclerotized, punctate, ending anteriorly in small shagreened flange. Small central sclerite lightly sclerotized, finely punctate, flat of no discernible shape, posterior end connecting with dorsal side of right dorsal phallomere. Right ventral phallomere arises from deep articulation to form large punctate flattened medially projecting lobe; becoming wider and more sclerotized anteriorly; after narrow gap, wide shagreened flange. Folded anterior portion of left phallomere wide, setose, closed at both ends, with small nipple at one end of fold, and rough-edged, flattened projection offset at an angle from other end. Genital hook with short extension to rounded head and short hook; arm robust and smoothly curving. See Fig. 28.

Habitat and natural history. All life history elements remain unobserved.

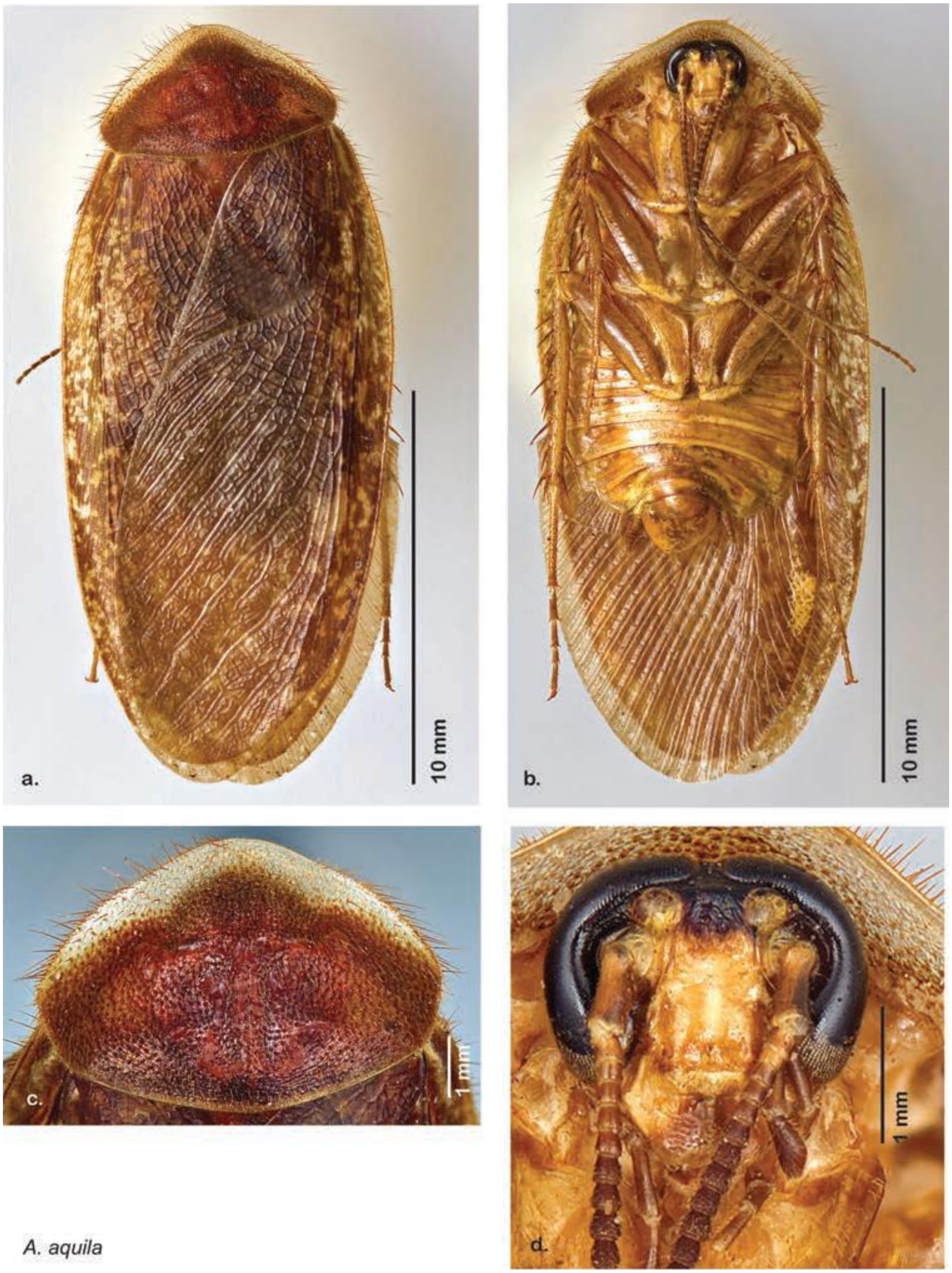


Figure 27. *A. aquila*, a dorsal habitus b ventral habitus c pronotum d head.

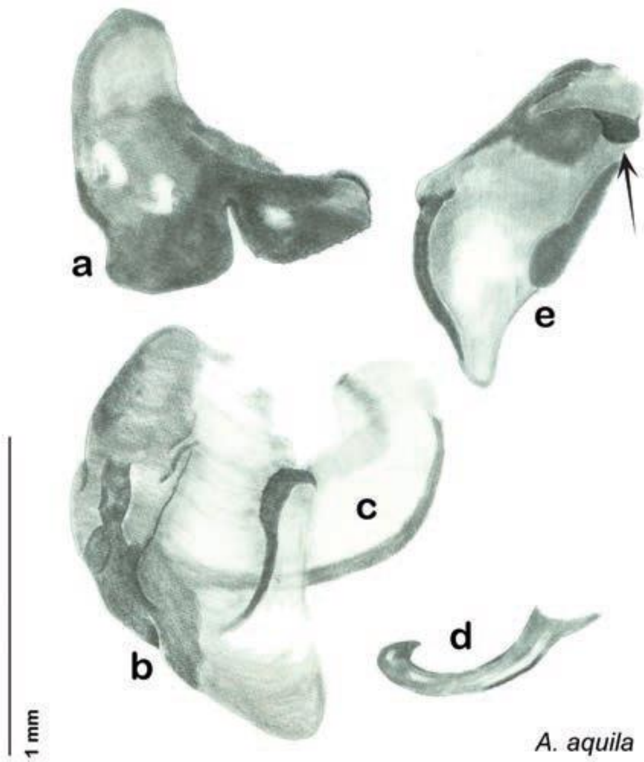


Figure 28. *A. aquila*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook e left phallomere. Arrow(s) indicate diagnostic characters (see text).

Figure 29. *A. aquila*, distribution.

***Arenivaga belli* sp. n.**

http://zoobank.org/C91E2047-7CE9-4610-AFD2-C30629249110

http://species-id.net/wiki/*Arenivaga_belli*

Figures 30–32

Type locality. USA, California, San Bernardino Co., Granite Mountains, Cottonwood Wash.

Material examined. Holotype: ♂ in LACM labeled "CALIF: San Bdno. Co., Granite Mts., #148623, Cottonwood Wash, 4000' T9N, R13E, SE cor. S.31, 14-15 September 1990, J.P. & K.E.S. Donahue" HOLOTYPE *Arenivaga belli* Hopkins, 2012" [red label with black border].

Paratypes (83): USA: CA, San Bernardino Co., Mescal Range, ~2 air mi S of Mountain Pass, 7/10/1982, 4900 ft., JP & KE Donahue (2, LACM); CA, San Bernardino Co., Keystone Canyon, New York Mts., 9/3/1959, FP Sala (4, LACM); CA, San Bernardino Co., Mex.Well, Ivanpah Mts., 9/1/1945 (2, LACM); CA, San Bernardino Co., New York Mts., 8.5 mi S of Ivanpah, 9/11-12/1955, 5000 ft., CD MacNeill (2, EMEC); CA, San Bernardino Co., Granite Mts., Cottonwood Wash, 9/14-15/1990, 4000 ft., JP & KE Donahue (2, LACM); CA, San Bernardino Co., New York Mts., 9/11/1911?, RC Osburn (1, FSCA); CA, Lone Pine, 7/28/1940, DE Hardy (1, SEMC); CA, Kern Co., Shafter, 8/4/1957, LA Stange (1, LACM); UT, Kane Co., 5 mi N and 40 mi E of Kanab, 3/?-9/?/1985, D Giuliani, Antifreeze pit trap (1, CSCA); UT, Hanksville, WD Stanton (1, SDMC). All paratypes labeled "Paratype *Arenivaga belli* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for the late Dr. William Bell, who spent much time exploring the chemical ecology of social insects such as cockroaches and co-authored "Cockroaches: Ecology, Behavior and Natural History".

Distribution. This species is distributed from Lone Pine, CA in the west to Hanksville, UT in the north and east, and the Rice Dunes in the south. See Fig. 32.

Diagnosis. *A. belli* is average in size and color for *Arenivaga* and very similar to *A.* nalepae and *A. milleri*. *A. belli* has the same right ventral phallomere as *A. milleri* (see Figs 31 and 103); it has a right dorsal phallomere very similar to *A. nalepae* in its medial margin, but the hook-shaped bulges are quite different (see Figs 31 and 112). Therefore a combination of the right dorsal phallomere and angular hook-shaped bulge as shown in Fig. 31 are what distinguish *A. belli*.

Description. Male. Measurements. Holotype TL = 19.2 mm, GW = 9.4 mm, PW = 5.47 mm, PL = 3.66 mm, TL/GW = 2.04, PL/PW = 0.67. EW = 0.2 mm; OW = 0.3 mm. Among paratypes range of TL 17.7–21.2 mm; range of GW 7.6–9.4 mm; range of PW 5.32–6.38 mm; range of PL 3.66–4.33 mm.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm); vertex medium brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space concave, medium brown, with two deep set dimples medial to inner apex of ocelli; with two smaller dimples anterior to those which may be very hard to see; rugose in some specimens. Frons light brown fading to waxy white towards margin with clypeus; concave with small vertical corrugations. Clypeus waxy white and bulbous; ends in broad flat anteclypeus of same color. See Fig. 30d.

Pronotum: Pronotum translucent, waxy beige; dorsal surface of pronotum with short fine orange-brown setae centrally and posteriorly grading to longer, thicker setae laterally and anteriorly; pronotal pattern orange-brown "panther face" with little discernible detail in most specimens; no aura. See Fig. 30c.

Body. Wing brace present. Legs and body light orange-brown, subgenital plate with darker margin, strongly asymmetrical with rounded apices. See Fig. 30b.

Forewings. Wings extended well beyond abdominal apex (~40% of wing length); color uniform brown, to blotchy brown; surface matte and opaque. See Fig. 30a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized hook-shaped lobe, articulated with right ventral phallomere on lateral side; central field broad, lightly sclerotized; medial margin heavily sclerotized, shagreened, with toothed edge extending into short spine near distal end. Small central sclerite flat and finely punctate with posteriorly projecting, shagreened crescent with elevated and toothed arms; right ventral phallomere extends from articulation to form rounded punctate structure at posterior apex but with shagreened corrugations at anterior apical end, followed by smaller offset shagreened projection, narrow gap, and rounded concave angled arm extending beyond depth of rest of phallomere. Folded anterior portion of left phallomere setose, otherwise unmodified. Genital hook with long extension to pointed head with slight concavity on short hook; arm smoothly curved. See Fig. 31.

Habitat and natural history. All life history elements remain unobserved.

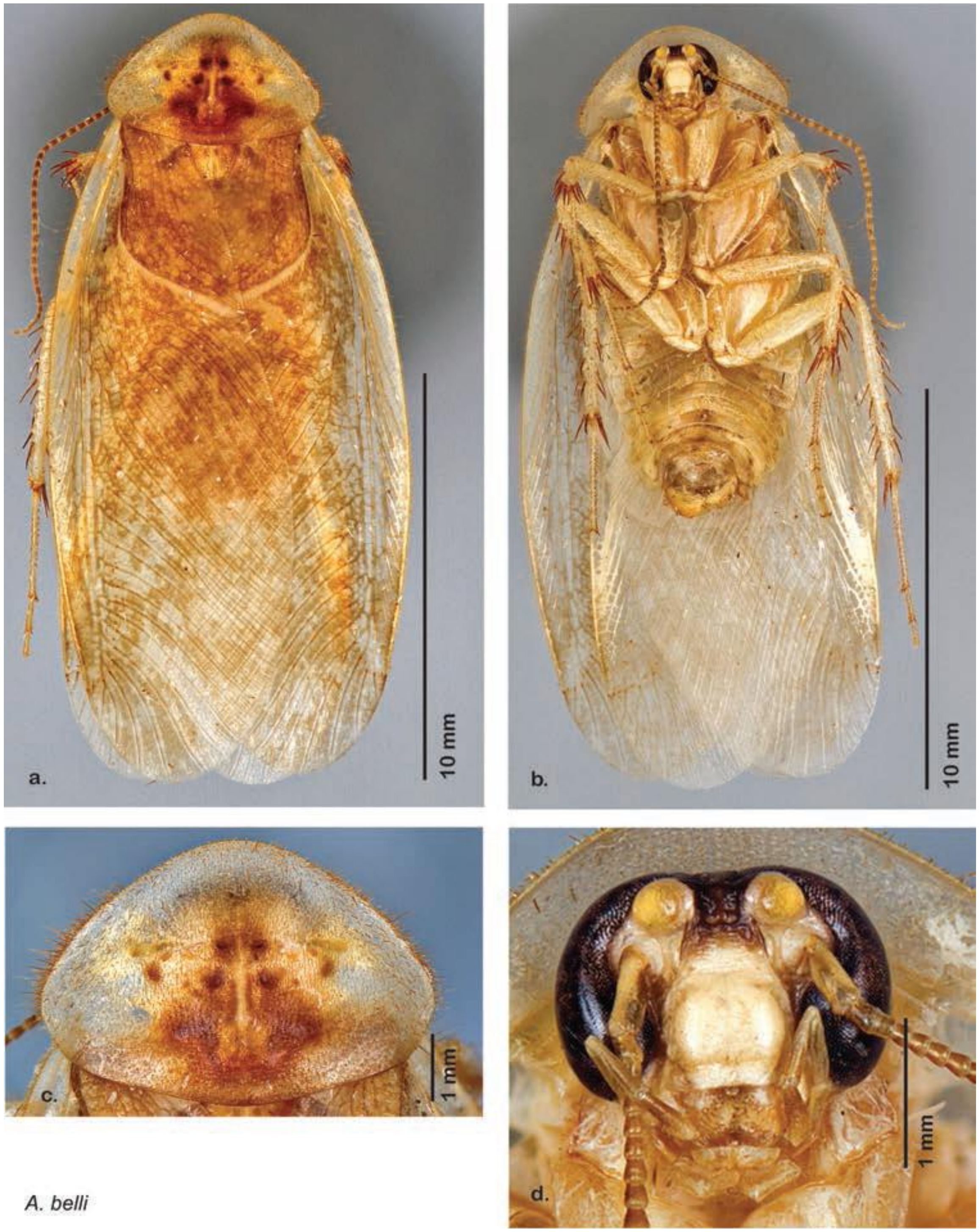


Figure 30. *A. belli*, a dorsal habitus b ventral habitus c pronotum d head.

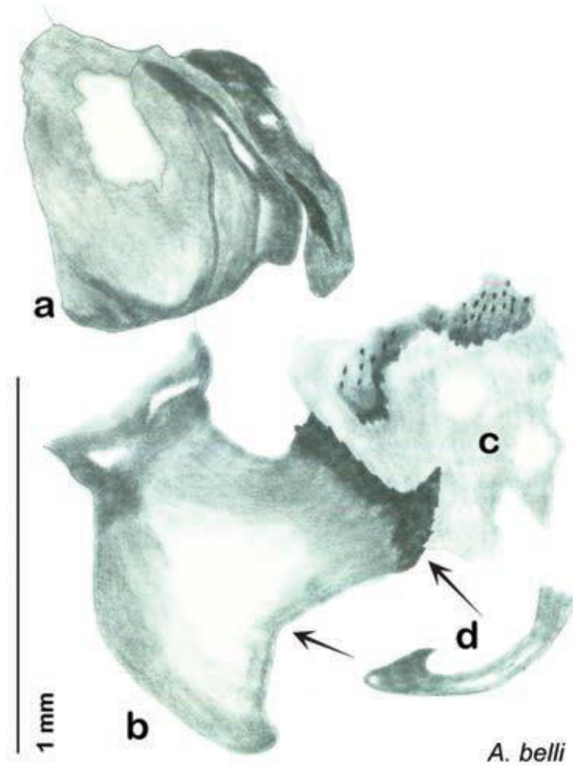


Figure 31. *A. belli*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

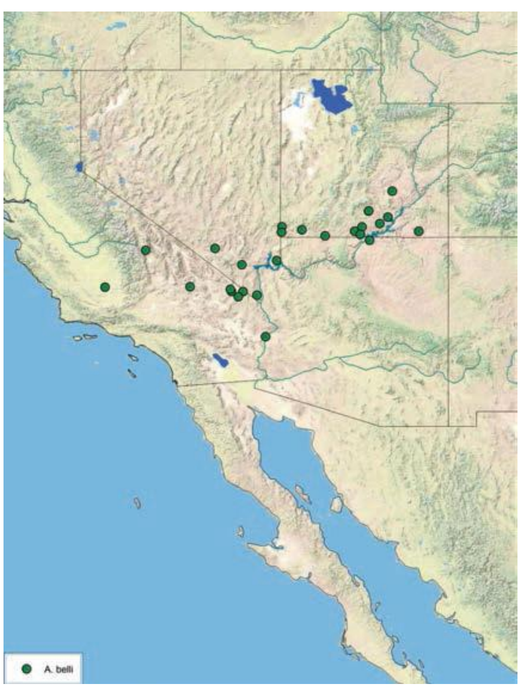


Figure 32. *A. belli*, distribution.

Arenivaga bolliana (Saussure)

http://species-id.net/wiki/*Arenivaga_bolliana*

Figures 33–35

1893 *Homoeogamia bolliana* Saussure, Revue Suisse de Zoologie, I, Fasc. 2, p.296. [Texas.]

1894 *Homoeogamia bolliana*, Saussure and Zehntner, Biol. Cent.-Amer., Orthopt., I, pp. 107. [New Mexico; Texas.]

1900 *Homoeogamia bolliana*, Scudder, Proc. Davenport Acad. Natu. Sci., VIII, p. 11. [Texas; New Mexico.]

1902 *Homoeogamia bolliana*, Rehn, Trans. Amer. Ent. Soc., XXVII, p. 331. [Round Mountain, Texas.]

1902 *Homoeogamia bolliana*, Scudder and Cockerell, Proc. Davenport Acad. Sci., IX, p. 19. [New Mexico; Las Cruces, NM.]

1903 *Homoeogamia* (*Arenivaga*) *bolliana* Rehn, Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 55, p. 188.

1904 *Homoeogamia* (*Arenivaga*) *bolliana* var. nigricans Caudell, Mus. Brooklyn Inst. A. & S. Sci. Bull., i. p. 107. [Esperanza Ranch, Brownville, Texas.]

1917 *Arenivaga bolliana* (Saussure) Hebard, Memoirs of the American Entomological Society, No. 2, pp. 223–227.

1920 *Arenivaga bolliana* (Saussure), Hebard, Transactions of the American Entomological Society, Vol. 46, pp. 201–203.

Material examined (294). USA: TX, Abilene, 8/7/1973 (1, UCRC); TX, Uvalde Co., Garner S.P. 8 mi. N of Concan, 10/2-4/2002, 1800', J.B.Heppner (2, FSCA); TX, Gillespie Co., Lange's Mill, 6/5/1969, Board & Hafernik (1, TAMU); TX, San Ygnacio, 10/10/1999, W.F.Chamberlain (2, TAMU); TX, Kerr Co., Kerrville, 9/5/1964, W.F.Chamberlain (4, TAMU); TX, Kerr Co., Kerrville, 9/19/1964, W.F.Chamberlain (1, TAMU); TX, Kerr Co., Kerrville, 9/19/1962, W.F.Chamberlain (2, TAMU); TX, Kerr Co., Kerrville, 9/24/1998, W.F.Chamberlain (1, TAMU); TX, Kerr Co., 4 mi. N of Kerrville, 6/11/2004, W.F.Chamberlain (2,TAMU); USA, TX, Kerr Co., 4 mi. N of Kerrville, 6/4/2004, W.F.Chamberlain, (1, TAMU); USA, TX, Kerr Co., Kerrville, 9/16/2001, W.F.Chamberlain, (1, TAMU); USA, TX, Kerr Co., Kerrville, 8/9/1988, W.F.Chamberlain, (2, TAMU); USA, TX, Kerr Co., Kerrville, 6/16/1997, W.F.Chamberlain, (2, TAMU); USA, TX, Kerr Co., Kerrville, 10/16/1996, W.F.Chamberlain, (1, TAMU); USA, TX, Kerr Co., 6 mi. N of Kerrville, 8/17/1996, W.F.Chamberlain, (1, TAMU); USA, TX, Kerr Co., Kerrville, 3/25/2000, W.F.Chamberlain, (1, TAMU); USA, TX, Kerr Co., Kerrville, 6/2/1997, W.F.Chamberlain, (1, TAMU); USA, TX, Kerr Co., Kerrville, 9/20/1960, W.F.Chamberlain, (1, TAMU); TX, Kerr Co., Kerrville, 5/11/1992, W.F.Chamberlain, (1, TAMU); TX, Kerr Co., Kerrville, Guadalupe R., 5/25/1983, Olson, Thomas & Burne, (2, UAIC); TX, Coryell Co., Mother Neff S.P., 12 mi. W of Eddy, 7/17/1962, U KS Mex. Exped., (1, SEMC); TX, Morris Co., 8/22/1960, Cohn & Triplehorn, (1, FSCA); TX, Brazos Co., 11/11/1959, (1, TAMU); TX, Leon Co., 5 mi. N of Flynn, 5/25/1995, E.G.Riley, (1, TAMU); TX, Leon Co., .5 mi. SW of Oakwood, 6/29/2000, 31°34'7"N, 95°51'42"W, Godwin & Riley, (1, TAMU); TX, Leon Co., 5 mi. N of

Flynn, 5/27/1994, E.G.Riley, (1, TAMU); TX, Maverick Co., Q.L.Nguyen, (1, TAMU); TX, Leon Co., 4 mi. NW Normangee, 9/27-10/6/2001, 31°04'N, 96°09'W, J.Yantis-59, (2, TAMU); TX, Leon Co., 5 mi. N of Flynn, 5/24/1994, E.Riley, (3, TAMU); TX, Wood Co., ca. 15 mi. N of Hawkins, 4/29/2000, 32°98'42"N, 95°10'04"W, W.Godwin, (3, TAMU); TX, Wood Co., Hawkins, 4 mi. N Jct 14 & 2869, 6/8-22/1996, W.Godwin, (1, TAMU); TX, Wood Co., ca. 18 mi. N of Hawkins, 5/14/1999, Yoder & Godwin, (1, TAMU); TX, Henderson Co., Cross Roads, 5/31/2001, E.G.Riley, (1, TAMU); TX, Dimmit Co., 9/10/1933, S.E.Jones, (1, ANSP); TX, Burleson Co., Lake Somerville, 8/9/1979, P.W.Kovarik, (1, TAMU); TX, Comal Co., Bulverde, 6/15-16/1996, Warner & Wappes, Bill Warner, (1, WB Warner); TX, Kleberg Co., 1 mi. SE of Kingsville, 6/9/1989, Schaffner, (1, TAMU); TX, Kleberg Co., Kingsville, C.T.Reed, (1, CUIC); TX, Anderson Co., Engeling WMA, 6/3/1995, E.G.Riley-130, (1, TAMU); TX, Three Rivers, 6/27/1938, D.W.Craik, (1, ANSP); TX, Kleberg Co., Kingsville, C.Reed, (1, ANSP); TX, San Patricio Co., Corpus Christi Lk. S.P., 8/18/1963, G.W.Byers, (2, SEMC); TX, Uvalde Co., 5/19/1918, J.C.Bradley, (1, ANSP); TX, Big Bend Reg., Summer 1928, F.F.Bibby, (1, ANSP); TX, Kerr Co., Kerrville, 9/14/1990, W.F.Chamberlain, (1, TAMU); TX, LaSalle Co., Chaparral WMA, 9/29-30/1989, J.Schaffner, (5, TAMU); TX, Kerr Co., Kerrville, 9/4/1964, W.F.Chamberlain, (1, TAMU); TX, Dimmit Co., 7/29/? (2, TAMU); TX, Dimmit Co., Chaparral WMA, Pasture 10, 10/10/2000, Raber & Riley, (4, TAMU); TX, Edwards Co., 24 mi. S Junction, Hwy. 377, 4/10/2002, 30°15'15"N, 99°57'48"W, Riley & Yoder, (1, TAMU); TX, Medina Co., .75 mi. S of D'Hanis, 9/17/1993, E.G.Riley, (8, TAMU); TX, Mason, 11/22/1969, B.L.Hofmann, (2, TAMU); TX, Chisos Mts., 6/30/1957, D.J. & J. N.Knull, (1, OSU); TX, Val Verde Co., Seminole

Canyon SHA, 8/30/1986, East, Kovarik & Haack, (1, TAMU); TX, Val Verde Co., Seminole Canyon SHP, 6/3/1983, C.B.Barr, (1, EMEC); TX, Val Verde Co., Lake Walk near Del Rio, 5/27/1967, E.E.Remington, (1, PMNH); TX, Kerr Co., Kerrville, 5/28/1963, W.F.Chamberlain, (1, TAMU); TX, Nueces Co., Corpus Christi, Hardee's on S Padre Island Dr., 6/29/1986, Weisman & Lightfoot, (1, CAS); TX, Hidalgo Co., Weslaco, 6/25/1979, G.W.Brooks, (1, TAMU); TX, Sinton, 8/31/1964, M.H.Sweet, (1, TAMU); TX, Hidalgo Co., Weslaco, 11/1/1940, P.T.Rihard, (2, TAMU); TX, San Patricio Co., Cd. Welder WA, 7/16/1989, J. Schaffner, (1, TAMU); TX, San Patricio Co., Corpus Christi SP, 7/12/1963, G.W.Byers & party, (1, SEMC); TX, San Patricio Co., Corpus Christi SP, 8/25/1962, H.R.Burke, (1, TAMU); TX, Brooks Co., 6 mi. S of Falfurrias, 10/10/1970, (1, TAMU); TX, Brooks Co., 7.3 mi. S of Falfurrias on hwy. 281, 4/27/1991, E.G.Riley, (1, TAMU); TX, Brooks Co., 7.3 mi. S of Falfurrias on hwy. 281 rest stop, 5/8/1989, E.G.Riley, (2, TAMU); TX, Milam Co., Sugarloaf Mt. 4 mi. N of Gause, 10/4-23/1992, 300', Abbott,Godwin,Migura & Riley, (3, TAMU); TX, Milam Co., Sugarloaf Mt., 7/22/1992, 500', Riley & Godwin, (1, TAMU); TX, Milam Co., 4 mi. N of Gause near Sugarloaf Mt., 4/18/1993, E.Riley, (1, TAMU); TX, Milam Co., Sugarloaf Mt., 5/30/1998, R.Turnbow, (1, FSCA); TX, Caldwell Co., 4.5 mi. E of McMahon, 6/2/1998, R.Turnbow, (1, FSCA); TX, Kenedy Co., 2.7 mi. S of Sarita, 4/27/1991, E.G.Riley, (1, TAMU); TX, Kenedy Co., Kenedy Ranch, Jaboncillos Pasture, sand dunes, 4/6-20/2001, 26°58'38"N, 97°40'59"W, Godwin & Riley, (2, TAMU); TX, Kenedy Co., Kenedy Ranch, Jaboncillos Pasture, sand dunes, 4/21/2001, 26°59'22"N, 97°40'11"W, Raber,Riley & Yoder, (1, TAMU); TX, Padre Island, 7/1/1965, Dr Lenczy, (1, LACM); TX, Bexar Co., Ebony Hill Res Station, 9/4/1984, Kendall &

Kendall, (1, TAMU); TX, Bexar Co., Lab. Garden, 9/11/1970, R.O.Kendall, (1, TAMU); TX, Bexar Co., Ebony Hill Res Station, 5/11/1991, Kendall & Kendall, (1, TAMU); TX, Bexar Co., Ebony Hill Res Station, 11/1/1980, Kendall & Kendall, (1, TAMU); TX, Burnet Co., Inks Lake SP, 6/13/1972, J.S.Ashe, (1, TAMU); TX, Duval Co., 8.5 mi. (?) San Diego, 9/18/1993, E.G.Riley, (1, TAMU); TX, Kleberg Co., vicinity of Kingsville, C.Reed, (3, ANSP); TX, Austin, 8/15/1968, (1, UCRC); TX, McLennan Co., Waco, Texarcana, 5/11/1938, (1, ANSP); TX, Three Rivers, 6/27/1938, R.H.Beamer, (1, ANSP); TX, Shovel Mount, 9/5/1901(?), F.G.Schaupp, (1, ANSP); TX, San Antonio, 7/4/1953, E.S.Ross, (1, CAS); TX, Brownsville, June, (1, ANSP); TX, San Antonio, 7/7/1942, E.S.Ross, (1, CAS); TX, Waco, 7/1910(?), (1, MCZ); TX, San Antonio, Oct. 1942, E.S.Ross, (1, CAS); TX, Nueces Co., Clare (Hazel?) Bazemore Park, 4/10/1970, C.W.Griffin, (1, USNM); TX, Corpus Christi SP, 10/6/1951, A.B.Gurney, (2, USNM); TX, San Antonio, 4/1/1935, E.V.Walter, (1, USNM); TX, Zavalla Co., Nueces Riv., 6/2?/????, F.C.Pratt, (1, USNM); TX, Belfrage, (3, USNM); TX, Kerrville, 9/21/1951, A.B.Gurney, (2, USNM); TX, ?/?/1927, Clyde T. Reed, (1, USNM); TX, Bexar Co., Randolph Field, 10/4/1943, Pierce Brodkorb, (1, UMMZ); TX, Corpus Christi nr. Casa Blanca Lake, 12/17/1939, L.Berner, (1, UMMZ); TX, Ft. Sam Houston, 9/20/1950, J.E.Gentry, (1, UMMZ); TX, Burnet Co., Longhorn Cavern 11 mi. SW Burnet, 7/5/1959, 1200’, T.J.Cohn, (2, UMMZ); TX, Belfrage, H.S.Wallace, (1, UMMZ); TX, Dallas, C.V.Riley, (1, USNM); TX, Hidalgo Co., Edinburg, 4/?/1939, Stanley Mulaik, (3, UMMZ); TX, Cameron Co., Brownsville, 7/31-8/5/1912, (1, ANSP); TX, Austin, 10/?/1900, (1, UMMZ); TX, Kleberg Co., 3.5 mi. N Riviera, 6/29/1961, L.Westcott, (1, LACM); TX, Travis Co., 5 mi. NE Austin PO (WFBlair’s), 7/15/1955, 600-700’, T.J.Cohn, (6, USNM); TX, Goliad Co., 1 mi. S Goliad, 7/22/1955, 100', T.J.Cohn, (4, USNM); TX, Belfrage, C.V.Riley, (1, USNM); TX, Belfrage [another illegible word], 9/?/1921, S.H.Scudder, (1, USNM); TX, Kerrville, ?/22/1908, F.C.Pratt, (1, USNM); TX, illegible label, S.H.Scudder, (1, USNM); TX, Brownsville, 12/2/1951, (1, USNM); TX, (1, USNM); TX, Austin, 6/4/1952, R.A.Stirton, (1, USNM); TX, Caldwell Lockhart SP, 4 mi. SW of Lockhart, 7/9/1955, 500-600', Cohn & Matthews, (2, USNM); TX, Shovel Mount, 10/18/1901, F.G.Schaupp, (1, USNM); TX, Travis Co., ?/?/1931, J.K.G.Silvey, (1, UMMZ); TX, Dimmit Co., Catarina, 7/7/1948, Nutting & Werner, (1, UAIC); TX, Gonzales Co., Luling, 6/19/1953, M.Wasbauer, (3, EMEC); TX, Kenedy Co., Armstrong, 3/31/1962, H.Glick, (1, CSCA); TX, Kenedy Co., Armstrong, 6/13/1962, P.A.Glick, (2, CSCA); TX, Ringgold Barracks Schott, S.H.Scudder, (1, USNM); TX, Carrizo Springs, 8/28/1985, Dr. A Wadgynear, (1, USNM); TX, Sonora, 8/28/1924, O.G.Babcock, (1, USNM); TX, San Antonio, Fall 1947, H.C.Barnett, (1, USNM); TX, San Antonio, 8/8/1933, E.V.Walter, (1, USNM); TX, Mercedes, May 1034, Thayer, (1, USNM); TX, Cameron Co., Sabal Palm Grove Sanct., 10/20/1990, Carlow & Riley, (3, TAMU); TX, Cameron Co., Sabal Palm Grove Sanct., 7/26/1991, Riley & Carlow, (2, TAMU); TX, Cameron Co., Sabal Palm Grove WR, 10/18/2002, Raber & Riley, (1, TAMU); TX, LaFeria, 9/26/1963, P.T.Riherd, (1, TAMU); TX, Cameron Co., Sabal Palm Grove Sanct., 10/13-14/1988, E.G.Riley, (1, TAMU); TX, Cameron Co., LRGVNWR Voshell Unit, Brownsville, 6/5-6/2009, 25.88873°N 97.43142°W, Heffern & Riley-1030, (4, TAMU); TX, LaFeria, 10/21/1959, P.T.Riherd, (1, TAMU); TX, Val Verde Co., 5/24/1948, Knull & Knull, (1, FSCA); TX, Val Verde Co., Comstock, 8/11/1975,Taylor & Sullivan, (4, LACM); TX, Langtry, Sept. 1979, H.Hartman, (1, MCZ); TX, Cameron Co., Brownsville, June, F.H.Snow, (1, ANSP); TX, Cameron Co., Sabal Palm Grove Ref. site 3, 9/18-10/2/2008, 25.84964°N 97.41849°W, Lindgren FT, King & Riley-193, (2, TAMU); TX, Cameron Co., Sabal Palm Grove Ref. site 1, 9/3-18/2008, 25.84799°N 97.41881°W, King & Riley, (1, TAMU); TX, Cameron Co., Brownsville, 6/21/1969, Board & Hafernik, (1, TAMU); TX, Cameron Co., Sabal Palm Grove Audubon Sanct., 5/5/1989, E.G.Riley, (1, TAMU); TX, Cameron Co., Brownsville, 12/9/1911, (1, ANSP); TX, Cameron Co., Sabal Palm Grove Sanct., 4/8/1994, E.G.Riley, (2, TAMU); TX, Val Verde Co., Seminole Canyon SHA, 8/30/1986, East, Kovarik &Haack, (3, TAMU); TX, Cameron Co., Esprza Rch Brownsville, 7/1/1930, (3, USNM); TX, Cameron Co., Brownsville, H.S.Barber, (2, USNM); TX, Cameron Co., Esprza Rch Brownsville, August, (2, USNM); TX, Uvalde Co., Speir Rch. 3 mi. NW Uvalde, 5/6/1977, Eichlin & Wasbauer, (1, CSCA); TX, Uvalde Co., Uvalde, 6/18/1920, Wickham, (1, USNM); TX, Maverick Co., Eagle Pass Horn., S.H. Scudder, (2, USNM); TX, Cameron Co., Brownsville, April, (1, USNM); TX, Cameron Co., 13.4 mi. E of Brownsville, 7/17/1962, (2, SEMC); TX, Hidalgo Co., Mission, 7/1/1961, R.L.Westcott, (1, LACM); TX, Cameron Co., Brownsville, 6 mi. N of PO, 8/20/1955, Bermler & Cohn, (4, UMMZ); TX, Hidalgo Co., Santa Ana WR, 7 mi. S of Alamo, 5/6/1967, A & M.E. Blauchard, (1, LACM); TX, Cameron Co., Esprza Rch Brownsville, 6/1/1915, (1, USNM); TX, Cameron Co., Brownsville, 5/1/1929, (5, USNM); TX, Cameron Co., Brownsville, Los Borregos, 6/5/1904, H.S.Barber, (2, USNM); TX, Cameron Co., Brownsville, 6/9/1962, P.A.Glick, (1, CSCA); TX, Cameron Co., Southmost, 6/13/1952, (1, SEMC); TX, Cameron Co., 8/3/1928, R.H.Beamer, (2, SEMC); TX, Cameron Co., Brownsville, 6/8/1920, R.D.Camp, (1, UMMZ); TX, San Antonio, at light on kitchen door at night, 6/13/1948, H.C.Barnett, (1, USNM); TX, Del Rio KOA, nite lite, 10/6/1974, (1, SDMC); TX, Las Paloma, 9/8/1968, Kirby & Phipps, (1, USNM); TX, Esprza Rch Brownsville, 8/1/1929, (1, USNM); FL, Gainesville, 9/10/1969, D.Bennett, (1, USNM); FL, Seminole, 10/?/1974, BJ Wyckoff, (1, MLBM); TX, Bexar Co., Leon Valley, 7/4/1968, GH & JM Nelson, (1, FSCA); TX, Lake Corpus Christi SP, 6/18/1971, GH Nelson, (2, FSCA); TX, Brewster Co., Big Bend NP near Pulliam Mtn., 8/16/1970, 6000 ft., RE Woodruff, (1, FSCA); TX, Travis Co., Austin, Breckenridge Field Lab, 10/6/1989, 550 ft., CR Nelson #5412, (1, MLBM); TX, Val Verde Co., Devils R, Dolan Falls, 8/5-7/1994, AM Hook & O Hernandez, (1, MLBM); TX, Uvalde Co., Garner SP, 6/17/1968, GH Nelson & family, (2, FSCA); TX, Dimmit Co., Chaparral WMA, 6/7-8/1992, AW Hook, (4, MLBM); TX, Starr Co., Falcon Heights, 10/9/1993, SM Clark, (1, MLBM); TX, Travis Co., BFL, 10/?/1997, SM Brandt, (1, MLBM); TX, Dimmit Co., Chaparral WMA, 8 mi W of Artesia Wells, 5/19/1999, 28.18.41N 99.24.25W, CR Nelson #6940, (1, MLBM); TX, Cameron Co., Sabal Palm Grove Sanctuary , 9/25/1996, SM Clark,(1, MLBM). MEXICO: Tamaulipas, Abasolo, 5/17/1952, Cazier,Gertsch & Schrammel, (2, AMNH); Tamaulipas, San Fernando, 8/26-27/1954, 700 ft., CD Michener & party, (5, SEMC); Tamaulipas, 8 mi. SW of Ciudad Victoria, 10/5/1958, 1500-2000 ft., TJ Cohn, (1, UMMZ); Tamaulipas, Hacienda Clementine 13 mi. ESE of Llera, 8/25/1955, 200 m, TJ Cohn, (1, UMMZ); Nuevo Leon, 16.5 mi. W of Linares, 7/22-24/1977, Peigler & Plitt, (1, TAMU); Nuevo Leon, 15 mi. W of Linares, 7/1-2/1973, Mastro & Schaffner, (1, TAMU); Tamaulipas, 12 mi. S of Nuevo

Laredo, 7/9/1936, 400 ft., HR Roberts, (1, ANSP); Tamaulipas, Canon la Libertad, 4/4/1986, RW Jones, (1, TAMU); Nuevo Leon, Garza Garcia, 4/18/1955, L Ayola Jr., (1, UMMZ); Durango, near Pedricena, 8/27/1932, H Smith, (1, ANSP); Monterey, 12/12/1991, WF Chamberlain, (1, TAMU); Nuevo Leon, 17 km N of Sabinas Hidalgo, 5/24/1948, Nutting & Werner, (1, UAIC); Tamaulipas, 8 mi. E of Padilla Rancho Sta. Ana, 12/21/1941, Cantrell & Friauf, (2, UMMZ). Determiner label *Arenivaga bolliana* Hopkins 2011" [white label with black border].

Distribution. *A. bolliana* is found across southern and eastern Texas and far northeastern Mexico. There are two isolated records in central and western Mexico, and two more in Florida. It is impossible to say if these are established populations or incidents of specimens transported by man or weather. It is hard to imagine four such incidences occurring and then the transported specimens being collected but it is remotely possible. See Fig. 35.

Diagnosis. *A. bolliana* may be easily confused with *A. grata*. Both are large and dark in color, though the territory of *A. grata* is distinctly to the west of that of *A. bolliana*. *A. bolliana* may be diagnosed by the large angular right dorsal phallomere with very simple medial margin and no complexity in the point of articulation of the two right phallomeres. See Figs 35 and 73.

Description. Male. NB: Holotype is half spread therefore GW is estimated.

Measurements. Holotype TL = 24.6 mm, GW = 13.0 mm, PW = 8.64 mm, PL = 5.60 mm, TL/GW = 1.89, PL/PW = 0.65. EW = 0.40 mm; OW = 0.60 mm. Among paratypes range of TL 20.1–30.7 mm; range of GW 9.6–15.3 mm; range of PW 7.25–10.10 mm; range of PL 4.74–6.17 mm.

Head. Two ocelli large, ovoid and protruding (0.50 × 0.40 mm); vertex dark brown, with small ridges between apices of eyes; interocellar space concave, dark brown. Frons medium brown, tectiform, concave with fine horizontal corrugations; bound on either side by ridges extending from inner apex of ocelli outwards to lateral edges of clypeus. Anterior portion of frons medium brown, bulbous; clypeal suture demarcates medium brown anteclypeus. See Fig. 33d.

Pronotum. Pronotum with broad anterior margin of translucent waxy beige, extending and narrowing laterally; variable length orange-brown setae along anterior margin; dorsal surface of pronotum covered with short orange-brown setae; pronotal pattern impressed ranging from medium brown to very dark brown, all with extensive aura; no discernible detail. See Fig. 33c.

Body. Wing brace absent. Legs and body medium orange-brown; subgenital plate asymmetrical with posterior edge emarginated, rounded apices. See Fig. 33b.

Forewings. Wings extended beyond abdominal apex (up to ~30% of the total wing length); color ranges from light brown with virtually no blotches to every level of blotchiness to uniform dark brown depending on specimen; surface opaque and matte. See Fig. 33a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized wavy dorsally projecting lobe, articulated with right ventral phallomere on lateral side; central field broad, slightly sclerotized; medial margin sclerotized, with toothed edge and slight central indentation. Small central sclerite finely punctate, folded lengthwise and attached dorsally. Right ventral phallomere extends from articulation into shagreened lobe with broad indentation at posterior end and medial concavity; after narrow gap, wide concave shagreened flange. Folded anterior portion of left phallomere of moderate width, setose, otherwise unmodified. Genital hook with rounded head with moderate hook; arm smoothly curved. See Fig. 34.

Habitat and natural history. All life history elements remain unobserved.

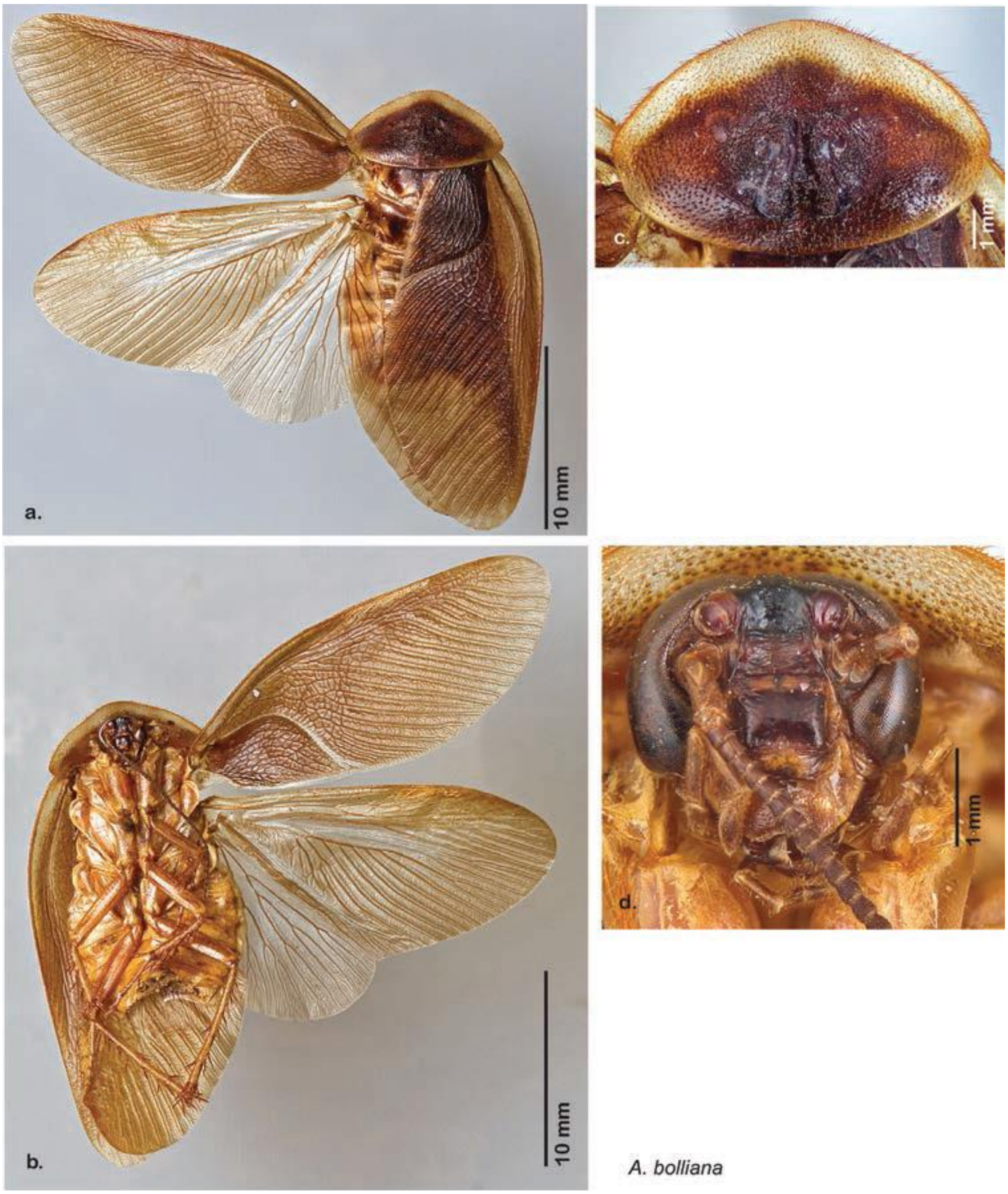


Figure 33. *A. bolliana*, a dorsal habitus b ventral habitus c pronotum d head.

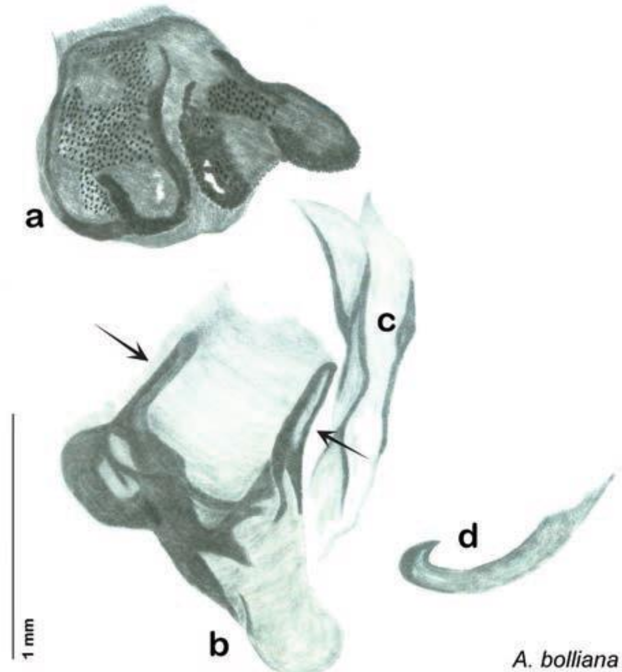


Figure 34. *A. bolliana*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

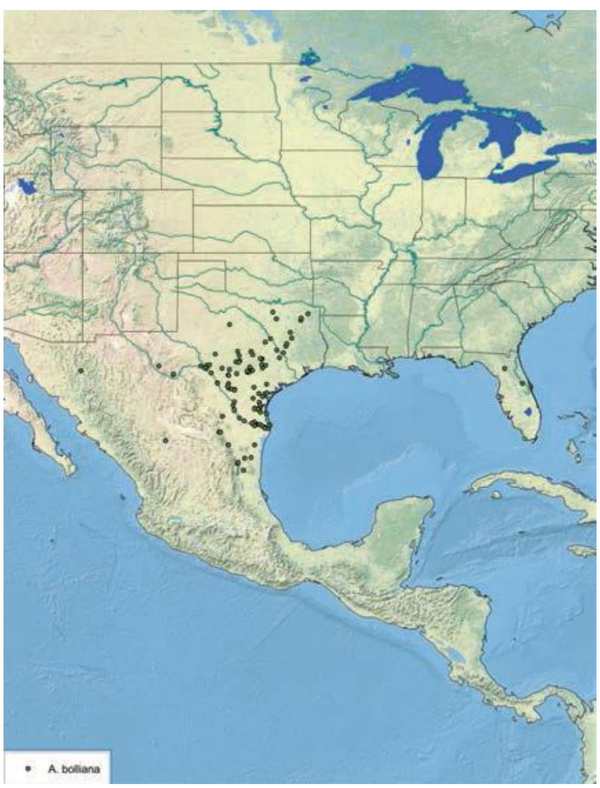


Figure 35. *A. bolliana*, distribution.

***Arenivaga darwini* sp. n.**

http://zoobank.org/CC9C923E-7E0F-4509-A6DF-8314E6E8BB81

http://species-id.net/wiki/*Arenivaga_darwini*

Figures 36–38

Type locality. USA, California, Imperial County, 2 mi. NW of Glamis.

Material examined. Holotype: ♂ in Essig labeled "CAL: Imperial Co., 2 mi. NW Glamis, III-29-77, Powell, on sand dunes" " HOLOTYPE *Arenivaga darwini* Hopkins, 2012" [red label with black border].

Paratypes (132): USA: CA, Imperial Co., Algodones Dunes, I8 at Ogilby Road, 3/7/1988, RE Woodruff, dunes at night (4, FSCA); CA, Imperial Co., 13 mi. SE of Glamis, 2/10/1972, AR Hardy, on sand dunes (1, UCRC); CA, Imperial Co., 2 mi. NW of Glamis, 3/29/1977, Powell, on sand dunes (20, EMEC); CA, Imperial Co., 3 mi. NW of Glamis, 4/3/1972, AR Hardy, sand dunes (1, UCRC); CA, Imperial Co., 1 mi. W of Glamis, ?/28/1965, ME Irwin, dunes (1, UCRC); CA, Imperial Co., 12 mi. W of AZ border, I10 dunes S of Ogilby exit, 2/27/1988, P Parrella, collected on sand dunes, Polyphagidae det. By P.Parrella 1988 (1, ASUT); CA, Imperial Co., 12 mi. W of AZ border, I10 dunes S of Ogilby exit, 2/27/1988, I Gallicano, collected on sand within 2 mi. of main road, Polyphagidae det. By Ian Gallicano 1988 (3, ASUT); CA, Imperial Co., 12 mi. W of AZ border, I10 dunes S of Ogilby exit, 2/27/1988, M Harding, Lying still on sand dunes, Polyphagidae det. By M Harding 1988 (1, ASUT); CA, Imperial Co., I10 0.5 mi. S of Ogilby Rd. exit, 2/27/1988, C Bagnoll, Lying still on sand dunes, Polyphagidae det. By C. Bagnoll 1988 (1, ASUT); CA, Imperial Co., 12 mi. W of AZ border, I10 dunes S of Ogilby exit, 2/27/1988, M Mustain, dunes at night, Polyphagidae det. By M.Mustain 1988

(1, ASUT); CA, Imperial Co., 12 mi. W of AZ border, I10 dunes S of Ogilby exit, 2/27/1988, R Shill, dunes at night, Polyphagidae det. By R Shill 1988 (1, ASUT); CA, Imperial Co., 12 mi. W of AZ border, I10 dunes S of Ogilby exit, 2/27/1988, L Davison, dunes at night (1, ASUT); CA, Imperial Co., 3.5 mi. NW of Glamis, 3/10/1973, Andrews & Hardy, on sand dunes (8, CSCA); CA, Imperial Co., Algodones Dunes, 7 mi. SE of Glamis, 3/25/-4/8/1979, 32.55.20N 114.59.14W, Site 4, dunes at night (2, CSCA); CA, Sand dunes E of Grays Well, 4/30/1952, ER Tinkham (2, USNM); CA, Imperial Co., Glamis sand dunes 5 mi. W of Ogilby, 5/29/1981, Werner,Olson,Hetz,Thomas,Burne, Frank,MacLachlan (1, UAIC); CA, Imperial Co., 3 mi. NW of Glamis, 4/4/1972, EA Kane, fluorescent black light (1, CSCA); CA, Imperial Co., 5 mi. W of Ogilby, 5/9/1959, V Roth (1, USNM); CA, Imperial Co., Imperial Sand Dunes RA, Wash Rd. ~7.2 mi. S of Hwy 78, 3/28/2002, 32.55.31N 114.58.52W, CB Barron, dunes at night (1, EMEC); AZ, Maricopa Co., Tempe, ASU campus, stairwell of life science bldg., 7/12/1988, Polyphagidae det. By E Rocklin 1988 (1, ASUT); AZ, Yuma Co., Yuma, 4/3/1959, L Anharal (1, UAIC); AZ, Yuma Co., lg.sand dunes SE of Yuma, 4/16/1994, 32.27N 114.25W, WB Warner (1, WB Warner); AZ, Yuma Co., Mittry Lake boat launch, 2.5 mi. ??? of Laguna YPG, 11/27/1988, M Childs, Polyphagidae det. By M Childs 1988 (1, ASUT); AZ, Maricopa Co., 3 mi. SE of I10 on Ray Rd., 4/6/1988, KK Menze, empty fields dry soil, Polyphagidae det. By KK Menze 1988 (1, ASUT); AZ, dunes, 22 mi. E of San Luis, 6/1/1958 150 ft., ER Tinkham (20, USNM). MEXICO: Sonora, 27 mi. E of San Luis, 6/24/1957, ER Tinkham, dunes (2, USNM); Sonora, 10 mi. N of C. Sotelo near Bahia Adair, 3/13/1973,Andrews & Hardy,on sand dunes (10, CSCA); Sonora, 50 mi. SW of Sonoyta,3/12/1973, Andrews & Hardy, on sand dunes (41, CSCA); BC, 4.9 mi.

SW of Algodones Dunes, 3/25/1986, 32.48.734N 114.48.234W, RH McPeak, blacklight (1, EMEC). All paratypes labeled “Paratype *Arenivaga darwini* Hopkins 2012” [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for Charles Darwin.

Distribution. This species is distributed in and around Yuma, AZ and vicinity and down the eastern coast of the Sea of Cortez. See Figure 38.

Diagnosis. *A. darwini* sp. n. has one tarsal claw on each leg, unique to the genus.

Description. Male. Measurements. Holotype TL = 16.2 mm, GW = 9.8 mm, PW = 7.25 mm, PL = 4.45 mm, TL/GW = 1.65, PL/PW = 0.61. EW = 0.6 mm; OW = 0.5 mm. Among paratypes range in TL 13.1–17.3 mm; range in GW 8.6–10.9 mm; range in PW 5.55–7.67 mm; range in PL 3.5–4.45 mm.

Head. Two ocelli large and ovoid (0.40 × 0.30 mm); vertex golden; interocellar space concave, golden fading to white towards frons. Frons concave; clypeus bulbous, golden with no notable sculpturing or setae, ends in broad flat anteclypeus. See Fig. 36d.

Pronotum. Pronotum unusually broad relative to length, pale, waxy beige-gold; anterior half of dorsal surface of pronotum covered in fine pale setae; posterior half sparsely setose; pronotal pattern ranges in color from same waxy beige-gold of background, to white and orange-brown depending on specimen; pattern is foreshortened “koala face”, indiscernible detail; no aura. See Fig. 36c.

Body. Wing brace present. One tarsal claw present. Legs and body golden with white deposits of uric acid particularly visible on outer margins of forewings. Abdominal sternites end in conspicuous points on lateral edges. Subgenital plate dramatically asymmetrical with pointed apices. See Fig. 36b.

Forewings. Wings extend beyond abdominal apex (~25% of wing length); forewings shorter than hindwings; color pale iridescent gold and translucent to transparent. Long golden setae on lateral edges. See Fig. 36a.

Genitalia. Right dorsal phallomere composed of large bulbous lightly sclerotized pointed lobe, articulated with right ventral phallomere on lateral side; unmodified, covered in fine punctations. Small central sclerite consists solely of thin half circle of sclerotized material beginning midlaterally on right dorsal phallomere and sweeping around to rear of same phallomere; interior tissue of ring finely punctate. Right ventral phallomere extends from articulation to form structure rounded at posterior apex and expanding to shagreened and more sclerotized area dorsally; attached anteriorly is an L-shaped shagreened lobe bordered by rolled shagreened lip. Left phallomere unmodified. Genital hook with long extension to pointed head with slight indentation on short hook; arm with distinct bend. See Fig. 37.

Habitat and natural history. This species occurs in sparsely vegetated sand dunes that are extremely dry and hot. More than one specimen carried mites. All other life history elements remain unobserved.

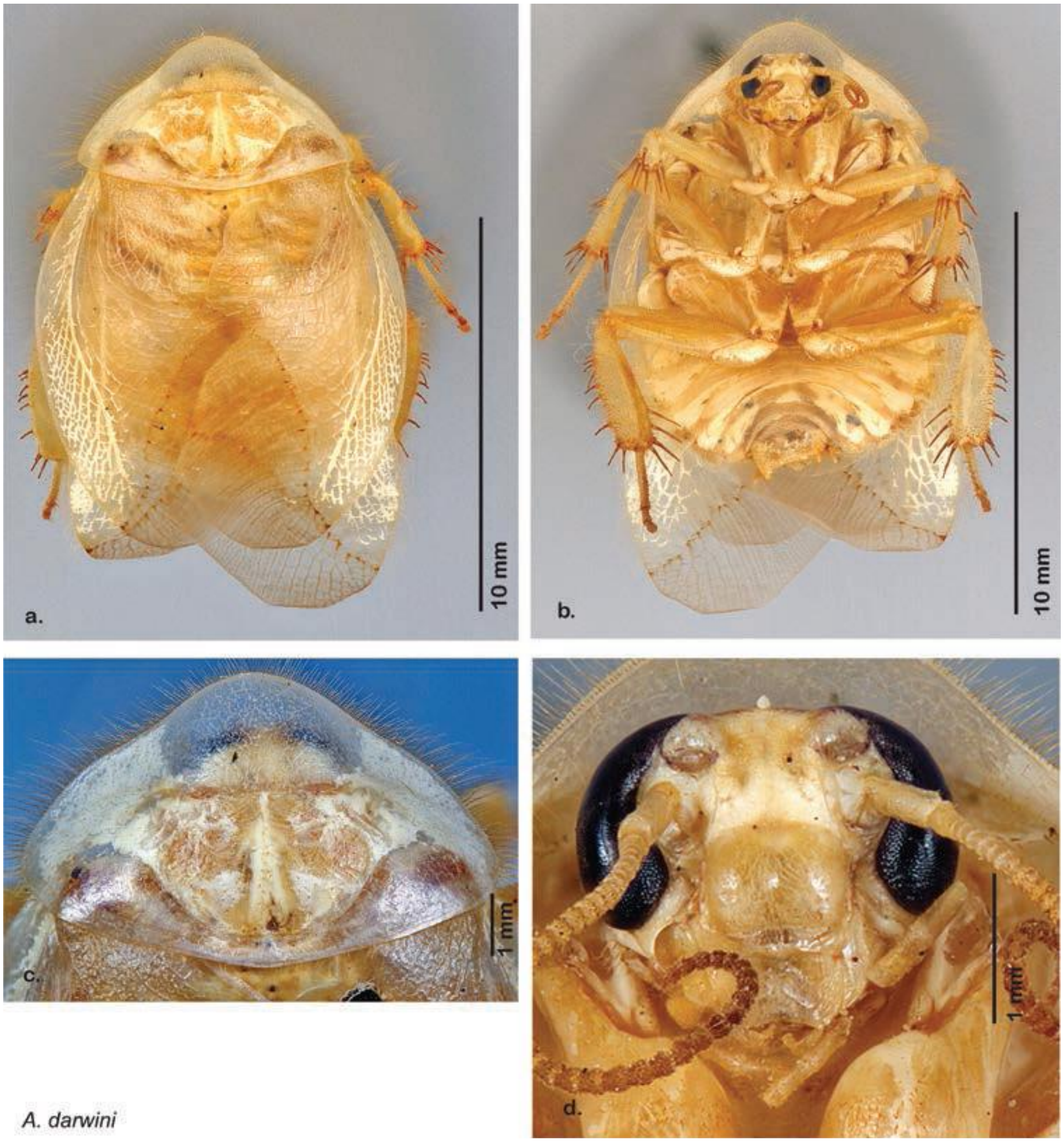


Figure 36. *A. darwini*, a dorsal habitus b ventral habitus c pronotum d head.

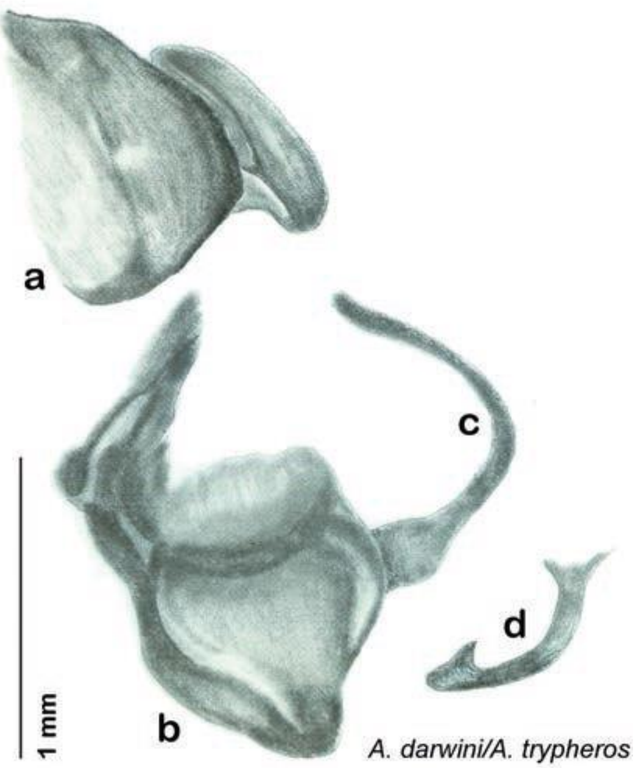


Figure 37. *A. darwini*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

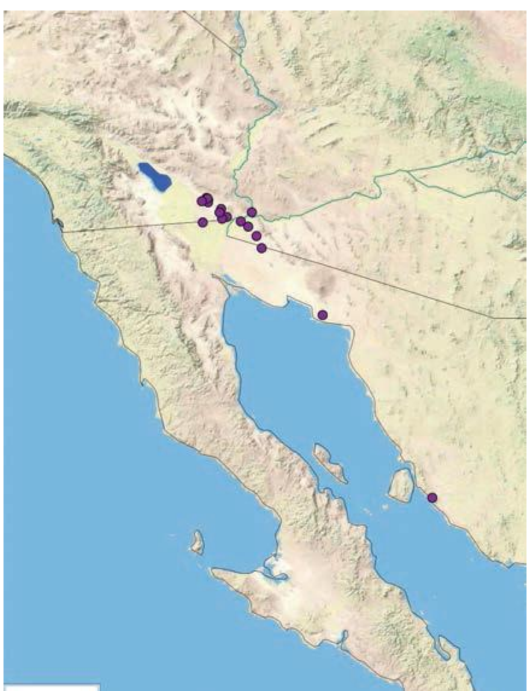


Figure 38. *A. darwini*, distribution.

***Arenivaga delicata* sp. n.**

http://zoobank.org/5AB46CDA-BE7E-435E-A292-CB50C62A7B05

http://species-id.net/wiki/*Arenivaga_delicata*

Figures 39–41

Type locality. USA, California, San Bernardino Co., Old Woman Mts.

Material examined. Holotype: ♂ in LACM labeled "CALIF. S. Bdno. Co: nr Sunflower Wash, 3300 ft., Old Woman Mts., T5N R18E SW ¼ sec 5, 28-29 May '88, JP and KES Donahue, 121578" " HOLOTYPE *Arenivaga delicata* Hopkins, 2012" [red label with black border].

Paratypes (23): USA: CA, Riverside Co., N of Blythe, 1/29/1966, D Park, under rock on ground, Cal.Dept.Agr.6687-25 (1, CSCA); CA, Kern Co., 1 mi S of Willow Spring, 10/4/1960, WE Ferguson, at light (1, EMEC); CA, Riverside Co., 4 mi N of Blythe, 7/22/1975, Sumlin,Garcia & Drake, alluvial fan, UV light (1, UCRC); CA, Cottonwood Springs, 11/7/1950, ER Tinkham, red tag (1, USNM); CA, San Bernardino Co., Halloran Springs, 14 mi E of Baker, 4/15/1964, RL Langston (1, EMEC); CA, San Diego Co., San Diego, GR Crotch (1, ANSP); CA, Riverside Co., 4 mi NW of Desert Center, 6/20/1956, M Wasbauer (1, EMEC); CA, Providence Mts., 4/12/1934, ML Walton, Collection of ML Walton donated to LACM 1975 (1, LACM); CA, San Bernardino Co., Needles, 5/31/1968, JC Lambert, light trap (1, CSCA); CA, San Bernardino Co., Needles, 5/10/1983, D Pendleton (1, SDMC); CA, Mono Co., White Mts., Coldwater Canyon, 4/21-11/15/1983, D Giuliani, antifreeze pit trap (1, CSCA); CA, Kern Co., Iron Canyon E of Garlock, 4/1/1961, CA Toschi (1, EMEC). All paratypes labeled "Paratype *Arenivaga delicata* Hopkins 2012" [blue label with black border].

Etymology. The name is an adjective in the nominative singular. This species is named *delicata* from Latin meaning delicate. Though not as short in total length as *A. pumila* or *A. ricei* it is one of the smallest and most delicate of the *Arenivaga*.

Distribution. This species is distributed from Willow Spring, CA in the north and west to Blythe, CA in the south and east. See Fig. 41.

Diagnosis. *A. delicata* is smaller than average for *Arenivaga* but may be confused with *A.mortisvallisensis* which has a sympatric distribution. *A. delicata* may be distinguished by the clamshell shape of the small central sclerite and the distinctive crossing band of teeth towards the anterior end. See Figs 40 and 109.

Description. Male. Measurements. Holotype TL = 17.7 mm, GW = 8.0 mm, PW = 4.76 mm, PL = 3.23 mm, TL/GW = 2.21, PL/PW = 0.68. EW = 0.40 mm; OW = 0.30 mm. Among paratypes range of TL 14.7–17.7 mm; range of GW 6.9–8.4 mm; range of PW 4.28–4.76 mm; range of PL 3.07–3.42 mm.

Head. Two ocelli very large, ovoid and protruding (0.4 × 0.3 mm); vertex dark brown with small ridges in rays around upper apex of eyes and extending onto ocellar tubercles; interocellar space concave, smooth, medium brown; two round indentations medial to ocelli. Frons pale beige, concave; clypeus bulbous; pale beige anteclypeus. See Fig. 39d.

Pronotum. Pronotum translucent, waxy beige; dorsal surface of pronotum with short fine light orange-brown setae centrally and posteriorly grading to longer, thicker setae laterally and anteriorly; pronotal pattern orange-brown “panther face” with no discernible detail; orange-brown posterior aura. See Fig. 39c.

Body. Wing brace present. Two tarsal claws present. Legs and body light brown with darker brown maculations laterally on each sternite; subgenital plate light brown; asymmetrical with rounded apices. See Fig. 39b.

Forewings. Wings extended well beyond abdominal apex (~45% of wing length); color golden with light to medium brown splotches depending on specimen; surface translucent and lustrous. See Fig. 39a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized hookshaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin short, shagreened with toothed margin. Small central sclerite shaped like clamshell, finely punctate with crossing band of teeth one third of distance from anterior end; right ventral phallomere extends from articulation to form rounded punctate structure; attached anteriorly is mildly dorsally projecting flanged arm, shagreened with roughly toothed edge. Folded anterior portion of left phallomere setose, otherwise unmodified. Genital hook with short extension to pointed rounded head and short hook; arm smoothly curving. See Fig. 40.

Habitat and natural history. All life history elements remain unobserved.

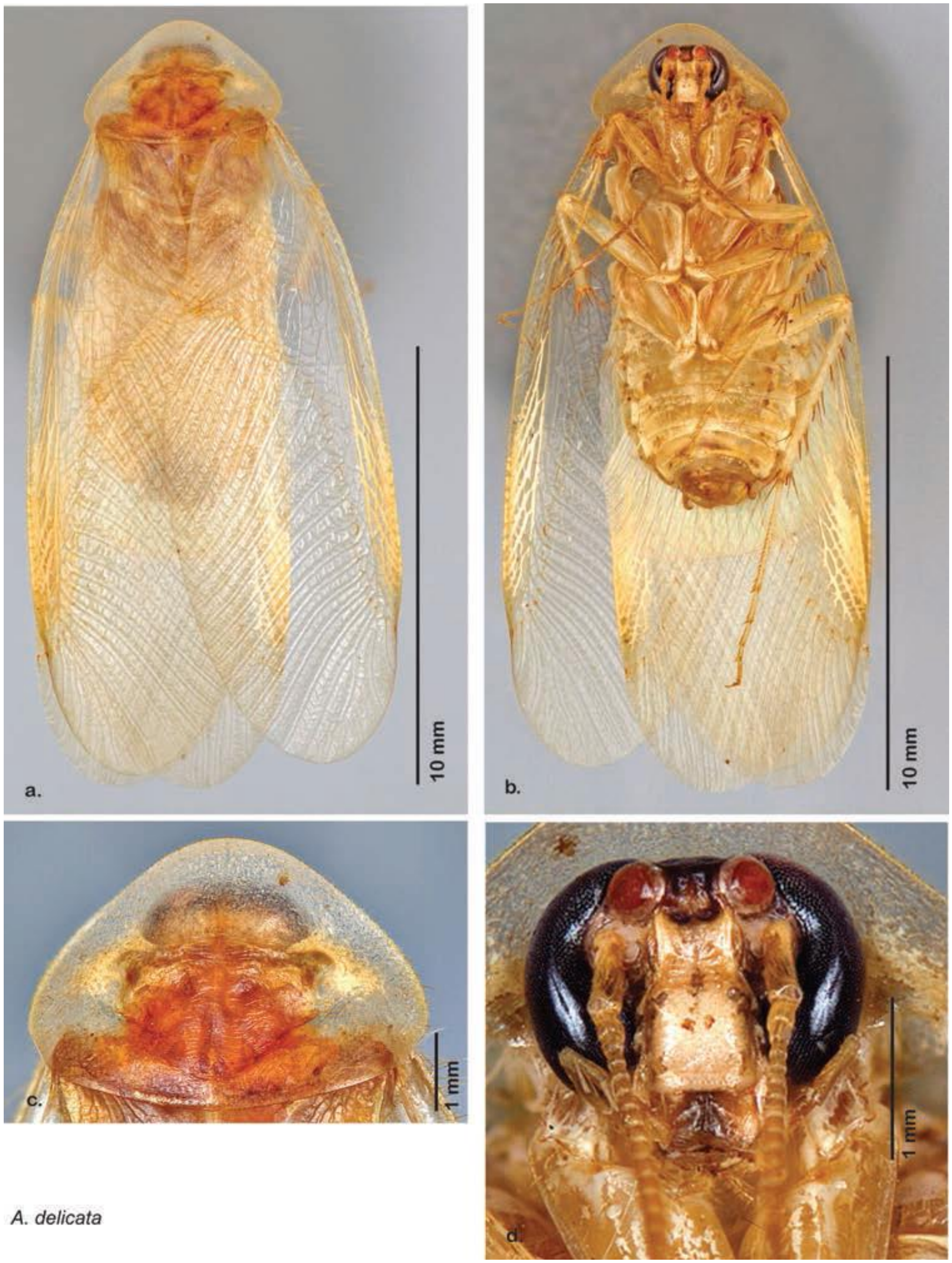


Figure 39. *A. delicata*, a dorsal habitus b ventral habitus c pronotum d head.

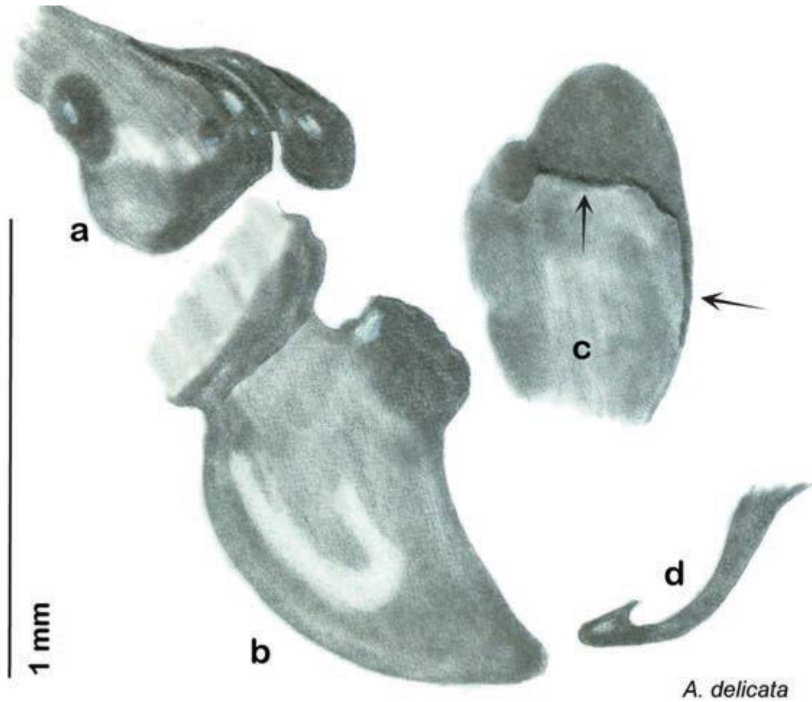


Figure 40. *A. delicata*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

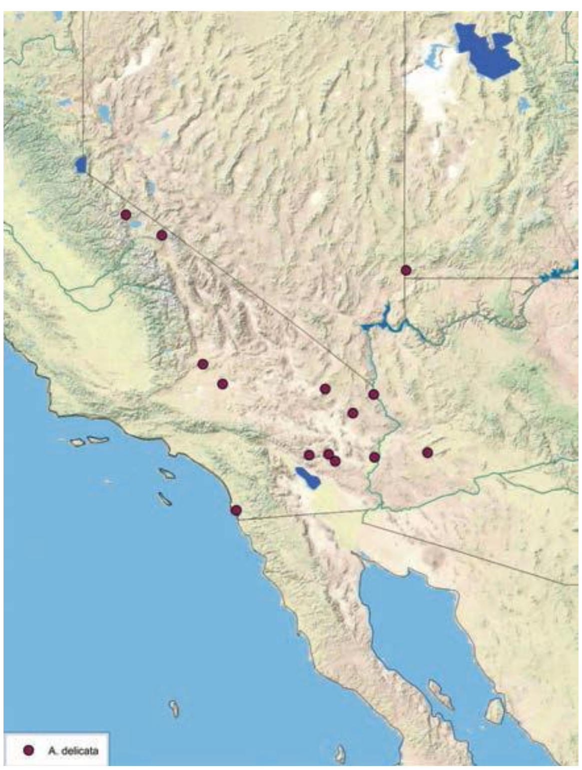


Figure 41. *A. delicata*, distribution.

***Arenivaga diaphana* sp. n.**

http://zoobank.org/5AB7F19E-30DE-4DC8-93F0-E86D3C48CAF6

http://species-id.net/wiki/*Arenivaga_diaphana*

Figures 42–44

Type locality. MEXICO, BCN, 10.1 mi W Catavina.

Material examined. Holotype: ♂ in SDMC labeled "MEX: Baja California Norte, 10.1 mi W. Catavina, 24-28 Feb 1988, N. Bloomfield, [green dot]" "HOLOTYPE *Arenivaga diaphana* Hopkins, 2012" [red label with black border].

Paratypes (123): MEXICO: BCN, 6 mi N of Guerrero Negro 3/16/1981, Andrews & Faulkner, Collected on sand dunes at night (1, CSCA); BCN, 6 mi NW of Rancho Ynez, 1/?/1976, 29.43N 114.43W, 1800 ft, D Ward (1, IMNH); BCN, 36 mi N of San Felipe, 4/18-21/1961, FS Truxal (1, LACM); BCN, Catavina Canyon, 6/1/1981, Werner,Olson,Hetz,Thomas,Burne,Frank, MacLachlan (1, UAIC); BCN, 10.1 mi W of Catavina, 2/24-28/1988, N Bloomfield, green dot (7, SDMC); BCS, 13 mi E of San Ignacio, 3/3/1947, ER Tinkham, mileage 63,817, In pumacy soil by wolf spider hole (1, NMNH); BCN, Arroyo Catavina, 35 mi S of El Progreso, 4/2/1976, Doyen & Rudeblack, light trap (7, EMEC); BCN, El Crucero, 4/3/1976, J Doyen, sifting on sand dunes (1, EMEC); BCN, Punta San Fermin, 4/7-10/71, EL Sleeper, Collected at black light (1, CAS); BCN, Bahia San Luis Gonzaga, 4/3/1973, Doyen,Powell & Szerlip (1, EMEC); BCN, 6 mi. NW Rancho Santa Ynez, 1/?/1976, 29.43.N, 114.43W, 1800', Dave Ward (1, IMNH); BCN, 22 mi. S of Catavina, 4/4/1982, Faulkner & Brown (10, SDMC); BC, Catavina, 4/13/1957, 29.43N, 114.40W, Farmer, (7, SDMC); BC, 2 mi. N of Catavina, 4/4/1935, 29.45, 114.40, CF Harbison (6, SDMC); BCN, 8 mi. NW of El Progreso, 4/17/1965, Cavagnaro, Ross & Vesterby (2, CAS); BCN, Diablito Canyon, east face Sierra San Pedro Martir, 4/5/1973, SL Szerlipat light (2, EMEC); BCN, 6 mi. NW Rancho Santa Ynez, 4/6/1977, 29.43N, 114.43W, 1800', WH Clark, night, ex. Opuntia acanthocarpa (1, IMNH); BCN, Diablito Canyon, east face Sierra San Pedro Martir, 4/5-6/1973, J Powell, at light (1, CAS); BCN, San Pedro Martir Diablito Cyn., 3/26-27/1970, 2000', Gruwell & Perkins, Collected at black light (4, CSLB); BC, Bahia de Los Angeles, 4/15/1947, 28.56 N, CF Harbison , (1 spec), Valle de Amarga (41 spcms.) (41, SDMC); BC, 51 mi. S of Catavina, Hwy. 1, 4/7/1982, Faulkner & Brown, (1, SDMC); BCN, 7 mi. N of Las Arrastras, 6/8/1967, Sleeper & Fisher, Collected at black light (1, CSLB); Lower Cal., Chapala Dry Lake, 6/21/1938, Michelbacher & Ross (1, CAS); Lower Cal., San Quintin, 6/7/1925, HH Keifer (1, CAS); BC, 4 mi. NW Rancho San Juan, 4/3-4/1961, AG Smith, under dung (1, CAS); BCN, 24 mi. N of Ba. San Luis Gonzaga, 4/14/1962, EL Sleeper, Collected at black light (1, CSLB); BCN, Ba. San Luis Gonzaga, 6/17/1970, A Tilzer, BL (1, CSLB); L. Calif., N end of Laguna Salada, 5/8/1939, ES Ross (15, CAS); Baja, N end of Laguna Salada, 5/8/1939, Ross & Michelbacher (4, CAS). All paratypes labeled "Paratype *Arenivaga diaphana* Hopkins 2012" [blue label with black border].

Etymology. The name is an adjective in the nominative singular. This species is named from the Greek meaning diaphanous, light, or fairy-like because of its diaphanous appearance.

Distribution. This species is located in central to southern Baja California Norte, Mexico. See Fig. 44.

Diagnosis. *A. diaphana* may be distinguished by the long serrated edge on the medial margin of the right dorsal phallomere and the deeply incised central field of the same. See Fig. 44.

Description. Male. Measurements. Holotype TL = 17.1 mm, GW = 8.5 mm, PW = 4.69 mm, PL = 3.73 mm, TL/GW = 2.01, PL/PW = 0.80 EW = 0.70 mm; OW = 0.30 mm. Among paratypes range of TL 15.5–17.9 mm; range of GW 6.2–7.6 mm; range of PW 3.78–4.69 mm; range of PL 2.88–3.71 mm.

Head. Two ocelli very large, ovoid and protruding (0.45 × 0.35 mm); vertex medium brown, with small ridges between apices of eyes and extending onto the ocellar tubercles; scattered small setae; interocellar space concave, medium brown. Frons light brown, concave with wide horizontal indentation posteriorly; anterior portion of frons light brown, bulbous; clypeal suture demarcates light brown anteclypeus; very wide labrum. See Fig. 42d.

Pronotum. Pronotum very small, translucent waxy beige; dorsal surface of pronotum covered with short pale gold setae that are longer and thicker laterally; pronotal pattern light yellow to dark brown "panther-face" depending on specimen, impressed, often with aura of a lighter shade. See Fig. 42c.

Body. Wing brace present. Two tarsal claws present. Legs and body from light brown to dark brown depending on specimen; subgenital plate color matching body color; angular apices. Uniquely amongst *Arenivaga*, specimens of *diaphana* often have no genicular spines. See Fig. 42b.

Forewings. Wings extended beyond abdominal apex (up to ~50% of total wing length); particularly diaphanous with band of darker venation laterally; translucent dark brown and hyaline. See Fig. 42a.

Genitalia. Right dorsal phallomere composed of a bulbous lightly scleritized hookshaped lobe, articulated with right ventral phallomere on lateral side; central field deeply emarginated anteriorly, remainder lightly scleritized; medial rim more heavily scleritized and toothed. Small right anterior dorsal sclerite attached to hook-shaped lobe of right dorsal phallomere posteriorly, punctate, with sinuous curve over toothed margin of right dorsal phallomere ending in a broad curve; small pointed extension projecting anteromedially from curve. Right ventral phallomere extends from articulation to form smooth rounded lobe, increasingly punctate and scleritized anteriorly; after a wide gap a rounded anteriorly projecting curved concave shagreenous arm, with toothed outer surface. Folded anterior portion of left phallomere narrow, setose, otherwise unmodified. Genital hook has long extension to pointed head and short hook; arm narrow with distinct bend. See Fig. 43.

Habitat and natural history. All life history elements remain unobserved.

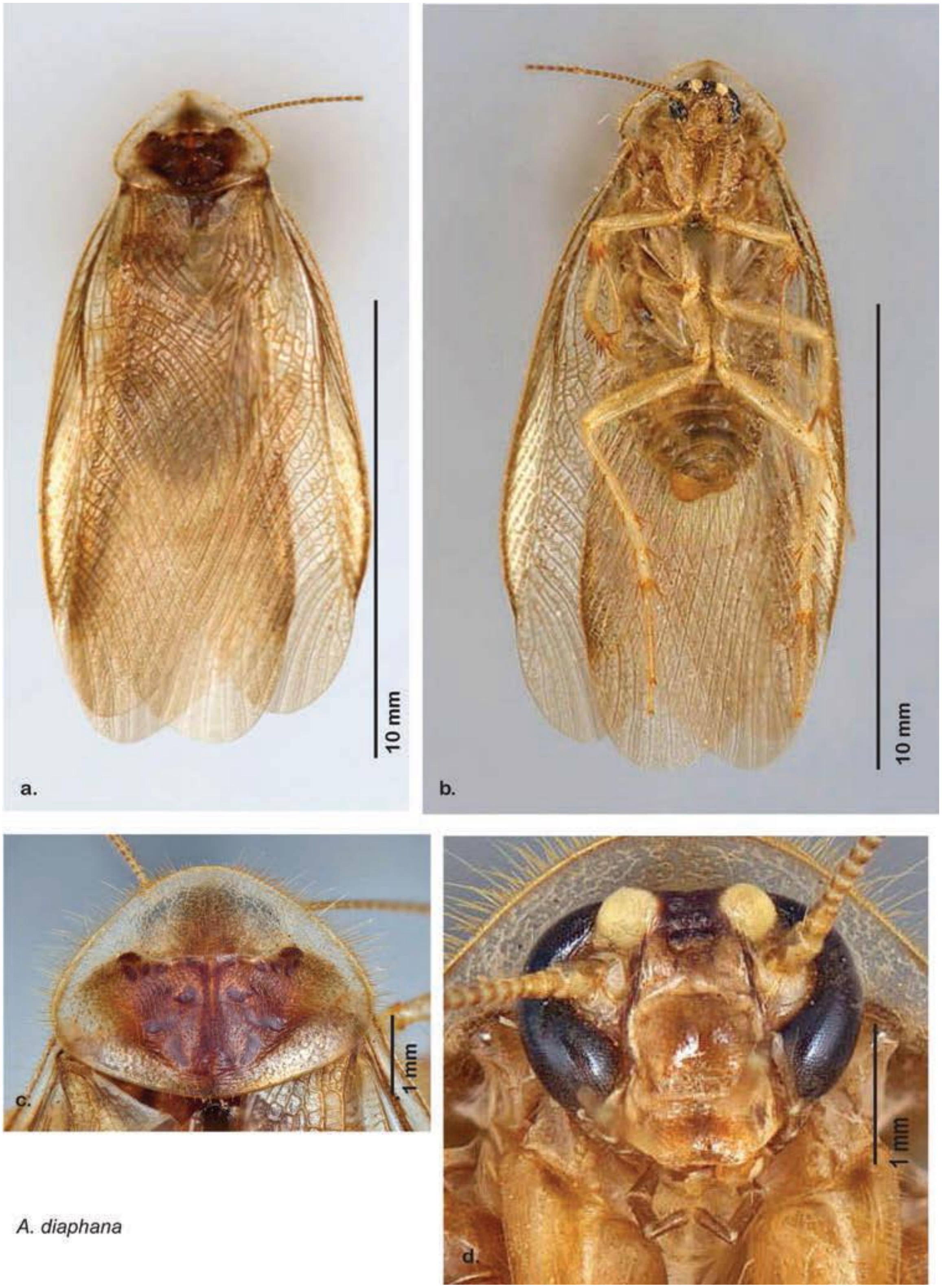


Figure 42. *A. diaphana*, a dorsal habitus b ventral habitus c pronotum d head.

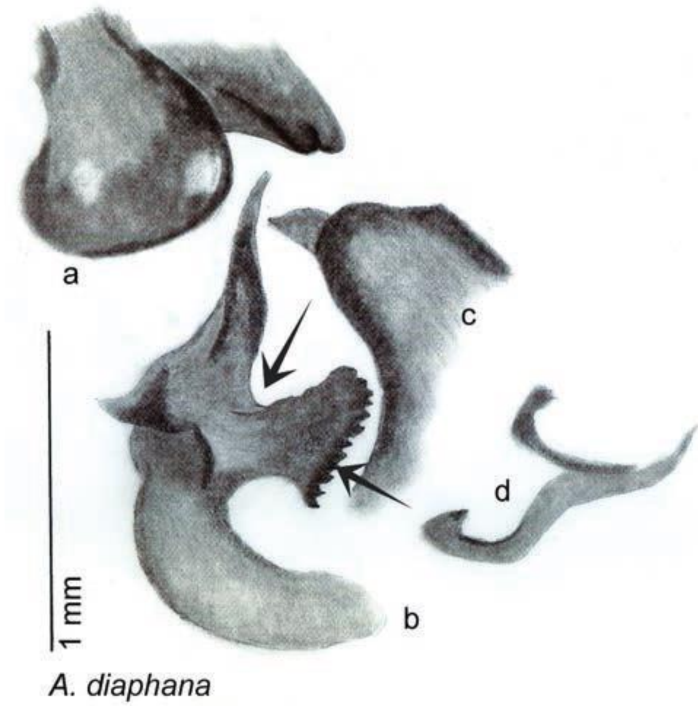


Figure 43. *A. diaphana*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite. Arrow(s) indicate diagnostic characters (see text).

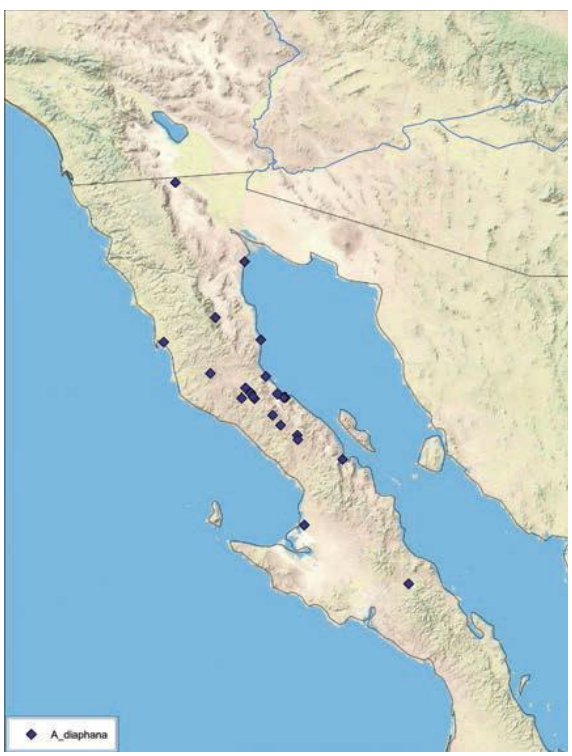


Figure 44. *A. diaphana*, distribution.

***Arenivaga dnopheros* sp. n.**

http://zoobank.org/58D8A942-BD79-49E1-A463-7F99C937ECBC

http://species-id.net/wiki/*Arenivaga_dnopheros*

Figures 45–47

Type locality. MEXICO, Puebla, 12 mi S of Atlixco.

Material examined. Holotype: ♂ in SEMC labeled "12 mi S Atlixco, Puebla, Mexico, VII-2-1953, 4900', Univ. Kans. Mex. Expedition" "HOLOTYPE *Arenivaga dnopheros* Hopkins, 2012" [red label with black border].

Paratypes (8): MEXICO: Puebla, 3 mi. NW of Petlalcinqo, 8/29/1972, 4600 ft., Byers & Thornhill, *Arenivaga* nr. *bolliana* det. FW Fisk, 415 (2, SEMC); Puebla, 3 mi. SE of Petlalcingo, 10/6/1986, Miller & Stane (1, FSAC); Puebla, 13.7 mi. SW of Izucar de Matamoros, 7/31/1981, Bogar, Schaffner & Friedlander (1, TAMU); Puebla, 12 mi. S of Atlixco, 7/2/1953, 4900 ft., UK Mex. Expedition (2, SEMC); Puebla, 12 mi. NW of Petlalcingo, 7/3/1953, 4000 ft., UK Mex. Expedition (1, SEMC); Puebla, 11 mi. SE of Acatlan, 7/10/1952, Gilbert & MacNeil (1, EMEC). All paratypes labeled "Paratype *Arenivaga dnopheros* Hopkins 2012" [blue label with black border].

Etymology. The name is an adjective in the nominative singular. This species is named from the Greek meaning dark, gloomy or murky because of its very dark color.

Distribution. This species is found in the state of Puebla, Mexico. See Fig. 47.

Diagnosis. *A. dnopheros* is very similar to *A. aquila*. *A. dnopheros* has larger projection on the left phallomere than *A. aquila*. The anterior arm of the right ventral phallomere is also much more shagreened with pronounced central indentation. These two characters may be used to distinguish *A. dnopheros*. See Figs 46 and 28.

Description. Male. Measurements. Holotype TL = 21.9 mm, GW = 9.6 mm, PW = 6.34 mm, PL = 4.38 mm, TL/GW = 2.28, PL/PW = 0.69. EW = 0.25 mm; OW = 0.60 mm. Among paratypes range of TL 18.5–22.0 mm; range of GW 8.4–10.0 mm; range of PW 5.20–6.70 mm; range of PL 3.62–4.45 mm.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm); vertex dark brown, with small ridges between apices of eyes and extending onto ocellar tubercles; interocellar space deeply concave, dark to medium brown, with <> shaped indentations. Frons medium brown; posterior concave but tectiform horizontally; anterior portion of frons bulbous but much less so than in most species, medium brown; narrow light brown anteclypeus. See Fig. 45d.

Pronotum. Pronotum with translucent waxy beige anterior margin; remainder of pronotum very dark orange-brown and dark brown; dorsal surface of pronotum with dense short orange-brown setae; pronotal pattern “panther face”, impressed; extensive dark aura. See Fig. 45c.

Body. Wing brace absent. Two tarsal claws present. Legs and body medium orange-brown; subgenital plate orange-brown; strongly asymmetrical with posterior edge only slightly emarginated and rounded apices. See Fig. 45b.

Forewings. Wings extended well beyond abdominal apex (up to ~40% of wing length); blotchy dark brown; surface matte or with very slight sheen and opaque. See Fig. 45a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, narrow bulbous lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized, slightly cupped; with narrow medial edge more sclerotized, punctate, ending anteriorly in small shagreened knob. Small central sclerite lightly sclerotized, finely punctate, flat of nondescript shape, posterior end connecting with dorsal side of right dorsal phallomere. Right ventral phallomere arises from deep articulation to form large punctate lobe; anteriorly moderate gap followed by two dorsally projecting sclerotized heavily toothed folds. Folded anterior portion of left phallomere wide, setose, closed at both ends, with small nipple at one end of fold, rough-edged, flattened projection offset at an angle from other end. Genital hook with short extension to rounded head; short hook; arm robust. See Fig. 46.

Habitat and natural history. All life history elements remain unobserved.

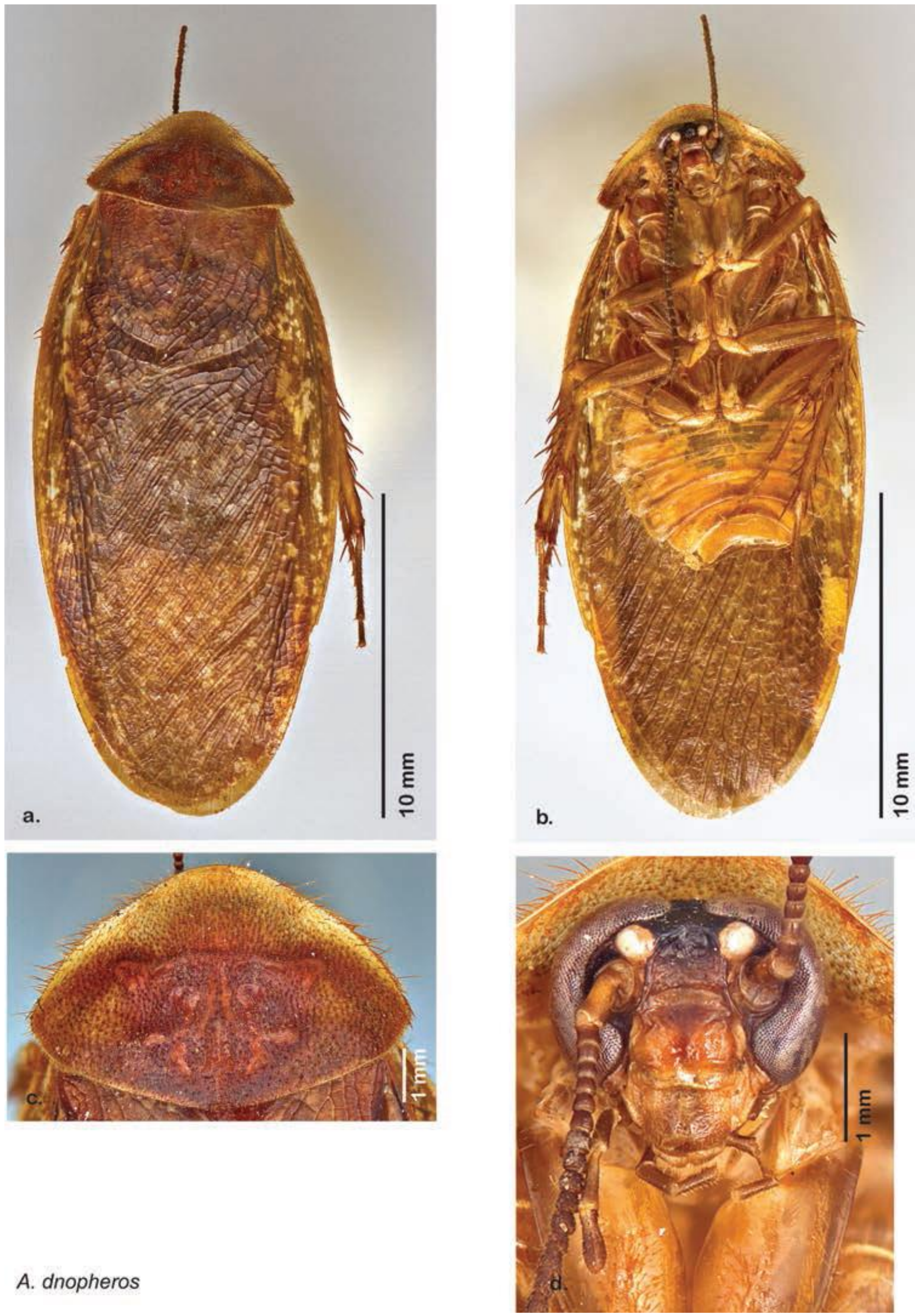


Figure 45. *A. dnopheros*, a dorsal habitus b ventral habitus c pronotum d head.

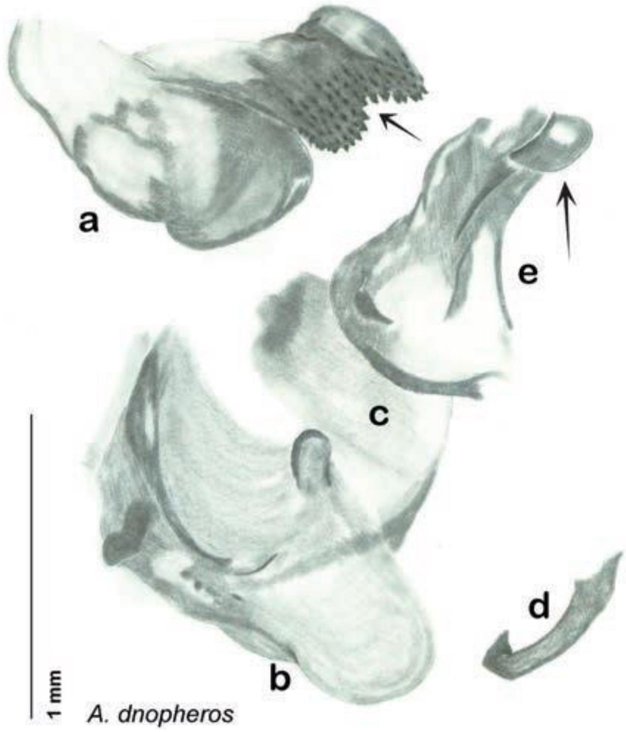


Figure 46. *A. dnopheros*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook e left phallomere. Arrow(s) indicate diagnostic characters (see text).

Figure 47. *A. dnopheros*, distribution.

***Arenivaga erratica* Caudell**

http://species-id.net/wiki/*Arenivaga_erratica*

Figures 48–50

1903 *Homoeogamia* (*Arenivaga*) *erratica* Rehn, Proceedings of the Academy of Natural Sciences of Philadelphia, 55, pp. 177-192.

1913 *Arenivaga erratica* (Rehn), Proceedings of the United States National Museum 44, pp. 595–614.

1917 *Arenivaga erratica* (Rehn), Memoirs of the American Entomological Society, 2, pp. 1-284 + plates and index.

1920 *Arenivaga erratica* (Rehn), Transactions of the American Entomological Society, 46(2), pp. 197–217.

Material examined (565). USA: AZ, Pima Co., 4 mi. NNW Redington, 6/30/1962, Johnson & Smith, UV light trap (1, UAIC); AZ, Pima Co., Tucson Mts., 8/2/1962, D.J. & J.N.Knull, (1, FSCA); AZ, Pima Co., 8 mi. W of Tucson on Hwy. 86, 7/8/1937, Stange & Harding, (1, FSCA); AZ, Pima Co., 16 mi. W of Tucson, 8/13/1988, (1, LACM); AZ, Pima Co., Tucson Mts., 8/2/1962, D.J. & J.N.Knull, (1, OSUC); AZ, Santa Cruz Co., 10 mi. S of Patagonia, 5/27/1964, R.F.Sternitsky, (1, PMNH); AZ, Cochise Co., SWRS 5 mi. W of Portal, 6/28/1963, 5400', V.Roth, (1, USNM); AZ, Pima Co., Tumamoc Hill, Tucson, 6/19/1967, R.Rice, UV light trap (4, UAIC); AZ, Douglas, 7/2/1963, black light trap,6318364 (1, USNM); AZ, Pima Co., Tucson Mt. Park, Caretaker's House, 10/19/1981, S.Pechal, (1, UAIC); AZ, Pima Co., Sonoran desert Museum, 8/5-8/1962, W.L.Nutting, light trap, Soman (2, UAIC); AZ, Pima Co., Sonoran desert Museum, 8/21-24/1962, W.L.Nutting, light trap, Soman (3, UAIC); AZ, Pima Co., Sonoran desert

Museum, 8/1-4/1962, W.L.Nutting, light trap, Soman, (1, HEH); AZ, Pima Co., Sonoran desert Museum, 8/5-8/1962, W.L.Nutting, light trap, Soman, (2, HEH); AZ, Ft. Grant, ?/?/1882, C.V.Riley, (1, USNM); AZ, Cochise Co., 5131 Bannock Street, Pueblo Del Sol, Huachuca Mts., 9/24/1985, R.S.Wielgus, UV light trap (1, ASUT); AZ, Cochise Co., 5131 Bannock Street, Pueblo Del Sol, Huachuca Mts., 6/5/1985, R.S.Wielgus, UV light trap (1, ASUT); AZ, Cochise Co., 1 mi. NE of Portal, 9/7/1959, J.M.Burns, (1, EMEC); AZ, Cochise Co., 4 mi. E of Portal, 8/21/1971, J.Doyen, J.Doyen Lot #71H6 outside enclosures (1, EMEC); AZ, Cochise Co., Chiricahua Mts., Portal Ranger Station, 7/30/1966, 4950', R.G.Beard, UV light trap (1, CUIC); AZ, Cochise Co., SWRS, Portal, 9/5/1970, L.D. & M.D. Anderson, (1, UCRC); AZ, Cochise Co., Cave Creek Ranch, 8/21/1974, E.G. & J.M. Linsley, (1, EMEC); AZ, Pima Co., Peppersauce Canyon, Santa Catalina Mts., 8/17/1924, J.O.Martin, (1, CAS); AZ, Pima Co., Stratton, S Catalina Mts., 7/27/1917, 6-7000', Wheeler, *erratica* (1, MCZ); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 11/2/1915, J.F.Tucker, (1, ANSP); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 7/12/1932, R.H.Beamer, (1, ANSP); AZ, Cochise Co., Portal, 6/17/1956, O.L.Cartweight, (1, USNM); AZ, Cochise Co., Portal, 6/18/1956, R. & K. Dreisbach, Dreisbach Collection return to Crandall (1, UMMZ); AZ, Benson, 9/?/1949, (1, EMEC); AZ, Cochise Co., Portal, 6/27/1963, A.Raske, at light (7, EMEC); AZ, Cochise Co., Portal, 7/18-9/1/1971, J.Doyen, pitfall trap, J.Doyen Lot #71G15 (2, EMEC); AZ, Cochise Co., 1 mi. S of Portal, 8/11/1965, 4800', Davidson, Davidson & Cazier, at light (1, ASUT); AZ, Cochise Co., 1 mi. S of Portal, 6/23/1965, 4800', Davidson,Davidson & Cazier, at light (1, ASUT); AZ, Cochise Co., 1 mi. S of Portal, 7/2/1965, 4800', Davidson,Davidson & Cazier, at light (1, ASUT); AZ, Cochise Co., 1 mi. S of Portal, 7/18/1965, 4800’, Davidson,Davidson & Cazier, at light (1, ASUT); AZ, Cochise Co., 1 mi. S of Portal, 7/7/1965, 4800’, Davidson,Davidson & Cazier, at light (1, ASUT); AZ, Cochise Co., 1 mi. S of Portal, 7/16/1965, 4800’, Davidson,Davidson & Cazier, at light (1, ASUT); AZ, Cochise Co., 1 mi. S of Portal, 7/23/1965, 4800’, Davidson,Davidson & Cazier, at light (1, ASUT); AZ, Cochise Co., 1 mi. S of Portal, 7/8/1965, 4800’, Davidson,Davidson & Cazier, at light (1, ASUT); AZ, Cochise Co., 1 mi. S of Portal, 7/5/1965, 4800’, Davidson,Davidson & Cazier, at light (2, ASUT); AZ, Cochise Co., 1 mi. S of Portal, 7/4/1965, 4800’, Davidson,Davidson & Cazier, at light (1, ASUT); AZ, Cochise Co., 1 mi. S of Portal, 7/28/1965, 4800’, Davidson,Davidson & Cazier, at light (1, ASUT); AZ, Cochise Co., 1 mi. S of Portal, 6/22/1965, 4800’, Davidson,Davidson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 8/25/1964, L.D.Anderson, light (1, UCRC); AZ, San Simon, 5/?/1907, Hubbard, (1, USNM); AZ, Cochise Co., Portal, 6/4/1917, L.A.Stange, UV light trap (1, LACM); AZ, Cochise Co., Douglas, 10/7/1955, Truxal & Martin, (1, LACM); AZ, Cochise Co., Portal, 6/15/1959, L.A.Stange, (1, LACM); AZ, Cochise Co., San Bernardino Ranch, 13 mi. E of Douglas, 6/12/1959, L.A.Stange, (2, LACM); AZ, Cochise Co., 7/20/1927, R.H.Beamer, (1, SEMC); AZ, Cochise Co., San Bernardino Ranch, 8/?/????, 3750’, F.H.Snow, (1, SEMC); AZ, Mescal, 7/28/1927, L.A.Anderson, (1, SEMC); AZ, Benson, 8/5-6/1947, E.R.Tinkham, E.R.T., (2, HEH); AZ, Benson, 7/4/1947, E.R.Tinkham, E.R.T., (1, HEH); AZ, Benson, 10/10/1947, E.R.Tinkham, (1, USNM); AZ, Pima Co., Tucson, 7/16/1953, R.S.Beal, (1, EMEC); AZ, Cochise Co., Portal, 7/1/1964, 4700’, Puckle,Mortenson & Cazier, at light (19, ASUT); AZ, Cochise Co., Portal, 6/16/1964, 4700’, Puckle,Mortenson & Cazier, at light (7, ASUT); AZ, Cochise Co., Portal, 6/17/1864, 4700’, Puckle,Mortenson & Cazier, at light (5, ASUT); AZ, Cochise Co., Portal, 7/2/1964, 4700’, Puckle,Mortenson & Cazier, at light (6, ASUT); AZ, Cochise Co., Portal, 6/21/1964, 4700’, Puckle,Mortenson & Cazier, at light (2, ASUT); AZ, Cochise Co., Portal, 6/10/1964, 4700’, Puckle, Mortenson & Cazier, at light (3, ASUT); AZ, Cochise Co., Portal, 6/28/1964, 4700’, Puckle,Mortenson & Cazier, at light (4, ASUT); AZ, Cochise Co., Portal, 6/7/1964, 4700’, Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 6/12/1964, 4700’, Puckle,Mortenson & Cazier, at light (2, ASUT); AZ, Cochise Co., Portal, 8/23/1982, R.A.Cunningham, (2, PMNH); AZ, Cochise Co., Portal, 6/25/1964, 4700’, Puckle,Mortenson & Cazier, at light (3, ASUT); AZ, Cochise Co., Portal, 6/29/1964, 4700’, Puckle, Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 6/22/1964, 4700’, Puckle,Mortenson & Cazier, at light (2, ASUT); AZ, Cochise Co., Portal, 7/15/1964, 4700’, Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 6/2/1964, 4700’, Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 6/3/1964, 4700’, Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 6/23/1964, 4700’, Puckle,Mortenson & Cazier, at light (5, ASUT); AZ, Cochise Co., Portal, 6/20/1964, 4700’, Puckle,Mortenson & Cazier, at light (2, ASUT); AZ, Cochise Co., Portal, 6/19/1964, 4700’, Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 7/3/1964, 4700’, Puckle,Mortenson & Cazier, at light (4, ASUT); AZ, Cochise Co., Portal, 8/16/1964, 4700’, Puckle,Mortenson & Cazier, at light (2, ASUT); AZ, Cochise Co., Portal, 7/25/1964, 4700’, Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 7/23/1964, 4700’, Puckle,Mortenson & Cazier, at light (1, ASUT);

AZ, Cochise Co., SWRS Portal, Chiricahua Mts,, 8/8/1968, L.D.Anderson, (1, UCRC); AZ, Cochise Co., US 666 4 mi. N of Sunsites, 8/16/1989, Skelley & Mason, street light (1, FSCA); AZ, Cochise Co., Portal, 6/26/1964, 4700’, Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 6/24/1964, 4700’, Puckle,Mortenson & Cazier, at light (2, ASUT); AZ, Cochise Co., Portal, 6/15/1964, 4700’, Puckle,Mortenson & Cazier, at light (4, ASUT); AZ, Cochise Co., Portal, 6/14/1964, 4700’, Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 6/13/1964, 4700’, Puckle,Mortenson & Cazier, at light (4, ASUT); AZ, Cochise Co., Portal, 6/27/1964, 4700’, Puckle,Mortenson & Cazier, at light (2, ASUT); AZ, Cochise Co., Portal, 6/9/1964, 4700’, Puckle, Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 6/8/1964, 4700’, Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 6/11/1964, 4700’, Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 6/18/1964, 4700’, Puckle,Mortenson & Cazier, at light (2, ASUT); AZ, Cochise Co., Portal, 6/5/1964, 4700’, Puckle,Mortenson & Cazier, at light (1, ASUT); AZ, Cochise Co., Portal, 6/4/1964, 4700’, Puckle,Mortenson & Cazier, at light (2, ASUT); AZ, Cochise Co., Portal, 7/7/1967, (1, USNM); AZ, Cochise Co., Portal, 7/18/1973, S.Frommer, (1, UCRC); AZ, Cochise Co., Texas Canyon, L.Dragoon Mts., 7/22/1983, Olson & Burns, (2, UAIC); AZ, Cochise Co., 32 mi. E of Douglas, 8/18/1967, (1, USNM); AZ, Cochise Co., Douglas, 7/12/1971, S.McCleve, at light (1, UAIC); AZ, Cochise Co., San Simon, M.J.Westfall, at light, for report to Fla.Pl.Board (1, USNM); AZ, Paradise, 8/?/????, Wickham collection 1933 (1, USNM); AZ, Cochise Co., 4 km. SW of Benson, 6/4/1991, L.R.Davis,Jr., T17S R20E Sec.20 (2, FSCA); AZ, Benson, 8/2/1941, R.A.Flock, (1, UCRC); AZ, Benson, 7/2/1941, R.A.Flock, (1, UCRC); AZ, Benson, 6/19/1941, R.A.Flock, (1, UCRC); AZ, Benson, 7/24/1941, R.A.Flock, (1, UCRC); AZ, San Carlos Reservation, 6/30/1967, (1, USNM); AZ, Cochise Co., San Pedro Reservation near Hereford, 8/20/1994, C.A.Olson, (2, UAIC); AZ, Chiricahua Mts., 8/28/1962, D.J. & J.N.Knull, (2, FSCA); AZ, Chiricahua Mts., 7/5/1949, D.J. & J.N.Knull, (1, FSCA); AZ, Cochise Co., SWRS Chiricahua Mts., 8/25/1968, L.D.Anderson, at lights (1, UCRC); AZ, Pima Co., Santa Rita Mts., Sycamore Canyon, 6/29-7/8/1981, J.C.Burne, Anamax Survey, illegible (2, UAIC); AZ, Apache Co., Canyon De Chelly NM, 8/18/2005, N.Cobb, (1, NAUF); AZ, Chiricahua Mts., 8/24/1962, D.J. & J.N.Knull, (2, OSUC); AZ, Chiricahua Mts., 7/14/1936, J.N.Knull, (3, OSUC); AZ, Chiricahua Mts., 7/15/1953, D.J. & J.N.Knull, (2, OSUC); AZ, Chiricahua Mts., 9/19/1947, D.J. & J.N.Knull, (1, OSUC); AZ, Chiricahua Mts., 7/22/1957, D.J. & J.N.Knull, (1, OSUC); AZ, Chiricahua Mts., 7/27/1957, D.J. & J.N.Knull, (2, OSUC); AZ, Huachuca Mts., 7/20/1937, D.J. & J.N.Knull, (1, OSUC); AZ, Chiricahua Mts., 7/22/1953, D.J. & J.N.Knull, (1, OSUC); AZ, Chiricahua Mts., 7/16/1959, D.J. & J.N.Knull, (1, OSUC); AZ, Chiricahua Mts., 7/29/1961, D.J. & J.N.Knull, (1, OSUC); AZ, Chiricahua Mts., 8/21/1962, D.J. & J.N.Knull, (1, OSUC); AZ, Chiricahua Mts., 7/23/1959, D.J. & J.N.Knull, (1, FSCA); AZ, Santa Cruz Village, Cobabi Mts., 8/10-12/1916, 32.1N 111.54W, 3100’, (1, ANSP); AZ, Douglas, F.H.Snow, (1, ANSP); AZ, Santa Cruz Co., Badger, 7/31/1924, J.O.Mastio, (1, CAS); AZ, Chiricahua Mts., 6/3/1935, J.N.Knull, (1, OSUC); AZ, Prescott, 6/10/1902, Oslar, *Homoeogamia erratica* Paratype, genitalia figured H1920 (1, ANSP); NM, 10 mi. E of Deming, 7/12/1917, Cornell U. Lot 882,Sub.145 (1, CUIC); NM, Mesille Park, 7/12/1917, Cornell U. Lot 677,Sub 547 (1, CUIC); TX, Brewster Co., Hills W of Ord Mts., 8/1-15/1926, O.C.Poling, (2, ANSP); TX, Belfrage, (1, USNM); TX, Reeves Co., Pecos, 8/17/1935, T.H. & G.G.Hubbell, (1, UMMZ); TX, Brewster Co., Marathon, 9/26/1950, 4000', Gertech & Cazier, (1, AMNH); TX, Culberson Co., Van Horn, 7/10/1948, C. & P. Vaurie, (2, AMNH); TX, Culberson Co., Van Horn, 7/10/1950, R.F.Smith, (4, AMNH); TX, El Paso Co., 7/17/1927, P.A.Radio, (1, SEMC); TX, Valentine, 7/12/1958, R.I.Sailer, (1, SEMC); TX, Valentine, 7/8/1917, (1, ANSP); TX, Hudspeth Co., McNary, 7/14/1948, Nutting & Werner, at light, mesquite area, W.L.N. (6, UAIC); TX, Terrell Co., Lester Canyon, 7/8/1948, 1360', Nutting & Werner, at light desert, W.L.N. (4, UAIC); TX, Brewster Co., S.G.Ranch, 3/1-15/1926, O.C.Poling, (1, UMMZ); TX, Brewster Co., S.G.Ranch, 4/15-30/1926, O.C.Poling, (1, UMMZ); TX, Brewster Co., Terlingua, 5/3/1927, J.O.Martin, (1, CAS); TX, Brewster Co., Terlingua, 7/9/1994, W.F.Chamberlain, at light (1, TAMU); TX, Jeff Davis Co., Point of Rocks Rest Stop, 8/10/1992, Godwin & Riley, at UV light (1, TAMU); TX, Brewster Co., Hackberry Creek, Boquillas Road, 9/2/1912, Rehn & Hebard, one-figured H1917 (3, ANSP); TX, Brewster Co., Big Bend NP, Castalon area, Cottonwood Cpgd, 8/1/2003, 30.12.24N 103.14.14W, E.Riley, uv light (1, TAMU); TX, Brewster Co., Hills W of Ord Mts., 9/15-20/1926, O.C.Poling, (1, ANSP); TX, Brewster Co., Hills W of Ord Mts., ?/?/1928, O.C.Poling, (4, ANSP); TX, Brewster Co., Hills W of Ord Mts., 8/22-31/1926, O.C.Poling, (6, ANSP); TX, Brewster Co., Hills W of Ord Mts., 6/1-15/1926, O.C.Poling, (1, ANSP); TX, Brewster Co., Hills W of Ord Mts., 9/1-16/1926, O.C.Poling, (1, ANSP); TX, Davis Mts., 7/16/1946, E.C.VanDyke, (1, CAS); TX, Davis Mts., 5/27/1935, J.N.Knull, (1, OSUC); TX, Culberson Co., 3 mi. E of Van Horn, 8/14/1965, J.C.Schaffner, at light (1, TAMU); TX, Presidio, 9/5/1949, at light (3, USNM); TX, Culberson Co., Van Horn, 7/1/1947, B.Malkin, (2, USNM); TX, Presidio, 7/5/1945, Presidio 1334,lights on screen at residence, Lot No.45-16511 (2, USNM); TX, Presidio, 10/1/1947, lights at screen (1, USNM); TX, Presidio, 7/22/1944, lights at screen door (3, USNM); TX, Presidio, 6/6-20/1947, J.H.Russell, at light (2, USNM); TX, Presidio, 5/14/1944, (1, USNM); TX, Presidio, 3/14/1946, lights on screen at residence (1, USNM); TX, Presidio, 8/1/1953, at light (19, USNM); TX, Presidio, 3/26-5/15/1951, J.H.Russell, at lights (1, USNM); TX, Presidio, 2/18/1948, at light (4, USNM); TX, Presidio, May-June 1953, at light (38, USNM); TX, Presidio, 7/1-25/1951, at lights, *Arenivaga apacha* Sauss. Det.Gurney (2, USNM); TX, Presidio, 6/6/1957, J.H.Russell, at lights (1, USNM); TX, Presidio, 5/5/1945, at light (1, USNM); TX, 4 mi. N of El Paso, 8/30/1951, at lights (7, USNM); TX, Presidio, 2/28/1951, at lights (3, USNM); TX, Presidio, 2/2/1950, collected at light, *Arenivaga apacha* (Sauss) det. Gurney (1, USNM); TX, Presidio, 7/24/1948, collected at light (1, USNM); TX, Presidio, 10/15/1944, night on screen (1, USNM); TX, Presidio, June-July 1947, J.H.Russell, at lights (1, USNM); TX, Valentine, 7/13/1927, R.H.Beamer, (1, ANSP); TX, Koebele Collection, Heterogamia sp. (1, CAS); TX, McKelligan Canyon, El Paso, 6/15/1948, H.S.Barber et al., under stone (1, USNM); TX, Jeff Davis Co., Rest stop 9.5 mi. S of jct. Hwy 118 on 166, 8/9/1992, Godwin & Riley, uv light (1, TAMU); TX, El Paso, 7/14/1947, C.F.Haller, in Japanese Beetle trap at municipal airport (1, USNM); TX, Presidio, 7/12/1950, J.H.Russell, in Japanese Beetle trap at end of RR bridge (1, USNM); TX, 4 mi. N of El Paso, 8/30/1951, at lights (1, AMNH); NM, Hidalgo Co., Double Adobe Ranch, Animas

Mts., 8/15/1952, 5500 ft., Leech & Green, (2, CAS); NM, Silver City, 9/2/1960, HG Rodeck, (1, UCMC); NM, Dona Ana Co., Anthony US 10 rest stop, 8/23-24/1997, 32.00675N 106.58138W, Scott & Powers, at lights (1, UCMC); NM, Gage, 7/12/1952, RH & LD Beamer,LaBerge & Liang, (1, SEMC); NM, Chaco Canyon NM, 7/20/1962, SF Wood, (1, LACM); NM, San Juan Co., Ship Rock, 1986/1987, 6500 ft., D.Giuliani, Antifreeze pit trap (1, CSCA); NM, Bernalillo Co., Albuquerque, 9/18/1944, 5000 ft., WO Griesel, at lights (3, LACM); NM, Hidalgo Co., San Simon Valley, Jct. of State Line Rd and Rt.533, 7/8/1992, 4250 ft., SP Cover, 2 ft. deep in active Bannertail Kangaroo rat mound, open desert ,mesquite & ephedra (2, MCZ); NM, Hidalgo Co., 9 mi. NW of Rodeo, 7/2/1973, 1300m, M Masters, Polyphagidae (1, CUIC); NM, Dona Ana Co., Pyramid Peak, FR Fosberg, Museum Coll.9076 (1, LACM); NM, Dona Ana Co., Pyramid Peak, 8/1/1930, FR Fosberg, Museum Coll.9686 (1, LACM); NM, Dona Ana Co., Pyramid Peak, 8/30/1930, FR Fosberg, Museum Coll.9685 (3, LACM); NM, Dona Ana Co., Pyramid Peak, 8/21/1930, FR Fosberg, Museum Coll.9279 (2, LACM); NM, Dona Ana Co., Pyramid Peak, 8/30/1930, FR Fosberg, Museum Coll.9685 (1, LACM); NM, SanJon, 7/31/1938, RP Allen, (1, CAS); NM, Eddy Co., White's City Cpgd.Guadalupe Mts., 7/21/1989, JP & KES Donahue, #136,564 (2, LACM); NM, Bent, 7/1-15/1927, OC Poling, (3, ANSP); NM, Las Cruces, TDA Cockerell, (1, ANSP); NM, Luna Co., Deming, 7/19/1907, 4315 ft., Hebard & Rehn, at lights (8, ANSP); NM, Bent, 6/15-30/1927, OC Poling, (1, ANSP); NM, No.262 (1, USNM); NM, Hidalgo Co., Rodeo, 9/4-8/1959, JM Burns, (3, EMEC); NM, Hidalgo Co., Rodeo, 9/8/1959, DD Linsdale, (3, EMEC); NM, Las Cruces, 9/?/1895, Ckll 4713 (1, USNM); NM, Virden, 6/12/1959, GL

Nielsen, *Arenivaga apacha* (Sauss.)det.AB Gurney 1959 (1, USNM); NM, Eddy Co., Site 7, 9/24/1979, 32.19.8N 103.47.3W, Murray & Schaffner, at lights (3, TAMU); NM, Socorro Co., La Sevilleta, 9/13/2008, 34.354N 106.885W, EI Rodriguez, (1, NAUF); NM, Socorro Co., Sevilleta NWR, 9/9-23/2008, 34.3431N 106.7417W, K.Wetherill, Creosote shrubland, Buchmann Funnel trap (2, MSB); NM, Socorro Co., Gran Quivira NM, 7/1-3/1964, 6600 ft., DR Davis, (1, USNM); NM, 2 mi. E of Tesuque Pueblo, 8/15/1934, 7000 ft., M.Hebard, (1, ANSP); NM, Mesille Park, 7/12/1917, (1, ANSP); NM, Roosevelt Co., Oasis SP, 8/31/1971, 4100 ft., Brown & Petrulis, at lights (2, PMNH); NM, University Park, 6/25/1960, A.Ross, (1, UAIC); NM, Lea Co., site 14, 9/23/1979, 32.22.8N 103.43.3W, Murray & Schaffner, at lights (1, TAMU); NM, McKinley Co., 5 mi. N of Tohatchi, 8/14/1948, Nutting & Werner, at lights, dry grass & juniper, sketch of genitalia, WLN (1, UAIC); NM, Hidalgo Co., 13 mi. N of Rodeo, 6/16/1956, E Ordway, (1, AMNH); NM, Eddy Co., Carlsbad Cavern, 8/15-18/1935, TH & GG Hubbell, (1, UMMZ); NM, Hidalgo Co., Rodeo, 6/8/1959, LA Stange, (1, LACM); NM, Luna Co., Deming, 7/2/1937, Burt, (1, USNM); NM, Luna Co., Deming, 7/12/1917, Wheeler, *Arenivaga* sp. near *rehni* det. TH Hubbell 1928 (1, UMMZ); NM, No.262 (1, AMNH); NM, Santa Fe, pack rat nest, 8/?/1961, B Miller, (1, USNM); NM, Sevilleta NWR, 9/10/2001, deep well fire site south transect, pitfall trap #14 (2, MSB); NM, Sevilleta NWR,McKenzie Flats, 8/10/2001, transect E km 1,West side juniper trap #1 (1, MSB); NM, Sevilleta NWR,McKenzie Flats, 8/10/2001, transect E km 0,East side juniper trap #3 (1, MSB); NM, Sevilleta NWR,McKenzie Flats, 6/26/2001, transect E km 1,East side juniper trap #3 (1, MSB); NM, Sevilleta NWR,McKenzie Flats, 9/10/2001, transect mid km 2,East side pitfall trap #2 (1, MSB); NM, Sevilleta NWR,McKenzie Flats, 10/8/2001, transect mid km 6,West side [pitfall trap#1 (1, MSB); NM, Sevilleta NWR,McKenzie Flats, 7/20/2001, transect mid km 4,East side pitfall trap #2 (1, MSB); NM, Socorro Co., Sevilleta NWR, 7/20/2001, South Transect pitfall trap #13 (1, MSB); NM, Socorro Co., Sevilleta NWR , 7/20/2001, deep well fire site north transect, pitfall trap #4 (1, MSB); NM, Socorro Co., Sevilleta NWR, 9/10/2001, deep well fire site north transect, pitfall trap #14 (1, MSB); NM, Socorro Co., Sevilleta NWR, 9/10/2001, deep well fire site south transect, pitfall trap #4 (1, MSB); TX, Presidio, 8/1/1953, collected at light, *Arenivaga apacha* (Sauss) det. Gurney (1, USNM); TX, Presidio, 7/11/1968, JE Hafernik, black light (2, TAMU); TX, Presidio Co., Big Bend Ranch St. Nat.Ar.,Aqua Adentro, 6/18-23/1990, D Judd, malaise trap (1, TAMU); TX, Presidio, 8/14/1928, ER Tinkham, (1, ANSP); TX, 3 mi. E of Van Horn, 8/14/1965, J.C.Schaffner, at light (1, TAMU); TX, Brewster Co., 22 mi. S of Marathon, 9/3/1960, L.A.Stange, (1, FSCA); TX, Jeff Davis Co., Fort Davis, 10/15-27/1927, 5000’, O.C.Poling, (2, UMMZ); TX, Alpine, 6/4/1952, J.E.Elkins, (1, SEMC); UT, Utah Co., Moab, Slick Rock Cmpgd., 9/5/1999, S. Belnap, (1, MLBM); UT, San Juan Co., Cottonwood Wash 10 mi SW Blanding, (1, MLBM); AZ, Navajo Co., along Rt. 87 N of Winslow, 8/9/2012, N35.04975 W110.59804, 1525 m, H Hopkins, HEH, (1,); AZ, Cochise Co., Bar Boot Ranch, 9/?/2010, LJ Vitt & JP Caldwell, *Arenivaga* sp. det. K. Menard 2012, Catalog No. OMNH-21117, 21118, 21119 (3, OMNH); AZ, Cochise Co., 3 mi N Douglas, 8/17/1968, V. Roth, at light (1, FSAC); AZ, Cochise Co., SWRS 5 mi W Portal, 9/5/1963, 5400’, (1, SWRS); TX, Brewster Co., Big Bend NP, 7/8/1961, RH Arnett Jr. & E Van Tassell, Lot

No. 475 (1, FSAC); AZ, Pima Co., in Sabino Cn., 7/1/1959, RH Arnett Jr., Lot No. 386 (1, FSAC); AZ, Pima Co., in Sabino Cn., 7/9/1959, RH Arnett Jr., Lot No. 399 (1, FSAC); AZ, Cochise Co., near Fairbanks, 6/29/1973, S. McCleve, lite (2, FSAC); AZ, Cochise Co., Portal , 6/25/1966, VD Roth, (1, SWRS); AZ, Cochise Co., Portal , 7/19/1964, VD Roth, *Arenivaga apacha* (Sauss.) (1, SWRS); NM, Hidalgo Co., Rodeo, 6/29/1971, (1, SWRS); NM, Rodeo, 9/17/1963, VD Roth, (1, SWRS); NM, Artesia, 7/19/1962, JR Eyer, (1, NMSU); NM, Carlsbad, 6/22/1964, (2, NMSU); NM, Dona Ana Co., Jornada Expt. Range, 7/28/1971, Ellstrom, 1 specimen-att. to light (2, NMSU); NM, Dona Ana Co., Mouth Baylor Can., 8/4-5/1979, 5100', C. Ferris, (2, FSAC);MEXICO, Chihuahua, Samalayuca, 6/24/1947, Schramel, D. Rockefeller Exp. (24, AMNH); Chihuahua, Samalayuca, 6/24/1947, Gertsch, D. Rockefeller Exp. (2, AMNH); Chihuahua, Samalayuca, 6/24/1947, Cazier, D. Rockefeller Exp. (4, AMNH); Chihuahua, Samalayuca, 6/24/1947, Spieth, D. Rockefeller Exp. (10, AMNH); Chihuahua, Samalayuca, 6/24/1947, Michener, D. Rockefeller Exp. (1, AMNH); Durango, 2 mi. S of Menores de Arriba, 9/14/1950, RF Smith, (2, AMNH); Chihuahua, Samalayuca Dunes,33 mi. S of Ciudad Juarez, 6/25/1959, ER Tinkham, (2, USNM); Chihuahua, 16 mi. SE of Chihuahua, 7/27/1953, 4000 ft., SEMC Mex.Expedition (2, SEMC); Chihuahua, Ojo Laguna, 6/30/1947, Gertsch, D. Rockefeller Exp. (1, AMNH); Chihuahua, Primavera, 6/30/1947, 5500-6000 ft., Cazier, D. Rockefeller Exp. (1, AMNH); Chihuahua, Namiquipa Dist., 7/3/1947, 6500 ft., Cazier, D. Rockefeller Exp. (1, AMNH); Chihuahua, 15 mi. E of Parral, 7/15/1947, 5500 ft., Cazier, D. Rockefeller Exp. (1, AMNH); Chihuahua, 15 mi. E of Parral, 7/15/1947, 5500 ft., Schramel, D. Rockefeller Exp. (1, AMNH); Chihuahua, 8 mi. S of Gallego, 7/27/1953, 5000 ft., SEMC Mex.Expedition (1, SEMC); Chihuahua, Colonia Dublan, ?/?/1931, Beck & Call, (1, HEH); Chihuahua, 25 mi. SW of Camargo, 7/14/1947, Gertsch, D. Rockefeller Exp. (2, AMNH); Chihuahua, 25 mi. SW of Camargo, 7/14/1947, Michener, D. Rockefeller Exp. (1, AMNH); Chihuahua, 10 mi. N of Jimenez, 9/10/1950, RF Smith, (2, AMNH); Coahuila, 6 mi. W of Matamoros, 6/8/1961, UCM EI MEI (1, UCMC); Chihuahua, Catarinas, 7/25/1947, 5800 ft., Michener, D. Rockefeller Exp. (1, AMNH); Chihuahua, Catarinas, 7/25/1947, 5800 ft., Gertsch, D. Rockefeller Exp. (1, AMNH); Chihuahua, 20 mi. SW of Camargo, 7/13/1947, 4500 ft., Michener, D. Rockefeller Exp. (2, AMNH); Chihuahua, 20 mi. SW of Camargo, 7/13/1947, 4500 ft., Spieth, D. Rockefeller Exp. (1, AMNH); Durango, Durango, 8/4/1951, PD Hurd, (3, EMEC); Durango, 9 mi. W of Durango, 9/6/1950, RF Smith, (1, AMNH); Durango, 41 mi. NE of Durango, 7/28/1956, RE Beer & party, at light (1, SEMC); Chihuahua, 63 mi. W of Santa Barbara, 7/20/1947, 5500 ft., Cazier, D. Rockefeller Exp. (2, AMNH); Chihuahua, 13 mi. E of Cuauhtemoc, 7/11/1964, 6600ft, Chemsak & Powell, at lights (2, EMEC); Chihuahua, Chihuahua, 8/26/1981, Chemsak, at lights (1, EMEC); Chihuahua, Hwy.45 vicinity of Laguna Encinillas, 7/1/1987, GF Ballmer, at lights (1, UCRC); Chihuahua, Camargo, 6/16/1965, SJ Arnold, at lights (1, EMEC); Chihuahua, 15 mi S El Sueco, 9/?/1983, Gary Fritz, (1, NMSU); Chihuahua City, 7/10/1983, Gary Fritz, (1, NMSU); Chihuahua, Colonia Dublan, Anson Ca?l Jr, *Arenivaga apacha* (Sauss.) det. ABGurney '53 (1, MLBM). Determiner label *Arenivaga erratica* Hopkins 2011" [white label with black border].

Distribution. This is a widespread species widely in New Mexico, the eastern half of Arizona, the far western part of Texas located south of New Mexico, south into central

Mexico. Isolated records from Utah, Nevada, and a record from Colorado not included in the distribution map. See Fig. 50.

Diagnosis. *A. erratica* may be diagnosed by shagreened or toothed ridge running along the anterolateral edge of the small dorsal sclerite. See Fig. 49.

Description. Male. Measurements. Holotype stand-in TL =17.3 mm, GW = 8.8 mm, PW = 5.73 mm, PL = 3.76 mm, TL/GW = 1.97, PL/PW = 0.66. EW = 0.25 mm; OW = 0.40 mm. Among paratypes range of TL 16.3–23.5 mm; range of GW 7.4–10.0 mm; range of PW 5.10–6.62 mm; range of PL 3.76–4.70 mm.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm); vertex medium brown, with small ridges between apices of eyes extending on to ocellar tubercles; interocellar space slightly concave, medium brown with light brown medial line; two oval indentations laterally at base of interocellar space. Frons waxy white, flat; bound on either side by ridges extending from inner apex of ocelli outwards to lateral edges of clypeus; scattered long setae on frons and ridges. Anterior portion of frons waxy white, bulbous; clypeal suture demarcates waxy white anteclypeus. See Fig. 48d.

Pronotum. Pronotum translucent waxy beige; variable length orange-brown setae along anterior margin; dorsal surface of pronotum covered with short orange-brown setae that are denser and longer anteriorly and laterally; pronotal pattern medium orange-brown "panther face", but runs through every shade to dark brown in other specimens; with no aura and little discernible detail, though considerable detail seen in some specimens. See Fig. 48c.

Body. Wing brace present. Legs and body light orange-brown; subgenital plate asymmetrical with posterior edge emarginated, rounded apices. See Fig. 48b.

Forewings. Wings extended beyond abdominal apex (up to ~35% of total wing length); color highly variable from light beige, to light brown, to light orange-brown, to medium brown; usually blotchy; surface semi-transparent and matte, or with faint sheen on many specimens. See Fig. 48a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized hookshaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin sclerotized, shagreened, often with one or two small dorsally projecting teeth; medial margin extends beyond rest of phallomere at each end. Small central sclerite punctate, with sclerotized shagreened ridge, toothed along edge, along anterolateral side. Right ventral phallomere extends from articulation into bulbous love that narrows anteriorly; after narrow gap, rounded, punctate arm extending to depth of rest of phallomere. Genital hook with pointed head and moderate hook; arm moderate with smooth curve. See Fig. 49.

Habitat and natural history. All life history elements remain unobserved.

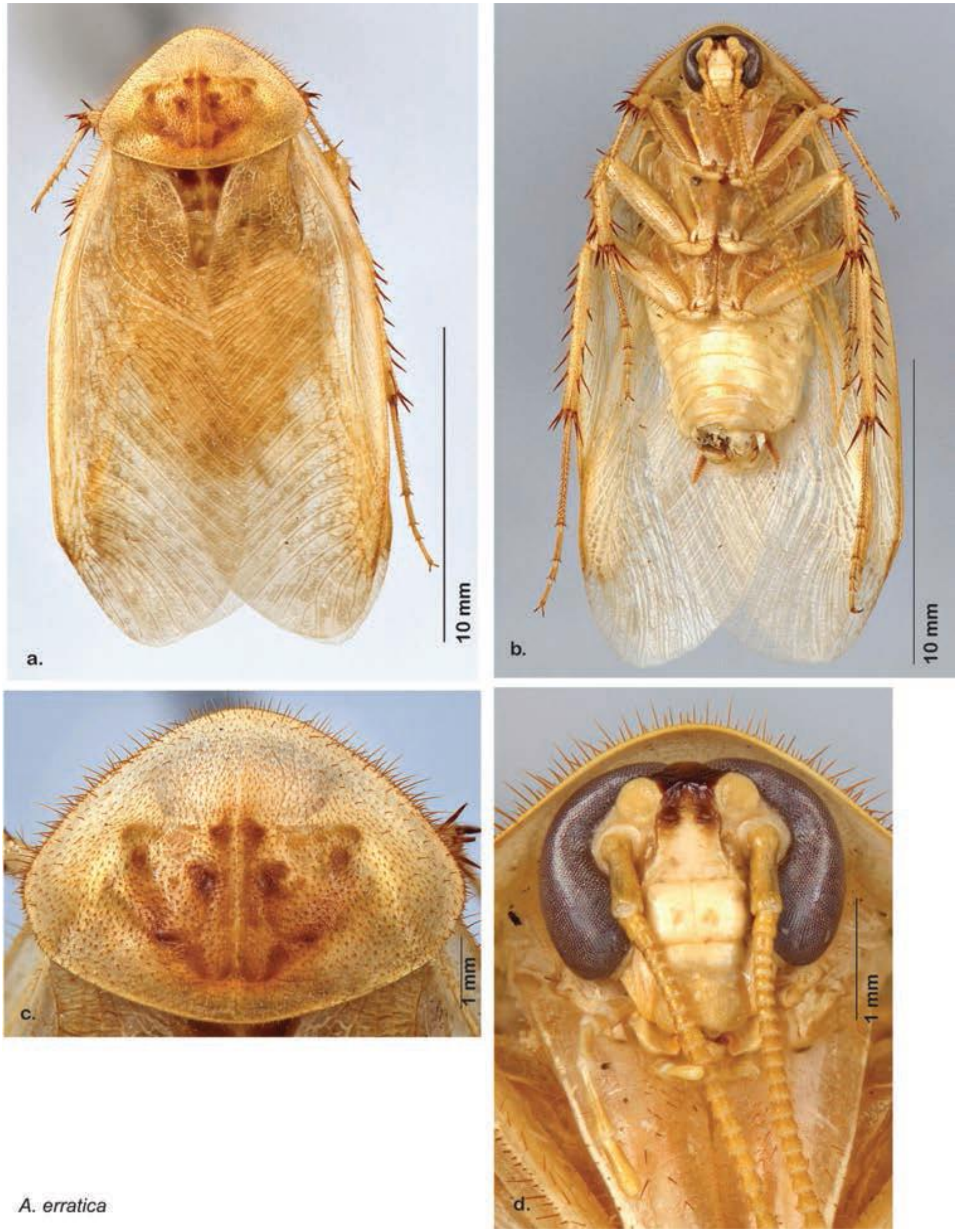


Figure 48. *A. erratica*, a dorsal habitus b ventral habitus c pronotum d head.

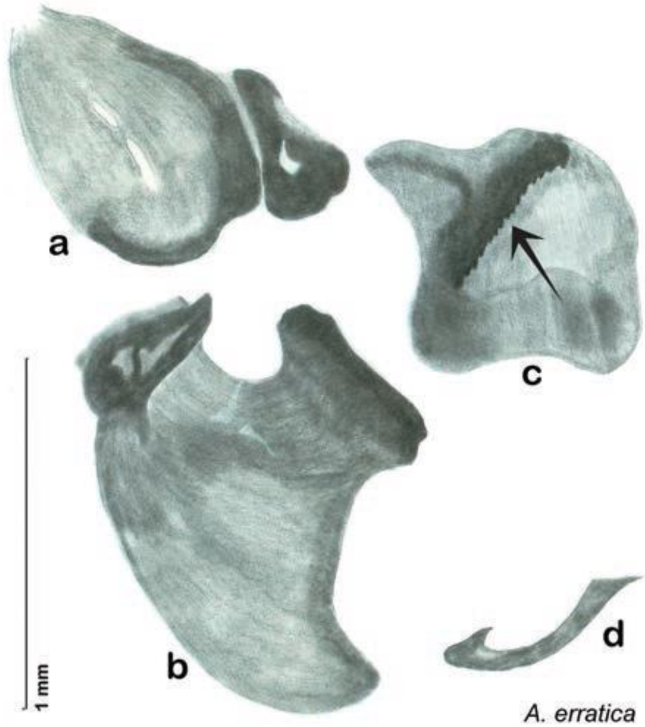


Figure 49. *A. erratica*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

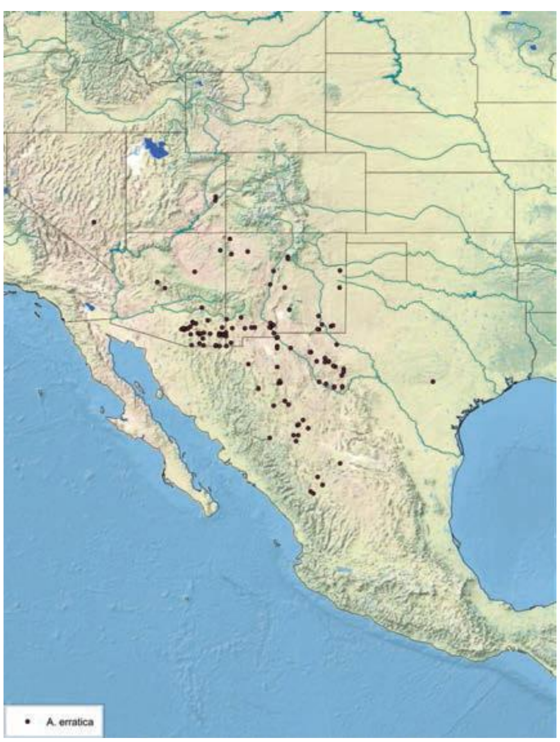


Figure 50. *A. erratica*, distribution.

***Arenivaga estelleae* sp. n.**

http://zoobank.org/0AF54DC2-9A96-494E-B967-976A5AAFD8ED

http://species-id.net/wiki/*Arenivaga_estelleae*

Figures 51–53

Type locality. USA, California, San Diego Co., north of Fallbrook.

Material examined. Holotype: ♂ in LACM labeled "July 27, 1957, 2.3 mi N. Fallbrook, San Diego Co., Calif., Lionel A Stange " HOLOTYPE *Arenivaga estelleae* Hopkins, 2012" [red label with black border].

Paratypes (41): USA: CA, San Diego Co., NAS Miramar 4, 11/13/1996, N Bloomfield, blacklite (1, SDMC); CA, San Diego Co., MCAS Miramar, 9/18/1998, N Bloomfield, blacklite (1, SDMC); CA, San Diego Co., Mission Gorge Dam, 7/26/1976, illegible (1, SDMC); CA, San Diego Co., San Diego, 6/10/1953, J Powell, at light (1, EMEC); CA, San Diego Co., Lake Hodges, 8/24/1976, DK Faulkner (1, SDMC); CA, San Diego Co., N San Vicente Res, 8/19/1976, DK Faulkner (1, SDMC); CA, San Diego Co., 2.3 mi N of Fallbrook, 7/27/1957, LA Stange (1, LACM); CA, San Diego Co., Boulevard Manzanita, 10/10/1980, R Messner (1, SDMC); CA, San Diego Co., Boulevard Manzanita, 10/5/1979, R Messner (1, SDMC); CA, San Diego Co., Boulevard Manzanita, 8/7/1979, R Messner (1, SDMC); CA, San Diego Co., Boulevard Manzanita, 7/12/1979, R Messner (4, SDMC); CA, San Diego Co., Boulevard Manzanita, 6/3/1980, R Messner (1, SDMC); CA, San Diego Co., Boulevard Manzanita, 5/28/1980, R Messner (1, SDMC); CA, San Diego Co., Rancho Santa Fe, 8/25/1958, JR Northern (1, LACM); CA, San Diego Co., San Diego, 6/19/1974, Munzenmaier & Patten, Japanese beetle trap, 74524-38, *Arenivaga* sp. Det. AR Hardy 1974 (1, CSCA); CA, San Diego Co., Boulevard Manzanita, 7/29/1979, R Messner (1, SDMC); CA, San Diego Co., Alpine, 7/18/1990, J Mitchell (1, SDMC); CA, San Diego Co.,, NAS Miramar 2, 5/19/1997, N Bloomfield, blacklite (1, USNM); CA, San Diego Co., San Diego, 7/17/1912, FE Maisdell (1, CAS); MEXICO: BC, 4 mi SW of La Zapopita, Valle de Trinidad, 4/16/1961, FS Truxal (4, LACM); BC, 11 mi E of Ojos Negros on road to Laguna Hanson, 8/9/1988, 1160 m, Weissman & Lightfoot, Stop #88-85 (1, CAS); BC, 8 mi E of Tecate, 7/6/1984, Brown & Tocco, green dot (1, CAS); BC, Ensenada, 8/30/1952 (2, USNM); BC, turnoff Hwy 1 to Motel Durado, 3 km S of Ensenada, 7/18/1977, D Weissman, coastal sand dunes (1, CAS); BC, 17 mi S of Ensenada, 6/14/1938, Michelbacher & Ross (1, CAS); BC, Hwy 2, 5.7 km W of El Condor at KM 88.7, 8/19/1995, 1210 m, Weissman & Lightfoot, Stop #95-65 (1, CAS); BC, 13 mi SW of La Zapopita, 6/14/1963, EL Sleeper, blacklite (2, CAS); BC, 17 mi S of Ensenada, 6/14/1938, Michelbacher & Ross, photo.spec. (1, LACM); BC, Km 56 on road to Sierra San Pedro Martir Park off Hwy 1, 8/4/1981, 900 m, Lightfoot & Weissman, #81-64 (1, CAS). All paratypes labeled "Paratype *Arenivaga estelleae* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for my grandmother, Estelle Beaumont, who taught me so much including how to be firm yet kind; also for the Latin stella, meaning star, because it is a lovely little roach.

Distribution. This species is found in far southwestern California and northwestern Baja California Norte, Mexico. See Fig. 53.

Diagnosis. *A. estelleae* is smaller and browner than average for *Arenivaga* and could be confused with the parapatric species *A. gaiophanes* (in its external appearance) and

A. paradoxa (in its genitalia). These three species are most likely closely related. *A. estelleae* may be distinguished by the broad central field on the right dorsal phallomere and very wide gap on the right ventral phallomere. See Figs 52 and 124.

Description. Male. Measurements. Holotype TL =16.5 mm, GW = 8.9 mm, PW = 4.93 mm, PL = 3.31 mm, TL/GW = 1.85, PL/PW = 0.67. EW = 0.45 mm; OW = 0.45 mm. Among paratypes range of TL 15.1–20.6 mm; range of GW 7.2–9.8 mm; range of PW 4.57–5.91 mm; range of PL 3.31–4.25 mm.

Head. Two ocelli large, ovoid and protruding (0.3 × 0.2 mm); vertex flat and medium brown with small ridges in rays around upper apex of eyes and extending onto ocellar tubercles; interocellar space concave with fine horizontal corrugations; medium brown laterally shading to light brown in concavity; deep vertical indentations medial to ocelli. Frons light brown, concave; anterior portion of frons bulbous, light brown medially, shading darker laterally; pale beige anteclypeus with one horizontal corrugation. See Fig. 51d.

Pronotum. Pronotum translucent, waxy beige; dorsal surface of pronotum with short fine brown setae centrally and posteriorly grading to longer, thicker setae laterally and anteriorly; pronotal pattern brown “panther face”; brown maculations scattered across posterior 80% of dorsal surface of pronotum; no aura. See Fig. 51c.

Body. Wing brace present. Two tarsal claws present. Legs beige, body light brown with dark brown markings on lateral anterior portion of each sternite; subgenital plate light brown; strongly asymmetrical with rounded apices. See Fig. 51b.

Forewings. Wings extended well beyond abdominal apex (~40% of wing length); color light brown to dark medium brown depending on specimen, faintly blotchy; surface matte and opaque. See Fig. 51a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized hookshaped lobe, articulated with right ventral phallomere on lateral side; central field sclerotized; medial margin with slight concavity, shagreened with toothed margin; anterior and posterior margins deeply emarginate, posterior margin curving back out to several teeth; interior of lateral articulation setose; broad rolled sclerotized lip projecting posteriorly from lateral articulation to several teeth. Small central sclerite broad, flat and finely punctate with posteriorly projecting, sclerotized lip at anterior end; right ventral phallomere extends from articulation to form rounded shagreened structure with acute edge; attached anteriorly is mildly dorsally projecting flanged arm, shagreened with roughly toothed edge. Folded anterior portion of left phallomere dramatically modified into heavily setose, medially projecting, scoop shape. Genital hook with short extension to pointed head with average hook; arm robust. See Fig. 52.

Habitat and natural history. All life history elements remain unobserved.

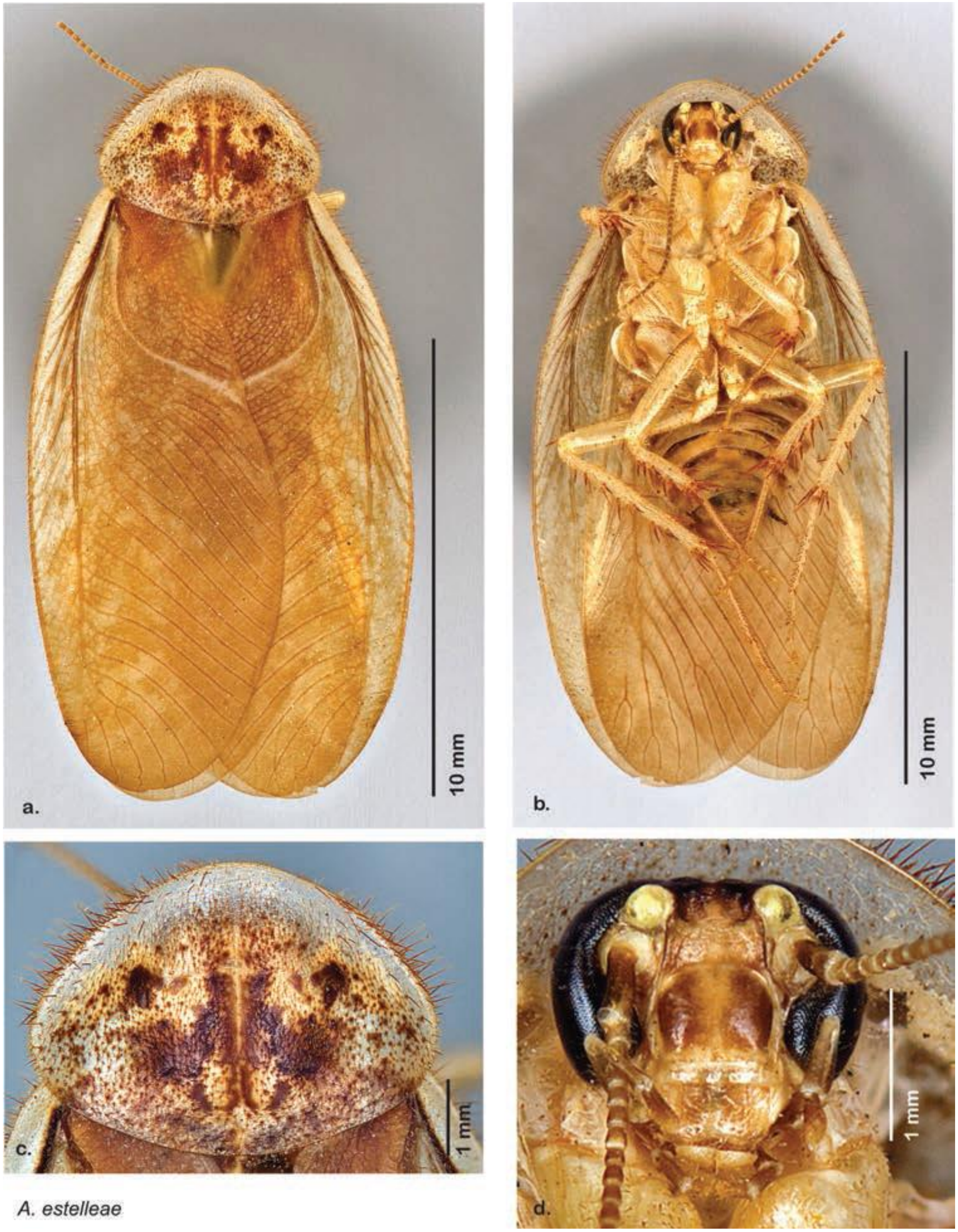


Figure 51. *A. estelleae*, a dorsal habitus b ventral habitus c pronotum d head.

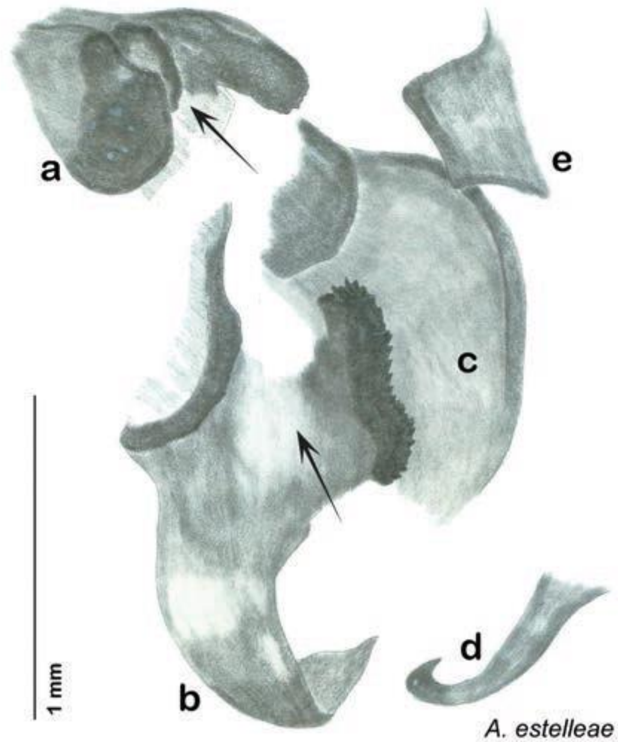


Figure 52. *A. estelleae*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook e left phallomere. Arrow(s) indicate diagnostic characters (see text).

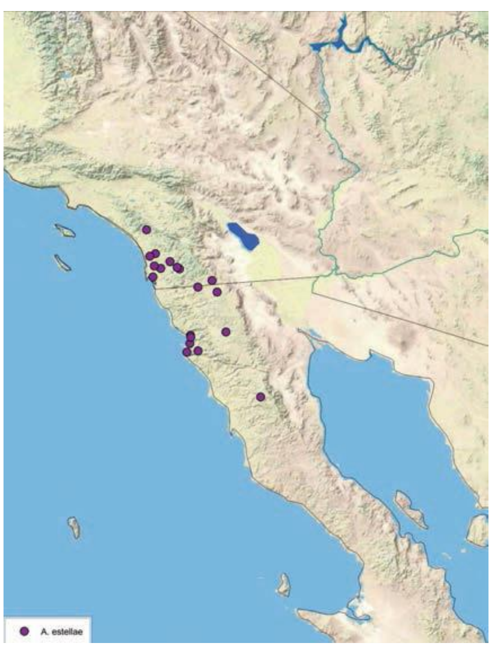


Figure 53. *A. estelleae*, distribution.

***Arenivaga floridensis* Caudell**

http://species-id.net/wiki/*Arenivaga_floridensis*

Figures 54–56

1918 *Arenivaga floridensis* Caudell, Proceedings of the Entomological Society of Washington, 20(7), pp. 156–157.

1920 *Arenivaga floridensis* Caudell, Hebard, Transactions of the American ntomological Society, 46(2), pp. 197–217.

Material examined (44). USA: FL, Polk Co., Auburndale, Lake Blue Scrub, 4/8/2009, P. Skelley, (1, FSCA); FL, Polk Co., Tiger Creek Preserve, 2.5 mi. SE Babson Park, 5/18-19/2006, Skelley and Almquist, sand sifts (2, FSCA); FL, Marion Co., Juniper Spring SP, 5/19/1990, P. Skelley, light (1, FSCA); FL, Levy Co., .25 mi. SW of Alachua Co. line, 6/28/1992, L.R.Davis Jr., (5, FSCA); FL, Volusia Co., in malt trap (1, FSCA); FL, Hillsborough Co., USF campus, 6/29/1972, (1, FSCA); FL, Putnam Co., Interlachen, 6/26/1992, L.R.Davis Jr., leg removed for DNA analysis T.Lamb X-2006 (1, FSCA); FL, Hillsborough Co., Vestavia Apts., 4/4/1977, Boyd, Blattidae (1, FSCA); FL, Alachua Co., 6/2/1986, E.G.Farnworth, (1, FSCA); FL, Levy Co., .25 mi. SW of Alachua Co. line on Rt. 24, 7/17/1993, L.R.Davis Jr., (1, UCRC); FL, Hillsborough Co., USF, Tampa, 6/6/1972, (1, FSCA); FL, Hillsborough Co., N. Tampa, 7/29/1972, (1, FSCA); FL, Levy Co., 3.9 mi. SW Archer, 4/1-7/1991, P. Skelley, pawpaw bloom (1, FSCA); FL, Highlands Co., Archbold Biol. Station, 3/22/1969, L.L.Pechuman, (1, CUIC); FL, Highlands Co., Archbold Biol. Station, 6/3/1966, R.G.Beard, (1, CUIC); FL, Highlands Co., Archbold Biol. Station, Lake Placid, 3/27-30/1959, J.G.Francelemont, (3, CUIC); FL, Highlands Co., Archbold Biol. Station, 3/27/1967, R.G.Beard, at 15 watt UV light (1, CUIC); FL, Highlands Co., Lake Placid, 7/13/1948, B.W.Crowder, (5, SEMC); FL, Lake Co., Ocala NF, 3/16/1956, Howden and Howell, (1, FSCA); FL, Highlands Co., 3/31/1961, J.C.Hanlon, in blacklight trap (1, FSCA); FL, Highlands Co., Archbold Biol. Station, 8 mi. S Lake Placid, 4/3/1974, G.C.Eickwort, (1, CUIC); FL, Tarpon Springs, 7/18/1983, Konger, (1, FSCA); FL, Orange Co., Orlando, 5/31/1924, F.W.Walker, (1, ANSP); FL, Co., Lakeland, 5/4/1912, W.T.Davis, genitalia figured H1920 (1, ANSP); FL, Highlands Co., Archbold Biol. Station, 2/14/1951, *floridensis* (1, USNM); FL, Orange Co., Orlando, 5/31/1924, F.W.Walker, (1, USNM); FL, Polk Co., Lake Streaty, 8/10/1938, T32S,R27E,Sec25 110/111, Hubbell and Friauf, (2, USNM); FL, Highlands Co., Archbold Biol. Station, Lake Placid, 2/2/1959, S.W.Frost, (1, USNM); FL, Clay Co., Gold Head Branch SP, 3/31/1956, T.H.Hubbell, (1, USUSNM); FL, Clay Co., Gold Head Branch SP, 5/6/1954, L.H.Krombein, (1, USNM); FL, Orange Co., Orlando, 5/10/1924, F.W.Walker, (1, UMMZ); FL, Levy Co., .2 mi SW Alachua County Line, Rt. 24, 6/6/1977, LR Davis, Jr., (1, FSCA). Determiner label *Arenivaga floridensis* Hopkins 2011" [white label with black border].

Distribution. This species is found in central Florida. See Figure 56.

Diagnosis. *A. floridensis* may be diagnosed by its locality or by the medially projecting knob by the posterior end of the point of articulation between the two right phallomeres. See Fig. 55.

Description. Male. NB: Holotype is half spread therefore GW is estimated.

Measurements. Holotype TL = 17.4 mm, GW = 9.0 mm, PW = 6.71 mm, PL = 4.26 mm, TL/GW =1.93, PL/PW = 0.63. EW = 0.50 mm; OW = 0.55 mm. Among paratypes range of TL 13.8–20.7 mm; range of GW 7.7–10.7 mm; range of PW 5.43–7.24 mm; range of PL 3.82–4.69 mm.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm); vertex dark brown, with small ridges between apices of eyes and scattered short setae; interocellar space concave, dark brown. Frons medium brown fading posteriorly to light brown, tectiform, concave; bound on either side by ridges extending from inner apex of ocelli outwards to lateral edges of clypeus; scattered long setae on ridges. Anterior portion of frons light brown with medium brown maculations, bulbous; clypeal suture demarcates light brown anteclypeus. See Fig. 54d.

Pronotum. Pronotum translucent waxy beige. Variable length orange-brown setae along anterior margin; dorsal surface of pronotum covered with short orange-brown setae; pronotal pattern "panther face" dark brown, with small to extensive aura depending on specimen; discernibility of detail variable but generally poor. See Fig. 54c.

Body. Wing brace present. Legs and body medium orange-brown; subgenital plate symmetrical with posterior edge emarginated, rounded apices. See Fig. 54b.

Forewings. Wings extended beyond abdominal apex (up to ~30% of total wing length); color uniform dark brown depending on specimen; surface opaque and matte, or with faint sheen on many specimens. See Fig. 54a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized hookshaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin sclerotized, heavily toothed, curving ventrally at anterior end. Small central sclerite finely punctate, concave, with shagreened bulge along ventral edge. Right ventral phallomere extends from articulation into smooth flattened posteriorly projecting lobe with anteriorly projecting spine on medial edge; after ridge and moderate gap, rounded concave smooth flange. Folded anterior portion of left phallomere wide, setose, otherwise unmodified. Genital hook with pointed head with dimple along extension to a moderate hook. See Fig. 55.

Habitat and natural history. All life history elements remain unobserved.

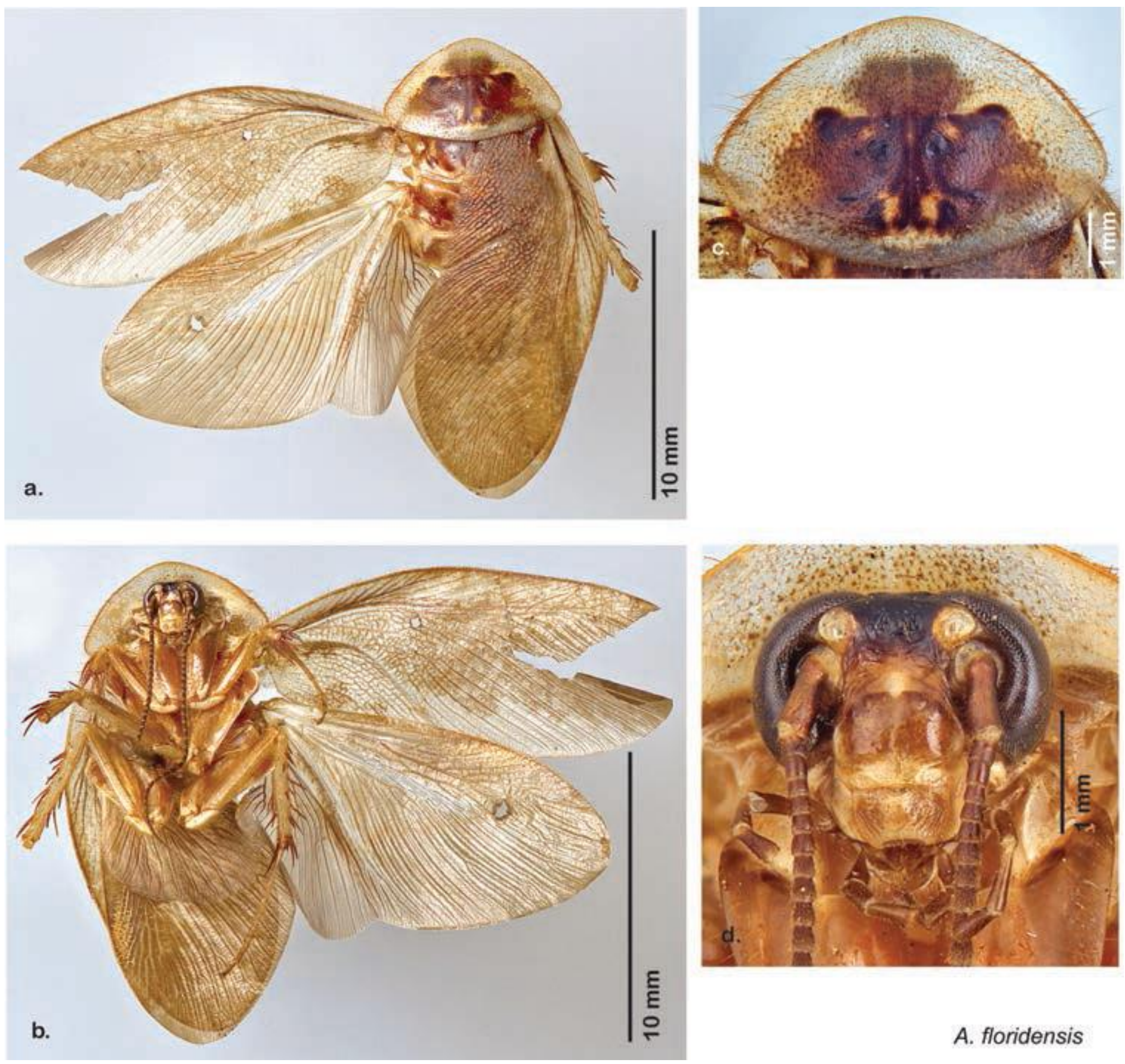


Figure 54. *A. floridensis*, a dorsal habitus b ventral habitus c pronotum d head.

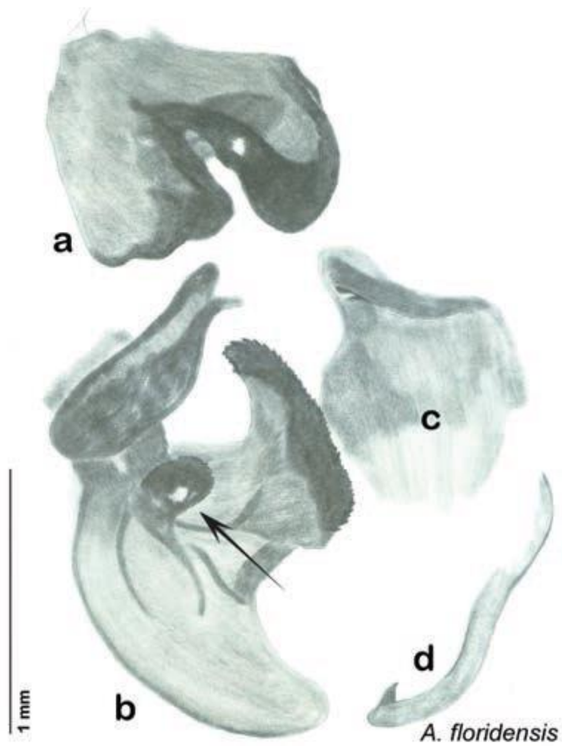


Figure 55. *A. floridensis*, genitalia: a right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 56. *A. floridensis*, distribution.

***Arenivaga florilega* sp. n.**

http://zoobank.org/6686685E-AA73-42D2-9D9B-F974A5DB8016

http://species-id.net/wiki/*Arenivaga_florilega*

Figures 57–59

Type locality. MEXICO, Hidalgo, Zimapan.

Material examined. Holotype: ♂ in EMEC labeled "Zimapan Hdgo. Mex. VI-11-14-51, on fls. of Eysenhardtia polystachya (Ort.), P.D.Hurd Collector" "HOLOTYPE *Arenivaga florilega* Hopkins, 2012" [red label with black border].

Paratypes: None at this time.

Etymology. The name is an adjective in the nominative singular. This species is named from the Latin meaning flower gathering because the only known specimen was collected off the flowers of Eysenhardtia polystachya.

Distribution. This species is known only from the type locality. See Fig. 59.

Diagnosis. *A. florilega* may be confused with *A. galeana* but may be distinguished by the almost complete lack of sculpturing or sclerotization on the right dorsal phallomere, the posteriorly projecting lobe on the right ventral phallomere, and a round curved genital hook. See Figs 58 and 64.

Description. Male. Measurements. Holotype TL = 19.7 mm, GW = 9.5 mm, PW = 5.37 mm, PL = 3.98 mm, TL/GW = 2.07, PL/PW = 0.74. EW = 0.15 mm; OW = 0.40 mm.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.25 mm); vertex dark brown, with small ridges between apices of eyes and extending onto ocellar tubercles; interocellar space concave, dark brown. Frons dark medium brown; posterior concave; anterior portion of frons bulbous but much less so than in most species, dark medium brown; light brown anteclypeus. See Fig. 57d.

Pronotum. Pronotum translucent waxy light brown; dorsal surface of pronotum with dense orange-brown setae that are longer and thicker laterally; pronotal pattern dark orange-brown "panther face", impressed; slight aura. See Fig. 57c.

Body. Wing brace absent. Two tarsal claws present. Legs and body medium brown; subgenital plate orange-brown; strongly asymmetrical with posterior edge only slightly emarginated and rounded apices. See Fig. 57b.

Forewings. Wings extended beyond abdominal apex; light brown with sparse medium brown blotches; surface translucent with mild sheen. See Fig. 57a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, narrow, bulbous lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized, cupped; with narrow medial edge more sclerotized, punctate, ending anteriorly in small shagreened flange. Small central sclerite lightly sclerotized, finely punctate, concave with two punctate lobes wrapping anteriorly around shagreened flange of right dorsal phallomere, posterior end connecting with dorsal side of right dorsal phallomere. Articulation between right phallomeres deep, concave and setose, with shagreened border adjacent to dorsal phallomere and smooth border adjacent to ventral phallomere. Right ventral phallomere consists of large punctate flattened medially projecting lobe; becoming wider and more sclerotized anteriorly; anteriorly narrow gap followed by wide shagreened flange. Folded anterior portion of left phallomere wide, setose, otherwise unmodified. Genital hook widely curved to sharp point; arm robust and straight. See Fig. 58.

Habitat and natural history. All life history elements remain unobserved.

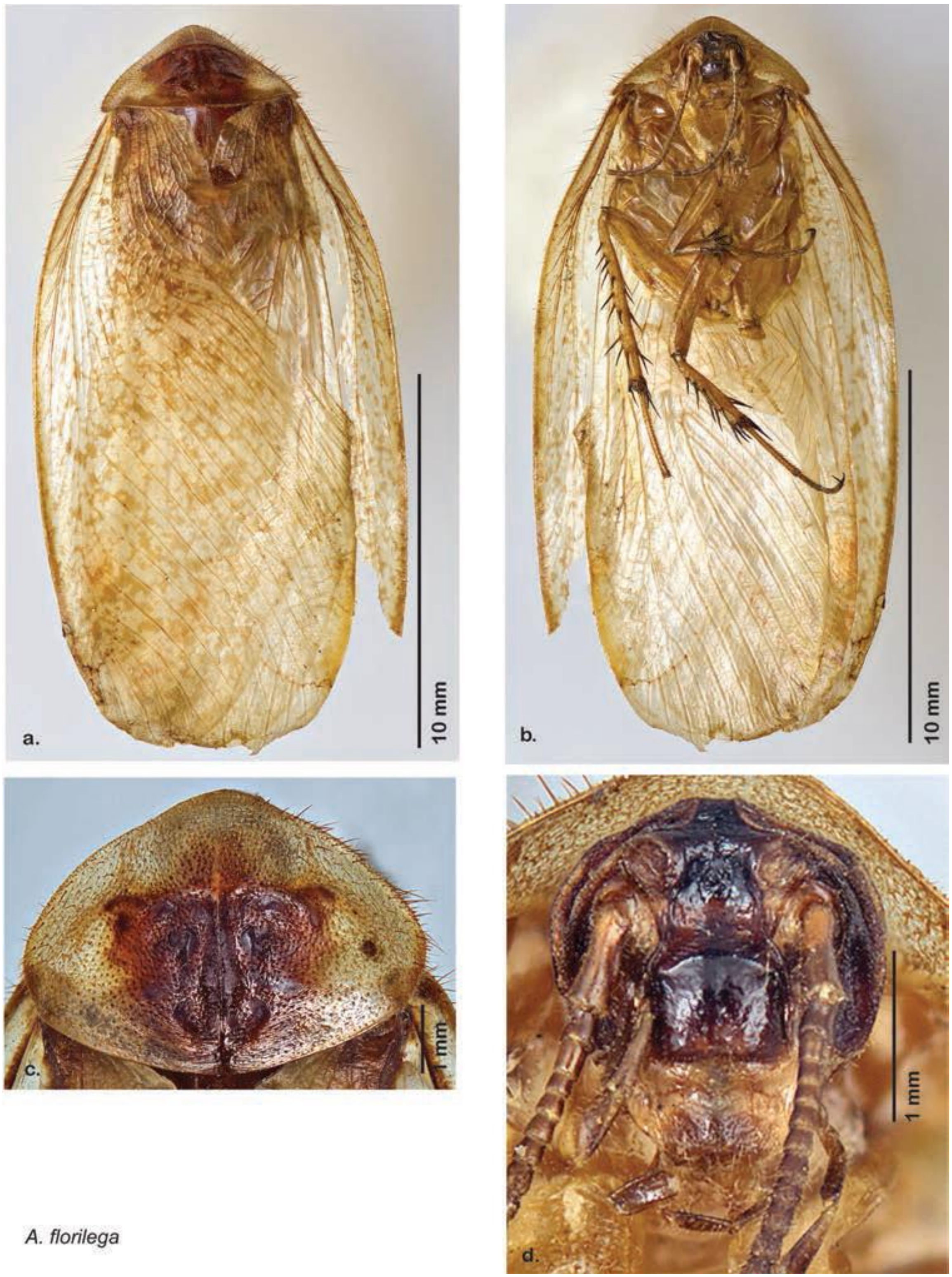


Figure 57. *A. florilega*, a dorsal habitus b ventral habitus c pronotum d head.

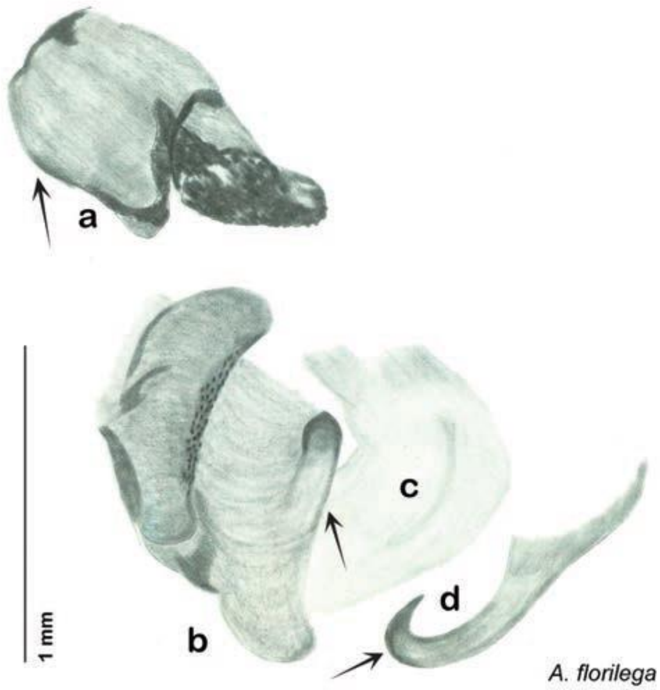


Figure 58. *A. florilega*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 59. *A. florilega*, distribution.

***Arenivaga gaiophanes* sp. n.**

http://zoobank.org/6D0A707A-46BA-4AE1-B5EB-98BA4F4A2F56

http://species-id.net/wiki/*Arenivaga_gaiophanes*

Figures 60–62

Type locality. USA, California, Riverside Co., Ranchos los Ninos de Luz.

Material examined. Holotype: ♂ in LACM labeled “Riverside Co., Calif. Rancho Los Ninos De Luz, Murrieta Rd., 10 Oct. 71, 600’, J.A.Honey” “ HOLOTYPE *Arenivaga gaiophanes* Hopkins, 2012” [red label with black border].

Paratypes (25): USA: CA, Riverside Co., Hemet, San Jacinto Rov., 6/14/2003, 33.45.46N 116.53.18W 526 m, GR Ballmer, at MV light, PhotoEloous 327:36,328:1-3 (1, UCRC); CA, Orange Co., Lower San Juan Cpgd., 7/27/1982, CW Melton (2, UCMC); CA, Riverside Co., Bundy Canyon, 9 mi S of Perris, 7/27/1978, 1660 ft., RJ Ford (2, LACM); CA, San Bernardino, Lake Arrowhead, 7/12/1964, EI Schlinger, at white light (1, UCRC); CA, Fallbrook, 7/8/1972, LD Anderson (1, UCRC); CA, Riverside Co., Rancho Los Ninos de Luz, Murrieta Rd., 10/10/1971, 600 ft., JA Honey (2, LACM); CA, Riverside Co., Menifee Valley, 7/4/1976, 33.39.19N 117.12 45W, SI & SL Frommer, at white light (1, UCRC); CA, Riverside Co., Menifee Valley, hills on W end, 8/6/20003, 3.39N 117.13W, 1800 ft. JD Pinto, at light (1, UCRC); CA, Riverside Co., Riverside, 4/17/1972, BJ Taylor (1, UCRC); CA, Riverside Co., Menifee Valley, 8/20/1976, 33.39.19N 117.12 45W, CL Lacey, genitalia missing (1, UCRC); CA, Riverside Co., Menifee Valley, hills on W end, 6/29/1984, 33.39N 117.13W, 1800 ft., JD Pinto (1, UCRC); CA, Riverside Co., Menifee Valley, hills on W end, 6/16/1978, 33.39N 117.13W, 1899 ft., JD Pinto (1, UCRC); CA, Orange Co., San Juan Creek, 9/27/1954, RJ

Ford (3, LACM); CA, Riverside Co., Menifee Valley, hills on W end, 6/1/2001, 33.39N 117.13W, 1800 ft., JD Pinto (1, UCRC); CA, San Diego Co., Wildcat Canyon near Lakeside, 8/3-28/1962, SC Williams, scorpion pit trap in 1961 chaparral burn area (1, ASUT); CA, Riverside Co., Tenajas Ranger Station, 7/29/1967, JA Honey (2, LACM); CA, Riverside Co., Tenajas Ranger Station, 8/19/1967, JA Honey (1, LACM), CA, Riverside Co., Pinyon Flat Campground, 14 mi SW of Palm Desert on SR74, 7/3-4/2008, JA Cole (1, ANSP), CA, Riverside Co., Pinyon Flat Campground, 14 mi SW of Palm Desert on SR74, 6/28-29/2003, JA Cole (1, ANSP). All paratypes labeled "Paratype *Arenivaga gaiophanes* Hopkins 2012" [blue label with black border].

Etymology. The name is an adjective in the nominative singular. This species is named *gaiophanes* for its beautiful uniform earth tone coloration, from Greek meaning "earth-colored".

Distribution. This species is distributed from Lake Arrowhead in the north, to Wildcat Canyon in the south, and from Hemet in the east, to San Juan Creek in the west. See Figure 62.

Diagnosis. *A. gaiophanes* sp. n. is slightly smaller than average, warm brown in color with scattered blotches. It can be mistaken phenotypically for *A. sequoia* but the genitalia are distinct; the medial margin of the right dorsal phallomere is deeply indented in *A. gaiophanes* but not at all in *A. sequoia*. See Figs 61 and 142.

Description. Male. Measurements. Holotype TL = 19.2 mm, GW = 9.2 mm, PW = 5.22 mm, PL = 3.81 mm, TL/GW = 2.09, PL/PW = 0.73. EW = 0.3 mm; OW = 0.4 mm. Among paratypes range of TL 15.6–19.2 mm; range of GW 7.5–9.2 mm; range of PW 5.02–6.00 mm; range of PL 2.97–4.24 mm.

Head. Two ocelli large, ovoid and protruding (0.45 × 0.35 mm); vertex medium brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space concave, rugose, medium brown. Posterior frons light brown, concave; anterior frons bulbous with slight central indentation; light brown anteclypeus. See Fig. 60d.

Pronotum. Pronotum translucent, waxy beige; dorsal surface of pronotum with short fine brown setae centrally and posteriorly grading to longer, thicker setae laterally and anteriorly; pronotal pattern brown "panther face"; brown maculations scattered across posterior 70% of dorsal surface of pronotum; no aura. See Fig. 60c.

Body. Wing brace present. Two tarsal claws present. Legs and body light orangebrown; darker maculation laterally on each sternite; subgenital plate dark orangebrown; strongly asymmetrical with rounded apices. See Fig. 60b.

Forewings. Wings extended well beyond abdominal apex (~40% of wing length); color uniform brown, to blotchy brown; surface matte and opaque. See Fig. 60a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized hookshaped lobe, articulated with right ventral phallomere on lateral side; central field sclerotized; medial margin with deep V-shaped emargination projecting to two broad flat points; entire phallomere shagreened except hook-shaped lobe and anterior point; entire medial margin with short teeth; interior of lateral articulation setose; broad rolled sclerotized lip projecting posteriorly from lateral articulation. Small central sclerite broad, flat and finely punctate with posteriorly projecting, sclerotized lip at anterior end; right ventral phallomere extends from articulation to form rounded shagreened structure with fine corrugations; attached anteriorly is mildly dorsally projecting flanged forked arm, shagreened with roughly toothed edge. Folded anterior portion of left phallomere setose, otherwise unmodified. Genital hook with short extension to pointed head with short hook; arm robust. See Fig. 61.

Habitat and natural history. This species occurs in hilly or mountainous habitat. All other life history elements remain unobserved.

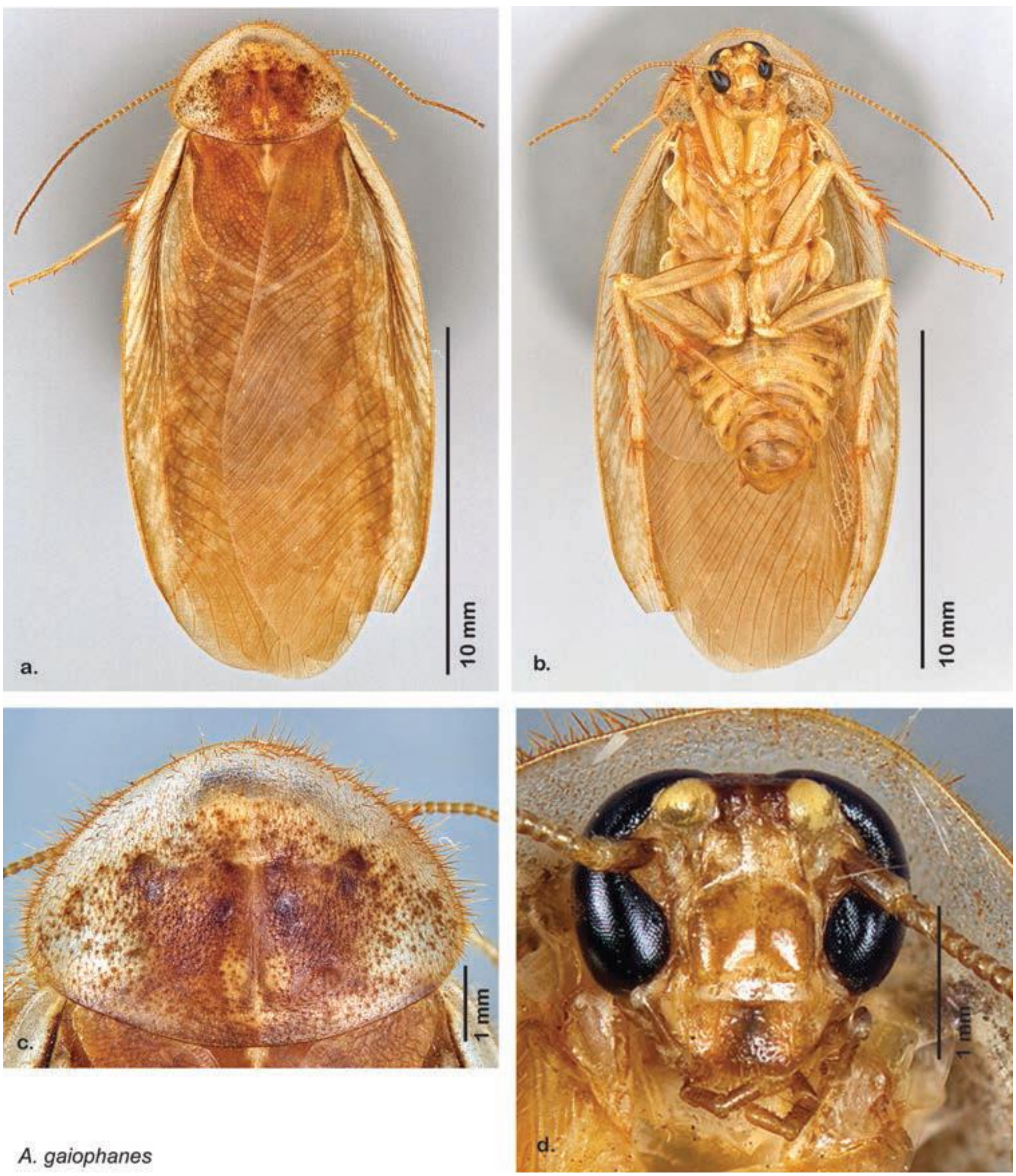


Figure 60. *A. gaiophanes* a dorsal habitus b ventral habitus c pronotum d head.

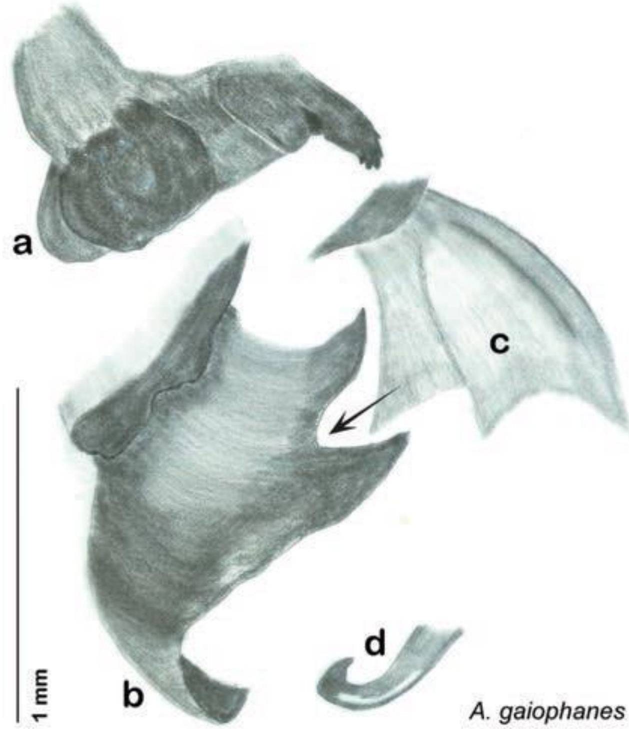


Figure 61. *A. gaiophanes*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

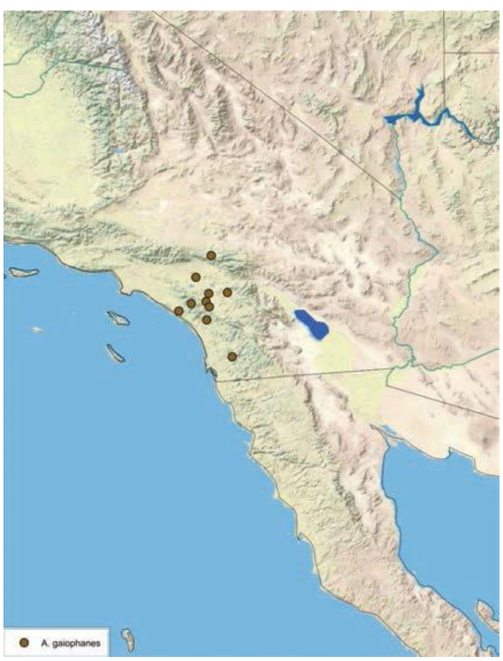


Figure 62. *A. gaiophanes*, distribution.

***Arenivaga galeana* sp. n.**

http://zoobank.org/6F2CBB4C-2342-42B3-9F5B-2629FF170642

http://species-id.net/wiki/*Arenivaga_galeana*

Figures 63–65

Type locality. MEXICO, Nuevo Leon, 3 mi E Galeana.

Material examined. Holotype: ♂ in USNM labeled "MEXICO: 3 mi. E. Galeana, N.L. 5000', Aug. 7–9, 1963, Duckworth & Davis" "HOLOTYPE *Arenivaga galeana* Hopkins, 2012" [red label with black border].

Paratypes (11): MEXICO: Nuevo Leon, 6.4 km W Iturbide, 7/16/1979, 24.44N 99.56W, 1800 m, DC Darling (1, CUIC); Nuevo Leon, 3 mi. E of Galeana, 8/7-9/1963, 5000 ft., Duckworth & Davis (8, USNM); El Salto Falls 26 mi. W of Antiguo Morelos, Tamps., 7/11-14/1963, 2000 ft., Duckworth & Davis (2, [one missing label] USNM). All paratypes labeled "Paratype *Arenivaga galeana* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genive case. This species is named for the Mexican town near where the majority of specimens originate, Galeana.

Distribution. This species occurs in the Sierra Madre Oriental mountains of eastern Mexico. See Fig. 65.

Diagnosis. *A. galeana* may be confused with *A. florilega* but may be distinguished by the right ventral phallomere which does not have a flattened, posteriorly projecting lobe as it does in *A. florilega*. Also the genital hook is the typical angular sort, not a sweeping curve as in *A. florilega*. See Figs 64 and 58.

Description. Male. Measurements. Holotype TL = 22.3 mm, GW = 9.8 mm, PW = 5.84 mm, PL = 3.79 mm, TL/GW = 2.28, PL/PW = 0.65. EW = 0.25 mm; OW = 0.40 mm. Among paratypes range of TL 19.6–23.5 mm; range of GW 8.4–9.8 mm; range of PW 5.38–6.22 mm; range of PL 3.73–4.33 mm.

Head. Two ocelli large, ovoid and protruding (0.50 × 0.30 mm); vertex dark brown, with small ridges between apices of eyes and extending onto ocellar tubercles; interocellar space concave, dark brown. Frons dark brown; posterior concave; anterior portion of frons slightly bulbous, anterior margin with medial point, medium brown; light brown anteclypeus. See Fig. 63d.

Pronotum. Pronotum translucent waxy beige; dorsal surface of pronotum with short orange-brown setae that are longer and thicker laterally; pronotal pattern dark orange-brown "panther face", impressed, with medium orange-brown aura. See Fig. 63c.

Body. Wing brace absent. Two tarsal claws present. Legs and body light brown; subgenital plate dark orange-brown; strongly asymmetrical with rounded apices. See Fig. 63b.

Forewings. Wings extended beyond abdominal apex (up to 40% of total wing length); blotchy medium brown; surface translucent with mild sheen. See Fig 63a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, bulbous lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized, cupped; with narrow medial edge more sclerotized, punctate, ending anteriorly in small shagreened knob. Small central sclerite lightly sclerotized, finely punctate, concave with two punctate lobes wrapping anteriorly around shagreened knob of right dorsal phallomere, posterior end connecting with dorsal side of right dorsal phallomere. Articulation between right phallomeres deep, concave and setose, with shagreened border adjacent to dorsal phallomere and faint smooth border adjacent to ventral phallomere; shagreened border coming to posteriorly projecting pointed extension. Right ventral phallomere consists of large punctate flattened medially projecting lobe with central indentation; becoming wider and more sclerotized anteriorly; anteriorly wide gap followed by wide shagreened flange with slight central concavity. Folded anterior portion of left phallomere wide, setose, enclosed at both ends with indentation at medial end, otherwise unmodified. Genital hook with short extension to pointed head and short hook; arm robust. See Fig. 64.

Habitat and natural history. All life history elements remain unobserved.

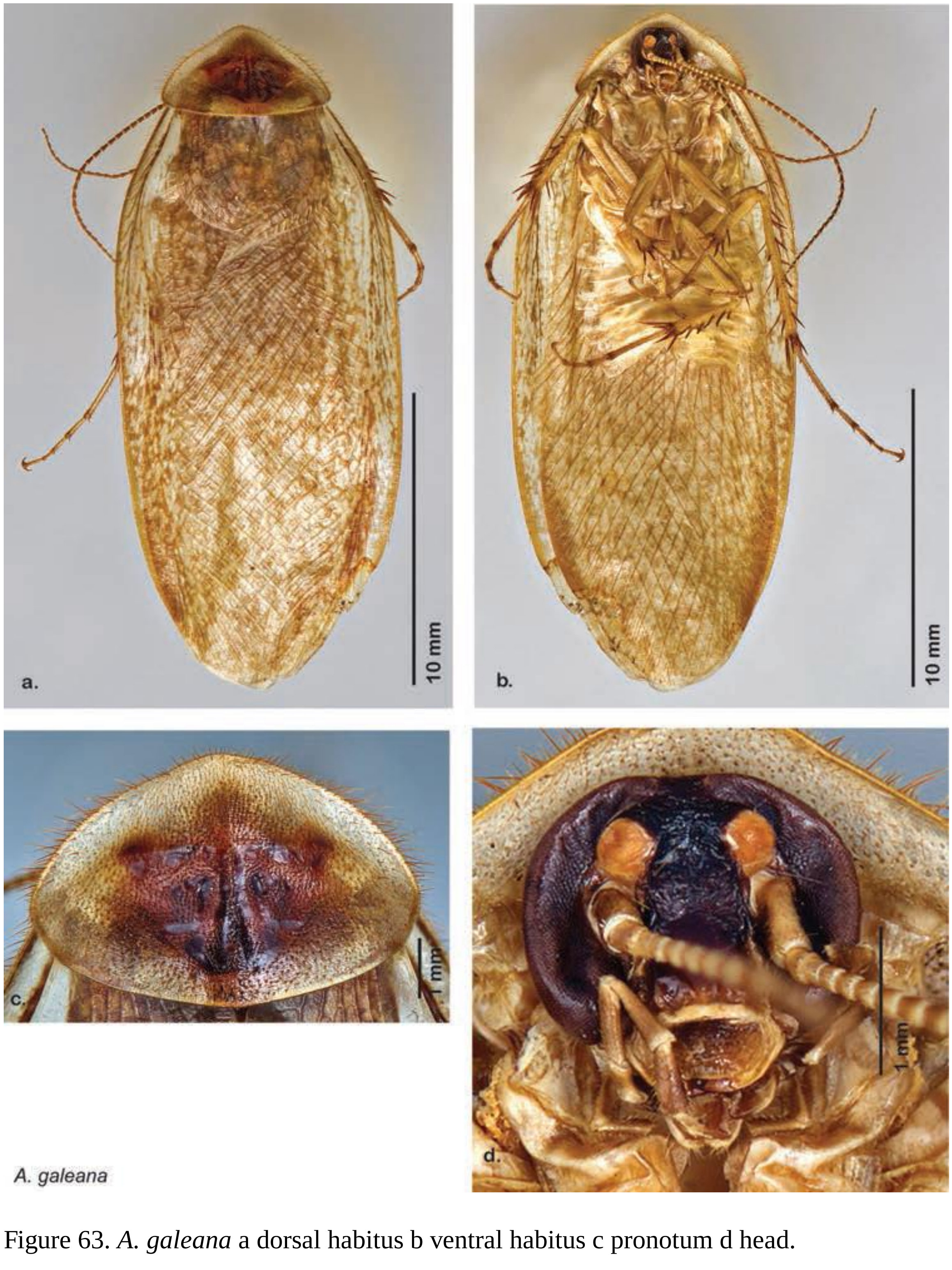


Figure 63. *A. galeana* a dorsal habitus b ventral habitus c pronotum d head.

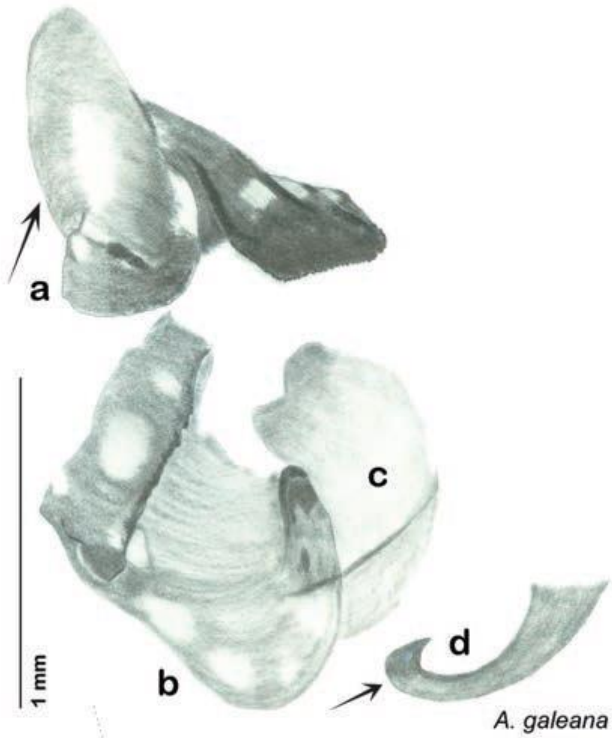


Figure 64. *A. galeana*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 65. *A. galeana*, distribution.

***Arenivaga genitalis* Caudell**

http://species-id.net/wiki/*Arenivaga_genitalis*

Figures 66–68

1918 *Arenivaga genitalis* Caudell, Proceedings of the Entomological Society of

Washington,

20(7), pp. 154-156.

1920 *Arenivaga genitalis* Caudell, Hebard, Transactions of the American Entomological Society, 46(2), pp. 197-217.

Material examined (343). USA: AZ, Pima Co., Lowell Ranger Sta., 7/6-20/1916, 32.18.5N 110.49W, 2000', 1:share with Clark and ANSP,1:*Arenivaga genitalis* Caud., Figured H 1920 (2, ANSP); AZ, Pinal Co., Florence, 7/17/1903, C.R.Biederman, (6, ANSP); AZ, Maricopa Co., Phoenix, _8/23/1966, R.S.Beal, at light. *Arenivaga* sp. Det. Rentz (1, NAUF); AZ, Pima Co., Redington Rd., 8/9/2003, 32.15.47N 110.39.11W, E.Riley, UV (1, TAMU); AZ, Maricopa Co., Phoenix, 6/9/1904, M.Hebard, *Arenivaga genitalis* Caudell TOPOTYPE (1, ANSP); AZ, Maricopa Co., Phoenix, 7/16-18/????, Wickham, *Arenivaga genitalis* Caudell TOPOTYPE (1, ANSP); AZ, Maricopa Co., Phoenix, 8/1/????, R.E.Kunze, *Arenivaga genitalis* Caudell TOPOTYPE (1, ANSP); AZ, Maricopa Co., Phoenix, 6/7/1904, M.Hebard, *Arenivaga genitalis* Caudell TOPOTYPE, Genitalia figured partially 1917, fully H 1920 (1, ANSP); AZ, Pima Co., Ft. Grant 60 mi. E of Tucson, (1, ANSP); AZ, Maricopa Co., Phoenix, 4/29/1902, Oslar, (1, ANSP); AZ, Maricopa Co., Tempe, 4/26/1902, Oslar, (1, ANSP); AZ, Pinal Co., Florence, 7/10/1903, C.R.Biederman, (1, ANSP); AZ, Pinal Co., Florence, 7/21/1903, C.R.Biederman, (1, ANSP); AZ, Pinal Co., Florence, 7/18/1903, C.R.Biederman, (1, ANSP); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 5/9/1916, J.F.Tucker, (1, ANSP); AZ, Pinal Co., Florence, 7/19/1903, C.R.Biederman, (1, ANSP); AZ, Pinal Co., Florence, 6/6/1903, (1, ANSP); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 11/2/1916, J.F.Tucker, (1, ANSP); AZ, Pinal Co., Picacho Peak SP, 8/4/1983, C.B.Barr, Collected at light (1, Essig); AZ, Pima Co., Tucson Mountain Park, 4/1/1969, R.E.Beer & party, *Arenivaga* sp. nr. *genitalis* Hebard (2, UK); AZ, Yuma Co., S Luis, 8/11/1940, E.C.Van Dyke, (1, CAS); AZ, Maricopa Co., Phoenix, 8/5/????, R.E.Kunze, Paratype No. 21879 U.S.N.M., *Arenivaga genitalis* Parat. "b" Caud. (1, USNM); AZ, Pima Co., Covered Wells, 4/12/1954, L.M.Martin, (2, LACM); AZ, Pinal Co., Florence, 5/8/1903, (1, ANSP); AZ, Pima Co., Tucson, 6/23/1963, Parker and Stange, (1, FSCA); AZ, Pinal Co., Florence, 5/10/1958, H.Tryon, (1, ASUT); AZ, Pima Co., 7/22/1927, L.D.Anderson, (1, ANSP); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 4/26/1916, J.F.Tucker, (1, ANSP); AZ, Pima Co., Sabino Canyon, 7/31/1941, R.H.Beamer, (3, ANSP); AZ, Pima Co., 3/30/1923, O.C.Poling, (1, ANSP); AZ, Pima Co., Ajo, 3/25/1923, O.C.Poling, (1, ANSP); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 4/20/1916, J.F.Tucker, (1, ANSP); AZ, Maricopa Co., Phoenix, 4/9/1902, Kunze, (1, ANSP); AZ, Maricopa Co., Phoenix, Oslar, (1, ANSP); AZ, Maricopa Co., Casa Grande, 4/7/1935, A.L.Melander, (1, MCZ); AZ, Maricopa Co., Paloverde, 4/21/1935, F.H.Parker, *apacha* (3, MCZ); AZ, Maricopa Co., Paloverde, 4/22/1935, F.H.Parker, (1, MCZ); AZ, Maricopa Co., Paloverde, 4/21/1935, F.H.Parker, (1, UCRC); AZ, Pima Co., Base of Tortolita Mts., S side, 6/14/1984, 3000', R.S.Beal, black light (9, NAUF); AZ, Pima Co., Tucson, 7/12/1937, D.J. & J.N.Knull, 122, genitalia missing (1, OSUC); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 7/30/1968, F.Werner, lt. (1, HEH); AZ, Pima Co., Sabino

Canyon, Santa Catalina Mts., 5/21/1967, J.Hesselt, lt. (1, HEH); AZ, Gila Co., Gila River 3 mi. SW of Christmas, 6/4/1962, F.Werner, lt. trap, (3, UAIC); AZ, Pima Co., U of AZ campus, Tucson, ?/?/1917, R.Abel, Ent. 101, (1, HEH); AZ, Pima Co., Bear Canyon, Catalina Mts., 5/26/1994, M.Singer, *Arenivaga* sp. Det. B.Mathison (1, UAIC); AZ, Maricopa Co., Salt River at Bush Hwy. Bridge, 5/27/1995, B.C.&W.B.Warner & K.Miller, UV light (7, WB Warner); AZ, Maricopa Co., Coons Bluff on Salt River, 7/29/2010, 33.32.52N 111.38.39W, Bill Warner, UV light (5, WB Warner); AZ, Maricopa Co., Tortilla Flat, 7/15/1975, W.F.Chamberlain, (1, TAMU); AZ, Maricopa Co., 24 mi. N Gila Bend, Gillespie Dam, 7/16/1975, J.D.Pinto, (1, UCRC); AZ, IBP:Santa Rita Desert Site 01, 8/2/1971, Emergence trap SR08,Aregen (1, UAIC); AZ, Pima Co., Santa Rita Mts., 7/23/1978, R.H.Crandall, (1, LACM); AZ, Pima Co., Tucson, 4/22/1958, R.C.Whistler, (1, UAIC); AZ, Pima Co., Tucson, 4/12/1958, J.May, (1, UAIC); AZ, Pima Co., Tucson, 4/26/1958, R.Price, (1, UAIC); AZ, Pima Co., Tucson, 4/8/1958, J.Claney, (1, UAIC); AZ, Pima Co., Tucson, 4/20/1958, H.Nather, (1, UAIC); AZ, Pima Co., Sonoran Desert Museum, 8/5-8/1962, W.L.Nutting, lt. trap, S.Oman (2, UAIC); AZ, Pima Co., Sonoran Desert Museum, 8/1-4/1962, W.L.Nutting, lt.trap, S.Oman (1, UAIC); AZ, Pima Co., Sonoran Desert Museum, 8/9-16/1962, W.L.Nutting, lt.trap, S.Oman (1, UAIC); AZ, Pima Co., Tucson, 8/27/1938, D.J. & J.N.Knull, (1, OSUC); AZ, Pima Co., Tucson, 6/23/1939, D.J. & J.N.Knull, (2, OSUC); AZ, Pima Co., Tucson, 6/8/1937, D.J. & J.N.Knull, (1, OSUC); AZ, Pima Co., Tucson, 8/26/1946, R.H.Crandall, (1, LACM); AZ, Pima Co., Tucson, 7/10/1946, R.H.Crandall, (1, LACM); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 7/7/1960, F.Werner & P.H.Johnson, UV light (2, UAIC); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 8/1/1962, F.Werner, , UV light (2, UAIC); AZ, Pima Co., Tucson, 7/11/1959, L.B.Koenig, at light (1, FSCA); AZ, Pima Co., Tucson, 5/3/1958, CAWood, (1, UAIC); AZ, Maricopa Co., Gila Bend, 4/7/2008, L.A.Stange, (1, FSCA); AZ, IBP:Silverbell Site, Sect.21, T11S R9E, Invert.plot UA, 7/17/1971, Emergence trap 106 under ceramic (1, UAIC); AZ, Pima Co., Tucson, 7/3/1961, L.B.Koenig, at light (1, UAIC); AZ, Pima Co., Tucson, 6/21/1961, L.B.Koenig, at light (2, UAIC); AZ, Pima Co., W. of Tucson, Tucson Mt. Park, 3/25-27/1986, P.Skelley, light trap (1, FSCA); AZ, Pima Co., Tucson, 5/10/1942, A.L.Melander, (1, UCRC); AZ, Pima Co., Organ Pipe NM, 4/11/1965, G.L.Jensen & W.J.Turner, (1, EMEC); AZ, Pima Co., Organ Pipe NM, 4/11/1947, A.L.Melander, (1, UCRC); AZ, Pima Co., Organ Pipe NM, 4/18/1947, A.L.Melander, (1, UCRC); AZ, Pima Co., Organ Pipe NM, Quitobaquito Oasis, 4/11/1973, S&S Frommer, at white light,7.30pm-8.55pm (1, UCRC); AZ, Pima Co., Organ Pipe NM, 3/10/1984, Olson, (1, UAIC); AZ, Pima Co., Soldier Canyon, 14 km. NE of Tucson, 3/24/1986, 950m, Steiner & Lowry, at black light in Sonoran Desert scrub (1, USNM); AZ, Pima Co., Tucson, 6/12/1948, R.H.Crandall, (1, LACM); AZ, Pima Co., Tucson, 4/23/1958, Bruner, (3, UAIC); AZ, Pima Co., Tucson, 5/3/1958, T.?, (1, UAIC); AZ, Pima Co., Tucson, 5/2/1958, Moore, (1, UAIC); AZ, Pima Co., Tucson, 5/9/1958, Dobson, (1, UAIC); AZ, Pima Co., Tucson, 5/3/1958, Bruner, (1, UAIC); AZ, Pima Co., Tucson, 4/27/1958, Tilt, (1, UAIC); AZ, Pima Co., Tucson, 4/25/1958, R.R.Frost, (1, UAIC); AZ, Pima Co., Tucson, 10/12/1959, G.T.Bottger, blacklight trap (1, UAIC); AZ, Pima Co., Tucson, 4/16/1958, Peltz, (1, UAIC); AZ, Pima Co., Tucson, 4/20/1958, Crisman, (1, UAIC); AZ, Yuma Co., Yuma, 6/1/1937, R.C.,Dickson, (1, UCRiverside); AZ, Yuma Co., Yuma, 7/22/1925, Brooklyn Museum Collection 1929 (2, USNM); AZ, Yuma Co., Yuma, _5/20/1958, V. Roth, at lights (1, UA); AZ, Yuma Co., Yuma, 1/1/1972, S.Kirkpatrick, on brick wall (1, ASUT); AZ, Yuma Co., Roll, 6/29/1939, L.L.Stitt, (1, ASUT); AZ, Maricopa Co., Tempe, 4/3/1972, S.C.Burns, near light (1, ASUT); AZ, Maricopa Co., Tempe, 4/8/1966, F.F.Hasbrouck, reared (1, ASUT); AZ, Maricopa Co., Tempe, 6/27/1964, F.F.Hasbrouck, at light (1, ASUT); AZ, Maricopa Co., Tempe, 6/20/1964, F.F.Hasbrouck, at light (1, ASUT); AZ, Maricopa Co., Mesa, 7/14/1959, S.A.Gorodenski, (1, ASUT); AZ, Maricopa Co., Mesa, Main St. and Recker Rd., 4/25/1966, Brennan, black light (7, ASUT); AZ, Maricopa Co., Ft. McDowell, 4/23/1964, G.McRaven, at light (1, ASUT); AZ, Maricopa Co., Germann and Higley, 5/9/1966, Brennan, black light (1, ASUT); AZ, Maricopa Co., Casa Grande, 4/22/1973, N.Kendle, on car window, Blattellidae (1, ASU); AZ, Maricopa Co., Liberty, 2/21/1974, B.Grandy, in house (1, ASUT); AZ, Maricopa Co., Thunderbird Park, 4/27/1979, Wielgus & Hasbrouck, at UVBL (1, ASUT); AZ, Maricopa Co., Tempe, 6/25/1964, F.F.Hasbrouck, at light (1, ASUT); AZ, Maricopa Co., Tempe, 4/24/1974, H.C.Conklin, at light (1, ASUT); AZ, Maricopa Co., Tempe, 10/1/1974, L.Porzer, on ground (1, ASUT); AZ, Pima Co., Tucson, vic. Ina/Oracle, 7/9/1989, W.L.Nutting, pool (2, UAIC); AZ, Pima Co., Tucson, 7/17/1966, M.L.Noller, at light (1, UAIC); AZ, Pima Co., Catalina SP, Santa Catalina Mts., 8/2/1996, Olson, (1, UAIC); AZ, Pima Co., ASDM, Tucson, 4/2/1953, W.W.Larson, light (1, UAIC); AZ, Pima Co., Tucson, 4/10/1969, F.G.Werner, UV trap (3, UAIC); AZ, Pima Co., Tucson, 4/11/1958, J.May, (1, UAIC); AZ, Pima Co., Tucson, 1/10/1969, R.H.Russell, (1, UAIC); AZ, Pima Co., Tucson, 11/6/1966, R.Rice, under board (7, UAIC); AZ, Pima Co., Tucson, 12/11/1966, R.Rice, under log (2, UAIC); AZ, Pima Co., Tucson, 1/29/1967, R.Rice, under door (4, UAIC); AZ, Pima Co., Tucson, 11/8/1967, R.Rice, under board (5, UAIC); AZ, Pima Co., Tucson, 1/22/1967, R.Rice, under board (6, UAIC); AZ, Pima Co., Tucson, R.Rice, black light trap (1, UAIC); AZ, Pima Co., Tucson, 1/24/1967, R.Rice, under door (2, UAIC); AZ, Pima Co., Helmet Peak, 1/31/1967, R.Rice, rock pile (2, UAIC); AZ, Pima Co., Tucson, 8/11/1965, R.Rice, black light trap (1, UAIC); AZ, Pima Co., Tucson Mts. Rear hill near A Mtn., 11/24/1966, rock pile (1, UAIC); AZ, Pima Co., 16 mi. W of Tucson, 8/13/1988, (1, LACM); AZ, Pima Co., Tucson, Catalina Foothills, 8/23/2001, 32.18N 110.56W, 762.2m, W.Moore, WM01.029 (1, UAIC); AZ, Pima Co., Waterman Mts., 10/1990-4/1991, Olson & Van Devender, pitfall trap (27, UAIC); AZ, Pima Co., Waterman Mts., 5/19-7/7/1991, Olson, pitfall trap (3, UAIC); AZ, Pima Co., Waterman Mts., 4/6-5/19/1991, Olson & Van Devender, pitfall trap (11, UAIC); AZ, Maricopa Co., Phoenix, 4/1/1915, R.E.Kunze, (1, USNM); AZ, Maricopa Co., Phoenix, 4/1/1915, R.E.Kunze, genit. lost, Paratype No.21879 U.S.N.M., *Arenivaga genitalis* parat. “a” Caud. (1, USNM); AZ, Catalina Springs, 7/4/????, paratype d, *Arenivaga genitalis* parat. “c” Caud. (1, USNM); AZ, Yuma Co., Wellton, 6/3/1939, L.L.Stitt, at light,H-175 (1, USNM); AZ, Pima Co., Tucson, 4/15/1953, R.S.Beal, (1, EMEC); AZ, Pinal Co., Goldfield, 8/9/1950, R.S.Beal, (1, EMEC); AZ, Maricopa Co., Higley, 6/18/1917, E.G.Holt, at light (1, SNM); AZ, Maricopa Co., Tempe, 6/5/1951, H.S.Wallace, No.1811 (1, UMMZ); AZ, Maricopa Co., Tempe, 7/3/1951, H.S.Wallace, No.1833 (1, UMMZ); AZ, Maricopa Co., Tempe, 7/6/1951, H.S.Wallace, No.1836 (2, UMMZ); AZ, Maricopa Co., Tempe, 7/7/1951, H.S.Wallace, No.1838 (6, UMMZ); AZ, Maricopa Co., Tempe, 5/8/1951, H.S.Wallace, No.1770 (2, UMMZ); AZ, Maricopa Co., Tempe, 5/6/1951, H.S.Wallace, No.1769 (1, UMMZ); AZ, Maricopa Co., Tempe, 4/10/1951, H.S.Wallace, No.1754 (1, UMMZ); AZ, Maricopa Co., Tempe, 3/21/1951, H.S.Wallace, No.1754 (1, UMMZ); AZ, Maricopa Co., Tempe, 6/9/1951, H.S.Wallace, No.1752 (1, UMMZ); AZ, Maricopa Co., Tempe, 7/4/1951, H.S.Wallace, No.1834 (2, UMMZ); AZ, Maricopa Co., Tempe, 7/10/1951, H.S.Wallace, No.1841 (2, UMMZ); AZ, Maricopa Co., Tempe, 7/22/1951, H.S.Wallace, No.1857 (1, UMMZ); AZ, Maricopa Co., Tempe, 7/8/1951, H.S.Wallace, No.1840 (1, UM); AZ, Pinal Co., 10 mi. S of Casa Grande, 5/29/1942, E.R.Tinkham, (1, HEH); AZ, Pima Co., Sabino Canyon, 8/6/1959, K.V.Krombein, (1, USNM); AZ, Pima Co., Ajo, 4/23/1952, E.R.Tinkham, red tag T9 (1, USNM); AZ, Pima Co., Tucson, 4/11/1956, Fida, (1, UAIC); AZ, Pima Co., Tucson, 3/28/1958, Howell, (1, UAIC); AZ, Pima Co., Tucson, 4/20/1956, Robertson, (1, UAIC); AZ, Pima Co., Tucson, ?/11/1956, ?, (1, UAIC); AZ, Pima Co., Tucson, 4/9/1956, Massman, (1, UAIC); AZ, Pima Co., Tucson, 4/4/1952, Simons, (1, UAIC); AZ, Pima Co., Tucson, 6/30/1952, G.D.Butler, at light (1, UAIC); AZ, Pima Co., Tucson, 3/28/1957, Howell, (2, UAIC); AZ, Pima Co., Tucson, 5/3/1956, Brandt, (2, UAIC); AZ, Pima Co., Tucson, 3/1/1956, ?, (1, UAIC); AZ, Pima Co., Tucson, 4/9/1956, Togi, (1, UAIC); AZ, Pima Co., Tucson, 3/6/1951, Yunt, (1, UAIC); AZ, Pima Co., Tucson, 3/14/1951, Platt, (2, UAIC); AZ, Pima Co., Tucson, 6/27/1954, M.Crazier, (1, AMNH); AZ, Pima Co., Tucson, 6/30/1949, 2200’, G.M.Brandt, (3, AMNH); AZ, Pima Co., Tucson, 6/11/1954, M.Crazier, (1, AMNH); AZ, Pima Co., Ajo, 8/16/1952, C & P Vaurie, (2, AMNH); AZ, Pima Co., Tucson, 4/4/1950, R.W.Simpson, (1, UAIC); AZ, Pima Co., Tucson, 3/31/1950, R.W.Simpson, (1, UAIC); AZ, Pima Co., Tucson, 4/10/1950, R.W.Simpson, (1, UAIC); AZ, Yuma Co., Yuma, 10/4/1959, V.Roth, (1, UAIC); AZ, Pima Co., Sabino Canyon, Santa Catalina

Mts., 7/30/1954, F.G.Werner, lt. (5, UAIC); AZ, Pima Co., Sabino Canyon, 7/9/1952, Beamer,LaBerge,Wolf,Liang & Winer, (1, SEMC); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 7/2/1956, Butler & Werner, lt. (1, UAIC); AZ, Pima Co., Tucson, 4/13/1944, M.H.Froat,Jr., (1, UAIC); AZ, Pima Co., Tucson, 6/17/1930, J.Yuill, (1, UAIC); AZ, Pima Co., Tucson, 4/9/1940, S.L.Green, (1, UAIC); AZ, Pima Co., Tucson, 3/28/1943, T.J.Smith, in house, Lot 102 Sublot 416 (1, UAIC); AZ, Pima Co., Tucson, 4/?/1952, Nelson, (1, UAIC); AZ, Pima Co., Tucson, 6/18/1932, R.A.Flock, (1, UAIC); AZ, Pima Co., Tucson, 6/7/1932, R.A.Flock, (2, UAIC); AZ, Pima Co., Tucson, 6/27/1932, R.A.Flock, (1, UAIC); AZ, Pima Co., Tucson, 6/20/1932, R.A.Flock, (1, UAIC); AZ, Pima Co., Tucson, 7/5/1932, R.A.Flock, (1, UAIC); AZ, Pima Co., Tucson, 7/7/1932, R.A.Flock, (2, UAIC); AZ, Pima Co., Tucson, 7/1/1932, R.A.Flock, (1, UAIC); AZ, Pima Co., Tucson, 7/4/1932, R.A.Flock, (1, UAIC); AZ, Santa Cruz Co., near mouth of Peck Canyon, 4/17/1950, R.B.Miller, P.M. (1, UMMZ); AZ, Pima Co., Ajo, 3/31/1923, O.Poling, (1, ANSP); AZ, Pima Co., Sabino Canyon, Baboquivari Mts., 4/15/1954, L.M.Martin, (3, LACM); AZ, Pima Co., Sabino Canyon, Baboquivari Mts., 4/12/1954, L.M.Martin, (1, LACM); AZ, Pima Co., Sabino Canyon, Baboquivari Mts., 7/30/1949, L.M.Martin, (1, LACM); AZ, Pima Co., Tucson, 5/?/1949, (1, LACM); AZ, Maricopa Co., Tempe, 4/14/1951, H.S.Wallace, No.1757 (1, UMMZ); AZ, Pima Co., Tucson, 7/20/1975, D Foster, (1, NMSU); AZ, Pima Co., Tucson, 5/10/1964, 24-2600', J Wehner, (2, FSCA); AZ, Pima Co., Tucson, 5/3/1964, J Wehner, (1, FSCA); CA, Yuma, H.Wickham, (1, ANSP); CA, Imperial Co., Andrade, 8/4/1966, M.Wasbauer, Fluorescent black light (1, CSCA); CA, Imperial Co., Bard, 7/11/1966, Ratcliff, Argon light trap (1, CSCA). MEXICO, Sonora, Pitiquito, 7/4/1952, C & P Vaurie, (3, AMNH); Sonora, 40 mi. S of Sonoyta, 3/19/1981, Werner,Olson & Burns , (2, UAIC); Sonora, 40 mi. N of El Saguaro, 3/18/1981, Werner,Olson & Borne, (1, UAIC). Determiner label *Arenivaga genitalis* Hopkins 2011" [white label with black border].

Distribution. This species is found in south central Arizona, extending south into Mexico and west to southwestern Arizona. See Fig. 68.

Diagnosis. *A. genitalis* may be diagnosed by the appearance of the right ventral phallomere which has three spines and a knob projecting from the dorsal surface. See Fig. 67.

Description. Male. NB: Holotype is broken and pieces are glued to card. Description is blend of holotype and another complete specimen. Measurements. Holotype TL = 15.8 mm, GW = 7.7 mm, PW = 5.17 mm, PL = 3.60 mm, TL/GW = 2.05, PL/PW = 0.70. EW = 0.40 mm; OW = 0.50 mm. Among paratypes range of TL 15.3–21.8 mm; range of GW 6.9–9.8 mm; range of PW 5.00–6.34 mm; range of PL 3.60–4.66 mm.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm); vertex medium brown, with small ridges between apices of eyes extending on to ocellar tubercles, scattered short setae; interocellar space concave, light brown. Frons waxy white, concave; bound on either side by ridges extending from inner apex of ocelli outwards to lateral edges of clypeus; scattered long setae on ridges. Anterior portion of frons waxy white, bulbous; clypeal suture demarcates waxy white anteclypeus. See Fig. 66d.

Pronotum. Pronotum translucent waxy beige; variable length orange-brown setae along anterior margin; dorsal surface of pronotum covered with short orange-brown setae that are denser and longer anteriorly and laterally; pronotal pattern dark orangebrown "panther face", dark brown in some specimens, with little to no aura (aura usually anterior) and discernible detail. See Fig. 66c.

Body. Wing brace present. Legs and body medium orange-brown; subgenital plate asymmetrical with posterior edge emarginated, rounded apices. See Fig. 66b.

Forewings. Wings extended beyond abdominal apex (up to ~30% of total wing length); color highly variable from light brown, to light orange-brown, to medium and dark brown; always blotchy; surface semi-transparent and matte, or with faint sheen on many specimens. See Fig. 66a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized narrow ended hook-shaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin sclerotized, smooth, concave in ventral view; medial margin smoothly curved at anterior end, shagreened greatly extended knob at posterior end; dorsal edge has central emargination with small spine in center, broader spine posterior to that. Small central sclerite smooth, concave, with field of punctations on interoventral surface. Right ventral phallomere extends from articulation into posterior pointing spine, nearby similarly directed smooth knob with adjacent small spine, and nearby small punctate flange; recedes anteriorly in wavy punctate corrugations; after narrow gap, broad, wavy, punctate arm extending to depth of rest of phallomere. Folded anterior portion of left phallomere missing on holotype. Genital hook with broad pointed head and moderate hook; arm narrow. See Fig. 67.

Habitat and natural history. All life history elements remain unobserved.

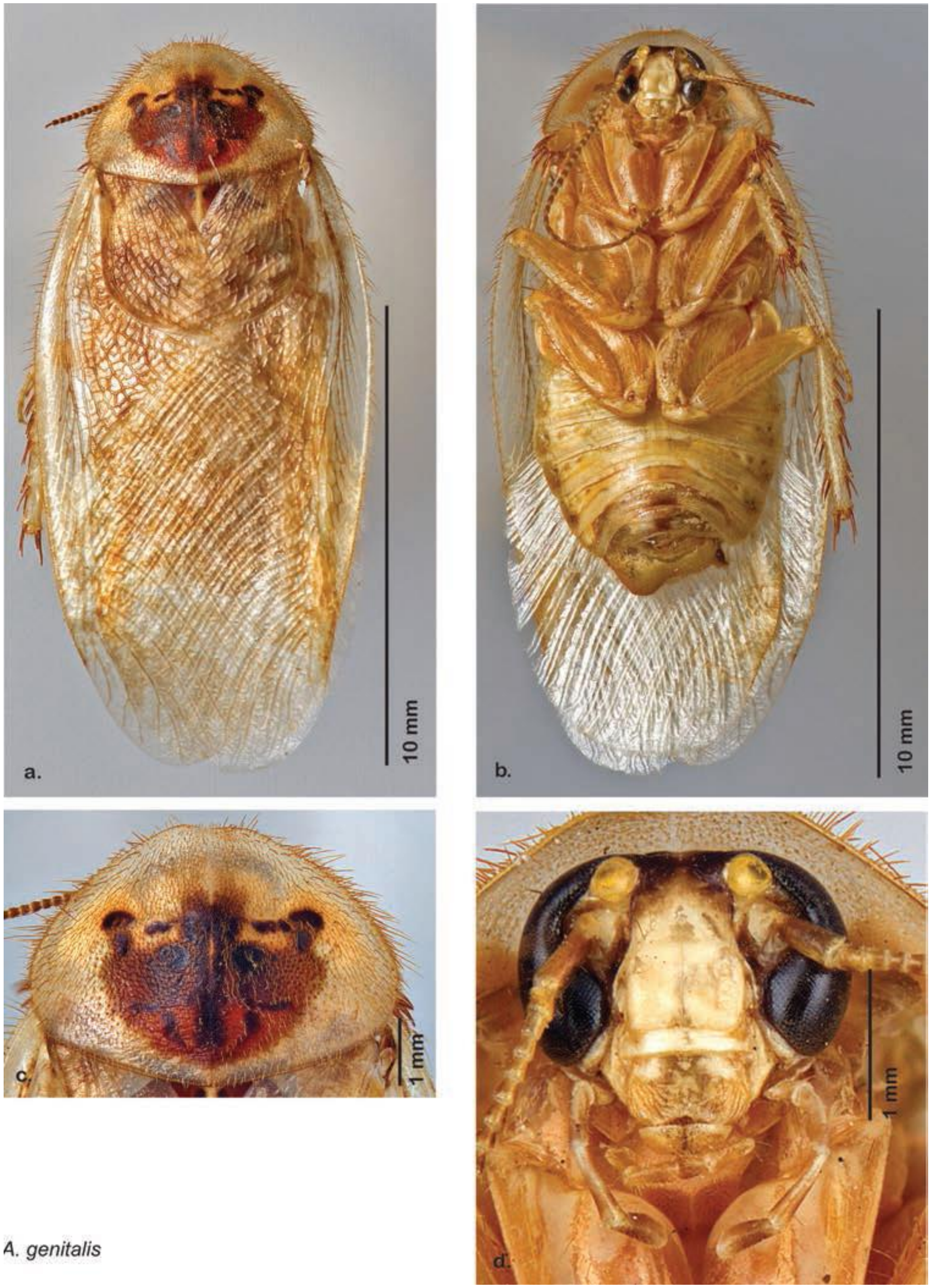


Figure 66. *A. genitalis* a dorsal habitus b ventral habitus c pronotum d head.

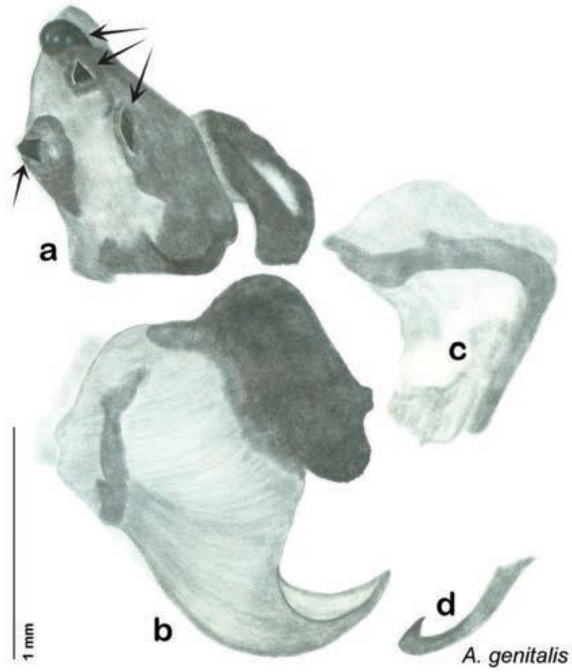


Figure 67. *A. genitalis*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

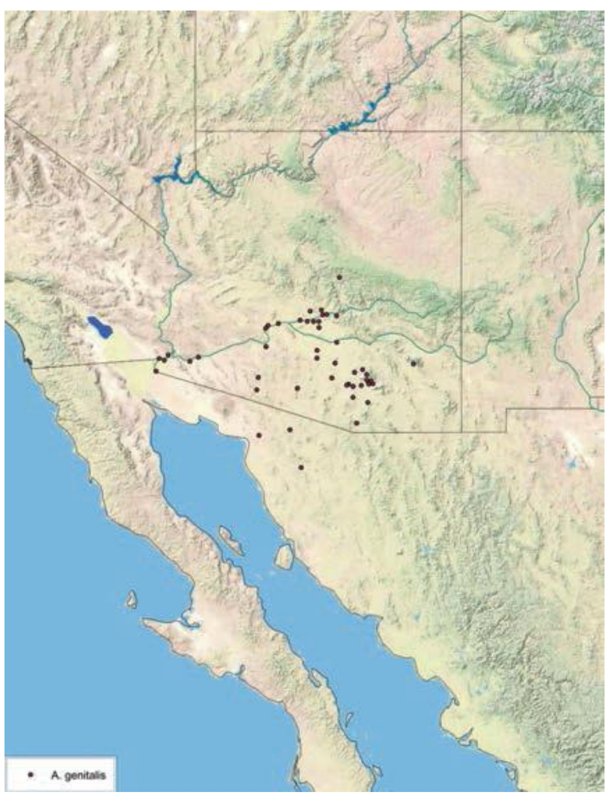


Figure 68. *A. genitalis*, distribution.

***Arenivaga grandiscanyonensis* sp. n.**

http://zoobank.org/4C6ACE63-5051-48ED-AD80-71CC3CD92053

http://species-id.net/wiki/*Arenivaga_grandiscanyonensis*

Figures 69–71

Type locality. USA, Arizona, Mohave Co., Colorado River, Grand Canyon.

Material examined. Holotype: ♂ in NAUF labeled "Mohave Co. AZ, Colorado R. GC, rm211.5R, 4/13/02, Coll. R.J.Delph, Ex: Light, Old High Water, blue label with '3'," "HOLOTYPE *Arenivaga grandiscanyonensis* Hopkins, 2012" [red label with black border].

Paratypes (2): USA: AZ, Coconino Co., Colorado River GC, 5/10/2001, J Rundall, rm160.5L, ex.light old high water, blue label '3', 1 specimen--NAU 106 (2, NAUF). All paratypes labeled "Paratype *Arenivaga grandiscanyonensis* Hopkins 2012" [blue label with black border].

Etymology. This species is named for the only place this species has been documented, the Grand Canyon.

Distribution. This species is found at the base of the Grand Canyon, Arizona. See Fig. 71.

Diagnosis. *A. grandiscanyonensis* may be confused with *A. pagana* but may be distinguished by the shagreened tongue arching anteriorly out of the central field of the right dorsal phallomere. See Figs 70 and 121.

Description. Male. Measurements. Holotype TL = 18.8 mm, GW = 9.2 mm, PW = 4.90 mm, PL = 4.28 mm, TL/GW = 2.04, PL/PW = 0.87. EW = 0.35 mm; OW = 0.30 mm. No notable differences in measurements among paratypes.

Head. Two ocelli large, ovoid and protruding (0.35 × 0.25 mm); vertex medium brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space concave, light brown, lighter brown medially, with two vertical indentations. Frons waxy white, posterior slightly concave; anterior portion of frons bulbous and waxy white; waxy white smooth anteclypeus. See Fig. 69d.

Pronotum. Pronotum translucent waxy beige; dorsal surface of pronotum with short orange-brown setae that are slightly thicker laterally; pronotal pattern orange-brown "panther face", little discernible detail; no aura. See Fig. 69c.

Body. Wing brace present. Two tarsal claws present. Legs and body pale beige; subgenital plate light brown with darker margin; asymmetrical with angular apices. See Fig. 69b.

Forewings. Wings extended well beyond abdominal apex (~30% of wing length); translucent light beige and hyaline. See Fig 69a.

Genitalia. Right dorsal phallomere composed of a bulbous lightly sclerotized bulbous lobe, articulated with right ventral phallomere on lateral side; central field with anteriorly projecting flat shagreened arm with toothed edge. Small central sclerite with smooth curved sculpturing, posterior edge flattened and shagreened with laterally projecting smooth flap; right ventral phallomere extends from articulation to form smooth rounded structure becoming lightly punctate anteriorly; attached anteriorly is broad dorsally projecting punctate arm that extends only to depth of rest of phallomere. Folded anterior portion of left phallomere finely punctate, otherwise unmodified. Genital hook with short extension to pointed head with short hook and distinct bend in arm. See Fig. 70.

Habitat and natural history. All life history elements remain unobserved.

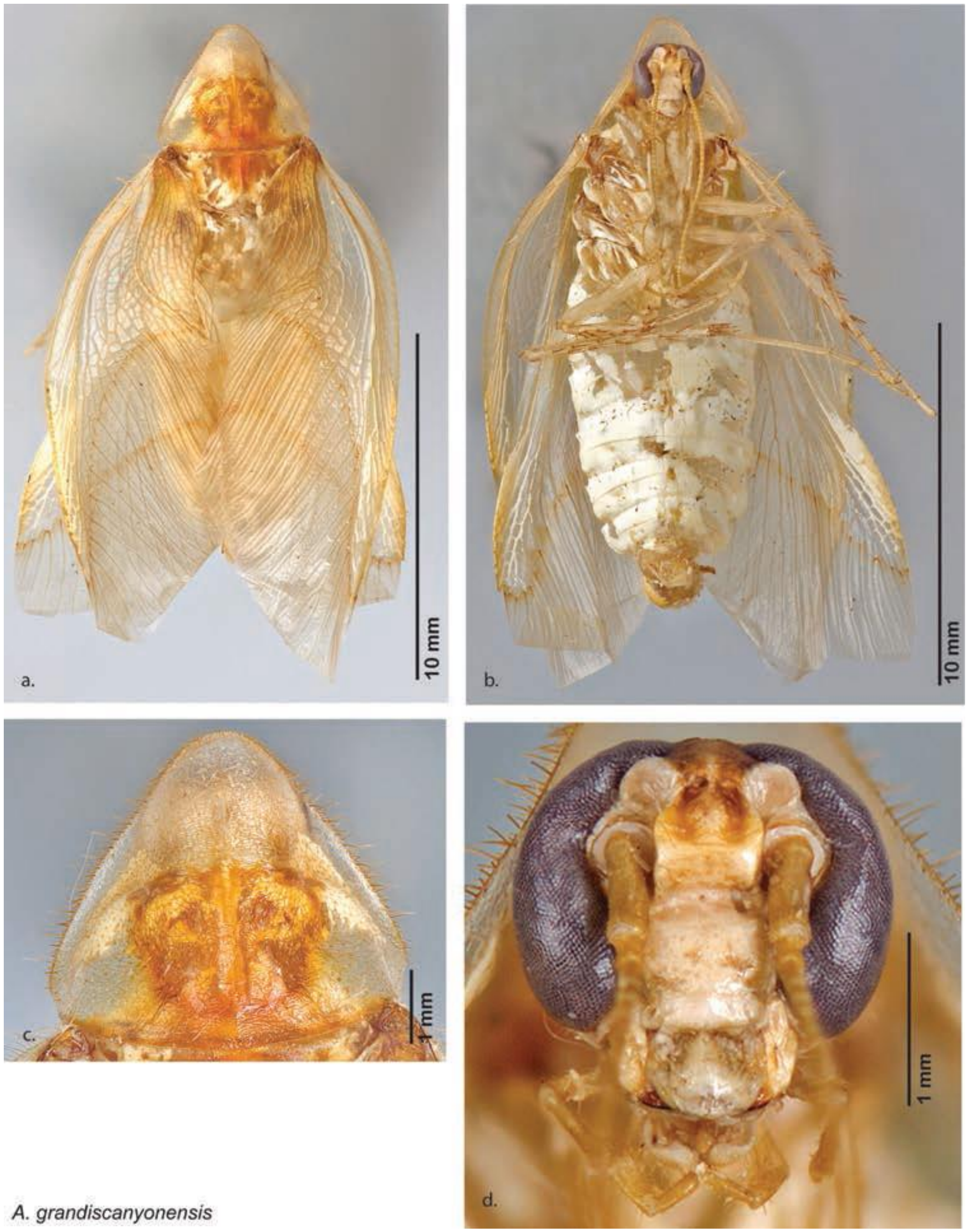


Figure 69. *A. grandiscanyonensis* a dorsal habitus b ventral habitus c pronotum d head.

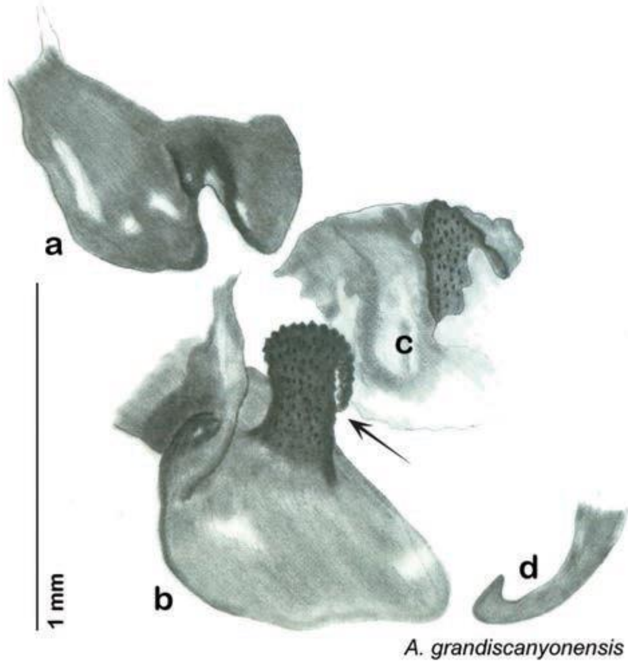


Figure 70. *A. grandiscanyonensis*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

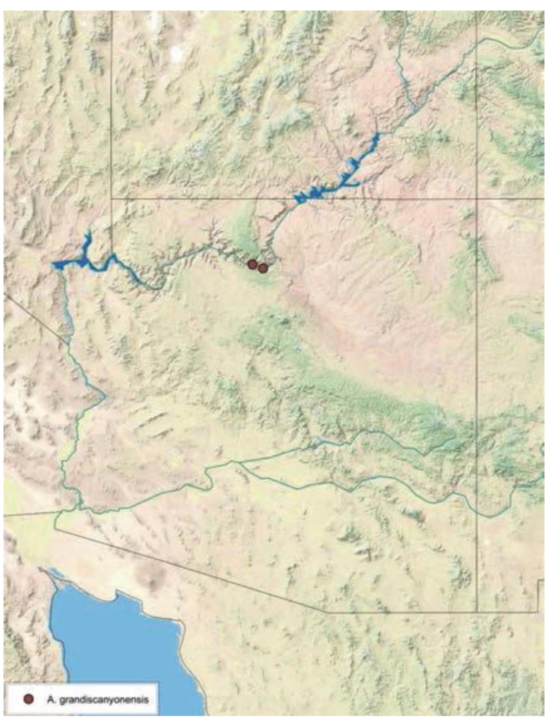


Figure 71. *A. grandiscanyonensis*, distribution.

***Arenivaga grata* Hebard**

http://species-id.net/wiki/*Arenivaga_grata*

Figures 72–74

1920 *Arenivaga grata* Hebard, Transactions of the American Entomological Society, 46(2), pp. 197–217.

Material examined (169). USA, AZ, Pima Co., Baboquivari Canyon W side of Baboquivari Mts., 7/23-27/1952, Leech & Green (2, CAS); AZ, Pima Co., Brown's Canyon E side of Baboquivari Mts., 7/29-30/1952, Leech & Green (8, CAS); AZ, Co., Miami, 8/6/1941, E.L.Todd (1, ANSP); AZ, Pima Co., Baboquivari Mts., 7/1-15/1924, 4000', O.C.Poling (23, UMMZ); AZ, Pima Co., Baboquivari Mts., 7/24/1941, L.H.Banker (1, ANSP); AZ, Pima Co., Baboquivari Mts., 11/1-15/1928, O.C.Poling (1, MCZ); AZ, Pima Co., Baboquivari Mts., 9/?/1924, 4000', O.C.Poling (1, UMMZ); AZ, Pima Co., Baboquivari Mts., 9/15-30/1923, 5000', O.C.Poling (5, UMMZ); AZ, Pima Co., Baboquivari Mts. Camp, 7/4/1970, CA & WE Triplehorn (1, OSUC); AZ, Pima Co., SASI:Tucson Mountain Park, 9/17/1998, M.Ture, UV,Blattaria,Blattidae (1, UAIC); AZ, Pima Co., Tucson, S.R.Exp.Range, 9/20/2005, A.Beyerlein (1, UAIC); AZ, Pima Co., Molino Basin Picnic Area, Catalina Mts., 8/21/1973, 4690', Garrison & Kolner, at light (1, ASUT); AZ, Cochise Co., Guadalupe Canyon, 29 mi. E of Douglas, 8/15-16/1972, J.Doyen, black light trap (1, EMEC); AZ, Santa Cruz Co., Pena Blanca Canyon, 0.4 mi. NE of Castle Rock, 9/19/1973, 4200', S.L.Szerlip, at blacklight (1, EMEC); AZ, Santa Cruz Co., Pena Blanca Lake, 8/12/1993, 31.38N 111.08W, B.V.Brown (1, LACM); AZ, Pima Co., Chutum Vaya canyon, W slope of Baboquivari Mts., 8/4/1966, 31.43N 111.37W, 3250', F.Werner family, light trap (2, UAIC); AZ, Pima Co., Tucson Mtn. Park caretaker's house, 10/19/1981, S.Pechal (1, UAIC); AZ, Pima Co., Molino Basin, Santa Catalina Mts., 7/28/1968, F.Werner (3, UAIC); AZ, Pima Co., Brown's Canyon E side of Baboquivari Mts., 8/8/1953, G.D.Butler (1, UAIC); AZ, Pima Co., Brown's Canyon E side of Baboquivari Mts., 9/6/1958, Menke & Stange (1, LACM); AZ, Pima Co., Brown's Canyon E side of Baboquivari Mts., 9/5-6/1953, L.Martin (6, LACM); AZ, Pima Co., Quinlan Mts., 9/3/1931, E.R.Tinkham (1, ANSP); AZ, Pima Co., Sabino Canyon, 9/6/1951, E.R.Tinkham (2, USNM); AZ, Pima Co., Molino Basin, Santa Catalina Mts., 8/29/1951, C.D.MacNeill (2, EMEC); AZ, Pima Co., Kits Peak, Baboquivari Mts., 8/1-4/1916, 31.57N 111.33W, 4050', (2, ANSP); AZ, Pima Co., Baboquivari Mts., 11/1-15/1923, O.C.Poling (5, UMMZ); AZ, Pima Co., Baboquivari Mts., 6/15-30/1924, 4000', O.C.Poling (11, UMMZ); AZ, Pima Co., Baboquivari Mts., 9/1-15/1923, 5000', O.C.Poling (14, UMMZ); AZ, Pima Co., Baboquivari Mts., 11/1-10/1923, O.C.Poling (1, UMMZ); AZ, Pima Co., Baboquivari Mts., 5/15-30/1924, 4000', O.C.Poling (8, UMMZ); AZ, Pima Co., Baboquivari Mts., 10/1-15/1923, O.C.Poling (2, UMMZ); AZ, Pima Co., Baboquivari Mts., 7/15-30/1924, 4000', O.C.Poling (1, UMMZ); AZ, Pima Co., Baboquivari, 6/1-15/1924, (1, UMMZ); AZ, Pima Co., Baboquivari Mts., 10/15-30/1923, O.C.Poling (4, UMMZ); AZ, Pima Co., Baboquivari Mts., F.H.Snow (1, ANSP); TX, Brewster Co., Chisos Mts. Juniper Canyon, 7/17/1928, F.M.Gaige, 238 (6, UMMZ); TX, Brewster Co., Chisos Mts. Juniper Canyon, 7/21/1928, F.M.Gaige, 237 (4, UMMZ); TX, Brewster Co., Chisos Mts. Upper Juniper Spr., 7/18-30/192?, F.M.Gaige (1, UMMZ); TX, Brewster Co., Chisos Mts. Juniper Canyon, 7/12/1928, F.M.Gaige, 183 (1, UMMZ); TX, Brewster Co., Chisos Mts. Juniper Canyon, 7/8/1928, F.M.Gaige, 150 (1, UMMZ); TX, Brewster Co., Big Bend Basin, Big Bend NP, 6/27-7/4/1965, A & M Blanchard (2, LACM); TX, Brewster Co., Chisos Mts. Below the Basin area, 10/7/1982, E.G.Riley (1, TAMU); TX, Brewster Co., BBNP Green Gulch, 8/2/2003, 29.17.19N 103.16.37W, 4900', E.G.Riley, UV light (15) (1, TAMU); TX, Brewster Co., BBNP Pine Canyon Camp Area no. 4, 10/1/2005, 29.15.59N 103.14.04W, 4700', Raber & Riley, 57 (1, TAMU); TX, Brewster Co., The Basin, Big Bend NP, 10/4/1956, J.W.MacSwain (2, EMEC); TX, Brewster Co., Big Bend NP, Chisos Mt. Basin, 5/27/1974, J.R.Powers (1, EMEC); TX, Brewster Co., Chisos Mts., 7/9-12/1948, 5260', Nutting & Werner, pinon-juniper-oak, *Arenivaga rehni* Hebard det.W.Nutting '50 (1, UAIC); MEXICO, Durango, Tlahualilo, 7/20/1934, CS Rude, 490 (2, TAMU); Durango, Tlahualilo, 7/1/1934, Mrs. CS Rude, 329 (1, TAMU); Durango, Tlahualilo, 5/27/1935, CS Rude, 1087 (1, TAMU); Durango, Tlahualilo, 7/19/1934, CS Rude, 478 (1, TAMU); Durango, Tlahualilo, 8/2/1934, CS Rude, 619 (1, TAMU); Durango, Tlahualilo, 8/16/1934, CS Rude, 891 (1, TAMU); Aguascalientes, Aguascalientes, 6/20/1953, C & P Vaurie, D.Rockefeller Mex.Exp.1953 (1, AMNH); Durango, Tlahualilo, 8/15/1934, Mrs. CS Rude, 884 (2, TAMU); Durango, Tlahualilo, 8/12/1934, CS Rude, 876 (1, TAMU); Durango, Tlahualilo, 7/9/1934, Mrs. CS Rude, 424 (1, TAMU); Durango, Tlahualilo, 8/7/1934, CS Rude, 682 (1, TAMU); Durango, Tlahualilo, 6/24/1934, CS Rude, 228 (1, TAMU); Durango, Gomez, Palacio, 5/?/1918, A.Busck. (2, USNM); Durango, Gomez, Palacio, 5/?/1918, A.Busck., *Arenivaga bolliana* Sauss. Det. A.N.C. (1, USNM); Durango, Tlahualilo, 5/15/1935, CS Rude, 1092 (1, TAMU); San Luis Potosi, Las Tablas, 10/11/1931, A Dampf (1, ANSP); Sonora, Guaymas area, Nacapule Canyon, 10/17/2003, 28.01N 111.03W, SIB 2003.0038 (1, UAIC); Chihuahua, 63 mi. W of Santa Barbara, 7/20/1947, 5500 ft., Spieth, D.Rockefeller Exp. (1, AMNH); Coahuila, San Lorenzo, 5/?/1920, SH Scudder, 1214,Palmer,ex MCZ (1, ANSP); Coahuila, 17 mi. SE of Saltillo, 7/8/1980, Taylor & Sullivan (1, LACM); Coahuila, Torreon, 6/6/1927, A. Dampf (1, ANSP); AZ, Cochise Turkey Creek, 8/11/1975, S McCleve, lite (3, FSAC); TX, Chisos Mts. Basin, 6/25/1963, GH Nelson & family, ultraviolet light (1, FSAC); Coahuila, 28 mi SW Saltillo on road to Jame, 7/18/1963, RH Arnett, Jr., ER Van Tassell, Lot No. 747 (1, FSAC); Sonora, Rancho los Alisos, 9.4 km WSW of Aconchi, Sierra Aconchi, 9/2/12, 29.79833N 110.31072 W, 1301 m, TR Van Devender, AL Reina, Rocky canyon, sycamore riparian deciduous forest, oak woodland on slopes. (2(one in alcohol), HEH). Determiner label *Arenivaga grata* Hopkins 2011" [white label with black border].

Distribution. This species is found in southeastern Arizona, with scattered records extending south into and across Mexico to the west side of the Sierra Madre Oriental, and an isolated record from far southern Texas. See Fig. 74.

Diagnosis. *A. grata* may be confused phenotypically with *A. bolliana* but their distributions are distinct. If locality information is not available *A. grata* may be diagnosed by the unusual shape of the hook-shaped lobe and the prominent shagreened ridge running interior to the point of articulation, both on the right dorsal phallomere. See Fig. 73.

Description. Male. Measurements. Holotype stand-in TL = 26.8 mm, GW = 11.5 mm, PW = 7.55 mm, PL = 5.16 mm, TL/GW = 2.33, PL/PW = 0.68. EW = 0.40 mm; OW = 0.70 mm. Among paratypes range of TL 21.4–29.2 mm; range of GW 9.5–12.8 mm; range of PW 6.36–8.35 mm; range of PL 4.22–5.38 mm.

Head. Two ocelli large, ovoid and protruding (0.50 × 0.40 mm); vertex dark brown, with small ridges between apices of eyes extending on to ocellar tubercles, scattered short setae; interocellar space concave, medium to light brown; two round medium brown indentations laterally at the base of the interocellar space. Frons light brown, slightly concave; bound on either side by ridges extending from inner apex of ocelli outwards to lateral edges of clypeus; scattered setae on ridges. Anterior portion of frons light brown, bulbous; clypeal suture demarcates light brown anteclypeus. See Fig. 72d.

Pronotum. Pronotum with translucent waxy beige anterior margin; variable length orange-brown setae along anterior margin; dorsal surface of pronotum covered with short orange-brown setae; pronotal pattern medium orange-brown “panther face”, with little detail and complete lateral and posterior aura in light orange-brown; pronotal pattern runs from light orange-brown to dark brown in other specimens, pattern always little discernible, aura always complete laterally and posteriorly. See Fig. 72c.

Body. Wing brace absent. Legs and body medium orange-brown; subgenital plate asymmetrical with posterior edge only slightly emarginated, rounded apices. See Fig. 72b.

Forewings. Wings extended beyond abdominal apex (up to ~35% of total wing length); medium orange-brown with darker blotches; color variable in species from medium orange-brown, to medium and dark brown, always blotchy; surface opaque and matte. See Fig. 72a.

Genitalia. Right dorsal phallomere composed of slightly bulbous lightly sclerotized narrow ended hook-shaped lobe with little to no curve to hook, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin straight and contiguous with medial edge of hook-shaped lobe, lightly sclerotized, smooth, with no sculpturing of any kind. Small central sclerite nondescript in shape, flat, finely punctate. Right ventral phallomere extends from articulation into posterior pointing punctate lobe with small dorsal projection on posterior end; after moderate gap, broad, punctate flange with shagreened emarginate edge, extending to depth of rest of phallomere. Genital hook with broad pointed head and moderate hook with bent tip; arm broad and smoothly curving. See Fig. 73.

Habitat and natural history. All life history elements remain unobserved.

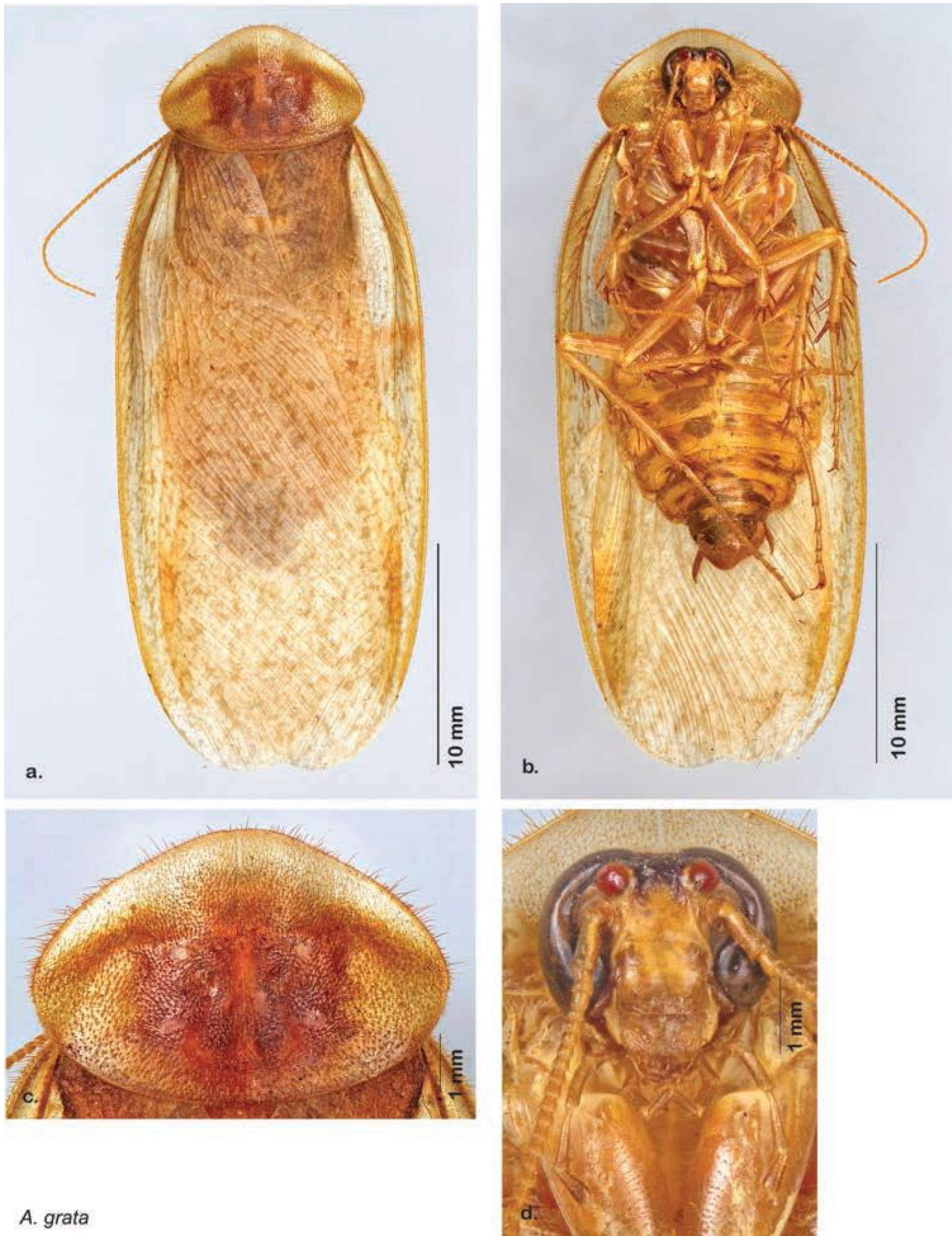


Figure 72. *A. grata* a dorsal habitus b ventral habitus c pronotum d head.

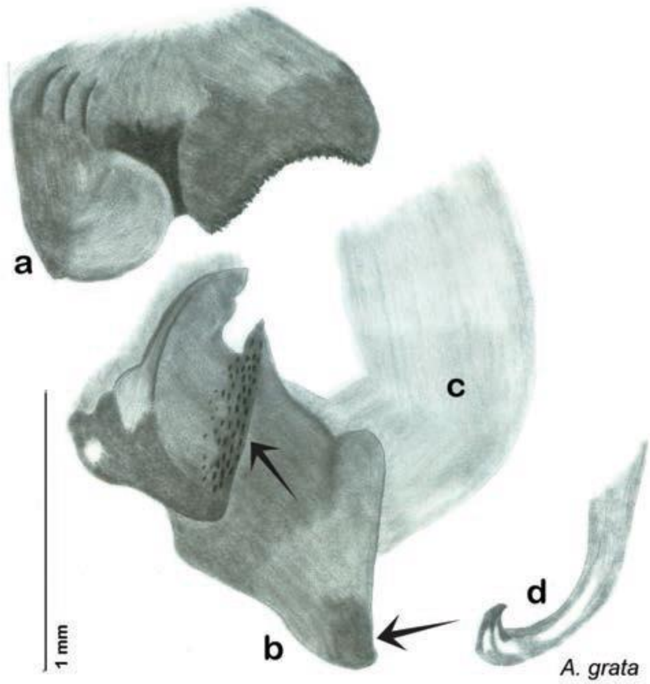


Figure 73. *A. grata*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

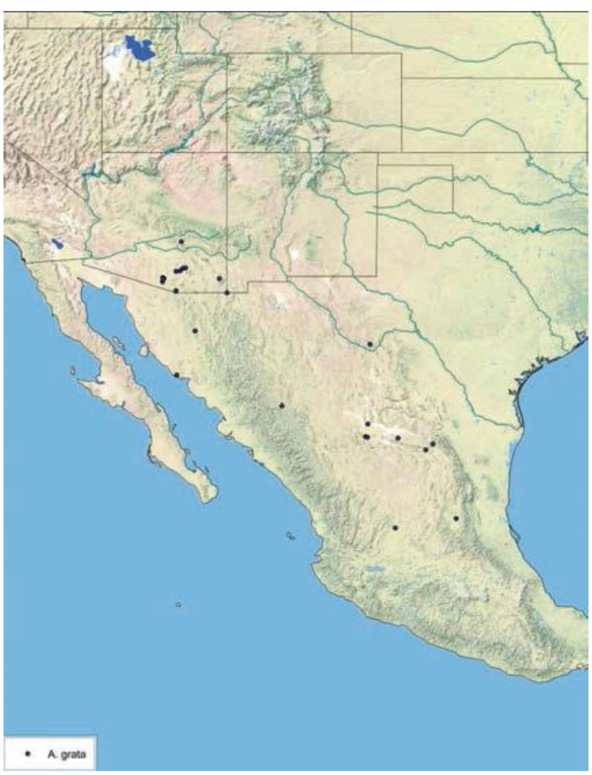


Figure 74. *A. grata*, distribution.

***Arenivaga gumperzae* sp. n.**

http://zoobank.org/E3E5D806-C42D-499E-848C-201739EECF9F

http://species-id.net/wiki/*Arenivaga_gumperzae*

Figures 75–77

Type locality. MEXICO, Durango, near Pedricena.

Material examined. Holotype: ♂ in ANSP labeled "near Pedricena, Durango, Mex, 8/27/1932, Hobart & Smith, ANS Lot 467" "HOLOTYPE *Arenivaga gumperzae* Hopkins, 2012" [red label with black border].

Paratypes (33): USA: TX, Pecos Co., 28 mi S of Ft. Stockton, 6/3/1998, R Turnbow, Blacklight (2, FSCA); TX, Kerrville, 9/?/1961 (1, TAMU); TX, Val Verde Co., Seminole Canyon State Historic Area, 8/30/1986, East, Kovarick & Haack (1, TAMU); TX, Kerrville, 9/4/1964, WF Chamberlain (1, TAMU); TX, Val Verde Co., Seminole Canyon State Historic Area, 4/1-7/1985, CB Barr, human dung pitfall (1, EMEC); TX, Presidio, 9/16/1929, ER Tinkham, (1, ANSP); TX, Pecos Co., 28 mi S of Ft. Stockton, Hwy. 385 rest stop, 4/19/1997, 30.28.57N 102.55.52W, E Riley, 469, (1, TAMU); TX, LaSalle Co., Chaparral WMA, Pasture 11, 9/11-10/10/2003, B Raber, pitfall, acacia area (1, TAMU); TX, Dimmit Co., 7/12/1940 (1, TAMU); TX, BBNP, Big Bend Basin, 6/27-7/4/1965, A & ME Blanchard (1, LACM); TX, Presidio, 3/26-5/15/1951, JH Russell, at lights (1, USNM). MEXICO: Coahuila, 5 mi. S of Monclova, 8/9/1977, EI Schlinger (1, EMEC); Coahuila, La Gloria, S of Monclova, 8/24/1947, 3300 ft., Cazier, D Rockefeller Exp. (6, AMNH); Coahuila, Torreon, 6/15/1957 (1, EMEC); Coahuila, 26 mi. E of Cuatro Cienegas, 8/2/1959, 1850 ft., TJ Cohn, #131 (4, UMMZ); Coahuila, 5 mi S of Hermanas, 8/1/1959, 1350 ft., TJ Cohn, #129 (1, UMMZ); Nuevo Leon, Monterrey, 4/23/1957, colectado por estudiante, Rockefeller Collection, return to Cantrell (2, UMMZ); Tamps, Santa Engracia, 11/2/1953, J Salazar, colectado por estudiante, Rockefeller Collection, return to Cantrell (1, UMMZ); Nuevo Leon, Monterrey, 12/12/1991, WF Chamberlain, at light (1, TAMU). All paratypes labeled "Paratype *Arenivaga gumperzae* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for the author's close friend, Linda Gumperz, who lost a short, brave battle with pancreatic cancer four days before the start of the author's PhD program. The first one is for you Linda, as promised.

Distribution. This species is distributed from Ft. Stockton, Pecos County, Texas in the north, to Pedricena, Durango, Mexico and Linares, Nuevo Leon, Mexico in the south. The western limit is Presidio, Presidio County, Texas and the eastern is Falcon State Recreation Area, Zapata County, Texas. See Fig. 77.

Diagnosis. *A. gumperzae* may be distinguished by the long posteriorly projecting extension of the medial margin of the right dorsal phallomere, which ends in a two pronged hook. See Fig. 76.

Description. Male. Measurements. Holotype TL = 19.0 mm, GW = 8.6 mm, PW = 6.3 mm, PL = 4.2 mm, TL/GW = 2.21, PL/PW = 0.67. Dimensions are average for the genus, approximating those of *A. erratica*. EW = 0.5 mm; OW = 0.4 mm. In paratypes, no notable variations in dimensions from those of holotype.

Head. Two ocelli, large, ovoid and protruding (0.4 × 0.3 mm); vertex dark brown, interocellar space deeply concave, dark brown. Frons concave, cream with pale brown edges and strongly demarcated from interocellar space; anterior frons cream, bulbous;

anteclypeus cream and smooth. See Fig. 76d.

Pronotum. Pronotum light brown; dorsal surface of pronotum covered in setae which are longer and denser anteriorly; pronotal pattern dark brown "panther face"; with scattered fine dark brown maculae; slight aural lines laterally and slight anterior aura. See Fig. 76c.

Body. Wing brace present. Two tarsal claws present. Legs and body pale brown subgenital plate asymmetrical, with rounded apices. See Fig. 76b.

Forewings. Wings extended well beyond abdominal apex (~ 50% of wing length); wings in most specimens light brown and opaque with long dark brown lines running apically from humeral angle; with scattered brown maculations. See Fig. 76a.

Genitalia. Right dorsal phallomere composed of large bulbous lightly sclerotized hook-shaped lobe, articulated with right ventral phallomere on lateral side. Posterior margin with strongly sclerotized ridge that extends towards posterior abdominal opening and ends in two hooks set at approximately right angles to each other. Small central sclerite with U-shaped structure positioned horizontally and intersecting with ridge of other phallomere. Dorsal arm of U-shaped structure longer than ventral arm, each with pointed apices. Right ventral phallomere extending from articulation to form structure rounded at posterior apex but with corrugations at anterior apical end, with rounded concave arm extending beyond depth of rest of phallomere. Left phallomere unmodified. Genital hook with moderate extension to pointed head and short hook; arm with bend. See Fig. 77.

Habitat and natural history. This species occurs in terrain that is dry, hot, and sandy. All other life history elements remain unobserved.

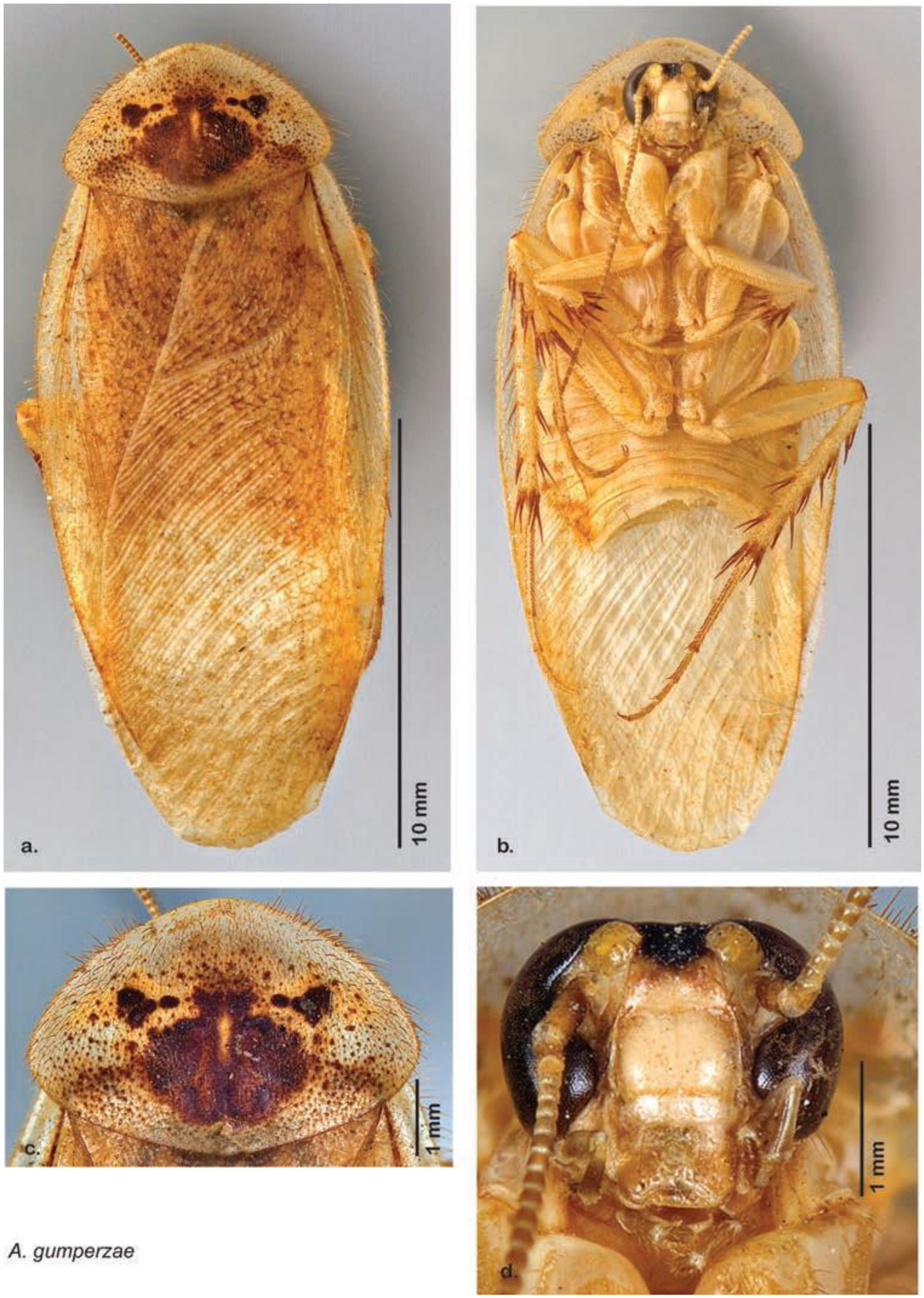


Figure 75. *A. gumperzae* a dorsal habitus b ventral habitus c pronotum d head.

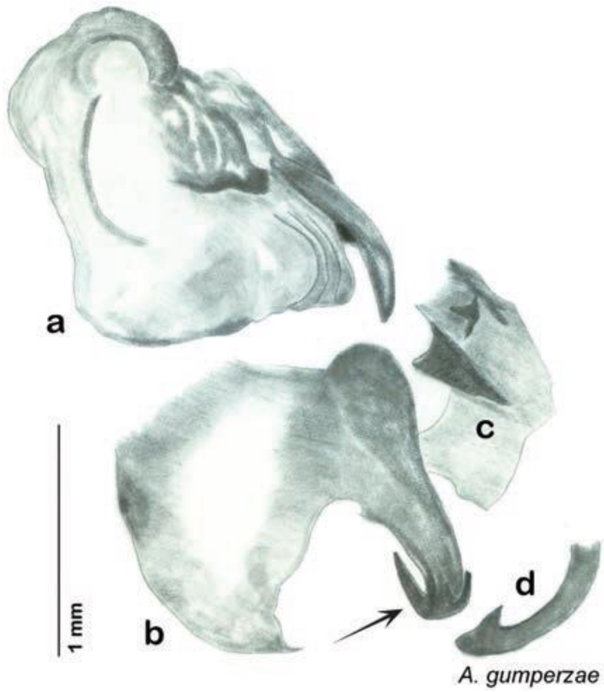


Figure 76. *A. gumperzae*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

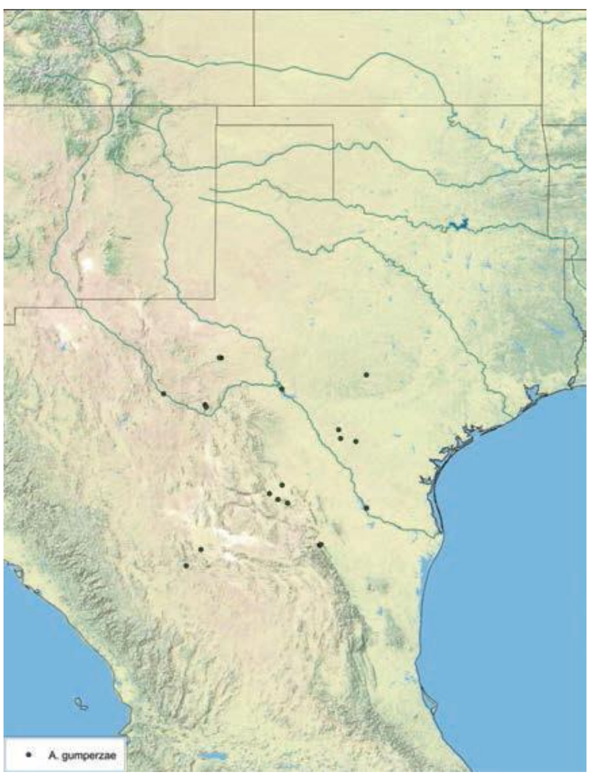


Figure 77. *A. gumperzae*, distribution.

***Arenivaga gurneyi* sp. n.**

http://zoobank.org/FAD72561-AF9D-4101-873D-56DFFE9C98A6

http://species-id.net/wiki/*Arenivaga_gurneyi*

Figures 78–80

Type locality. MEXICO, Michoacan, Acahuato.

Material examined. Holotype: ♂ in USNM labeled "Acahuato, Michoacan, MEXICO, Alt. 3000 ft., August 19, 1941, Coll. H. Hoogstraal" "HOLOTYPE *Arenivaga gurneyi* Hopkins, 2012" [red label with black border].

Paratypes (7): MEXICO: Michoacan, Acahuato, 8/19/1941, 3000 ft., H Hoogstraal (1, USNM); Michoacan, Acahuato, 8/19/1941, 3000 ft., H Hoogstraal, '035' on 2 specimens (3, ANSP); San Jose Purua [locality decision by HHopkins 2012, specimens sent to ANSP], 8/4/1947, Hodge, Data uncertain. "San Jose Purua, Mex., VII-4-1947, Hodge" but may be San Jose de Pimas in Sonora near Hermosillo. Also may belong to ANSP, as I suspect this. 3 males. ABG (3, ANSP). All paratypes labeled "Paratype *Arenivaga gurneyi* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for the late Dr. Ashley B. Gurney, who with Dr. David Nickle was the last to work on revising *Arenivaga*.

Distribution. This species is found in the state of Michoacan, Mexico. See Fig. 80.

Diagnosis. *A. gurneyi* may be distinguished by the very short hook-shaped lobe on the right dorsal phallomere and the curious shape of the medial margin on same. See Fig. 79.

Description. Male. Measurements. Holotype TL = 19.2 mm, GW = 9.8 mm, PW = 6.79 mm, PL = 4.43 mm, TL/GW = 1.96, PL/PW = 0.65. EW = 0.25 mm; OW = 0.50 mm.

Among paratypes range of TL 18.0–21.6 mm; range of GW 8.7–10.3 mm; range of PW 6.30–7.73 mm; range of PL 4.20–5.03 mm.

Head. Two ocelli, somewhat smaller and rounder than usual, ovoid and protruding (0.35 × 0.30 mm); vertex medium brown, with small ridges between apices of eyes and extending onto ocellar tubercles; interocellar space concave, medium brown. Frons light brown; posterior tectiform horizontally with fine corrugations. Anterior frons slightly bulbous, light brown; light brown anteclypeus. See Fig. 78d.

Pronotum. Pronotum translucent waxy beige; dorsal surface of pronotum with orange-brown setae, dense in some specimens; pronotal pattern impressed, medium orange-brown, with lighter or much darker orange-brown aura depending on specimen; area of pattern too dark and often too setose to discern detail. See Fig. 78c.

Body. Wing brace absent. Two tarsal claws present. Legs and body medium orange-brown; subgenital plate orange-brown; asymmetrical with rounded apices. See Fig. 78b.

Forewings. Wings extended beyond abdominal apex (up to 30% of total wing length); blotchy medium to dark brown; surface opaque and matte. See Fig. 78a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized cup, articulated with right ventral phallomere on lateral side; posterior projecting bulbous lobe entirely absent; medial edge with small smooth projection posteriorly, becoming more heavily sclerotized and punctate anteriorly, making right angle extending medially, ending in shagreened knob. Small central sclerite lightly sclerotized, finely punctate, existing only as flap attached to dorsal side of right angle and knob of dorsal phallomere. Articulation between right phallomeres deep, concave and setose, with toothed border adjacent to dorsal phallomere posterior end of which projects out to point. Right ventral phallomere consists of large punctate medially projecting lobe with central indentation; anteriorly is attached large shagreened anteriorly oriented pointed lobe. Folded anterior portion of left phallomere wide, setose, enclosed at both ends, otherwise unmodified. Genital hook widely curving to short point; arm slender. See Fig. 79.

Habitat and natural history. All life history elements remain unobserved.

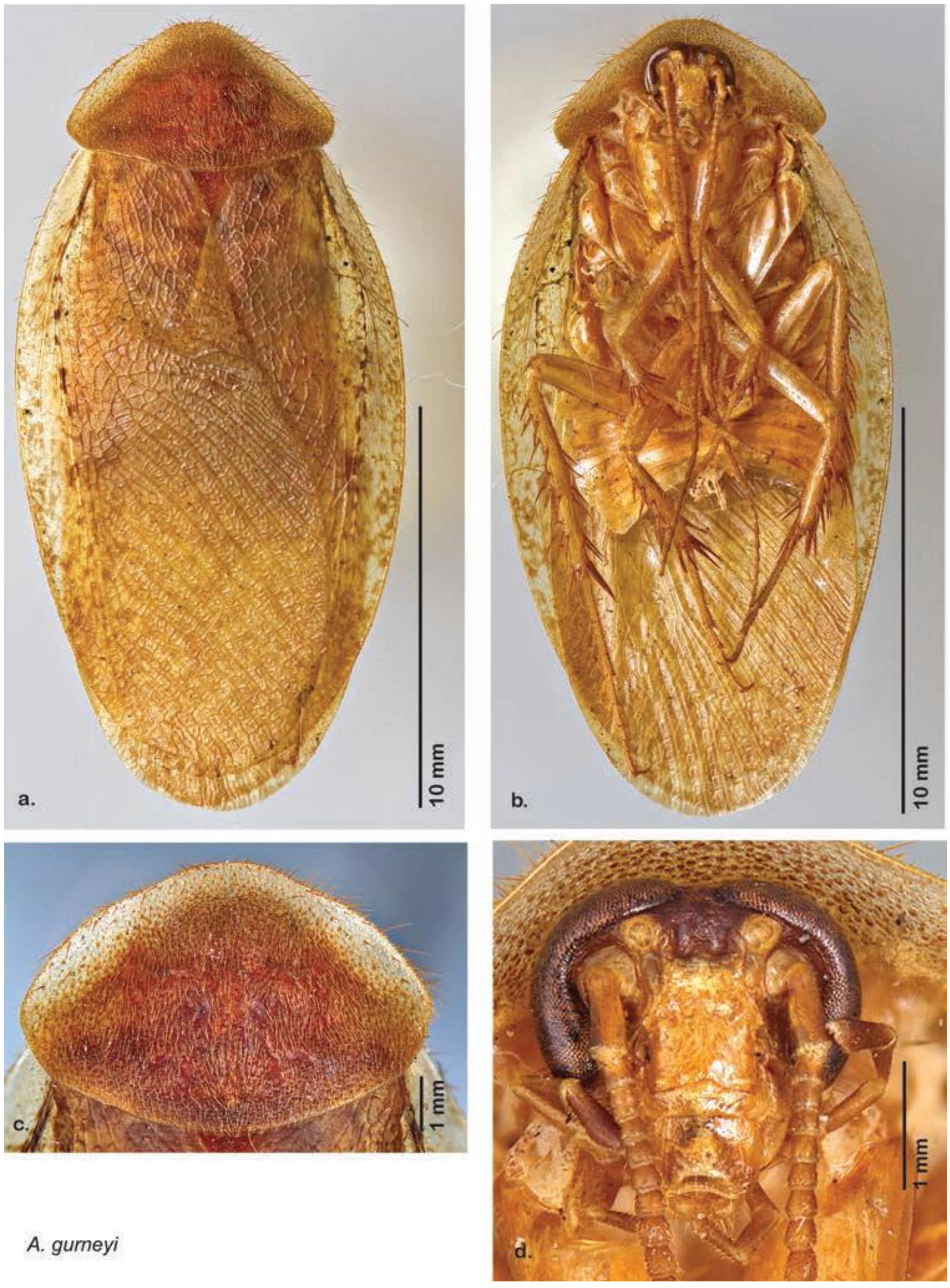


Figure 78. *A. gurneyi* a dorsal habitus b ventral habitus c pronotum d head.

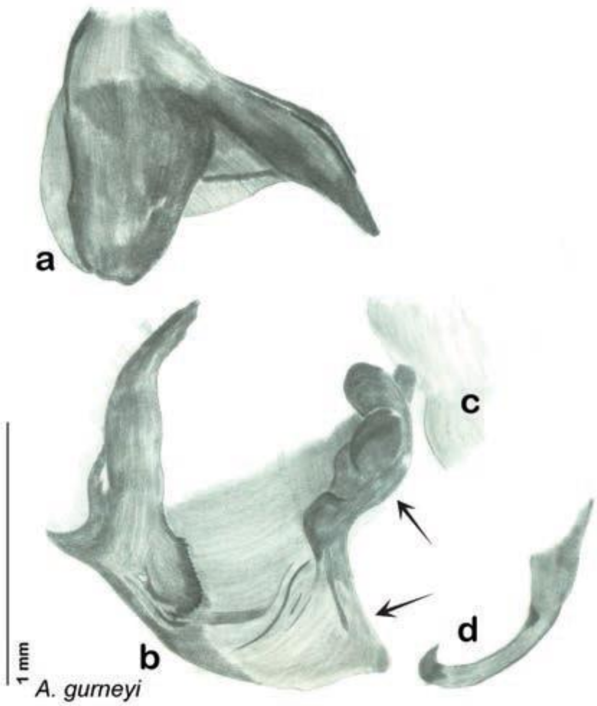


Figure 79. *A. gurneyi*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 80. *A. gurneyi*, distribution.

Arenivaga haringtoni sp. n.

http://zoobank.org/F4319ADE-81E1-462D-A5BB-0D68C2D6BE00

http://species-id.net/wiki/*Arenivaga_haringtoni*

Figures 81–83

Type locality. USA, Arizona, Mohave Co., near Kingman.

Material examined. Holotype: ♂ in NVDA labeled "2 mi NE Gold Butte, NV, Clark Co., VI-16-1988, R.C. Bechtel, J.L. Carpenter, .J.B. Knight Collectors, Black Light Trap" "HOLOTYPE *Arenivaga haringtoni* Hopkins, 2012" [red label with black border].

Paratypes (6): USA: AZ, Yuma Co., Alamo Crossing, 9/7/1959, CE Benson (1, UAIC); AZ, Mohave Co., near Kingman, 7/9/1920, OC Poling, *A.erratica* (Rehn) det. Hebard 1932 (1, ANSP); AZ, Yuma Co., (now La Paz Co.), Alamo Crossing, 9/7/193?, C.E.Benson (1, UAIC); NV, Clark Co., 2 mi NE Gold Butte, 7/14/1977, RC Bechtel, JB Knight & DF Zoller Black Light Trap (2, NVDA); NV, Clark Co., Cedar Basin, 7/22/1976, 4400 ft., RC Bechtel, JB Knight & DF Zoller, Black Light Trap (1, NVDA). All paratypes labeled "Paratype *Arenivaga haringtoni* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named in honor of Donald Harington, author of "The Cockroaches of Stay More", a priceless novel about wonderful animals.

Distribution. This species is found in west central Arizona and southeastern Nevada. See Fig. 83.

Diagnosis. *A. haringtoni* may be distinguished by its dark brown color as it is the only species of its color found in its range. If locality information is not available it may be distinguished by the long medial margin on the right dorsal phallomere, which extends posteriorly some distance beyond the rest of the phallomere. See Fig. 82.

Description. Male. Measurements. Holotype TL = 17.6 mm, GW = 8.7 mm, PW = 5.82 mm, PL = 4.04 mm, TL/GW = 2.02, PL/PW = 0.69. EW = 0.65 mm; OW = 0.45 mm. Among paratypes range of TL 16.9–18.3 mm; range of GW 7.6–10.7 mm; range of PW 5.33–6.28 mm; range of PL 4.04–4.45 mm.

Head. Two ocelli large, ovoid and protruding (0.35 × 0.25 mm); vertex dark brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; pale medial line; interocellar space concave, dark brown, light brown medially, with two oval indentations. Frons translucent beige, posterior concave; anterior portion of frons bulbous and translucent beige; translucent beige smooth anteclypeus. See Fig. 81d.

Pronotum. Pronotum translucent, waxy beige; dorsal surface of pronotum with short orange-brown setae that are thicker and longer laterally; pronotal pattern dark brown to red-brown "panther face", with some discernible detail and extensive aura, generally on all sides. See Fig. 81c.

Body. Wing brace present. Two tarsal claws present. Legs and body light brown; sternites medium brown laterally; subgenital plate light brown with darker posterior edge; asymmetrical with rounded apices. See Fig. 81b.

Forewings. Wings extended well beyond abdominal apex (~40% of wing length); color varies from uniform medium brown to blotchy medium brown; surface may be matte and opaque or translucent and lustrous. See Fig. 81a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized bulbous lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized;

medial margin more heavily sclerotized, shagreened with rough edge, very slightly arcuate centrally. Small central sclerite nearly flat, nondescript in shape, finely punctate, rugose anteriorly; right ventral phallomere extends from articulation to form smooth rounded structure becoming punctate and corrugated anteriorly; attached anteriorly is mildly dorsally projecting flanged concave punctate arm that extends beyond depth of rest of phallomere, exterior surface shagreened. Folded anterior portion of left phallomere setose and punctate, otherwise unmodified. Genital hook with long extension to pointed head, and slight indentation on moderate hook; distinct bend in arm. See Fig. 82.

Habitat and natural history. All life history elements remain unobserved.

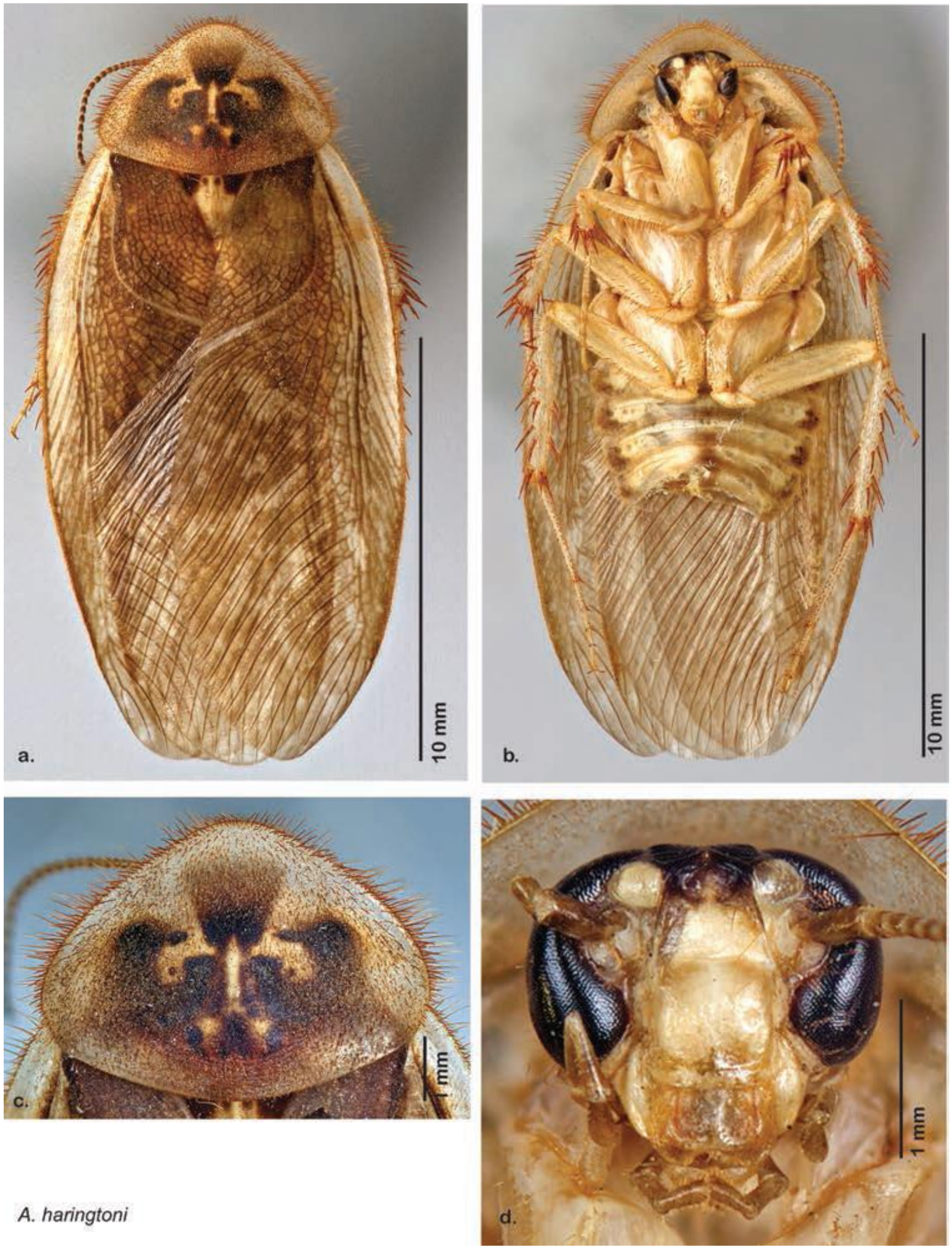


Figure 81. *A. haringtoni* a dorsal habitus b ventral habitus c pronotum d head.

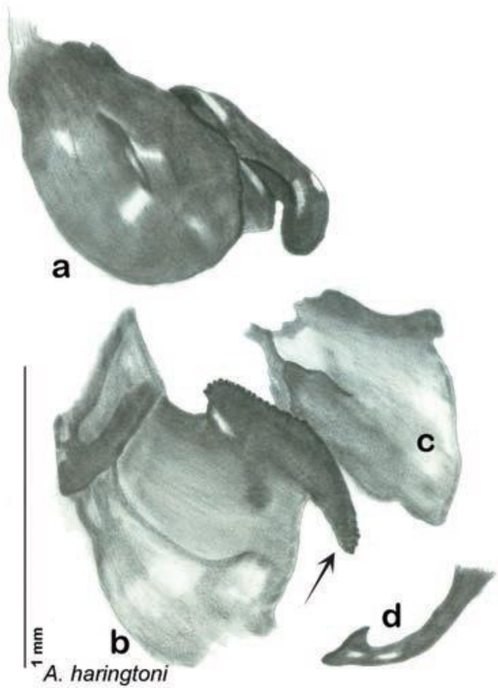


Figure 82. *A. haringtoni*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

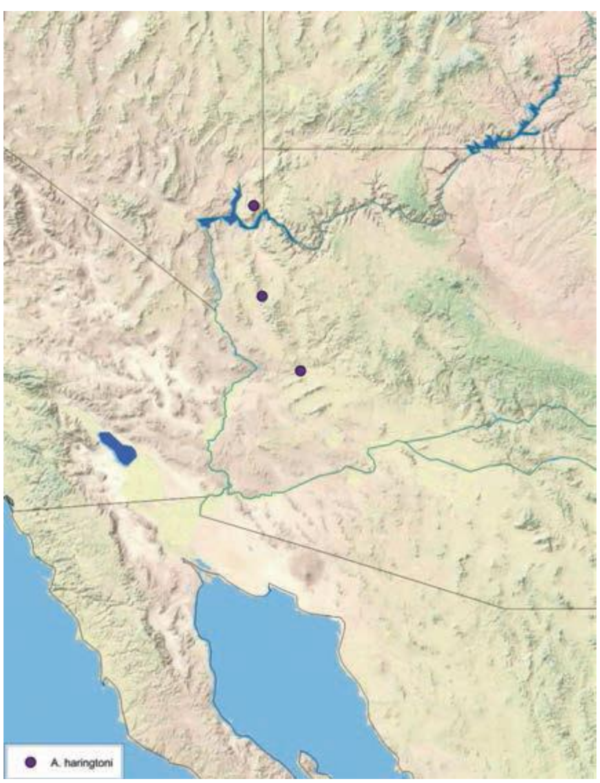


Figure 83. *A. haringtoni*, distribution.

***Arenivaga hebardi* sp. n.**

http://zoobank.org/5107CE7A-2609-4690-92B8-A16DB52E787B

http://species-id.net/wiki/*Arenivaga_hebardi*

Figures 84–86

Type locality. MEXICO, Sonora, Ciudad Obregon.

Material examined. Holotype: ♂ in UAIC labeled "CD. OBREGON, SON. MEXICO, 9-VIII-1960, at light, Wm. W. Gibson Collector" "HOLOTYPE *Arenivaga hebardi* Hopkins, 2012" [red label with black border].

Paratypes (3): MEXICO: Sonora, Obregon, 7/29/1952, C & P Vaurie (2, AMNH); Sonora, Ciudad Obregon, 8/9/1960, WW Gibson, at light (1, UAIC). All paratypes labeled "Paratype *Arenivaga hebardi* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for the great Orthoptera researcher of the early 20th century and last reviser of this genus, Morgan Hebard.

Distribution. This species is found in and around Ciudad Obregon, Sonora, Mexico. See Fig. 86.

Diagnosis. *A. hebardi* may be distinguished by the robust double hook at the posterior and of the medial margin of the right dorsal phallomere. See Fig. 85.

Description. Male. Measurements. Holotype TL = 17.7 mm, GW = 8.4 mm, PW = 5.94 mm, PL = 4.22 mm, TL/GW = 2.11, PL/PW = 0.71. EW = 0.15 mm; OW = 0.30 mm. No notable size variation among paratypes.

Head. Two ocelli large, ovoid and protruding (0.50 × 0.40 mm); vertex medium brown, with small ridges between apices of eyes and extending onto ocellar tubercles; interocellar space concave, medium brown, with arrowhead-shaped indentation. Frons light brown; posterior concave, with shallow horizontal corrugations; anterior portion of frons bulbous, light brown; wide light brown anteclypeus with medial point. See Fig. 84d.

Pronotum. Pronotum translucent waxy beige; dorsal surface of pronotum with dense very short light orange-brown setae; pronotal pattern medium orange-brown "hippo face" with some discernible detail; no aura. See Fig. 84c.

Body. Wing brace present. Two tarsal claws present. Legs and body light orangebrown; subgenital plate light orange-brown with darker border; asymmetrical with rounded apices. See Fig. 84b.

Forewings. Wings extended well beyond abdominal apex (up to ~30% of wing length); blotchy medium orange-brown; surface matte and opaque. See Fig. 84a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, broad bulbous lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized, slightly cupped; medial edge more sclerotized, smooth, with robust posteriorly projecting spine and immediately adjacent medially projecting smaller spine. Small central sclerite lightly sclerotized, finely punctate, concave, anterior end with smooth posteriorly projecting ridge; smooth flat point at dorsal end of ridge with one or two very small spines along rest of ridge. Right ventral phallomere arises from articulation to form large punctate rounded lobe, becoming more sclerotized, corrugated, shagreened and narrow anteriorly; small shagreened fold in moderate gap followed by wide dorsally flanged, concave arm, smooth to punctate, extending to slightly greater depth than rest of phallomere. Folded anterior portion of left phallomere narrow and setose, otherwise unmodified. Genital hook with short extension to pointed head; short hook; arm delicate with distinct bend. See Fig. 85.

Habitat and natural history. All life history elements remain unobserved.

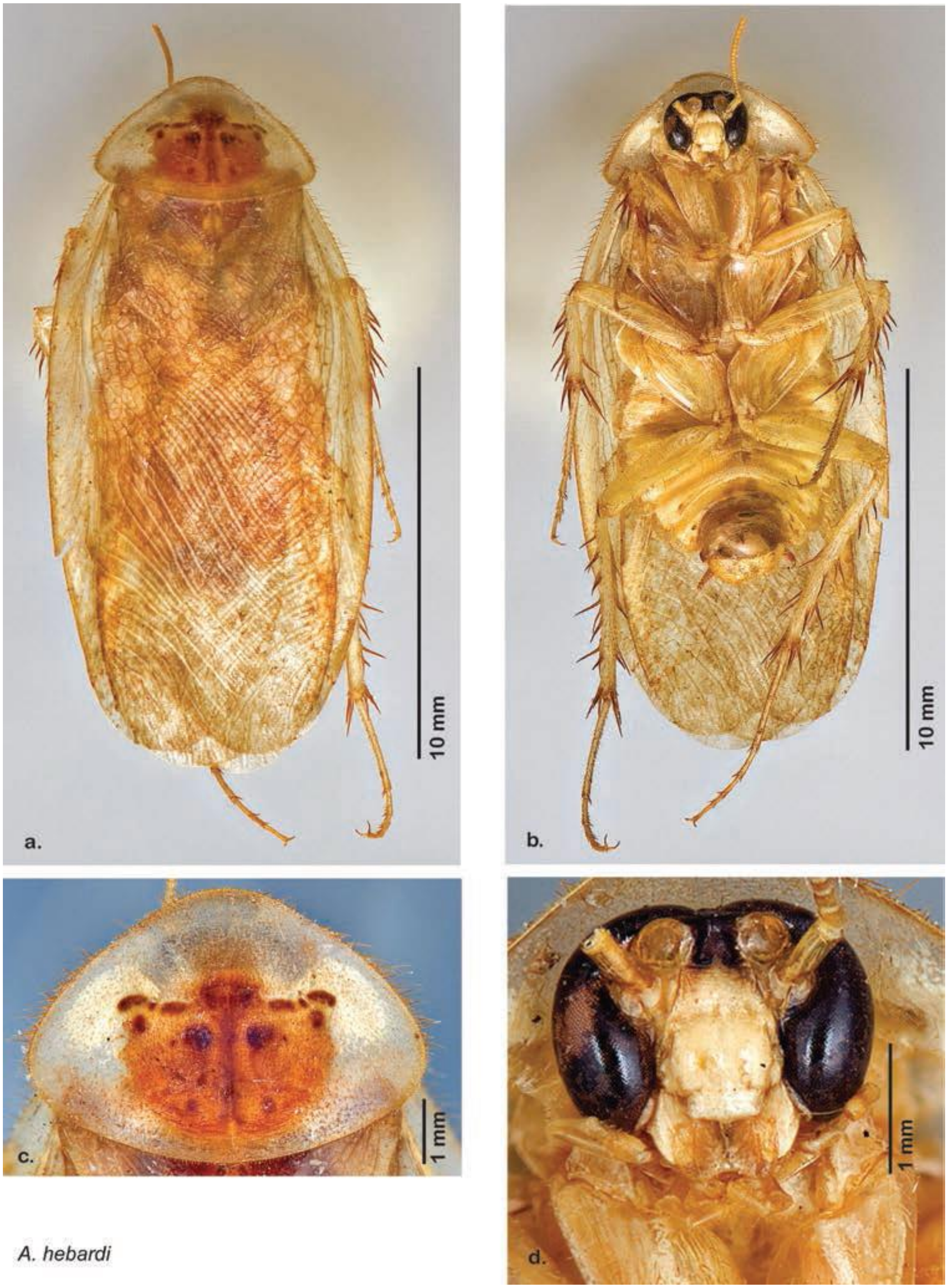


Figure 84. *A. hebardi* a dorsal habitus b ventral habitus c pronotum d head.

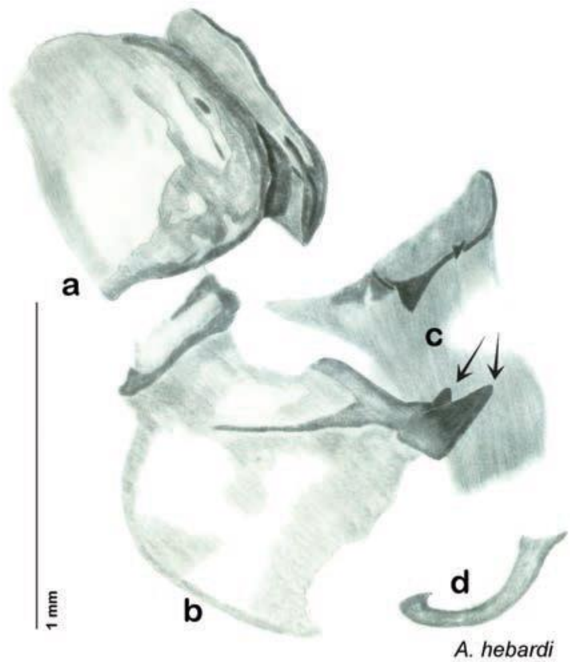


Figure 85. *A. hebardi*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 86. *A. hebardi*, distribution.

***Arenivaga hopkinsorum* sp. n.**

http://zoobank.org/12BF5D0A-3635-40A2-86DA-F80F3CD49889

http://species-id.net/wiki/*Arenivaga_hopkinsorum*

Figures 87–89

Type locality. USA, Arizona, Santa Cruz Co., Nogales.

Material examined. Holotype: ♂ in USNM labeled “Nogales, Ariz., July 9, 1965, J.E.Mills” “HOLOTYPE *Arenivaga hopkinsorum* Hopkins, 2012” [red label with black border].

Paratypes (319): USA: AZ, Pima Co., Brown Canyon, Baboquivari Mts., 9/6/1953, L Martin (3, LACM); AZ, Santa Cruz Co., Nogales, 7/15/1952, DJ & JN Knull (7, OSUC); AZ, Santa Cruz Co., Nogales, 7/7/1949, DJ & JN Knull (6, OSUC); AZ, Santa Cruz Co., Nogales, 7/7/1949, DJ & JN Knull (1, FSCA); AZ, Santa Cruz Co., Nogales, 6/7/1961, JM Kaiser, at lights (2, USNM); AZ, Santa Cruz Co., Nogales, 7/8/1961, FA Allen, 61-19807 (1, USNM); AZ, Santa Cruz Co., Nogales, 6/30/1903, Oslar, Homoeogamia apache Sauss, 8 (1, USNM); AZ, Santa Cruz Co., Patagonia, 8/7/1940, at lights (1,UCRC); AZ, Santa Cruz Co., Nogales, 6/15/1967, R Rice, under metal sheet (19, UAIC); AZ, Santa Cruz Co., Nogales, 12/3/1966, R Rice, under metal sheet (2, UAIC); AZ, Santa Cruz Co., Baboquivari Mts., 8/3/1967, Hessel & Ritchie, 46001 (1, UAIC); AZ, Pima Co., Brown Canyon, Baboquivari Mts., 8/4/1962, Werner & Johnson, UV Light trap (3, UAIC); AZ, Pima Co., Tucson, 4/3/1959, RS Beal (1, ASUT); AZ, Pima Co., Organ Pipe Cactus NM, 4/3/1966, CW Obrien, Dripping Springs at night (1, FSCA); AZ, Pima Co., Baboquivari Mts., 8/4/1966, 31.43N 111.37W, 3250 ft., Werner family, Chutum Vaya Canyon, W. slope (2, UAIC); AZ, Pima Co., Baboquivari Mts., 8/8/1988, Werner & Olson, Solano Canyon, UV (1, UAIC); AZ, Pinal Co., Jct. Hwy. 84 & I8, 7/23/2000, WB Warner, lights (1, WB Warner); AZ, Santa Cruz Co., Pena Blanca Lake, 7/9/1994, M Siner, *Arenivaga* sp. Det. B. Mathison 1994 (1, UAIC); AZ, Pima Co., Kitt Peak, 6/17/1990, 1370-2130 m, DB & BI Weissman #90-52 (2, CAS); AZ, Pima Co., Brown Canyon, Baboquivari Mts., 6/27-28/1957, at lights (2, UAIC); AZ, Pima Co., Baboquivari Mts., 4/28/1938, JA Comstock (1, LACM); AZ, Santa Cruz Co., Nogales, 7/25/1903, Oslar (1, LACM); AZ, Pima Co., Sabino Canyon, 8/12/1932, RH Beamer *Arenivaga apacha* (Sauss.) Det. Hebard 1935 (1, SEMC); AZ, Santa Cruz Co., Tumacacori Pk., Tumacacori Mts., 7/28/1948, WL Nutting, chaparral area, WLN (1, UAIC); AZ, Pima Co., Brown Canyon, Baboquivari Mts., 7/27/1948, 3800 ft., Nutting & Werner, at lights, sycamore-oak-mesquite, WLN (1, UAIC); AZ, Pima Co., Baboquivari Mts., FH Snow, *Homoeogamia erratica* Rehn (1, CSCA); AZ, Pima Co., Baboquivari Mts., 7/17/1950, RH & LD Beamer (7, SEMC); AZ, Pima Co., Brown Canyon, Baboquivari Mts., 6/8/1952, Cazier, Gertsch & Schrammel (14, AMNH); AZ, Santa Cruz Co., Nogales, 4 mi. N of Jct. Hwy.289 & I9, 7/27/1977, JD Pinto, Black light (2, UCRC); AZ, Santa Cruz Co., 12 mi. E of Nogales, 9/1/1969, PN Jump (1, LACM); AZ, Santa Cruz Co., Rio Rico, 8/5/1995, BC & WB Warner (1, WB Warner); AZ, Pima Co., Sycamore Canyon, Baboquivari Mts., 10/6-9/1910, 3700 ft., *Arenivaga apacha* (Sauss.) Hebard Collection (1, ANSP); AZ, Pima Co., Kitt Peak, Baboquivari Mts., 8/1-4/1916, 31.57N 111.33W, 4050 ft., *Arenivaga apacha* (Sauss.) Det. Hebard 1917, 1 specimen-figured 1920 (3, ANSP); AZ, Santa Cruz Co., Patagonia Mts., Solano Canyon, 8/8/1988, Werner, UV (2, UAIC); AZ, Pima Co., near Kitt Peak, Baboquivari Mts., 9/7-9/1916, 32.0N 111.36W, 3600 ft. (1, ANSP); AZ, Pima Co., Baboquivari Mts., 4/28/1925, 4500 ft., AA Nichol (1, ANSP); AZ, Santa Cruz Co., Pena Blanca Lake, 7/20/1972, 3950 ft., B Harding (2, LACM); AZ, Santa Cruz Co., Washington Mts., Nogales, 7/15/1920 (1, ANSP); AZ, Santa Cruz Co., Nogales, 6/30/1903 (1, ANSP); AZ, Pinal Co., I10 rest stop 33 mi. SE of Phoenix, 7/16/2009, W Warner, Na Lights (1, WB Warner); AZ, Pima Co., Brown Canyon, Baboquivari Mts., 7/9/1959, V Roth (1, UAIC); AZ, Pima Co., Brown Canyon, Baboquivari Mts., 6/1-15/1923, 5000 ft., O Poling (9, ANSP); AZ, Santa Cruz Co., W.slope Patagonia Mts. on Lochiel Rd., 7/28/1958, 5330 ft., W Nutting, mesquite-chaparral, WLN, 1 specimen-*Arenivaga apacha* (Sauss.) det.WL Nutting 1950 (2, UAIC); AZ, Santa Cruz Co., Cayetano Mts. near Calabasas, 2/16/1919, 3800 ft., RD Camp 2122, *Arenivaga apacha* (Saussure) 1920 det. TH Hubbell (1, UMMZ); AZ, Pima Co., Baboquivari Mts., 5/1-15/1924, OC Poling, *Arenivaga apacha* (Saussure) det. TH Hubbell 1932 (1, UMMZ); AZ, Santa Cruz Co., Nogales, 11/5/1966, R Rice, under metal sheet (1, UAIC); AZ, Santa Cruz Co., Nogales, 4/16/1966, R Rice, under metal sheet (2, UAIC); AZ, Pima Co., Baboquivari Mts., FH Snow, 1 specimen-*Arenivaga apacha* (Sauss.) det. Hebard 1926 (2,ANSP); AZ, Pima Co., Allison Dam, Fresnal Mts., Baboquivari Mts., 4/22/1923, O Poling (5, ANSP); AZ, Pima Co., Brown Canyon, Baboquivari Mts., 4/15-30/1923, 5000 ft., O Poling (10, ANSP); AZ, Santa Rita Mts., 6/12/1936, RA Flock (1, ANSP); AZ, Patagonia, 7/29/1941, RH Beamer (1, ANSP); AZ, Santa Cruz Co., Tumacacori Mts., Yanks Spring, Sycamore Canyon, 8/3/1952, Leech & Green (1, CAS); AZ, Santa Cruz Co., Patagonia Mts., 2.5 mi. W of Harshaw, 8/2/1952, Leech & Green (1, CAS); AZ, Santa Cruz, Patagonia on Sonoita Cr., 10/14/1927, JA Kusche (1, CAS); AZ, Santa Cruz Co., Washington Mts., Nogales, 7/15/1920, JA Kusche, 1 specimen-*Arenivaga apacha* (Sauss.) det. Hebard 1924 (3, CAS); AZ, Pima Co., Brown

Canyon, Baboquivari Mts., 7/29-30/1952, Leech & Green (3, CAS); AZ, Pima Co., W. side of Baboquivari Canyon, Baboquivari Mts., 7/25-27/1952, Leech & Green (3, CAS); AZ, Cochise Co., Chiricahua Mts., Cave Creek, 7/?/1927, 6-9800 ft., JA Kusche (1, CAS); AZ, Huachuca Mts., 8/20/1903, Oslar, Univ. of Kan. Lot 968 (2, ANSP); AZ, Santa Cruz Co., Nogales, 6/28/1957, Spitzer, 57 10547 (1, USNM); AZ, Santa Cruz Co., Nogales, 7/10/1947, Byers, 47 10508 (1, USNM); AZ, Santa Cruz Co., Nogales, 6/17/1903, Oslar (1, USNM); AZ, Santa Cruz Co., Nogales, 8/23/1903, Oslar (1, USNM); AZ, Pima Co., Baboquivari Mts., 9/1-15/1923, 5000 ft., OC Poling, 13 specimens-*Arenivaga apacha* (Saussure) det. TH Hubbell 1932 (14, UMMZ); AZ, Pima Co., Baboquivari Mts., 5/15-30/1924, 4000 ft., OC Poling, 4 specimens-*Arenivaga apacha* (Saussure) det. TH Hubbell 1931/2 (35, UMMZ); AZ, Pima Co., Baboquivari Mts., 5/1-15/1924, OC Poling, 14 specimens-*Arenivaga apacha* (Saussure) det. TH Hubbell 1932 (15, UMMZ); AZ, Pima Co., Baboquivari Mts., 6/15-30/1924, 4000 ft., OC Poling, *Arenivaga apacha* (Saussure) det. TH Hubbell 1932 (4, UMMZ); AZ, Pima Co., Baboquivari Mts., 9/?/1924, 4000 ft., OC Poling, 2 specimens-*Arenivaga apacha* (Saussure) det. TH Hubbell 1932 (3, UMMZ); AZ, Pima Co., Baboquivari Mts., 7/1-15/1924, 4000 ft., OC Poling (1, UMMZ); AZ, Pima Co., Baboquivari Mts., 11/1-15/1923, OC Poling, *Arenivaga apacha* (Saussure) det. TH Hubbell 1932 (1, UMMZ); AZ, Pima Co., Baboquivari Mts., 10/?/1924, 4-5000 ft., OC Poling (1, UMMZ); AZ, Pima Co., Baboquivari Mts., 6/1-15/1924, OC Poling (1, UMMZ); AZ, Pima Co., Baboquivari Mts., 9/15-30/1923, OC Poling, *Arenivaga apacha* (Saussure) det. TH Hubbell 1932 (2, UMMZ); AZ, Santa Cruz Co., Pena Blanca, Oro Blanco Mts., 5/27/1963, LM Martin (1, LACM); AZ, Santa Cruz Co., Pena Blanca, Oro Blanco

Mts., 8/2/1960; LM Martin (1, LACM); AZ, Pima Co., Baboquivari Mts., 4/24/1938, JA Comstock (1, LACM); AZ, Pima Co., Ajo, 3/25/1923, O Poling (1, ANSP); CA, San Bernardino, dry bed Mojave R. 6 mi. E of Yermo, 8/27/1952, Leech & Green (1, CAS); MEXICO: Sonora, Hermosillo, 6/21/1957, Chemsak & Rannells, at light (8, EMEC); Sonora, San Carlos, Caracol Penn., 5/19/2003, 27.57N 111.03W, SIB 2003.0000, blue tag 9000 (2, UAIC); Sonora, NW San Carlos near Rancho Palo Fiero, 5/20/2003, 27.58N 111.05W, SIB2003.0010, blue tag 9000 (2, UAIC); Sonora, Aconchi Rio Sonora, dry wash, 6/12/1982, Olson, Thomas & Burne (2, UAIC); Sonora, Hermosillo, 7/9-16/1953, B Malkin (1, CAS); Sonora, 5 mi. S of Santa Ana,

7/10/1970, B & R Harding (2, LACM); Sonora, Pitiquito, 7/4/1952, C & P Vaurie (1, ANSP); Sonora, 5 mi. NE of Magdalene, 9/27/1953, ER Tinkham (1, USNM); Sonora, Desemboque, 8/1-15/1953, B Malkin (39, CAS); Sonora, Desemboque, 7/17-31/1953, B Malkin (4, CAS); Sonora, Desemboque, 9/1-10/1953, B Malkin (5, CAS); Sonora, Desemboque, 8/20-31/1953, B Malkin (2, CAS); Sonora, Tiburon Island (north end), 7/10/1952, C & P Vaurie (2, AMNH); Sonora, Tiburon Island (south end), 7/13/1952, C & P Vaurie (3, AMNH); Sonora, Puerto Libertad, 2/3/1935, N Bloomfield (1, SDMC). All paratypes labeled "Paratype *Arenivaga hopkinsorum* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for my parents, Richard and Alberta Hopkins, with deep gratitude for an extraordinary childhood; and all the encouragement since.

Distribution. This species is found in northwestern Sonora, Mexico and southeastern and south central Arizona. The lone specimen from southern California is believed to have an incorrect label or carried there by an outside agent. See Fig. 89.

Diagnosis. *A. hopkinsorum* may be confused with *A. adamsi* but can be distinguished by the presence of two large spines (and occasionally a small third spine) on the medial margin of the right dorsal phallomere. See Figs 88 and 13.

Description. Male. Measurements. Holotype TL = 18.3 mm, GW = 9.2 mm, PW = 6.10 mm, PL = 4.07 mm, TL/GW = 1.99, PL/PW = 0.67. EW = 0.30 mm; OW = 0.40 mm. Among paratypes range of TL 15.5–22.3 mm; range of GW 7.6–10.3 mm; range of PW 5.25–6.63 mm; range of PL 3.85–4.49 mm.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm); vertex dark brown with small ridges in rays around upper apex of eyes and extending onto ocellar tubercles; interocellar space concave, dark brown, lighter brown anteriorly, with horizontal indentation. Frons waxy white, posterior concave; anterior portion of frons bulbous and waxy white; waxy white smooth anteclypeus. See Fig. 87d.

Pronotum. Pronotum opaque, light brown; dorsal surface of pronotum with short orange-brown setae that are thicker and longer laterally; pronotal pattern dark brown "panther face", in some specimens so dark as to obscure detail; slight lateral and anterior aura. See Fig. 87c.

Body. Wing brace present. Two tarsal claws present. Legs and body light brown; sternites of many specimens with fine brown line and brown maculations laterally; subgenital plate light brown; asymmetrical with particularly deep central emargination and angular apices. See Fig. 87b.

Forewings. Wings extended well beyond abdominal apex (up to 50% of wing length); blotchy medium to dark brown depending on specimen; surface matte and opaque. See Fig. 87a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized bulbous hookshaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin more heavily sclerotized, narrow with two prominent spines. Small central sclerite deeply concave, punctate, with two sclerotized, punctate lobes on ventral wall; right ventral phallomere extends from articulation to form smooth rounded structure, punctate, with prominent medially projecting spine located posteriorly; attached anteriorly and at an acute angle is mildly dorsally projecting narrowly flanged concave punctate arm that extends beyond depth of rest of phallomere. Folded anterior portion of left phallomere dramatically modified with sclerotized anterior wall and posteriorly projecting spine located ventrally. Genital hook with moderate extension to pointed head with short hook; arm smoothly curving. See Fig. 88.

Habitat and natural history. All life history elements remain unobserved.

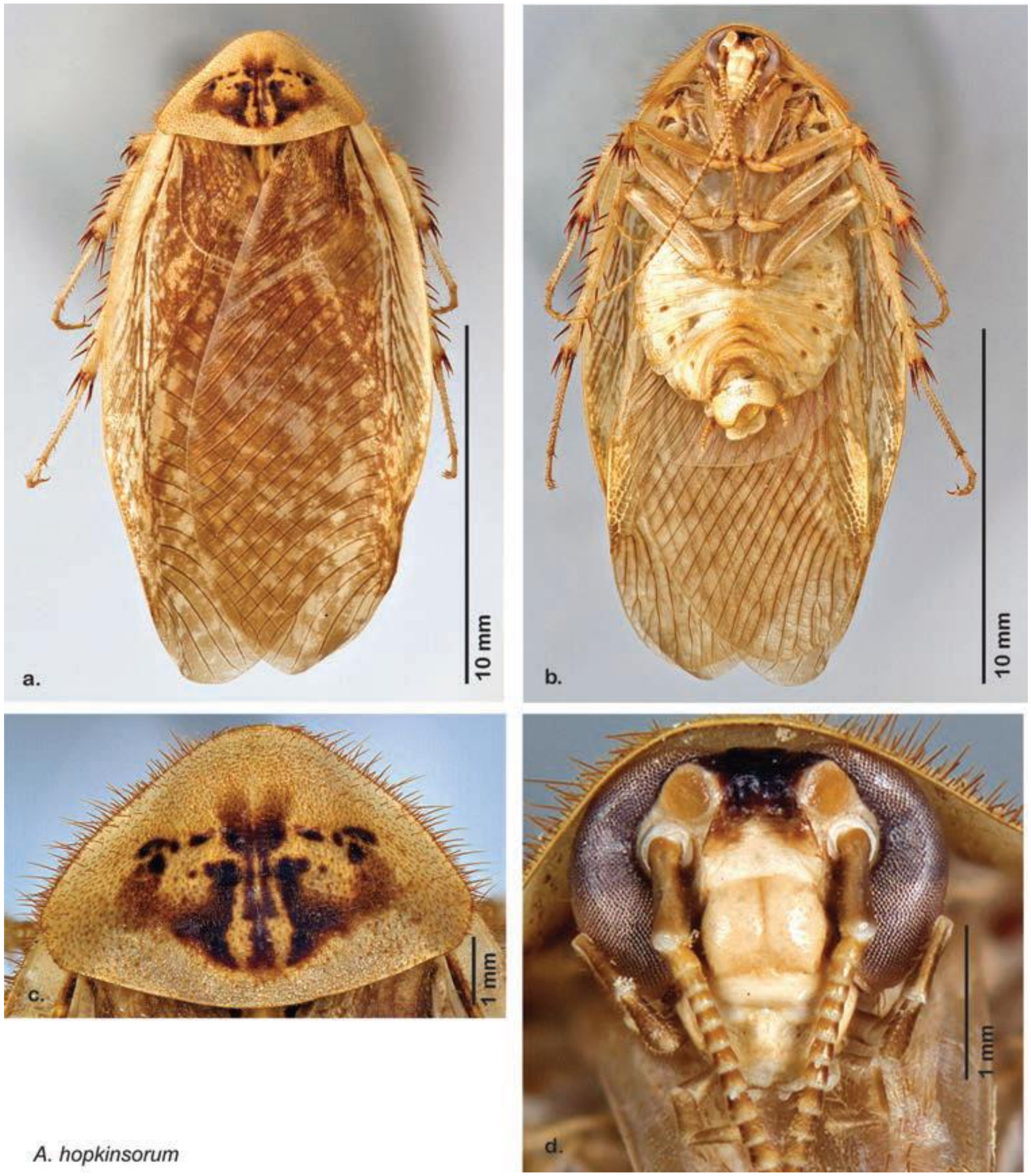


Figure 87. *A. hopkinsorum* a dorsal habitus b ventral habitus c pronotum d head.

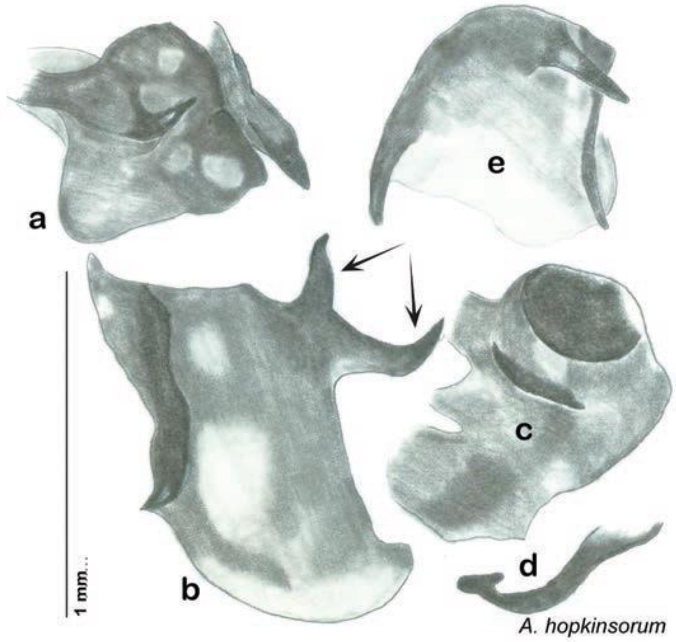


Figure 88. *A. hopkinsorum*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook e left phallomere. Arrow(s) indicate diagnostic characters (see text).

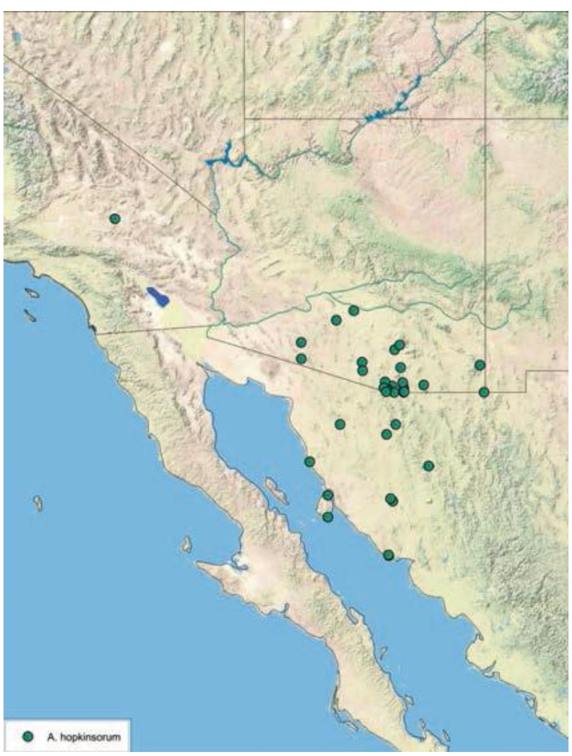


Figure 89. *A. hopkinsorum*, distribution.

***Arenivaga hypogaios* sp. n.**

http://zoobank.org/EBD47441-6E8C-438D-B164-CA6EC82E1D4E

http://species-id.net/wiki/*Arenivaga_hypogaios*

Figures 90–92

Type locality. MEXICO, Coahuila, 15 mi N San Pedro de las Colonias.

Material examined. Holotype: ♂ in USNM labeled "MEX: Coahuila 15 miles N of San Pedro de las Colonias, 2 Jul 1959, E.R.T." "HOLOTYPE *Arenivaga hypogaios* Hopkins, 2012" [red label with black border].

Paratypes (12): MEXICO: San Luis Potosi, Nunez 22 mi. NE of Villa Hidalgo, 8/27/1959, 4900 ft., Cohn & Cantrall, #37 (1, UMMZ); Coahuila, 15 mi. N of San Pedro de Las Cobrias, 7/2/1959, ERT (2, USNM). USA: TX, Terrel Co., Lozier Canyon, 7/8/1948, WL Nutting, *Arenivaga* sp. near *rehni*?, Det. WL Nutting 1950 (2, USNM). All paratypes labeled "Paratype *Arenivaga hypogaios* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the nominative singular. This species is named from the Greek meaning underground, in recognition of its subterranean life.

Distribution. This species is found from the central Texas-Mexico border south through central Mexico including the states of Coahuila and San Luis Potosi. See Fig. 92.

Diagnosis. *A. hypogaios* may be confused with *A. florilega* and *A. galeana* but may be distinguished by the difference in genital hooks, and the narrower anterior arm in *A. hypogaios* on the right ventral phallomere. *A. hypogaios* also has a ridge of serrations on the lateral side of the open field of the right dorsal phallomere which is not present in *florilega* or *galeana*. See Figs 91, 58 and 64.

Description. Male. Measurements. Holotype TL = 23.0 mm, GW = 9.7 mm, PW = 6.92 mm, PL = 4.82 mm, TL/GW = 2.37, PL/PW = 0.70. EW = 0.20 mm; OW = 0.50 mm. Among specimens examined range of TL 17.4–23.0; range of GW 8.2–9.7; range of PW 6.34–6.92; range of PL 4.45–4.82.

Head. Two ocelli large, ovoid and protruding (0.50 × 0.40 mm); vertex dark brown, with small ridges between apices of eyes and extending onto ocellar tubercles; interocellar space concave, dark brown. Posterior frons light brown, tectiform horizontally then concave; anterior frons light brown, bulbous; light brown anteclypeus. See Fig. 90d.

Pronotum. Pronotum translucent waxy beige with dark brown posterior border; dorsal surface of pronotum with short orange-brown setae; pronotal pattern dark brown “hippo face”; impressed, no discernible detail; no aura. See Fig. 90c.

Body. Wing brace very small to absent. Two tarsal claws present. Legs and body light orange-brown; subgenital plate light orange-brown; asymmetrical with rounded apices. See Fig. 90b.

Forewings. Wings extended beyond abdominal apex (up to 40% of total wing length); light brown with widely scattered blotches medium orange-brown to medium brown; surface opaque and matte, or with slight sheen. See Fig. 90a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, long, bulbous lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized, deeply cupped; very short punctate medial edge, short shagreened ridge on lateral side of cup. Small central sclerite lightly sclerotized, finely punctate, flat; posterior end connecting with dorsal side of right dorsal phallomere. Articulation between right phallomeres extends into right ventral phallomere consisting of punctate to shagreened medially projecting lobe that is medially flattened; anteriorly moderate gap followed by small shagreened flange open-ended anteriorly. Folded anterior portion of left phallomere wide, with dense, short setae medially, otherwise unmodified. Genital hook with short extension to pointed head and short, wide hook; arm robust with distinct bend. See Fig. 91.

Habitat and natural history. All life history elements remain unobserved.

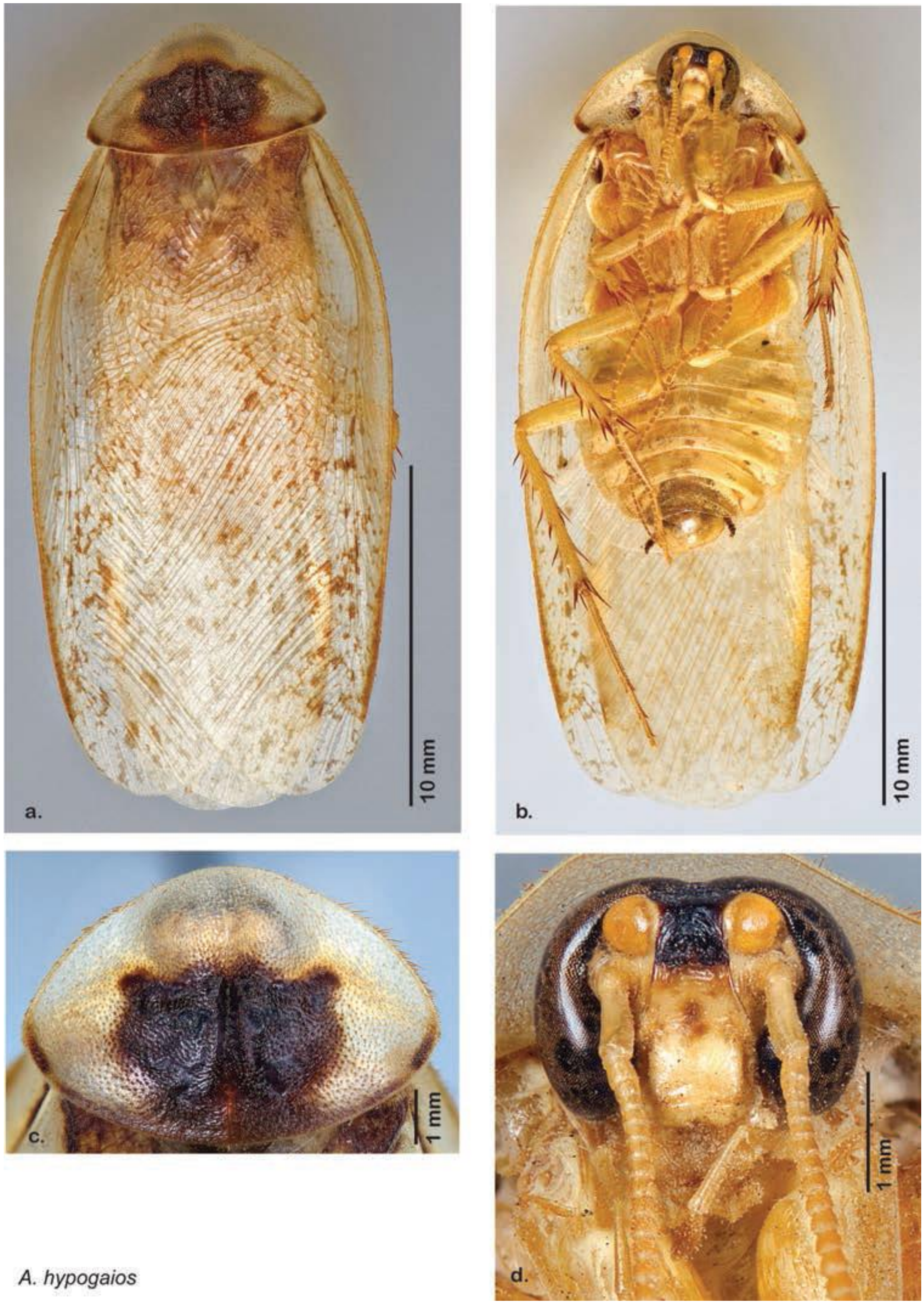


Figure 90. *A. hypogaios* a dorsal habitus b ventral habitus c pronotum d head.

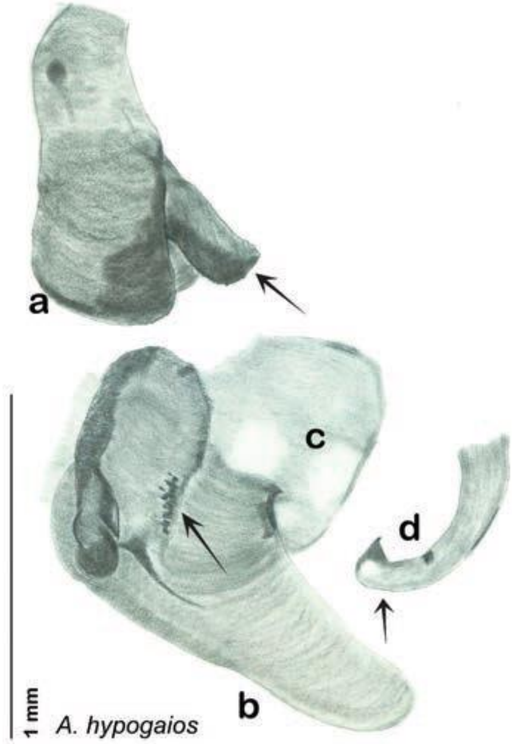


Figure 91. *A. hypogaios*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 92. *A. hypogaios*, distribution.

***Arenivaga impensa* sp. n.**

http://zoobank.org/CA7785A1-33E2-4BB6-B4B3-0ABA6CD93288

http://species-id.net/wiki/*Arenivaga_impensa*

Figures 93–95

Type locality. USA, Arizona, Kingman.

Material examined. Holotype: ♂ in ANSP labeled "Kingman, Ariz. IX-10-1920 (O.C. Poling)" "HOLOTYPE *Arenivaga impensa* Hopkins, 2012" [red label with black border].

Paratypes (14): USA: AZ, Oak Creek Canyon, 4 mi. N of Sedona, 8/24/1966, RS Beal (1, NAUF); AZ, Indian Garden, Grand Canyon, 7/24/1934, 3800 ft., EL Bell & FE Lutz (2, AMNH); AZ, Coconino Co., Grand Canyon, 6/18/1954, M Cazier (1, AMNH); AZ, Coconino Co., Midgley Bridge, Oak Creek Canyon, 8/25/1952, Leech & Green (1, CAS); AZ, Mohave Co., Hualapai Mts., 7/15/1920, OC Poling (1, ANSP); AZ, Coconino Co., West Fork, Oak Creek Canyon, 9/19/1979, MW Sanderson, A79-31 (1, NAUF); AZ, Yavapai Co., WCCER, 8/18/2007, 34.92N 112.834W, S Dorr 1 (1, NAUF); AZ, Yavapai Co., Grasshopper Flat, 8/6/1964, TL Bedwell (1, NAUF); AZ, Sawmill Canyon, Hualapai Mts., 8/30/1919, OC Poling (1, ANSP). All paratypes labeled "Paratype *Arenivaga impensa* Hopkins 2012" [blue label with black border].

Etymology. The name is an adjective in the nominative singular. This species is named from the Latin meaning ample, large, or strong because of its large size for *Arenivaga*.

Distribution. This species is found in the northwestern corner of Arizona. See Fig. 95.

Diagnosis. The external phenotype of *A. impensa* may be confused with *A. tonkawa* but the genitalia distinguished them. *A. impensa* has a narrower hook-shaped lobe than *tonkawa* and the structures of the medial margin of the right dorsal phallomere are very different. See Figs 94 and 148.

Description. Male. Measurements. Holotype TL = 24.0 mm, GW = 11.1 mm, PW = 7.56 mm, PL = 5.23 mm, TL/GW = 2.16, PL/PW = 0.69. EW = 0.45 mm; OW = 0.60 mm. Among paratypes range of TL 18.7–24.6; range of GW 9.0–11.8; range of PW 6.73–8.14; range of PL 4.40–5.23.

Head. Two ocelli large, ovoid and protruding (0.45 × 0.40 mm); vertex brown with small ridges in rays around upper apex of eyes and extending onto ocellar tubercles; interocellar space only slightly concave, brown, with three small round indentations at points of an equilateral triangle. Posterior frons concave, brown grading into waxy beige, with horizontal corrugations; anterior portion of frons bulbous and waxy beige; waxy beige smooth anteclypeus. See Fig. 93d.

Pronotum. Pronotum large, translucent waxy beige; dorsal surface of pronotum with short orange-brown setae that are thicker and longer laterally; pronotal pattern orange-brown “panther face”, with little discernible detail; no aura. See Fig. 93c.

Body. Wing brace present. Two tarsal claws present. Legs and body light brown; some specimens with brown maculations laterally on each sternite; subgenital plate orange-brown; asymmetrical with rounded apices. See Fig. 93b.

Forewings. Wings extended well beyond abdominal apex (~35% of wing length); blotchy orange-brown to medium brown; surface opaque and matte. See Fig. 93a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized bulbous hook-shaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized with deep open rectangular area posterior-medially; medial margin more heavily sclerotized, with short toothed region at posterior end, and prominent flat spine adjacent, remainder of margin uneven. Small central sclerite with uneven margins nearly flat and finely punctate; anterior end bent posteriorly, shagreened with uneven toothed edge; right ventral phallomere extends from articulation to form smooth rounded structure, punctate, corrugated and narrowed anteriorly; attached anteriorly is mildly dorsally projecting flanged concave punctate arm that extends beyond depth of posterior portion of phallomere. Genital hook with moderate extension to rounded head with moderate hook; arm delicate with distinct bend. See Fig. 94.

Habitat and natural history. All life history elements remain unobserved.

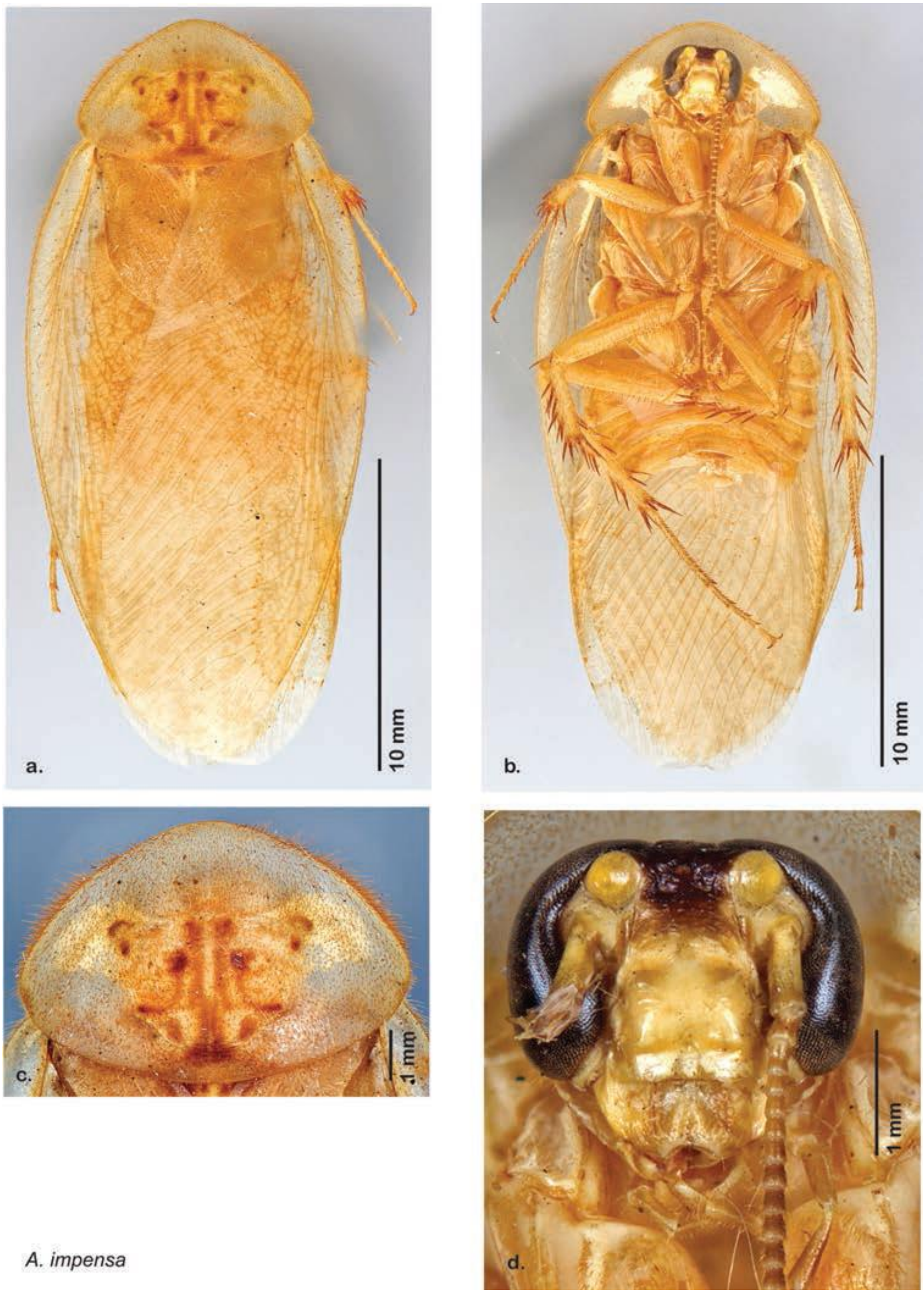


Figure 93. *A. impensa* a dorsal habitus b ventral habitus c pronotum d head.

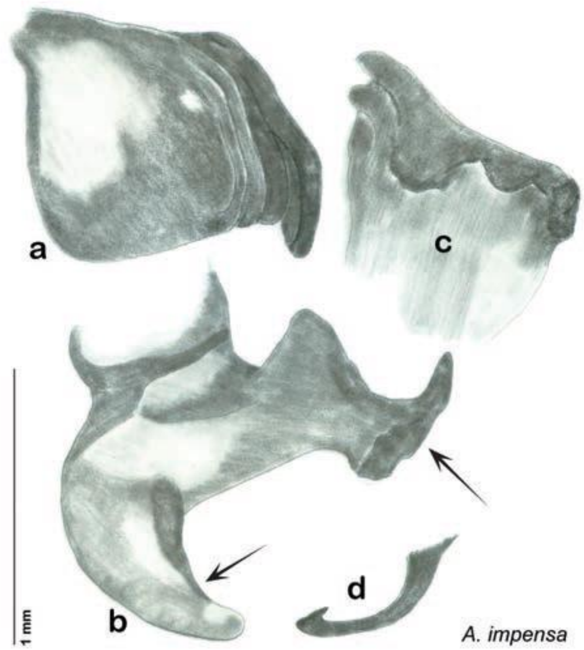


Figure 94. *A. impensa*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

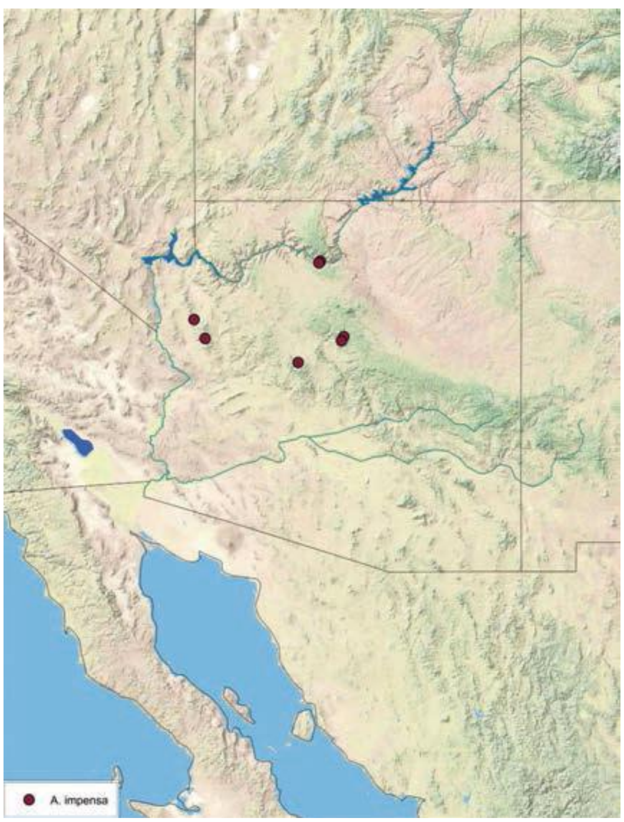


Figure 95. *A. impensa*, distribution.

***Arenivaga investigata* Friauf & Edney**

http://species-id.net/wiki/*Arenivaga_investigata*

Figures 96–98

1969 *Arenivaga investigata* Friauf and Edney, Proceedings of the Entomological Society of Washington, 20(7), pp. 154–156.

Neotype locality. USA, California, Riverside County, Windy Point.

Material examined (811). Neotype: ♂ in EMEC labeled "CA, Riverside Co., Windy Point 3 mi. S of Whitewater, 1/25-26/1977, Doyen,Rude,Bentzien, J.Doyen Lot #77A2.1" "NEOTYPE *Arenivaga investigata* Hopkins, 2014" [red label with black border].

Neoparatypes (6): USA: CA, Riverside Co., Coachella Valley Dunes 3 mi. W of Thousand Palms, 5/19/1959, 200', E.R.Tinkham, (6, USNM). All paratypes labeled "Neoparatype *Arenivaga investigata* Hopkins 2014" [blue label with black border].

Other material examined. USA: CA, San Diego Co., Palm Canyon Cpgd Anza-Borrego SP, 6/4/1970, Crazier,Frencke, and Welch, taken at light (1, ASUT); CA, Imperial Co., Algodones Dunes, I8 at Ogilby Rd., 3/7/1988, R.E. Woodruff, dunes at night (1, FSCA); CA, Imperial Co., Algodones Dunes, I8 0.7 mi. W of Ogilby Rd., 3/5/1988, R.E. Woodruff, blacklight trap (3, FSCA); CA, Imperial Co., Algodones Dunes WA, Ted Kipf Rd. NW of Glamis, 3/25-28/2002, 33.01.29N 115.06.53W, 110m, K.Will et al., pitfall trap (1, EMEC); CA, Imperial Co., Imperial Sand Dunes RA, Wash Rd. ca. 7.2 mi. S Hwy. 78, 3/28/2002, 32.55.31N 114.58.52W, C.B. Barr, on dunes at night (1, EMEC); CA, Imperial Co., Hwy. 78 10.5 mi. SW of Glamis, 3/4/1987, R.A. Cunningham, (1, PMNH); CA, San Bernardino Co., Cronise Valley, 4/29/1956, B.J. Adelson/M.Wasbauer/J.Powell/P.D.Hurd, (4, EMEC); CA, San Diego Co., Borego, 4/20/1951, C.D. MacNeill, (1, CAS); CA, San Diego Co., Borego Valley, 6/6/1940, (1, CAS); CA, L.A. Co., Lovejoy Buttes, Mojave Desert, 4/15/1946, L. Martin, collected at light (1, LACM); CA, San Diego Co., Borrego Springs, 3/30/1960, M. Wasbauer, (1, CSCA); CA, Imperial Co., 17 mi. NW of Glamis, 6/27-28/1978, J.Doyen/J.Powell, white light, pitfall trap, JDLot #78F2 (4, EMEC); CA, Imperial Co., Seeley, 4/7/1971, E.L. Paddock, pit trap at night, CA Dept. of Agr. 71D19-85 (1, CSCA); CA, Imperial Co., El Centro, 4/16/1973, R.A. Flock, (5, CSCA); CA, Imperial Co., El Centro, 5/5/1973, (4, CSCA); CA, Imperial Co., Calipatria, 3/28/1962, Killgore coll., argon light trap (1, CSCA); CA, Imperial Co., El Centro, 4/16/1973, R.A. Flock, (1, CSCA); CA, Imperial Co., 6 mi. W of Glamis, 8/5/1966, M. Wasbauer, bowl traps in sand (1, CSCA); CA, San Diego Co., Borrego Springs, 6/22/1958, L.A. Stange, (1, LACM); CA, San Diego Co., Borrego, 5/3/1956, B.J.Adelson/P.D.Hurd/M.Wasbauer, (10, EMEC); CA, San Diego Co., Borego, 4/25-26/1955, P.D.Hurd, on one specimen “Cryptantha augustifolia” (6, EMEC); CA, San Diego Co., Ocotillo, 9/15/1947, G.A.Marsh, light (1, EMEC); CA, San Diego Co., Borrego, 5/8/1953, J.Powell, (1, EMEC); CA, San Diego Co., Borego, 4/25/1955, P. Wygodynsky, (1, EMEC); CA, Imperial Co., Glamis Sand Dunes,5 mi. W of Ogilby, 5/29/1981, Werner,Olson,Hetz,Thomas,Burne,Frank,McLachlan, (1, UAIC); CA, San Bernardino Co., Kelso Sand Dunes, 5/1/1974, 2500’, Eichlin & Hardy, (1, CSCA); CA, Riverside Co., Mule Mts., I13, 2/13/1983, Andrews & Gilbert, (1, CSCA); CA, Riverside Co., 11.8 mi. WNW Inca RR Siding, 4/7/1994, 33.49.4N 114.57.3W, R.R.Snelling, (1, LACM); CA, Imperial Co., Algodones Dunes, 1–2 mi. W of Glamis, 4/7/2008, 32.59N 115.06?, Bill Warner, (1, W.B.Warner); CA, Imperial Co., 1 mi. W of Glamis, 3/29/1979, R.L.Aalbu, collected on slip face of dune (1, CSCA); CA, Imperial

Co., 5 km. N of Glamis sand dunes, 4/17/1974, D.Giuliani, (1, CSCA); CA, Riverside Co., Palm Springs, 5/23/1940, W.L.Swisher, light (2, LACM); CA, Riverside Co., Palm Springs, 6/24/1956, A.Menke,Jr., (1, LACM); CA, Riverside Co., Palm Springs, 7/8/1956, L.A.Stange, (1, LACM); CA, Riverside Co., Palm Springs, 7/19/1958, L.A.Stange, (1, LACM); CA, Riverside Co., Cathedral City, 6/14/1958, L.A.Stange, (1, LACM); CA, Riverside Co., Cathedral City, 7/21/1952, R.Tinglof, UCLA Coll. Accessioned LACM 1965 (1, LACM); CA, Riverside Co., Pushawalls Canyon, Indio Hills, 7/14/1947, (1, LACM); CA, Riverside Co., Palm Springs, 5/24/1940, Brereton & King, lights (1, LACM); CA, Riverside Co., Palm Springs, 5/24/1940, (1, CSCA); CA, Riverside Co., Palm Springs, 7/6/1950, W.A.McDonald, (1, USNM); CA, Riverside Co., Palm Springs, 7/16/1950, D.C.Blodget, (1, USNM); CA, Imperial Co., 3 mi. NW of Glamis, 9/15-16/1972, Wasbauer & Hardy, blacklight trap (1, CSCA); CA, Imperial Co., 3.5 mi. NW of Glamis, 3/10/1975, Andrews & Hardy, sand dune (1, CSCA); CA, Riverside Co., Thermal, 6/18/1956, M.Wasbauer, (4, EMEC); CA, Riverside Co., Thermal, 7/17/1956, M.Wasbauer, (1, EMEC); CA, Imperial Co., 3 mi. NW of Glamis, 3/3-4/1972, E.A.Kane, sand dunes (3, CSCA); CA, Co., 25 mi. W of Blythe, 8/18-19/1927, Cornell University Lot 542 sub 326,*Arenivaga apacha* Sauss.Det.Hebard 1929 (1, ANSP); CA, Imperial Co., Algodones Dunes 2 mi. W of Sand Hills Rest Area, 4/26/1980, D.K.Faulkner, (1, SDMC); CA, Imperial Co., 13 mi. W of Winterhaven, 6/13/1958, V.Roth, (1, UAIC); CA, Imperial Co., Imperial Dam, 5/28/1954, W.McDonald, UCLA Coll. Accessioned LACM 1965 (1, LACM); CA, Imperial Co., Algodones Sand Hills, W.G.Reeder, blattidae,500224 (4, USNM); CA, Riverside Co., Hopkins Well, 4/14-16/1958, P.D.Hurd/J.Powell, (15, EMEC); CA, Imperial Co., Algodones Dunes,5.6 mi. NW & 1 mi. SW of Glamis, 3/20/1993, 270’, J.P. & K.E.S. Donahue, 164,060-A (5, LACM); CA, Imperial Co., Algodones Dunes, S of Ruthven, 4/6/2000, 32.55.30N 114.59.34W, 120 m, D.Yanega, at light (2, UCRC); CA, Imperial Co., Algodones Dunes, S of Ruthven, 4/30/2001, 32.55.30N 114.59.34W, Hawks & Yanega, (5, UCRC); CA, Imperial Co., 5 mi. N of Ogilby, 4/17/1965, R.C.Dickson, at light (1, UCRC); CA, San Bernardino Co., Saratoga Springs, Death Valley, 7/10-12/1953, (2, USNM); CA, Calexico, 8/11/1914, J.C.Bradley, Cornell U. Lot 882, Sub.146, *Arenivaga apacha* (Sauss.)Det.Hebard 1935 (1, CUIC); CA, Imperial Co., Salton Sea, North Shore Area, 3/30/1983, R.A.Cunningham, (1, PMNH); CA, Cronese, 4/28/1952, Timberlake, at light (1, UCRC); CA, 1000 Palms, D.W.Cherney, (1, UCRC); CA, 2 mi. S of Oasis, ?/7/1936, Timberlake, at light (1, UCRC); CA, Riverside Co., Blythe, 7/22/1916, W.F.Barr, *Arenivaga apacha* 9Sauss.) Det.Strch.1952 (1, USNM); CA, Imperial Co., Imperial Valley, Summer 1966, D.A.Ward, (1, UCRC); CA, Imperial Co., Holtville, 7/2/1929, 144 Heidi Hopkins / ZooKeys 384: 1–256 (2014) P.W.Oman, (1, SEMC); CA, Imperial Co., 8 mi. E of Holtville, 4/29/1961, D.S.Verity, (1, LACM); CA, Imperial Co., 8 mi. E of Holtville, 6/24/1958, G.H.Nelson, to light (1, UMMZ); CA, Brawley, 4/7/1925, (1, LACM); CA, San Diego Co., Borego SP, 6/4/1956, A.Menke, (1, LACM); CA, San Diego Co., Borego SP, 6/6/1940, around lights (2, LACM); CA, Los Angeles Co., (2, LACM); CA, Colorado Desert, 8/11/1917, Wheeler, *Arenivaga* wheeleri n.sp.M.S.Det.T.H.Hubbell 1928 (1, UMMZ); CA, San Bernardino Co., Yermo, 4/11/1936, J.A.Comst., L.J.Muchmore (2, LACM); CA, San Bernardino Co., Yermo, 7/5/1939, W.M.Pearce, ex.coll.M.A.Cazier (1, AMNH); CA, San Bernardino Co., Yermo, 5/15/1939, T.G.Altken, ex.coll.M.A.Cazier (1, AMNH); CA, San Bernardino Co., Deadman’s Point, 9/9/1963, R.J.Hamton, (1, HEH); CA, Riverside Co., Palm Desert, 3/26/1953, AH & SK Rindge, collection of Fred H Rindge (1, AMNH); CA, Riverside Co., Palm Desert, 6/22/1956, M.Wasbauer, (3, EMEC); CA, Riverside Co., Dos Palmas Spa, 4/5/1937, G.Willett, (1, LACM); CA, Riverside Co., Coachella Valley Dunes,2 mi. W of Indio, 5/25/1957, 10’, E.R.Tinkham, (1, USNM); CA, Riverside Co., Coachella Valley, 10/23/1938, JAC, (1, LACM); CA, Riverside Co., Coachella Valley, 10/30/1938, J.A.Comstock, (1, LACM); CA, Riverside Co., N end of Salton Sea, 5/19/1955, F.S.Truxal, (4, LACM); CA, Imperial Co., 2 mi. S of Palo Verde, 6/28/1978, D.J.Powell, (1, EMEC); CA, Riverside Co., N shore near Salton Sea, 5/30/1992, R.L.Allen, white light, Blattodea:Polyphagidae, *Arenivaga* (1, LACM); CA, San Bernardino Co., Stovepipe Wells Hostel, Death Valley NM, 4/2/1954, F.B.Turner, at light (1, EMEC); CA, Inyo Co., 7 mi. NE of Panamint Springs, 5/16/1969, Rude & Doyen, (3, EMEC); CA, Kern Co., Red Rock Canyon, 5/2/1968, J.T.Doyen/J.Powell, blacklight (6, EMEC); CA, San Diego Co., 6 mi. E of Banner, 7/13/1963, H.L.Griffin/J.Powell/P.Welies, at light (5, EMEC); CA, San Bernardino Co., Death Valley NM,2 mi. NE Saratoga Springs, 3/17/1978, P.Rude, at UV light (1, EMEC); CA, Inyo Co., Shoshone, 5/4/1962, R.W.Thorp, at light (1, EMEC); CA, San Diego Co., Borego, 4/28/1955, R.C.Schuster, (1, EMEC); CA, San Diego Co., Borrego, 4/21/1960, J.Powell, (3, EMEC); CA, San Diego Co., Borrego Springs, 6/11/1965, G.R.Ballmer, light (1, UCRC); CA, San Diego Co., Borego, 4/28/1955, R.O.Schuster, 1 specimen-*Arenivaga* sp.Det.H.F.Strohecker (2, EMEC); CA, San Diego Co., Borego, 5/14/1949, J.E.Giliaspy, coll. At light (1, FSCA); CA, San Diego Co., Borego, 4/24/1959, Timberlake, at light (3, UCRC); CA, San Diego Co., Anza Borrego off 53 June oasis, 4/3/1993, S.O’Keefe, bl.sand at night (1, EMEC);

CA, Inyo Co., Owens Riv. 2 mi. NE of Lone Pine, 5/11/1969, P.A.Opler, blacklight (1, EMEC); CA, Inyo Co., Olancha, 6/26/1949, H.E.Cott, (1, FSCA); CA, Inyo Co., 3 mi. S of Olancha, 8/6/1948, Hurd & MacSwain, *Arenivaga apacha* (Sauss.) Det.H.F.Strohecker (1, FSCA); CA, San Bernardino Co., Afton Canyon, 3/24/1997, M.S.Caterino, (2, EMEC); CA, San Bernardino Co., Afton Rd. 23 mi. SW of Baker, 4/23/1977, Kitayama,Cave & Chemsak, on sand at UV light (1, EMEC); CA, San Bernardino Co., Yermo, 4/22/1949, R.v.d.Bosch, light trap (1, FSCA); CA, San Bernardino Co., Saratoga Springs, Death Valley NM, 4/15/1965, C.W.O'Brien, (1, FSCA); CA, Imperial Co., Holtville, 7/15/1989, (1, FSCA); CA, Imperial Co., Holtville, 5/8/1997, W.F.Chamberlain, at light (5, TAMU); CA, San Bernardino Co., Death Valley Juno, 4/22/1935, A.L.Melander, (1, UCRC); CA, Inyo Co., Darwin Canyon,5.7 mi. NE of Darwin, 7/6/1991, 2520', J.P. & K.E.S. Donahue, T18S,R41E,SE1/4 Sec.34,#21,874 (7, LACM); CA, San Bernardino Co., S. side of Kelso Dunes, 6/19/1999, Ballmer,Hawks,Powells & Yanega, (4, UCRC); CA, San Bernardino Co., Baker, Mohave Desert Scrub, 8/26/2002, L. Stange, at light (1, FSCA); CA, Riverside Co., 2 mi. W of Hopkins Well, 3/3/1959, J.W.MacSwain, (5, EMEC); CA, Riverside Co., Hopkins Well, 3/7/1959, W.E.Ferguson, at light (2, EMEC); CA, Riverside Co., Hopkins Well, 6/20/1966, J.W.MacSwain, (1, EMEC); CA, Riverside Co., 5 mi. e of Mt. Eagle, 7/8/1976, Doug Whitman, #570 (8, EMEC); CA, Riverside Co., Indio, 4/16/1965, J.Doyen, at light (3, EMEC); CA, Riverside Co., Indio, 8/4/1959, C.R.James, (1, FSCA); CA, Riverside Co., 4 mi. S of Palm Desert, 7/2/1963, R.L.Langston, at light (1, EMEC); CA, Riverside Co., Deep Canyon at station, 6/17/1975, P.McNally, white light (1, UCRC); CA, Riverside Co., Coachella Valley, Miles Ave. 0.5 mi. SW of Washington

St., 2/19/1990, G.R.Ballmer, pitfall trap (2, UCRC); CA, Needles, 4/1-6/1918, J.C.Bradley, (1, ANSP); CA, San Bernardino Co., Kelso Dunes,8 mi. SW of Kelso, 7/14-15/1974, J.Doyen, on ground at light, Lot No.74G13 (3, EMEC); CA, Imperial Co., 16 mi. W of AZ/CA border on I10,sand dunes off Ogilby, 2/27/1988, M.Thomas, crawling on sand dune, Polyphagidae Det. Max Thomas 1988 (1, ASUT); CA, San Bernardino Co., Essex, 4/5/1966, 1700', P.A.Opler, (1, EMEC); CA, San Bernardino Co., 9 air mi. S of Baker, Zzyzx Springs, 4/20/1977, Chemsak, (1, EMEC); CA, San Bernardino Co., 9 air mi. S of Baker, Zzyzx Springs, 7/1/1978, J.Doyen, Lot #78F5 (2, EMEC); CA, San Bernardino Co., 9 air mi. S of Baker, Zzyzx Springs, 4/18-23/1984, S.Hawley, blacklight trap (1,); CA, San Bernardino Co., 9 air mi. S of Baker, Zzyzx Springs, 4/18-23/1984, R.Gill, (2, EMEC); CA, San Bernardino Co., Zzyzx Springs, 4/20/1984, D.Sandri, (1, EMEC); CA, San Bernardino Co., Soda Springs (Zzyzx) W side of Soda Dry Lake,9 air mi. S of Baker, 5/22-24/1982, J.P.Donahue, (1, LACM); CA, Riverside Co., Eagle Mt. Dunes, E corner of JoshUAIC Tree NM, 6/17/1961, (13, USNM); CA, Riverside Co., Indio, 8/?/1950, (1, USNM); CA, Riverside Co., Indio, 7/2/1961, (1, USNM); CA, Riverside Co., 3 mi. W of Indio, 7/2/1956, M.Wasbauer, (4, EMEC); CA, Riverside Co., Indio, 6/7/1956, M.Wasbauer, (1, EMEC); CA, Riverside Co., Indio, 4/24-26/1953, G.Yamamoto/A.Fukushima, (5, USNM); CA, Riverside Co., Indio, 5/9/1952, (1, USNM); CA, Riverside Co., Indio, 4/30/1952, (1, USNM); CA, Riverside Co., Indio, 6/15/1955, (1, USNM); CA, Riverside Co., Indian Wells, 4/29/1952, (1, USNM); CA, Riverside Co., Indian Wells, 4/17/1952, (2, USNM); CA, Riverside Co., Indian Wells, 4/24-25/1953, B.Markley/W.R.Lower/M.C.Anderson, (10, USNM); CA, Riverside Co., Indian Wells, 9/7/1938, R.B.Cowles, (4, USNM); CA, Riverside Co., Indian Wells, 4/5/1931, A.C.Browne, Collected from desert flora, (3, HEH); CA, Riverside Co., Indian Wells, 3/12/1938, R.B.Cowles, (2, USNM); CA, Riverside Co., 3 mi. W of Indio, 5/19/1959, (3, USNM); CA, Riverside Co., Coachella Valley Dunes 3 mi. W of Thousand Palms, 5/3/1958, 200', E.R.Tinkham, (5, USNM); CA, Riverside Co., Coachella Valley 9 mi. W of Palm Springs, 4/2/1954, E.R.Tinkham, (1, USNM); CA, Riverside Co., Coachella Valley Dunes 3 mi. W of Thousand Palms, 5/19/1959, 200', E.R.Tinkham, (1, USNM); CA, Riverside Co., Coachella Valley Dunes 9 mi. W of Palm Springs, 5/27/1954, E.R.Tinkham, (1, USNM); CA, Riverside Co., Coachella Valley Dunes 1 mi. N of Palm Desert, 5/15/1954, E.R.Tinkham, (1, USNM); CA, Riverside Co., Whitewater, 7/9/1950, J.W.MacSwain, (1, USNM); CA, Riverside Co., Palm Springs, 6/?/1965, E.B.Edney, (2, USNM); CA, Riverside Co., Indio, 4/29/1962, V.Theresa Luine, (1, UCRC); CA, Riverside Co., San Gorgonio Pass, Windy Point, 6/16/1975, P.McNally, (4, UCRC); CA, Riverside Co., Whitewater, 7/9/1950, P.D.Hurd, (1, FSCA); CA, Riverside Co., Windy Point sand dunes nr. Palm Springs, broad form, bred from nymphs (1, UCRC); CA, Riverside Co., Windy Point 3 mi. S of Whitewater, 1/25-26/1977, Doyen,Rude,Bentzien broad form, J.Doyen Lot #77A2.1 (1, EMEC); CA, Riverside Co., Coachella Valley, Mt.View Rd. 0.5 mi. N of jct. w/ Varner Rd., 5/17/1995, G.R.Ballmer, (1, UCRC); CA, 4 mi. W of Thousand Palms, 4/25/1968, E.R.Tinkham, (3, USNM); CA, 3 mi. W of Thousand Palms, 5/10/1960, (1, USNM); CA, Riverside Co., Palm Springs, 1-6/?/1966, Edney, (6, USNM); CA, Riverside Co., Palm Springs, 7/19/1958, L. Stange, (1, LACM); CA, Riverside Co., Palm Springs, 6/5/1967, R.Rice, in sand under bush (1, UAIC); CA, Calexico, 8/11/1914, J.C.Bradley, (1, ANSP); CA, Riverside Co., Palm Springs, 6/1/1937, P.D.Gerhardt, at light (1, UAIC); CA, San

Felipe, 9/9/1938, Timberlake, at light (1, UCRC); CA, Riverside Co., Blythe, 5/24/1935, G.M.Kohle, *Arenivaga erratica* Rehn Det. Rehn 1941 (1, ANSP); CA, Indio, 4/19/1962, Erwin #134 (1, USNM); CA, Riverside Co., Blythe, 8/9-10/1959, K.L.Japport, Rentz, argon light trap (4, USNM); CA, Riverside Co., Palm Springs, 4/?/1966, C.&V. Brandes, (1, USNM); CA, San Diego Co., Mason Valley, 4/14/1945, D.Meadows, (1, USNM); CA, Imperial Co., Experiment Farm, 6/7/1912, J.C.Bridwell, (3, USNM); CA, Imperial Co., Imperial Sand Dunes, 3/28/2002, G.M.Nishida, at MV light (2, EMEC); CA, Riverside Co., Coachella Valley 3 mi. W of Indio, 5/9/1955, E.R.Tinkham, mated pair (1, USNM); CA, Riverside Co., Coachella Valley, Indio, 7/5/1957, E.R.Tinkham, (2, USNM); CA, Riverside Co., Coachella Valley 4 mi. W of Indio, 4/18/1955, E.R.Tinkham, (1, USNM); CA, Riverside Co., Coachella Valley 9 mi. W of Palm Springs Dunes, 5/27/1954, E.R.Tinkham, (1, USNM); CA, Kelso Dunes, 6/24-25/1954, 2400’, E.R.Tinkham, (2, USNM); CA, Riverside Co., Coachella Valley Dunes 2 mi. W of Indio, 5/25/1957, 10’, E.R.Tinkham, (1, USNM); CA, San Diego Co., Ocotillo, 6/13/1949, G.A.Marsh, (1, USNM); CA, San Diego Co., Anza Borrego SP, Borrego Palm Canyon Cpgd., 4/10/1993, R.L.Allen, (1, LACM); CA, Riverside Co., Palm Springs, 5/24/1940, (1, CAS); CA, Riverside Co., Palm Springs, 5/28/1939, P.D.Gerhardt, at light (1, UAIC); CA, Inyo Co., Death Valley 1.5 mi. N 2 mi. W Ashford Mill, 3/23/1984, 200’, D. Giuliani, sand dunes (1, CSCA); CA, Inyo Co., 4.3 mi. NE Saratoga Springs, Death Valley NM, 4/16-18/1973, A.R.Hardy, sand dunes (4, CSCA); CA, San Bernardino Co., Baker, 5/29/1950, C.D. MacNeill, (1, EMEC); CA, 65 mi. ENE of Indio,13 mi. NE & 2.5 mi. E of Desert Center, 4/3/1960, E.R.Tinkham, (2, USNM); CA, Riverside Co., Desert Center, 8/31/1946, (1, LACM); CA, Inyo Co., Tecopa, 6/17/1954, Belkin & McD., UCLA Coll. Accessioned

LACM 1965 (1, LACM); CA, 29 Palms, 5/?/1952, E.R.Tinkham, (1, USNM); CA, Riverside Co., Coachella Valley 2 mi. W of Indio, 5/25/1955, E.R.Tinkham, (1, USNM); CA, Sand dunes E of Gray's Well, 7/18/1953, E.R.Tinkham, (1, USNM); CA, San Diego Co., Borego SP, 4/11/1949, E.S.Ross, (2, CAS); CA, Holtville, 6/23/1946, E.C.VanDyke, (6, CAS); CA, Imperial Co., Coyote Wells, 5/5/1922, O.C.Poling, (4, ANSP); CA, 5 mi. W of Blythe, 8/19-20/1927, CUIC University (3, ANSP); CA, Death Valley, 10/?/1926, J.D.Gunder, (1, CAS); CA, Coachella, 5/23/1929, E.C.VanDyke, (1, CAS); CA, Riverside Co., Palm Springs, 4/22-27/1933, E.P.Van Duzee, (5, CAS); CA, Kern Co., 5/?/????, (1, ANSP); CA, Coachella, 5/19/1923, E.C.VanDyke, (1, CAS); CA, Riverside Co., 3/30/1918, E.R.Leach, (2, CAS); CA, Coachella, 5/10/1928, E.C.VanDyke, (1, CAS); CA, Coachella, 5/22-25/1928, E.C.VanDyke, (3, CAS); CA, Riverside Co., Indian Wells, 4/24/1922, K.R.Coolidge, at light (1, ANSP); CA, 25 mi. W of Blythe, 8/18-19/1927, Cornell University Lot 542 sub 326 (6, ANSP/CUIC); CA, Holtville, 7/2/1929, R.H.Beamer, (1, ANSP); CA, Needles, 4/1-6/1918, (1, ANSP); CA, Needles, 4/1-6/1918, J.C.Bradley, Cornell University Lot 882 sub 146 (1, CUIC); CA, Kern Co., Red Rock Canyon, 5/2/1968, J.T.Doyen, black light (1, EMEC); CA, Inyo Co., Owen's River 2 mi. NE of Lone Pine, 5/11/1969, P.A.Opler, black light (1, EMEC); CA, Inyo Co., 31 mi. NE of Big Pine, 7/8/1966, 6000', C.W.O'Brien, at night (1, FSCA); CA, Heber, 7/10/1926, (1, UCRC); CA, Inyo Co., 9 mi. N of Olancha nr Cottonwood Charcoal Kilns, 5/24/1969, R.Hardy, (1, UCRC); CA, Riverside Co., Wiley's Well Rd. at I10, 3/28/2001, 33.36.22N 114.54.30W, D.Yanega, (2, UCRC); CA, San Bernardino Co., 23 mi. E of 29 Palms, 4/30/1971, R.Hardy, (1, UCRC); CA, San Bernardino Co., Kelso Dunes, 4/16-18/1974, Andrews & Wasbauer, (3, CSCA); CA, Indio, 8/31/1961, C.Myers, (1, CSCA); CA, Riverside Co., Blythe, 7/8/1956, A.Menke, Jr., (1, LACM); CA, Riverside Co., Indian Wells, 4/1/1938, R.B.Cowles, UCLA Coll. Accessioned LACM 1965 (2, LACM); CA, Riverside Co., Indian Wells, 4/12/1957, C.W.Schaefer, UCLA Coll. Accessioned LACM 1965 (1, LACM); CA, Riverside Co., Indian Wells, 4/21/1956, Schlek, UCLA Coll. Accessioned LACM 1965 (1, LACM); CA, Riverside Co., Blythe, 8/20/1927, Cornell University (3, ANSP/CUIC); CA, Riverside Co., 5 mi. W of Blythe, 8/19-20/1927, Cornell University Lot 542 sub 328,*Arenivaga apacha* (Sauss.) Hebard 1937 (1, CUIC); CA, Riverside Co., 5 mi. W of Blythe, 8/19-20/1927, Cornell University Lot 542 sub 328 (1, CUIC); CA, Riverside Co., 25 mi. W of Blythe, 8/18-19/1927, Cornell University Lot 542 sub 326,*Arenivaga apacha* (Sauss.) Hebard 1929 (2, CUIC/UCRC); CA, Riverside Co., 18 mi. W of Blythe, 4/8/195?, Timberlake, at light (5, UCRC); CA, Riverside Co., Blythe, 8/25/1973, (1, UCRC); CA, Inyo Co., Shoshone, 9/10/1954, UCLA Coll. Accessioned LACM 1965 (1, LACM); CA, Inyo Co., Bailey Canyon, Carlego, 7/2/1940, (1, LACM); CA, San Bernardino Co., Amboy Crater, 7/22/1956, J.F.Lawrence, 102 (1, EMEC); CA, San Bernardino Co., Amboy Crater, 6/6/1957, J.M.Burns, (1, EMEC); CA, San Bernardino Co., 10 mi. E of 29 Palms, 6/11/1966, fluorescent black light (6, CSCA); CA, Imperial Co., 6 mi. W of Glamis, 8/5/1966, M.Wasbauer, bowl traps in sand (2, CSCA); CA, Imperial Co., Andrade, 8/4/1966, M.Wasbauer, fluorescent black light (1, CSCA); CA, Cornise, 4/28/1937, orthoptera, *Arenivaga apacha* (Sauss.) det. H.F.Strohecker (1, FSCA); CA, Imperial Co., 3 mi. SW of Glamis, 7/12/1974, J.Doyen, black light trap (1, EMEC); CA, San Diego Co., Ocotillo, 6/13/1949, (1, EMEC); CA, San Diego Co., Ocotillo, 9/15/1947, G.A.Marsh, light (1, EMEC); CA, San Bernardino

Co., Pisgah Crater, 4/7/1962, Norris & Heath, Sta.33 (1, LACM); CA, San Bernardino Co., .3 mi. S of I15, Basin Pond, 7/15/1984, Faulkner & Brown, (1, SDMC); CA, San Bernardino Co., Baker, 7/31/1955, Menke & Truxal, (1, LACM); CA, San Bernardino Co., Cronise Valley, 4/29/1956, M.Wasbauer/J.Powell, (3, EMEC); CA, San Diego Co., Borrego, 5/3/1956, B.J.Adelson, (1, EMEC); CA, San Diego Co., Borego, 4/23/1955, P.D.Hurd, (4, EMEC); CA, Riverside Co., Hopkins Well, 4/16/1958, P.D.Hurd/J.Powell, (2, EMEC); CA, Ft. Yuma, 8/16/1951, origin unknown, FY 51,H25 (1, CSCA); CA, Riverside Co., Thousand Palms, 7/28/1958, P.Opler, (1, EMEC); CA, Imperial Co., Glamis Sand Dunes,5 mi. W of Ogilby, 5/29/1981, Werner,Olson,Hetz,Thomas,Burne,Frank & MacLachlan, (2, UAIC); CA, 4 mi. W of Thousand Palms, 4/25/1968, E.R.Tinkham, (1, USNM); CA, Riverside Co., Indio, 6/25/1939, J.C.von Bloeker, (1, LACM); CA, Inyo Co., “The Dunes” Panamint Valley, 4/28/1974, 2600’, Eichlin & Hardy, (1, CSCA); CA, Inyo Co., Panamint Valley Dunes, 9/14/1975, Andrews & Hardy, (1, CSCA); CA, San Bernardino Co., Death Valley NM, Saratoga Springs, 5/3/1974, D.Giuliani, (2, CSCA); CA, San Bernardino Co., Marble Mts. 1 mi. E of Kelbaker Rd., 5/7-8/10/1981, R.Aalbu, antifreeze trap (1, CSCA); CA, Riverside Co., Blythe, 7/26/1946, Hurd & Barr, 17NW (1, USNM); CA, Riverside Co., 20 mi. W of Blythe, 7/4/1951, J.W.MacSwain, (1, USNM); CA, Riverside Co., Blythe, 6/21/1946, W.F.Barr, (1, USNM); CA, San Diego Co., Borego, 4/27/1954, J.G.Rozen, *Arenivaga apacha* (Sauss.) det. H.F.Strohecker (1, USNM); CA, Coachella Valley,2 mi. NW of Indio, 5/9/1955, E.R.Tinkham, (1, USNM); CA, Coachella Valley,3 mi. W of Indio, 5/9/1955, E.R.Tinkham, (1, USNM); CA, Coachella Valley,3 mi. W of Indio, 5/25/1955, E.R.Tinkham, (1, USNM); CA, Coachella Valley,4 mi. W of Indio, 4/16/1955, E.R.Tinkham, (1, USNM); CA, Saratoga Springs, Death Valley, 4/16/1965, J.B.Snell, (1, USNM); CA, Riverside Co., Indio, 4/20/1939, (1, LACM); CA, Riverside Co., Hopkins Well, 4/27/1949, L.W.Quate, coll. at light, *Arenivaga apacha* (Sauss.) det.H.F.Strohecker (1, USNM); CA, Riverside Co., Strawberry Valley, S of Jacinto Mt., 3/4/1910, Grinnell,Jr., (1, USNM); CA, San Bernardino Co., Yermo, 4/11/1949, R.v.d.Bosch, light trap (1, USNM); CA, San Diego Co., Borego, 5/1/1952, P.D.Hurd, *Arenivaga apacha* (Sauss.) det. H.F.Strohecker 1953 (2, USNM); CA, San Diego Co., Borego, 4/24/1949, J.E.Gillaspy, coll. At light (1, USNM); CA, Riverside Co., Cathedral City, 7/16/1950, B.Adelson, electric light (1, USNM); CA, Riverside Co., Whitewater, 7/9/1950, J.W.MacSwain, (1, USNM); CA, Riverside Co., Mecca, 4/25/1952, P.D.Hurd, (1, USNM); CA, San Bernardino Co., Cronise Camp, 4/16/1953, J.Linsley, (2, USNM); CA, Salt Creek Death Valley, 4/14/1965, J.L.Pierce, collected at light (1, USNM); CA, Stovepipe Wells Death Valley, 4/5/1966, D.Ramsey, at light (1, USNM); CA, Stovepipe Wells Death Valley, 4/5/1966, K.St??????, on table at light (1, USNM); CA, Stovepipe Wells Death Valley, 4/14/1965, W.H.Tyson, collected at light (1, USNM); CA, Stovepipe Wells Death Valley, 4/15/1965, W.E.Ferguson, (1, USNM); CA, Stovepipe Wells Death Valley, 4/5/1966, P.Gibbs, collected at light (1, USNM); CA, Stovepipe Wells Death Valley, A revision of the genus *Arenivaga* (Rehn) (Blattodea, Corydiidae)... 149 4/6/1966, R.E.Main, collected at light (1, USNM); CA, Riverside Co., Hopkins Well, 4/29/1952, J.G.Rozen, (1, USNM); CA, Riverside Co., Hopkins Well, 4/14-16/1958, P.D.Hurd/J.Powell, (8, USNM/ EMEC); CA, Imperial Co., El Centro, 8/?/1981, H.W.Browning, (2, UCMC); CA, Imperial Co., El Centro, 8/6/1963, R.Flock, (1, UCMC); CA, Olancha, 4/27/1959, R.P.Allen, (2, CSCA); CA, Imperial Co., 3.5 mi.

NW of Glamis, 3/10/1973, Andrews & Hardy, sand dune (1, CSCA); AZ, Yuma Co., Wellton, 2/25-26/1925, O.C.Poling, (13, UMMZ); AZ, Yuma Co., Wellton, 3/3/1925, O.C.Poling, (3, UMMZ); AZ, Yuma Co., Wellton, 3/25/1925, O.C.Poling, (17, UMMZ); AZ, Yuma Co., Mohave Valley nr. Wellton, 3/5/1925, O.C.Poling, at light, (1, UMMZ); AZ, Yuma Co., Wellton, 3/6/1925, O.C.Poling, (7, UMMZ); AZ, Yuma Co., Welton, 6/28/1950, R.F.Smith, (1, AMNH); AZ, Yuma Co., Sentinel, 7/23/1941, R.H.Beamer, (20, ANSP); AZ, Yuma Co., Ehrenberg, 6/24/1938, F.H.Parker, (2,); AZ, Maricopa Co., Gila Bend, 6/19/1953, UCLA Coll. Accessioned LACM 1965 (2, LACM); AZ, Yuma Co., Aztec, 4/16/1954, Menk & Stange, (1, LACM); AZ, Yuma Co., Mohawk Dunes 12 mi. E of Tacna, 3/6/1988, R.E.Woodruff, blacklight trap (7, FSCA); AZ, Yuma Co., Aztec, 7/7/1957, Stange & Harding, (2, FSCA); AZ, Yuma Co., San Cristobal Dunes, Goldwater Range, 5/2-4/1997, Olson,Schwalbe et al, UV (3, UAIC); AZ, La Paz Co., Ehrenberg, 3/31/2001, BC & WB Warner, Bill Warner, (4,); AZ, Yuma Co., Dateland, 6/14/1964, A.G.Raske, (1, EMEC); AZ, Yuma Co., Yuma, 6/11/1937, D.J. & J.N.Knull, (1, OSU); AZ, Yuma Co., Yuma, 1/6/1967, R.S.Funk, at light, (1, NAU); AZ, Yuma Co., Yuma, 3/23/1965, R.S.Funk, (1, NAU); AZ, Yuma Co., Yuma desert 9 mi. E of San Luis, 3/18/1980, Werner,Olsen,Metz & MacLachlan, (2, UAIC); AZ, Yuma Co., Yuma, 4/29/1959, D.Muse, at light, (1, UAIC); AZ, Yuma Co., 10 mi. E of Tacna, N end of Mohawk Dunes, 3/30/2001, WB & BC Warner, Bill Warner, (2,); AZ, Yuma Co., 10 mi. E of Tacna, N end of Mohawk Dunes, 3/21/1997, WB & BC Warner, night (5, WB Warner); AZ, Yuma Co., N end of Mohawk Dunes 0.2 mi. N of BMG Range, 4/1/1994, Warners, (2, WB Warner); AZ, Yuma Co., 10 mi. E of Tacna, Mohawk Dunes, 3/20/1998, 32.41.8N 113.47.4W, B & W Warner, Bill Warner, (2,); AZ, Yuma Co., 7.5-8 mi. E Tacna, sand dunes, 3/21/1998, 32.41.8N 113.48.4W, B & W Warner, Bill Warner, (2,); AZ, Yuma Co., Mohawk Dunes 10 mi. E of Tacna, 6/4/2010, 32.41.45N 113.47.22W, WB Warner, Bill Warner, UV (1,); AZ, Yuma Co., 6 mi. SE of Parker, 7/9/1966, Davidson & Cazier, (2, ASUT); AZ, Yuma Co., Goldwater Mil Rge, San Cristobal Dunes, 3/3/1997, CA Olson, pitfall traps (2, UAIC); AZ, Yuma Co., Goldwater Mil Rge, San Cristobal Dunes, 3/2/1997, CA Olson, UV (1, UAIC); AZ, Yuma Co., Yuma, 3/29/1960, D.Muse, at light, desert (1, UAIC); AZ, Yuma Co., Yuma, 5/5/1973, Walker, at night (1, ASUT); AZ, 22 mi. E of San Luis, 4/16/1960, (1, USNM); AZ, Yuma Co., Yuma, 3/12/1956, G.Lorenz, (1, UAIC); AZ, Mohave Co., Sacramento Wash at Franconia Sta. 0.4 mi. N of I40, 7/28/1989, 1200', J.P.Donahue, #137,707 (1, LACM); AZ, Yuma Co., Yuma, 4/26/1935, J.D.Ball, (1, UAIC); AZ, Yuma Co., Yuma, 5/14/1959, D.Muse, at lights (1, UAIC); AZ, 5 mi. W of Bouse, 8/1/1957, E.R.Tinkham, dunes (2, USNM); AZ, (1, USNM); AZ, Yuma Co., Yuma, 5/15/1939, T.G.Aitken, ex coll. M.A.Cazier (1, AMNH); AZ, Ehrenberg, Colorado River, Palmer, *Arenivaga apacha* (Sauss.) Hebard Collection (1, ANSP); AZ, Pima Co., Ajo, 7/23/1938, R.I.Sailer, (1, ANSP); AZ, Mohave (now La Paz) Co., 3 mi. SE of Parker, 6/28/1978, J.Powell, black light trap (2, EMEC); NV, Nye Co., Big Dune, 4/19/1976, D.Giuliani, (1, CSCA); NV, Nye Co., Big Dune, 4/29/1974, 2500', R.Hardy, (3, CSCA); NV, Nye Co., Big Dune, 4/28/1975, Andrews & Hardy, cereal bowl pit trap under (2, CSCA); NV, Nye Co., Carrara, 4/18/1969, F.G.Andrews, (1, CSCA); NV, Clark Co., 10 mi. NE of Las Vegas, 4/27/1975, Andrews & Hardy, sand dune association (1, CSCA); NV, Nye Co., Pahrump, 7/7/1959, D.F.Zoller, (1, FSCA); NV, Nye Co., Pahrump, 7/4/1959, F.D.Parker, light trap (1, FSCA) NV, Mercury, 8/6/1964, 5M(TB) (1, USNM); NV, Nye Co., Pahrump, 6/?/1959, DF Zoller, 1 specimen-*Arenivaga apacha* (Sauss.) det. HF Strohecker (6, NV Dept. of Ag); NV, Nye Co., Pahrump, 7/7/1959, DF Zoller, (1, NV Dept. of Ag); NV, Nye Co., Pahrump, 7/29/1959, FD Parker, (1, NV Dept. of Ag); NV, Nye Co., Pahrump, 8/4/1959, FD Parker, light trap (2, NV Dept. of Ag); NV, Nye Co., Pahrump, 8/2/1959, FD Parker, light trap (1, NV Dept. of Ag); NV, Nye Co., Pahrump, 7/30/1959, FD Parker, light trap (1, NV Dept. of Ag); NV, Lincoln Co., Ash Springs, 6/20/1966, 2400 ft., RW Lauderdale, (1, NV Dept. of Ag); NV, Nye Co., Big Dune, 5/16/1982, RC Bechtel & RW Rust, 3 specimens-black light trap (6, NV Dept. of Ag); NV, Nye Co., Big Dune, 4/29/1982, RC Bechtel & RW Rust, black light trap (2, NV Dept. of Ag); NV, Clark Co., Glendale, 8/3/1961, RC Bechtel, (1, NV Dept. of Ag); NV, Nye Co., Lava Dune, 5/15/1982, RC Bechtel & RW Rust, black light trap, T14S R49E (1, NV Dept. of Ag); NV, Nye Co., Amargosa Dune, 4/5/1994, JLP RWR, (1, NV Dept. of Ag); CA, Brawley, 4/7/1925, *Arenivaga erratica* Rehn det. Caudell (1, NV Dept. of Ag); CA, Riverside Co., Palm Springs, 5/29/1939, B Brookman, (1, NV Dept. of Ag); CA, Riverside Co., Snow Creek Game Refuge, 8 mi W Palm Springs, 6/27/1956, LD Moore, (3, MLBM); CA, Riverside Co., Sand dunes near Palm Springs, 5/29/1954, AH Barnum, (7, MLBM); CA, Ocotillo Wells, 3/18/1966, DR Estes, (7, FS Ento.); CA, Riverside Co., Mecca, 8/?/1955, LD Moore, light trap (2, MLBM); CA, San Diego Co., Borrego Springs, 9/3/1982, TB Moore, *Arenivaga apacha* (Saussure) det. AH Barnum 2005 (1, MLBM); CA, Riverside Co., Mecca, 4/27/1960, LD Moore, light trap (1, MLBM); CA, Riverside Co., Mecca, 6/1/1960, LD Moore, light trap (1, MLBM); CA, Riverside Co., Mecca, 7/20/1960, LD Moore, light trap (1, MLBM); CA, Riverside Co., Thermal, 9/11/1970, LD Moore, (1, MLBM); CA, Riverside Co., Mecca, 6/21/1955, LD Moore, (2, MLBM); CA, Riverside

Co., Thermal, 6/21/1955, LD Moore, 1 specimen-light trap (2, MLBM); CA, Riverside Co., LaQuinta, 6/?/1968, LD Moore, light trap (2, MLBM); CA, San Bernardino Co., 2.5 mi W Amboy Crater on road, 3/5/1988, MM Fuller, 0.5 mi S of National Trails Hwy. in lava field at night, attracted to flashlight. (1, MSB); AZ, Mohave Co., 3 mi SE Parker, 6/28/1978, J Powell, black light trap (2, EMEC); AZ, Maricopa Co., Gila River at Airport Rd., 4/29-5/19/2011, 33.21.06N, 112.30.13W, Bill Warner, barrier pitfall traps on river sand (3, WB Warner); AZ, Maricopa Co., Gila River at Airport Rd., 4/12-14/2011, 33.21.06N, 112.30.13W, Bill Warner, human dung baited pitfall traps (2, WB Warner); AZ, Maricopa Co., Gila River at Airport Rd., 4/14-22/2011, 33.21.06N, 112.30.13W, Bill Warner, barrier pitfall traps on river sand (2, WB Warner). MEXICO: Sonora, La Choya, 6/12/1952, Cazier,Gertsch & Schrammel, (7, AMNH); Sonora, 20 mi. SE of San Luis RC, 6/6/1959, DH Tuttle, (2, USNM); Sonora, coastal dunes, Puerto Penasco, 6/23/1957, ER Tinkham, (3, USNM); Sonora, 6 mi. E of Punta Penasco, 6/22/1957, ER Tinkham, (7, USNM); Sonora, Punta Penasco, 4/10/1963, FG Andrews, (1, LA State College); Sonora, Punta Penasco, 6/23/1957, ER Tinkham, (2, USNM); Sonora, 15 mi. N of Puerto Penasco, 7/21/1973, F Werner, at light (1, UAIC); Sonora, Punta Penasco, 10/1/1989, G Simmons, (1, UAIC); Sonora, Rocky Point, 4/16/1965, JW Wienko, (1, UAIC); Sonora, El Gulfo de Santa Clara, 3/16/1958, V Roth, (1, UAIC); Sonora, Cholla Bay, 4/18/1959, A Ross, on ground (2, UAIC); Sonora, Rocky Point, 2/17/1934, (3, SDMC); Sonora, Rocky Point, 7/27/1956, C & M Cazier, (6, AMNH); Sonora, Puerto Penasco, 6/11/1952, Cazier,Gertsch & Schrammel, (1, AMNH); Sonora, 47 mi. W of Sonoyta, 8/9/1957, ER Tinkham, (1, USNM); Sonora, San Luis, 5/24/1938, (4, CAS); Sonora, Laguna Prieta, 5/25/1938, (3, CAS); Sonora, San Luis, 5/24/1938, (1, LACM); Sonora, E San Luis, 10/6/1953, Ruckman,Let & Ames, (1, USNM); Sonora, Dunes 22 mi. E of San Luis, 6/1/1958, 150 ft., ER Tinkham, (1, USNM); Sonora, Cabin 245 Choya Bay, 9/8/1968, BL Burch, (1, ASUT); Sonora, Choya Bay, 7/30/1969, M Kolner, at light (2, ASUT); BC, 36 mi. N of San Felipe, 4/18-21/1961, FS Truxel, (2, LACM); BC, San Felipe, 2/21-26/1971, Santa Barbara Malacological Society (1, CAS); BC, 23.9 km W of Mexicali on Hwy. 2, 4/13/1979, DB Weissman, #79-45 (2, CAS); BC, San Felipe, 5/18/1963, JC Ball, (4, UCRC); BC, 89 km S of Mexicali on Hwy. 5, 7/30/1978, Weissman & Lightfoot, #78-109 (1, CAS); BC, 88.3 km S of Mexicali on Hwy. 5, 9/17/1979, Weissman,Lightfoot & Love, 79-163 (1, CAS); BC, 10.3 mi. SW of Los Medanos, 3/27/1964, Irwin & Ball, at light on sand dunes (3, UCRC); BC, 4.9 mi. SW of Algodones, 3/25/1986, 32.48.734N 114.48.234W, RH McPeak, black light (1, EMEC); BC, San Felipe, 3/25/1963, GI Stage, (1, HEH); BC, Rancho Potrero, 5/7-8/1959, D Patterson, (1, USNM); BC, 5 mi. N of San Felipe, Playa del Sol camp, 6/16/1973, Williams & Blair, SCW #309(2) (1, CAS); Sonora, Puerto Penasco, 7/?/1960, AH Barnum, (1, MLBM). Determiner label *Arenivaga investigata* Hopkins 2011" [white label

with black border].

Distribution. This species is found from northern Baja California and northwestern Sonora, Mexico northwards through southeastern California, southwestern Arizona, and southern Nevada. See Fig. 98.

Diagnosis. *A. investigata* may be diagnosed by the single spine on the right ventral phallomere. See Fig. 97.

Description. Male. NB: Holotype is destroyed by dermestid beetles. Neotype designated and described here. Measurements. Holotype TL = 18.3 mm, GW = 11.3 mm, PW = 8.00 mm, PL = 5.49 mm, TL/GW = 1.62, PL/PW = 0.69. EW = 0.70 mm; OW = 0.70 mm. Among paratypes range of TL 15.0–24.8; range of GW 6.5–11.5; range of PW 4.73–8.13; range of PL 3.73–5.82.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.35 mm); vertex light orange-brown, with darker small ridges between apices of eyes extending on to ocellar tubercles, scattered short setae; interocellar space slightly concave, light orange-brown. Frons light orange-brown, concave; bound on either side by ridges extending from inner apex of ocelli outwards to lateral edges of clypeus; scattered long setae on ridges. Anterior portion of frons light orange-brown, very bulbous; clypeal suture demarcates light orange-brown anteclypeus. See Fig. 96d.

Pronotum. Pronotum translucent waxy beige; variable length orange-brown setae along anterior margin; dorsal surface of pronotum covered with short orange-brown setae that are denser and longer anteriorly and laterally; pronotal pattern variable in color from light orange-brown through every shade to medium brown, "panther face", no aura, usually discernible detail. See Fig. 96c.

Body. Wing brace present. Legs and body medium orange-brown; subgenital plate strongly asymmetrical with posterior edge emarginated, rounded apices. See Fig. 96b.

Forewings. Wings extended beyond abdominal apex a great distance in some specimens, but only a short distance in others; color, like size, highly variable from pale with no blotches through medium brown with darker blotches; surface opaque and matte. See Fig. 96a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized narrow ended hook-shaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin sclerotized, smooth, concave in ventral view; medial margin smoothly curved at anterior end, shagreened greatly extended knob at posterior end with dorsally pointing thick blunt spine. Small central sclerite smooth, concave, with field of punctations on interoventral surface. Right ventral phallomere extends from articulation smooth bulbous lobe with posteromedial pointing spine that may have narrow or broad base; recedes anteriorly to collar-like rim; after moderate gap, long, narrow, flanged, concave arm, extending to greater depth than rest of phallomere. Folded anterior portion of left phallomere moderately wide, finely punctate and setose. Genital hook with long pointed head and depression along short hook; arm smoothly curving. See Fig. 97.

Habitat and natural history. All life history elements remain unobserved.

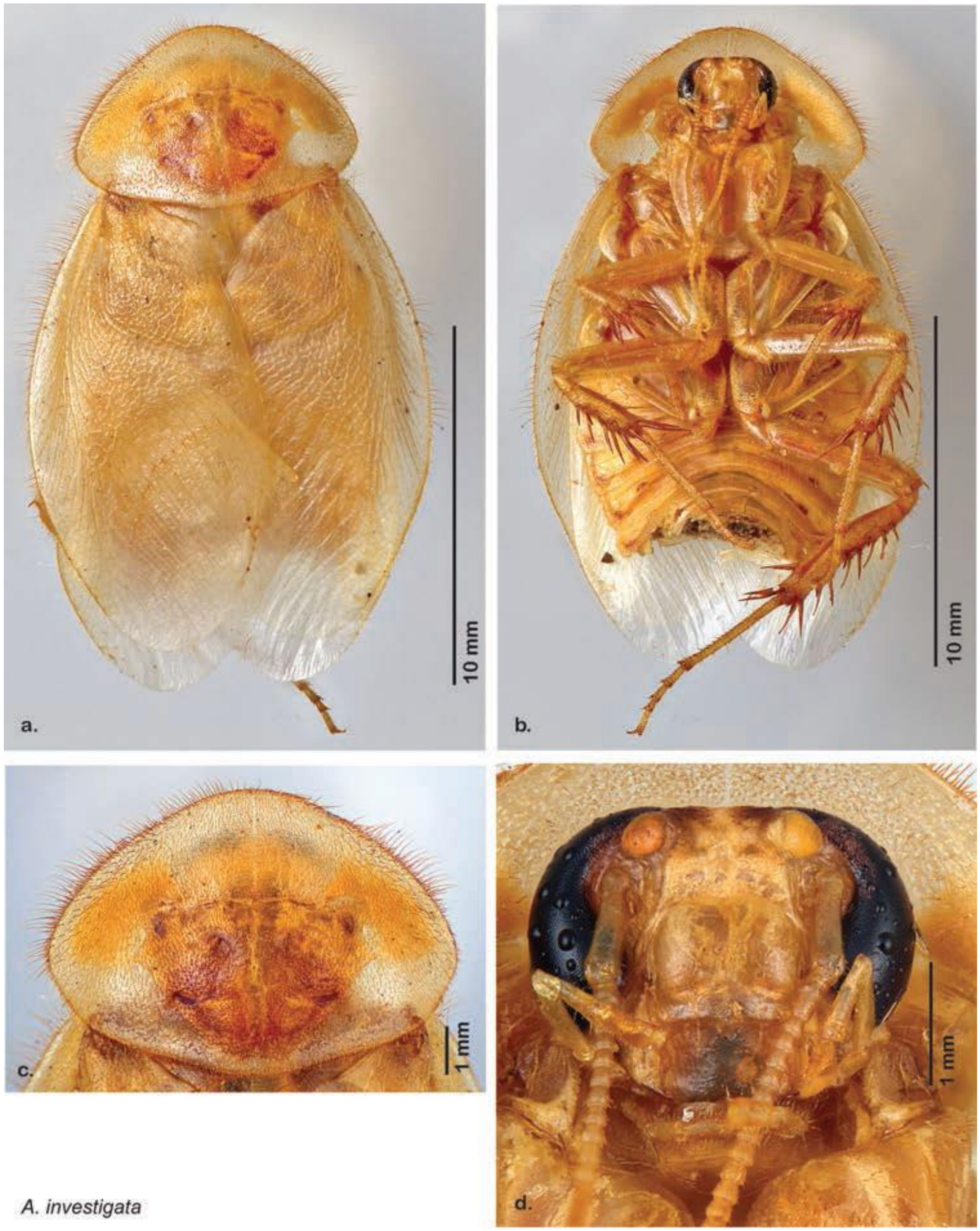


Figure 96. *A. investigata* a dorsal habitus b ventral habitus c pronotum d head.

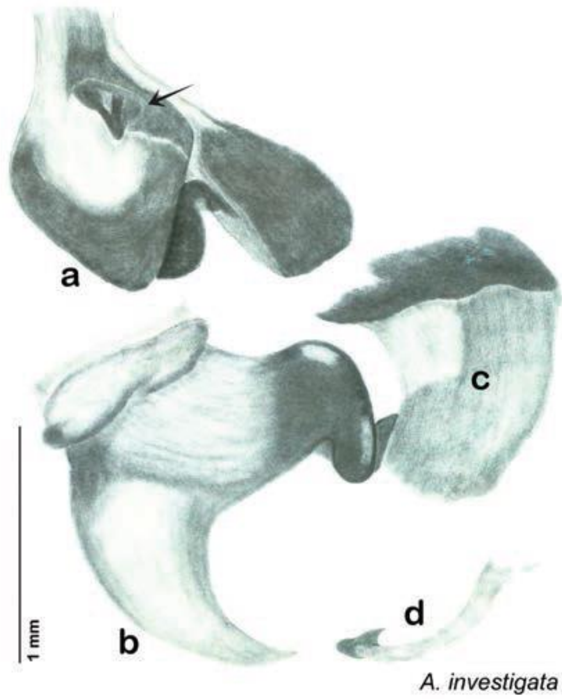


Figure 97. *A. investigata*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

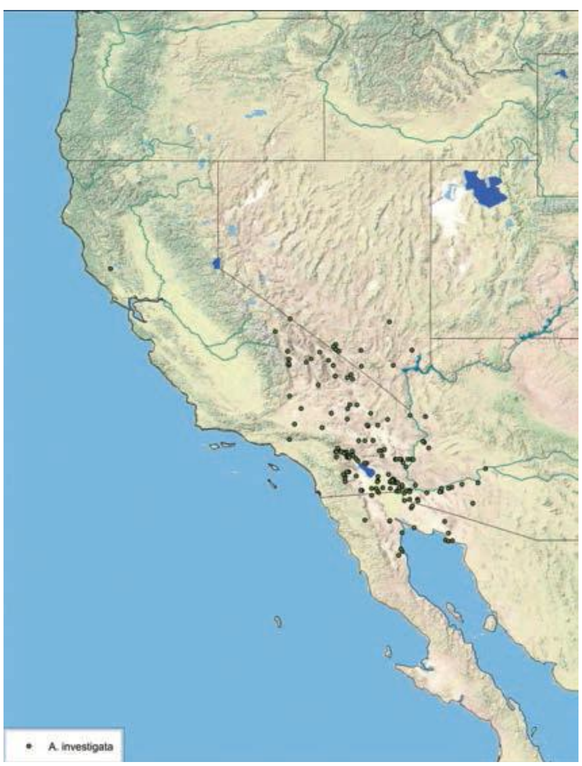


Figure 98. *A. investigata*, distribution.

***Arenivaga mckittrickae* sp. n.**

http://zoobank.org/0D018D80-7DA6-46A6-A669-AB1AECB6377D

http://species-id.net/wiki/*Arenivaga_mckittrickae*

Figures 99–101

Type locality. USA, California, San Bernardino Co., UC Burns Reserve.

Material examined. Holotype: ♂ in UCRC labeled "CA: San Bernardino Co, Pioneertown, 1350 m, UC Burns Reserve, 25 June 1995, J. Freilich, 37-78N 5-50E" " HOLOTYPE *Arenivaga mckittrickae* Hopkins, 2012" [red label with black border].

Paratypes (24): USA: CA, Los Angeles Co., Mint Canyon, 9/4/1946, P Greeley (3, LACM); CA, Los Angeles Co., Mint Canyon, 8/15/1946, 2000 ft., P Greeley, *Arenivaga* (1, LACM); CA, Los Angeles Co., Mint Canyon, 7/1/1946, 2000 ft., P Greeley (1, LACM); CA, Wrightwood, San Gabriel Mts., 6/26/1986, GH Nelson, Merc.Vap.Lite (3, FSCA); CA, San Bernardino Co., Mojave River Forks, 10 km SE of Hesperia, 7/11/1986, (3, UCRC); CA, San Bernardino Co., 4 mi. N of Cajon Pass, 6/12/1966, Middlekauff & Rentz (1, EMEC); CA, San Bernardino Co., Yucca Valley, Skyline Rd., UC Burns Res., 9/17/1994, W Sakai, black light (1, UCRC); CA, San Bernardino Co., San Bernardino Mts., Cushionberry Grade, 7/8/1986, GF Pratt (1, UCRC); CA, San Bernardino Co., Pioneertown, UC Burns Res., 7/9/1994, J Frellich (1, UCRC); CA, Los Angeles Co., Bouquet, 7/23/1937, N Westerland (2, LACM); CA, Los Angeles Co., Bouquet Canyon, 6/23/1937, N Westerland, at lights (1, LACM); CA, Sierra Madre, 4/10/1940 (2, LACM); CA, San Mateo (1, LACM); CA, Riverside Co., Joshua Tree NM, 9/22/1979, CD Nagano, U.Covington Flat (1, LACM); CA, San Bernardino Co., Pioneertown, UC Burns

Res., 8/30/1995, 1350 m, J Frellich, 37-78N 5-50E (1,UCRC). All paratypes labeled "Paratype *Arenivaga mckittrickae* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for F.A. McKittrick, author of the incomparable "Evolutionary Studies of Cockroaches".

Distribution. This species is distributed from Mint Canyon, Los Angeles Co., in its northern and western extents to Joshua Tree NM, Riverside Co., in its southern and eastern extents. Its distribution follows the San Gabriel Mountain range of southern California. One specimen labeled "San Mateo" may be mislabeled or transported to that locality. See Fig. 101.

Diagnosis. *A. mckittrickae* is distinguished by the sinuous medial margin and narrow hook-shaped lobe on the right dorsal phallomere as well as the unusually shaped head on the genital hook. See Fig. 100.

Description. Male. Measurements. Holotype TL = 18.4 mm, GW = 7.6 mm, PW = 4.98 mm, PL = 3.58 mm, TL/GW = 2.42, PL/PW = 0.72. EW = 0.3 mm; OW = 0.45 mm. Among paratypes range of TL 16.9–19.8; range of GW 7.4–9.3; range of PW 5.10–5.79; range of PL 3.20–4.06.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm); interocular space mildly convex and dark brown with small ridges in rays around upper apex of eyes and extending onto ocellar tubercles, interocellar space concave, with faint horizontal corrugations. Posterior frons concave, uniformly light brown; anterior frons bulbous with slight central indentation at posterior end; broad, flat, light brown anteclypeus. See Fig. 99d.

Pronotum. Pronotum translucent, waxy beige; dorsal surface of pronotum with short fine brown setae centrally and posteriorly grading to longer, thicker setae laterally and anteriorly; pronotal pattern brown “panther face”; some detail discernible; brown maculations scattered across posterior 70% of dorsal surface of pronotum. See Fig. 99c. Body. Wing brace present. Two tarsal claws present. Legs and body light orangebrown, with darker maculation laterally on each sternite; subgenital plate dark orangebrown; strongly asymmetrical with rounded apices. See Fig. 99b.

Forewings. Wings extended well beyond abdominal apex (~50% of wing length); color varies from uniform brown, to blotchy brown, to light orange-brown; surface ranges from glossy translucent to matte opaque. See Fig. 99a.

Genitalia. Right dorsal phallomere composed of bulbous sclerotized hook-shaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; increasingly punctate towards rim; rim shagreened; inner rim forms sweeping S-curve with added straight edge posteriorly; phallomere otherwise unmodified. Small central sclerite rugose, punctate, with posteriorly projecting, more sclerotized lip at anterior end; right ventral phallomere extends from articulation to form rounded shagreened structure with small interiorly directed nipple; attached anteriorly is mildly dorsally projecting flanged arm, shagreened with roughly toothed edge. Folded anterior portion of left phallomere with lightly sclerotized indentation, otherwise unmodified. Genital hook with blunt rounded head with short hook; arm robust and slightly shorter than usual in *Arenivaga*. See Fig. 100.

Habitat and natural history. All life history elements remain unobserved.

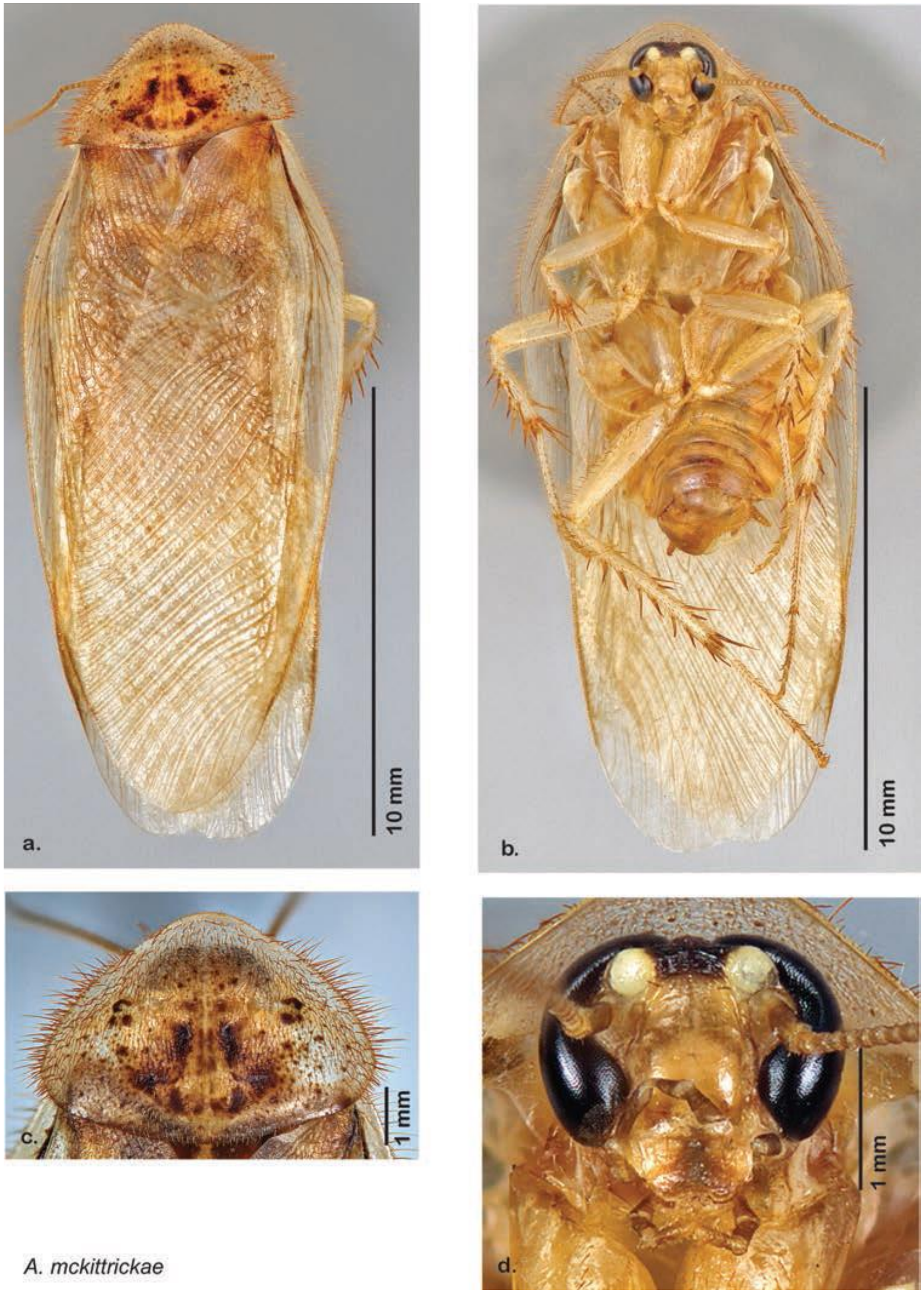


Figure 99. *A. mckittrickae* a dorsal habitus b ventral habitus c pronotum d head.

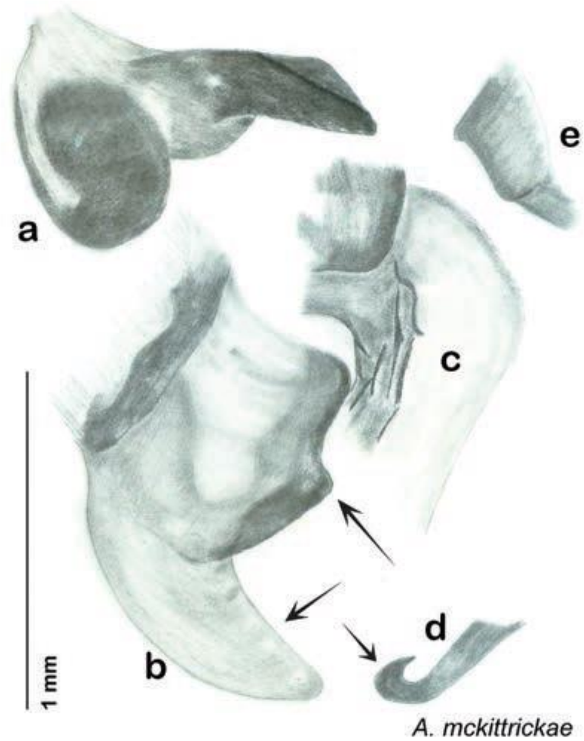


Figure 100. *A. mckittrickae*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook e left phallomere. Arrow(s) indicate diagnostic characters (see text).

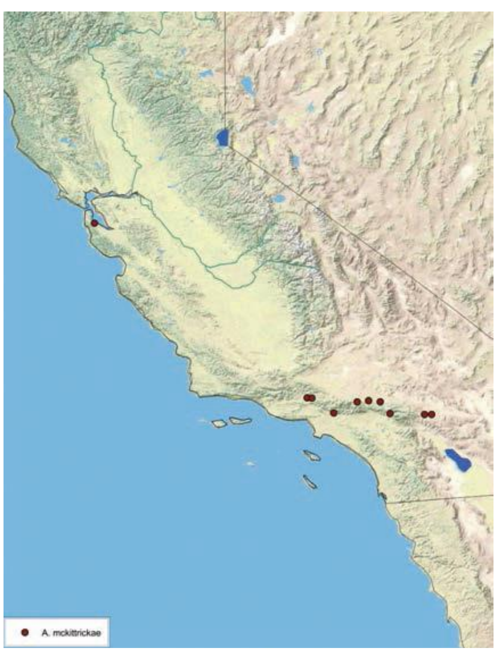


Figure 101. *A. mckittrickae*, distribution.

***Arenivaga milleri* sp. n.**

http://zoobank.org/E197CE33-847B-43C1-A982-691D8DF7732A

http://species-id.net/wiki/*Arenivaga_milleri*

Figures 102–104

Type locality. USA, California, Mono Co., Benton.

Material examined. Holotype: ♂ in FSCA labeled “Benton, Mono Co., Calif., VII-20-50, H. A. Hunt Collector” “ HOLOTYPE *Arenivaga milleri* Hopkins, 2012” [red label with black border].

Paratypes (29): USA: CA, Mono Co., Benton, 7/16/1972 (7, CSCA); CA, Mono Co., Benton, 8/10/1972 (3, CSCA); CA, Mono Co., Benton, 7/10/1940, JG Shanafelt (3, LACM); CA, Mono Co., Benton Station, 6/10/1940, JG Shanafelt (2, LACM); CA, Mono Co., Benton, 8/5/1940, JG Shanafelt (3, LACM); CA, Mono Co., 4 mi N of Benton, 6/12-8/31/1980, 5600 ft., D Giuliani, antifreeze pit trap (1, CSCA); CA, Inyo Co., Fish Lake Valley, 6 mi S and 4 mi E of Oasis, 10/20/1983-6/1/1986, 5200 ft., D Giuliani, antifreeze pit trap (2, CSCA); CA, Inyo Co., 8/1/1922, OC Poling (1, ANSP); CA, Inyo Co., Westguard Pass, White Mts., 7/19/1968, J Scott, at light (1, EMEC); NV, Mercury, 8/9/1964, 12M(TB) (2, USNM); NV, Churchill Co., Blow Sand Mts., T15N, R30E, 8/2/1979, RC Bechtel, LM Hanks, DL Horton & RW Rust, Black Light Trap, 1 specimen-*Arenivaga erratica* Rehn det. RC Bechtel ‘80 (2, NVDA); NV, Churchill Co., Blow Sand Mt. 28 mi SSE Fallon, 8/3/1979, RW Rust, *Arenivaga erratica* Rehn det. RC Bechtel ‘80 (1, NVDA); NV, Washoe Co., Reno, 7/26/1982, JB Knight (1, NVDA). All paratypes labeled “Paratype *Arenivaga milleri* Hopkins 2012” [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for my PI Dr. Kelly Miller, an outstanding systematist, patient PI and friend, in grateful appreciation for giving the lover of cockroaches a place in your beetle lab.

Distribution. This species is found in the Mohave Desert along the California-Nevada border and northwards. An isolated specimen from northwest California is probably mislabeled or transported. See Fig. 104.

Diagnosis. *A. milleri* may be confused with *A. belli* but is distinguished by the lack of a spine on the medial margin of the right dorsal phallomere. See Figs 103 and 31.

Description. Male. Measurements. Holotype TL = 17.9 mm, GW = 10.7 mm, PW = 6.05 mm, PL = 3.70 mm, TL/GW = 1.67, PL/PW = 0.61. EW = 0.40 mm; OW = 0.40 mm. Among paratypes range of TL 17.2–20.0; range of GW 7.45–10.7; range of PW 5.37–6.05; range of PL 3.54–4.07.

Head. Two ocelli very large, ovoid and protruding (0.4 × 0.25 mm); vertex brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space deeply concave, smooth, brown fading to light brown at intersection with frons with two light brown circular indentations at base of interocular space. Posterior frons light brown fading quickly to waxy white, mildly concave with horizontal corrugations on brown portion, anterior portion of frons bulbous and waxy white; waxy white smooth anteclypeus. See Fig. 102d.

Pronotum. Pronotum translucent, waxy beige; dorsal surface of pronotum densely setose with fine light brown setae; pronotal pattern light orange-brown “panther face” with moderate detail discernible; no aura. See Fig. 102c.

Body. Wing brace present. Two tarsal claws present. Legs and body light brown;

subgenital plate light brown with orange-brown margin; asymmetrical with rounded apices. See Fig. 102b.

Forewings. Wings extended well beyond abdominal apex (~30% of wing length); color light brown to medium brown depending on specimen and blotchy; surface matte and opaque. See Fig. 102a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized hook-shaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin heavily sclerotized, shagreened, with slightly wavy toothed edge. Small central sclerite flat and finely punctate with posteriorly projecting, heavily toothed flanges dorsally and ventrally; right ventral phallomere extends from articulation to form structure rounded and punctate at posterior apex receding into narrower corrugations apically, followed by punctate rounded concave arm extending beyond depth of rest of phallomere. Folded anterior portion of left phallomere setose, otherwise unmodified. Genital hook with moderate extension to pointed head with very slight concavity on short hook; arm smoothly curving. See Fig. 103.

Habitat and natural history. All life history elements remain unobserved.

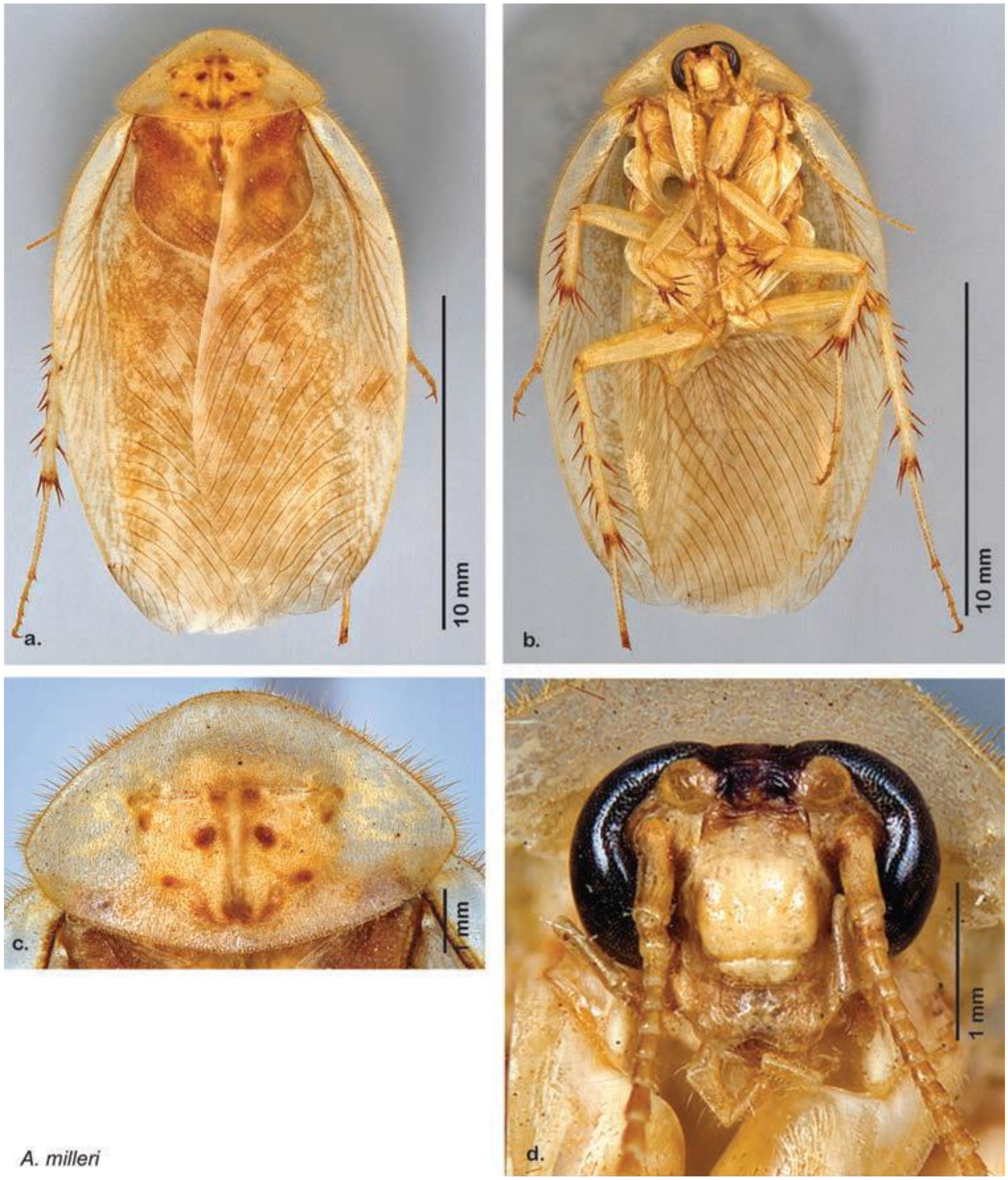


Figure 102. *A. milleri* a dorsal habitus b ventral habitus c pronotum d head.

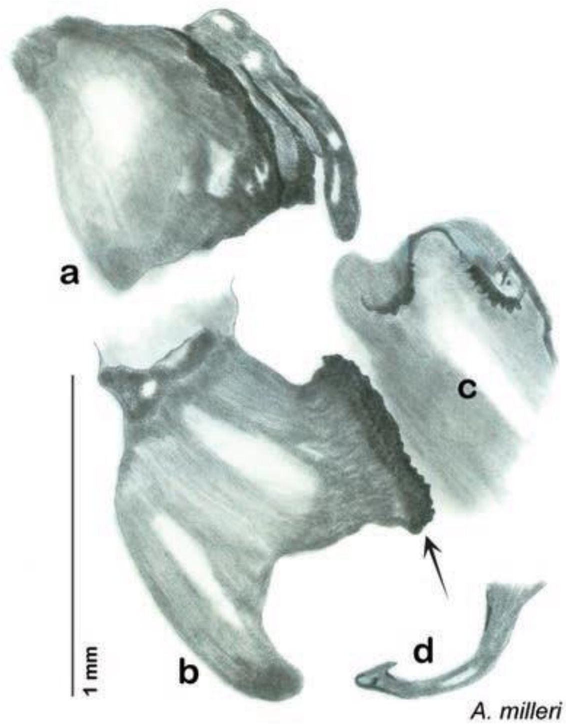


Figure 103. *A. milleri*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

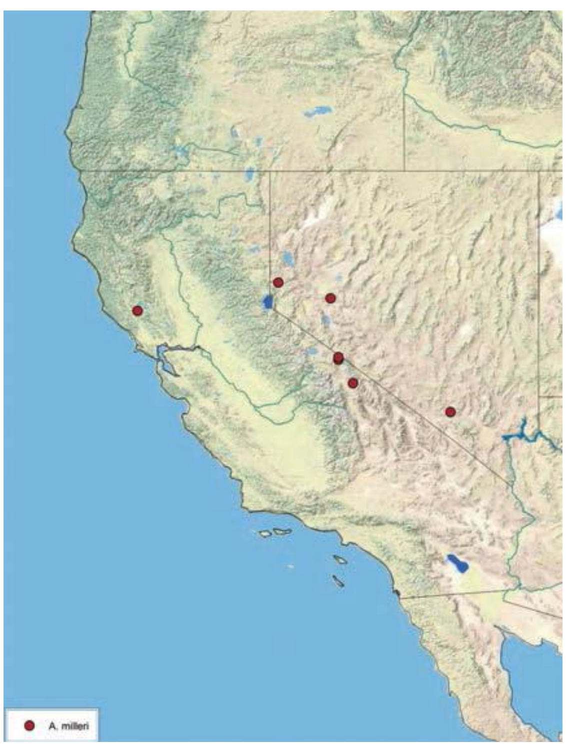


Figure 104. *A. milleri*, distribution.

***Arenivaga moctezuma* sp. n.**

http://zoobank.org/F550FA6F-0039-44DD-943A-882ED7C70A64

http://species-id.net/wiki/*Arenivaga_moctezuma*

Figures 105–107

Type locality. MEXICO, Sonora, 4.3 mi E Moctezuma.

Material examined. Holotype: ♂ in SDMC labeled "MEXICO: Sonora, 4.3 mi E Moctezuma, 18-21 July 1987, N. Bloomfield" "HOLOTYPE *Arenivaga moctezuma* Hopkins, 2012" [red label with black border].

Paratypes (3): MEXICO: Sonora, 4.3 mi E of Moctezuma, 7/18-21/1987, N Bloomfield (3, SDMC). All paratypes labeled "Paratype *Arenivaga moctezuma* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for the town Moctezuma, near which all known specimens originate.

Distribution. This species is known only from the type locality. See Fig. 107.

Diagnosis. *A. moctezuma* may be mistaken for *A. adamsi* but is distinguished by a smaller, glabrous spine on the left phallomere and a much smaller and simpler small central sclerite. See Figs 106 and 13.

Description. Male. Measurements. Holotype TL = 18.1 mm, GW = 8.9 mm, PW = 5.70 mm, PL = 4.25 mm, TL/GW = 2.03, PL/PW = 0.75. EW = 0.50 mm; OW = 0.50 mm. No notable difference in size among paratypes.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm); vertex dark brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; pale midline; interocellar space concave, medium brown, lighter anteriorly with three indentations at points of an equilateral triangle, top one round, bottom two eyebrow-shaped. Frons waxy white with brown edges near ocelli; posterior concave; anterior frons bulbous and waxy white; waxy white smooth anteclypeus. See Fig. 105d.

Pronotum. Pronotum translucent waxy beige; dorsal surface of pronotum with short orange-brown setae that are thicker and longer laterally; pronotal pattern dark orange-brown "panther face" with considerable detail discernible; lateral and anterior aura. See Fig. 105c.

Body. Wing brace present. Two tarsal claws present. Legs and body light brown; subgenital plate light brown; asymmetrical with rounded apices. See Fig. 105b.

Forewings. Wings extended well beyond abdominal apex (~35% of wing length); blotchy medium to dark brown; surface matte and opaque. See Fig. 105a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, unusually curved, bulbous hook-shaped lobe, articulated with right ventral phallomere on lateral side; medial side of lobe deeply emarginated from medial edge of remainder of phallomere; central field deep, cupped, lightly sclerotized; medial margin wide, more heavily sclerotized, smooth, with long ventrally projecting spine and one dorsally projecting spine located midway along margin. Small central sclerite concave, punctate, with large shagreened medially projecting wide upside-down-V-shape on anterior edge; right ventral phallomere extends from articulation to form shagreened rounded structure, with prominent medially projecting two-prong spine located posteriorly; attached anteriorly is flanged punctate concave arm that extends slightly beyond depth of rest of phallomere, edge shagreened. Folded anterior portion of left phallomere dramatically modified with sclerotized punctate anterior wall and posteriorly projecting smooth spine located ventrally. Genital hook with moderate extension to pointed head with moderate hook; curve of arm reduced. See Fig. 106.

Habitat and natural history. All life history elements remain unobserved.

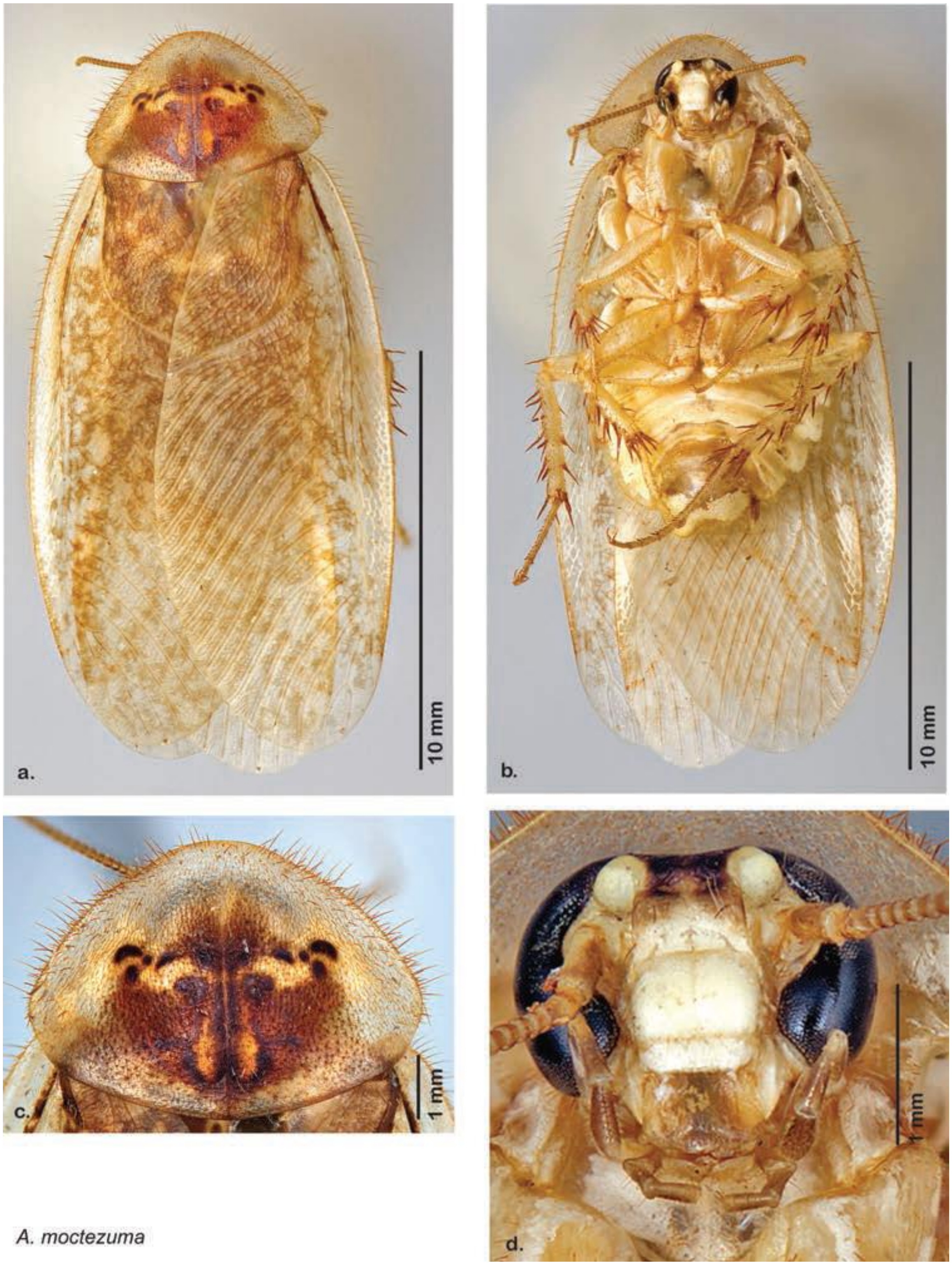


Figure 105. *A. moctezuma* a dorsal habitus b ventral habitus c pronotum d head.

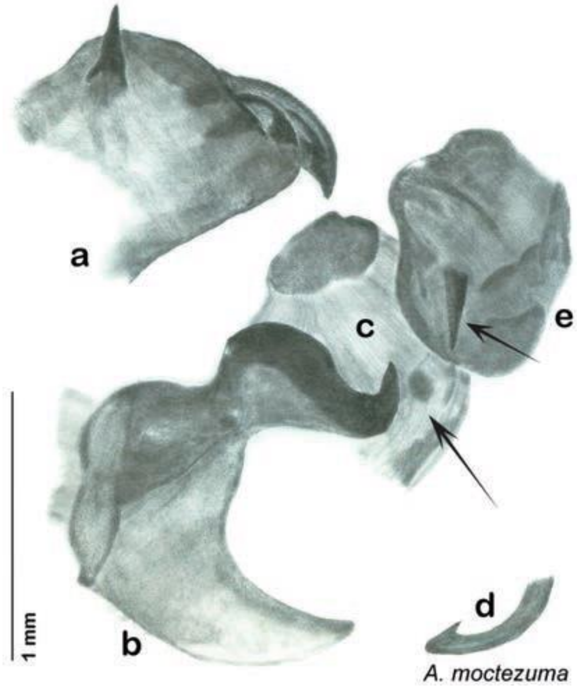


Figure 106. *A. moctezuma*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook e left phallomere. Arrow(s) indicate diagnostic characters (see text).

Figure 107. *A. moctezuma*, distribution.

***Arenivaga mortisvallisensis* sp. n.**

http://zoobank.org/3086A1CB-8F24-43DE-89B7-E9EF84621413

http://species-id.net/wiki/*Arenivaga_mortisvallisensis*

Figures 108–110

Type locality. USA, California, Inyo Co., Death Valley, Sand Spring

Material examined. Holotype: ♂ in CSCA labeled "CALIF: Inyo Co., Sand Spring 15.5 mi NW Scottys Castle, 3100', II-87 to IX-1987, Antifreeze pit trap" "HOLOTYPE *Arenivaga mortisvallisensis* Hopkins, 2012" [red label with black border].

Paratypes: None at this time.

Etymology. This species is named for its locality, Death Valley, CA.

Distribution. This species is only known from one specimen from Death Valley NM, CA. See Fig. 110.

Diagnosis. *A. mortisvallisensis* is smaller than average for *Arenivaga* but may be confused with *A. delicata* which has sympatric distribution. *A. mortisvallisensis* may be distinguished by the medial margin of the right dorsal phallomere that projects anteriorly in pronounced manner into rounded, shagreened lobe with toothed margin. See Figs 109 and 40.

Description. Male. Measurements. Approximate due to poor condition of specimen. Holotype TL = 15.3 mm, GW = 6.2 mm, PW = 4.3 mm, PL = 3.24 mm, TL/GW = 2.47, PL/PW = 0.75. EW = 0.60 mm; OW = 0.40 mm.

Head. Two ocelli large, ovoid and less protruding than on most species (0.3 × 0.2 mm); vertex unusually broad, dark brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space concave, smooth, dark brown; two teardrop shaped indentations medial to ocelli. Frons very dark brown, posterior half flat, tectiform just below indentations; anterior portion of frons bulbous, very dark brown; very dark brown smooth anteclypeus. See Fig. 108d.

Pronotum. Pronotum translucent, waxy beige; dorsal surface of pronotum with short fine golden setae centrally and posteriorly grading to longer, thicker setae laterally and anteriorly; pronotal pattern dark brown “panther face”, impressed, with little discernible detail; no aura. See Fig. 108c.

Body. Wing brace present. Two tarsal claws present. Legs and body orange-brown; abdomen missing from specimen; species, or perhaps just this specimen, unique in its almost complete absence of deposits of uric acid, and those only very minimally in forewings. Subgenital plate cleared in KOH with genitalia therefore color uncertain; strongly asymmetrical with rounded apices. See Fig. 108b.

Forewings. Wings extended beyond abdominal apex though distance cannot be estimated as abdomen is missing; transparent pale brown with veins darker brown; surface hyaline. See Fig. 108a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin strongly projected anteriorly into rounded, shagreened lobe with toothed margin. Small central sclerite of nondescript shape, finely punctate, mostly flat with ventrally bent rim slightly more sclerotize and densely punctate; right ventral phallomere extends from articulation to form rounded somewhat elongate smooth structure that becomes shorter and punctate anteriorly; attached anteriorly is mildly dorsally projecting flanged arm, shagreened with lightly toothed edge. Folded anterior portion of left phallomere setose, otherwise unmodified. Genital hook with short distance to pointed head with short hook; arm very delicate. See Fig. 109.

Habitat and natural history. All life history elements remain unobserved.

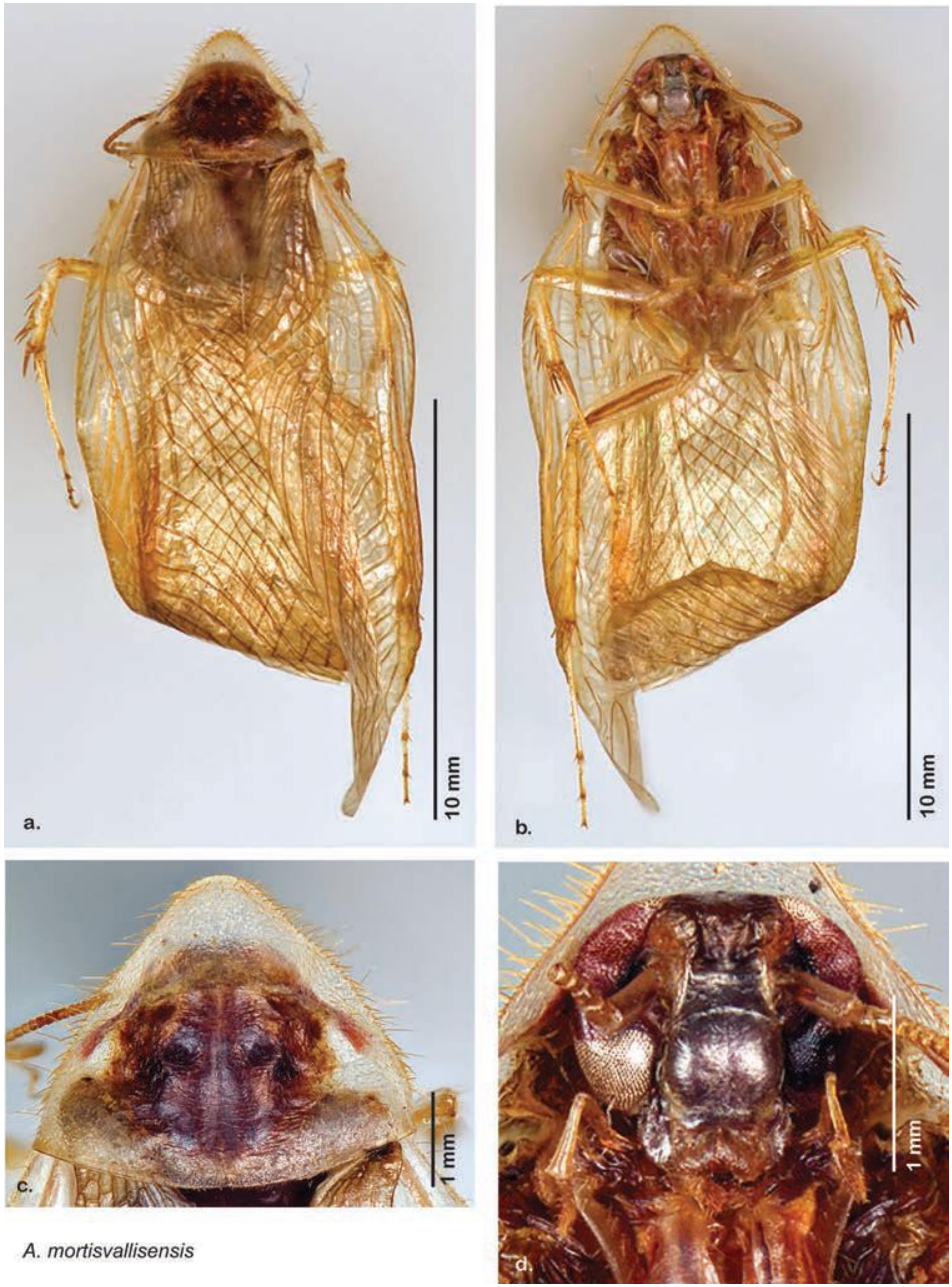


Figure 108. *A. mortisvallisensis* a dorsal habitus b ventral habitus c pronotum d head.

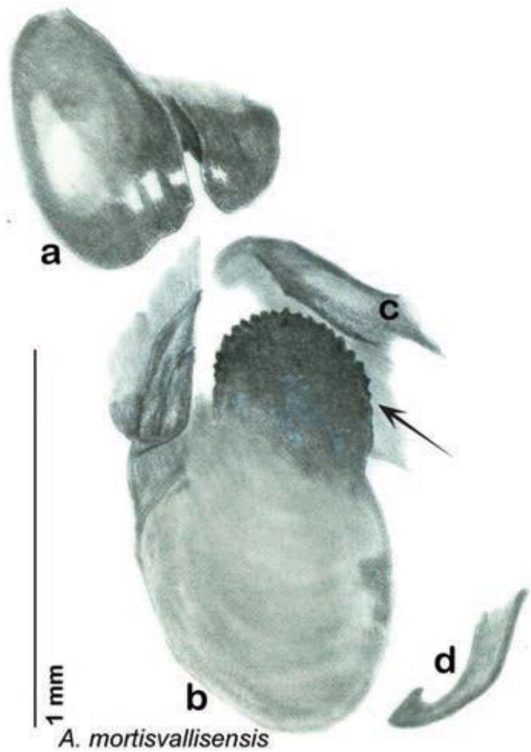


Figure 109. *A. mortisvallisensis*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 110. *A. mortisvallisensis*, distribution.

***Arenivaga nalepae* sp. n.**

http://zoobank.org/FEC7E11C-1FB4-48F3-BCE1-2BD1CD580790

http://species-id.net/wiki/*Arenivaga_nalepae*

Figures 111–113

Type locality. USA, California, Riverside Co., Box Canyon.

Material examined. Holotype: ♂ in LACM labeled "CALIF., Riverside Co., Box Canyon, Mecca Hills, 600 ft. el., 12 Sept. 1986, J P & KES Donahue" " HOLOTYPE *Arenivaga nalepae* Hopkins, 2012" [red label with black border].

Paratypes (73): USA: CA, Riverside Co., Box Canyon, Mecca Hills, 9/12/1986, 600 ft., JP & KES Donahue (14, LACM); CA, Imperial Co., Imperial Valley, near Wister, 10/27/1990, minus 75 ft., JP & KES Donahue, T9S R13E Sec.35, #149799 (1, LACM); CA, Riverside Co., Lamb Canyon, 2 mi. NW of Gilman Hot Springs, 3/7-11/27/1988, 1500 ft., FG Andrews, Pit trap (1, CSCA); CA, Riverside Co., Painted Canyon, 9/13/1979-1/7/1979, FG Andrews, E.glycol pit trap in desert wash (1, CSCA); CA, Riverside Co., Pinyon Flat, 8/5/1966, CA & MJ Tauber (1, EMEC); CA, Riverside Co., S side of Orocopia Mts., 3/25/1990, 900 ft., JP & KB Donahue,T7S R13B SW 1/4S.30, #2911 (1, LACM); CA, San Diego Co., Borrego Springs, 11/21/1958, JW Baker Jr., Black light trap, 58K25-1 (1, CSCA); CA, Riverside Co., Chiriaco Pass, 9/18/1971 (2, UCRC); CA, Imperial, 13 mi. NW of Glamis, 10/9/1993, 33.06.3N 115.15.3W, 250 ft., RR & C Snelling, black light (1, LACM); CA, Colton(?), 9/?/1949, O Cluh(?) (1, UCRC); CA, Fresno Co., Waltham Creek, 4 mi W of Coalinga, 8/28/1952, Leech & Green, dry bed (1, CAS); CA, San Bdno. Co., Cajon Wash, 8/4/40, 2000', Collected by J. C. vonBloeker (1, LACM); CA, Los Angeles Co., Black Butte, Antelope Valley, 8/22/1959, G Sphon (3, LACM); CA, LA Co., Black Butte, Antelope Valley, 7/25/1959, G Sphon, one specimen genitalia incomplete (5, LACM); CA, Inyo Co., Dunmovin, 9/6/1948, SA Sher, *Arenivaga erratica* Rehn det. HF Strohecker 1953 (1, USNM); CA, Los Angeles Co., Whitehorn Picnic Area, Angeles NF, 8/22/1959, JA Honey (1, LACM); CA, Los Angeles, 6 mi. W of Lancaster, 10/3-5/1960, JA Chemsak (1, EMEC); CA, Kern Co., 8/29/1949, McKittrick, [one specimen missing head] (3, LACM); CA, Boron, 8/9/1959, J Helfer, black dot (1, USNM); CA, Los Angeles Co., Juniper Hills, 8/26/1973, A.V. Evans (1, LACM); CA, Kern Co., 4 mi NE of Mohave, 9/17/1966, TR Haig (6,CSCA); CA, Kern Co., Red Rock Canyon SP, Ricardo Ranger Station, 8/31-9/1/1991, 2700 ft., JP Donahue T9S R37E Sec.34,#24,431 (3, LACM); CA, Kern Co., Bakersfield, 4/6/1981, M Bock (1, LACM); CA, Kern Co., Bakersfield, 8/?/1954, R Smith, Cal.Dept.Agr.59H14-13, ex building (2,CSCA); CA, Fresno Co., Ciero Hills 18 air mi. SW of Mendota, 3/16/1975, J.T.Doyen, at light (2,EMEC); CA, Kings Co., Kettleman, 8/29/1972, L Bookout, *Arenivaga* sp. Det.AR Hardy 1972, Cal.Dept.Agr.37260, 7255-24, black light (2,CSCA); CA, Kern Co., near Buttonwillow, 9/27/1962, JR Anderson, ex burrow of Citellus beecheyi (1, EMEC); CA, Inyo Co., Saline Valley Salt Marsh, 1060’, 7/1/1976, D. Giuliani, collected at blacklight (1, CSCA); CA, Inyo Co., Inyo Mts., Lead Canyon, 9/2/1976, 6-6500 ft., D Giuliani, BLM Survey, Inyo Co. Saline Valley 1976 site 3 (3, LACM); CA, Inyo Co., Eureka Valley Dunes, 9/4/1975, D Giuliani (3, CSCA); CA, Inyo Co., Eureka Valley Dunes, 7/13/1975, Andrews & Hardy (1, CSCA); NV, Mercury, 8/14/1964, 1BB25M(T) (1, USNM); AZ, Yuma Co., nr. Tacna, on dunes, night, 12/16/2010, 32.696N 113.79W, 148 m, AD Smith (3, HEH). MEXICO: BC, San Felipe, 6/15/1952, Cazier, Gertsch & Schrammel (1, AMNH). All paratypes labeled "Paratype *Arenivaga nalepae* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for Christine Nalepa, who loves cockroaches, encourages that love in others, and co-authored "Cockroaches: Ecology, Behavior and Natural History", a book that had a profound effect on me.

Distribution. This species is distributed from Saline Valley Salt Marsh in its northern and western extents to San Felipe, Baja California Norte, Mexico in its southern and eastern extents. See Fig. 113.

Diagnosis. *A. nalepae* sp. n. is average in size and coloration for *Arenivaga*. It can be mistaken phenotypically for many other species, and its genitalia closely resemble that of *A. belli*, with whom it is probably closely related. The shape of the hook-shaped lobe on the right dorsal phallomere and the overall proportions of the right ventral phallomere are two distinguishing characters of this species. See Figs 112 and 31.

Description. Male. Measurements. Holotype TL = 20.4 mm, GW = 8.8 mm, PW = 6.22 mm, PL = 4.08 mm, TL/GW = 2.32, PL/PW = 0.65. EW = 0.25 mm; OW = 0.25 mm. Among paratypes range of TL 15.9–22.7; range of GW 6.9–11.0; range of PW 4.83–7.75; range of PL 3.43–4.61.

Head. Two ocelli very large, ovoid and protruding (0.5 × 0.4 mm), surrounded by waxy beige >0.1 mm border; vertex dark brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space concave, dark brown with central medium brown dimple and two deep set medium brown dimples medial to inner apex of ocelli. Posterior frons pale orange-brown fading to waxy white towards clypeus, concave; anterior frons waxy white, bulbous; broad flat waxy white anteclypeus. See Fig. 111d.

Pronotum. Pronotum translucent, waxy beige; dorsal surface of pronotum with short fine brown setae laterally and anteriorly; pronotal pattern orange-brown “panther face” with little discernible detail; slight lateral aura. See Fig. 111c.

Body. Wing brace present. Two tarsal claws present. Legs and body light orangebrown, darker maculation laterally on each sternite; subgenital plate with darker orange-brown border; strongly asymmetrical with rounded apices. See Fig. 111b.

Forewings. Wings extended well beyond abdominal apex (~40% of wing length); light beige with occasional orange-brown blotches depending on specimen; surface translucent with slight sheen. See Fig. 111a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized hookshaped lobe, articulated with right ventral phallomere on lateral side; central field slightly sclerotized; medial margin heavily sclerotized, extending into smooth spine near distal end. Small central sclerite flat and finely punctate with posteriorly projecting, shagreened crescent in which dorsal arm of crescent is more prominently raised and toothed than ventral arm; right ventral phallomere extends from articulation to form rounded punctate structure at posterior apex but with shagreened corrugations at anterior apical end, followed by smaller offset shagreened projection and then by rounded concave arm extending beyond depth of rest of phallomere. Folded anterior portion of left phallomere setose, otherwise unmodified. Genital hook with long extension to pointed head with slight concavity on short hook; arm has distinct bend. See Fig. 112.

Habitat and natural history. This species is found in varied habitat from seashore to mountains to inland sand dunes and lakeshores. All other life history elements remain unobserved.

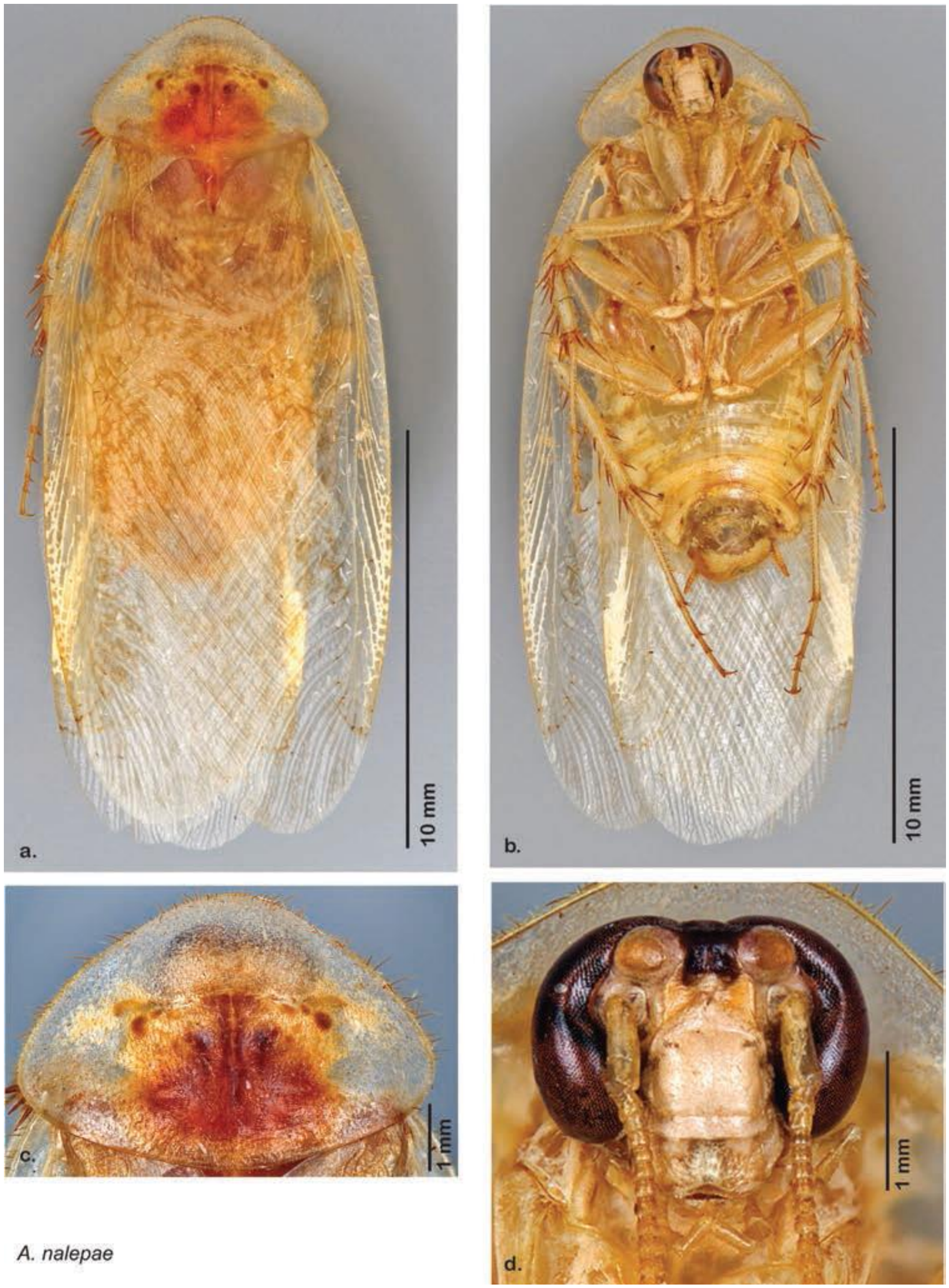


Figure 111. *A. nalepae* a dorsal habitus b ventral habitus c pronotum d head.

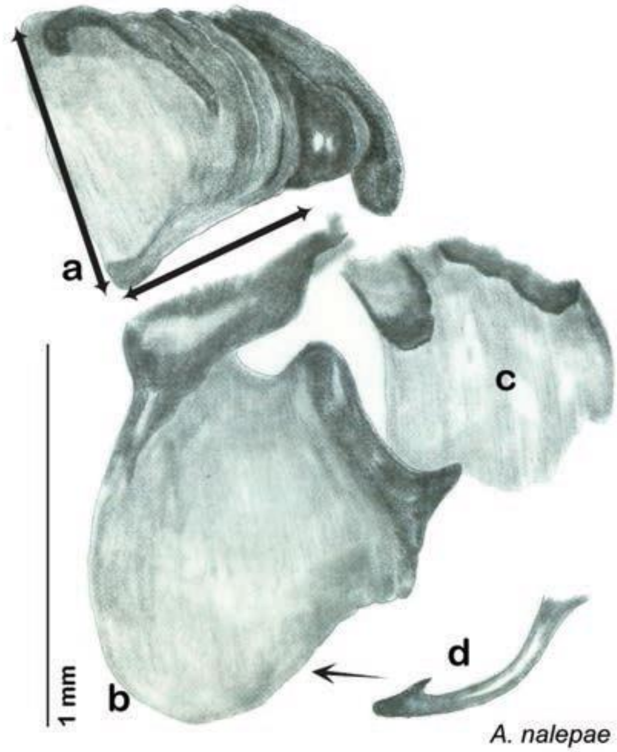


Figure 112. *A. nalepae*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

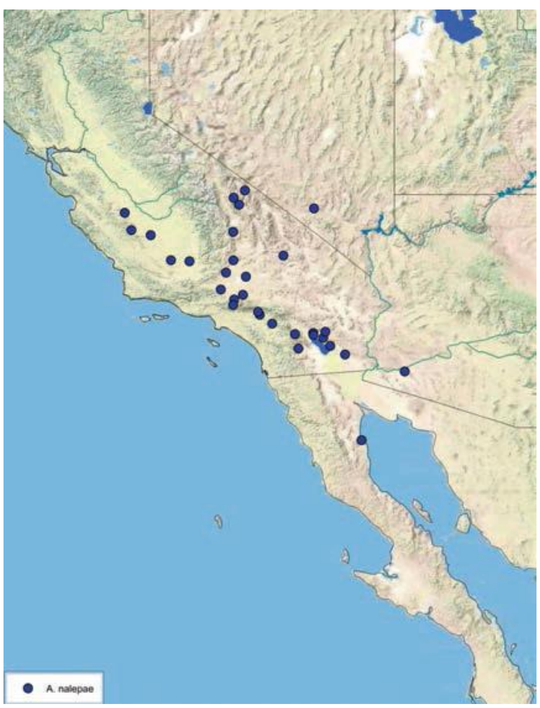


Figure 113. *A. nalepae*, distribution.

***Arenivaga nicklei* sp. n.**

http://zoobank.org/6D09FDC0-2F98-4FCA-A510-02682881B662

http://species-id.net/wiki/*Arenivaga_nicklei*

Figures 114–116

Type locality. MEXICO, BC, 14.4 mi S Campo Alfonsina.

Material examined. Holotype: ♂ in SDMC labeled "MEX: Baja Cal. Nor., 14.4 mi. S. Campo Alfonsina, X-20/26-87, Norris Bloomfield, green dot" "HOLOTYPE *Arenivaga nicklei* Hopkins, 2012" [red label with black border].

Paratypes (16): MEXICO: BC, Isla San Lorenzo Sur, canyon at SW end, 7/27/1986, Weissman & Lightfoot, Stop #86-86 (7, CAS); BCS, 10 mi S of Punta Prieta, 6/21/1938, Michelbacher & Ross, photo.spec. (1, CAS); BC, Isla de Cedros, trail from El Pueblo to Cerro de Cedros, 9/28/1984, 0-180 m, Weissman & Lee, Stop #84-64 (1, CAS); BC, 19 mi SW of Campo Alfonsina (canyon), 10/27-28/1987, N Bloomfield, green dot (2, SDMC); BC, 14.4 mi S of Campo Alfonsina, 10/20-26/1987, N Bloomfield, green dot (4, SDMC). USA: AZ, Pima Co., Organ Pipe Cactus NM, 3/23/1953, & H Dietrich (1, CUIC). All paratypes labeled "Paratype *Arenivaga nicklei* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for Dr. David Nickle, who with Dr. Ashley Gurney was the last to work on revising *Arenivaga* and was most generous with his knowledge upon learning of my work.

Distribution. This species in found in central Baja and the nearby islands. See Fig. 116.

Diagnosis. *A. nicklei* can be distinguished by its very prominent lobe on the small central sclerite and two prominent spines on the medial margin of the right dorsal phallomere. See Fig. 115.

Description. Male. Measurements. Holotype TL = 18.4 mm, GW = 9.5 mm, PW = 5.20 mm, PL = 3.94 mm, TL/GW = 1.94, PL/PW = 0.76. EW = 0.20 mm; OW = 0.35 mm. Among paratypes range of TL 16.1–20.0; range of GW 6.75–9.5; range of PW 5.00–6.05; range of PL 3.94–4.23.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm); vertex medium brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space concave, medium brown, with small round central indentation. Posterior frons waxy white, unusually wide, concave; anterior portion of frons bulbous and waxy white; waxy white smooth anteclypeus. See Fig. 114d.

Pronotum. Pronotum translucent waxy beige; dorsal surface of pronotum with short orange-brown setae that are thicker and longer laterally; pronotal pattern orange-brown to dark brown "panther face", with considerable detail no aura. See Fig. 114c.

Body. Wing brace present. Two tarsal claws present. Legs and body light brown; many specimens with yellow-brown maculations laterally on each sternite; subgenital plate light brown with darker margin; asymmetrical with rounded apices. See Fig. 114b.

Forewings. Wings extended well beyond abdominal apex (up to 30% of wing length); blotchy light to medium brown depending on specimen; surface matte and opaque. See Fig. 114a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, unusually long, bulbous hook-shaped lobe, articulated with right ventral phallomere on lateral side; medial side of lobe deeply emarginated from medial edge of remainder of phallomere; central field shallow, cupped, lightly sclerotized; medial margin more heavily sclerotized, smooth, with long posterior projecting spine and second medially projecting spine located midway along medial margin. Small central sclerite concave, punctate, with large shagreened medially projecting bulge on ventral edge, second smaller punctate bulge above first; right ventral phallomere extends from articulation to form shagreened rounded structure, with prominent medially projecting spine located posteriorly; attached anteriorly is mildly dorsally projecting flanged punctate concave arm, that extends beyond depth of rest of phallomere. Folded anterior portion of left phallomere tri-fold, with small bulge on posterior fold, setose. Genital hook with moderate extension to pointed head with slight indentation along line to moderate hook; arm with distinct bend. See Fig. 115.

Habitat and natural history. All life history elements remain unobserved.

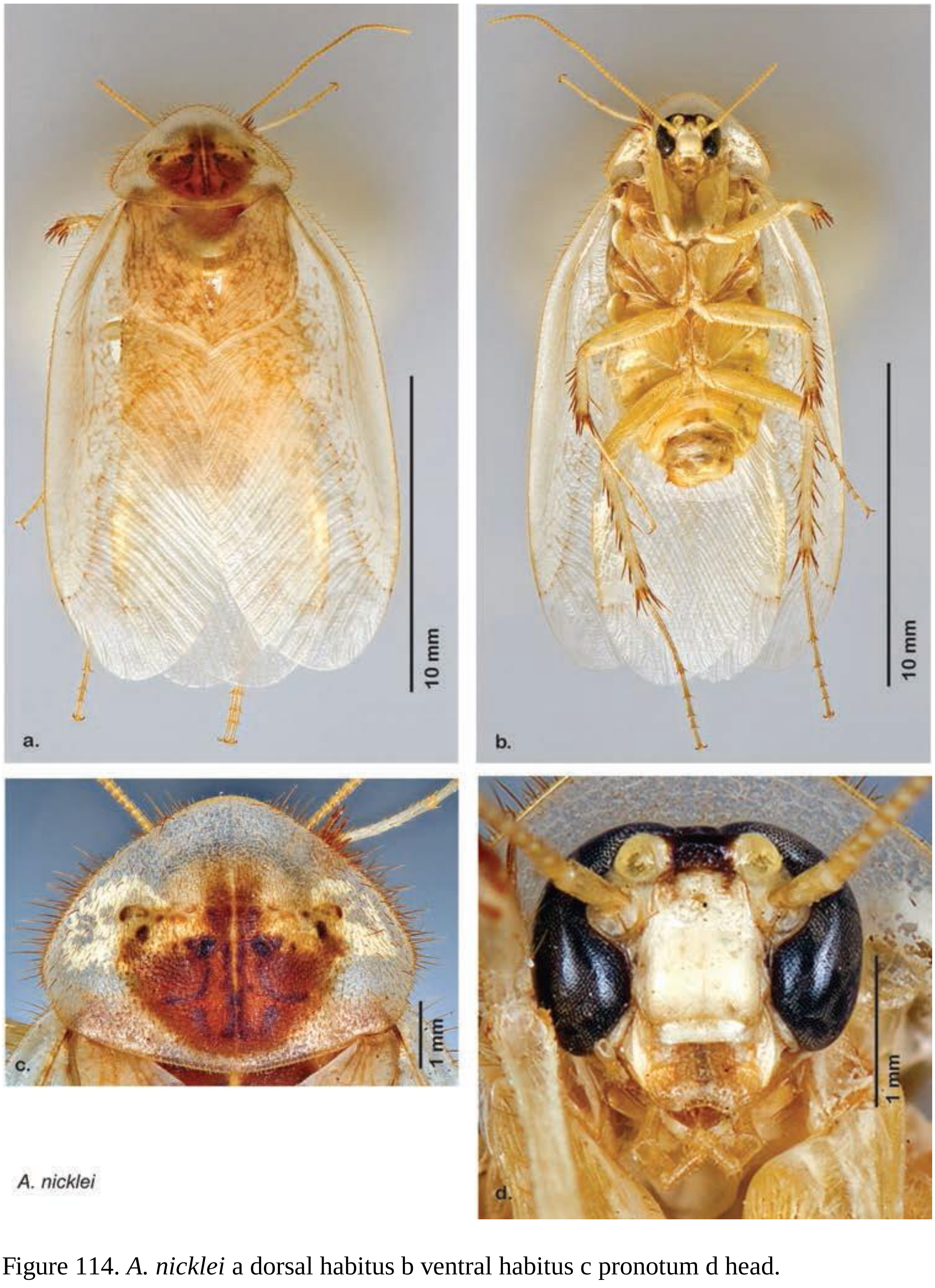


Figure 114. *A. nicklei* a dorsal habitus b ventral habitus c pronotum d head.

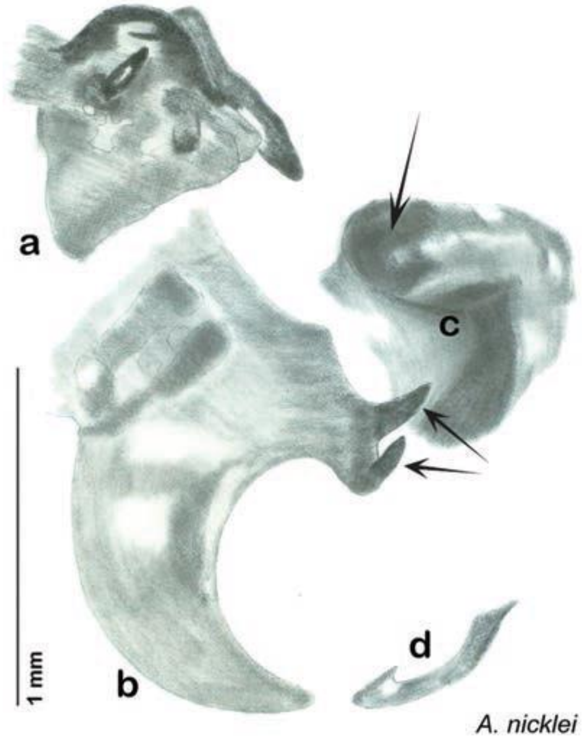


Figure 115. *A. nicklei*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 116. *A. nicklei*, distribution.

***Arenivaga nocturna* sp. n.**

http://zoobank.org/331ED73E-ED88-4D7B-8CA3-DF35AB3416B6

http://species-id.net/wiki/*Arenivaga_nocturna*

Figures 117–119

Type locality. MEXICO, Baja California, Rancho Union.

Material examined. Holotype: ♂ in SDMC labeled "Rancho Union, Baja California Mex., April 17, 1947,Charles F. Harbison Collector" "HOLOTYPE *Arenivaga nocturna* Hopkins, 2012" [red label with black border].

Paratypes (8): MEXICO: BC, Angeles Bay, Gulf of CA, 6/26/1921, EP Van Duzee, *Arenivaga erratica* Rehn det. Hebard 1922 on one specimen (2, CAS); BC, Angeles Bay, Gulf of CA, 6/26/1921, EP Van Duzee, Hebard Collection (2, ANSP); BC, Rancho Union, 4/17/1947, CF Harbison (1, SDMC); BC, Bahia de LA, 6/2/1981, Werner,Olson,Hetz,Thomas,Burne,Frank & MacLachlan (2, UAIC); Coahuila, ca. 7.2 mi. SSW of Cuatro Cienegas, 10/10/1978, C.E. Dunnr (1, ANSP). All paratypes labeled "Paratype *Arenivaga nocturna* Hopkins 2012" [blue label with black border].

Etymology. The name is an adjective in the nominative singular. This species is named from the Latin meaning nocturnal or "of the evening".

Distribution. This species is found in southeastern Baja California Norte, Mexico. See Fig. 119.

Diagnosis. *A. nocturna* can be distinguished by its narrow, sweeping hook-shaped lobe on the right dorsal phallomere, as well as the broad short spine on the medioventral side of the posterior end of the medial margin of the same phallomere. See Fig. 118.

Description. Male. Measurements. Holotype TL = 20.7 mm, GW = 9.2 mm, PW = 6.53 mm, PL = 4.61 mm, TL/GW = 2.25, PL/PW = 0.71. EW = 0.30 mm; OW = 0.50 mm. Among paratypes range of TL 17.1–21.7; range of GW 8.3–9.8; range of PW 5.70–6.72; range of PL 4.05–4.63.

Head. Two ocelli large, ovoid and protruding (0.50 × 0.35 mm); vertex medium brown, with small ridges between apices of eyes and extending onto ocellar tubercles; interocellar space concave, medium brown, with two pale round indentations, pale medially. Posterior frons light brown, concave; anterior frons light brown, bulbous; light brown anteclypeus. See Fig. 117d.

Pronotum. Pronotum translucent waxy beige; dorsal surface of pronotum covered with short orange-brown setae that are longer and thicker laterally; pronotal pattern light orange-brown "panther face"; little discernible detail; no aura. See Fig. 117c.

Body. Wing brace present. Two tarsal claws present. Legs and body medium orange-brown; subgenital plate light orange-brown, strongly asymmetrical with rounded apices. See Fig. 117b.

Forewings. Wings extended beyond abdominal apex (up to 40% of total wing length); pale golden beige with no markings to light brown with scattered medium brown blotches; surface translucent and hyaline in most specimens, though matte and opaque in some. See Fig. 117a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized hookshaped lobe, articulated with right ventral phallomere on lateral side; central field slightly sclerotized; medial margin heavily sclerotized, smooth anteriorly, becoming punctate then shagreened posteriorly, extending posteriorly into shagreened knob with short dorsally projecting spine. Small central sclerite large for this sclerite, concave, punctate with toothed patch along ventral edge. Right ventral phallomere extends from articulation to form large smooth rounded, increasingly punctate and sclerotized anteriorly; one smaller punctate ridge anteriorly, followed by moderate gap and then by long rounded concave shagreened arm extending beyond depth of rest of phallomere. Folded anterior portion of left phallomere setose, otherwise unmodified. Genital hook with moderate extension to pointed head with slight concavity on short hook; arm long, narrow, barely curved. See Fig. 118.

Habitat and natural history. All life history elements remain unobserved.

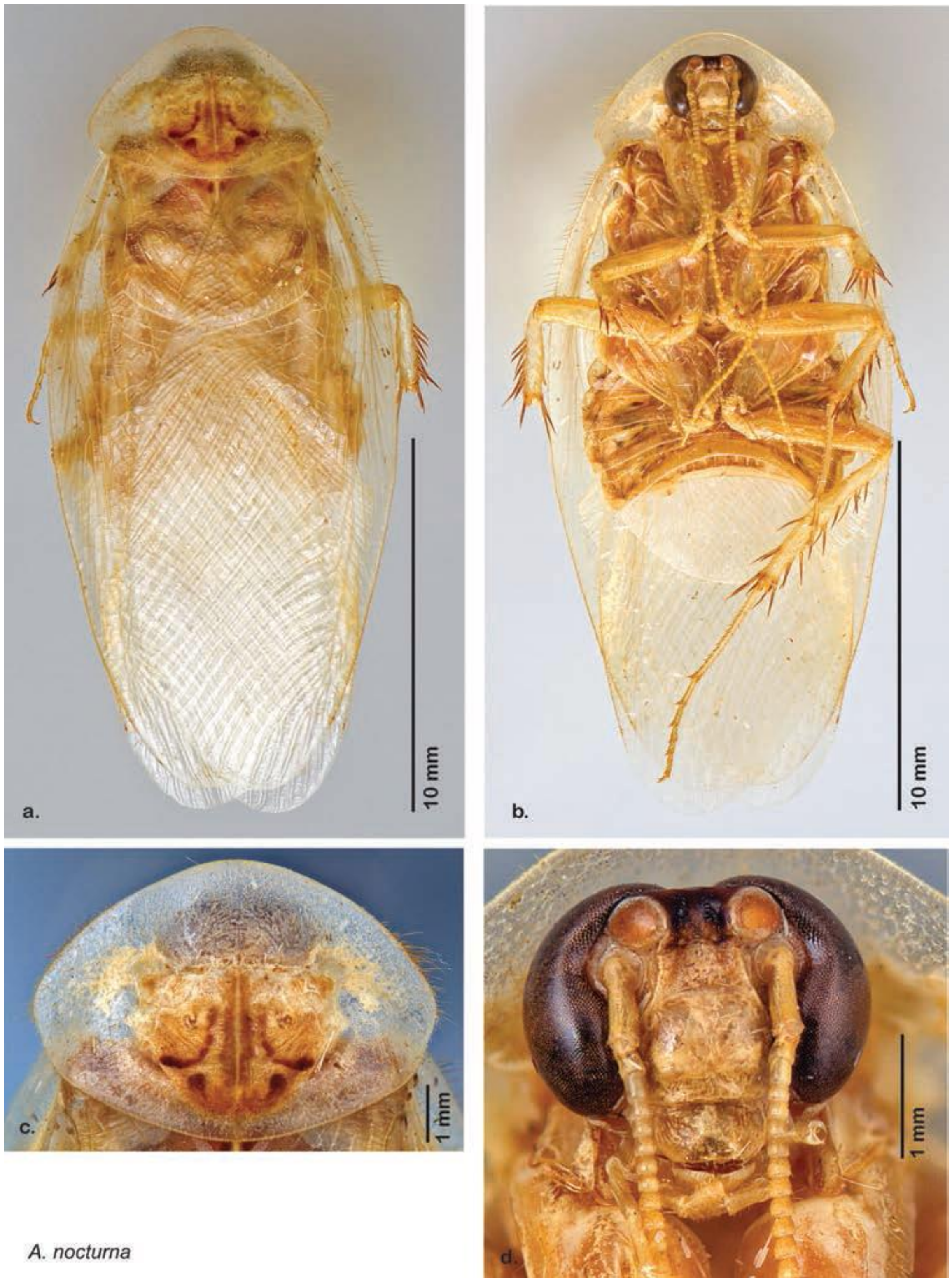


Figure 117. *A. nocturna* a dorsal habitus b ventral habitus c pronotum d head.

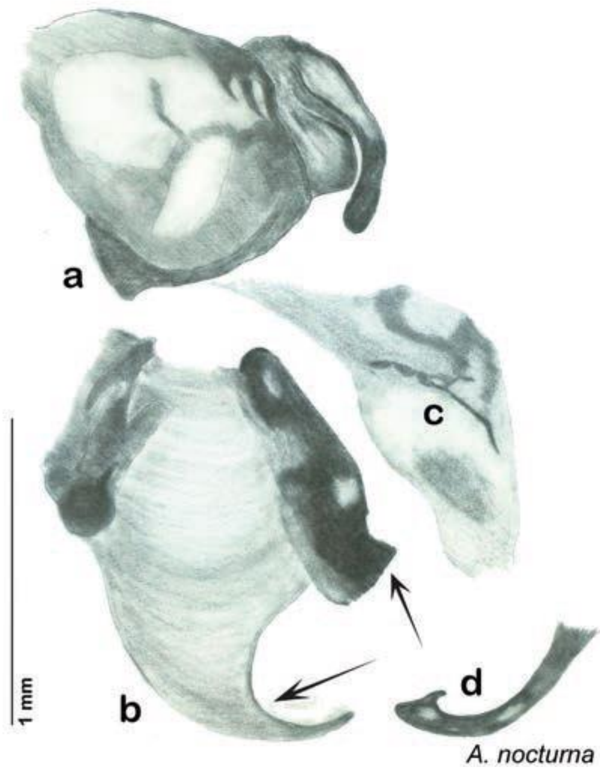


Figure 118. *A. nocturna*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

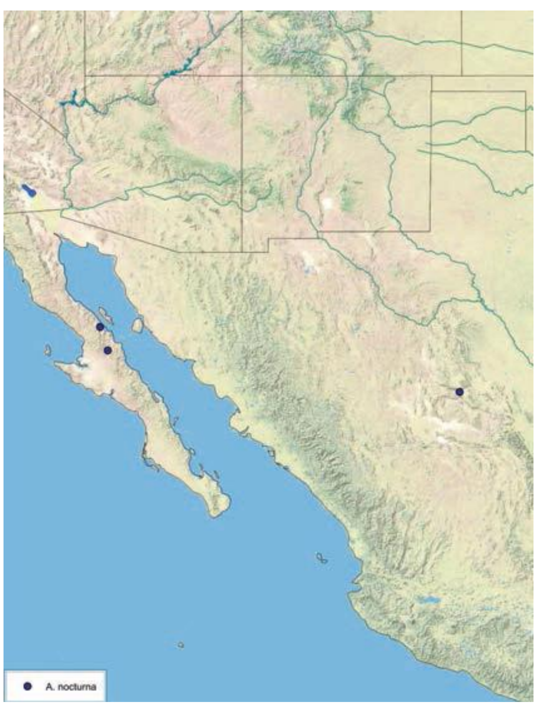


Figure 119. *A. nocturna*, distribution.

***Arenivaga pagana* sp. n.**

http://zoobank.org/65A4DC70-14C8-422B-B4C7-2D0185D1D002

http://species-id.net/wiki/*Arenivaga_pagana*

Figures 120–122

Type locality. USA, Arizona, Mohave Co., Colorado River, Grand Canyon.

Material examined. Holotype: ♂ in NAUF labeled "Mohave Co. AZ, Colorado R. GC, blue label with '3', rm202.5L, 9/4/03, Coll. R.J.Delph, Ex: Light, New High Water" "HOLOTYPE *Arenivaga pagana* Hopkins, 2012" [red label with black border].

Paratypes (9): USA: AZ, Mohave Co., Colorado River GC, 9/4/2003, RJ Delph, blue label with '3', rm 202.5L, ex.light, new high water (2, NAUF); AZ, Mohave Co., Colorado River GC, 9/9/2001, J Rundall, blue label with '3', rm 198.0R, ex.light, old high water (1, NAUF); AZ, Mohave Co., Colorado River GC, 9/9/2002, RJ Delph, blue label with '3', rm 186.5L, ex.light, old high water, NAU 107 (1, NAUF); AZ, Coconino Co., 10 mi. N & 4 mi. W of Page, 3/?-9/?/1985, 6000 ft., D Giuliani, antifreeze pit trap (2, CSCA); AZ, Coconino Co., Colorado River GC, 9/1/2002, RJ Delph, blue label with '3', rm37.3L, ex.light, old high water (1, NAUF); AZ, Coconino Co., Colorado River GC, 10/18/1982, 855 m, LE Stevens, blue label with '3', M:53R, Nankowap, sand dunes at night, Polyphagidae, *Arenivaga* det. D.Lightfoot (1, NAUF); AZ, Mojave Co., Virgin River Gorge, 8/3/1976, A.Strong (1, UCRC). All paratypes labeled "Paratype *Arenivaga pagana* Hopkins 2012" [blue label with black border].

Etymology. The name is an adjective in the nominative singular. This species is named from the Latin meaning "of the country", or rustic.

Distribution. This species is found north of the Grand Canyon from southwestern Utah through northwestern Arizona to southeastern Nevada. See Fig. 122.

Diagnosis. *A. pagana* can be distinguished by the unusual 90 degree bend in the medial margin of the right dorsal phallomere. See Fig. 121.

Description. Male. Measurements. Holotype TL = 16.5 mm, GW = 9.1 mm, PW = 5.00 mm, PL = 3.46 mm, TL/GW = 1.81, PL/PW = 0.69. EW = 0.20 mm; OW = 0.30 mm. Among paratypes range of TL 16.2–16.6; range of GW 6.9–9.1; range of PW 4.50–5.00; range of PL 3.43–3.89.

Head. Two ocelli very large, ovoid and protruding (0.4 × 0.30 mm); vertex dark brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space concave, smooth, medium brown, lighter brown medially, with two white horizontal indentations at base of interocular space. Posterior frons light transparent brown posteriorly fading to waxy beige anteriorly, slightly concave, with horizontal corrugations; anterior frons bulbous and waxy beige; light transparent brown smooth anteclypeus. See Fig. 120d.

Pronotum. Pronotum translucent, waxy beige; dorsal surface of pronotum with short orange-brown setae that are slightly thicker laterally; pronotal pattern varying from yellow to orange-brown to dark orange-brown “panther face”, with little discernible detail; no aura. See Fig. 120c.

Body. Wing brace present. Two tarsal claws present. Legs and body light brown with darker brown maculations laterally on each sternite; subgenital plate light brown with darker margin; asymmetrical with rounded apices. See Fig. 120b.

Forewings. Wings extended well beyond abdominal apex (~40% of wing length); translucent light beige with light brown blotches; surface varies from hyaline to very slight sheen depending on specimen. See Fig. 120a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized hookshaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin more heavily sclerotized, shagreened with rough edge, edge extends into slight point one third back from posterior end; anterior end of rim forms posteriorly curving point; anterior end of margin thickened for s short distance interiorly. Small central sclerite nearly flat, nondescript in shape, finely punctate with posteriorly projecting shagreened flanges at anterior end; right ventral phallomere extends from articulation to form smooth rounded structure becoming punctate and rugose anteriorly; attached anteriorly is mildly dorsally projecting flanged concave punctate arm that extends beyond depth of rest of phallomere. Folded anterior portion of left phallomere finely setose, otherwise unmodified. Genital hook with moderate extension to pointed head with short hook; arm with distinct bend. See Fig. 121.

Habitat and natural history. All life history elements remain unobserved.

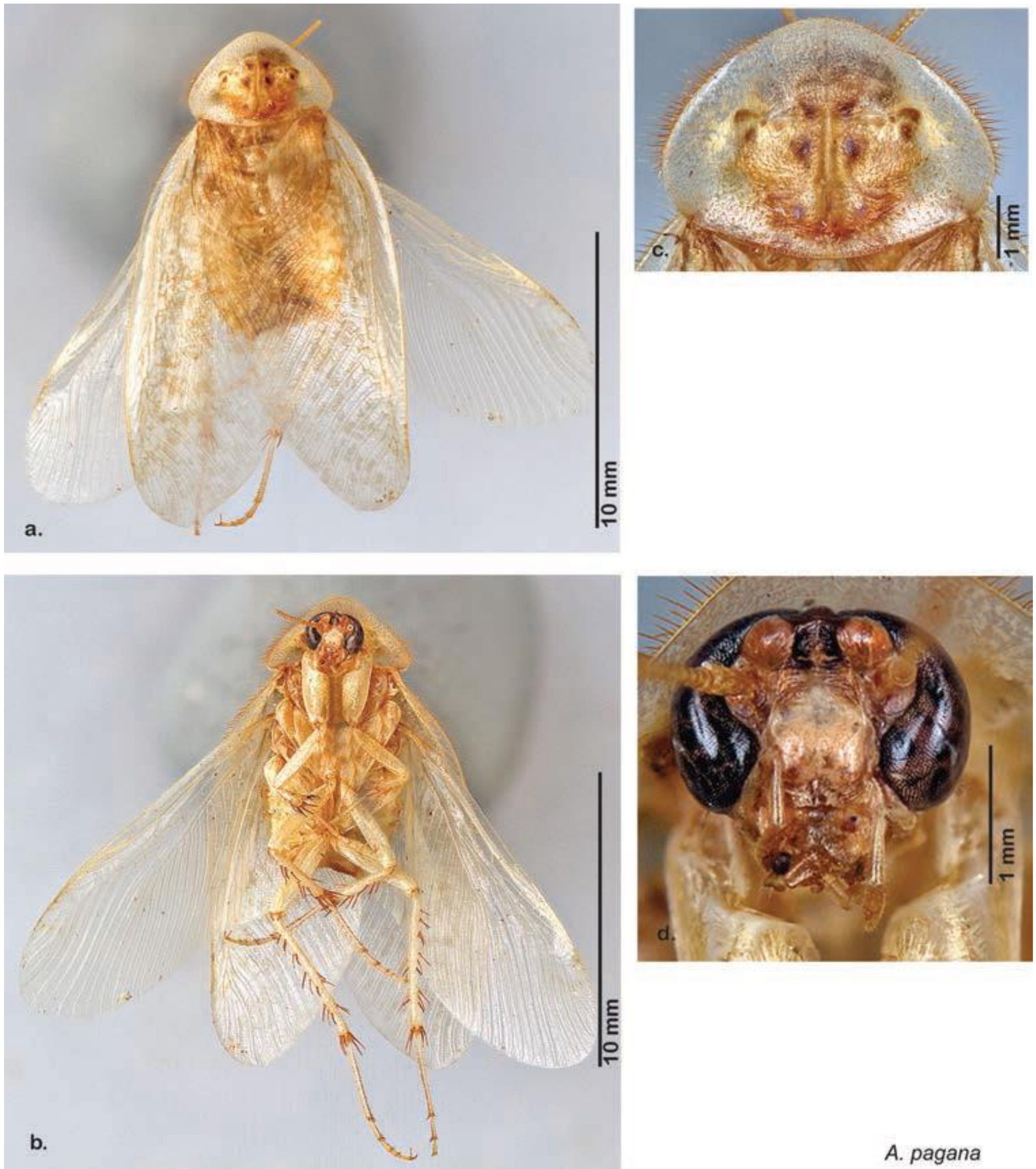


Figure 120. *A. pagana* a dorsal habitus b ventral habitus c pronotum d head.

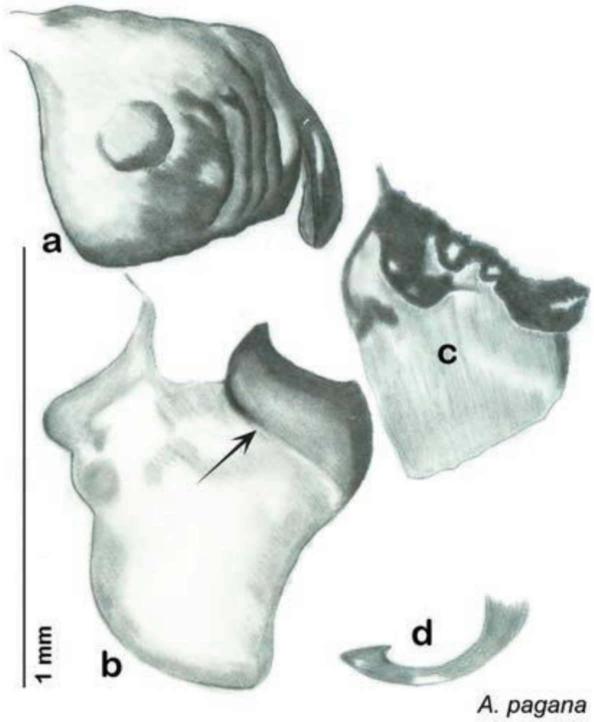


Figure 121. *A. pagana*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 122. *A. pagana*, distribution.

***Arenivaga paradoxa* sp. n.**

http://zoobank.org/B5B9ABB1-4D6A-4A66-974A-3CC4755E6821

http://species-id.net/wiki/*Arenivaga_paradoxa*

Figures 123–125

Type locality. MEXICO, BC, 15 mi S San Quintin.

Material examined. Holotype: ♂ in SDMC labeled "MEXICO: Baja Ca. Norte, 15 mi S San Quintin (dunes), 12 July 1986, Bloomfield, green dot" "HOLOTYPE *Arenivaga paradoxa* Hopkins, 2012" [red label with black border].

Paratypes: None at this time.

Etymology. The name is an adjective in the nominative singular. This species is from the Latin meaning strange or marvelous because of its strange modifications of all genital phallomeres.

Distribution. This species is known only from the type locality in on the west coast of Baja California, Mexico. See Fig. 125.

Diagnosis. *A. paradoxa* is very like *A. estelleae* but can be distinguished by the serrated and deeply sinuous medial margin on the right dorsal phallomere, as well as the large horseshoe-shaped gap on the right ventral phallomere. It shares with *A. estelleae* and *A. pumila* the odd scoop-shaped modification on the left phallomere. See Figs 124, 52 and 130.

Description. Male. Measurements. Holotype TL = 18.1 mm, GW = 9.6 mm, PW = 5.00 mm, PL = 3.62 mm, TL/GW = 1.88, PL/PW = 0.72. EW = 0.45 mm; OW = 0.50 mm. *Head.* Two ocelli large, ovoid and protruding (0.30 × 0.25 mm); vertex dark brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles;

interocellar space very slightly concave, nearly flat, dark brown, lighter center line with two short horizontal linear indentations. Posterior frons medium brown; slightly concave; anterior frons bulbous, medium brown fading to light brown anteriorly, pointed posteriorly; waxy white smooth anteclypeus. See Fig. 123d.

Pronotum. Pronotum translucent waxy beige, with fine medium brown border; dorsal surface of pronotum with short orange-brown setae that are thicker and longer laterally; pronotal pattern light and medium brown "panther face", with moderate detail discernible; scattered small brown maculations on posterior half of pronotum; no aura. See Fig. 123c.

Body. Wing brace present. Two tarsal claws present. Legs and body light brown; subgenital plate light brown; asymmetrical with rounded apices. See Fig. 123b.

Forewings. Wings extended well beyond abdominal apex; very light brown with light brown blotches; surface translucent with very slight sheen. See Fig. 123a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, bulbous hookshaped lobe, articulated with right ventral phallomere on lateral side; medial side of lobe becoming more sclerotized and shagreened as it recedes anteriorly; central field lightly sclerotized; medial margin comprised of two toothed waves. Small central sclerite delicate, concave, finely punctate, with thin sweeping margin that swings forward and attaches to dorsal side of bulbous hook-shaped lobe; anterior edge slightly or punctate and folded back posteriorly; right ventral phallomere extends from and unusually wide articulation to form punctate rounded structure, becoming shagreened on anterior side, with prominent medially projecting flat rough-edged spine located anteriorly; attached anteriorly after wide gap is broad flanged punctate concave arm that extends to depth of adjacent spine, edge toothed. Folded anterior portion of left phallomere dramatically modified into heavily setose, medially projecting, scoop shape. Genital hook with moderate extension to pointed head with broad hook, arm with shallow curve. See Fig. 124.

Habitat and natural history. All life history elements remain unobserved.

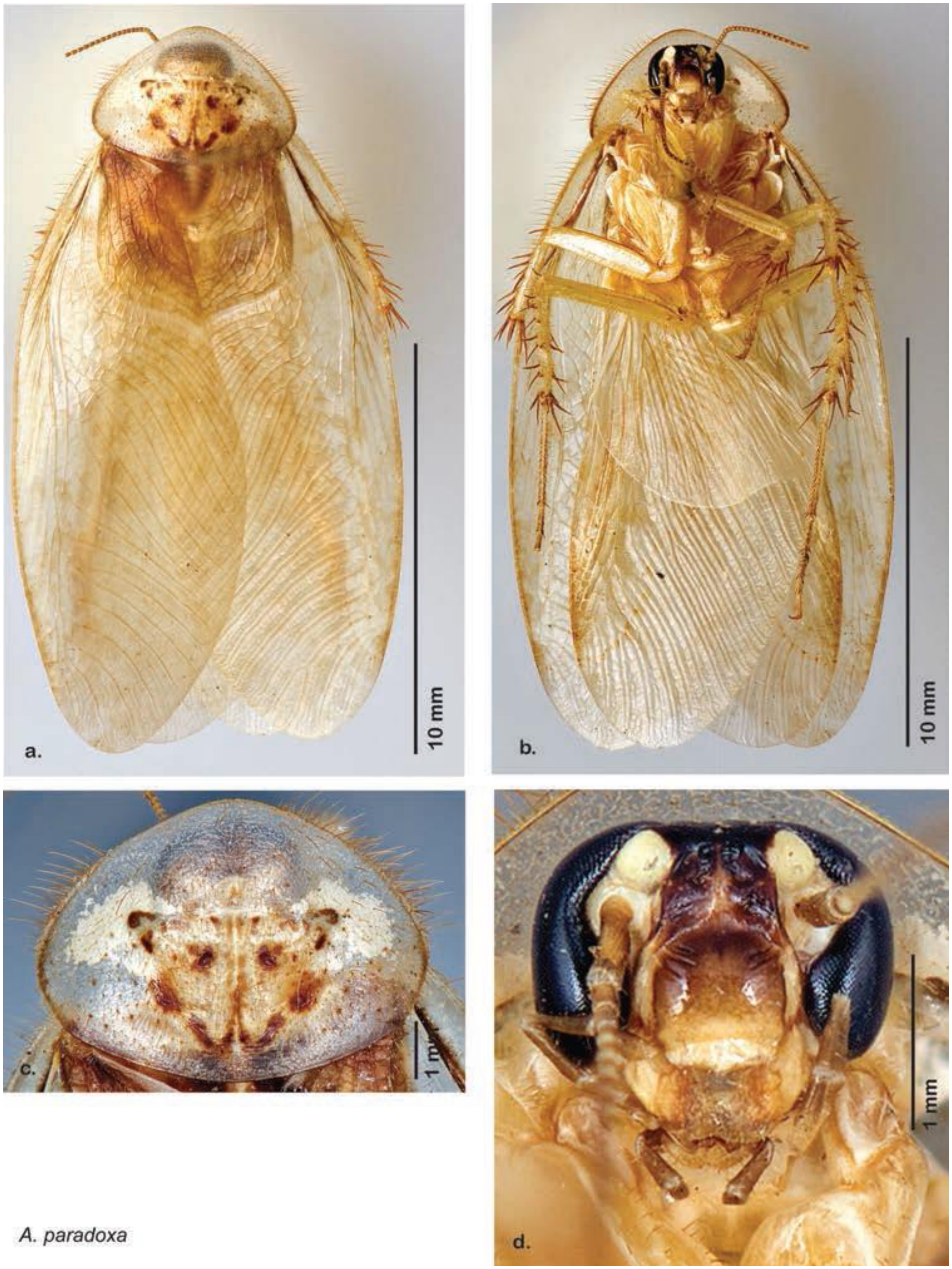


Figure 123. *A. paradoxa* a dorsal habitus b ventral habitus c pronotum d head.

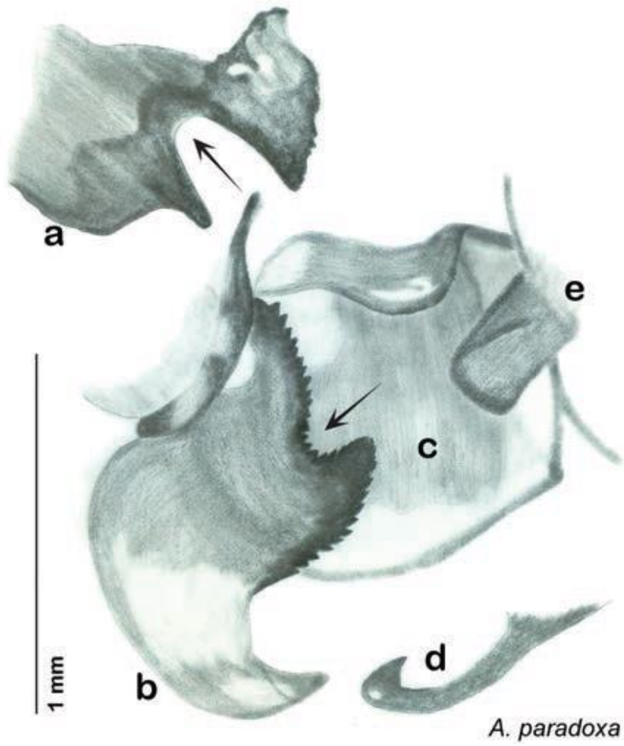


Figure 124. *A. paradoxa*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook e left phallomere. Arrow(s) indicate diagnostic characters (see text).

Figure 125. *A. paradoxa*, distribution.

***Arenivaga pratchetti* sp. n.**

http://zoobank.org/A2799EE6-7FEC-485A-85D7-109D22F90A07

http://species-id.net/wiki/*Arenivaga_pratchetti*

Figures 126–128

Type locality. USA, California, Riverside Co., Rice Dunes.

Material examined. Holotype: ♂ in EMEC labeled "ARIZ: Mohave Co. [now La Paz Co.], 3 mi. SE of Parker, VI-28-78, J.Powell, black light trap" " HOLOTYPE *Arenivaga pratchetti* Hopkins, 2012" [red label with black border].

Paratypes (15): USA: CA, Riverside Co., Rice Dunes, 19 Sept 1977, A.R. Hardy & FG Andrews, cereal bowl pit trap (1, CSCA); CA, LA Co., Black Butte, Antelope Valley, 8/22/1959, G Sphon (1, LACM); CA, LA Co., Black Butte, Antelope Valley, 10/5/1959, Honey & Sphon (1, LACM); CA, San Bernardino Co., Kelso Dunes, 9 air mi SW of Kelso, 6/29/1978, J Powell, black light (2,EMEC); CA, San Bernardino Co., Kelso Dunes, 9 air mi S of Kelso, 6/29-30/1978, Doyen & Rude, Pitfall trap (3, EMEC); AZ, Mohave Co. (now La Paz Co.), 3 mi. SE of Parker, 6/28/1978, J.Powell, black light trap (7, EMEC). All paratypes labeled "Paratype *Arenivaga pratchetti* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for the one and only Terry Pratchett, creator of Disc World and many happy hours of reading. May the strength and durability of these creatures I so love impart those gifts to him in full measure in his fight against Alzheimer's.

Distribution. This is species is found in the southern Mohave Desert of California and far western Arizona. See Fig. 128.

Diagnosis. The external phenotype of *A. pratchetti* may be confused with that of *A. investigata* with whom it is sympatric but *A. pratchetti* has dramatically pointed apices on its subgenital plate which distinguish it. See Fig. 9.

Description. Male. Measurements. Holotype TL = 16.7 mm, GW = 7.6 mm, PW = 5.35 mm, PL = 3.97 mm, TL/GW = 2.12, PL/PW = 0.74. EW = 0.25 mm; OW = 0.20 mm. Among paratypes range of TL 16.4–18.6; range of GW 7.6–9.0; range of PW 5.32–6.09; range of PL 3.93–4.48.

Head. Two ocelli very large, ovoid and protruding (0.5 × 0.35 mm); vertex medium brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space deeply concave, smooth, medium brown with light brown arrowhead shape medially. Frons and clypeus waxy white; posterior frons with horizontal corrugations, slightly concave; anterior portion of frons bulbous; waxy white smooth anteclypeus. See Fig. 126d.

Pronotum. Pronotum translucent, waxy beige; dorsal surface of pronotum with short orange-brown setae that are slightly thicker laterally; pronotal pattern “koala face” varying from yellow to orange-brown to dark orange-brown depending on specimen but in all instances with very little detail discernible; no aura. See Fig. 126c.

Body. Wing brace present. Two tarsal claws present. Legs and body light brown with pale yellow striping brown maculations laterally on each sternite; subgenital plate light brown; strongly asymmetrical with pointed apices. See Fig. 126b.

Forewings. Wings extended well beyond abdominal apex (~30% of wing length); light golden beige; surface translucent with very slight sheen. See Fig. 126a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized hookshaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin more heavily sclerotized, shagreened with toothed edge and slight thickening centrally creating small bulge along rim. Small central sclerite nearly flat, nondescript in shape, finely punctate with posteriorly projecting shagreened curved flange at anterior end; right ventral phallomere extends from articulation to form smooth rounded structure becoming punctate and rugose anteriorly; attached anteriorly is mildly dorsally projecting flanged concave punctate arm that extends greater than depth of phallomere. Folded anterior portion of left phallomere finely setose, otherwise unmodified. Genital hook with moderate extension to pointed head with short hook; arm with distinct bend. See Fig. 127.

Habitat and natural history. All life history elements remain unobserved.

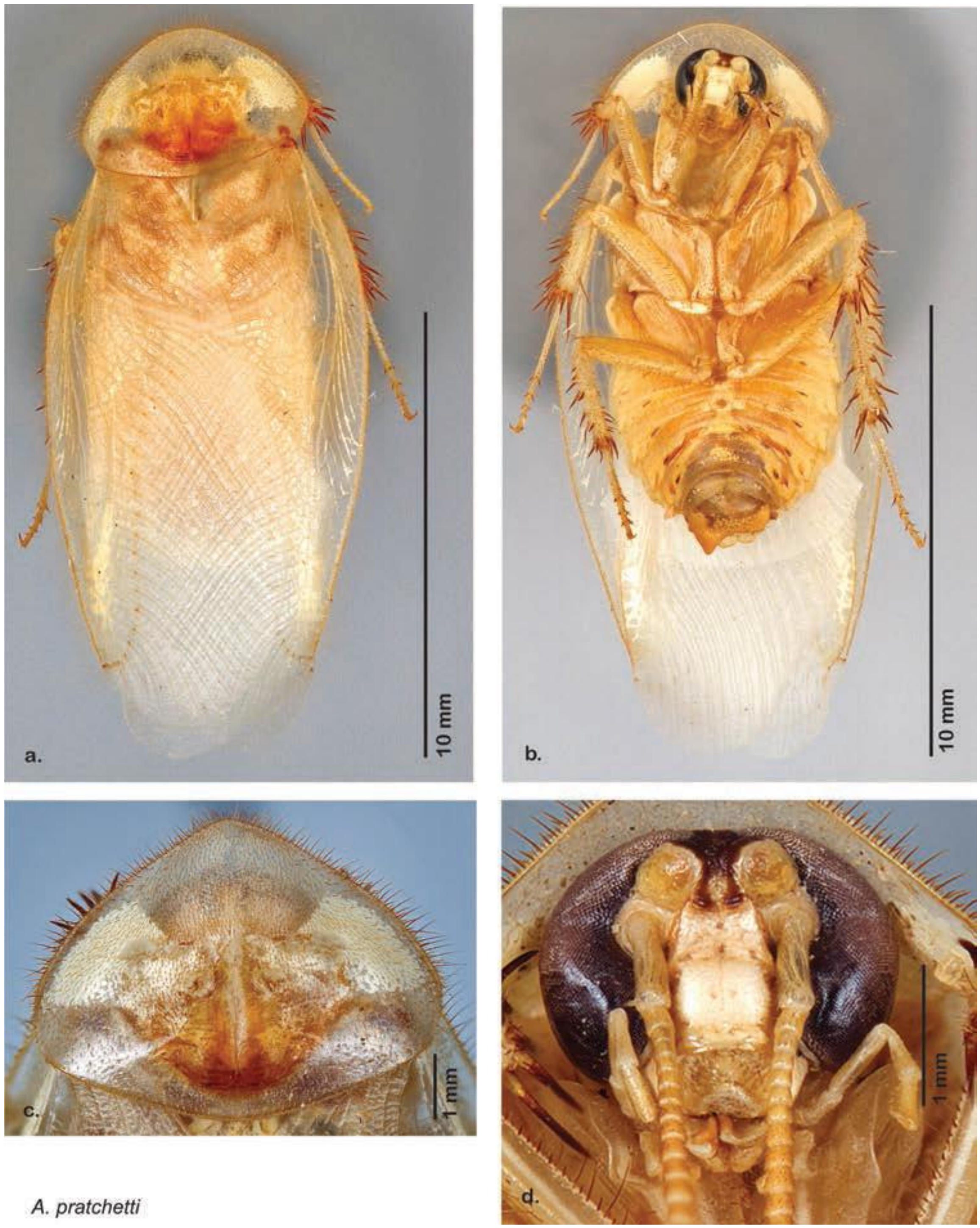


Figure 126. *A. pratchetti* a dorsal habitus b ventral habitus c pronotum d head.

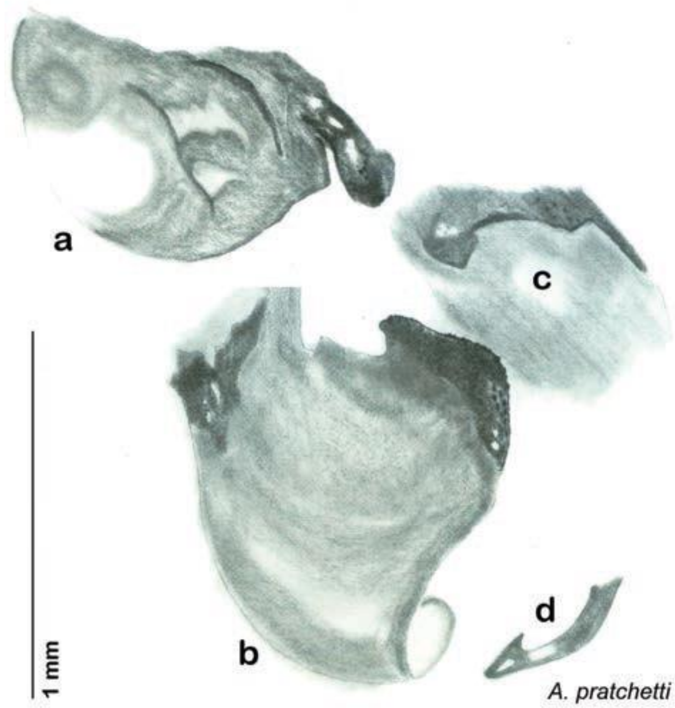


Figure 127. *A. pratchetti*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook.

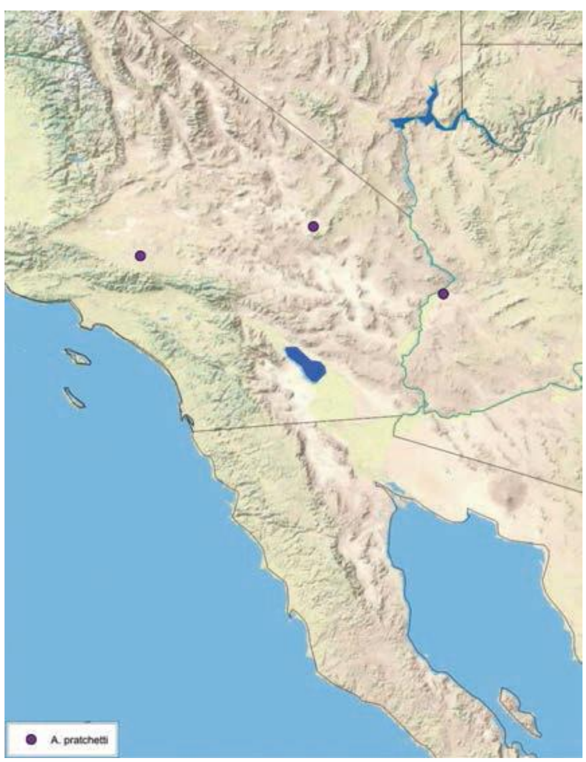


Figure 128. *A. pratchetti*, distribution.

***Arenivaga pumila* sp. n.**

http://zoobank.org/84440053-AC59-43E9-8F0B-51BEE1741D3E

http://species-id.net/wiki/*Arenivaga_pumila*

Figures 129–131

Type locality. MEXICO, BCS, San Hilario.

Material examined. Holotype: ♂ in CAS labeled "MEX., Baja Calif. Sur, San Hilario, El.1000', XI-5-68, E.L.Sleeper & F.J. Moore, Collected at BLACKLITE" "HOLOTYPE *Arenivaga pumila* Hopkins, 2012" [red label with black border].

Paratypes (33): MEXICO: BCS, 25 mi S of Santa Rosalia, 7/25/1938, Michelbacher & Ross, genitalia missing on one specimen (5, CAS); BCS, 5.7 mi SE of Mulege, 7/7/1979, Andrews, Hardy & Giuliana, walking dunes at night (1, CSCA); BCS, 38.8 km S of Santa Rosalia, 5/30/1973, Sleeper 61965-6, polyphagidae, *Arenivaga* n. sp. A, det. FW Fisk 81 (3, CSLB); BCS, 25 mi S of Santa Rosalia, 7/25/1938, Michelbacher & Ross, photo.spec. (1, USNM); BCS, 15 mi N of El Refugio, 7/4/1938, Michelbacher & Ross (7, CAS); BCS, Magdalena Bay, 7/18/1938, Ross & Michelbacher (1, CAS); BCS, Arroyo San Gregorio, 13 air km WNW of La Purissima, 4/24-26/1983, Wasbauer & Slansky, taken at lights (1, CSCA); BC, 4 mi NW of Rancho San Juan, 4/3-4/1961, AG Smith, at lantern (1, CAS); BCS, 27 mi W of La Paz, 11/18/1968, 1000 ft., Sleeper & Moore#1, E1, blacklite (1, CAS); BCS, 1/20-21/1980, Sleeper 77884.7 (1, CSLB); BC, 1 mi S of Mulege, 8/27/1959, Radford & Werner, light trap (1, UAIC); BCS, 5 mi S of Mulege, 10/15-16/1990, S McElfresh (2, UCRC); BCS, San Hilario, 11/5/1968, 1000 ft., Sleeper & Moore, blacklite (3, CAS); BCS, 7.4 km W of Santa Rita on road to Puerto Chale, river crossing at El Medano, 12/30/1978, Weissman,Love,Lee & Mullinex, Stop

79-12, polyphagidae (2, CAS); BCS, 9 km SE of Santa Rita (km 148), 8/25/1977, 75 m, Fisher & Westcott (1, CAS); BCS, 19 mi SW of San Miguel Comondu, 11/14-15/1968, 800 ft., Sleeper & Moore (1, CAS); BCS, 3.3 km S El Cien, 9/26/1981, D Faulkner & F Andrews, at blacklight (1, CSCA). All paratypes labeled "Paratype *Arenivaga pumila* Hopkins 2012" [blue label with black border].

Etymology. The name is an adjective in the nominative singular. This species is named from the Latin meaning small or dwarfish because of its small size.

Distribution. This species is found throughout Baja California Sur, Mexico. See Fig. 131.

Diagnosis. *A. pumila* is easily distinguished by its small size. It is the smallest in overall size of the *Arenivaga* identified to date, though *A. ricei* is shorter in total length than some specimens of *pumila*.

Description. Male. Measurements. Holotype TL = 14.2 mm, GW = 7.0 mm, PW = 4.16 mm, PL = 3.13 mm, TL/GW = 2.03, PL/PW = 0.75. EW = 0.05 mm; OW = 0.20 mm. Among paratypes range of TL 10.6–14.6; range of GW 4.9–7.0; range of PW 4.02–4.27; range of PL 2.80–3.14.

Head. Two ocelli large, ovoid and protruding (0.30 × 0.25 mm); vertex dark brown; interocellar space concave, dark brown. Posterior frons medium brown, concave; anterior frons light brown, bulbous, posterior margin with medial point; light brown anteclypeus. See Fig. 129d.

Pronotum. Pronotum translucent waxy beige; dorsal surface of pronotum with short orange-brown setae; pronotal pattern light to medium orange-brown or medium brown "panther face"; no discernible detail; no aura. See Fig. 129c.

Body. Wing brace absent. Two tarsal claws present. Legs and body light orangebrown;

subgenital plate light orange-brown; asymmetrical with long apex pointed, short apex rounded. See Fig. 129b.

Forewings. Wings extended beyond abdominal apex (up to 40% of total wing length); blotchy medium orange-brown to medium brown; surface translucent, matte or with slight sheen. See Fig. 129a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, bulbous lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized, deeply cupped; punctate as approaching medial edge which is toothed and has central concavity. Small central sclerite in two parts, lightly sclerotized, finely punctate; first part concave with slight anterior bulge, posterior end connecting with dorsal side of right dorsal phallomere; second part small lightly sclerotized square sitting adjacent to bulge of first part; attached to anterior end of left phallomere. Articulation between right phallomeres extends into right ventral phallomere consisting of punctate to shagreened medially projecting lobe with central indentation; anteriorly narrow gap followed by shagreened flange. Folded anterior portion of left phallomere dramatically modified into setose, medially projecting, scoop shape. Genital hook with moderate extension to pointed head and moderate hook; arm with distinct bend. See Fig. 130.

Habitat and natural history. All life history elements remain unobserved.

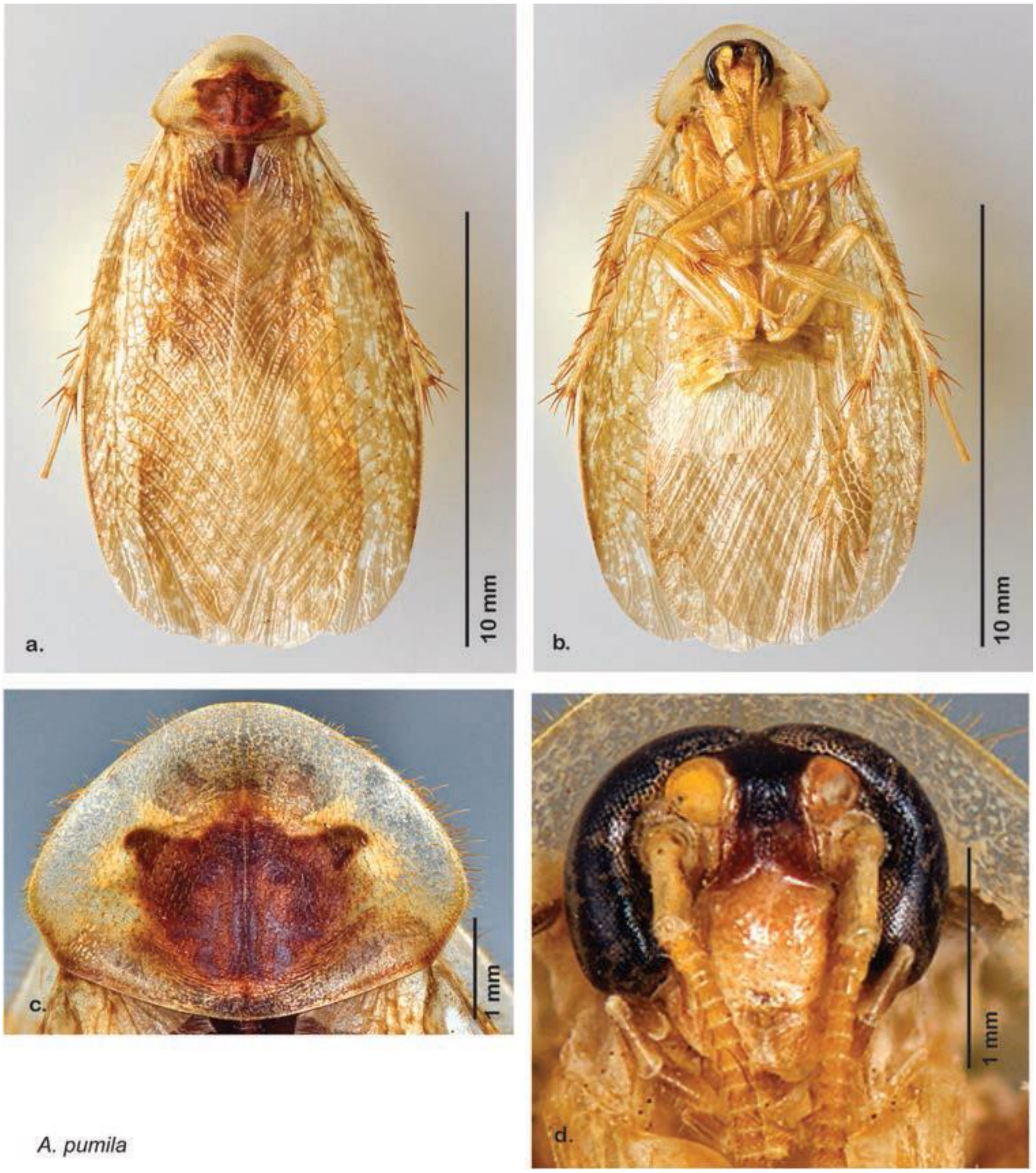


Figure 129. *A. pumila* a dorsal habitus b ventral habitus c pronotum d head.

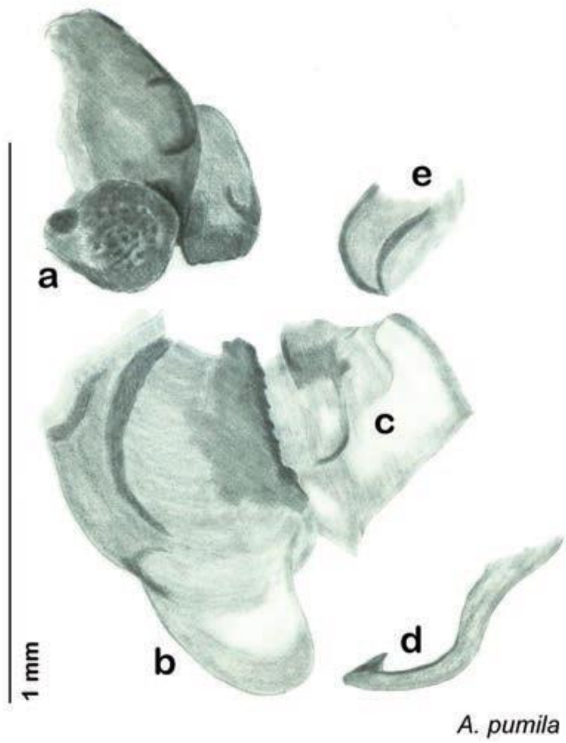


Figure 130. *A. pumila*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook e left phallomere. Arrow(s) indicate diagnostic characters (see text).

Figure 131. *A. pumila*, distribution.

***Arenivaga rehni* Hebard**

http://species-id.net/wiki/*Arenivaga_rehni*

Figures 132–134

1917 *Arenivaga rehni* Hebard, Memoirs of the American Entomological Society, 2, pp. 1–284 + plates and index.

1920 *Arenivaga rehni* Hebard, Transactions of the American Entomological Society, 46(2), pp. 197–217.

Material examined (485). BCS, San Miguel, 7/3/1938, Michelbacher & Ross (3, CAS); BCS, 6 mi. N of Triunfo, 7/15/1938, Michelbacher & Ross (2, CAS); BCS, Venancio, 7/17/1938, Michelbacher & Ross (7, CAS); BCS, 25 mi. S Santa Rosalia, 7/25/1938, Michelbacher & Ross (1, USNM); BCS, 20 mi. N of Comondu, 7/23/1938, Michelbacher & Ross (1, USNM); BCS, 3 mi. N of San Pedro, 7/6/1938, Michelbacher & Ross (4, CAS); BCS, 17 mi. S of Ensenada, 6/14/1938, Michelbacher & Ross (2, CAS); BCS, Triunfo, 7/13/1938, Michelbacher & Ross (2, CAS); BCS, Triunfo, 7/7/1938, Michelbacher & Ross (2, CAS); BCS, 15 mi. N of El Refugio, 7/4/1938, Michelbacher & Ross (8, CAS); BCS, San Domingo, 7/19/1938, Michelbacher & Ross (1, CAS); BCS, 15 mi. W of La Paz, 7/5/1938, Michelbacher & Ross (2, CAS); BCS, 5 mi. S of Miraflores, 7/10/1938, Michelbacher & Ross (1, CAS); BCS, 4 mi. S of Mission San Javier, 5/18/1969, 1000 ft., S.C.Williams, #201(2) (2, CAS); BCS, Playa los Cerritos, 3/24/1986, Faulkner & Bloomfield, UV light, green dot (1, CAS); BCS, 1/4 m S. Rancho Buena Vista, 25 ft., S.C.Williams, #190(2) (2, CAS); BCS, Cabo Pulmo, 9/10-11/1984, sea level, J.P & K.E. Donahue (3, CAS); BCS, Gulf of Baja California, Isla Danzante, 7/16/1984, Weissman & Lightfoot, S84-31 (1, CAS); BCS, 6 mi. SE of Santa Rita, 6/24/1967, Sleeper & Fisher, Black light (2, CAS); BCS, 9 km SE Santa Rita (km148), 8/25/1977, 75 m, Fisher & Westcott (1, CAS); BCS, 1 km S of San Lucas turnoff on Hwy.1 at km 176, 7/13/1978, Weissman & Lightfoot, Stop 47 (2, CAS); BCS, 9.9 mi. W of Ramal a los Naranjos, 3/23/1986, Faulkner & Bloomfield, green dot (2, CAS); BCS, S end of Isla San Francisco, 4/10/1974, JT Doyen (1, CAS); BCS, 6 km W of Hwy.1 at km 54, 9/26/2003, Bill Warner (2, WB Warner); BCS, 1 km W of Ranal de los Naranjos, 7/3/2002, 23.14.15N 109.57.22, Bill Warner, UV light (1, WB Warner); BCS, Ro. Palmarito, 10/30/1961 (1, USNM); BCS, S end of Isla San Francisco, 4/11-12/1974, JT Doyen (2, CAS); BCS, 12.8 mi. SSE Santa Rosalia, 9/23/1981, Faulkner & Andrews, green dot (4, SDMC); BCS, Santiago, NW side of town, 9/26/1979, Weissman,Lightfoot & Love, Stop 79-204 (1, CAS); BCS, 4 mi. S El Pescadero, 10/23-24/1968, Sleeper & Moore, Black light (1, CAS); BCS, 1.5 mi. E of San Jorge, 7/25/1971, Real & Main, UV light (1, CAS); BCS, area just N of Santa Inez, 4/26/1979, 518 m, DB Weissman, #79-97 (1, CAS); BCS, Puerto Escondido, 4/25/1979, DB Weissman, #79-97 (1, CAS); BCS, S end of Isla San Francisco, 4/11-12/1974, L.Cheng (1, CAS); BCS, El Sargento, 7/29/1971, Real & Main, UV light (10, CAS); BCS, 6 mi. E of San Jose del Cabo, 10/26-27/1968, 200 ft., Sleeper & Moore, Black light (2, CAS); BCS, San Jose del Cabo, garden area, 7/19/1978, Weissman & Lightfoot, #78-69 (1, CAS); BCS, 10 mi. SW of San Jose del Cabo, 9/1/1959, Radford & Werner, light trap (13, UAIC); BCS, 15 km. E of San Jose del Cabo, 11/8-9/1982, Sclinger,Irwin & Griswold (2, EMEC); BCS, #6 Puerto L.Mateos Rd.17.8 mi. W of Mex. 1, 8/29/1981, RE Love (1, CAS); BCS, 15 mi. W of Mulege, 8/24/1995, 290 m, Weissman & Lightfoot, Stop 95-79 (1, CAS); BCS, Mulege, 8/29/1995, Weissman & Lightfoot, Stop 95-92 (1, CAS); BCS, 5 mi. W of San

Bartolo, 7/13/1938, Michelbacher & Ross (1, CAS); BCS, El Marmol, 9/24/1941, Ross & Bohart (1, CAS); BCS, 2 mi. NE of El Rosario, 12/7/1958, HB Leech (1, CAS); BCS, 9 mi. S of Todos Santos on Hwy. 17, 1/14/1959, HB Leech (2, CAS); BCS, San Pedro ~4 mi. S of Todos Santos, 1/13/1959, HB Leech (2, CAS); BCS, Chapala Dry Lake, 9/25/1941, Ross & Bohart (1, CAS); BCS, 7 mi. N of Santa Anita on Hwy. 19, 1/7/1959, HB Leech (2, CAS); BCS, 14.5 km E of Mex. Hwy.19 on road to La Burrera , 4/22/1979, 304 m, DB Weissman, #79-87 (4, CAS); BCS, 3 mi. E of La Burrera, 10/17-18/1968, 1800 ft., Sleeper & Moore, Black light (2, CAS); BCS, 1 mi. W of La Burrera, 10/17-18/1968, 1500 ft., Sleeper & Moore, Black light (1, CAS); BCS, Puerto Chileno, 11/26/1961, (1, USNM); BCS, San Jose del Cabo, 11/11/1952, CF Harbison (1, SDMC); BCS, 2.5 mi. SE of Todos Santos, 10/16-17/1968, 200 ft., Sleeper & Moore, Black light (2, CAS); BCS, Todos Santos, garden area, 7/22/1978, Weissman & Lightfoot, Stop 76 (1, CAS); BCS, La Burrera Wash, 9/27/1979, Weissman,Lightfoot & Love, Stop 79-209 (1, CAS); BCS, 3 mi. W of San Miduel de Comondu, 4/21/1969, 1500 ft., SC Williams, #181(1) (9, CAS); BCS, San Jose del Cabo, 12/30/1967, CF Harbison (2, SDMC); BCS, Isla San Jose,1 mi. S of Punta Colorado, 4/8-9/1974, JT Doyen (6, CAS); BCS, Gulf of California, Isla San Jose , 4/12/1962, ??.59N 110.38W, CF Harbison (1, SDMC); BCS, 1.5 mi.N of El Pilar, 11/6-7/1968, 1000 ft., Sleeper & Moore, Black light (1, CAS); BCS, Isla Cayo, 4/11/1974, Doyen,Cheng & Lewin (1, CAS); BCS, Isla del Carmen, canyon on W side of island near Punta Baja, 7/19/1984, Weissman & Lightfoot, S84-37 (5, CAS); BCS, Isla del Carmen, NW side, 7/18/1984, Weissman & Lightfoot, S84-34 (2, CAS); BCS, Isla del Carmen,1st major canyon S of Punta Cholla, 7/18/1984, Weissman & Lightfoot, S84-35 (2, CAS); BCS, dunes ~4.5 mi. S of Mulege, 9/13/1983, Evans,Smith

& Snelling (1, CAS); BCS, 6 mi. SW of Santiago, 8/31/1959, Radford & Werner, light trap (2, UAIC); BCS, Cabo San Lucas, Hotel Finisterra, 9/8-14/1978, JP & KE Donahue (3, LACM); BCS, 19 mi. NW of Cabo San Lucas, 10/1/1967, GA Marsh (2, CAS); BCS, 5 mi. E of San Lucas, Playa Barco Varado, 4/11/1991, Ballmer & Mayor, at light (2, UCRC); BCS, Cabo San Lucas, 10/26/1941, ?F Gander (1, SDMC); BCS, 7.8 km E of Cabo San Lucas at km 7.8 on Hwy.1, 4/23/1979, DB Weissman, #79-91 (2, CAS); BCS, 7 mi. S of Punta Colorada (arroyo), 12/23-30/1987, N.Bloomfield, green dot (3, SDMC); BCS, Arroyo San Gregorio,13 air km WNW of La Purissima, 4/24-26/1983, Wasbauer & Slansky (4, CSCA); BCS, 27.7 mi. NE of Arroyo San Miguel, 4/1/1985, Bloomfield & Faulkner, green dot (2, CAS); BCS, Mulege, 8/22-23/1966, Ray Bandar (1, CAS); BCS, 6.4 mi. W Hwy. 1 to San Isidro, 3/21/1986, Faulkner & Bloomfield, green dot (2, CAS); BCS, 250 ft., JP & KE Donahue, #88,852 (3, CAS); BCS, Las Baracas,30 km E of Santiago, 4/1-6/1982, Paul DeBach, malaise trap (2, EMEC); BCS, Las Baracas, 30 km E of La Ribera, 3/21-24/1982, Irwin & Schlinger (1, EMEC); BCS, Rancho Las Barracas 30 km E of Santiago, 11/6-8/1982, Irwin,Griswold & Schlinger (1, EMEC); BCS, Las Barracas, 5/13/1983, P DeBach, malaise trap (1, UCRC); BCS, Las Barracas, 6/9/1984, P DeBach, malaise trap (1, UCRC); BC, SW base Los Frailes, 2/18/1960, D Porter (1, USNM); BCS, Las Barracas, 4/16/1984, P DeBach, malaise trap (1, UCRC); BCS, San Francisco de la Sierra, 10/16/1997, DK Faulkner, green dot (1, SDMC); BCS, 1 mi. E El Triunfo, 10/10-13/1989, N.Bloomfield, green dot (3, SDMC); BCS, Las Barracas, 9/5/1983, Thomas & Olson (1, UAIC); BCS, Los Barriles, 5/3-4/1979, M.Wasbauer, at light (1, CSCA); BC, 7 mi. S Punta Colorada (arroyo), 12/23-30/1987, N.Bloomfield, green dot (2, CAS); BC, Loreto, 12/7/1977, 23.16N (1, SDMC); BC, 1.2-5.4 mi. N of

Santa Ines, 12/5-9/1967, N.Bloomfield, green dot (3, CAS); BC, Sierra Juarez, Tajo Canyon, 4/2/1953, green dot (1, CAS); BC, Cantiles (Tajo) Canyon, 4/20/1955, 32.17N (1, SDMC); BC, L.Cantillas Cyn. Sierra Juarez, 3/20/1967, Opler & Powell (2, EMEC); BC, 7 mi. SE of San Quintin, 4/20/1947, CF Harbison (2, SDMC); BCS, Puerto San Tomas, 8/29/1967, M. Lieberman (5, CAS); BC, Isla de Cedros, canyon SW of Punta Norte, 4/2/1983, green dot (2, CAS); BC, Isla de Cedros, canyon SW of Punta Norte, 3/31/1983, green dot (2, CAS); BC, 5-7 km NW of Catavina on Hwy.1 , 8/5/1981, Lightfoot & Weissman, #81-68 (1, CAS); BC, 3.5 mi. NNW of Catavina on Hwy. 1, 9/2/1985, 2000 ft., JP & KE Donahue, #96,262;#89,284 (3, CAS); BC, 2.6 mi. SE of Catavina, 3/23/1981, Faulkner & Andrews, green dot (2, SDMC); BC, 3.2 km N of Catavina on Hwy.1, 7/9/1978, Weissman & Lightfoot, Stop 32 (1, CAS); BC, 7.3 km NW of Catavina, 9/15/1988, 2000 ft., JP & KE Donahue, #124,936 (1, LACM); BC, 2 mi. N of El Rovenir, 4/6-7/1961, AG Smith, gas lantern (1, CAS); BC, Bahia de los Angeles , 5/10/1952, JP Figg-Hobyn (1, CAS); BC, 13 mi. SW La Zapopita, 6/14/1963, EL Sleeper (1, CAS); BC, Bahia de Las Animas, 9/5/1985, sea level, JP & KE Donahue, #96,431 (1, CAS); BCS, Sierra de la Giganta, mouth of Arroyo Comondu,16.4 mi. NE of La Poza Grande, 9/17/1985, 400 ft., JP & KE Donahue, #97,621 (1, CAS); BC, Puertecitos, 11/28/1964, G Sphon (2, CAS); BC, 1.8 km NE of Millers Landing (Beach dune), 5/27-28/1973, 35 m, EL Sleeper, 28114cb (1, CAS); BC, 38 km NW of Bahia de Los Angeles on Hwy.1, 8/6/1981, 290 m, Lightfoot & Weissman, #81-72 (4, CAS); BC, Punta San Fermin, 4/7-10/1971, EL Sleeper, black light (4, CAS); BC, Isla de Cedros, Cerro de Cedros, 7/1/1983, 183 m, Weissman & Lightfoot, #83-83 (1, CAS); BCS, 9 mi. N of Cabo San Lucas, 9/9/1988, EG Riley, black light (2, TAMU); BC, nr. La Zapopita de Trinidad, 4/9-14/1961, FS Truxal (1, LACM); USA, CA, In-Ko-Pah Gorge, E.Jacumba, 4/15/1942, 2000 ft., HR Roberts (3, ANSP); BCS, Playa San Lucas 11 road mi. S of Santa Rosalia, 9/4/1983, sea level, JP & KE Donahue (2, CAS); BCS, 3 mi. NE San Isidro (La Purisima), 4/2/1985, Bloomfield & Faulkner, green dot (2, CAS); BC, 6 mi. N of Guerrero Negro, 10/13/1981, Andrews & Faulkner, green dot (1, SDMC); BC, 7 km N of Guerrero Negro on Hwy.1, 7/10/1978, Weissman & Lightfoot, Stop 34 (1, CAS); BC, Rancho Union, 4/17/1947, CF Harbison (2, SDMC); BCS, Las Barracas, 10/15/1985, P DeBach, black light (3, UCRC); BCS, Las Barracas 30 km E of Santiago, 12/1-7/1982, P DeBach (1, EMEC); BCS, Las Barracas 30 km E of Santiago, 11/6-8/1982, Irwin,Griswold & Schlinger (3, EMEC); BCS, Las Barracas, 11/21/1984, P DeBach, black light (1, UCRC); BCS, La Paz, 8/22/1941, F.Ander (3, SDMC); BCS, 7 mi. SW of La Paz, 8/6/1966, Linsley,Chemsak & Hurd, at light (4, CSCA); BCS, 14 mi. NW of La Paz (in Cardon area), 4/23/1974, R Hardy (1, CSCA); BC, San Vincente, 5/14/1938, CE Norland (1, LACM); BC, Canyon del Tajo, Sierra Juarez, 4/1/1953, J Powell, at light (1, EMEC); BCS, S. Santa Rosalia (?), 5/30/1973, black light (1, CSLB); BC, 1 mi. S of Mulege, 8/27/1959, Radford & Werner, light trap (2, UAIC); BC, N of Guerrero Negro, 6/19-20/1973, 280 m, EL Sleeper, black light (1, CAS); BC, 20 km N of Ensenada on Hwy. 1, Weissman & Lightfoot, Stop 23 (1, CAS); BC, 4 mi. NW Rancho San Juan, 4/3-4/1961, AG Smith, gas lantern (1, CAS); BC, nr. km 31 sign on Hwy.1, 9/19/1979, Weissman, Lightfoot & Love, #79-173 (1, CAS); BC, Diablito Canyon, E face of San Pedro Martir, 4/5/1973, SL Szerlip, at light (1, EMEC); BC, 0.4 km W of km 60 on road to Sierra San Pedro Martir NP off Hwy.1, 7/26/1978, 752 m, Weissman & Lightfoot, Stop 86 (1, CAS); BC, km 59.7 on road to San Pedro Martir NP, 8/20/1995, 1010 m, Weissman & Lightfoot, Stop 95-68 (1, CAS); BC, Mesa La Pitahaya, 9/2/1988, 30.00N 115.35W, 1000 ft., JP & KE Donahue, #124,134 (2, LACM); BC, 9.4 km W of Penjamo, 6/20/1973, 550 m, EL Sleeper (2, CAS); BC, 19 mi. SW Campo Alfonsina (canyon), 10/27-28/1987, N Bloomfield, green dot (1, SDMC); BC, 14.4 mi. S Campo Alfonsina, 10/20-26/1987, N Bloomfield, green dot (6, SDMC); BC, Baia San Luis Gonzaga, 4/3/1973, Doyen,Powell & Szerlip, at light (1, EMEC); BC, 1.5 mi. N of Rancho Punjamo, 8/14/1971, Real & Main, UV light (2, CAS); BC, San Bartolo, 10/24/1941, 23.45N, FF Gander (1, SDMC); BC, 24 mi. N Bahia San Luis Gonzaga, 4/14/1962, EL Sleeper, black light (2, CAS); BC, Santo Tomas, 7/8/1953, WJ & JW Gertsch (1, AMNH); BC, Arroyo 13 mi. N of San Ignacio, 4/2/1961, AG Smith (3, CAS); BC, Punta Prieta, 3/17/1947, 28.56N, CF Harbison (2, SDMC); BC, 12 mi. E of El Rosario, 6/10/1979, black light (1, UCRC); BC, Canyon de Guadalupe, 5/3/1964, EM Fisher (1, LACM); BC, 10 mi. NNW of Catavina on Hwy.1, 9/1-2/1983, 2400 ft., JP & KE Donahue (1, CAS); BCS, 1.4 km S of turnoff to La Poza Grande, 7/15/1978, Weissman & Lightfoot, Stop 54 (1, CAS); BCS, Playa los Cerritos,11.2 mi. S Todos Santos, 9/28/1981, Andrews & Faulkner, Dark brown, green dot, black light (3, SDMC); BCS, Playa los Cerritos, 10/8/1983, Andrews & Faulkner, Dark brown, green dot, black light (1, CAS); BCS, San Jose del Cabo, G Eisen (2, ANSP); BCS, San Jose del Cabo (5, ANSP); BCS, San Jose del Cabo, Eisen, Abdomen Mount B1:2A (5, ANSP); BCS, San Jose del Cabo, Eisen, Abdomen Mount B1:3 (1, ANSP); BCS, San Jose del Cabo, Eisen (2, CAS); BCS, San Jose del Cabo, Eisen, Abdomen Mount B1.2 (1, ANSP); BCS, Isla Magdalena, Howlands Lagoon, sand dunes, 7/8/1983, Weissman & Lee, Stop #83-93 (8, CAS); BCS, Isla Magdalena canyon I km NW of Puerto Magdalena, 8/8/1983, Faulkner & Lightfoot, Stop #83-94 (1, CAS); BCS, La Paz, 10/21/1979, WF Chamberlain (2, TAMU); BCS, San Miguel, 7/3/1938, Michelbacher & Ross (1, CAS); BC, 1.3 mi. NW of El Triunfo, 1/20/1959, HB Leech (1, CAS); BCS, Comondu, Haines (1, CAS); BCS, Sierra El Tasti, 10/?/1893, Eisen (1, CAS); BC, Catavina, 9/25/1941, Ross & Bohart (1, CAS); BC, Venancio, 7/17/1938, Michelbacher & Ross (2, CAS); , *Arenivaga* sp. undet. Det. FW Fisk 1980 (1, SEMC); BCS, Comondu, 3/?/1889, Haines (2, ANSP); BCS, Env. De la Paz,?/?/1914, L Digguet, Museum Paris (1, ANSP); BCS, Golfo de California, Isla Cerralvo, 4/15/1962, 24.14N, 109.51W, CF Harbison, Accn. No. 1576 (2, SDMC); BC, Golfo de California, Isla Cerralvo, canyon W side nr. Punta El Limon, 7/15/1985, Weissman, Lightfoot & Faulkner, S85-85 (4, CAS); BC, 6 mi. W of San Felipe, 6/4/1967, Davis & Webb (1, CAS); BCS, 44 mi. NW of Vizcaino on road to Bahia Tortuga, 8/22/1995, 85 m, Weissman & Lightfoot, Stop #95-72 (2, CAS); BCS, Comondu Viejo, 4/4-5/1980, D Davis (1, USNM); BC, Santo Domingo, 5/8/1938, WE Simonds (1, CAS); BCS, 3 mi. N of San Antonio, 10/9-10/1968, 1200 ft., Sleeper & Moore, black light (3, CAS); BCS, 12 km E of San Antonio, 12/27/1978, P. Rude, UV and white light (3, EMEC); BCS, Sierra de la Laguna,5 mi. S of San Antonio, 9/2-3/1983, Thomas & Olson (1, UAIC); BCS, Playa El Coyote, Bahia Concepcion, 9/8-9/1985, sea level, JP & KE Donahue, #96-807 (6, LACM); BCS, Playa El Coyote, Bahia Concepcion, 9/11-12/1988, 25 ft., JP & KE Donahue, #124,558 (9, LACM); BCS, La Paz, 10/6/1968, 50 ft., Sleeper & Moore, black light (3, CAS); BCS, La Paz, 12/19/1973, W.Middlekauff (2, EMEC); BCS, La Paz, 12/26/1974, W.Middlekauff (1, EMEC); BCS, Hwy.1,35 km W of La Paz, 8/25/1995, 340 m, Weissman & Lightfoot, #95-82 (2, CAS); BCS, 8 mi. SE of La Paz, 10/13/1968, 1000 ft., Sleeper & Moore, black light (1, CAS); BCS, 18 km SW of

La Paz, 6/1/1973, 118 m, EL Sleeper, 24110CdI (CapeThormFor.) (1, CAS); BCS, 26 mi. W of La Paz, 8/11-13/1966, Chemsak, Doyen & Powell, black/white lights (5, EMEC); BCS, 7 mi. SW of La Paz, 8/6/1966, Linsley, Chemsak & Hurd, at light (3, EMEC); BCS, 26 mi. W of La Paz, 8/11/1966, JT Doyen (1, EMEC); BCS, Sierra El Tasti, 10/?/1893, Eisen (2, ANSP); BCS, 0.5 km N of La Paz on Hwy.1, 7/16/1978, Weissman & Lightfoot, Stop 59 (7, CAS); BCS, La Paz across street from Hotel Posado, 4/21/1979, D.Weissman, #79-85 (5, CAS); BCS, 25 mi. W of La Paz, 8/30/1959, Radford & Werner, light trap (3, UAIC); BCS, La Paz, 11/9/1941, 24.10N, CF Harbison (6, SDMC); BCS, Grounds of Guaycura Hotel, 12/4-6/1961 (4, USNM); BCS, Grounds of Guaycura Hotel, 11/3/1961, (1, USNM); BCS, La Paz, 3/24/1958, K Bechtel (1, USNM); BC, El Barril, 3/27/1947, 28.16N, CF Harbison (1, SDMC); BC, Las Flores, LA Bay, 4/12/1947, CF Harbison (1, SDMC); BC, 14.4 mi. S of Campo Alfonsina, 10/20-26/1987, N Bloomfield, green dot (2, SDMC); BC, Aquajito Spring, Valle de la Trinidad, 7/?/1927, CF Harbison (1, SDMC); BC, Nr. La Zapopita, Valle de Trinidad, 4/9-14/1961, FS Truxal (1, LACM); BCS, 8 km W of La Paz, D Weissman, #79-84 (1, CAS); BCS, 22 mi. W of La Paz, 6/25/1967, Sleeper & Fisher, black light (1, CAS); BC, Santa Rosalia, 10/20/1930, EH Quayle (1, SDMC); BCS, Pichilingue Bay N of La Paz floating on water, 4/16/1974, RA Lewin (1, CAS); BCS, 3 mi. NE of San Isidro, 4/3/1985, Bloomfield & Faulkner, green dot (1, CAS); BCS, 1 mi. N of lighthouse on Cabo Falso, vegetated dune, 9/29/2003, Bill Warner, (1, WB Warner); BCS, Playa San Cristobal, 4/16/1984, Brown & Dodero, green dot (1, CAS); BCS, Cabo San Lucas, 6/11/1973, black light (2, CAS); BCS, 8/1-2/1978, 60096.8,black light (1, CAS); BCS, 9 mi. N of Cabo San Lucas, 9/15/1988, EG Riley, black light (1, TAMU); BCS, 3.3 mi. S of El Cien, 9/26/1981, Faulkner &

Andrews, green dot (1, SDMC); BCS, 1.4 km S of turnoff to La Poza Grande N of Villa Insurgentes, 7/15/1978, Weissman & Lightfoot, Stop 54 (2, CAS); BCS, Hwy.1, 12 mi. NE of Villa Insurgentes, 9/7/1983, 250 ft., JP & KE Donahue (3, CAS); BCS, La Paz, 7/28/1969, W Middlekauff (1, EMEC); BCS, La Paz, 11/7/1941, 24.10N, FF Gander (1, SDMC); BCS, La Paz, 11/9/1941, 24.10N (2, SDMC); BCS, Isla Santa Margarita, NW island sand dunes, 7/7/1983, Faulkner, green dot (1, CAS); BCS, Isla Santa Margarita, sand dunes 3 km SW of Puerto Cortes, 7/7/1983, Weissman & Lightfoot (4, CAS); BCS, 8.8 mi. E of San Ignacio,4.3 mi. N of KP 59.5, 9/7/1985, 650 ft., JP & KE Donahue, #96,707 (1, CAS); BCS, Hwy.1, 0-4 km N of San Ignacio, at night, 7/12/1978, Weissman & Lightfoot, Stop 42 (1, CAS); BCS, 4.2 mi. W of Miraflores, 9/30/1981, Andrews & Faulkner, green dot (2, SDMC); BCS, Road to San Pedro De la Soledad, off Hwy.1, 8/27/1995, 23.14N 109.57W, 820 m, Weissman & Lightfoot, Stop #95-87 (4, CAS); BCS, Isla Monserrate, canyon area W side, middle of island, 7/20/1984, Weissman & Lightfoot, S84-40 (2, CAS); BCS, Isla San Marcos, 7/17/1985, Weissman & Lightfoot, Stop #85-86 (1, CAS); BCS, Isla del Espiritu Santo, 7/8/1985, Weissman & Lightfoot, #85-76 (1, CAS); BCS, Isla Santa Cruz, 7/10/1985, Weissman & Lightfoot, #85-78 (2, CAS); BCS, 1st wash on road to Miraflores off Hwy.1, 1/3/1979, Weissman,Love,Lee & Mullinex, Stop 79-27 (1, CAS); BCS, 1.5 mi. NW of Miraflores, 10/28-29/1968, 700 ft., Sleeper & Moore, black light (2, CAS); BCS, 4.3 mi. SW of Miraflores, 9/12-13/1988, EG Riley, black light (2, TAMU); BCS, 0.8 km W of Hwy.1 on road to Miraflores, 9/26/1979, 210 m, Weissman,Lightfoot & Love (2, CAS); BCS, 0.25 km S of Miraflores turnoff on Hwy.1, 4/24/1979, D.Weissman, #79-93 (3, CAS); BCS, 64.5 km E of Villa Insurgentes on Hwy.1, 9/29/1979, #79-213 (1, CAS). Determiner label *Arenivaga rehni* Hopkins 2011" [white label with black border].

Distribution. This species is found the length and breadth of the Baja peninsula and adjacent islands as well as isolated records in far southern California. See Fig. 134.

Diagnosis. *A. rehni* is a highly variable species phenotypically. Its genitalia superficially resembles that of *A. grata* but *A. rehni* may be diagnosed by the narrow central field and broad heavily shagreened concavity interior to the point of articulation on the right dorsal phallomere, and the posterior projection on the lobe of the right ventral phallomere. See Fig. 133.

Description. Male. Measurements. Holotype stand-in TL = 19.0 mm, GW = 8.3 mm, PW = 5.89 mm, PL = 4.23 mm, TL/GW = 2.29, PL/PW = 0.72. EW = 0.25 mm; OW = 0.45 mm. Among paratypes range of TL 15.3–26.7 mm; range of GW 6.9–11.4 mm; range of PW 5.18–7.83 mm; range of PL 3.90–5.27 mm.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm), with one long seta in middle of upper ocellar rim; vertex very dark brown, with small ridges between apices of eyes extending on to ocellar tubercles, scattered short setae; interocellar space concave, very dark brown. Frons light brown, concave; bound on either side by dark brown ridges extending from inner apex of ocelli outwards to lateral edges of clypeus; scattered long setae on ridges. Anterior portion of frons light brown, bulbous; clypeal suture demarcates light brown anteclypeus. See Fig. 132d.

Pronotum. Pronotum translucent waxy beige; variable length orange-brown setae along anterior margin; dorsal surface of pronotum covered with short orange-brown setae that are denser and longer anteriorly and laterally; pronotal pattern dark orange-brown "panther face", with no discernible detail and complete aura laterally and posteriorly;

color of pattern and extent of aura highly variable within species; color from light orange-brown through all shades to very dark brown but always with no detail discernible; aura missing or complete laterally and posteriorly. See Fig. 132c.

Body. Wing brace absent. Legs and body light to medium orange-brown; subgenital plate asymmetrical with posterior edge emarginated, rounded apices, often with one or both styli present in very rudimentary form. See Fig. 132b.

Forewings. Wings extended beyond abdominal apex (up to ~40% of total wing length); medium brown with darker blotches; color highly variable in species from light brown, through all shades to dark brown; always blotchy; surface opaque and matte. See Fig. 132a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized lobe, articulated with right ventral phallomere on lateral side; central field narrow, lightly sclerotized; medial margin with small punctate region anteriorly, otherwise, smooth, lightly sclerotized and contiguous with medial margin of bulbous lobe; wide, heavily shagreened to toothed, concavity interior to point of articulation. Small central sclerite nondescript in shape, flat, punctate. Right ventral phallomere extends from articulation to shagreened lobe with posterior pointing smooth projection; after moderate gap, broad, shagreened flange with toothed edge, extending to depth of rest of phallomere. Genital hook with broad pointed head and moderate hook with bent tip; arm robust. See Fig. 133.

Habitat and natural history. All life history elements remain unobserved.

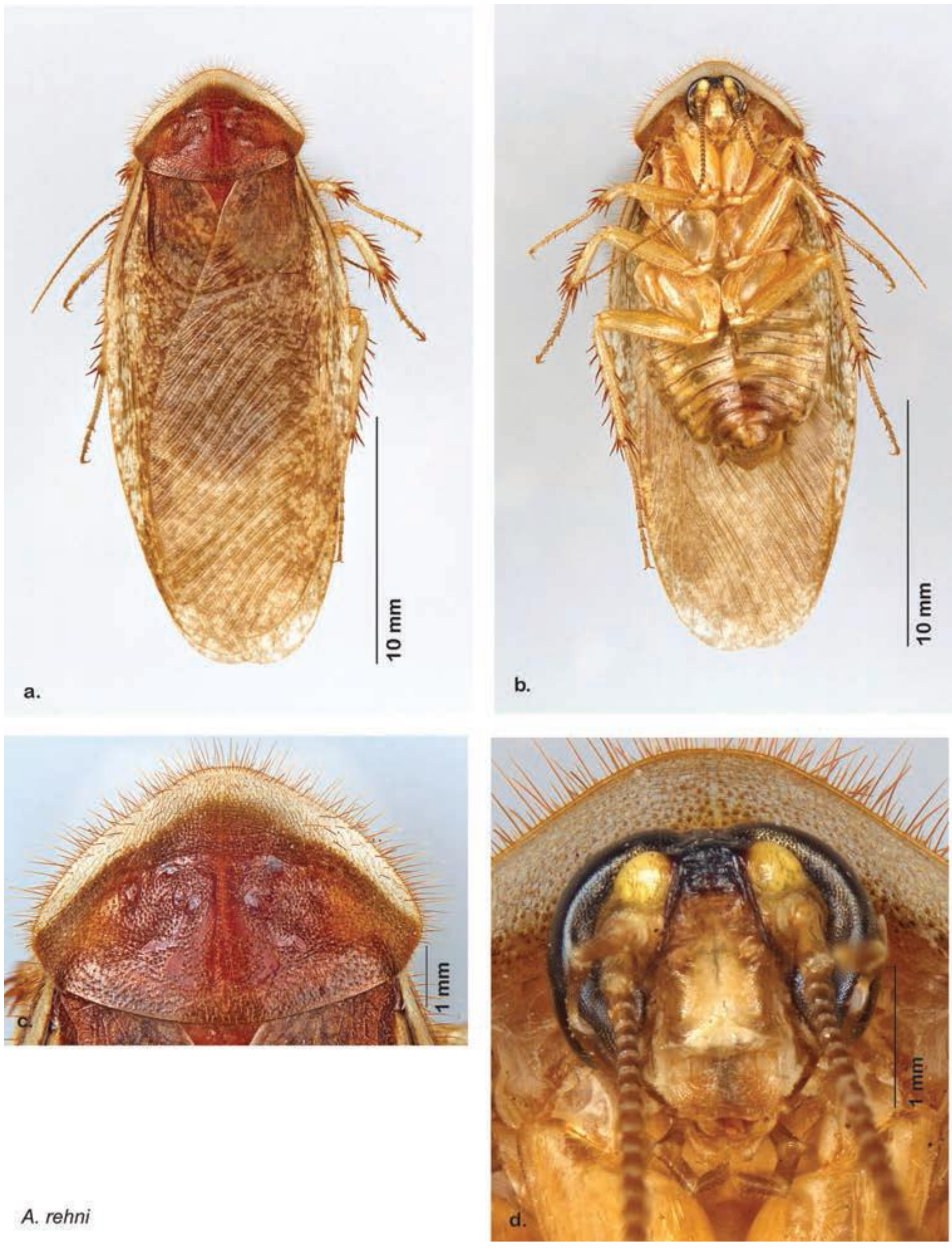


Figure 132. *A. rehni* a dorsal habitus b ventral habitus c pronotum d head.

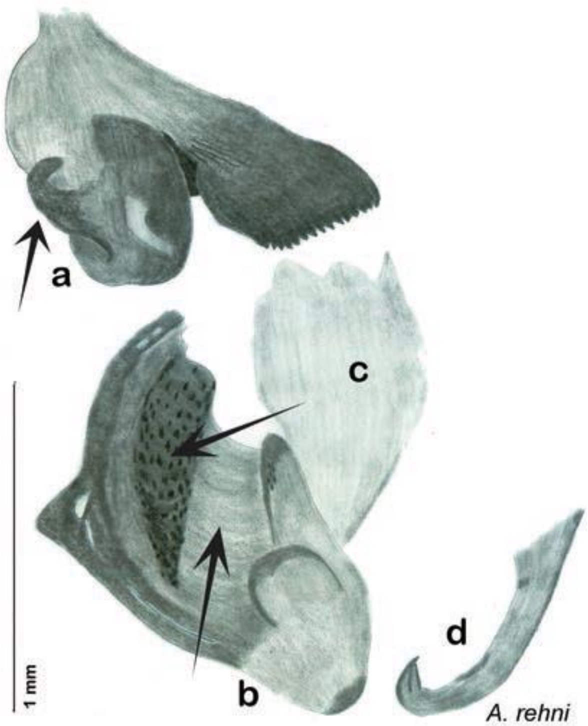


Figure 133. *A. rehni*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 134. *A. rehni*, distribution.

***Arenivaga ricei* sp. n.**

http://zoobank.org/82FB4E20-4701-4A6A-960E-130B2A6F2CDC

http://species-id.net/wiki/*Arenivaga_ricei*

Figures 135–137

Type locality. USA, Texas, Val Verde County, Langtry.

Material examined. Holotype: ♂ in USNM labeled “Langtry, Tex., May 22, 1977, W.W. Walthol, R.R. Stewart“ HOLOTYPE *Arenivaga ricei* Hopkins, 2012” [red label with black border].

Paratypes (8): USA: TX, Val Verde Co., 14 mi. NW of Del Rio, Hwy.90, 5/27/1972, RCA Rice, from rock dust in shallow caves along dry arroyo (4, USNM); TX, Langtry, died at Beltsville MD in captivity, Feb. and Apr. 1978, from Joann Alexander (2, USNM); TX, Langtry, 11/6/1976, Walthol & Stewart (1, USNM). All paratypes labeled “Paratype *Arenivaga ricei* Hopkins 2012” [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for Rob Rice, enthusiastic worldwide collector of Corydiid cockroaches, and collector of the first of this species.

Distribution. This species is found along the Rio Grande River in Val Verde County, Texas. See Fig. 137.

Diagnosis. *A. ricei* sp. n. is characterized by its short pumpkin seed-like shape and pale unmarked wings. While it is superficially similar to *A. darwini* and Mylacris grolator, it has two tarsal claws unlike *A. darwini*, which has one, and has genicular spines on the meso and metalegs unlike M. grolator which has none.

Description. Male. Measurements. Holotype TL = 12.9 mm, GW = 7.84 mm, PW = 5.7 mm, PL = 3.57 mm, TL/GW = 1.65, PL/PW = 0.63. This is the shortest species of *Arenivaga* in total length and with its curious shape has the lowest TL/GW ratio of any species. EW = 0.4 mm; OW = 0.5 mm. In paratypes, no notable variations in dimensions from those of holotype.

Head. Two ocelli ovoid and not as protruding as on many species (0.3 × 0.20 mm); vertex brown with pale central line and small ridges in rays around upper apices of eyes; interocellar space concave, brown laterally fading to lighter brown towards center line. Posterior frons slightly tectiform horizontally, waxy white, smooth and shiny; anterior frons bulbous, waxy white, smooth and shiny; anteclypeus wide, smooth and waxy white. See Fig. 135d.

Pronotum. Pronotum translucent beige, anterior half of dorsal surface of pronotum also covered in fine pale setae with scattering of thicker orange-brown setae throughout; pronotal pattern orange-brown “hippo face” with extensive aura; some detail discernible. See Fig. 135c.

Body. Wing brace present. Two tarsal claws present. Legs and body pale brown; subgenital plate white with darker margin, asymmetrical, with rounded apices. See Fig. 135b.

Forewings. Wings extend only a short distance beyond abdominal apex (~ 20% of wing length); pale translucent brown with no sheen. See Fig. 135a.

Genitalia. Right dorsal phallomere composed of large bulbous lightly sclerotized hook-shaped lobe, articulated with right ventral phallomere on lateral side; anterior edge with small teeth leading to large ventrally projecting spine that is shagreened on its exterior surface. Small central sclerite is minutely punctate over entire surface with no sclerotized structures. Right ventral phallomere extends from articulation to form structure rounded at posterior apex but with corrugations at anterior apex, with rounded concave arm extending beyond depth of rest of phallomere; arm heavily sclerotized at its apex and shagreened over its external surface. Left phallomere unmodified. Genital hook with short extension to pointed head and slight dimple on short hook; arm gently curving. See Fig. 136.

Habitat and natural history. This species occurs in terrain that is dry, hot, and dusty; it has been collected in shallow caves along dry arroyos. All other life history elements remain unobserved.

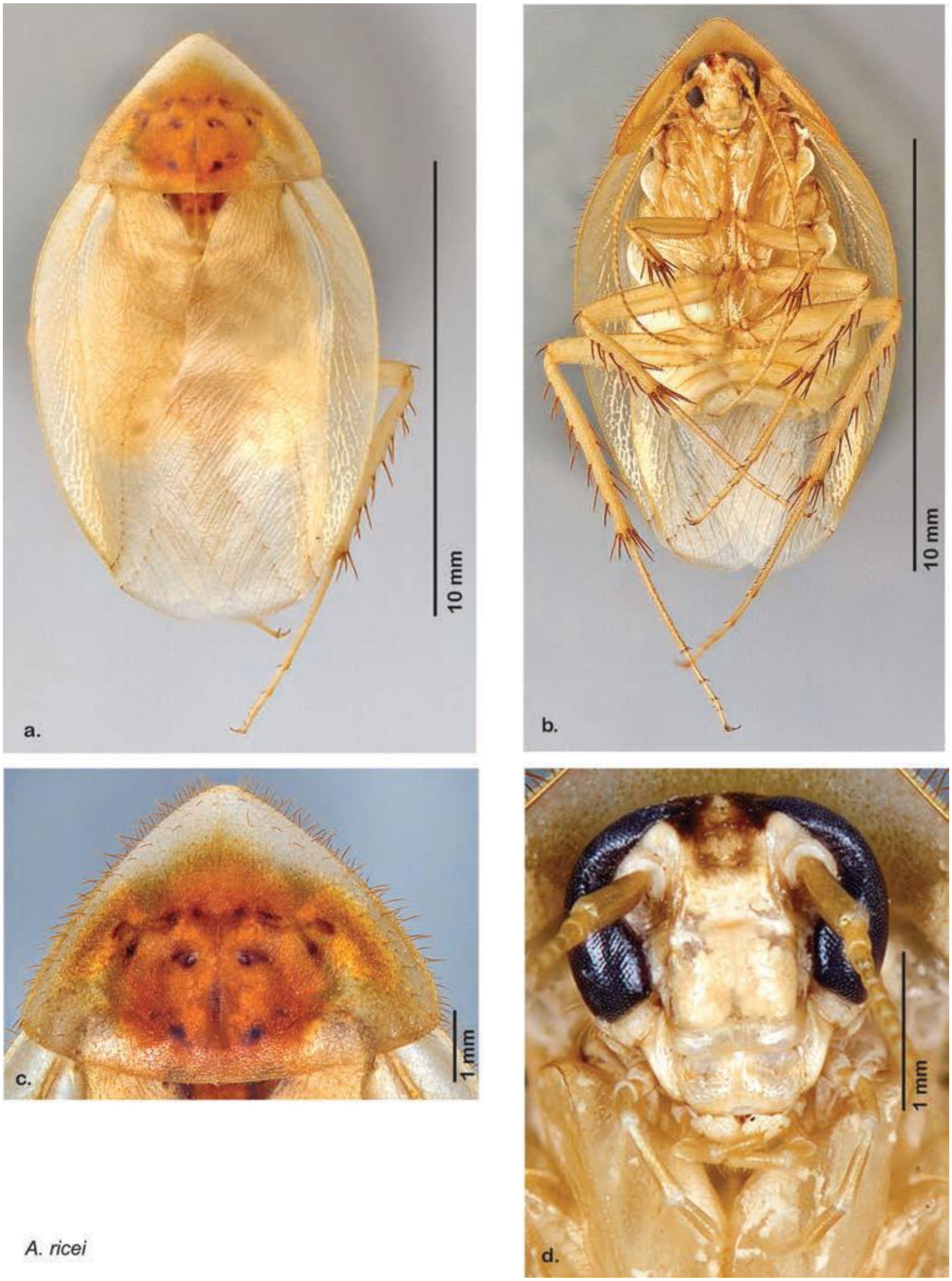


Figure 135. *A. ricei* a dorsal habitus b ventral habitus c pronotum d head.

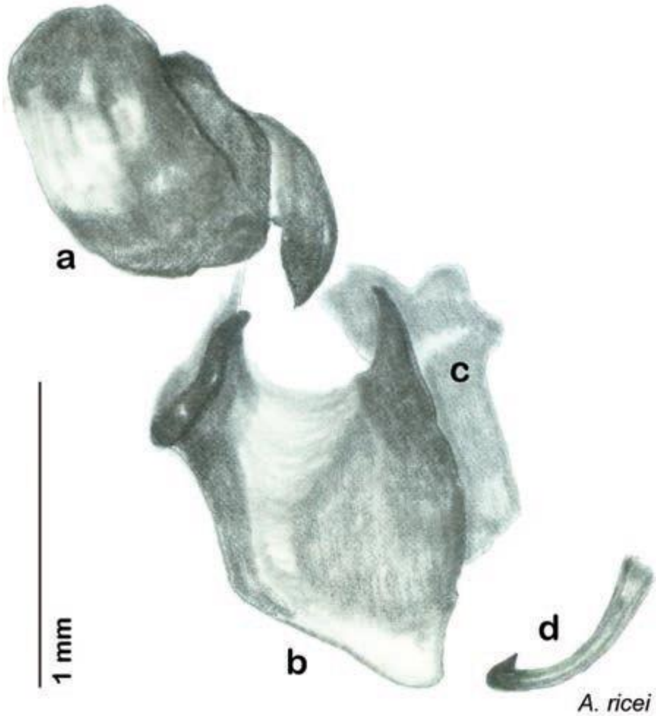


Figure 136. *A. ricei*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook.

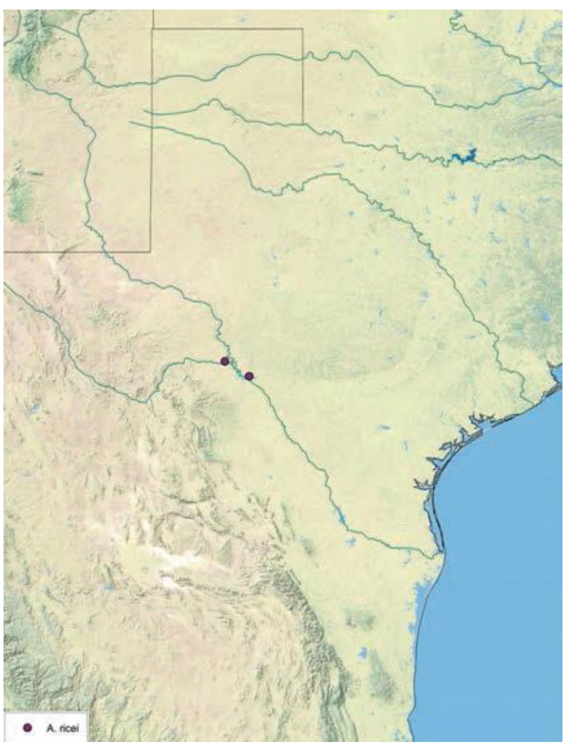


Figure 137. *A. ricei*, distribution.

***Arenivaga rothi* sp. n.**

http://zoobank.org/AE40A344-BA80-414C-BA4A-16A469412DBF

http://species-id.net/wiki/*Arenivaga_rothi*

Figures 138–140

Type locality. MEXICO, Coahuila, 8 mi N Viesca.

Material examined. Holotype: ♂ in EMEC labeled "MEX: Coah., sand dunes at Bilbao, 8 mi. N. Viesca, V-30/31-1981, J. Doyen, J. Liebherr, at blacklight" "HOLOTYPE *Arenivaga rothi* Hopkins, 2012" [red label with black border].

Paratypes (13): USA: TX, Presidio, May-June 1953, 53-10102, Presidio-3268L, at lights (8, USNM); TX, Presidio, 6/?-8/?/1955, JH Russell, at electric light (1, USNM); TX, Presidio, 6/17/1954, JH Russell, at light, 54-6842, Int. 3399L, (1, HEH); TX, Presidio, 5/14/1944, Presidio 1334, Lot No. 44-16214 (1, LACM). MEXICO: Coahuila, Bilbao 8 mi N of Viesca, 5/30-31/1981, Doyen & Liebherr, on sand at night (2, EMEC); Coahuila, 10 mi E of San Pedro de las Colonias, 7/3/1959, ER Tinkham, low dunes (1, USNM). All paratypes labeled "Paratype *Arenivaga rothi* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the genitive case. This species is named for the late Louis M. Roth who devoted his career to the description of new cockroach species and co-authored Cockroaches: Ecology, Behavior and Natural History.

Distribution. This species is found in north central Mexico in the state of Coahuila up to Presidio County, Texas. See Fig. 140.

Diagnosis. *A. rothi* may be distinguished by the very wide gap on the right ventral phallomere and the unusually narrow, pointed head on the genital hook. See Fig. 139.

Description. Male. Measurements. Holotype TL = 21.0 mm, GW = 10.2 mm, PW = 6.64 mm, PL = 4.65 mm, TL/GW =2.06, PL/PW = 0.70. EW = 0.20 mm; OW = 0.40 mm. Size range among paratypes: TL 17.9–21.8, GW 8.2–10.4, PW 5.70–7.00, PW 4.40–4.82.

Head. Two ocelli large, ovoid and protruding (0.50 × 0.40 mm); vertex dark brown, with small ridges between apices of eyes and extending onto ocellar tubercles; interocellar space concave, dark brown, light brown medially, with two pale spots medial to base of ocelli. Frons light brown; posterior concave; anterior portion of frons bulbous, light brown; wide light brown anteclypeus. See Fig. 138d.

Pronotum. Pronotum translucent waxy beige; dorsal surface of pronotum with dense very short light orange-brown setae that are thicker and longer laterally; pronotal pattern light orange-brown "hippo face" with little discernible detail; no aura. See Fig. 138c.

Body. Wing brace present. Two tarsal claws present. Legs and body light brown; sternites with small pale maculations and fine lines laterally on each; subgenital plate light orange-brown with darker border; asymmetrical with pointed apices. See Fig. 138b.

Forewings. Wings extended well beyond abdominal apex (up to ~35% of wing length); very pale translucent white-beige or brown; surface translucent and matte or with dull sheen. See Fig. 138a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized, bulbous hookshaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized, punctate and deeply foreshortened; medial edge rolled outwards from central field, heavily sclerotized, shagreened to toothed. Small central sclerite lightly sclerotized, finely punctate, concave with posterior rim attaching to dorsal posterior point of dorsal phallomere, anterior end folded posteriorly into wide punctate cup. Right ventral phallomere arises from articulation to form smooth rounded lobe becoming sclerotized and shagreened medially and anteriorly; small shagreened fold in moderate gap followed by wide dorsally curving shagreened lip with central convexity. Folded anterior portion of left phallomere setose, otherwise unmodified. Genital hook with long extension to pointed head; short hook with slight dimple near point; arm smoothly curved and relatively short. See Fig. 139.

Habitat and natural history. All life history elements remain unobserved.

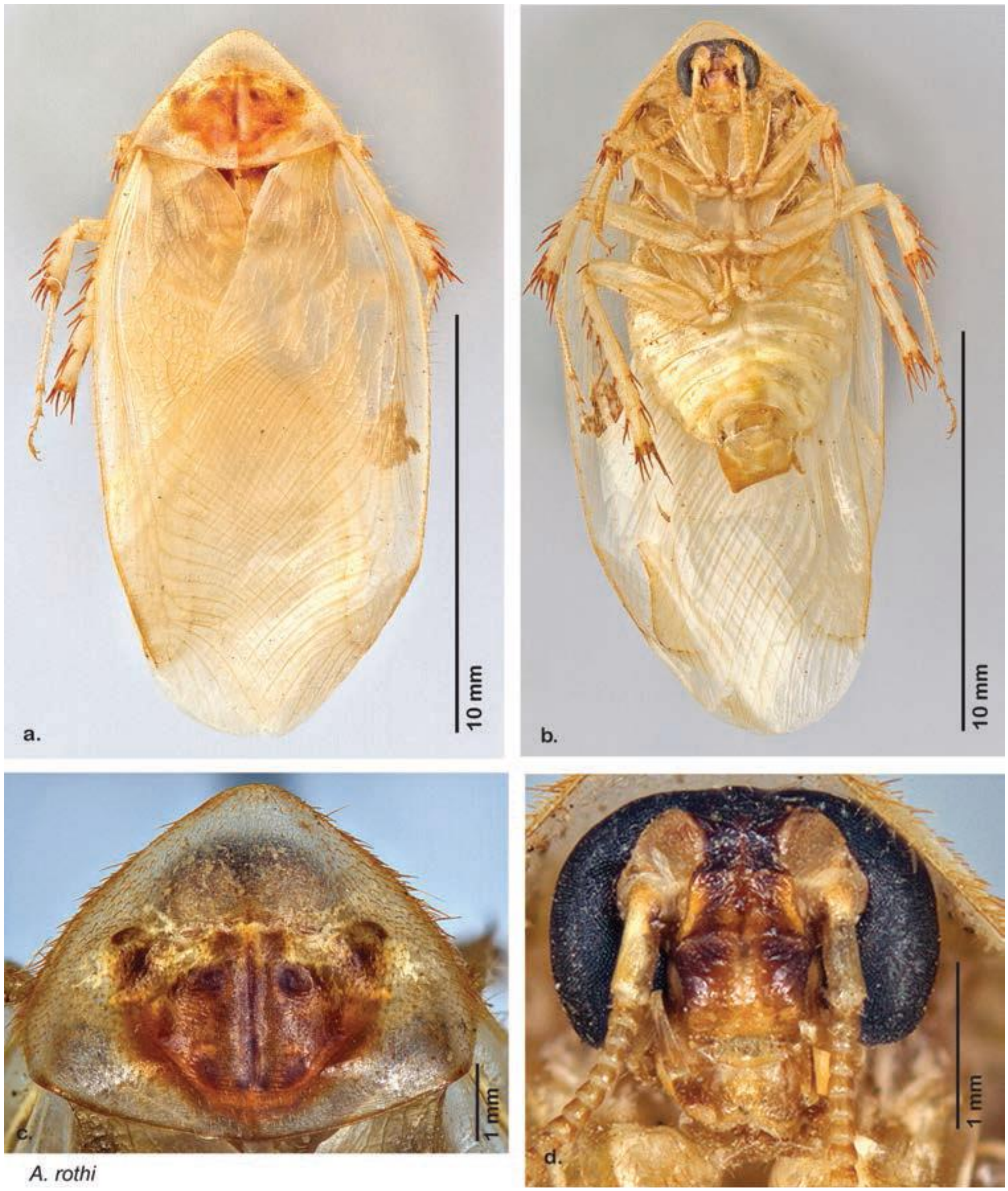


Figure 138. *A. rothi* a dorsal habitus b ventral habitus c pronotum d head.

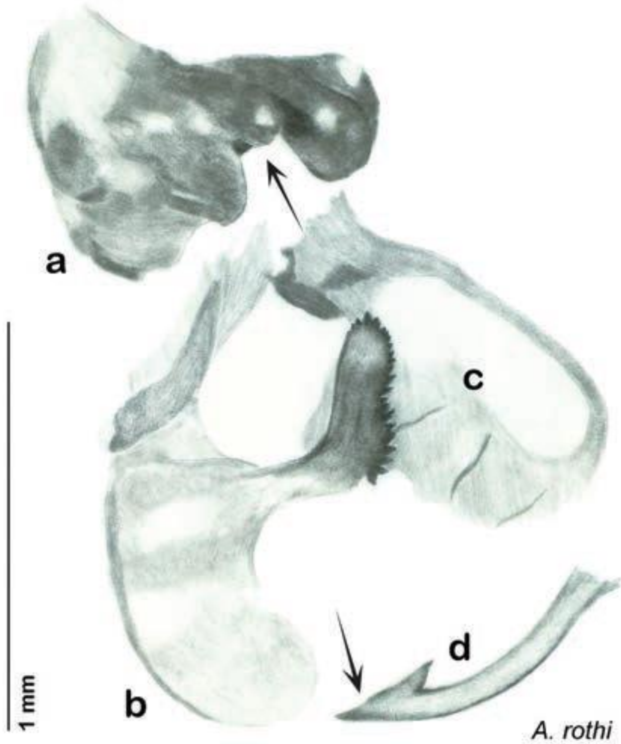


Figure 139. *A. rothi*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

Figure 140. *A. rothi*, distribution.

***Arenivaga sequoia* sp. n.**

http://zoobank.org/30135D08-F2F6-4D53-981E-83DF37C7E05F

http://species-id.net/wiki/*Arenivaga_sequoia*

Figures 141–143

Type locality. USA, California, Los Angeles County, Mt. Washington.

Material examined. Holotype: ♂ in LACM labeled "CALIF., L. A. CO: Mt. Washington (LA), 22-26.vi.76, coll J P Donahue" " HOLOTYPE *Arenivaga sequoia* Hopkins, 2012" [red label with black border].

Paratypes (116): USA: CA, Glendale, 8/5/1989, WF Chamberlain (3, TAMU); CA, Glendale, 3/21/1947, EI Schlinger (1, FSCA); CA, Los Angeles Co., Big Tujunga Canyon, 4/22/1972 (1, LACM); CA, Los Angeles Co., San Pedro Defense Fuel Support Pt., ?/?/1996, 33.46.25N 118.18.5W, Rogers & Matori, Pitfall trap (1, UCRC); CA, Los Angeles Co., Coldwater Canyon, 7/15/1984, S Ziff (2, LACM); CA, Los Angeles Co., Los Angeles, Mt. Washington Dist., 6/1/2001, 34.05.910N 118.13.177W, 840 ft., JP Donahue (1, LACM); CA, Los Angeles Co., Pasadena, 7/3/2002, 34.13N 118.13W, K McNassor (1, LACM); CA, Los Angeles Co., Westwood Hills, 4/8/1934, P Miller (1, ANSP); CA, Los Angeles Co., Los Angeles, Mt. Washington Dist., 6/22-26/1976, JP Donahue (1, LACM); CA, Los Angeles Co., Los Angeles, Mt. Washington Dist., 8/4/1983, 840 ft., JP & KE Donahue (1, LACM); CA, Los Angeles Co., Los Angeles, Mt. Washington Dist., 7/27/1976, 840 ft., JP & KE Donahue (1, LACM); CA, Los Angeles Co., Los Angeles, Mt. Washington Dist., 1/14/1976, 840 ft., JP & KE Donahue (1, LACM); CA, Los Angeles Co., Sulphur Springs Cmp., San Gabriel Mts., 7/28/1993, 5200 ft., AV Evans (1,LACM); CA, Altadena, 7/16/1975, RH Crandall Jr. (1,LACM); CA, Los

Angeles Co., Pasadena, 7/8/2002, K McNassor (1, LACM); CA, Los Angeles Co., Franklin Canyon, 6/5/1966, S Ziff (1, LACM); CA, Eaton Canyon, San Gabriel Mts., 9/5/1963, RH Crandall Jr. (1, LACM); CA, Los Angeles Co., Hungry Valley, 4 air mi. S of Gorman, 7/16/1975, J Powell, at black light (1, EMEC); CA, Los Angeles Co., Burbank, 7/12/1960, FP Sala, Orthoptera Blattidae det. F.Sala, (3, HEH); CA, Los Angeles Co., Soledad Canyon, 9/17/1979, A Comproni II, Collection of C.Hamera, (1, SDMC); CA, Los Angeles Co., So. Pasadena, 7/28/1942, at light (1, LACM); CA, Los Angeles Co., Los Angeles, Mt. Washington Dist., 11/24/1975, 840 ft., JP & KE Donahue (3, LACM); CA, Los Angeles Co., Los Angeles, Mt. Washington Dist., 11/13/1975, 840 ft., JP & KE Donahue (1, LACM); CA, Los Angeles Co., Los Angeles, 8/31/1930, J Hornung (1, LACM); CA, Los Angeles, 7/?/1968, Guardian Pest Control (1, CSCA); CA, Los Angeles, Mt. Wilson, 8/10/1909, F Grinnell Jr. (1, ANSP); CA, Los Angeles Co., El Segundo Sand Dunes, 6/15/1938, WD Pierce, El Segundo Sand Dunes Biological Survey (3, LACM); CA, Los Angeles Co., El Segundo Sand Dunes, 7/13/1938, WD Pierce (1,LACM); CA, Los Angeles Co., El Segundo Sand Dunes, 5/20/1939, WD Pierce (1, LACM); CA, Los Angeles Co., Waldon Canyon, 7/26/1947, LE Myers, light (2, CSCA); CA, Los Angeles Co., Burbank, 7/24/1954, at light (2, LACM); CA, Los Angeles Co., El Segundo Sand Dunes, 4/28/1945, L Martin, Ericameria ericoides (1, LACM); CA, Whittier, 8/14/1949 (1, USNM); CA, Oak Grove Park, La Canada, 8/15/1950, GP Taylor (1, SDMC); CA, Santa Barbara, Aliso Canyon 6 mi. SW of New Cayuma, 7/9/1965, D Bragg (1, EMEC); CA, Loomis, 6/25/1939, D Meadows (1, LACM); CA, Temecula, 9/9/1930, JA Hornung (1, LACM); CA, LaGrange, 7/20/1962, RP Allen (1, CSCA); CA, Stanislaus Co., Turlock, 5/3/1970, RR Snelling (3, LACM); CA, Stanislaus Co., Raines

Park, 8/2/1974, J Denk, ultraviolet light (1, SDMC); CA, Stanislaus Co., Turlock, 7/12/1959, RR Snelling, at light, 59G29-16 (2, CSCA); CA, Stanislaus Co., LaGrange, 7/27/1959, RP Allen, light trap, 59H14-1, *Arenivaga erratica* Rehn det. Buxton 1966 (1, CSCA); CA, Los Angeles Co., Southgate, 5/26/1939 (1, USNM); CA, Inyo Co., Sequoia NP, Potwisha, 6/18/1929, Van Dyke Collection (1, CAS); CA, Inyo Co., Sequoia NP, Potwisha, 7/16/1931, EO Van Dyke (1, CAS); CA, Inyo Co., Sequoia NP, Potwisha, 7/1/1941, EO Van Dyke (12, CAS); CA, Inyo Co., Sequoia NP, Potwisha, 6/13/1929, EO Van Dyke (3, CAS); CA, Inyo Co., Sequoia NP, Potwisha, 6/20/1929, EO Van Dyke (1, CAS); CA, Three Rivers, 8/5/1940, DE Hardy (1, ANSP); CA, Kernville, 7/24/1940, DE Hardy (1, ANSP); CA, Madera Co., San Joaquin Exp. R., 7/29/1953, HE Childs (1,USNM); CA, Coachella Valley, Snow Creek, 5/11/1952, ER Tinkham (1, USNM); CA, Los Angeles Co., Tanbark Flat, 7/3/1950, FX Williams (1, CAS); CA, Contra Costa Co., Antioch NWR, 7/10/1990, Hsu & Powell, lights (3, EMEC); CA, Contra Costa Co., Antioch, 1/24/1975, J Doyen, sifting sand, J.Doyen Lot 75 A1.1 (2, EMEC); CA, Contra Costa Co., Antioch NWR, 9/30/1981, J Powell (1, EMEC); CA, Contra Costa Co., Antioch, 7/3/1953, Marah & Schuster, *Arenivaga erratica* Rehn det. HF Strohecker (1, EMEC); CA, Madera Co., Lake Millerton, 5/29/1992, WF Chamberlain, at light (2, TAMU); CA, Madera Co., Millerton Lake RA, 5/10/1997, WF Chamberlain, at light (1, TAMU); CA, Walker Pass, 7/13/1961, EI Schlinger (1, UCRC); CA, Monterey Co., 4 mi. E of Arroyo Seco Guard Station, 5/9/1975, 650 ft., J Chemsak (1, EMEC); CA, Monterey Co., Marina dunes, 4/3/1988, GR Ballmer (1, UCRC); CA, Inyo Co., Sequoia NP Hosp. Flat Cpgd., 7/7/1973, LJ Orsak, black light (1, EMEC); CA, Ventura (1, LACM); CA, Santa Paula, 7/1/1939, (1, USNM); CA, San Diego Co., San Ysidro, 6/24/1969, light trap, plant quarantine division, USDA (1, CSCA); CA, Orange Co., 4 mi. E of Olive, 8/3/1980, JW Wilcox, black light (2, CSCA); CA, Laguna Beach, 7/10/1919 (1, USNM); CA, Fresno Co., Kerman, 8/3/1988, KS Hagen (2, EMEC); CA, Fresno Co., Piedra, 8/6/1982, RF Gill (1, EMEC); CA, Fresno Co., Pine Flat Dam, 6/3/1968, EA Kane (1, CSCA); CA, Sutter Co., Sutter Buttes, 2/6/1980-2/4/1981, AR Hardy, antifreeze pit trap (1, CSCA); CA, Kern Co., Frasier Park, 6/20/1948, AT McClay, *Arenivaga erratica* Rehn det. Strohecker (1, FSCA); CA, Kern Co., 11 mi. W & 1 mi. N of Wasco, 7/26-27/1965, JP Bruen, at light (8, EMEC). All paratypes labeled "Paratype *Arenivaga sequoia* Hopkins 2012" [blue label with black border].

Etymology. The name is a noun in the nominative singular. This species is named for the fact that it occurs, amongst other places, in Sequoia National Park and Sequoia National Forest–the first desert sand roach species found in a forest.

Distribution. This species is found throughout the western half of southern and central California and on one off-shore island. See Fig. 143.

Diagnosis. *A. sequoia* can be identified by the narrow dorsally turning hookshaped lobe on the right dorsal phallomere and the wide gap on the right ventral phallomere. See Fig. 142.

Description. Male. Measurements. Holotype TL = 18.5 mm, GW = 9.4 mm, PW = 5.65 mm, PL = 3.90 mm, TL/GW = 1.97, PL/PW = 0.69. EW = 0.4 mm; OW = 0.5 mm. Among paratypes range of TL 13.6–22.0; range in GW 6.1–10.0; range in PW 5.00–6.65; range in PL 3.30–4.64.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.25 mm); vertex dark brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles;

interocellar space concave, dark brown anteriorly and laterally fading to light brown towards center and frons. Posterior frons concave; color of frons grades from narrow dark brown line at peak of ridges to light brown at center; faint vertical corrugations. Anterior frons bulbous with central indentation at posterior end; anteclypeus broad, flat, light brown. See Fig. 141d.

Pronotum. Pronotum translucent, waxy beige anteriorly shading to chestnut at posterior end; anterior half of dorsal surface of pronotum with short fine orange-brown setae with scattering of longer, thicker setae throughout; pronotal pattern light brown to brown "panther face" depending on specimen; brown maculations of same color as pattern scattered across posterior 70% of dorsal surface of pronotum; appearance of lateral and posterior aura beneath maculations. See Fig. 141c.

Body. Wing brace present. Two tarsal claws present. Legs and body light orange-brown, darker at joints, lateral edges of sternites, and posterior margin of subgenital plate; subgenital plate asymmetrical with rounded apices. See Fig. 141b.

Forewings. Wings extended well beyond abdominal apex (~40% of wing length); color varies from uniform brown, to blotchy brown, to light brown. See Fig. 141a.

Genitalia. Right dorsal phallomere composed of bulbous sclerotized hook-shaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; setae projecting inwards over central field from lateral rim; medial margin of lobe punctate gradating to heavily toothed edge. Small central sclerite flat, unmodified, finely punctate; right ventral phallomere extends from articulation to form structure rounded at posterior apex and expanding to punctate and more sclerotized area dorsally; attached anteriorly after wide gap is dorsally projecting flanged arm, shagreened with toothed edge. Left phallomere unmodified. Genital hook with moderate extension to pointed head with short hook; arm with shallow bend. See Fig. 142.

Habitat and natural history. This species occurs from in varied terrain at elevations of 5 m to over 1700 m along the western slopes of the southern Sierra Nevada Mountains and westwards to the coast. All other life history elements remain unobserved.

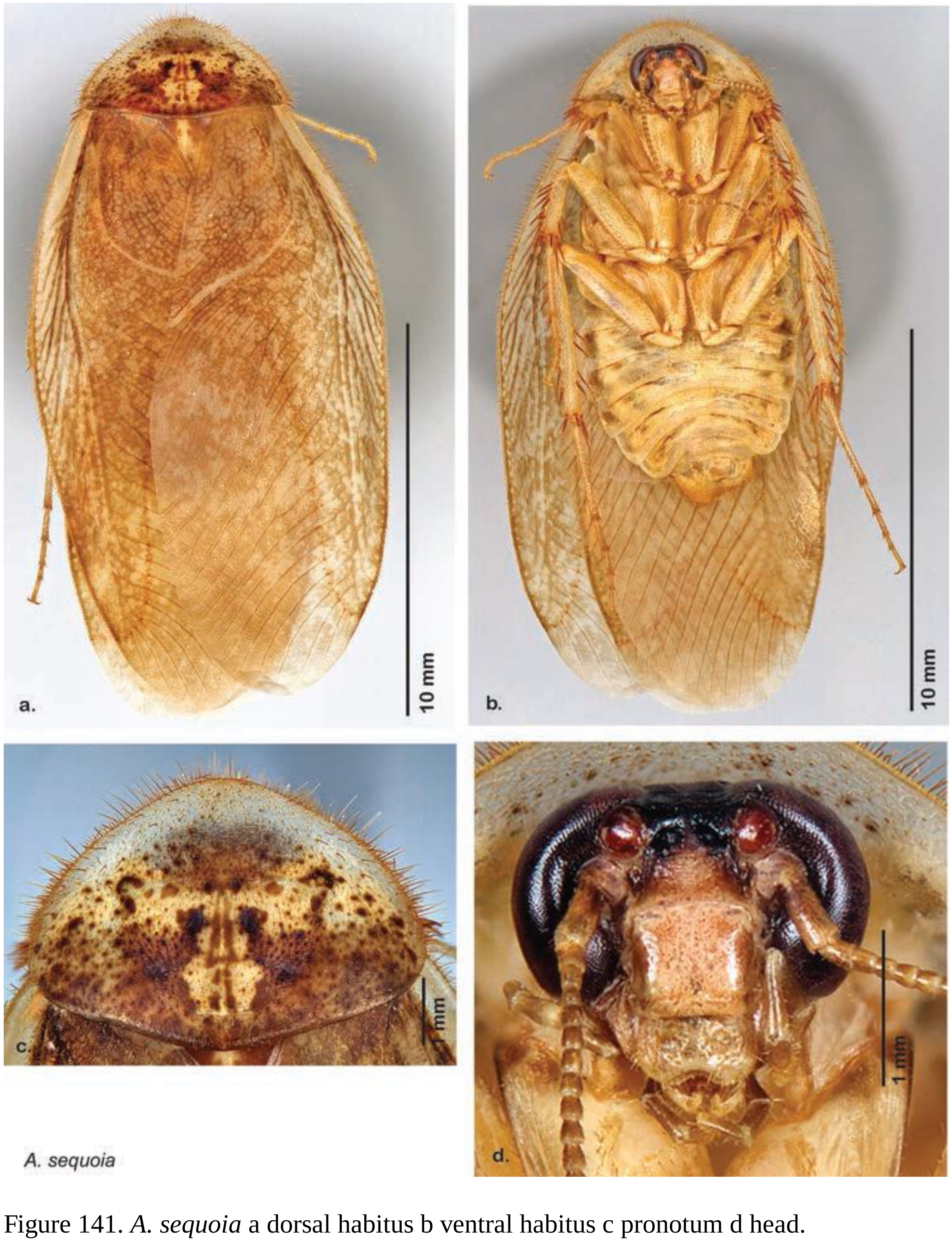


Figure 141. *A. sequoia* a dorsal habitus b ventral habitus c pronotum d head.

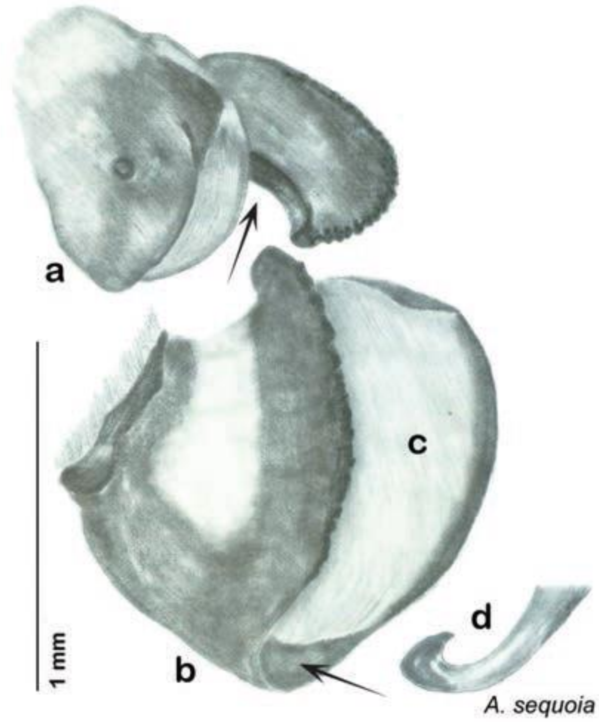


Figure 142. *A. sequoia*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

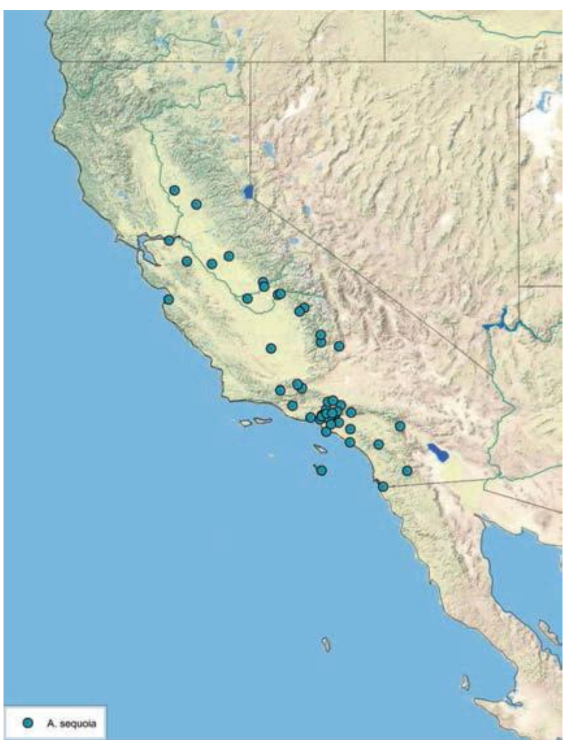


Figure 143. *A. sequoia*, distribution.

***Arenivaga tenax* sp. n.**

http://zoobank.org/5749CACF-DB41-4538-B1CD-4E7C58D91615

http://species-id.net/wiki/*Arenivaga_tenax*

Figures 144–146

Type locality. USA, New Mexico, Otero Co., White Sands NM.

Material examined. Holotype: ♂ in MSB labeled "USA: NM, Otero Co., White Sands NM, Interdune Veg., WSNMF, 4008' UV trap, 32.46.64N 106.10.84W, 14 Jul 2010, EH Metzler" "HOLOTYPE *Arenivaga tenax* Hopkins, 2012" [red label with black border]. *Paratypes (50):* USA: AZ, Cochise Co., Willcox, 7/20/1970, S Kozloski, black light (16, ASUT); AZ, Portal, 6/28/1956, OL Cartwright, from No. 3 rat nest Neotoma (1, USNM); TX, Monahan Sandhills SP, 7/10/1994, WF Chamberlain, at light, *Arenivaga erratica* Rehn det. Stiehan 94 (1, TAMU); TX, El Paso, 6/28/1947, Cazier, D Rockefeller Exp. (1, AMNH); TX, El Paso Co., 12 mi NNE of Fabens, 4/23/1998, 31.40.31N 106.02.30W, EG Riley, UV light (2, TAMU); TX, El Paso Co., I10 rest stop 1 mi SE of Fabens, 7/1/1994, W & B Warner (1, WB Bill Warner); TX, El Paso Co., Clint, 6/9/1977, CR Burgess, light trap, *Arenivaga erratica* Rehn det. J.Stidham 98 (1, TAMU); TX, El Paso Co., Hueco Tanks, 5/15/1971, Murray & Gaumer, at light (1, TAMU); TX, El Paso Co., El Paso, 8/?/????, GW Dunn (1, ANSP); TX, El Paso Co., 7/17/1927, PA Readio (1, ANSP); TX, Culberson Co., Guadalupe Mts., 6/15/2002, W Reeves, *Arenivaga erratica* Rehn det. Roth 2002 (1, MCZ); NM, Bernalillo Co., Albuquerque, 6/8/1953, JR Stuntz, Truth or Consequences establishment thru Ralph E.Heal,e49,537288 (1, USNM); NM, Hidalgo Co., Rodeo, 8/4/1967, 4100 ft., LD Anderson (1, UCRC); NM, Las Cruces, 6/? or 7/?/1961, JH Russell, at lights (1, USNM); NM, Otero Co., White Sands NM, 7/14/2010, 32.46.64N 106.10.84W, EH Metzler, interdune vegetation (1, MSB); NM, Otero Co., White Sands NM, 6/20/2009, 32.46.69N 106.11.38W, 4000 ft., EH Metzler, interdune vegetation (1, MSB); NM, Dona Ana Co., Las Cruces, 7/26/1982, CA Sutherland (1, NMSU); NM, Dona Ana Co., Las Cruces, 10/5/1985, CA Sutherland, lite (1, NMSU); NM, Portales, 6/29/1965, LL Garcia (1, NMSU); NM, Sandoval Co., Coronado SP, 8/21/1985, Baumann,Huish,Nelson, Wells,Whiting,Bernalillo, *Arenivaga erratica* (Rehn) Det. AH Barnum 2010 (1, MLBM); NM, Dona Ana Co., Dona Ana, on side of house, 4/29/2002, J Grimes, Blattaria MISC (1, NMSU); NM, Dona Ana Co., Ft. Selden SP, 6/16/1979, CD Ferris (1, FSAC); AZ, Cochise Co., Hwy. 186 at Blue Sky Rd., 8/28-10/9/2011, 32.12.52N 109.46.54W, WB Warner, black cup barrier pitfalls (2, Bill Warner); AZ, Cochise Co., Hwy. 186 at Blue Sky Rd., 7/29-8/28/2011, 32.12.52N 109.46.54W, WB Warner, black cup barrier pitfalls (6, Bill Warner); AZ, Cochise Co., Birch Rd., 4.1 mi. E of Hwy. 191, 7/28-10/9/2011, 31.58.43N 109.46.41W, WB Warner, black cup barrier pitfalls (1, Bill Warner); NM, Mesilla Park, 7/12/1917 (1, ANSP); NM, Sheridan Canyon, Big Hachet Mountains, HA Pilsbry (1, ANSP); AZ, Cochise Co., SWRS, Cave Creek Canyon, Chiricahua Mts., 8/8/1961, 5400 ft., (Eades)taken with light at night (1, ANSP). MEXICO: Ahumada, 7/22/1952, RB & JM Salander, at light (1, ANSP). All paratypes labeled “Paratype *Arenivaga tenax* Hopkins 2012” [blue label with black border].

Etymology. The name is an adjective in the nominative singular. This species is named from the Latin meaning tenacious.

Distribution. This species is found in New Mexico, far northwestern Texas, far southeastern Arizona, and neighboring parts of Mexico. See Fig. 146.

Diagnosis. *A. tenax* can be distinguished by the small medial spine on the medial margin of the right dorsal phallomere and the toothed distal end of that margin. See Fig. 145.

Description. Male. Measurements. Holotype TL = 19.2 mm, GW = 8.1 mm, PW = 5.22 mm, PL = 3.89 mm, TL/GW = 2.37, PL/PW = 0.75. EW = 0.20 mm; OW = 0.30 mm. Among paratypes range of TL 19.2–21.7; range of GW 7.8–10.0; range of PW 5.22–6.61; range of PL 3.89–4.33.

Head. Two ocelli large, ovoid and protruding (0.40 × 0.30 mm); vertex dark brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space concave, dark brown, with three small round indentations at points of an equilateral triangle. Posterior frons dark brown grading into waxy white; concave, smooth with anterior portion of frons bulbous and waxy white; waxy white smooth anteclypeus. See Fig. 144d.

Pronotum. Pronotum translucent waxy beige; dorsal surface of pronotum with short orange-brown setae that are thicker and longer laterally; pronotal pattern brown "panther face" with some discernible detail; no aura. See Fig. 144c.

Body. Wing brace present. Two tarsal claws present. Legs and body light brown, many specimens with brown maculations laterally on each sternite; subgenital plate light brown; asymmetrical with angular apices. See Fig. 144b.

Forewings. Wings extended well beyond abdominal apex (~40% of wing length); blotchy medium brown; surface opaque and matte or with very slight sheen. See Fig. 144a.

Genitalia. Right dorsal phallomere composed of lightly sclerotized bulbous hookshaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin more heavily sclerotized, with short toothed region at posterior end, and short flat spine medially, otherwise smooth. Small central sclerite nearly flat and finely punctate, with raised sinuous line of teeth at lateral edge; right ventral phallomere extends from articulation to form smooth rounded structure, shagreened, corrugated and narrowed anteriorly; attached anteriorly is mildly dorsally projecting flanged concave punctate arm, with shagreened edge, that extends to depth of posterior portion of phallomere. Folded anterior portion of left phallomere setose, otherwise unmodified. Genital hook with moderate extension to pointed head with moderate hook; arm with smooth shallow curve. See Fig. 145.

Habitat and natural history. All life history elements remain unobserved.

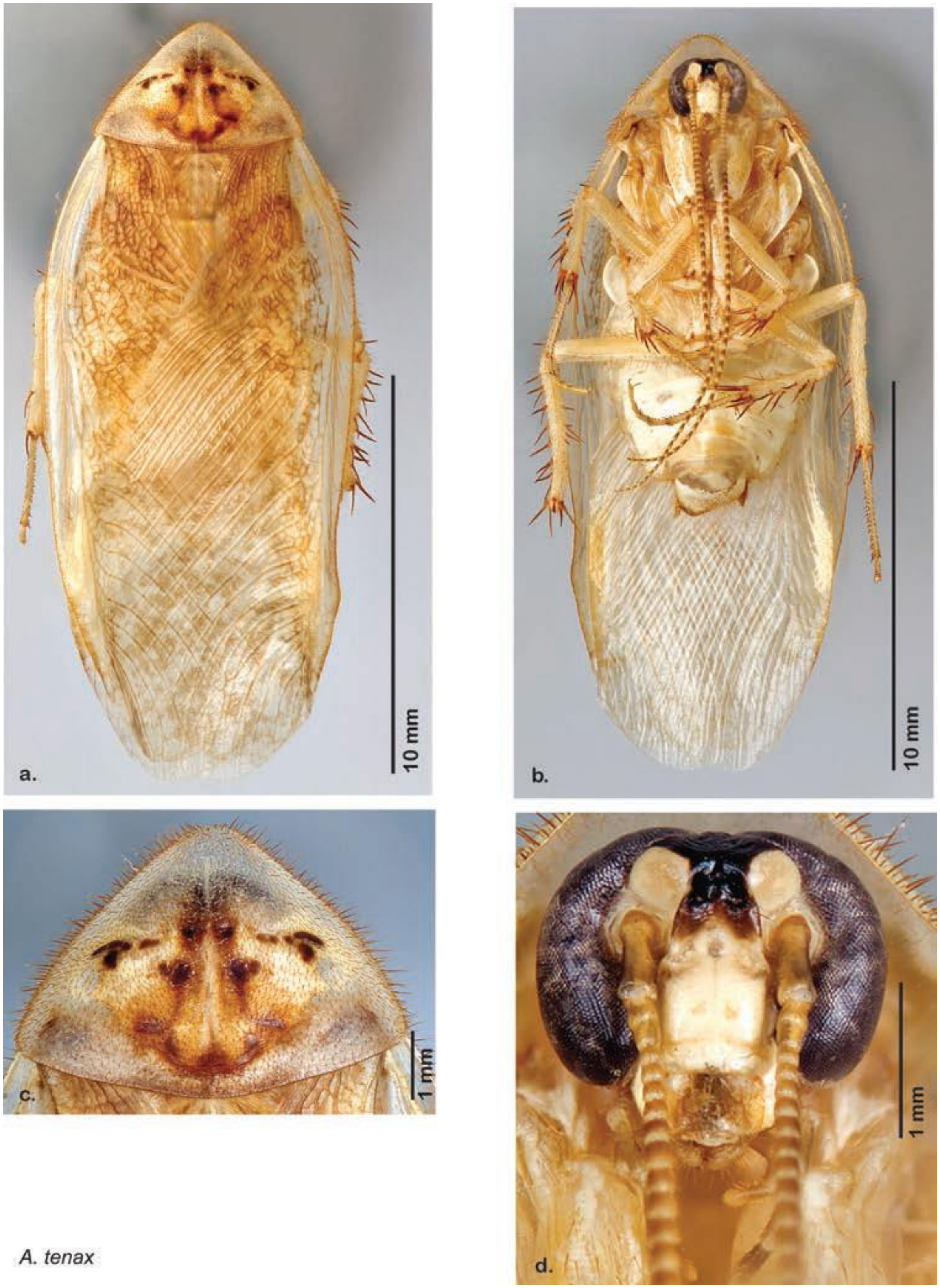


Figure 144. *A. tenax* a dorsal habitus b ventral habitus c pronotum d head.

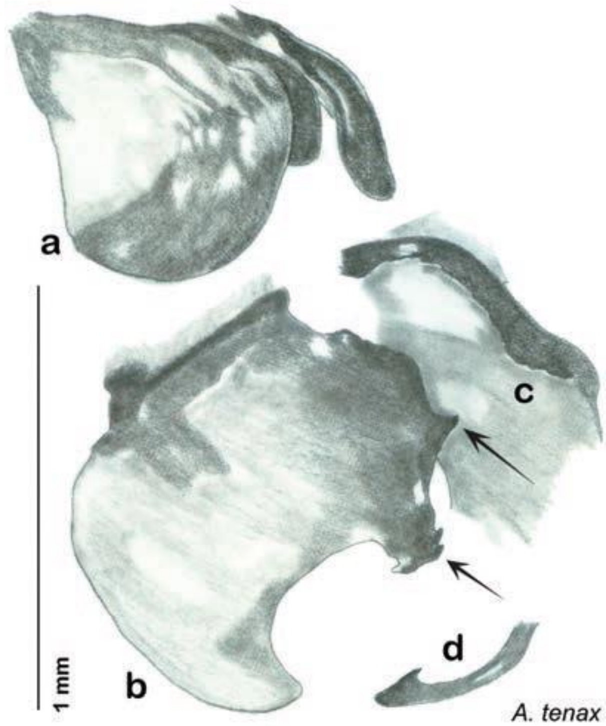


Figure 145. *A. tenax*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

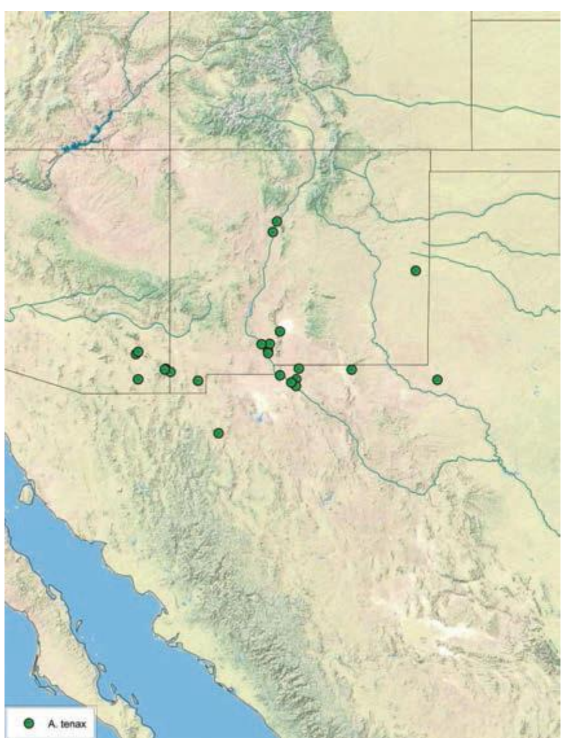


Figure 146. *A. tenax*, distribution.

***Arenivaga tonkawa* Hebard**

http://species-id.net/wiki/*Arenivaga_tonkawa*

Figures 147–149

1920 *Arenivaga tonkawa* Hebard, Transactions of the American Entomological Society, 46(2), pp. 197–217.

Material examined (795). USA: AZ, Pima Co., near Kits Pk. Baboquivari Mts., 8/7-9/1916, 32.00N 111.36W, 3600’, (1, ANSP); AZ, Pima Co., Baboquivari Mts., 7/24/1941, B.Hodgden, (4, ANSP); AZ, Pima Co., Baboquivari Mts., Schaeffer Canyon (R&H), 9/18/1924, 5160’-5500’, (2, ANSP); AZ, Pima Co., near NW base of Baboquivari Mts. (R&H), 9/17/1924, 3000’, (2, ANSP); AZ, Pima Co., Baboquivari Mts., 7/24/1941, L.H.Banker, (5, ANSP); AZ, Pima Co., Baboquivari Mts., 7/24/1941, R.H.Beamer, (1, ANSP); AZ, Pima Co., Sabino Canyon, 7/31/1941, R.H.Beamer, (3, ANSP); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 6/5/1916, J.F.Tucker, (1, ANSP); AZ, Pima Co., Kvitak, E of Quijotoa Mts. (R&H), 9/16/1924, 1530’, (1, ANSP); AZ, Pima Co., Lowell Ranger Sta., 7/6-20/1916, 32.185N 110.49W, 2700’, (1, ANSP); AZ, Pima Co., roadside mine, Coyote Mts. (R&H), 9/14/1924, 2800’, (1, ANSP); AZ, Florence, 7/1/1922, C.R.Biederman, 1 specimen with *A. erratica* det. label by Hebard (2, ANSP); AZ, Pima Co., Ajo (R&H), 9/18/1922, 1800’, at light (1, ANSP); AZ, Pima Co., Sabino Basin Sta. Catalinas, 8/15-21/1916, 32.22N 110.46.5W, 3800’, share w/ Clark and ANSP, *A.erratica* det. label by Hebard (1, ANSP); AZ, Pima Co., Robles Pass, Tucson Mts. (R&H), 9/27/1924, 2700’-3000’, (3, ANSP); AZ, Madera Canyon, Santa Rita Mts., 7/26/1955, F.X.Williams, (2, CAS); AZ, Yuma Co., 4 mi. W of Salome, 6/8/1958, MacNeill & MacNeill, (2, CAS); AZ, Yuma Co., S Luis, 8/11/1940, E.C. Van Dyke, (1, CAS); AZ, Yuma Co., Palomas, 8/8/1917, C.U.Biol.Exp. (1, ANSP); AZ, 6 mi. S of Florence, 7/23/1924, E.P.Van Duzee, (7, CAS); AZ, Florence, 7/28/1917, Wheeler, (1, MCZ); AZ, Pinal Co., Oak Flat Cpgd. off US60 , 7/18/2010, 33.18.28N 111.03.10W, Warner & Gruber, Bill Warner, headlamp & UV light (1, WB Warner); AZ, Pinal Co., I8 10 mi. E of Gila Bend, 1/18-3/1-2002, Bill Warner (1, WB Warner); AZ, Mohave Co., Burro Creek Cpgd. 16 mi. S of Wikieup, 8/31/1991, Strange & Miller, (1, FSCA); AZ, Maricopa Co., 13401 N Scottsdale Rd. Scottsdale, 9/26/1968, R.D.Hill, (1, ASUT); AZ, Apache Junction, 4/25/1966, Brennan, blacklight (3, ASUT); AZ, Dome, 7/21/1924, E.P.Van Duzee, (3, CAS); AZ, Pima Co., Bog Springs Cpgd., Madera Canyon, 7/10/1976, D.Whitman #575, blacklight (1, EMEC); AZ, Santa Cruz Co., Madera Canyon, 7/24/1982, D.Colby, blacklight, von blockers ,RCH013 (2, LACM); AZ, Santa Cruz Co., Madera Canyon, 8/2/1981, D.Colby, blacklight,RCH008 (1, LACM); AZ, Santa Cruz Co., Santa Rita Lodge, Madera Canyon, 7/27-28/1997, 31.72N 110.87W, Evans & Russell, (1, LACM); AZ, Madera Canyon, Santa Rita Mts., 6/18-23/1962, 5000’, F.Werner, UV light trap (1, UAIC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/17/1980, R.H.Crandall, (2, LACM); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/26-31/1965, R.H.Crandall, (3, LACM); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 8/4/1981, R.H.Crandall, (2, LACM); AZ, Santa Rita Mts., 7/24/1979, R.H.Crandall, (1, LACM); AZ, Santa Rita Mts., 7/23/1978, R.H.Crandall, (1, LACM); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 9/2/1959, 4880’, J.C.Franclemont, (2, CUIC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/10/1959, 4880’, J.C.Franclemont, (1, CUIC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/9/1959, 4880’, J.C.Franclemont, (1, CUIC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/14/1959, 4880', J.C.Franclemont, (1, CUIC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/24/1959, 4880', J.C.Franclemont, (1, CUIC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/8/1959, 4880', J.C.Franclemont, (1, CUIC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/20/1959, 4880', J.C.Franclemont, (1, CUIC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/31/1980, R.H.Crandall, (1, LACM); AZ, Pima Co., Tucson Mts., 8/11/1962, Knull & Knull, (1, OSUC); AZ, Yuma Co., Wellton, 8/9/1917, Corn.Univ.Exped. Lot 542, Sub 5? (1, CUIC); AZ, Yuma Co., Wellton, 6/13/19?9, L.L.Stitt, A-175,at light trap (1, USNM); AZ, Wickenburg, 8/20/1938, Knull & Knull, (5, OSUC); AZ, Yuma Co., Yuma, 6/1/1937, R.C.Dickson, (1, UCRC); AZ, Yuma Co., Yuma, 7/16/1957, V.Roth, at lights (1, UAIC); AZ, Yuma Co., Yuma, 4/29/1959, D.Muse, at lights (2, UAIC); AZ, Yuma Co., Yuma, 4/24/1959, D.Muse, at lights (1, UAIC); AZ, Yuma Co., Yuma, 7/14/1925, E.E.Russell, 4270 (1, ASUT); AZ, Yuma Co., Yuma, Sheep Tank Mine, Kora Mts., 10/29/1958, V.Roth, (1, UAIC); AZ, Yuma Co., Yuma, 5/14/1959, D.Muse, at lights (2, UAIC); AZ, Yuma Co., Yuma, 7/22/1925, (1, USNM); AZ, Yuma Co., 15 mi. SE of Alamo Crossing, 7/14/1962, Werner & Johnson, UV light trap (1, UAIC); AZ, Roll, 6/29/1939, L.L.Stitt, *A. genitalis* det. By A.B.Gurney (1, ASUT); AZ, Yuma Co., 11 mi. E of Wenden, 7/30/1965, K.W.Brown, at UV light (2, UCRC); AZ, Wickenburg, 7/8/1937, Knull & Knull, (3, OSUC); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., Summer 1967, J.Hessel, light trap (3, UAIC); AZ, Pima Co., Catalina SP, 7/27/1983, Barr & Barr, at light (1, EMEC); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 8/9/1953, F.G.Werner, (1, UAIC); AZ, Yuma Co., Palm Canyon, Kofa Mts., 4/8/1963, R.L.Langston, (1, EMEC); AZ, Yuma Co., Palm Canyon, 4/6/1963, W.H.Ewert, (1, UCRC); AZ, Pima Co., Tucson, 7/6/1967, R.Steslak, (1, UAIC); AZ, Pima Co., 16 mi. SE of Tucson, 6/15/1964, A.G.Raske, at light (1, EMEC); AZ, S base of Tortolita Mts., 6/30/1984, R.S.Beal, black light (1, NAUF); AZ, Pima Co., Tucson, 9/8/1967, M.Druckenduod, (2, USNM); AZ, Pima Co., Tucson, 6/24/1944, R.A.Flock, (1, UCRC); AZ, Pima Co., Tucson, 8/4/1946, R.H.Crandall, (1, LACM); AZ, Pima Co., Sabino Canyon, 1/2/1964, Tauber & Toschi, (1, EMEC); AZ, Pima Co., Peppersauce Canyon, Santa Catalina Mts., 7/8/1961, P.H.Johnson, UV light trap (1, UAIC); AZ, Pima Co., Tucson, 7/12/1937, Knull & Knull, (3, OSUC); AZ, Pima Co., Tucson, 6/3/1937, Knull & Knull, (1, OSUC); AZ, Pima Co., Organ Pipe NM, 6/25/1965, (1, USNM); AZ, Pima Co., W slope of Chutum Vaya Canyon Baboquivari Mts., 8/4/1966, 31.431N 111.37W, 3250’, F.Werner fam, light trap (1, UAIC); AZ, Salome, 7/25/1952, (1, USNM); AZ, Maricopa Co., Phoenix, 9/11/1942, P.C.Grassman, (1, UCRC); AZ, Pima Co., Tucson, Avra Valley Rd., 8/8/1998, Harrison & Sohns, (1, USNM); AZ, Pima Co., Tumamoc Hill, Tucson, 6/10-11/1967, R.Rice, rock pile (2, UAIC); AZ, Pima Co., Tucson, 10/10/1965, R.Rice, black light trap (2, UAIC); AZ, Pima Co., Tucson, 10/9/1965, R.Rice, under board, *A.erratica* det. label by R.Rice (1, UAIC); AZ, Gila Co., Globe, 6/2/1935, Parker, (1, MCZ); AZ, Gila Co., Parker Ranch, Sixshooter Canyon, Globe, 8/22/1932, Leech & Green, (1, CAS); AZ, Pima Co., Batamote Well, Ajo Valley (R&H), 10/16/1924, 1200’, (2, ANSP); AZ, Topock, 10/9/1917, O.C.Poling, (1, ANSP); AZ, Pima Co., Tucson, Jun/Jul 1910, L.C.Reynolds, *A.erratica* det. label by Hebard (1, CAS); AZ, Pima Co., St. Xavier Mon., 8/12/1924, J.O.Martin, (1, CAS); AZ, Pima Co., Tucson, 7/31/1993, Valentine & Valentine, *A.erratica* det. label by Roth (3, MCZ); AZ, Gila Bend, 8/20/1924, E.P.Van Duzee, (4, CAS); AZ, Maricopa Co., Maricopa Rd & I10, 7/4/1973, at light (4, ASUT); AZ, Maricopa Co., Maricopa Rd & I10, 6/27/1973, at light (1, ASUT); AZ, Maricopa Co., Tempe, 9/12/1971, C.Weller, on floor (1, ASUT); AZ, Maricopa Co., 7.5 mi. SSE of Bumble Bee, 9/17/1971, 2000', Kolner & Covert, at light (1, ASUT); AZ, Santa Rita Mts., 7/26/1925, (4, USNM); AZ, Pima Co., Molino Basin, Santa Catalina Mts., 7/31/1968, F.Werner, (1, UAIC); AZ, Pima Co., Agua Caliente Cave,6 mi. E of Amado, 11/9/1968, 300', W.D.Peachey, in from main entrance, very dry in cave, at least 1 other alive (1, UAIC); AZ, Pima Co., Molino Basin, Santa Catalina Mts., 7/28/1968, F.Werner, (1, UAIC); AZ, Santa Cruz Co., Madera Canyon, Santa Rita Mts., 7/10-26/1964, 5100', D.R.Davis, Bog Spring Cpgd. (1, USNM); AZ, Pima Co., Tucson, Olson res., 8/2/1989, C.A.Olson, UV (2, UAIC); AZ, Pima Co., Tucson Mt. Park, caretaker's house, 11/1/1981, S.Prchal, (1, UAIC); AZ (1, MCZ); AZ, Pima Co., Tucson, C.Bendier, (1, MCZ); AZ, Patagonia, Sonoita Cr., 10/14/1927, J.A.Kusche, (1, CAS); AZ, Yuma Co., Yuma, 7/27/1907, Hebard & Rehn, *A.erratica* det label by Hebard (1, ANSP); AZ, Roosevelt, Cornell Univ. Lot 445, Sub 5 (1, CUIC); AZ, Yavapai Co., Montezuma Well NM, 9/19/1993, S.M.Fondriest, site 24 (1, NAUF); AZ, Yavapai Co., Montezuma Castle NM, 8/1/1993, S.M.Fondriest, at light, site 23 (2, NAUF); AZ, Pima Co., Waterman Mts., 8/3/1980, Olson & VanDavender, UV, *A.erratica* det label by Olson (1, UAIC); AZ, Higley, 7/1/1917, (1, ANSP); AZ, Maricopa Co., Phoenix, 10/5/1904, M.Hebard, *A.erratica* det label by Hebard (1, ANSP); AZ, Maricopa Co., Phoenix, 5/9/1972, K.Mathieson, entrance to gopher hole (1, ASUT); AZ, Maricopa Co., Papago Park, Phoenix, 10/30/1970, L.McGill, (1, ASUT); AZ, Maricopa Co., Currey Corner, 5/27/1966, Brennan, black light (1, ASUT); AZ, Maricopa Co., Salt River, 5/2/1966, Brennan, black light (2, ASUT); AZ, Pima Co., Tucson, 10/28/1984, R.T.Huber, (1, UAIC); AZ, Pima Co., IBP:Santa Rita Range Res., Dest. Sample Plot, 6/29/1970, (1, UAIC); AZ, Pima Co., Tucson, Vic. of Ina & Oracle, 8/17/1987, W.L.Nutting, in pool (2, UAIC); AZ, Salome, 5/5/1920, O.C.Poling, *A.erratica* det label by Hebard (1, ANSP); AZ, Yuma Co., Yuma, 8/21/1930, Mrs.Smith, (1, ANSP); AZ, Maricopa Co., Phoenix, 10/2/1933, R.H.Crandall, (1, LACM); AZ, Maricopa Co., Phoenix, 4/19/1933, R.H.Crandall, (1, LACM); AZ, Maricopa Co., Phoenix, 10/30/19?3, R.H.Crandall, (1, LACM); AZ, Maricopa Co., Phoenix, 10/2/1933, R.H.Crandall, (1, LACM); AZ, Maricopa Co., Cave Creek, 10/9/2004, E.Pelton, (1, NAUF); AZ, Parker, 8/10/1942, R.A.Flock, (1, UCRC); AZ, Maricopa Co., Phoenix, 10/15/1933, R.H.Crandall, (1, LACM); AZ, Maricopa Co., Gila Bend, 9/12/1957, R.C.Dickson, (2, UCRC); AZ, Maricopa Co., Aguila, 8/21-22/1927, Cornell Univ. Lot 542 Sub 330, *A.erratica* det label by Hebard (1, CUIC); AZ, Florence, 7/28/1917, Cornell Univ. Lot 882 Sub 145 (1, CUIC); AZ, Maricopa Co., Sept. 1970, W.Mastriani, (1, EMEC); AZ, Maricopa Co., Tonopah, 7/20/2000, 33.29.40N 112.56.11W, 360m, D.Yanega, at light (2, UCRC); AZ, Maricopa Co., Scottsdale, 10/13/1991, R.M.Gillmore, at light (1, FSCA); AZ, Maricopa Co., Mesquite Flat, 7/6/1968, Noler & Burger, UV light (1, HEH); AZ, Maricopa Co., Phoenix, 9/11/1942, P.C. Grassman, (1, UCRC); AZ, Maricopa Co., 23rd Ave. Sewage Treatment Plant 3R, 9/17/1979, (3, UAIC); AZ, Maricopa Co., Phoenix, 8/1/1965, R.S.Beal, at light (1, NAUF); AZ, Coconino Co., Walnut Canyon 6 mi. ESE of Flagstaff, 8/7/1964, 6500 ft., JG Franclemont, (2, CUIC); AZ, Coconino Co., Walnut Canyon 3 mi. E of Flagstaff, 7/?/?/????, 6600 ft., Hsu,Powell & Prentice, black light (1, EMEC); AZ, Coconino Co., West Fork 16 mi. SW of Flagstaff, 8/17/1964, 6500 ft., JG Franclemont, (1, CUIC); AZ, Coconino Co., Tuba City, 6/27/1967, Davidson & Cazier, at light (1, ASUT); AZ, Hackberry near Kingman, 8/8/1920, OC Poling, *Arenivaga erratica* det. Hebard 1932 (1, ANSP); AZ, Mohave Co., Boulder Springs near Kingman, 8/2/1920, OC Poling, (1, ANSP); AZ, Pima Co., Tucson, 6/15/1932, RA Flock, (1, NAUF); AZ, Pima Co., Tucson, 6/28/1932, RA Flock, (1, UAIC); AZ, Pima Co., Tucson, 6/28/1932, RA Flock, (1, NAUF); AZ, Yuma Co., Yuma, 9/18/1959, D Muse, at light (1, UAIC); AZ, Cochise Co., Tex Canyon Chiricahua Mts., 8/28/1927, ?700 ft., JA Kusche, (1, CAS); AZ, Poza Nuevo, Organ Pipe National Monument, 7/20/1981, P Bennett, at light (1, UAIC); AZ, Oak Creek Canyon, 7/22/1958, CW OBrien, lights (2, UAIC); AZ, Pima Co., Tucson, 6/25/1932, R.A.Flock, (1, UAIC); AZ, Pima Co., Tucson, 6/21/1932, R.A.Flock, (1, UAIC); AZ, Pima Co., Tucson, 6/18/1932, R.A.Flock, (1, UAIC); AZ, Pima Co., Tucson, 7/9/1932, R.A.Flock, (1, UAIC); AZ, Pima Co., Tucson, 7/14/1932, R.A.Flock, (1, UAIC); AZ, Pima Co., Tucson, 7/6/1932, R.A.Flock, (1, UAIC); AZ, Yuma Co., Yuma, ?/?/1899, H.Brown, H.S.Wallace No.968,Homoeogamia (Polyphaga) *erratica* A.N.C. (2, UMMZ,USNM); AZ, Sawmill Canyon, Hualapai Mts., 9/22/1919, O.C.Poling, *Arenivaga erratica* Rehn Det. Hebard 1922 (1, UMMZ); AZ, Welton, 7/9/1917, Wheeler, *Arenivaga erratica* Rehn Det. T.H.Hubbell 1932 (1, UMMZ); AZ, Pima Co., Sabino Canyon, Santa Catalina Mts., 6/6/1916, J.F.Tucker, *Arenivaga erratica* Rehn Det. T.H.Hubbell 1932 (1, UMMZ); AZ, Avondale Ranch, Agua Fria R., 8/7/1917, Wheeler, *Arenivaga erratica* Rehn Det. T.H.Hubbell 1928,1932 (2, UMMZ); AZ, Yuma Co., Yuma, 8/18/1930, Leonora K. Gloyd, 179,*Arenivaga erratica* Rehn Det.

T.H.Hubbell 1931,1932 (2, UMMZ); AZ, Pima Co., Tucson, 7/7/1947, R.E.Elbe, Collection of H.S.Wallace (1, UMMZ); AZ, Maricopa Co., Phoenix, 9/10/1936, (1, UMMZ); AZ, Pima Co., Batamote Well, Ajo Valley (R&H), 9/16/1924, 1200', (1, ANSP); AZ, Casa Grande NM, Coolidge, 6/15/1949, L.Arnberger, (1, LACM); AZ, Pima Co., Tucson, 8/6/1935, 2460', JRTB, Mendenhall,Phoenix, (1, HEH); AZ, Madera Canyon, Santa Rita Mts., 8/16/1932, Kirkwood & Reid, (1, LACM); AZ, Benson, 8/7/1947, E.R.Tinkham, E.R.T., (1, HEH); AZ, Madera Canyon, Santa Rita Mts., 9/12/1953, E.R.Tinkham, (2, USNM); AZ, Sabino Basin, 9/19/????, C.H.T.Townsend, (1, USNM); AZ, Madera Canyon, Santa Rita Mts., 7/20/1948, J.F.Curry, Collected at light (1, CSCA); AZ, Madera Canyon, Santa Rita Mts., 8/20/1949, L.M.Martin, (2, LACM); AZ, Madera Canyon, Santa Rita Mts., 8/7/1947, L.M.Martin, (1, LACM); AZ, Madera Canyon, Santa Rita Mts., 8/15/1949, L.M.Martin, (1, LACM); AZ, Madera Canyon, Santa Rita Mts., 8/16/1947, L.M.Martin, (1, LACM); AZ, Madera Canyon, Santa Rita Mts., 7/12/1956, Martin, Comstock & Rees, (1, LACM); AZ, Molino Basin, Santa Catalina Mts., 8/29/1951, C.D.McNeill, (4, EMEC); AZ, 10 mi. E of Diablo Canyon, 7/16/1947, E.R.Tinkham, E.R.T., (1, HEH); AZ, Pima Co., Saguaro NM, 6/6/1966, Gordon & Brach, (1, LACM); AZ, Pinal Co., Hidden Valley,5 mi. SW Maricopa, 11/3-5/1958, K.Roever, (5, LACM); AZ, Pima Co., Ajo, 8/16/1952, C.& P.Vaurie, (1, AMNH); AZ, Pima Co., Organ Pipe NM, 8/6/1955, Werner & Butler, (2, UAIC); AZ, Pima Co., Organ Pipe NM, 6/14/1952, Cazier, Gertsch & Schrammel, (10, AMNH); AZ, Pima Co., Quitobaquito, Organ Pipe NM, 6/13/1952, Cazier, Gertsch & Schrammel, (3, AMNH); AZ, Yuma Co., Yuma, 8/6/1948, C.& P.Vaurie, (1, AMNH);

AZ, 36 mi. E of Gila Bend, 7/21/1955, G.D.Butler, at light (4, UAIC); AZ, Maricopa Co., Gila Bend, 7/22/1948, C.& P.Vaurie, (5, AMNH); AZ, Pima Co., Sabino Canyon, west slope station, Catalina Mts., 7/26/1948, 2500', W.Nutting, Sycamore-oak-mesquite, W.L.N., drawing of genitalia (1, UAIC); AZ, Santa Rita Mts., 7/12/1950, J.Arnold, (1, SEMC); AZ, Pima Co., Sabino Canyon, 7/9/1952, E.H.&L.D.Beamer,LaBerge,Wolf, Liang&Winer, (2, SEMC); AZ, Pima Co., Santa Catalina Mts., 6/26/1933, Bryant, Lot 272 (1, UAIC); AZ, Pima Co., S. of mouth of Sabino Canyon, Santa Catalina Mts., 9/2/1950, 2600', Cohn,Boone&Cazier, (1, AMNH); AZ, Pima Co., Tucson, 7/5/1954, Cazier&Gertsch, (2, AMNH); AZ, Pima Co., Tucson, 6/27/1954, M.Cazier, (1, AMNH); AZ, Pima Co., Tucson, 6/30/1949, 2200', G.M.Brandt, (1, AMNH); AZ, Pima Co., Tucson, 7/18/1953, G.M.Brandt, (1, AMNH); AZ, Yuma Co., Laguna Dam, Yuma, 8/10/1948, 1000', Nutting & Werner, at light, willow area, W.L.N., drawing of genitalia (1, UAIC); AZ, Yuma Co., Hope, 8/12/1948, 1400', Nutting & Werner, at light, greenwood desert, W.L.N., *Arenivaga erratica* Rehn det.W.Nutting 1950 (1, UAIC); AZ, Yuma Co., Hope, 8/12/1948, 1400', Nutting & Werner, at light, greenwood desert, W.L.N., drawing of genitalia (1, UAIC); AZ, Pima Co., Tucson, (1, AMNH); AZ, Madera Canyon, Santa Rita Mts., 8/8/1947, L.Martin, (1, LACM); AZ, Pima Co., Tucson, 9/18/1937, E.D.Ball, (1, UAIC); AZ, Pima Co., Tucson, 9/?/1929, S.B.Tatum, (1, UAIC); AZ, Madera Canyon, Santa Rita Mts., 8/18/1949, L.Martin, (1, LACM); AZ, Pima Co., Tucson, 9/?/1929, W.P.Stockwell, (2, UAIC); AZ, Yuma Co., Yuma, 5/27/1952, G.Butlwe, (1, UAIC); AZ, Pima Co., Tucson, 9/30/1938, Bryant, (1, UAIC); AZ, Pima Co., Tucson, 9/30/1939, Bryant, (1, UAIC); AZ, Pima Co., Tucson, 10/10/1939, Bryant, (2, UAIC); AZ, Pima Co., Tucson, 10/2-25/1916, Ac.1920 (1, AMNH); AZ, Pima Co., Tucson, 9/29/1940, E.L.Peterson, (2, UAIC); AZ, Pima Co., Tucson, 10/?/1929, C.Dierking, (2, UAIC); AZ, Pima Co., Tucson, 10/15/1927, L.C.Bailey, (3, UAIC); AZ, Pima Co., Tucson, 9/18/1935, M.Hattis, (1, UAIC); AZ, Pima Co., Tucson, 10/10/1927, T.Knight, (1, UAIC); AZ, Pima Co., Tucson, 9/?/1929, J.S.Thornber, (1, UAIC); AZ, Pima Co., Tucson, 7/?/1929, at light (1, UAIC); AZ, Pima Co., Tucson, 10/2/1923, (1, UAIC); AZ, Pima Co., Tucson, 10/4/1923, (1, UAIC); AZ, Pima Co., Tucson,1130 E.Helen St., 10/8/1937, L.P.Wehrle, Lot 102,Sublot 416,*Arenivaga erratica* (Rehn) Det.E.R.Tinkham 1938 (1, HEH); AZ, Pima Co., Tucson, 11/11/1939, J.Sprecher, (1, UAIC); AZ, Pima Co., Tucson, 10/7/1939, D.Foote, (1, UAIC); AZ, Pima Co., Tucson, 9/25/1943, M.H.Frost,Jr., *Arenivaga erratica* (Rehn) (1, UAIC); AZ, Pima Co., Tucson, 10/15/1942, L.Middleton, *Arenivaga erratica* (Rehn) MFJr. (1, UAIC); AZ, Pima Co., Tucson, 10/14/1935, (1, UAIC); AZ, Pima Co., Tucson, 10/10/1923, (1, UAIC); AZ, Wickenburg, 7/5/1950, H.O.Wright, (1, SEMC); AZ, Pima Co., Tucson, 7/2-8/1932, R.A.Flock, (5, UAIC); AZ, Pima Co., Tucson, 6/12-27/1932, R.A.Flock, (13, UAIC); AZ, Pima Co., Tucson, 5/20/1932, R.A.Flock, (1, UAIC); AZ, Pinal Co., Maricopa, 10/17/1927, J.A.Kusche, (2, CAS); AZ, 10 mi. W. of Casa Grande, 8/31/1942, E.O.VanDyke, (1, CAS); AZ, Hope, 7/19/1946, E.O.VanDyke, (1, CAS); AZ, Tuba City, 8/1/1937, R.P.Allen, (1, CAS); AZ, Tuba City, 7/18/1937, R.P.Allen, (1, CAS); AZ, Tuba City, ?/9/1937, R.P.Allen, (1, CAS); AZ, Coconino Co., Rainbow Lodge, Navajo Mt., 7/14/1933, 6500’, H.N.Hultgren, Ansel F. Hail Expedition 1933 (1, CAS); AZ, Pima Co., Alamo Canyon, Ajo Mt., 7/?/1923, Leech & Green, (1, CAS); AZ, Pima Co., Organ Pipe NM, Campground, 8/25/1979, C.Melton, (1, UCMC); AZ, Pima Co., Tucson, KOA Campground 20 mi. N on I10, 9/5/1980, S,W.Nichols, at night on concrete wall, *Arenivaga erratica* Rehn Det.F.W.Fisk 1980 (1, CUIC); AZ, Pima Co., Organ Pipe Cactus NM, 6/4/1956, A.Menke, (1, LACM); AZ, Madera Canyon, Santa Rita Mts., 9/11/1951, L.Martin, (1, LACM); AZ, Hope, 17002, 33.721149, -113.694339, E.O.VanDyke, (1, CAS); AZ, Florence, 7/28/1917, Wheeler, (1, USNM); AZ, Pima Co., Organ Pipe Cactus NM, 4/16/1947, E.R.Tinkham, E.R.T., (1, HEH); AZ, C.V.Riley, (1, USNM); AZ, Pima Co., Sabino Canyon, 8/6/1959, K.V.Krombein, (1, USNM); AZ, Pima Co., Tucson, 7/28/1954, R.S.Beal, (2, EMEC); AZ, Pima Co., Tucson, 9/1/1947, R.S.Beal, *Arenivaga erratica* Rehn det. H.F.Strohecker (1, EMEC); AZ, Pleasant Lake, 7/7/1952, R.H.&L.D.Beamer, LaBerge & Liang, (1, SEMC); AZ, Santa Cruz Co., Madera Canyon, 8/27/1977, G.Forbes, (1, SDMC); AZ, Santa Rita Mts., 7/10-12/1950, J.Arnold, (2, SEMC); AZ, Santa Rita Mts., 7/5/1950, J.G.Rosen, (2, SEMC); AZ, Santa Rita Mts., 7/12/1950, R.H.&L.D.Beamer, (3, SEMC); AZ, Santa Cruz Co., Madera Canyon, 7/31/1992, A revision of the genus *Arenivaga* (Rehn) (Blattodea, Corydiidae)... 223 Faulkner & Gillen, (1, SDMC); AZ, Hayden, 8/?/1940, (1, UAIC); AZ, Santa Cruz Co., Madera Canyon, 8/9-20/1978, Brown & Faulkner, (1, SDMC); AZ, Madera Canyon, Santa Rita Mts., 9/12/1951, L.Martin, (1, LACM); AZ, Madera Canyon, Santa Rita Mts., 8/24/1951, L.Martin, (1, LACM); AZ, Maricopa Co., 19 mi. NE Mesa, 7/31/1960, Wood, Warren & Shurtleff, light (1, SEMC); AZ, Maricopa Co., Gillespie Dam, Gila Bend, 8/9/1948, 1000’, Nutting & Werner, tamerix-willow in desert, at light, W.L.N. (5, UAIC); AZ, Madera Canyon, Santa Rita Mts., 8/17-18/1949, L.Martin, (1, LACM); AZ, Madera Canyon, Santa Rita Mts., 8/8/1947, L. Martin, (1, LACM); AZ, W.Gila Valley, 7/30/1957, V.Roth, (1, UAIC); AZ, Topock, 10/9/1917, O.C.Poling, (1, ANSP); AZ, Yuma (now La Paz) Co., 0.5 mi. S of Parker Dam, 8/10/1983, R.E.Wagner, at black light (1, UCRC); AZ, Yuma (now La Paz) Co., Colorado River at Parker, 8/15/1963, Tauber & Toschi, (1, EMEC); AZ, Sawmill Canyon, Hualapai Mts., 9/22/1919, OC Poling, (1, ANSP); TX, Carrizo Springs, A. Wadgymar, PARATYPE; 1 specimen genitalia figured H1920 (5, ANSP); TX, Weslaco, 11/1/1940, P.T.Riherd, light trap (12, TAMU); TX, Eastland Co., 5/3/1921, G.O.Wiley, (1, ANSP); TX, Kenedy Co., Kenedy Ranch, Jaboncillos Pasture, sand dunes, 4/20-22/2001, 26.58.38N 97.40.59W, Godwin & Riley, malaise trap (4, TAMU); TX, Round Mt., (3, ANSP); TX, Jim Wells Co., La Copita Res. Sta. 8 mi. W of Ben Bolt, 5/20/1987, J.C.Schaffner, at light (2, TAMU); TX, Sabinal, 5/1/1910, F.C.Platt, (1, ANSP); TX, San Antonio, 9/18/1927, Palmer, (1, ANSP); TX, Kerrville, 4/11/1907, F.C.Platt, at light (2, ANSP); TX, Mission, 7/5/1939, R.I.Sailer, (1, ANSP); TX, Goliad, Jul.1928, W.A.Cushman, (1, ANSP); TX, Brownsville, 4/30/1895, C.H.T.Townsend, (1, ANSP); TX, Brownsville, May.1922, (2, ANSP); TX, Hays Co., Aug.1936, E.P.C., (1, ANSP); TX, Kingsville, C.T.Reed, Cornell Univ. Lot 912 Sub 811 (1, CUIC); TX, Burleson Co., Old River Ranch ca. 3 mi. E of Clay, 10/12/1998, W.Godwin, (2, TAMU); TX, Brown Co., Lake Brownwood SP, 4/29/1995, E.G.Riley-80, UV (2, TAMU); TX, Georgetown, 1 specimen-S.H.Scudder, Palmercave (2, ANSP); TX, vicinity of Kingsville, C.Reed, (1, ANSP); TX, Bexar Co., 2/5/1929, (2, ANSP); TX, Uvalde Co., 5/19/1918, J.C.Bradley, (1, ANSP); TX, Brownsville, 6/1/1924, J.N.Knull, (1, OSUC); TX, Pharr, 4/27/1948, R.P.Dow, (1, FSCA); TX, Dimmit Co., Winterhaven, S.E.Jones, (3, ANSP); TX, Hidalgo Co., Tex. Exp.Sta., 6/14/1931, light trap, 485 (2, ANSP); TX, Dimmit Co., Tex.Exp.Sta., 6/7/1933, H.J.Reinhard, light trap (2, ANSP); TX, Kenedy Co., Kenedy Ranch, Jaboncillos Pasture, sand dunes, 4/21/2001, 27.01.294N 97.43.114W, W.Godwin, UV light (1, AMU); TX, Kenedy Co., Kenedy Ranch, Jaboncillos Pasture, sand dunes, 4/21/2001, 26.59.22N 97.40.11W, Raber,Riley & Yoder, UV light (1, TAMU); TX, Bexar Co., 2/5/1929, H.B.Parks, (4, TAMU); TX, Corpus Christi, 8/24/1969, C.W.Griffin, Suntide Refining, at light (1, USNM); TX, Nueces Co., Clare (should be Hazel) Bazemore Park, 4/10/1970, C.W.Griffin, UV light (1, USNM); TX, Kenedy Co., Kenedy Ranch, Jaboncillos Pasture, sand dunes, 4/21/2001, 27.01.293N 97.43.114W, Gillogly & Schaffner, MV light (1, TAMU); TX, Kleberg Co., Riviera, 7/25/1961, H.R.Burke, (1, TAMU); TX, San Patricio Co., Corpus Christi SP, 5/20-21/1981, Doyen & Liebherr, (1, EMEC); TX, Dimmit Co., Tex.Exp.Sta., 10/21/1933, 224 Heidi Hopkins / ZooKeys 384: 1–256 (2014) S.E.Jones, (1, TAMU); TX, Bexar Co., Mt.View Acres Ebony Hill Res. Station, 3/21/1972, Kendall & Kendall, (2, FSCA); TX, Comal Co., Bulverde, 4/15-16/1996, Warner & Wappes, Bill Warner, UVBL, (1, WB Warner); TX, Atascosa Co., 14 mi. S of Lyttle, 5/26/1994, Godwin & Gibson, BL (1, TAMU); TX, Uvalde Co., 4/1/1994, J.W.Stewart, at light (1, TAMU); TX, Carrizo Springs, June 1885, A.Wadgymar, (1, CAS); TX, Starr Co., 3 mi. E of Falcon Hts., 4/26/1991, E.G.Riley, (1, TAMU); TX, Dimmit Co., Tex.Exp.Sta., 6/7/1933, H.J.Reinhard, light trap (1, CUIC); TX, Weslaco, 11/21/1940, Riherd, light trap (4, TAMU); TX, Edinburg, 10/28/1971, P.T.Riherd, (1, TAMU); TX, Kerrville, 5/25/1984, W.F.Chamberlain, at light (2, TAMU); TX, Kerrville, 6/16/1997, W.F.Chamberlain, at light (1, TAMU); TX, Burnet Co., Inks Lake SP, 4/19/1980, C.W.Agnew, (2, TAMU); TX, Nueces Co., Corpus Christi, 4/10/1970, C.W.Griffin, (2, TAMU); TX, Padre Island, 7/1/1965, Dr.Lenczy, (1, LACM); TX, Uvalde Co., Dec. 1920, Bridwell, (1, USNM); TX, Austin, May.1942, E.J.Gerberg, (1, USNM); TX, Austin, Aug.1942, E.J.Gerberg, (2, USNM); TX, Cameron Co., 7/24/1955, S.W.Bromley, (1, USNM); TX, Hemphill Co., Canadian (should be Gene Howe) WMA, 7/11-12/1974, E.L.Todd, (1, USNM); TX, New Braunfels, 7/26/1942, E.S.Ross, (1, USNM); TX, Kinney Co., Brackettville, 6/20-25/1988, S.A.Stockwell, black light (2, EMEC); TX, Brownsville, 8/6/1937, C.S.Rude, (1, TAMU); TX, San Patricio Co., Welder (should be Welder Flats) WMA, 7/16/1989, J.Schaffner, (1, TAMU); TX, Karnes Co., 7/23/1928, R.H.Beamer, (1, ANSP); TX, Pecos Co., Jul.-Aug. 1966, C.W.Neeb, light trap (1, TAMU); TX, Shovel Mount, 9/10/1901, F.G.Schaupp, (1, ANSP); TX, Brownsville, June, F.H.Snow, (1, ANSP); TX, Carrizo Springs, F.G.Schaupp, (1, MCZ); TX, Brownsville, 3/11/?, G.Dorner, (1, ANSP); TX, Starr Co., 3 mi. E of Falcon Mts., 7/28/1991, Carlow & Riley, at UV light (1, TAMU); TX, San Antonio, 7/10/1939, J Vich, (1, CUIC); TX, Camp Bullis in tent, 3/16/1969, Spencer, (1, SDMC); TX, Schaupp, (2, MCZ); TX, Duval Co., 6.3 mi. W of San Diego, 4/4/1970, C.W.Griffin, Sepulveda Ranch, collected at black light (1, USNM); TX, Duval Co., Saenz Ranch, Benavides on FM2295, 5/20/1993, Goodwin & Abbott, UV light (1, TAMU); TX, Bexar Co., San Antonio, 3/20/1982, R.R.Thomas, (1, TAMU); TX, Wichita Co., 5/24/1975, L.Burt, Grass (1, UCRC); TX, Hall Co., 5/27/1968, D.D.Collins, (2, USNM); TX, Hall Co., 6 mi. SE of Turkey, 5/6/1970, Brien & Huddleston, Temik Project, Pitfall trap (1, USNM); TX, Waco, [tiny illegible label] (1, MCZ); TX, Starr Co., 7/5/1938, R.H.Beamer, (1, ANSP); TX, Jim Wells Co., La Copita Res. Sta. 8 mi. W of Ben Bolt, 5/20/1987, J.C.Schaffer, taken at light (1, TAMU); TX, Starr Co., 10 mi. N of Sullivan City, 4/13/1994, R.L.Aalbu, on road at night (1, CSCA); TX, Austin, 10/?/1899, (4, UMMZ); TX, Travis Co., ?/?/1931, S.U.G.Silvey, (1, UMMZ); TX, Brownsville, C.H.T.Townsend, (1, USNM); TX, Esperanza Ranch, Brownsville, 8/29/????, Brooklyn Museum Colln. 1929 (1, USNM); TX, Kerr Co., Kerrville, 4/11/1907, F.C.Pratt, at light (3, USNM); TX, Brownsville, 4/30/1895, C.H.T.Townsend, (2, USNM); TX, Brownsville, 4/14/1925, (1, USNM); TX, Esperanza Ranch, Brownsville, 8/?/1922, Catal.No.31,Brooklyn Museum Colln.1929,Homoeogamia *erratica* Rehn A.N.C.,BI (2, USNM); TX (1, USNM); TX, Belfrage, C.V.Riley, (1, USNM); TX, Sabino, 5/?/1910, F.C.Pratt, (1, USNM); TX, San Antonio, 9/18/1927, Palmer, 1215.S.H.Scudder Coll. (4, USNM); TX, Eagle Pass, 3/30/1908, Jones & Pratt, at light, (1, HEH); TX, Roanoke, 2/3/1932, F.C.Bishopp, Bishopp No. 18617 (3, USNM); TX, Ballinger, 10/5/1911, H.Pinkus, at light (1, USNM); TX, Carrizo Springs, 8/28/1885, Dr.A.Wadgymar, Collection C.V.Riley (1, USNM); TX, Belfrage, (2, USNM); TX, Bexar Co., Ft. Sam Houston, 11/4/1953, B.J.Adelson, electric light (1, EMEC); TX, Bexar Co., Ft. Sam Houston, 6/18/1952, B.J.Adelson, (1, EMEC); TX, Mills Co., 11 mi. SE of Goldthwaite, 7/12/1955, 1300-1400’, T.J.Cohn, (1, USNM); TX, near Casa Blanca Lake, Corpus Christi, 12/17/1938, L.Berner, (2, UMMZ); TX, Menard, 10/1/1946, L.J.Bottimer, photo spec. (1, USNM); TX, San Antonio, 4/1/1935, E.V.Walter, T#6378 (1, USNM); TX, San Antonio, 11/13/1934, L.Seaton, T#6377 (1, USNM); TX, Cotulla, 5/12/1906, Crawford & Pratt, at light (1, USNM); TX, Kenedy Co., Armstrong, 6/13/1962, P.A.Glick, (1, CSCA); TX, Kenedy Co., Armstrong, 3/31/1962, H.Glick, (2, CSCA); TX, Randall Co., Palo Duro Canyon SP, 5/12/1961, L.M.Martin, Reid, Rees & Ford (2, LACM); TX, Jeff Davis Co., Fort Davis, 10/13/1953, R.H.Reid, (1, LACM); TX, Kleberg Co., 3.5 mi. N of Riviera, 6/29/1961, R.L.Westcott, (1, LACM); TX, San Patricio Co., Lake Corpus Christi SP4 mi. SW of Mathis, 7/30/1955, 100', T.J.Cohn, (1, USNM); TX, Lubbock Co., Lubbock, 9/27/1968, Rutledge, (2, USNM); TX, Lubbock Co., 9 mi. E of Lubbock, 10/1/1970, G.R.Graves, (2, USNM); TX, Lubbock Co., 2 mi. N of Lubbock, 9/10/1970, G.R.Graves, (1, USNM); TX, Lubbock Co., Lubbock, 9/30/1970, S.D.Kemper, (1, USNM); TX, Goliad Co., 7/?/1928, R.A.Cushman, (1, USNM); TX, Lubbock Co., 5/6/1967, J.Hatfield, (1, USNM); TX, Lubbock Co., 9/29/????, J.England, (1, USNM); TX, Lubbock Co., Lubbock, 10/10/1968, J.Stroebele, (1, USNM); TX, Lubbock Co., Lubbock, 10/3/1968, C.Vars, (1, USNM); TX, Lubbock Co., Lubbock, 4/11/1957, A.Brown, (1, USNM); TX, Lubbect (?), 10/12/1968, R Fulkerson, (1, USNM); TX, Lubbock Co., Lubbock, 9/12/1970, G.W.Brothers, (1, USNM); TX, Justiceberg, 10/13/1968, Ward & Huddleston, white and UV light (1, USNM); TX, San Antonio, 3/23/1927, W.Ewing, on ground under stone (1, USNM); TX, Laguna Madre,25 mi. SE of Harlingen, 5/30/1948, Hardy & Woolley, nest of Nectoma micropus,46-10489 (1, USNM); TX, Hamilton Co., 11/24/1968, R.A.Padney, (1, USNM); TX, Jim Wells Co., 7/29/1969, J.Snelgrove, (1, USNM); TX, Jim Wells Co., 7/22/1969, J.Snelgrove, (1, USNM); TX, Weslaco, 6/26/1931, *Arenivaga apacha* Rehn Heb.,4551 (1, TAMU); TX, Webb Co., Laredo, 5/20-24/1948, Nutting & Werner, mesquite area, drawing of genitalia, W.L.N. (1, UAIC); TX, Brownswood (should be Brownwood), 7/8/1919, Acc.23972 (1, AMNH); TX, Austin, 4/28/1950, H.T.Spieth, (2, AMNH); TX, Hidalgo Co., Edinburg, 4/?/1938, S. Mulaik, (1, UMMZ); TX, Taylor Co., Camp Barkley (should be Barkeley) near Abilene, 10/10/1943, C.L.Remington, (1, PMNH); TX, Uvalde Co., Tampke Ranch Cave,5 mi. S of Utopia, 2/11/1966, Reddell & McKenzie, at twilight in main passage (1, USNM); CA, Borrego

Springs, Pegleg Canyon, 11/10/1957, at dusk, (1, HEH); CA, Mt.Springs, 7/25/1938, Jean Russell, (1, SEMC); CA, Imperial Co., Ocotillo, 7/17/1988, B.Morris, (1, SDMC); CA, Imperial Co., Palo Verde Valley, 7/28/1959, K.L.Japport, (1, CSCA); CA, Imperial Co., Bard, 6/29/1959, Salazar, Argon light trap (2, CSCA); CA, Imperial Co., Bard, 7/11/1966, Ratcliff, Argon light trap (6, CSCA); CA, Imperial Co., Bard, 8/26/1959, Kilgore, Cotton (1, CSCA); CA, Imperial Co., Bard, 6/20/1961, Harrison, Argon light trap (1, CSCA); CA, Imperial Co., Bard, 9/24/1959, Kilgore, light trap (4, CSCA); CA, Imperial Co., Winterhaven, 10/20/1959, H.Blakemore, light trap (6, CSCA); CA, Temecula, 9/11/1930, (1, LACM); CA, Temecula, 9/9/1930, (1, LACM); CA, Riverside Co., Ripley, 8/16/1946, P.D.Hurd, (1, EMEC); CA, Imperial Co., Bard, 10/26-27/1959, H.Blakemore, Argon light trap (13, CSCA); CA, Imperial Co., Bard, 11/12/1959, H.Blakemore, Argon light trap (1, CSCA); CA, Imperial Co., Bard, 10/26/1959, Argon light trap (1, CSCA); CA, Imperial Co., Bard, 11/12/1959, Colby & Balion, Argon light trap (1, CSCA); CA, Imperial Co., Haughtelin, Lake, Bard, 7/21-22/1953, (1, USNM); CA, Imperial Co., Ft. Yuma Sta., 5/18/1952, on an inspection table, CA Dept. .Agr.No.52F4 (1, CSCA); CA, Imperial Co., Imperial Valley near Wister, T9S R13E Sec.35, 10/27/1990, ~75’, JP & KES Donahue, (1, LACM); CA, Imperial Co., 2 mi. NW of Glamis, 11/1/1974, Doyen & Powell, in pitfalls (1, EMEC); CA, Riverside Co., Blythe, 7/22/1963, (7, CSCA); CA, Riverside Co., Blythe, 6/21/1961, Maxwell, Argon light trap (1, CSCA); CA, Riverside Co., Blythe, 9/15/1960, K.L.Japport, (2, CSCA); CA, Riverside Co., Blythe, 6/23-25/1961, W.E.Gunderson, Argon light trap (2, CSCA); CA, Riverside Co., Blythe, 7/26/1946, Hurd & Barr, 17NW (1, EMEC); CA, Riverside Co., Blythe, 6/15/1959, E.W.Magoon, (1, FSCA); CA, Imperial Co., Imperial Dam, 6/28/1954, W.McDonald, (3, LACM); CA, Riverside Co., Deep Canyon, 11/12/1969, O.C. & J. Wheeler, *Arenivaga* Det. Saul I. Frommer (2, UAIC); CA, San Bernardino Co., 10 mi. NE of Earp, 4/17/1964, R.L.Langston, blacklight trap (1, EMEC); CA, San Bernardino Co., 10 mi. NE of Earp, 4/17/1964, D.D.Linsdale, (1, EMEC); CA, Riverside Co., Blythe, 7/8/1956, J.I.Stage, (1, EMEC); CA, San Diego Co., Pamo Guard Station, Ramona, 8/23/1949, (1, SDMC); CA, San Diego Co., Borego, 6/19/1956, (1, SDMC); CA, Port El Ysidro, 8/22/1931, E.R.Tinkham, (1, ANSP); CA, San Diego Co., San Felipe Valley, 8/30/1946, C.Henne, (3, LACM); CA, San Diego Co., Lakeside U-Totum, 8/22/1978, Faulkner & Brown, (1, SDMC); CO, Montezuma Co., Battle Rock 13 mi. W of Cortez, 9/3/1989, 1650 ft., Speiler,Weissmann & Penhall, at light (1, UCMC); CO, Mesa Co., COL.Mon.night (Colorado National Monument), 7/28/1962, Lanham et al., (1, UCMC); CO, Montezuma Co., Durango, 8/?/1900, FJ Olsen, *Arenivaga erratica* det. Hebard 1916 (1, USNM); OK, Jackson Co., Jct. Hwy. 6 & Red River, 6/17/1995, E.G.Riley, 141,UV (1, TAMU); OK, Comanche Co., Wichita NF, 6/10/1926, T.H.Hubbell, 17,small square blue label (1, UMMZ); OK, Murray Co., 4/22/1933, R.D.Bird, (1, ANSP); OK, Grandfield, 7/5/1937, Standish-Kaiser, (1, ANSP); OK, Cheyenne, 6/7/1937, Standish-Kaiser, (1, ANSP); OK, Lugert, 7/7/1937, Standish-Kaiser, (1, ANSP); NV, Lincoln Co., 15.7 mi. N of Jct. Hwy.168 on Meadow Valley Rd., 8/13/2005, 36.53.9N 114.39.8?, W.B.Warner, Meadow Valley Wash riparian zone (2, WB Warner); UT, Washington Co., Red Cliffs Rec, Area, !4 mi. SW Leeds, 7/11/1982, 3200’, J.P. & K.E Donahue, (1, LACM); UT, Washington Co., 10905, C.C.Searl, (1, SDMC); UT, Arches NM, 8/1/1950, DM Allred, (1, SDMC); CA, Riverside Co., Thermal, 9/28/1960, LD Moore, (3, MLBM); CA, 4 mi S El Cajon, 7/21/1967, T Ashley

67-26, (1, FSCA); CA, San Bernardino Co., Needles, 9/20/2005, 34.52N 114.38W, 620 ft., SM Clark & RC Mower, *Arenivaga apacha* (Saussure) det. AH Barnum 2010 (7, MLBM); UT, Washington Co., Virgin R, 9/3/1993, (3, MLBM); UT, Washington Co., 3 mi E Gunlock on Santa Clara R, 8/19/1967, Barnum & Moore, (1, MLBM); UT, Washington Co., 5 mi S Hurricane, 7/12/1978, GH Nelson, ultaviolet light (1, FSCA); NV, Lincoln Co., Beaver Dam SP, 8/11/1971, GM Nishida & DF Zoller, light trap, *Arenivaga erratica* Rehn det. RC Bechtel '71 (1, NVDA); NV, Clark Co., 5 mi NW Moapa, 7/21/1962, RC Bechtel & FD Parker, light trap, 1 specimen-*Arenivaga erratica* Rehn det. HF Strohecker (3, NVDA); NV, Clark Co., St. Thomas Gap, 6/13/1984, RC Bechtel & JP Young, black light trap, T17S R71E S31 (1, NVDA); NV, Clark Co., Warm Springs, 8/1/1996, RW Baumann, *Arenivaga erratica* (Rehn) det. AH Barnum 2010 (1, MLBM); NV, Clark Co., Warm Springs LDS Rec. Area, 8/18/1997, 36.43.22N 114.43.00W, Baumann & Huillet, *Arenivaga erratica* (Rehn) det. AH Barnum 3/1999 (1, MLBM); NV, Clark Co., Warm Springs, 7/19/1990, RW Baumann, *Arenivaga erratica* (Rehn) det. AH Barnum 2010 (5, MLBM); NV, Mercury NTS, 7/25/1960, MLBM-AEC code 1BF25e (1, MLBM); OK, Woodward Co., Woodward, 9/14/1966, DC Arnold, in building (1, OSEC); OK, Stephens Co., Comanche, 5/7/1974, DC Arnold, at light (1, OSEC); OK, Lugert, 7/7/1937, Standish-Kaiser, (1, OSEC); OK, Beckham Co., Sandy Sanders WMA, 5/?/2010, LJ Vitt & JP Caldwell, Catalog No. OMNH-20889, *Arenivaga* sp. det. K. Menard 2012 (1, OMNH); AZ, Graham Co., Pinaleno Mt. Hwy. 366 milepost 120.6, 6/10/2012, 32 40 10.2 109 47 20.0, 5100 ft., DB Weissman, oaks and shrubs (1, HEH); AZ, Kofa Mtns., 7/2/1969, W. Rosenberg Collection (1, FSAC); AZ, Pima Co., Organ Pipe Cactus NM, 4 mi N Lukeville, 7/21/1974, JB

Heppert, at (UV) blacklight (1, FSAC); AZ, Tucson Mts., Gilbert Ray Campground, 7/27/1975, GH Nelson, ultaviolet light (1, FSAC); AZ, Tucson Mts., Gilbert Ray Campground, 7/29/1975, GH Nelson, ultaviolet light (1, FSAC); AZ, Maricopa Co., 10 mi N Scottsdale, 7/?/1962, T. Blaine Moore, *Arenivaga erratica* (Rehn) Det. AH Barnum 2005 (1, MLBM); AZ, Pima Co., Organ Pipe Cactus NM, 6/29/1962, T. Blaine Moore, *Arenivaga erratica* (Rehn) Det. AH Barnum 2005 (3, MLBM); AZ, Pima Co., Organ Pipe Cactus NM Campground, 8/7/1970, T. Blaine Moore, Night Lt., *Arenivaga erratica* (Rehn) Det. AH Barnum 2005 (2, MLBM); AZ, Pima Co., Organ Pipe Cactus NM Campground, 8/7/1970, Andrew H. Barnum, Night Lt. (2, MLBM); AZ, Wickenburg, 8/15/1957, JC Schaffner, (1, MLBM); AZ, Maricopa Co., 19 mi NE Mesa, 7/31/1960, SL Wood,JB Karren, H Shurtleff, at light, *Arenivaga* e*rratica* (Rehn) Det. AH Barnum 2010 (3, MLBM); AZ, Pima Co., Colossal Cave, 8/25/1970, RE Woodruff, blacklight trap (1, FSAC); AZ, Pima Co., nr. Sabino Canyon, 7/21/1958, RH Arnett, Jr., at light 342 (1, FSAC); AZ, Pima Co., nr. Sabino Canyon, 6/30/1959, RH Arnett, Jr., Lot No. 385 (5, FSAC); AZ, Maricopa Co., Painted Rock Petroglyphs, 9/18/2011, 33 01 23.1N 113 02 51.8W, 570’, DB Weissman, (2, HEH); TX, San Antonio, 4/2/1940, KC Emerson, (1, OSEC); TX, Dimmit Co., Chaparral WMA, 6/7-8/1992, AW Hook, (8, MLBM); TX, Zapata Co., Falcon, 5/5/1999, SM Clark, (1, MLBM); TX, Starr Co., Falcon Heights, 10/9/1993, SM Clark, (1, MLBM); TX, Travis Co., Austin, Bull Creek, Spicewood Springs Rd., 4/24/1991, CR Nelson, #5661, Photograph voucher for C. Riley Nelson (1, MLBM); TX, 6-7/?/1962, G Nichols, (1, FSAC); UT, St. George, 9/9/1954, (Goodarzy)(GF Knowlton), (1, ANSP); NV, Esmeralda Co., Clayton Valley 2 mi S of Silver Peak, 8/22/1924, 4350 ft., (R&H), (1, ANSP). MEXICO: Sonora, Desemboque,5 km village in arroyo near well, 8/8-10/1953, B Malkin, (3, CAS); Sonora, 18 mi. E of El Puerto, 8/7/1960, Arnaud Jr.,Ross & Rentz, (3, CAS); Tamaulipas, San Fernando, 8/26/1954, 700 ft., (2, SEMC); Sonora, *Arenivaga erratica* det. Rehn (1, ANSP); Sonora, Poza Coyote, 7/5/1952, P & C Vaurie, (1, AMNH); Sonora, Rocky Point, 10/5/1953, MA Cazier, (1, AMNH); Sonora, Desemboque, 8/1-15/1953, B Malkin, (1, CAS); Sonora, Hermosillo, 7/9-16/1953, B Malkin, (1, CAS); Coahuila, 5 mi. S of Hermanas, 8/1/1959, 1350 ft., T Cohn, #129 (1, UMMZ); Tamaulipas, Nuevo Laredo, 5-6/?/1930, A Dampf, (1, ANSP); Tamaulipas, 8 mi. N of Jimenez, 6/15/1953, UK Mex. Expedition (1, SEMC); Tamaulipas, San Fernando, 8/27/1954, 700 ft., CD Michener & party, (1, SEMC); Tamaulipas, Abasolo, 5/17/1952, Cazier,Gertsch & Schrammel, (1, AMNH); Monterey, 7/12/1991, WF Chamberlain, at light (2, TAMU); BC, 2 mi S of Tijuana, 8/21/1931, ER Tinkham, (1, ANSP); Sonora, 10 mi. E of Sonoita on Hwy. 2, 9/24/1967, C Cushner, (3, EMEC); BC, ? Tanks, 11/15/1936, CF Harbison, (1, SDMC); Tamaulipas, 8 mi. E of Padilla Rancho Sta. Ana, 12/21/1941, Cantrell & Friauf, #27 (2, UMMZ); Sonora, 20 mi. S of Sonoita, 9/22/1867, CF Harbison, (1, SDMC); Sonora, 8 km W of Carbo, 10/5/1960, WW Gibson, at light (1, UAIC). Determiner label *Arenivaga tonkawa* Hopkins 2011" [white label with black border].

Distribution. This species has a disjunct distribution comprising Texas, western Oklahoma and northeastern Mexico in one part, and Arizona, far southern California, southern Nevada, southern Utah, western Colorado and northwestern Mexico in the other part. See Fig. 149.

Diagnosis. *A. tonkawa* varies widely phenotypically but may be diagnosed by always having two adjacent spines on the posterior end of the medial margin of the right dorsal phallomere combined with a small central sclerite with folded over anterior edge. See Fig. 148.

Description. Male. Measurements. Holotype stand-in TL = 20.2 mm, GW = 8.9 mm, PW = 5.92 mm, PL = 4.28 mm, TL/GW = 2.27, PL/PW = 0.72. EW = 0.15 mm; OW = 0.40 mm. Among paratypes range of TL 15.7–25.5; range of GW 7.3–12.5; range of PW 5.02–8.55; range of PL 3.83–5.25.

Head. Two ocelli very large, ovoid and protruding (0.50 × 0.40 mm); vertex dark brown, with small ridges between apices of eyes extending on to ocellar tubercles; interocellar space concave, dark brown grading to medium brown medially; two oval indentations laterally at base of interocellar space. Frons light brown, concave; bound on either side by ridges extending from inner apex of ocelli outwards to lateral edges of clypeus; scattered long setae on ridges. Anterior portion of frons light brown, bulbous; clypeal suture demarcates light brown anteclypeus. See Fig. 147d.

Pronotum. Pronotum translucent waxy beige; variable length orange-brown setae along anterior margin; dorsal surface of pronotum covered with short orange-brown setae that are denser and longer anteriorly and laterally; pronotal pattern medium orange-brown "panther face", with little detail and no aura; within the species pronotal pattern runs from light brown through every shade to dark brown, some with considerable discernible detail, but always with no aura. See Fig. 147c.

Body. Wing brace present. Legs and body medium orange-brown; subgenital plate asymmetrical with posterior edge emarginated, rounded apices. See Fig. 147b.

Forewings. Wings extended beyond abdominal apex (up to ~35% of total wing length); light orange-brown with darker blotches; within the species color variable from light orange-brown, to dark orange-brown, always blotchy; surface opaque and matte. See Fig. 147a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin sclerotized, smooth, with two adjacent spines at posterior end; spines may vary in size and exact placement from specimen to specimen. Small central sclerite smooth, concave, with punctate, posteriorly pointing lip at anterior end. Right ventral phallomere extends from articulation into smooth lobe, punctate towards point of articulation; narrows anteriorly in punctate corrugations; after narrow gap, broad, punctate, posteriorly curving arm extending to depth of rest of phallomere. Genital hook with narrow pointed head and short hook; arm short with distinct bend. See Fig. 148.

Habitat and natural history. All life history elements remain unobserved.

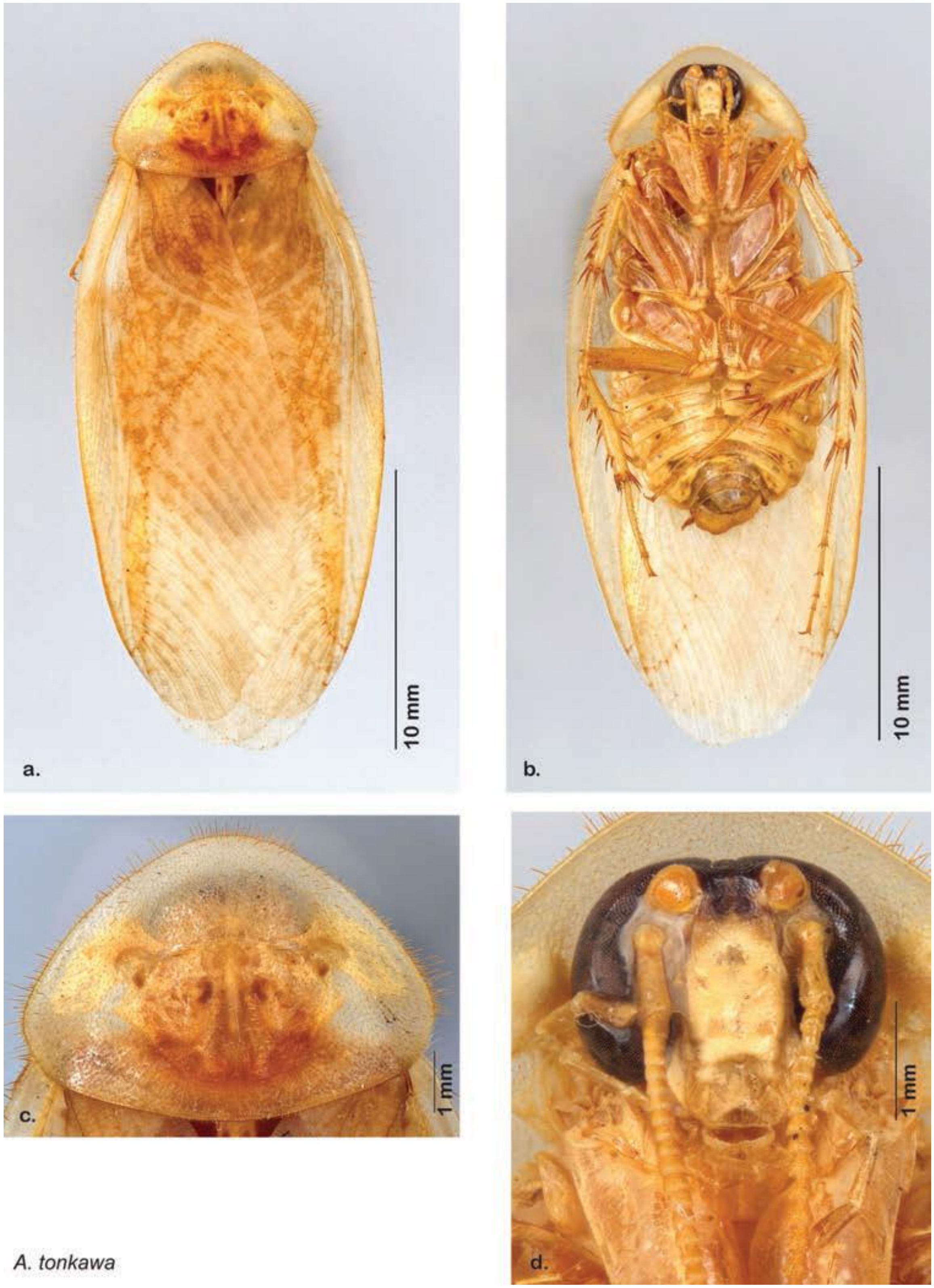


Figure 147. *A. tonkawa* a dorsal habitus b ventral habitus c pronotum d head.

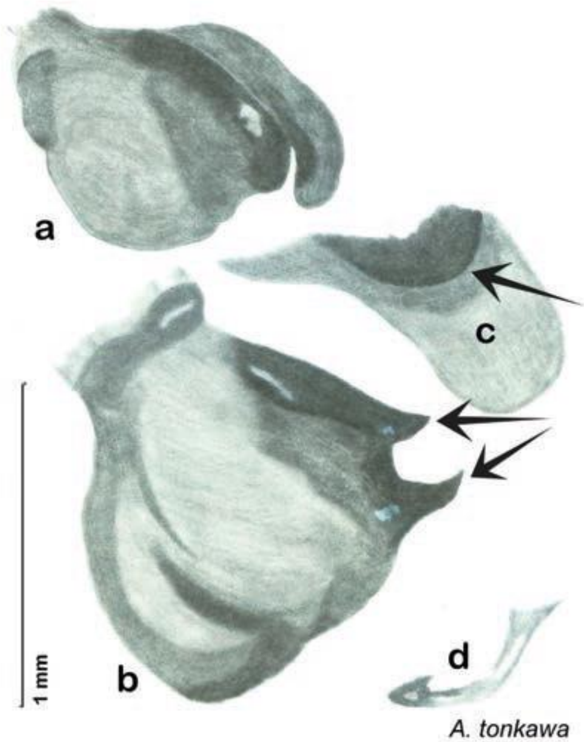


Figure 148. *A. tonkawa*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook. Arrow(s) indicate diagnostic characters (see text).

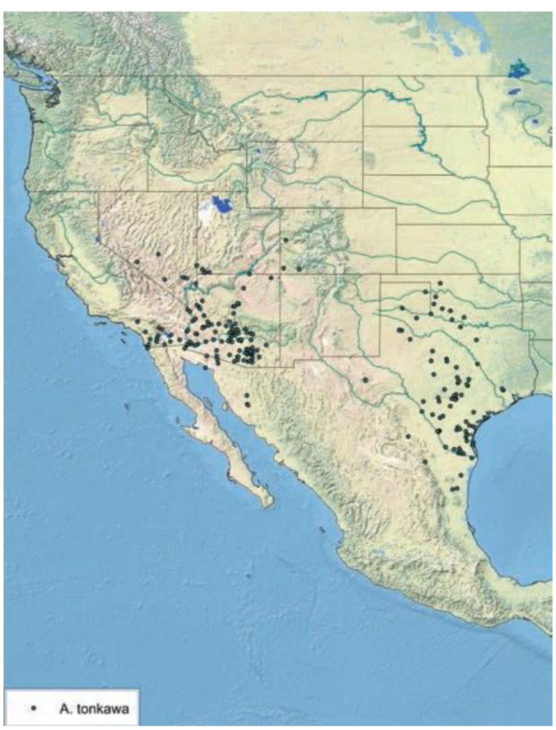


Figure 149. *A. tonkawa*, distribution.

***Arenivaga trypheros* sp. n.**

http://zoobank.org/66C1C0DB-931A-4E11-8D21-EB09F5F6A7E7

http://species-id.net/wiki/*Arenivaga_trypheros*

Figures 37, 150–151

Type locality. USA, California, Imperial County, 1 mi. S of Glamis.

Material examined. Holotype: ♂ in EMEC labeled "CAL: Imperial Co., 1 mi. S Glamis, 31-III-1978, J. Powell, coll., in pitfall trap" " HOLOTYPE *Arenivaga trypheros* Hopkins, 2012" [red label with black border].

Paratypes (18): USA: CA, Imperial Co., 17 mi. NW of Glamis, 6/27/1978, D & J Powell, blacklight trap (6, EMEC); CA, Imperial Co., 3 mi. SW of Glamis, 7/12/1974, J Doyen, blacklight trap (2, EMEC); CA, Imperial Co., 2 mi. W of Glamis, 6/2/1971, AJ Gilbert, pit trap,71F7-28 (1, CSCA); AZ, Yuma Co., Goldwater Military Range, San Cristoball Dunes, 3/4/1997, CA Olson, Pitfall traps (2, UAIC); AZ, Yuma Co., Yuma desert 9 mi. E of San Luis, 3/16/1980, Werner,Olson,Metz & MacLachlan (1, UAIC); AZ, Yuma Co., Large sand dunes SE of Yuma, 4/16/1994, 32.27N 114.25W, WB Warner (1, WB Warner). MEXICO: BC, 10 mi. S of San Felipe, 3/25/1961, EL Sleeper (2, CAS); BC, Sierra Pinta Dunes, 6.5 mi. S of Mexicali, 4/?/1953, ER Tinkham, died 8/15/1953 (1, USNM); BC, San Felipe, 3/25/1963, GI Stage (1, HEH); BC, 3 mi. N of La Puerta, 4/20/1973, Chandler & Levin (1, UAIC). All paratypes labeled "Paratype *Arenivaga trypheros* Hopkins 2012" [blue label with black border].

Etymology. The name is an adjective in the nominative singular. This species is named *trypheros*, Greek for "delicate, dainty, soft" because it is very delicate and dainty in its morphology.

Distribution. This species is found in far southwestern Arizona, far southeastern California, northeastern Baja California, Mexico and a short distance down the western coast of the Sea of Cortez. See Fig. 151.

Diagnosis. *A. trypheros* sp. n. is characterized by its long, narrow iridescent wings that extend a long distance beyond the end of the abdomen. The genitalia are indistinguishable from that of *A. darwini*, a sympatric species that is otherwise phenotypically quite different. See Fig. 37.

Description. Male. Measurements. Holotype TL = 20.9 mm, GW = 7.4 mm, PW = 4.87 mm, PL = 3.57 mm, TL/GW = 2.82, PL/PW = 0.73. One of the longest and narrowest species of *Arenivaga*. EW = 0.35 mm; OW = 0.3 mm. The only notable difference in measurements among paratypes was in total length; the holotype total length is equal to the longest observed, the shortest TL = 16.7 mm.

Head. Two ocelli large, ovoid and strongly protruding (0.45 × 0.30 mm); vertex brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space deeply concave, brown anteriorly fading to lighter brown towards frons. Posterior frons deeply concave, light brown; anterior frons bulbous and light brown; anteclypeus broad, flat, light brown. See Fig. 150d.

Pronotum. Pronotum pale, waxy beige-gold; anterior half of dorsal surface of pronotum covered in fine pale setae with scattering of thicker golden setae throughout; pronotal pattern ranges in color from same waxy beige-gold of background, to orange-brown, brown and very dark brown depending on specimen, “panther face” pattern, not well-defined or detailed in its presentation; no aura. See Fig. 150c.

Body. Wing brace present. Two tarsal claws present. Legs and body light waxy beige-gold, subgenital plate dramatically asymmetrical with strongly emarginated posterior edge and pointed apices. See Fig. 140b.

Forewings. Wings extended well beyond abdominal apex (> 50% of wing length); color varies from pale iridescent gold to iridescent grey-brown. See Fig. 150a.

Genitalia. Right dorsal phallomere composed of large bulbous lightly sclerotized hook-shaped lobe, articulated with right ventral phallomere on lateral side; unmodified. Small central sclerite consists solely of thin half circle of sclerotized material beginning near front of right ventral phallomere and sweeping around to rear of same phallomere; right ventral phallomere extends from articulation to form structure rounded at posterior apex and expanding to shagreened and more sclerotized area dorsally; attached anteriorly is U-shaped shagreened lobe bordered by rolled shagreened lip. Left phallomere unmodified. Genital hook with long extension to pointed head and short hook; arm with shallow curve. See Fig. 37.

Habitat and natural history. This species occurs in sparsely vegetated sand dunes that are extremely dry and hot. All other life history elements remain unobserved.

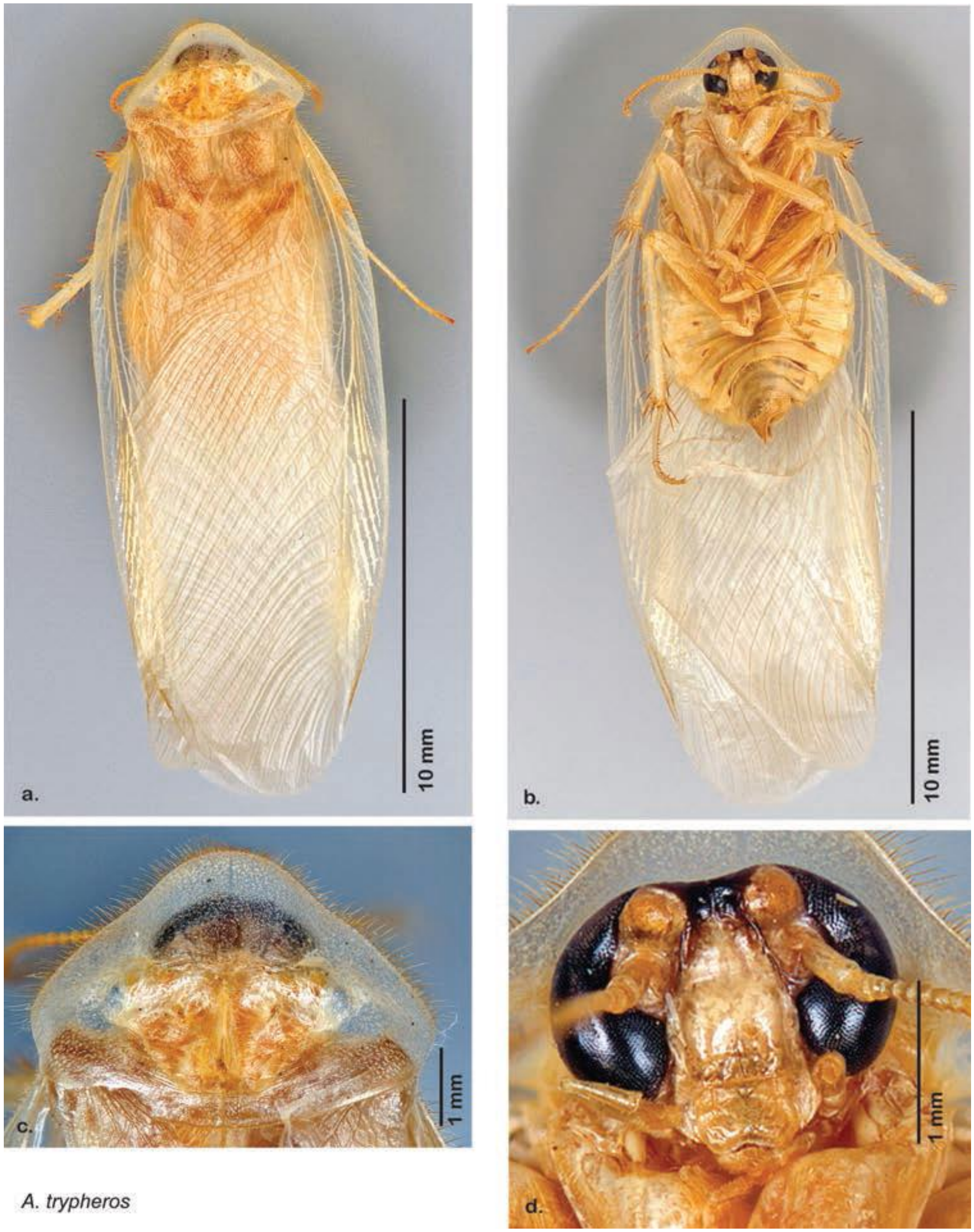


Figure 150. *A. trypheros* a dorsal habitus b ventral habitus c pronotum d head.

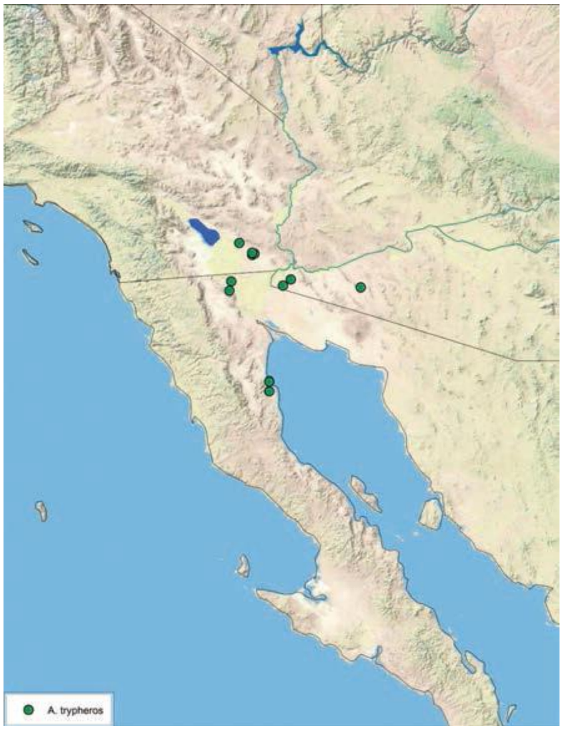


Figure 151. *A. trypheros*, distribution.

***Arenivaga umbratilis* sp. n.**

http://zoobank.org/E6D74644-4076-423E-9379-737C8B4C71F7

http://species-id.net/wiki/*Arenivaga_umbratilis*

Figures 152–154

Type locality. USA, Arizona, Maricopa County, Phoenix.

Material examined. Holotype: ♂ in ANSP labeled "Phoenix, X.9.03, Ariz. Kunze, Hebard Collection" "HOLOTYPE *Arenivaga umbratilis* Hopkins, 2012" [red label with black border].

Paratypes: None at this time.

Etymology. This species is named from the Latin phrase meaning "in retirement", as there is only one specimen of this species and it was collected in 1903. I strongly suspect this is either a hybrid, or an extinct species.

Distribution. This species is known only from the type locality. See Fig. 154.

Diagnosis. *A. umbratilis* has the external appearance of *A. tonkawa* but the genitalia of *A. pratchetti*. This species will be known when, upon genitalic dissection, a specimen has the genitalia of *A. pratchetti* but a subgenital plate with rounded apices. *A. pratchetti* has pointed apices on its subgenital plate (See Fig. 7). See Figs 153 and 127.

Description. Male. Measurements. Holotype TL = 21.0 mm, GW = 10.0 mm, PW = 6.27 mm, PL = 4.58 mm, TL/GW = 2.10, PL/PW = 0.73. EW = 0.20 mm; OW = 0.50 mm.

Head. Two ocelli very large, ovoid and protruding (0.40 × 0.30 mm); vertex medium brown with small ridges in rays around upper apices of eyes and extending onto ocellar tubercles; interocellar space concave, smooth, medium brown, paler medially with two triangular shaped indentations. Frons very light brown fading to waxy white; posterior frons mildly concave, bound on either side by ridges extending from inner apex of ocelli outwards to lateral edges of clypeus; ridges with occasional long setae. Anterior portion of frons bulbous; clypeal suture demarcates waxy white smooth anteclypeus; no setae apparent. See Fig. 152d.

Pronotum. Pronotum translucent, waxy beige; variable length orange-brown setae along anterior margin; dorsal surface of pronotum thickly encrusted with sand and specimen too fragile to clean so surface setae undetectable; pronotal pattern light orange-brown to yellow "panther face" with no detail or aura. See Fig. 152c.

Body. Wing brace present. Legs and body light orange-brown. Subgenital plate dissected and cleared; asymmetrical with concave posterior edge and rounded apices. See Fig. 152b.

Forewings. Wings extended well beyond abdominal apex; light orange-brown with light brown blotches; surface matte and opaque. See Fig. 152a.

Genitalia. Right dorsal phallomere composed of bulbous lightly sclerotized hook-shaped lobe, articulated with right ventral phallomere on lateral side; central field lightly sclerotized; medial margin more heavily sclerotized, shagreened with toothed edge and slight thickening centrally creating small bulge along rim. Small central sclerite concave, nondescript in shape, finely punctate with an irregular shagreened projection on internal ventral surface; right ventral phallomere extends from articulation to form smooth rounded structure becoming punctate and narrower anteriorly; attached anteriorly is slightly dorsally projecting flanged concave punctate arm that extends to depth of phallomere; shagreened edge. Folded anterior portion of left phallomere of moderate width, setose, otherwise unmodified. Genital hook with moderate extension to pointed head with short hook. See Fig. 153.

Habitat and natural history. All life history elements remain unobserved.

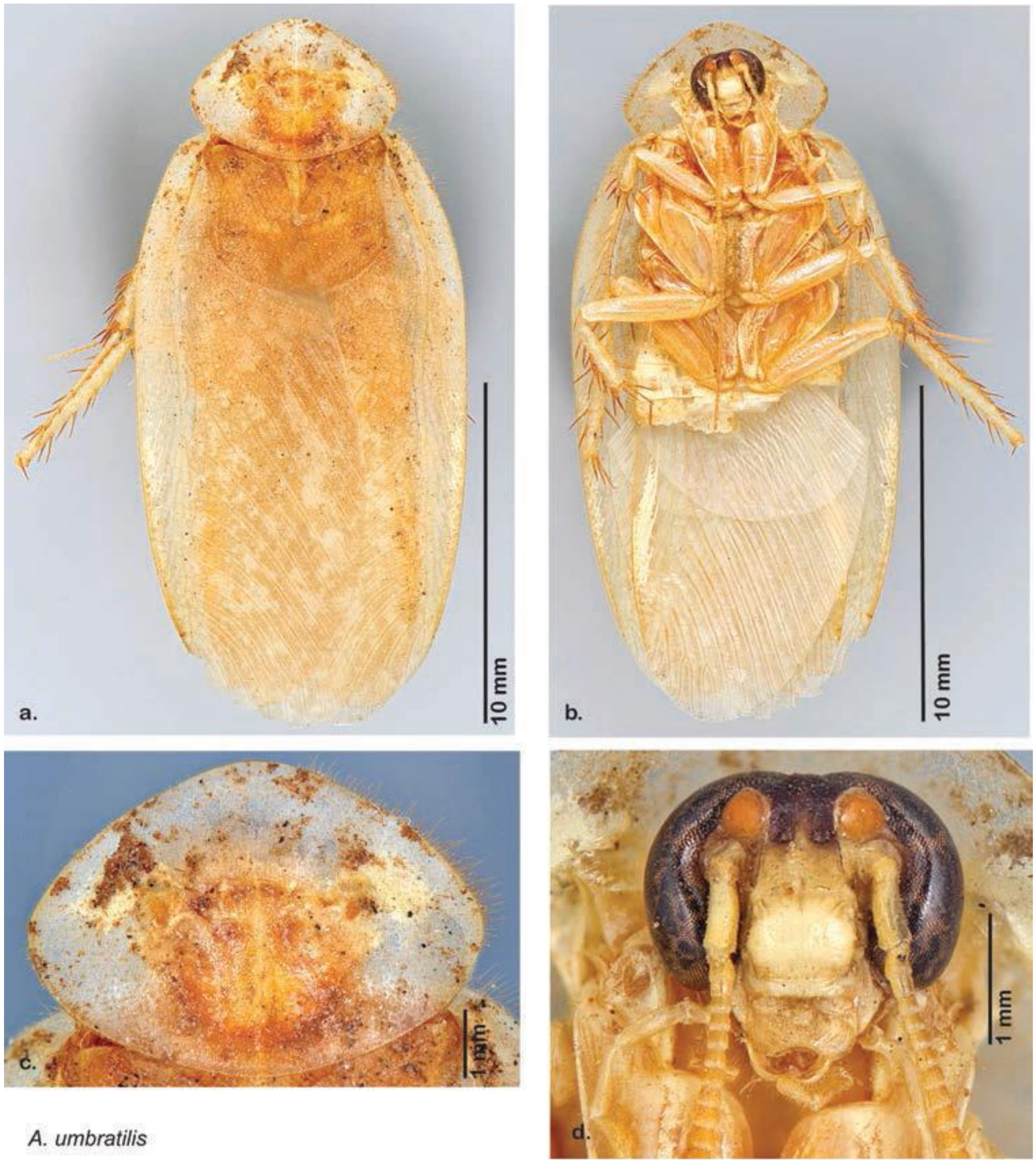


Figure 152. *A. umbratilis* a dorsal habitus b ventral habitus c pronotum d head.

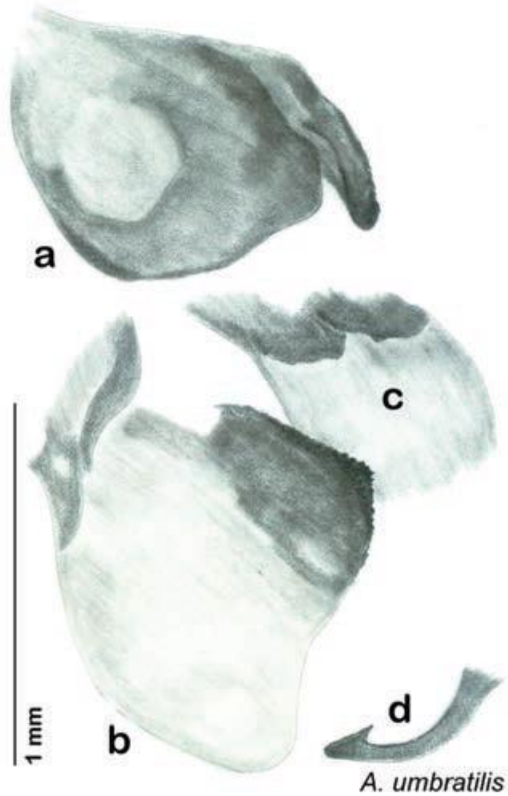


Figure 153. *A. umbratilis*, genitalia: a) right dorsal phallomere b right ventral phallomere c small central sclerite d genital hook.

Figure 154. *A. umbratilis*, distribution.

Key to the males of *Arenivaga* (Rehn 1903)

NB: Either maps of the southwest and Mexico or Google Earth are required to use this key.

1 Large (average 25 mm long × 12 mm wide, may be as large as 30 mm × 16 mm); generally medium (below left) to dark brown (below right); usually with no distinct pattern on pronotum..2


1’ Smaller than 25 mm × 12 mm; any color from pale (below left) to dark brown (below right)..3


2 Medial margin sclerotized but simple, with no complexity in the point of articulation between the two right phallomeres (below left); from Texas or portions of eastern Mexico adjacent to Texas (Fig. 35). (Specimens occasionally shorter and very dark brown; see below right.) .... *bolliana* (Saussure 1893)

2’ Hook-shaped lobe unique in shape, shagreened ridge running interior to the point of articulation on the right dorsal phallomere (below); from Arizona or western and central Mexico (Fig. 74) .... *grata* Hebard 1920

3 Length < 20 mm; pumpkin seed shaped (below)..4

3’ Length > 20 mm; not pumpkin seed shaped...7

4 Pale or very pale in color 5

4’ Brown in color...6

5 Very pale (below); one tarsal claw; southeastern California to southwestern Arizona and eastern Gulf of California (Fig. 38)..*darwini* sp. n.

5’ Pale; pronotum triangular (below); central Rio Grande in Texas (Fig. 137) ...*ricei* sp. n.

6 Medium orange-brown or mottled medium orange-brown (below); Florida (Fig. 56)..*floridensis* Caudell 1918

6’ Concolorous medium brown; pronotum triangular with impressed dark brown pattern, densely setose (below); Baja California, Mexico (Fig. 20) ....*alichenas* sp. n.

7 Narrow and delicate (TL/GW> 2.0) (below) 8

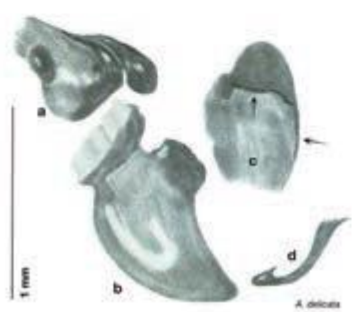
7’ Not narrow and delicate (TL/GW <2.0) 11

8 Length > 17 mm..9

8’ Length < 17 mm..10

9 Very long and pale (TL/GW ~ 2.8)(below left); sharply pointed apices on subgenital plate (below right); southeastern California, southwestern Arizona, western side of Gulf of California (Fig. 151) ....*trypheros* sp. n.

9’ Not as long as in *trypheros* (above) (TL/GW ~ 2.2); rounded apices on subgenital plate (below left); small dorsal sclerite clamshell in shape with distinctive cross band of teeth (below right); only known from US (Fig. 41) ....*delicata* sp. n.



10 Dark brown or dark orange-brown impressed pronotal pattern (below left); long serrated edge on medial margin of right dorsal phallomere, central field deeply incised (below right); central Baja peninsula (Fig. 44); often with no genicular spines..*diaphana* sp. n.

10’ Slight and delicate; transparent wings and dark brown impressed pronotal pattern (below left); medial margin of right dorsal phallomere projects anteriorly into rounded, shagreened lobe with toothed margin (below right); Death Valley, California (Fig. 110)...*mortisvallisensis* sp. n.

11 From the Baja peninsula, Mexico or southwestern California 12

11’ Not from the Baja peninsula, Mexico or southwestern California..............................18

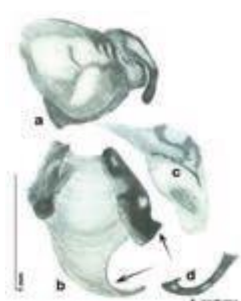
12 Very small (~14 mm × 7 mm)(below); Baja California Sur (Fig. 131).......*pumila* sp. n.

12’ Larger than 14 mm × 7 mm 13

13 Setose pronotum; dark brown or dark red-brown pronotal pattern with no detail or aura (below); 7 miles SW of La Paz (Fig. 26) .... *apaeninsula* sp. n.

13’ Not as in previous 14

14 Pronotal pattern light orange-brown with little detail (below left); narrow sweeping hook-shaped lobe on the right dorsal phallomere; broad short spine on medioventral side of posterior end of medial margin (below right); southeastern Baja California (outlier in Mexico may be mislabeled or transported) (Fig. 119)..................................*nocturna* sp. n.

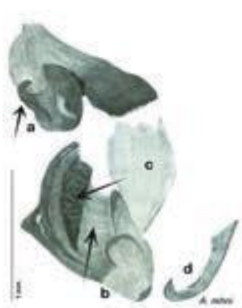


14’ Pronotal pattern darker or more detailed than in previous 15

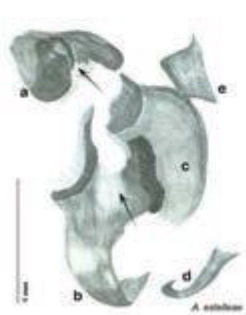
15 Right dorsal phallomere with long posterior projecting spine and second medially projecting spine located midway along medial margin; spine on right ventral phallomere (below); central Baja peninsula and adjacent islands (Fig. 116)...................... *nicklei* sp. n.

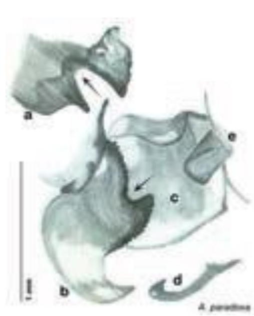
15’ Genitalia with no spines on any phallomeres 16

16 Broad shagreened concavity interior to point of articulation on right dorsal phallomere; narrow central field, broad hook-shaped lobe with no curve; medial margin smooth (below); Baja peninsula (Fig. 134); may have one or both rudimentary styli... *rehni* Hebard 1917

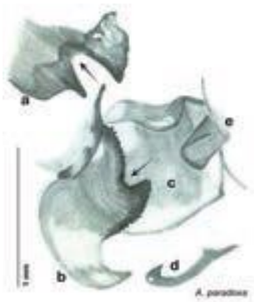


16’ Right dorsal phallomere with serrate medial margin; left phallomere with setose, medially-projecting, scoop-shaped extension (two examples shown below)....................17





17 Deeply sinuous, serrate medial margin (below); 15 miles south of San Quintin, Baja California (Fig. 125) ....*paradoxa* sp. n.



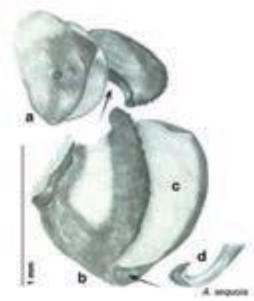
17' Medial margin with central indentation; broad central field (below); southwestern California and northern Baja California (Fig. 53) ....*estelleae* sp. n.

18 Brown maculations scattered over pronotum (below)..19

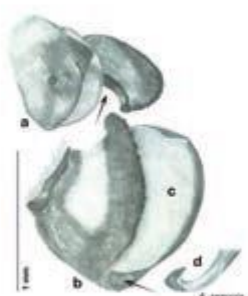
18' No maculations on pronotum 22

19 Long posteriorly projecting extension of medial margin ending in two-pronged hook (below); Texas or central Mexico (Fig. 77)... *gumperzae* sp. n.

19’ No projections from medial margin; tip of hook-shaped lobe turned dorsally; wide gap on right ventral phallomere (below); California 20

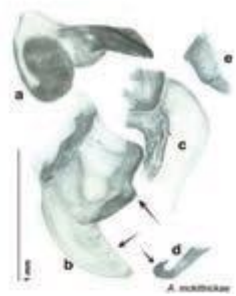


20 Medial margin slightly convex (below); southern and western California (Fig. 143)..*sequoia* sp. n.



20’ Medial margin not straight or convex 21

21 Medial margin shallowly sinuous (below); along the San Gabriel Mountains, southern California (Fig. 101) .... *mckittrickae* sp. n.



21’ Medial margin with deep V-shaped emargination bordered by two broad flat points (below); in and around San Bernardino and Riverside, California (Fig. 62)..*gaiophanes* sp. n.

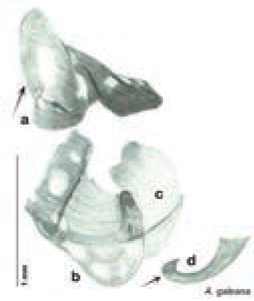
22 From mainland Mexico or the Texas/Mexico border 23

22’ Not from mainland Mexico or the Texas/Mexico border 29

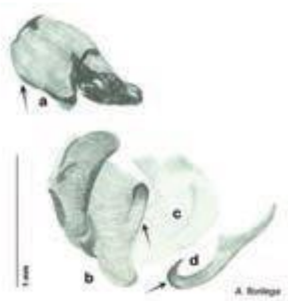
23 Forewings light to medium blotchy brown or blotchy orange-brown, with dark orange-brown or dark brown pronotal pattern (examples below) 24

23’ Not as in previous 26

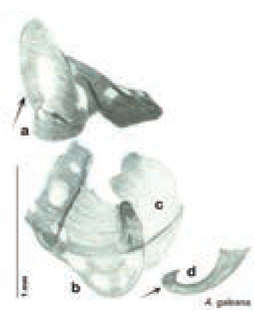
24 Angular-headed genital hook (below) 25



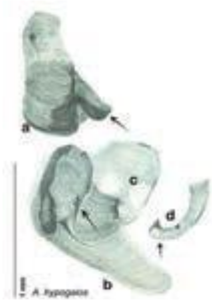
24’ With widely curved genital hook and posteriorly directed laterally compressed bulge on the right ventral phallomere (below); southern foothills of San Madre Oriental Mountains, Hidalgo, Mexico (Fig. 59)..*florilega* sp. n.



25 Broad serrated arm extending anteriorly from right ventral phallomere (below); western foothills of the San Madre Oriental Mountains, Mexico (Fig. 65)....*galeana* sp. n.



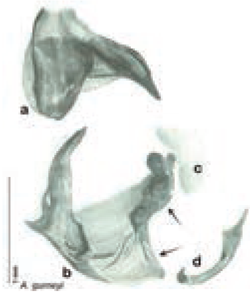
25’ Narrow serrated arm extending anteriorly from right ventral phallomere; ridge of serration on lateral edge of open field (below); central Mexico to Texas border (Fig. 92)...*hypogaios* sp. n.



26 Pale in color with light orange-brown pronotal pattern (below left); large gap in right ventral phallomere and long narrow pointed head on genital hook (below right); central Mexico to the Texas border (Fig. 140) .... *rothi* sp. n.

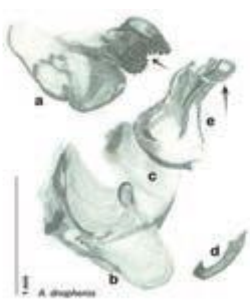
26’ Medium orange-brown to very dark orange-brown with similarly colored pronotal pattern and aura (examples below) 27

27 Abbreviated hook-shaped lobe; unusual curvature and modeling of medial margin (below); Michoacan, Mexico (Fig. 80) ....*gurneyi* sp. n.

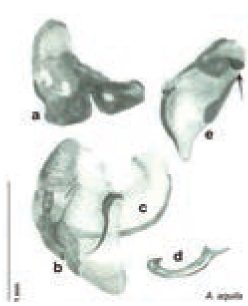


27’ Hook-shaped lobe not abbreviated 28

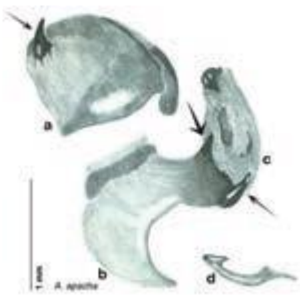
28 Broad heavily serrated arm extending anteriorly from right ventral phallomere, with pronounced medial emargination (below); Puebla, Mexico (Fig. 47)........ *dnopheros* sp. n.



28’ Arm extending from right ventral phallomere lightly serrated with no medial emargination; small ridge projecting from ventrolateral edge of left phallomere (below); Guerrero and Morelos, Mexico (Fig. 29)...*aquila* sp. n.



29 Spines on at least two phallomeres (example below); Arizona, southwestern New Mexico, western mainland Mexico south of Arizona...30

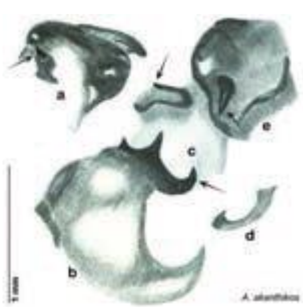


29’ Spines on more or less than two phallomeres 36

30 Spines at either end of the medial margin (anterior spine may be small to absent); spine on right ventral phallomere; no spine on the left phallomere (below); Arizona (Fig. 23)..*apacha* (Saussure 1893)

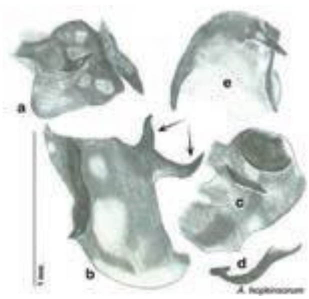
30’ Spine on left phallomere...31

31 Three spines arrayed along the medial margin (anterior spine may be quite small); spine on right ventral phallomere (below); Sonora, Mexico (Fig. 17).. *akanthikos* sp. n.



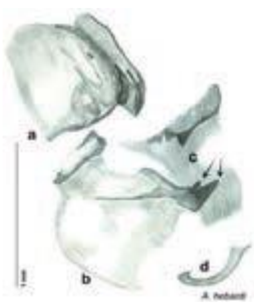
31’ Without three spines arrayed along medial margin 32

32 Two spines along very contracted medial margin; spine on right ventral phallomere (below); southern Arizona, Sonora and Tiburon Island, Mexico (Fig. 89).. *hopkinsorum* sp. n.



32’ Without two spines along very contracted medial margin 33

33 Robust double spine at posterior end of medial margin; at least one posteriorly projecting spine on anterior edge of small central sclerite (below); southern Sonora, Mexico (Fig. 86) ....*hebardi* sp. n.

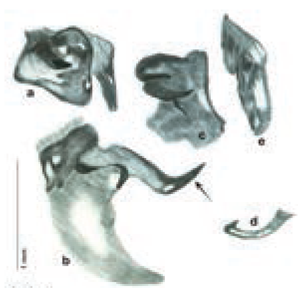


33’ Without robust double spine at posterior end of medial margin or posteriorly projecting spine on anterior edge of small central sclerite 34

34 Right ventral phallomere with knob and three spines on dorsal surface; broadly sclerotized medial margin with two broad spines dorsally (below); southern Arizona and northern Sonora, Mexico (Fig. 68).. *genitalis* Caudell 1918

34’ Without knob and three spines on dorsal surface of right ventral phallomere or broadly sclerotized medial margin with two broad spines dorsally..................................35

35 Large medially projecting spine on posterior end of medial margin; large setose spine on left phallomere; large bilobed bulge extending medially from small central sclerite; spine on right ventral phallomere (below); Sinaloa and Sonora, Mexico to the Arizona border (Fig. 14) .... *adamsi* sp. n.



35’ Large ventrally projecting curved spine on posterior end of medial margin; spine on left phallomere smaller than in previous and glabrous; bulge on small central sclerite single-lobed and smaller than in previous; double pronged spine on right ventral phallomere (below); Sierra de la Madera mountains, Sonora, Mexico (Fig. 107)..*moctezuma* sp. n.

36 From southwestern Arizona, New Mexico, or parts of Texas and Mexico south of New Mexico (Figs 50 and 146) 37

36’ Not from southwestern Arizona, New Mexico, or parts of Texas and Mexico south of New Mexico..38

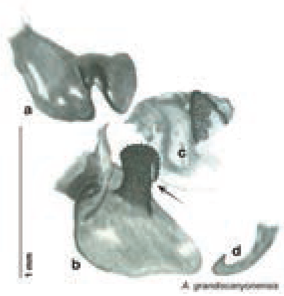
37 Serrated posterior end to medial margin of right dorsal phallomere, and short spine projecting medially halfway along same margin; small central sclerite with sinuous line of teeth on lateral edge (below) .... *tenax* sp. n.

37’ Straight shagreened medial margin, often two short teeth projecting medially a short distance from each end; small central sclerite with heavy shagreened rim along anterior edge (below)... *erratica* (Rehn 1903)

38 From central or northwestern Arizona (isolated specimens from the Nevada/ Arizona and Utah/Arizona borders 39

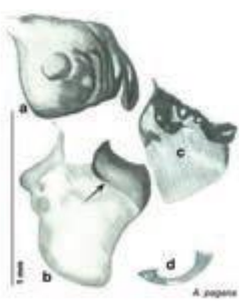
38’ Not from central or northwestern Arizona 43

39 Anteriorly directed shagreened tongue rising out of central field (below); along Colorado River at bottom of Grand Canyon (Fig. 71) .... *grandiscanyonensis* sp. n.



39’ With no such modification to the central field...40

40 Medial margin bent at a 90 degree angle to the central field (below); along Colorado River at bottom of Grand Canyon and northwards along Utah and Nevada borders with Arizona (Fig. 122)...*pagana* sp. n.

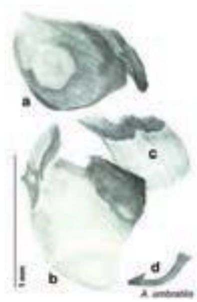


40’ Without 90 degree bend in medial margin relative to central field............................41

41 Larger than most species (~24 mm × 11 mm), generally light to medium brown in color; large shagreened medial margin, with toothed flange at posterior end and adjacent spine; delicate genital hook (below); northwestern Arizona south of the Colorado river (Fig. 95)...*impensa* sp. n.

41’ Not larger than average; without large shagreened medial margin............................42

42 Light orange-brown; shagreened medial margin with slight central thickening creating small convexity (below); Gila River west of Phoenix, Arizona (Fig. 154) .*umbratilis* sp. n.

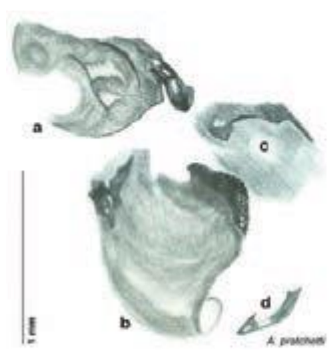


42’ Medium to dark brown or red-brown with similarly colored pronotal pattern and aura; long shagreened convex medial margin that extends posteriorly beyond the rest of the phallomere (below); northwestern Arizona and southern Nevada (Fig. 83)...*haringtoni* sp. n.

43 From southeastern California, southern Nevada, southern Utah, along the western Arizona border or from northeastern Baja California, or northwestern Sonora, Mexico 44

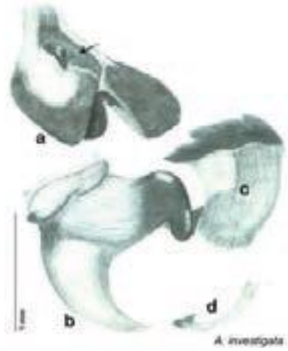
43’ One spine at the posterior end and second spine medially on medial margin (below); disjunct distribution, one part being Arizona, southern California or western mainland Mexico south of Arizona (occasional specimens from Nevada, Utah and Colorado), the second part being central Texas, western Oklahoma, or eastern Mexico south of Texas (Fig. 149).. *tonkawa* Hebard 1920

44 Pale, though pronotal pattern may range from yellow to orange-brown to dark orange-brown; strongly asymmetrical subgenital plate with pointed apices (below left); internal genitalia the same as *umbratilis* (below right)... *pratchetti* sp. n.



44’ Rounded apices on subgenital plate 45

45 Spine extending from lobe of right ventral phallomere (below); southeastern California into southern Nevada, northern Mexico and western Arizona (Fig. 98)... *investigata* Friauf and Edney 1969



45’ No spine on right ventral phallomere 46

46 Shagreened medial margin that extends beyond rest of phallomere at each end; small central sclerite with posteriorly projecting heavily toothed flanges dorsally and ventrally (below); central Nevada/California border (California coastal record may be label error or transported specimen) (Fig. 104).. *milleri* sp. n.

46’ Medially projecting spine interior to posterior end of medial margin 47

47 Hook-shaped lobe bulbous with no bend; lobe portion of right ventral phallomere somewhat narrowed and lengthened (below); southern California, with isolated records in Mexico, Arizona, and Nevada (Fig. 113).. *nalepae* sp. n.

47’ Hook-shaped lobe with indentation along medial edge; lobe portion of right ventral phallomere stout and short (below); southern Utah, southern Nevada into eastern California (Fig. 32) ....*belli* sp. n.

Discussion

Hebard was not exaggerating when he stated that this was the most difficult genus of cockroaches found in this country (Hebard 1920). This is now the most speciose genus of cockroaches in the United States with 48 species (39 of them new). An additional two new genera were also discovered (to be described separately). It seems likely, though, that my efforts here only scratch the surface of the mysteries surrounding the group. In particular, few specimens from Mexico were examined, and it seems likely that many new species remain to be found there. Additional collecting in the United States, particularly northern Arizona, southern Utah, and southern Colorado, will likely produce additional new species.

There are many intriguing puzzles within *Arenivaga* that cannot be fully resolved at this time nor by a species level evolutionary biologist such as me. For example, there are several groups of *Arenivaga* that occur along genitalic morphoclines. *Arenivaga belli* (eastern distribution), *A. milleri* (northern distribution) and *A. nalepae* (western distribution) have very similar genitalia and parapatric distributions. While I have described these as separate species, a population level study could reveal an argument that they are in fact one. The same can be said for the two species *A. aquila* (western distribution) and *A. dnopheros* (eastern distribution); for the group *A. florilega* (southern distribution), *A. galeana* (high elevation/eastern distribution), and *A. hypogaios* (western distribution); for the group *A. paradoxa* (southern distribution), *A. estelleae* (central distribution), and *A. gaiophanes* (northern distribution); and finally for the two species *A. adamsi* (western distribution) and *A. moctezuma* (eastern/valley isolate distribution). *Arenivaga* provides a rich field of study for a population geneticist with the funding, time, and interest in what drives populations towards speciation.

On the other hand, there are cases of possible hybrid specimens. The description of *Arenivaga umbratilis* is based on one specimen. This specimen is externally similar to *A. tonkawa* but has genitalia similar to *A. pratchetti* and is located geographically between the ranges of these two species. Given the available specimens and data, I recognize this as a species, but additional specimens will be needed to better assess species limits in these taxa. Based upon intermediate characteristics, *A. moctezuma* could also be a hybrid between sympatric species *A. adamsi* and *A. hopkinsorum*.

Finally, and perhapsmost curious of all, are *A. darwini* and *A. trypheros* that may represent two morphs of a species since they have very different external morphology, occur sympatrically, and have identical male genitalia. In this work I can only acknowledge these issues in species delimitation within *Arenivaga*; I must leave the search for answers to future workers.

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A first total evidence phylogeny of the genus *Arenivaga* (Rehn)

(Blattodea, Corydiidae)

by

Heidi Hopkins and Kelly B. Miller

Abstract

The phylogenetic relationships between 24 species of the Corydiid cockroach genus *Arenivaga* were investigated using morphological and molecular data. The molecular dataset included the following markers: the nuclear gene histone III (H3), the mitochondrial ribosomal RNA gene 12S (12S), and the mitochondrial cytochrome c oxidase I gene (CO1). The phylogenetic relationships of these 24 species were then explored using three optimality criteria: parsimony, maximum likelihood and Bayesian analyses. The putative sister genus *Eremoblatta* and more distantly related *Blatta orientalis* were used as outgroups. A partitioned Bremer analysis was performed to provide some insight into which portions of the data provided the most evolutionary insight into this unusual group of insects. All analyses confirm the genus is monophyletic. Several relationships within the genus are recovered with strong support. Both the parsimony and likelihood estimations fail to provide good resolution along the backbone of the generic tree, whereas the Bayesian estimation resolves most nodes. Most of the strongly supported relationships are reinforced by both geographical distribution and genital morphology.

Keywords

Cockroach, desert cockroach, sand cockroach, *Arenivaga*, Corydiidae, Polyphagidae, Blattodea, morphology, phylogeny, molecular, CO1, H3, 12S

Introduction

Cockroaches are an ancient group of insects with stem lineage roachoid ancestors dating to the Carboniferous (Grimaldi and Engel, 2005), also known as the "Age of the Cockroach". Whereas many small orders of insects are understudied and therefore poorly understood, few are as little known or as misunderstood as cockroaches (Blattodea). The order comprises approximately eight thousand described species, and the family structure within the order is still unsettled (Inward et al., 2007; Djernaes et al., 2012; Beccaloni and Eggleton, 2013). The most recent phylogenetic work on Blattodea (Djernaes at al., 2012) provides a thorough summation of the efforts over recent years to understand relationships within the order. Djernaes et al. (2012) recovered Corydiidae, (the family in which *Arenivaga* is found) as sister to the Nocticolidae (cave cockroaches), and this clade sister to Cryptocercidae + Termitoidea. Similar relationships have been suggested previously (Klass 1995; 1997; Klass and Meier, 2006; Inward et al., 2007; Ware at al., 2008; Murienne, 2009). The family Corydiidae (Polyphagidae *sensu lato*) (Beccaloni and Eggleton 2011; 2013) has received very little attention, and its phylogenetic organization is unknown. Based on the little we know about its extant members, Corydiidae could best be described as the family of extremophiles within Blattodea. Elevationally they are found from high on Mount Everest to Death Valley, and in many, if not all, deserts of the world.

The genus *Arenivaga* (Rehn), Latin for "sand runner," is endemic to North America and is found in the American southwest, Mexico, and Florida (Fig. 1), but its evolutionary and biogeographical history is not known. The restricted New World range of *Arenivaga* is noteworthy since most other genera of sand cockroaches, all currently placed in the family Corydiidae based on morphology, occur on every continent except Antarctica. These genera along with the rest of the Corydiidae remain little studied. The earliest known Corydiid fossils date to the early Cretaceous (Vrsansky and Ansorge, 2001) and the Paleocene (Vrsansky et al., 2013), and are from the Old World, though it is likely that they originated well before this.

Arenivaga females and nymphs are subterranean in sandy, dune habitats, and other rocky, dry terrain, feeding on mycorrhizal fungi, leaf detritus of desert shrubs, and the seeds collected by the mammals whose burrows they sometimes cohabit (Cohen and Cohen 1976, Hawke and Farley 1973). Their cryptic life history has never been fully documented although their adaptations for life in the desert are well-studied in laboratory settings (Walthall and Hartman 1981, Edney 1968, Hawke and Farley 1971a, 1971b, 1973, Cohen and Cohen 1976, 1981, Edney and McFarlane 1974, Hartman et al. 1987, Edney at al. 1974, 1978, Jackson 1983, O'Donnell 1977, 1981, 1982, Appel et al. 1983). Mature males, the only winged form, live most of their short lives above-ground (Appel et al. 1983). Females are most active near and at the surface of the soil during the summer, which is most likely the mating season. Mature females "swim" to the surface after dark when the first few centimeters of sand have cooled. There, they wander the surface of the sand, presumably attracting males using pheromones (Hawke and Farley

1973). Courtship has never been observed, but mating occurs in an end-to-end position typical of Blattodea (Fig. 2).

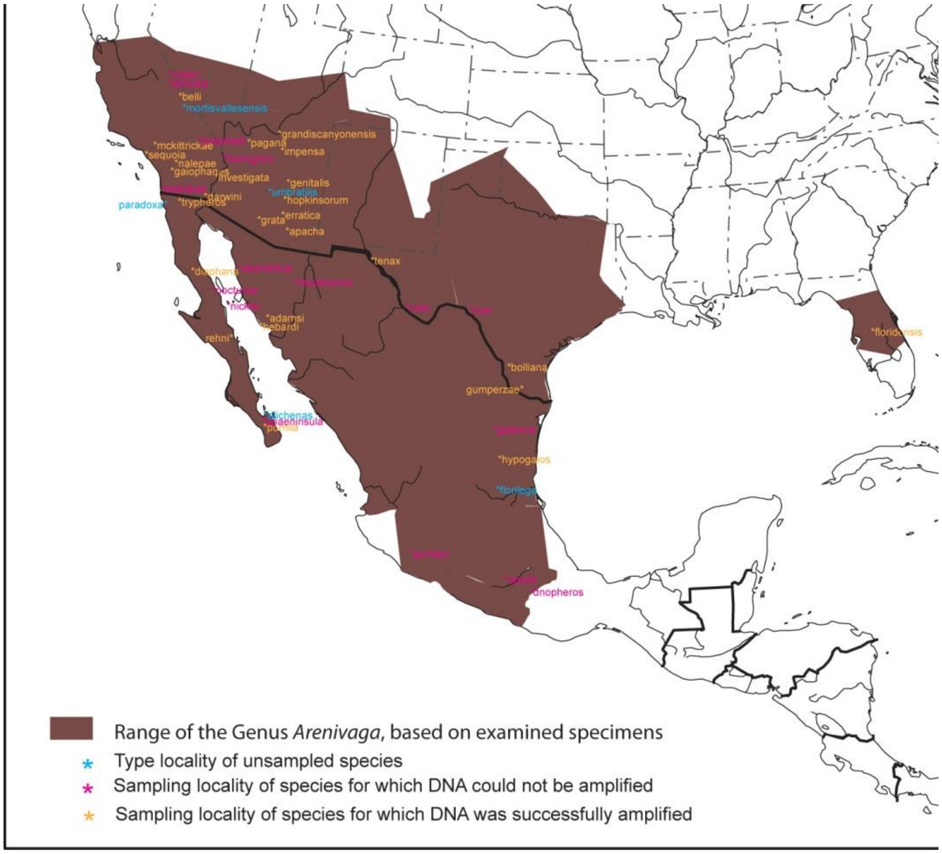


Figure 1. *Arenivaga* distribution with descriptions of sampling efforts for this study.

Figure 2. *Arenivaga* in copula.

Cockroaches have been little examined for external morphological characters for use in phylogenetic analyses (though see Klass and Meier, 2006; Grandcolas, 1994; 1996), and tend to be character–poor and cryptic in their morphology. Of the morphological phylogenetic work done in Blattodea, none of it specifically addresses the family Corydiidae, including *Arenivaga*. *Arenivaga* comprised nine species until a recent revision which described 39 new species (Hopkins, 2014), dramatically expanding the range of available character diversity. Further complicating comprehensive knowledge of species-level morphology in *Arenivaga* and related groups is the dramatic sexual dimorphism with females that are relatively character depauperate (e.g. Fig. 2). The goals of this research are to produce the first intrageneric phylogenetic hypothesis for *Arenivaga,* to document the monophyly of the genus, to determine whether certain morphological characters support the phylogeny produced here, and to investigate biogeographic patterns in the genus.

Materials and Methods

The external morphology and that of the dissected genitalia of male specimens of the 48 species were examined for characters. Various habitus measurements and ratios were also taken. These characters were coded and a parsimony tree based on 24 morphological characters produced. A bootstrap analysis recovered a large polytomy (Figure S1). Then 21 morphological characters were added to 1507 molecular characters from three genes that were obtained for 24 species, and Parsimony, Maximum Likelihood and Bayesian trees produced. (NB: the number of informative morphological characters was reduced from 24 to 21 when the number of species in this analysis was reduced because three characters varied only in eliminated taxa.) The present work is the first phylogenetic analysis of the genus using both morphological and molecular characters. While the total evidence phylogeny is limited to only half of the species present in the genus due to a lack of fresh specimens, several interesting relationships are nevertheless revealed and discussed. A partition Bremer analysis also reveals which data were the most informative for *Arenivaga*. This paper makes first inroads into understanding the evolutionary relationships between species of this genus of insects.

Morphology Taxon Sampling

Collections borrowed, numbers of specimens examined, and details of methods of dissection and preparation of male genitalia follow Hopkins (2014). Outgroup taxa included *Eremoblatta* Rehn species and *Blatta orientalis* Linnaeus. Since no previous phylogenetic work within Corydiidae has clarified the relationships of *Arenivaga* with other genera, *Eremoblatta* was chosen as an outgroup since it has similar specialized morphology (cercal tricholiths) that are otherwise not found in the cockroaches of North America. Trees were rooted with B. orientalis since that genus is currently placed in Blattidae and is clearly a more distantly related roach. The genitalia of the 48 *Arenivaga* species are complex involving numerous phallomeres and extensive sclerotized protuberances and invaginations. These were illustrated and the characters described more comprehensively in Hopkins (2014). The following 21 morphological characters were coded and analyzed, and character coding is indicated in Table S1 (Supplementary Materials). All multistate characters were treated as nonadditive.

External Morphology

1. Ratio of length to width (measured in tenths of millimeters) of habitus: 0, 1.63-1.92; 1, 1.93-2.22; 2, 2.23-2.52; 3, 2.53-2.83. This is a continuous character that has been segment coded (Thorpe, 1984) into four bins.

2. Ratio of length to width (measured in tenths of millimeters) of pronotum: 0, 0.59-0.65; 1, 0.66-0.72; 2, 0.73-0.79; 3, 0.80-0.87. This is a continuous character that has been segment coded into four bins.

3. Distance between compound eyes (EW) relative to distance between ocelli (OW): 0, EW > OW; 1, EW = OW; 2, EW < OW.

4. Pronotal aura: 0, absent (Fig. 3a); 1, present (Fig. 3b, see arrows).

   Several *Arenivaga* have a radiation of color around the central pronotal pattern.

5. Pronotal pattern: 0, not impressed (Fig. 4a); 1, impressed (Fig. 4b).

   Some species have the central pronotal pattern formed as deposited pigments and others have a pattern impressed into the pronotum.

6. Wing brace: 0, absent; 1, present.

   The wing brace is unique to several *Arenivaga* species (Fig. 5, see also Hopkins, 2014).

7. Frons: 0, not bulbous; 1, bulbous.

   Most cockroaches have the frons flat, but most *Arenivaga* have the frons distinctly projecting and bulbous.

8. Subgenital plate: 0, pointed (Fig. 6c); 1, angular (Fig. 6b); 2, rounded (Fig. 6a).

9. Styli: 0, present; 1, absent.

Male Genitalia

10. Lobe of the right dorsal phallomere: 0, not curved (Fig. 7a); 1, curved (Fig. 7b).

11. Lobe of the right dorsal phallomere: 0, narrow (Fig. 8a); 1, wide (Fig. 8b).

12. Medial margin of right dorsal phallomere: 0, not sclerotized (Fig. 9a); 1, sclerotized (Fig. 9b).

13. Spines on margin of right dorsal phallomere: 0, absent (Fig. 9a); 1, present Fig. 9b).

14. Location of spines on right dorsal phallomere: 0, none (Fig. 10a; 1, posteriorly (Fig. 10b); 2, posteriorly and medially (Fig. 10c); 3, posteriorly, medially and anteriorly (Fig. 10d).

15. Sculpting on point of articulation between right dorsal phallomere and right ventral phallomere: 0, absent (Fig. 11b); 1, present (Fig. 11a).

16. Spine on right ventral phallomere: 0, absent (Fig. 12a); I, present (Fig. 12b).

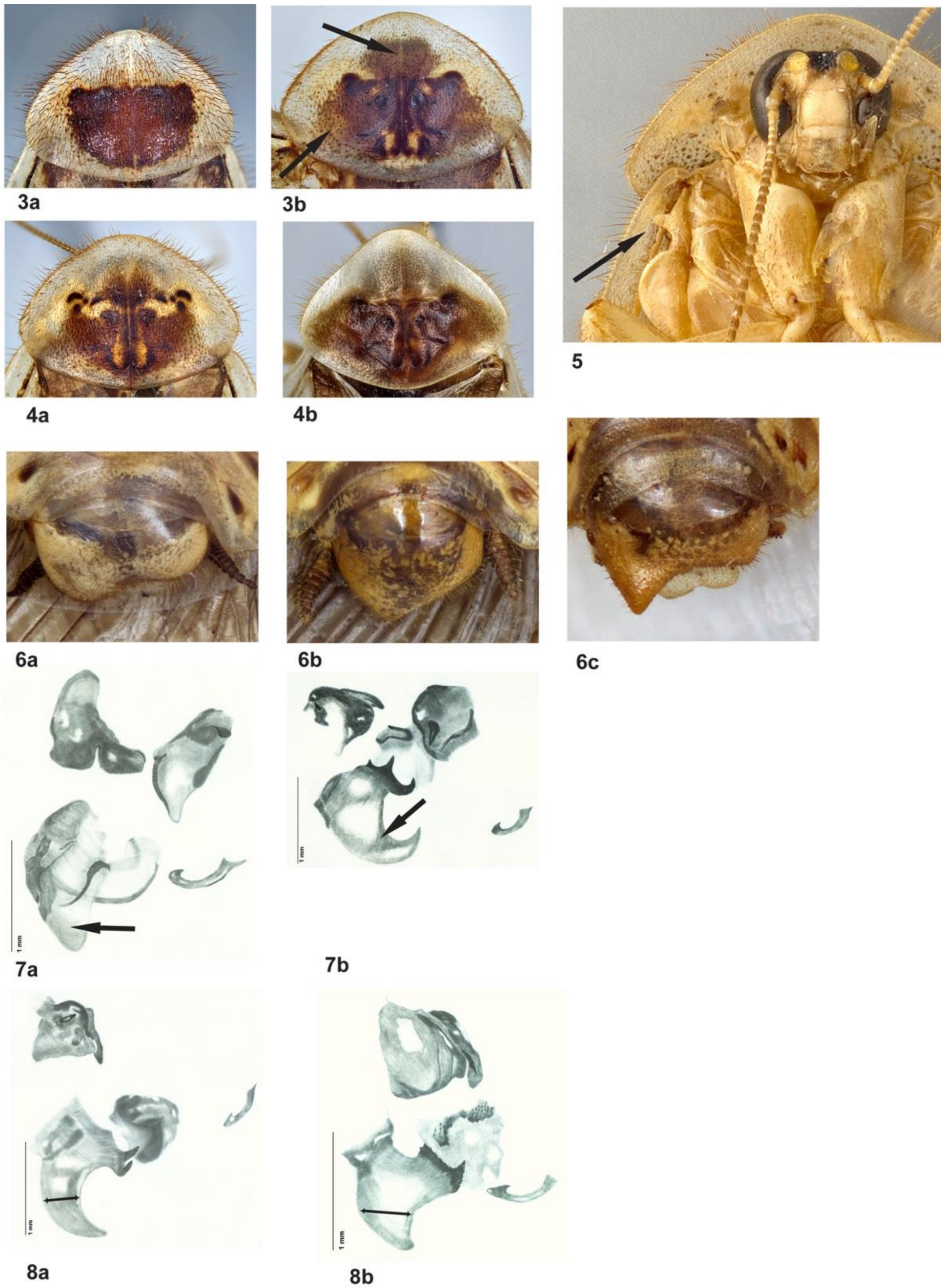
17. Size of emargination on right ventral phallomere: 0, narrow (no wider than width of genital hook) (Fig. 13a); 1, moderate (wider than width of genital hook but no wider than 90 degrees) (Fig. 13b); 2, wide (wider than 90 degrees) (Fig. 13c).

18. Anterior arm of right ventral phallomere: 0, single (Fig. 14a); 1, double (Fig. 14b).

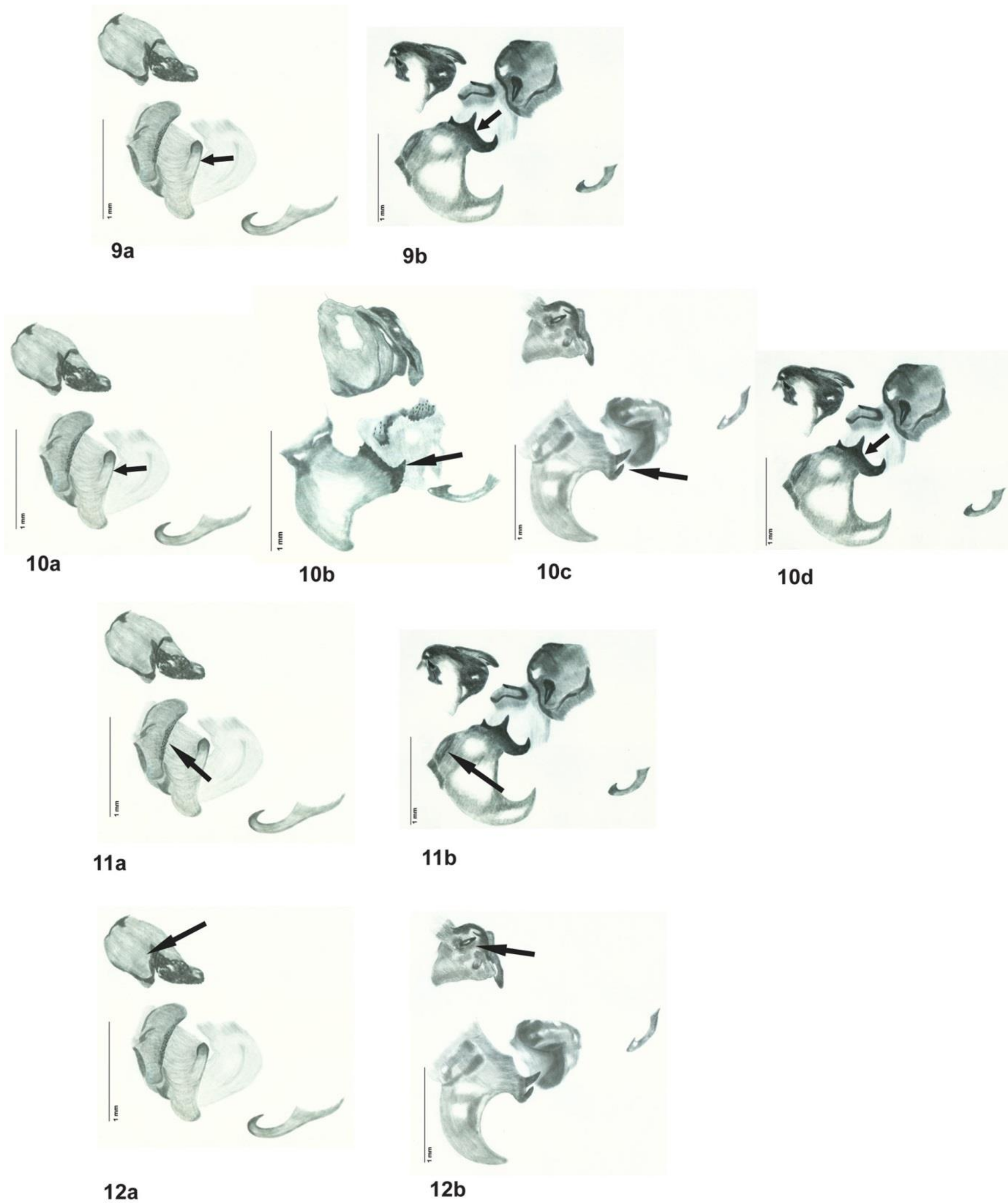
19. Sclerotization of small anterior phallomere: 0, absent (Fig. 15a); 1, present (Fig. 15b).

20. Spine on left phallomere: 0, absent (Fig. 16b); 1, present (Fig. 16a).

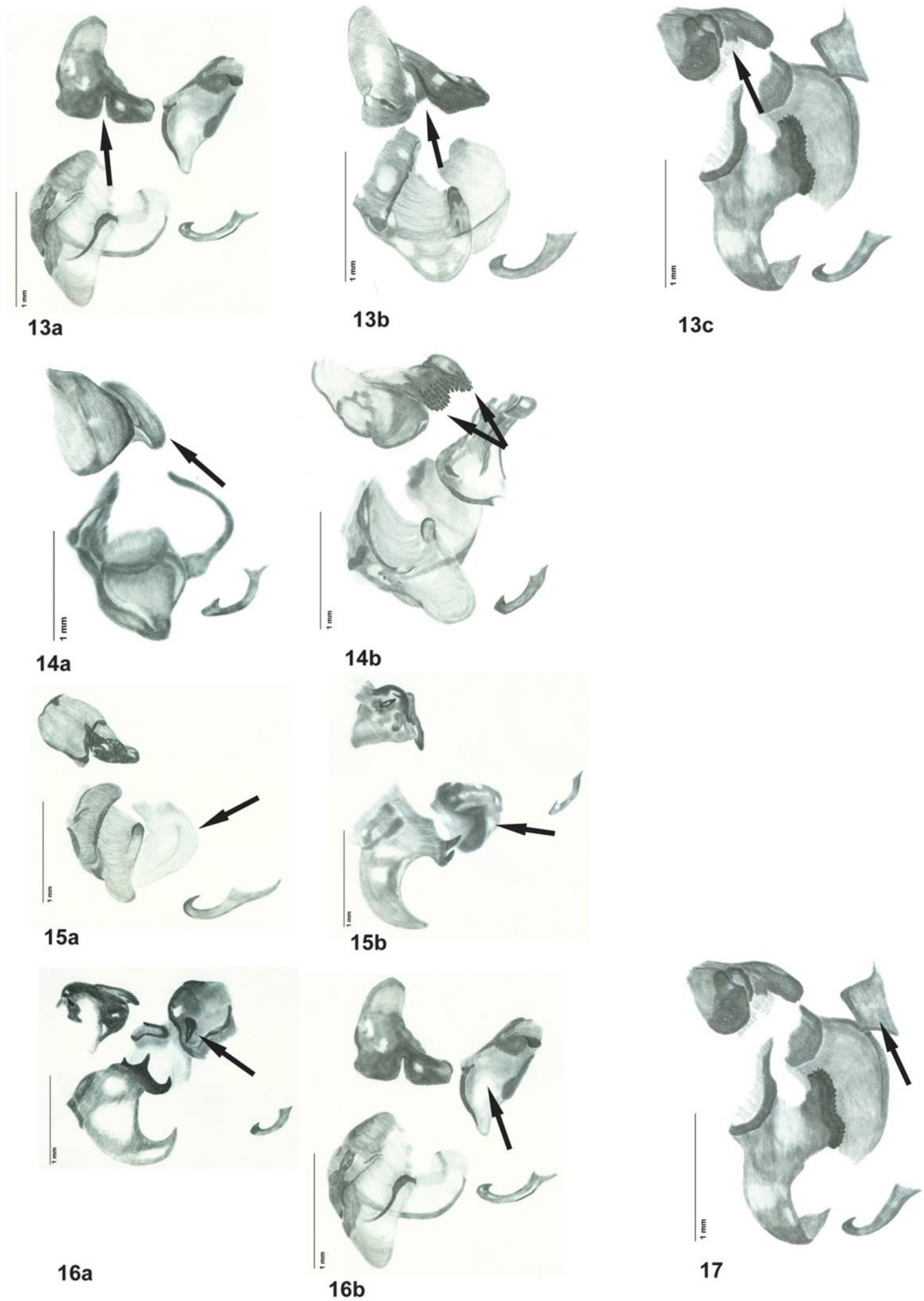
21. Flange on left phallomere: 0, absent; 1, present (Fig. 17).



Figures 3-8. 3. Aura a. absent; b. present. 4. Pronotal pattern a. not impressed; b. impressed. 5. Wing brace. 6. Subgenital plate a. rounded; b. angular; c. pointed. 7. Lobe of right dorsal phallomere a. not curved; b. curved. 8. Lobe of right dorsal phallomere a. narrow; b. wide.



Figures 9-12. 9. Medial margin of right dorsal phallomere a. not sclerotized; b. sclerotized; also 9. Spines on margin of right dorsal phallomere a. absent; b. present. 10. Location of spines on right dorsal phallomere a. none; b. posteriorly; c. posteriorly and medially; d, posteriorly, medially and anteriorly. 11. Sculpting on point of articulation between right dorsal phallomere and right ventral phallomere a. absent; b. present. 12. Spine on right ventral phallomere a. absent; b. present.



Figures 13-17. 13. Size of emargination on right ventral phallomere a. narrow (no wider than width of genital hook); b. moderate (wider than width of genital hook but no wider than 90 degrees); c. wide (wider than 90 degrees). 14. Anterior arm of right ventral phallomere a. single; b. double. 15. Sclerotization of small anterior phallomere a. absent; b. present. 16. Spine on left phallomere a. absent; b. present. 17. Flange on left phallomere a. absent; b. present. NB: all of left phallomere is not depicted, only the flange in the position where it would be found.

Molecular Taxon Sampling

Many *Arenivaga* are narrowly endemic, rarely collected, and occur in areas difficult to collect. Therefore, for most species in the morphological matrix fresh material for DNA data acquisition was not available. However, fresh material was available for a subset of the taxa (eight species, or 17%) and in other cases, museum specimens were found to be suitable for sequencing. Three gene fragments were successfully amplified and sequenced for 24 species and two outgroup species.

DNA Sequencing Protocol

DNA was extracted using Qiagen DNEasy kit (Valencia, California, USA) and the protocol for animal tissue. In all instances muscle tissue at the point of wing attachment were pulled for extraction. Extractions were made on fresh specimens of both outgroups. The portions of the specimens remaining after extraction were retained for vouchering. Vouchers and DNAs are deposited in the Museum of Southwestern Biology Division of Arthropods (MSBA, K.B. Miller, curator).

Portions of three genes were used in the analysis, *cytochrome c oxidase I* (COI, 767 aligned bp), *histone III* (H3, 328 aligned bp) and *12S rRNA* (12S, 415 aligned bp). Primers used for amplification and sequencing were derived from several sources (Table S2 of the Supplementary Materials). DNA fragments were amplified using PCR with TaKaRa Taq (Applied Biosystems, Foster City, CA, USA) on an Eppendorf Mastercycler Thermal Cycler (Eppendorf, Hamburg, Germany). Many amplification conditions were tried because obtaining DNA from degraded specimens was very challenging. In this study, the protocols that obtained the best results for each gene were as follows:

CO1	Step 1		Step 2		Step 3	
Conditions	Temp	Time	Temp	Time	Temp	Time
Denaturation	94	0.30				
Annealing	50	1.00				
Elongation	70	1.30	70	7.00		
Cycles	35		1			

H3	Step 1		Step 2		Step 3	
Conditions	Temp	Time	Temp	Time	Temp	Time
Denaturation	94	0.45				
Annealing	50	1.00				
Elongation	72	0.45	72	7.00		
Cycles	35		1			

12S	Step 1		Step 2		Step 3	
Conditions	Temp	Time	Temp	Time	Temp	Time
Denaturation	94	0.30	94	0.30		
Annealing	39	1.00	44	1.00		
Elongation	68	1.00	68	7.00	68	7.00
Cycles	5		30		1	

Negative controls were used to check for contamination, and PCR products were checked using gel electrophoresis. Products were purified using ExoSAP-IT (USB-Affymetrix, Cleveland, OH, USA) and cycle sequenced using ABI Prism Big Dye (version 3.1, Fairfax, VA, USA) using the same primers used to amplify. Sequencing reaction products were purified using Sephadex G-50 Fine or Medium (GE Healthcare, Uppsala, Sweden). All sequencing reactions took place at the Molecular Biology Facility at the University of New Mexico using an ABI 3130xl Genetic analyzer (Applied Biosystems, Foster City, CA, USA). Genes were sequenced in both directions and examined and edited using Sequencher (Genecodes, 1999). All resulting sequences were BLASTed in GenBank and non-target sequences were discarded. GenBank accession numbers for gene sequences used in this study as well as MSB voucher numbers for the specimens are listed in Table S3 (Supplementary Materials).

Sequence Alignment

All sequences were aligned using Muscle (Edgar, 2004a; 2004b) as implemented by the program MEGA (Tamura et al., 2011). Protein coding fragments were converted to protein sequences during alignment to conserve reading frame. Gaps, which were infrequent, were treated as missing data. All alignments were visually checked for evident ambiguities and none were found.

Phylogenetic Analysis Using Morphology and Molecules

The concatenated data were analyzed and phylogenetic trees estimated using three optimality criteria, parsimony, maximum likelihood and Bayesian.

Parsimony

Parsimony analysis was implemented in TNT (Goloboff et al., 2008). There were 1531 characters in this analysis of which 439 were parsimony informative. The analysis used the traditional search function with 10 replicates and 10 trees saved/replicate. Tree searches were conducted under the tree bisection reconnection (TBR) algorithm. Node support was evaluated using nonparametric bootstrap, traditional search and 1000 replicates, with TNT settings at starting trees of 10 search replicates in TBR, 30 trees saved per replicate, and keeping all trees found.

Maximum Likelihood

Maximum likelihood inference was implemented in RAxML 8.0 (Stamatakis 2014) on the CIPRES portal (Miller et al. 2010). The best model for these data was determined using MEGA (Tamura et al., 2011) which contrasted each model's log-likelihood score and recovered GTR+G+I as most appropriate (i.e. yielded the highest likelihood). Node support was quantified with 1000 rapid bootstrap replicates as implemented in the parallel versions of RAxML. The resulting tree was examined in FigTree (Rambaut, 2006-2009).

Bayesian

Bayesian analysis was implemented in MrBayes 3.2.1. Optimal partitioning strategy was identified using PartitionFinder (Lanfear et al. 2012) which returned eight data partitions with three models and four rates. The Bayes block was written to accommodate the partitions, models and rates indicated by PartitionFinder as follows: 12S—GTR + G; H3, position 1—GTR + G; H3, position 2—JC; H3, position 3—HKY + G; CO1, position 1—GTR + I + G; CO1, position 2—HKY + I; CO1, position 3—HKY + G; morphology—HKY + G.). Seven partitions were allowed separate rates, and the rate for H3, position 2 (JC model) was set to fixed and equal. All parameters except branch lengths and topology were unlinked across partitions. For all analyses we ran two separate 10 million MCMC generations each with one cold and three heated chains (temp=0.2) and we sampled the cold chain every 100^{th} generation. A maximum likelihood user tree for the data was used and any zero length branch lengths on the user tree were reset to 0.00000001 to prevent an error termination. A stop rule convergence value of 0.01 was set and a stoprule placed on the run when that value was reached, which occurred on the 1118000 generation. Successful convergence was confirmed independently in Tracer (Rambaut et al., 2013). A relative burn-in of 0.25 was set and discarded leaving 2 × 8385 samples to be processed. The resulting tree was manipulated in FigTree.

Partitioned Bremer Analysis

A partitioned Bremer analysis (Baker and DeSalle, 1997) was performed following the method in Pena et al. (2006), and implemented in TNT (Goloboff et al., 2008). Data were interleaved by partition and most parsimonious trees found using a traditional search. A strict consensus tree was calculated and partitioned Bremer analysis performed using the data, the most parsimonious trees (of which there were two) and the strict consensus tree.

Results

All analyses returned trees with similar topologies. The parsimony analysis resulted in two most parsimonious trees of length 2026, CI=0.49, RI=0.44. The majority rule consensus tree calculated using 1000 bootstrap (bs) replicates is well-supported in some relationships, less so in others (Fig. 18). The tree returns a monophyletic *Arenivaga* (bs = 99) with one major clade and one smaller clade, neither of which are well supported. Although the backbone of the tree has poor support there are several deeper relationships that are well-supported. One well-supported clade in all analyses, the *A. pagana* group (Fig. 19) includes *A. nalepae*, *A. hopkinsorum* and *A. tonkawa* (bs = 81), and that clade sister to *A. pagana* (bs = 73). The sister relationships between *A. pumila* and *A. gumperzae* also has strong support (bs = 100). The most robust clade in the parsimony phylogeny (the *A. bolliana* group, Fig. 19) is comprised of a well-supported relationship between *A. trypheros* and *A. darwini* (bs = 100), with *A. rehni* sister to them (bs = 88). Within the *A. bolliana* group, *A. bolliana* and *A. grata* also resolve as sisters (bs = 82).

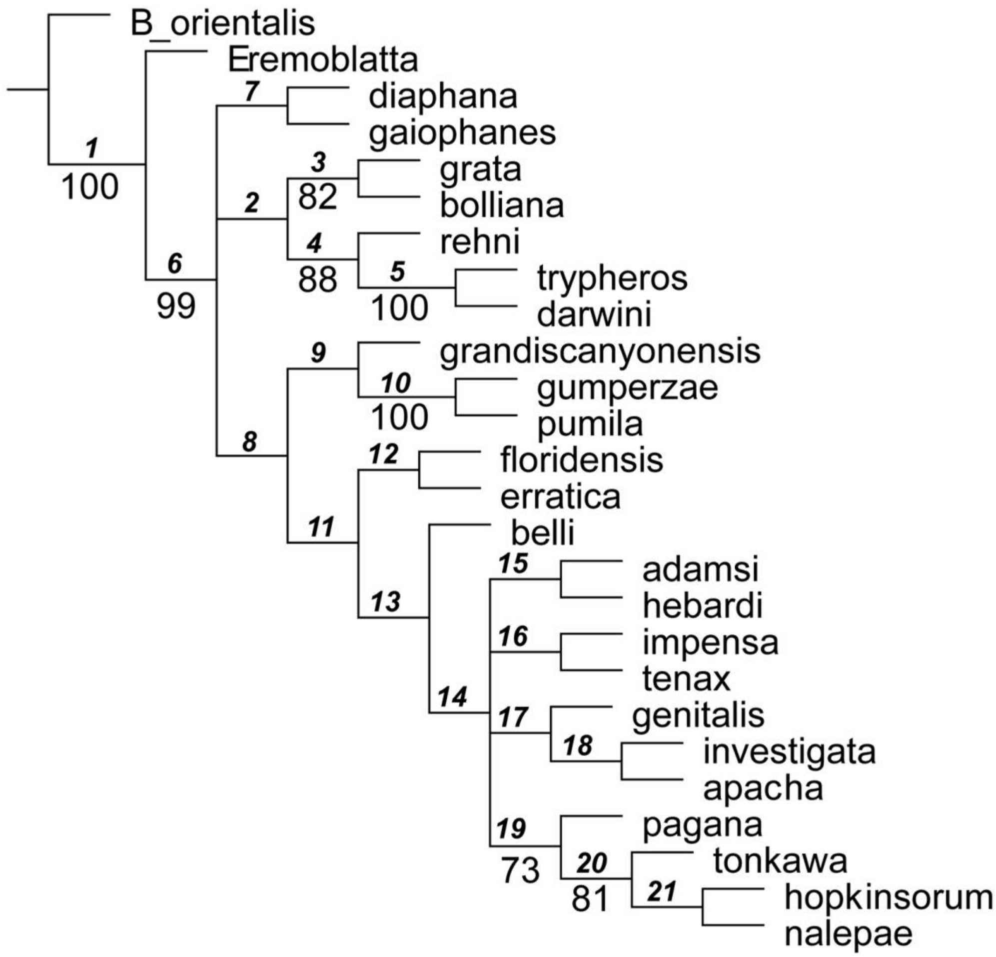


Figure 18. A parsimony tree of 24 species of *Arenivaga,* rooted with two outgroups, produced using TNT. The majority rule consensus tree with supports from 1000 parsimony bootstrap replicates is depicted. Only bootstrap supports of 50 or above are shown. Bold italic numbers indicate clades in the partitioned Bremer analysis (see Table 4 of the Supplementary Materials).

Like the parsimony analysis, the likelihood analysis (Fig. 19) returned *Arenivaga* as monophyletic and divided into two clades, but resolves *A. diaphana* as sister to the rest of the genus, although with poor support (bs = 65); there are some differences between the trees, but all such differences resolve with poor support (bs of 44 or less). Other nodes found in the parsimony phylogeny are here returned with greater support. For example, *A. impensa* and *A. tenax* were resolved as sister in the parsimony tree, but with negligible support (bs = 75). Likewise the pairing of *A. floridensis* and *A. erratica* as sister species is only modestly supported (bs = 65). The sister species *A. pumila* and *A. gumperzae* has strong support (bs = 100) as it did in the parsimony phylogeny. The *pagana* clade is resolved with relationships like those in the parsimony analysis, but with greater node support (((*A. hopkinsorum* + *A. nalepae* bs = 62) + *A. tonkawa* bs = 93) + *A. pagana* bs = 92). The most robust clade in the parsimony phylogeny (the *bolliana* clade) is likewise strongly supported under likelihood. All relationships in this clade are well supported (bs > 84).

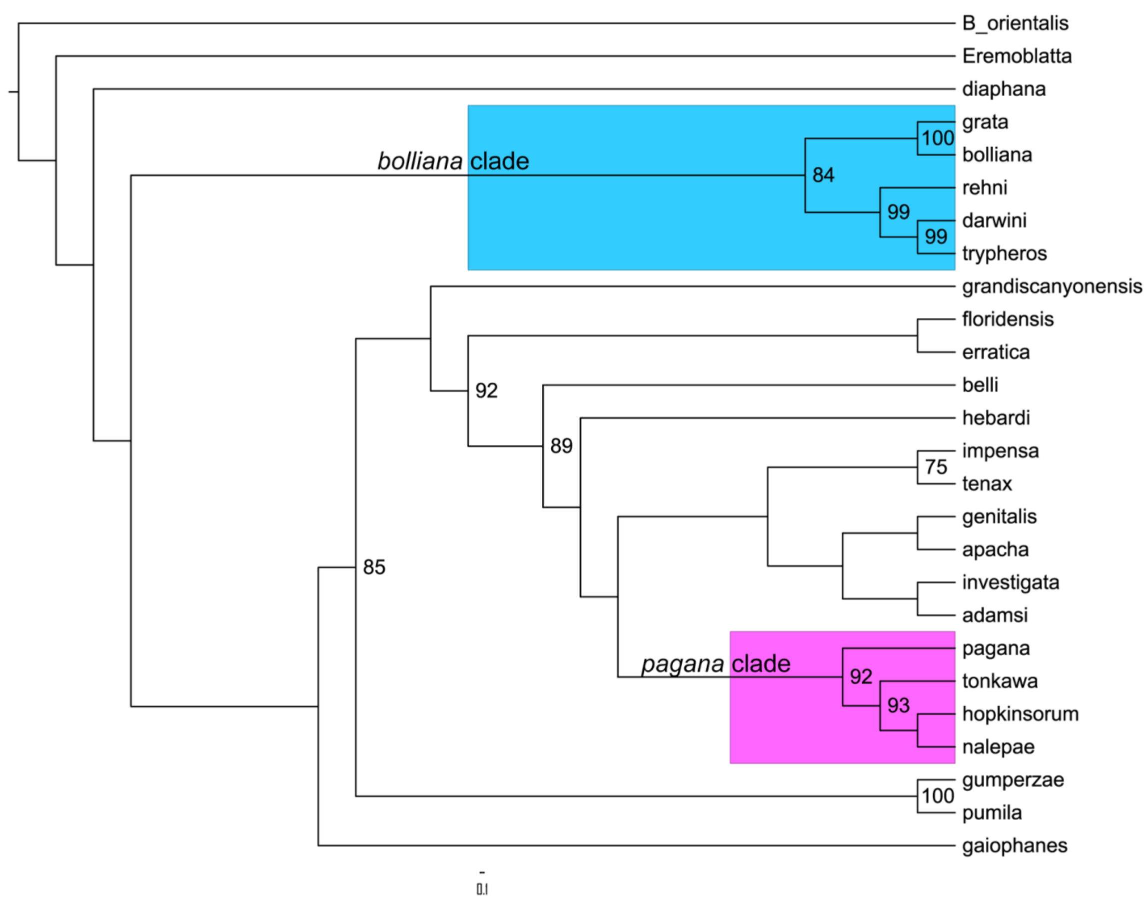


Figure 19. A maximum likelihood tree of 24 species of *Arenivaga*, rooted with two outgroups, produced using RAxML. The majority rule consensus tree with supports from 1000 parsimony bootstrap replicates is depicted. Only bootstrap supports of 70 and above are shown. Colored rectangles indicate two named clades, *A. pagana* and *A. bolliana* discussed in Results and Discussion sections.

The Bayesian analysis (Fig. 20) returned a tree topology only slightly different from those of both parsimony and likelihood, and the support (in the form of posterior probability, pp) along the spine of the tree is much stronger. *Arenivaga diaphana* is resolved as sister to the rest of the genus as in likelihood but with much greater support (pp = 1). Different from parsimony and likelihood, the Bayesian analysis returns *A. investigata* as sister to the duo of *A. hebardi* and *A. adamsi* with pp of 0.87. The sister group of *A. tenax* and *A. impensa* (pp = 0.99) resolve as sister to this trio with pp of 0.80. Sister to this entire group we have the *A. pagana* clade (pp = 0.89) of *A. nalepae* and *A. hopkinsorum* (pp = 0.99), *A. tonkawa* (pp = 0.99), and *A. pagana* (pp= 1.0). Uniquely, the Bayesian analysis pairs *A. apacha* sister to *A. genitalis* (pp = 0.92) and this clade sister to all of the above (pp = 1.0). Next there is *A. belli* alone (pp = 0.99) and then the clade *A. erratica* + *A. floridensis* (pp = 0.75) sister to all of the above with pp of 1.0. Similar to the likelihood analysis, *A. grandiscanyonensis* resolves next in the tree, alone, with pp of 0.74, and then the sister group of *A. pumila* and *A. gumperzae* (pp = 1.0) as sister to all of the above (pp = 0.99). The above described clade forms a polytomy with *A. gaiophanes* and the *A. bolliana* clade. The *A. bolliana* clade resolves as it did in both other estimates and comprises *A. bolliana* and *A. grata* as sister with pp of 1.0, and that duo sister to the trio of *A. darwini* and *A. trypheros* (pp = 1.0), and *A. rehni* (pp = 1.0) with pp of 0.98.

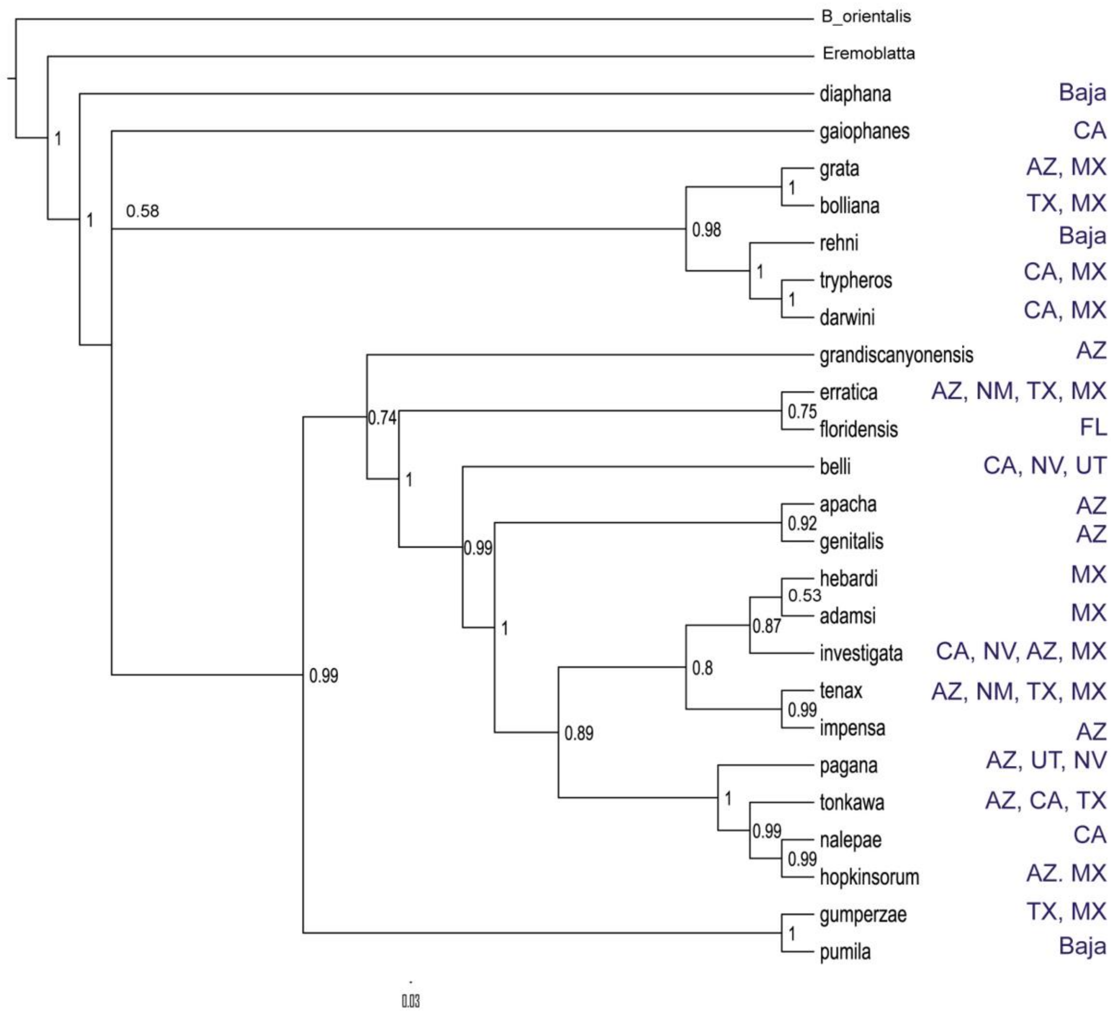


Figure 20. A Bayesian majority rule consensus tree of 24 species of *Arenivaga*, rooted with two outgroups, produced using a partitioned analysis in MrBayes. All posterior probabilities are shown. Rough area of distribution of each species is indicated in blue to the right of each species. Key: MX = Mexico, Baja = Baja peninsula, Mexico.

Summary of Results

The three phylogenetic estimates resulted in similar tree topologies and agree on the following relationships: 1) monophyly of *Arenivaga*, 2) certain clades within the genus are well supported through all three phylogenetic applications: the *A. bolliana* clade, the *A. pagana* clade, and the sister relationship between *A. gumperzae* and *A. pumila*, 3) in the likelihood and Bayesian analyses the placement within the genus of *A.*

belli and the sister species *A. erratica* and *A. floridensis*, and *A. pumila* and *A. gumperzae*, are congruent and well supported, and 4) the Bayesian posterior probabilities are 0.75 or above for all nodes in the tree except for the basal polytomy discussed above (pp = 0.58) and the sister relationship of *A. hebardi* and *A. adamsi* (pp = 0.53).

Relative Contributions of the Data

The partitioned Bremer analysis of the three gene fragments and morphological characters indicate that the best support overall was derived from the COI partition (56.4%), with 12S (26%) and morphology (17.6%) providing the rest. H3 actually provided overall conflicting support (18%, not normalized). From this analysis it can be seen 1) that CO1 provides the strongest support of all data partitions and fails to provide support for only three clades (13, 18 and 21) in this topology, 2) that data from 12S also supports 15 of the 21 clades examined, 3) that morphology supports 12 of the 21 clades examined, and 4) that data from H3 do not support the overall topology suggested by the rest of the data, and provide individual support for only seven clades of those examined. Strongest combined Bremer support is found for clades one (the genus), two, three, four, five (all in the *A. bolliana* clade), ten (the sister group of *A. gumperzae* and *A. pumila*), 19, and 20 (both in the *A. pagana* clade). An incongruence length difference (ILD) test (Farris et al., 1994) performed in WinClada (Nixon, 1999-2002) on the partitioned data revealed that the trees from partitioned data were not significantly incongruent ($p=0.1667$). Tree topologies for each of the three genes used in this analysis are shown in supplementary materials (Figs. S2, S3, and S4).

Discussion

The Monophyly of Arenivaga

Each phylogenetic estimate resulted in monophyly of Arenivaga, though with the limited outgroup sampling from within Corydiidae, this conclusion is not strong. In addition, the putative sister taxon, *Eremoblatta,* is always returned outside of the genus *Arenivaga*, though the closeness of the relationship between these genera is not established. In addition, when this phylogeny is unrooted, a single branch separates ingroup taxa from outgroup taxa, which is consistent with an assumption of ingroup monophyly (Hillis et al. 1996). This one-sided test only demonstrates that an attempt to reject the hypothesis of ingroup monophyly has failed. An improved knowledge of the lineages sister to *Arenivaga* is required before a more robust test of monophyly can be made. There are other interesting relationships, or lack thereof, revealed by tzhis phylogeny. One is the case of *A. grandiscanyonensis*, interesting in that none of the three analyses done here shows us what the sister species is to this species found at the bottom of the Grand Canyon, even though geographically adjacent species are included in this study. Another is the case of *A. floridensis*, interesting because unlike *A. grandiscanyonensis*, all analyses return the same sister taxon for this lone species found in Florida, that being *A. erratica,* a widespread species found in Arizona, New Mexico, Texas, and mainland Mexico.

Phylogenetic Support from Morphological Characters of Arenivaga

Morphological characters of *Arenivaga* do provide some support for the phylogenetic relationships discovered here. Some relationships between species are consistent across all analyses and strongly supported in the Bayesian analysis, such as those of the *A. pagana* and *A. bolliana* clades. The *A. pagana* clade (comprised of *A.*

nalepae, *A. hopkinsorum*, *A. tonkawa*, and *A. pagana*,) have adjacent or overlapping distributions in Arizona and California, and three of the species have a pale or sandy brown appearance and somewhat similar genitalia. *Arenivaga hopkinsorum* is unusual in this clade since it has strikingly different genitalia and medium dark coloration. Support for *A. hopkinsorum* in this clade (as sister to *A. nalepae*) is very strong in the Bayesian analysis but weak in the parsimony and likelihood analyses, suggesting it may not actually be part of this clade. The *A. bolliana* clade ranges in distribution from Texas (*A. bolliana*) to Arizona/Mexico (*A. grata*) to California/Mexico (*A. darwini* and *A. trypheros*) and south into the Baja peninsula (*A. rehni*). These species are resolved in identical relationships with strong support across all analyses, except for the sister relationship between *A. grata* and *A. bolliana* and *A. rehni* + *A. trypheros* + *A. darwini* in the parsimony analysis, which is not well supported. Three of these species do not have the wing brace character (discussed below), but overall appearance, especially coloration, of these species is otherwise widely varying supporting the idea that overall appearance my not be a good predictor of relatedness in *Arenivaga* (Hopkins, 2014). The genitalia of all five species, in contrast, are markedly similar, and some of the simplest in the genus. The sister relationship of *A. pumila* and *A. gumperzae* is strongly supported in all estimates, which is interesting since their distributions are widely disjunct and their genitalia are not similar. Whereas *A. apacha* and *A. genitalis* change in position depending on method of estimation, their sister group relationship is strongly supported by the Bayesian analysis, and the two species occur with adjacent distributions, have similarly elaborate genitalia, and both species are similar in size and dark coloration.

In the recent revision of this genus (Hopkins, 2014) a new character, the "wing brace," was described. This character is distinctive, not described before in any family of cockroaches, and common within the genus (only nine species do not have it). Three of the four species in this study that do not have the wing brace are found in the *A. bolliana* clade, (these are *A. rehni*, *A. bolliana,* and *A. grata*). The fourth, *A. pumila*, is not in this clade nor closely related to it, indicating that this character has been lost at least twice in the genus.

Two species that have overlapping territories and strikingly different external morphologies, *A. darwini* and *A. trypheros,* are resolved as sister to one another in every estimate. This pair of species is interesting in that even though their external morphologies are dramatically different, they have nearly identical male genitalia. Additionally, the two largest species of *Arenivaga*, *A. bolliana* and *A. grata*, are recovered as sister taxa in every analysis. The distributions of these two species are parapatric and they have only a small difference in genitalic morphology.

Geographic Structure of Arenivaga

The Bayesian tree topology (see Figure 20) indicates the earliest branching taxon is *A. diaphana*, found in Baja, Mexico. From here we see a consistent radiation eastward across the American southwest and Mexico. It is unknown how the single Florida species came to be in that locality; did it migrate across the southern US, becoming isolated during the flooding of much of middle America by the Western Interior Seaway approximately 75 mya (Rosen, 1978)? Or perhaps *Arenivaga* invaded Florida at the time of the glacial maximum when the shorelines of Mexico and Florida were in much closer proximity to each other, with Cuba as a possible stepping stone (Rosen, 1978, see especially Figure 15). What is certain is the distribution pattern of many other taxa match that of *Arenivaga*, with numerous species located in the American southwest and Mexico and one or a few species located in the relict sand dunes of northern Florida (e.g. Rosen, 1978; Goodrich and Skelley, 1993; Kerr and Packer, 1998; Pemberton and Liu, 2008). Florida was last completely inundated just over 15 mya making it unlikely that *A. floridensis* invaded Florida earlier than that. Nevertheless, *Arenivaga* shows an impressive record of adapting to and acquiring new territories (Hopkins, 2014; Hopkins et al., in prep), and could possibly have retreated and advanced in response to the changing Florida coastline. A comprehensive examination of the fossil cockroaches of the North American continent might provide insights into the deep history of *Arenivaga*, but such a work has not yet been undertaken.

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An analysis of the relative importance of biotic and abiotic factors to the niche of the genus Arenivaga (Blattodea, Corydiidae)

by

Heidi Hopkins, J. Tomasz Giermakowski, and Kelly B. Miller

Abstract

The relative contributions of 23 ecological variables to the niche of the genus *Arenivaga* were examined. This analysis revealed that more than 95% of their ecological niche could be described by eight variables: soil, isothermality, minimum temperature of the coldest month, mean temperature of the driest quarter, annual precipitation, precipitation of the driest month, precipitation of the wettest quarter and ground cover. These eight variables with respect to their relative contributions to the niche of the genus as a whole as well as the individual niches of 27 species in the genus were then examined. This revealed the similarity of niche composition of most of the species, as well as how varied the niches were of several species. A species dendrogram built from similarity of contribution of the eight variables to niche composition was compared to a phylogeny of the genus, but few similarities in topology were found. This analysis revealed that soil is the most important contributor to these species' niches, followed by precipitation of the driest month, and finally, precipitation of the wettest quarter. It also confirmed that the majority of *Arenivaga* species have niches comprised of similar, but not identical, proportions of as few as four, and as many as eight ecological variables. Currently there is no evidence to support niche conservatism between closely related species, indicating that adapting to new and variable niches is one of the drivers of speciation in this genus.

Keywords

Blattodea, cockroach, desert cockroach, sand cockroach, *Arenivaga*, Corydiidae, Polyphagidae, ecological niche models, species boundaries, species distributions, biotic, abiotic, biogeography, niche conservatism, niche evolution

Introduction

A point of great interest to biologists, especially in this time of global climate change, is the pattern of distribution of species across the surface of the planet. When considering the presence or absence of a taxon in a given terrain, as well as its abundance if present, questions arise as to what factors contribute to the success or failure of that taxon in the environment. Species' distributions are constrained by a variety of environmental factors both biotic and abiotic, such as temperature, precipitation, ground cover, food resources, and predation. A species cannot persist in an area in which its basic requirements for survival are not met. Those requirements include, for example: sufficient territory to acquire needed nutrients and mates; terrain that is unfavorable to predators or permits escape from predation if one is a prey item, or the opposite if one is a predator; and sufficient niche diversification to prevent competition from congeneric species (Lomolino et al., 2005). In addition, the distribution and survival of a species across a given terrain, as well as the radiation of that species into two or more daughter lineages, is profoundly affected by adaptability to new ecological variables, geographic disruption, and isolation caused by stochastic vicariant events (Figure 1) (Coope, 1994; Lomolino et al., 2005; Araujo and Luoto, 2007). A taxon's ability to adapt to changes in the environment determine that taxon's presence and density in the landscape, its persistence in the environment over time, and its acquisition of adjacent territory through migration, expansion, or speciation (Gaston, 1998; Peterson, 2003). Much of this can be summarized as a tendency towards niche conservatism, or niche evolution, in a species (Wiens and Graham, 2005; Smith et al., 2005; Wiens and Donoghue, 2004).

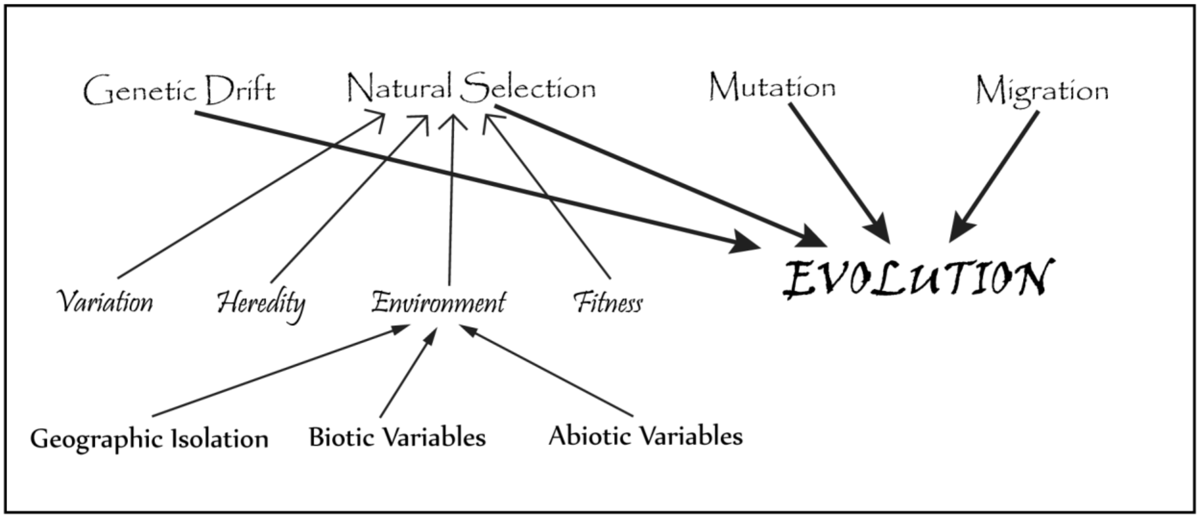


Figure 1. A diagram of the factors that contribute to evolution. The relative contributions of biotic and abiotic variables on the niches of the genus *Arenivaga*, as well as the niches of 27 species therein, are examined in this paper.

One way to begin to understand the environmental factors that account for the pattern in which species are distributed over the earth is to map a species' distribution and then search for biotic and abiotic factors that unite the resulting terrain. This process, known as ecological niche modeling (ENM), is complicated by limited knowledge of the factors critical to a given species' success. For example, climate data for a species' habitat is readily available, but a measure of the contribution to a species' niche made by a facilitating symbiont, or understanding the impact of a taxon's vagility upon its niche may be much more difficult. As a consequence these latter variables are rarely if ever included in ecological niche modeling; therefore all conclusions of such modeling must be understood within the limited context within which they are drawn. In addition, environmental factors play a role in both permitting and preventing the successful occupation of an area by a species (Stevenson, 1982; Krasnov and Shenbrot, 1996). Therefore, the factors contributing to species' realized niches are complex and varied, but not outside the abilities of science to discover.

Ecological niche models permit enumeration and quantification of the factors that are determinants of a species' presence in the landscape (Elith et al., 2006; 2010, Wiens and Graham, 2005). They also can be used to predict whether a species is likely to be present in an unsampled area, or predict where a species may successfully migrate as a result of climate change or other anthropogenic changes to the environment. Whereas many models created to predict species' ranges have been based on abiotic variables, Gonzalez-Salazar et al. (2013) showed that inclusion of biotic variables could result in higher predictability (although also see Meier et al., 2010); therefore both types of variables were used in this study.

This study examines the relative importance of 23 biotic and abiotic factors in determining the ecological niche of the cockroach genus *Arenivaga*, and the niches of 27 species within that genus. It seeks to answer the following questions: Which biotic and abiotic factors are strongly predictive of where *Arenivaga* may be found? What are the relative contributions of those factors to the ecological niche of the genus? Are these factors mirrored in their relative importance amongst 27 species in the genus and can any species be grouped according to similar biotic or abiotic niche requirements? Finally, are there any correlations between habitat requirements and evolutionary relationships in the genus that allow us to conclude that Arenivaga species tend towards niche conservatism or niche evolution? (Peterson, 2003; Wiens and Graham, 2005; Wiens and Donoghue, 2004).

Materials and Methods

Study subject

Arenivaga is a subterranean genus of cockroaches in the family Corydiidae (Polyphagidae, *sensu lato*), that are found in the American southwest, Florida and Mexico. While something is known about their physiological adaptations for their terrain and lifestyle (Cohen and Cohen, 1976; 1981; Edney, 1968; Edney et al., 1974; 1978; Edney and McFarlane, 1974; Hartman et al., 1987; Hawke and Farley, 1971a; 1971b; 1973; Jackson, 1983; O'Donnell, 1977; 1981; 1982), their phenology is largely unknown. They live in dry, sandy or rocky terrain, though they may also be found in other terrains that receive greater precipitation, calling into question their common designation as "sand" or "desert" roaches (Figure 2).

Species occurrence data

This analysis is based on locality data of more than 5200 adult male specimens of *Arenivaga*. Areas of the United States are better represented by these specimens than Mexico. Although Mexico includes a great diversity of *Arenivaga* it is under-collected for this genus with the exception of the Baja peninsula which is better surveyed for many arthropods, including Blattodea (D. Lightfoot, pers. com.)(e.g. Lightfoot and Weissman, 1991; Lightfoot, et al., 2011; Weissman et al., 1980; Vickery, 1997; Kevan, 1990; Gomez

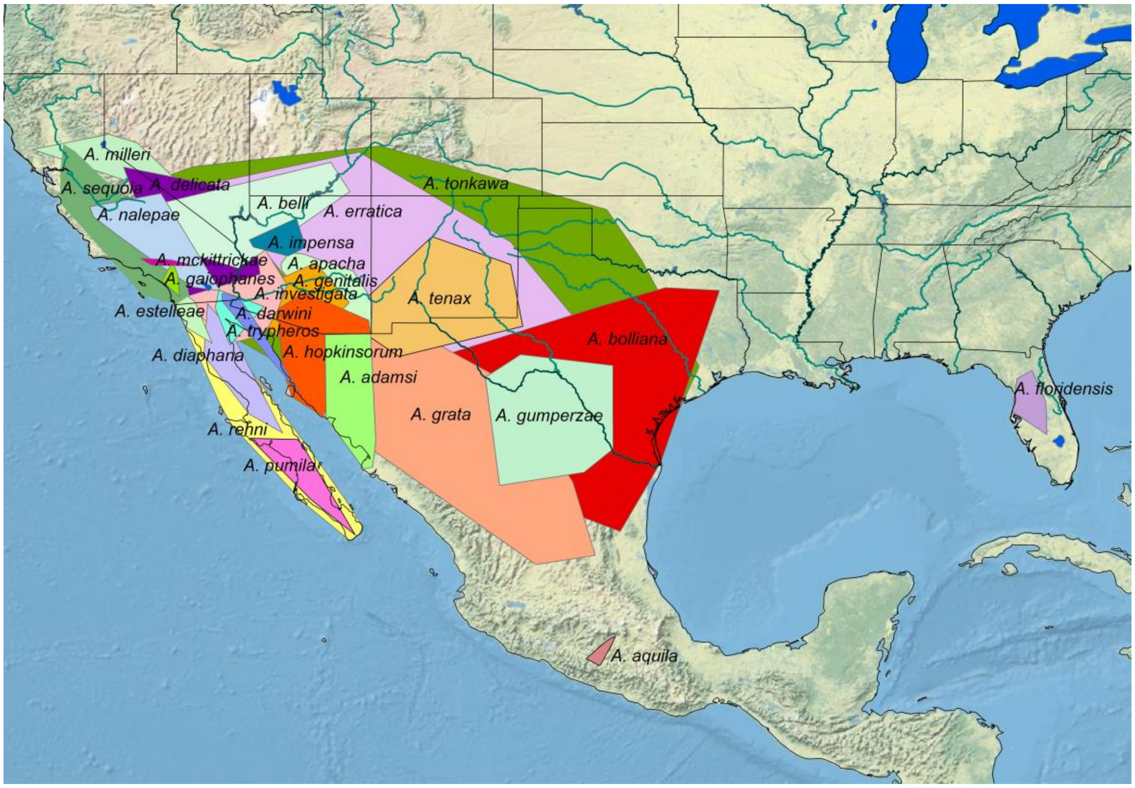


Figure 2. Distributions of the 27 *Arenivaga* species included in this study.

et al., 2012). Specimens examined for this study were borrowed from the following collections or collected in the field by Hopkins:

AMNH	American Museum of Natural History
ANSP	Academy of Natural Science, Philadelphia
ASUT	Arizona State University, Tempe
MLBM	Monte L. Bean Life Science Museum, Brigham Young University
CAS	California Academy of Science
CSCA	California State Collection of Arthropods
CSLB	California State University, Long Beach
J Cole	Jeff Cole private collection

CUIC	Cornell University Insect Collection
EMEC	Essig Museum of Entomology, California
FSCA	Florida State Collection of Arthropods
HEH	Heidi Hopkins private collection
IMNH	Idaho Museum of Natural History
LACM	Los Angeles County Museum
MCZ	Museum of Comparative Zoology, Harvard
MSB	Museum of Southwestern Biology, Albuquerque
NAUF	Northern Arizona University, Flagstaff
NVDA	Nevada Department of Agriculture
OMNH	University of Oklahoma
OSEC	Oklahoma State University
OSUC	Ohio State University Collection
PMNH	Peabody Museum of Natural History, Yale
SDMC	San Diego Natural History Museum
SEMC	University of Kansas Snow Entomological Museum Collection
TAMU	Texas A&M University
UAIC	University of Arizona Insect Collection
UCMC	University of Colorado Museum Collection
UCRC	University of California, Riverside
UMMZ	University of Michigan Museum of Zoology
USNM	National Museum of Natural History, Smithsonian Institution
WB Warner	Bill Warner private collection

All distribution information is based on males (females and immatures cannot be identified to species based on morphology (Hopkins, pers. obs.)). Label data of borrowed specimens as well as the pertinent data of freshly collected specimens was entered in Excel. Only rarely were latitude and longitude provided on specimen data labels, thus each locality without these data was georeferenced using Google Earth. Coordinates were then entered into ArcGIS 10, and distribution maps produced. The maps were used to clean the data by inspecting them for outliers that might indicate potentially problematic georeferences or label data, and such specimens were eliminated if significant doubts about the locality remained. Although there are 48 species of *Arenivaga*, only 27 with more than five distinct locality records were used in order to ameliorate the effects of small sample size on the significance of the results. A bootstrap analysis was done (Peterson and Cohoon, 1999) to determine whether there was an adverse effect on the analyses from small sample sizes of some of the included species.

Environmental Data

The data for some abiotic variables pertinent to this study were accessed through WorldClim's collection of 19 temperature and precipitation variables available from their BioClim website (http://worldclim.org/bioclim) (Hijmans et al., 2005; Busby, 1991). These 19 variables represent measures taken annually and seasonally, as well as the extremes of temperature and precipitation. In addition, the soil data from the Harmonized World Soil Database (HWSD) (FAO et al., 2012) were used. This database, created under the auspices of the Food and Agriculture Organization of the United Nations (FAO) and the International Institute for Applied Systems Analysis (IIASA), combines four world soil databases to create the most complete picture of soil types of the entire planet. A measure of terrain ruggedness was generated by applying a script that quantifies the topographic texture of terrain by combining measures of variability in slope and aspect (Vector Ruggedness Measure or VRM, Hobson, 1972; Sappington et al., 2007). This analysis also used a measure of altitude (digital elevation model or DEM) as well as data on major vegetation types from the Global Land Cover 2000 (GLC2000) database (Latifovic et al, 2003; 2004). See Table 1 for a complete listing of variables. All variables were processed in ArcGIS 10.1 (ESRI Inc., Redlands, CA, USA) at a common scale of 30" (approximately 1km). While this scale could be problematic for fine scale analyses of microhabitat selection, it is the most comprehensive and consistent data available for the range of the entire *Arenivaga* genus.

Modeling procedures

Because there is little knowledge about the distribution of the genus *Arenivaga,* all available presence localities were analyzed for the entire genus using 23 biotic and abiotic variables. From this initial analysis, only those variables were selected which contributed more than 3% to the model because such a cutoff nevertheless accounted for 95.24% of the ecological composition of the niche of the genus. Further analyses examining the niche of each species were based on those selected variables.

The extent of distribution was modeled using the Maxent algorithm (version 3.3.3k, http://www.cs.princeton.edu/~schapire/maxent/; Phillips et al., 2006; Phillips and Dudík, 2008). Maxent uses a maximum entropy probability distribution to contrast occurrence data with environmental data in the background and estimates a probability distribution that has the maximum entropy (i.e., that is most spread out, or uniform) given certain constraints. The constraints are that the expected values of each feature (for example, a variable representing annual precipitation) must equal the empirical average (the average value at known occurrence points; Phillips et al., 2006). Maxent is one of the best algorithms to calculate the suitability of landscape for a taxon when presence/absence data are not available (Elith et al., 2006; Elith and Leathwick, 2009). Models built with presence-only data do not incorporate information on the frequency of occurrence of a species in a region, and therefore cannot accurately predict probability of presence (Guisan and Thuiller, 2005; MacKenzie et al., 2002). However, such models can be used to estimate a relative index of the suitability of landscape for a species (Elith et al., 2006). Here Maxent was used to evaluate the relative contribution of variables rather than make predictions.

Models were fitted in Maxent using functions for random seeds, selection of background, cross-validation and model averaging (Phillips and Dudík, 2008). Although choice of background data can have important effects on predictions (VanDerWal et al., 2009), a random set of data was used as pseudo-absences selected from within a set distance from known *Arenivaga* localities. The distance was calculated as the average nearest neighbor distance between all known localities (see Species occurrence data above). A large number of locations (1000) from a broad range of conditions were used to ensure good representation of all possible environments, which is important when models are based on different conditions (Elith et al., 2010). Models were then generated to estimate errors around fitted functions and evaluate predictive performance on held-out data (Elith et al., 2010) by using ten bootstrapped model runs. In addition, 20% of cells were selected for model testing, while the remaining 80% were used for model training (to formulate the model parameters).

The importance of different variables was evaluated for inclusion in the final models in several ways. Initially, the analysis incorporated all 23 variables but did not include any variables in models that would account for spatial pattern in the distributional data. To develop models based on current conditions, this study used the default settings in Maxent but restricted model building to hinged, threshold, quadratic and categorical features (in machine learning language, features are transformations of variables into functions). This is because hinge features produce model projections similar to those based on generalized linear or additive models (GLMs or GAMs; Elith et al., 2010; Phillips and Dudík, 2008). Product features were not selected because of the complexity in the ecological interpretation of interacting variables, and linear features were not selected because they tend to be redundant with hinge features (Elith et al., 2010). Default regularization parameters were selected for all models because of lack of data on detectability of different species. All continuous variables were examined for correlations by calculating the Pearson pairwise correlation coefficient for every pairwise combination of files using ENM Tools (Warren et al., 2010). However, correlated variables were not excluded because the strength of correlation varied spatially and because analyses have also shown that Maxent is more stable in face of correlated variables than stepwise regression (James et al., 2013). Included predictor variables were assessed using the built-in jackknife tests that, for each variable, quantify its contribution to the model (expressed as percent and based on increase in gain; Phillips et al., 2006) and permutation importance (Phillips and Dudík, 2008).

Models were run excluding variables with less than 3% contribution differences in area under the curve (AUC) were examined for both training and test data. Area under the curve of the receiver operating characteristic (ROC) was used as a threshold-independent measure of model performance (Elith et al., 2006). The AUC characterizes performance of the model at all possible thresholds and is summarized by a number ranging from 0 to 1, where 1 indicates perfect model performance, 0.5 indicates the equivalent of a random (presence and background not different), and less than 0.5 indicates performance worse than random (Phillips et al., 2006).

Cluster and ordination analyses

Nonparametric multidimensional scaling analysis was used to portray in two dimensions the impact of the selected eight variables on individual species' distributions and evaluated the overlap of variable importance between species based on this ordination. The R statistical language version 3.0.2 (R Core Team, 2013) and the R package "ecodist" were used for these analyses (Goslee and Urban, 2007). In addition, based on the relative importance of variables in models, a matrix of similarity between observations was generated and used to ordinate and cluster the observations. A dendrogram of the similarity of variable importances of each species was generated based on a matrix of Mahalanobis distances and the average clustering method. This method uses a linkage function specifying the distance between two clusters and is computed as the average distance between objects from the first cluster and objects from the second cluster. The dendrogram generated was then compared to the phylogeny of the genus to see if any similarity of topology and clade structure were revealed between habitat requirements and evolutionary relationships.

Results

Exploratory Analysis--Which Ecological Variables Contribute to the Ecological Niche of the Genus **Arenivaga?**

The exploratory analysis revealed that eight ecological variables were the only ones that contributed significantly to the niche of the genus *Arenivaga*: isothermality (the measure of the day-to-night temperature difference as compared to the summer-to-winter difference), minimum temperature of the coldest month, mean temperature of the driest quarter, annual precipitation, precipitation of the driest month, precipitation of the wettest quarter, ground cover, and soil (Table 1).

Table 1. Percentage contribution of 23 environmental variables to the ecological niche of the genus *Arenivaga.* The eight variables in green describe 95.24% of the niche and only these variables were used in the remainder of the study.

Variable	% contribution to ecological niche model of the genus
Ground Cover	3.61
Soil	9.47
Altitude	0.28
Vector Ruggedness Measure	0.32
Annual Mean Temperature	0.00
Mean Diurnal Range	0.16
Isothermality	3.81
Temperature Seasonality	0.00

Maximum Temperature of the Warmest Month	0.04
Minimum Temperature of the Coldest Month	11.72
Temperature Annual Range	0.20
Mean Temperature of the Wettest Quarter	0.07
Mean Temperature of the Driest Quarter	18.84
Mean Temperature of the Warmest Quarter	0.00
Mean Temperature of the Coldest Quarter	0.04
Annual Precipitation	22.86
Precipitation of the Wettest Month	1.36
Precipitation of the Driest Month	12.05
Precipitation Seasonality	0.57
Precipitation of the Wettest Quarter	12.88
Precipitation of the Driest Quarter	1.51
Precipitation of the Warmest Quarter	0.09
Precipitation of the Coldest Quarter	0.12

Selective Analysis--The Relative Contribution of Eight Ecological Variables to the Niches of the Genus* Arenivaga *and 27 of its Species

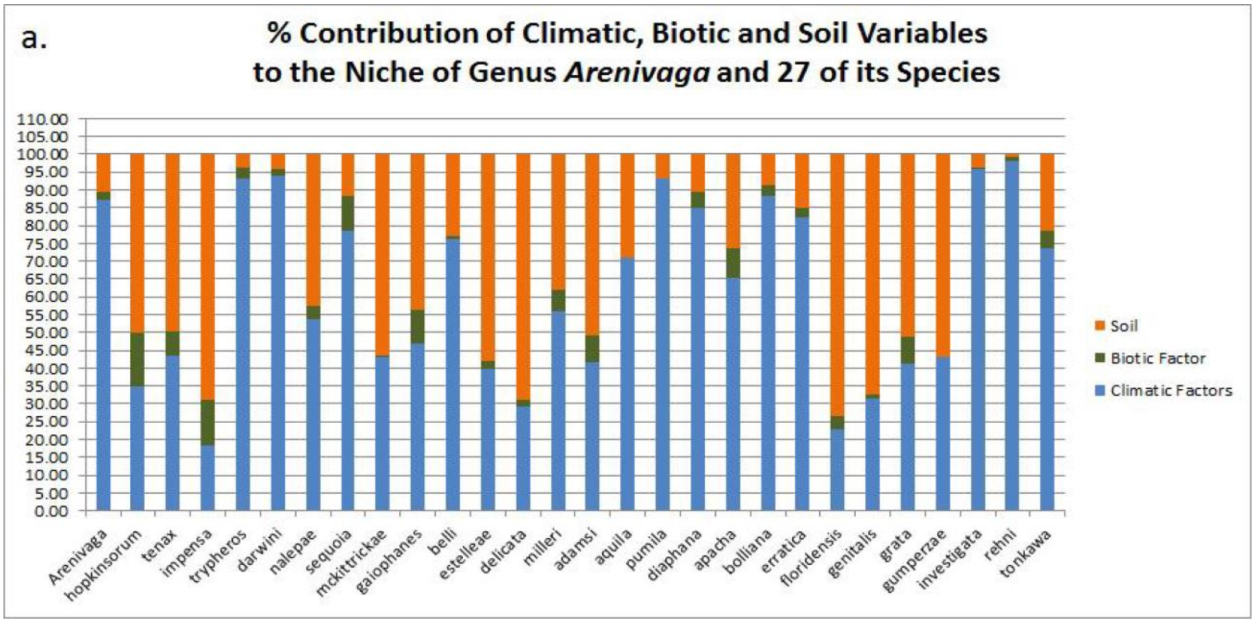
The exploratory analysis showed eight ecological variables contribute 95.24% to the description of the ecological niche of *Arenivaga*. Because these eight variables explained such a high percentage of the total *Arenivaga* niche, they were treated as equally sufficient as all 23 variables for developing ecological niche modeling of *Arenivaga* and the species included in this study. These variables were soil, ground cover, isothermality, minimum temperature of the coldest month, mean temperature of the driest quarter, annual precipitation, precipitation of the driest month, and precipitation of the wettest quarter. We analyzed the impact of each of these eight variables on the ecological niche of both the genus and the 27 species included in this study. These results are summarized in Figure 3. The importance of each variable in the selective analysis and discernible patterns within the genus are examined more closely in the Discussion.

A bootstrap analysis was performed on the presence data to determine the possible impact of small sample size in a minority of included species. The coefficients of variation of the percent importance of variables (either as contribution or permutation) for ten bootstrap replicates were low (CV values for all 27 species mean=0.72 SD=0.28) and thus did not suggest an adverse impact of small sample size.

The distributions of the AUCs for training and test data which were used as a measure of model performance (Elith et al., 2006) are shown in Figure 4. The AUCs for training data from 27 species are 0.88 and above, with a median of 0.98. The AUCs for test data are 0.77 and above, with a median of 0.97. While these two groups of data are significantly different ($p<0.01$), the scores are all well above 0.5, indicating the models performed better with the analyzed data than they would with random data.

Cluster and Ordination Analyses

The result of the NMDS analysis is shown in Figure 5. This figure depicts in two dimensions the relative importance of the eight variables in the selective study. The length and direction of the eight blue arrows indicate the relative strength of each variable overall, and each species name within the matrix is placed proportionately to



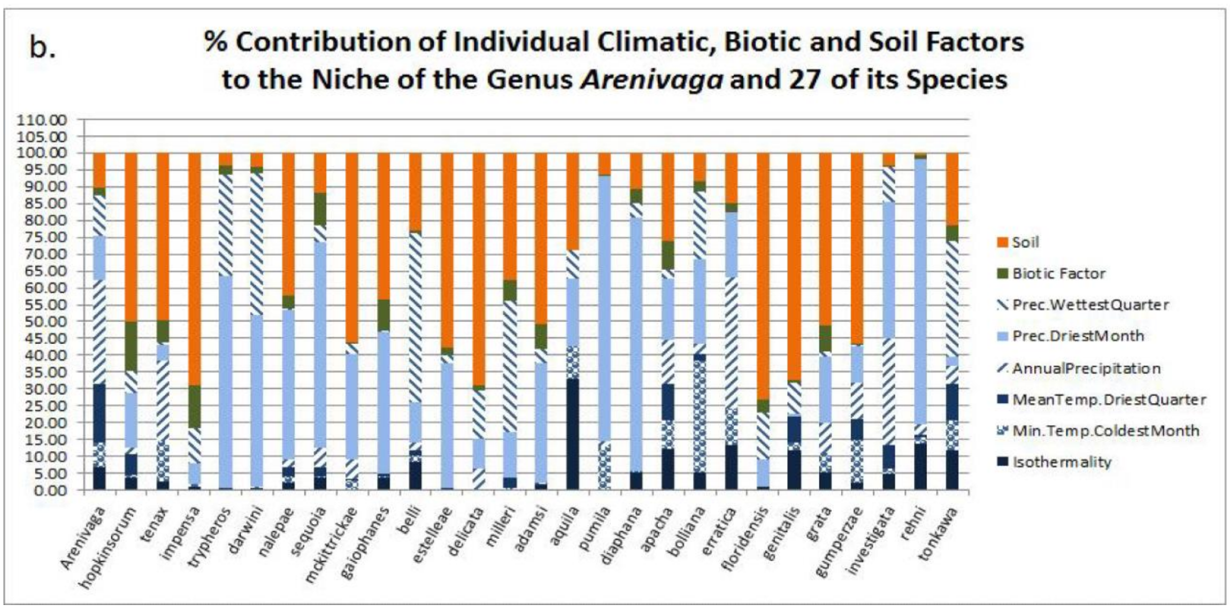


Figure 3. a. The relative contributions of biotic and abiotic variables to the niches of 27 species of *Arenivaga*. b. Details of the individual contributions of the six climatic abiotic variables.

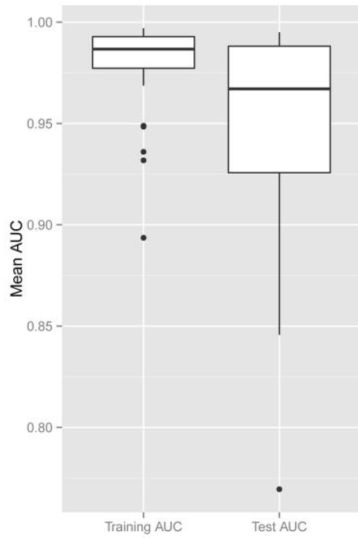


Figure 4. Distributions of AUCs of both training and test data used to analyze 27 species of *Arenivaga*. Although the difference between AUCs between training and test data was significant, both results in all species score well above 0.5, an indication that the model performs better with the analyzed data than it would with random data.

how each ecological variable impacts its niche. This reveals how alike or unalike *Arenivaga* species are in their preferred niches overall, those species that are outliers, and which variable(s) cause them to be so. This analysis clearly demonstrates the similarity of the ecological niches of individual species of *Arenivaga.* It is also evident that *A. bolliana, A. aquila, A. apacha* and *A. estelleae* are the most extreme outliers of the 27 species analyzed. *Arenivaga investigata, A. erratica, A. gumperzae* and *A. tonkawa* are somewhat less so. The other 19 species share a more similar ecological niche.

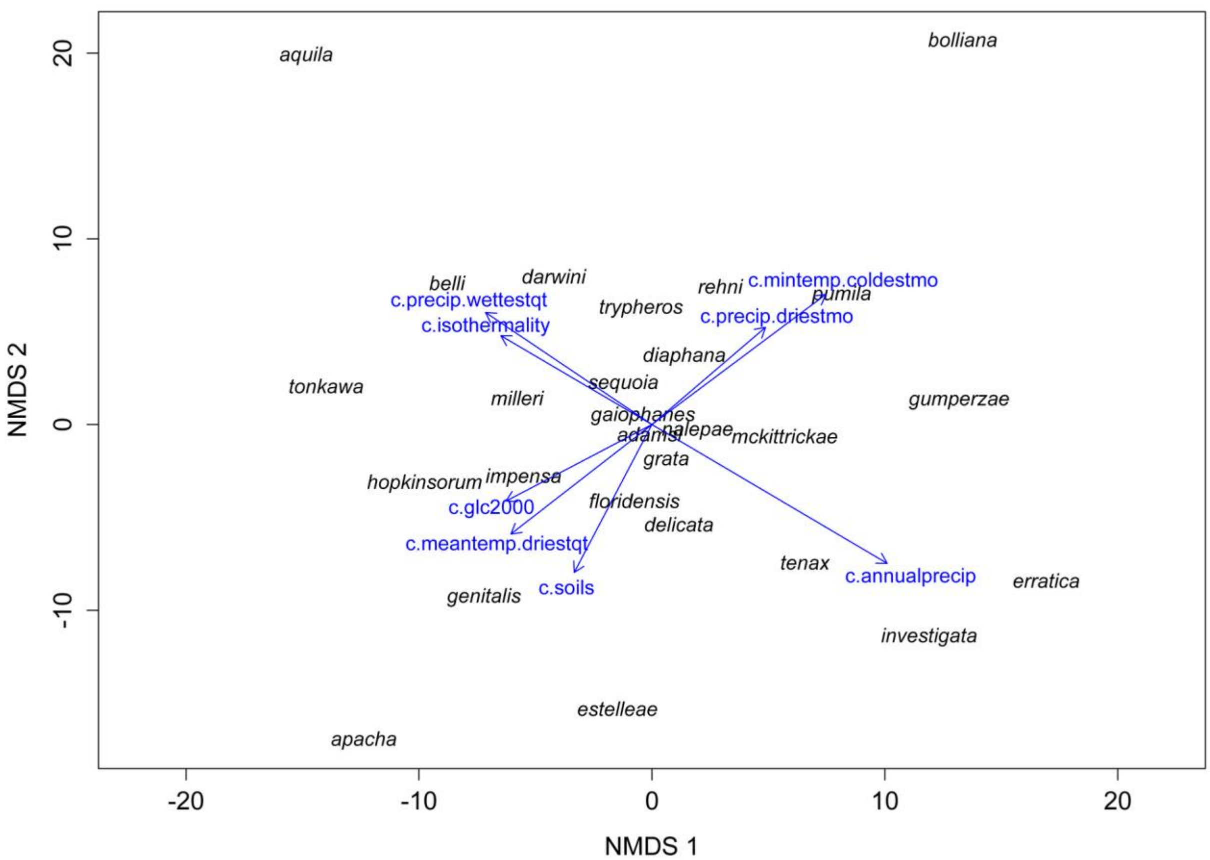


Figure 5. A scatter diagram showing the relative importance of the eight biotic and abiotic variables to the ecological niches of 27 *Arenivaga* species.

The results in Figure 5 were transformed into a dendrogram showing relatedness of species according to similarity of niche composition (Figure 6a). This dendrogram was compared to the partial phylogeny of the genus shown in Figure 6b (Hopkins and Miller, in prep.). This comparison revealed that only the sister species *A. trypheros* and *A. darwini* show a parallel between evolutionary relationship and ecological niche. This result, showing that closely related species occupy terrain that is not alike in

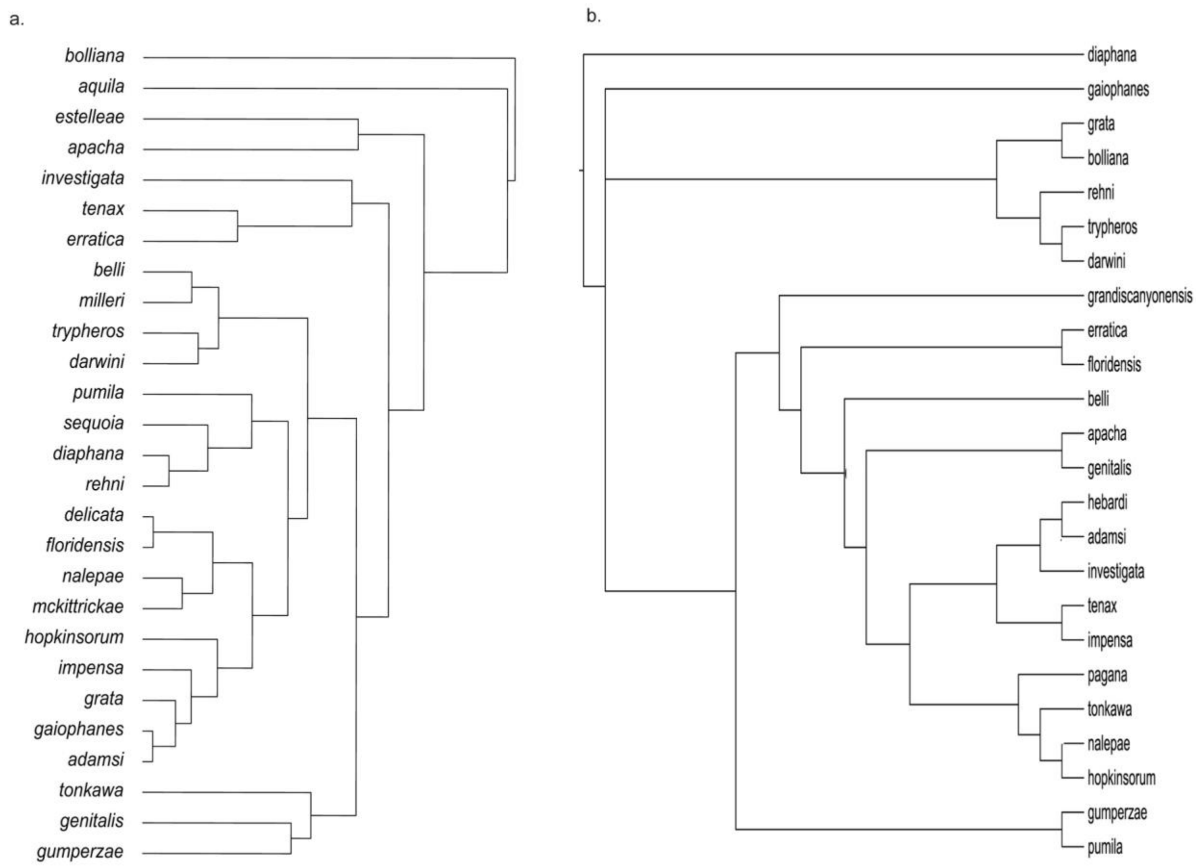


Figure 6. (a) A dendrogram of the relative contributions of eight biotic and abiotic ecological variables to the niches of species of *Arenivaga* as compared to (b) the Bayesian phylogeny of the genus. Phylogeny from Hopkins and Miller, in prep.

composition, would tend to support the proposition that *Arenivaga* is a highly adaptive group of insects, able to migrate into neighboring habitat that is not identical to the terrain from which they originated. They are adept at niche evolution.

Discussion

Ecological niche models have been criticized for relying solely on abiotic variables, thereby missing such elements of the realized niche as competition, facilitation or accommodation, and biotic variables such as ground cover or predation (Pearson and Dawson, 2002, and citations therein). Ecological niche models are also unable to account for the roles played by speciation, extinction, dispersal ability, and barriers to dispersal (Pearson and Dawson, 2002; Peterson, 2003; Guisan and Thuiller, 2005; Araujo and Guisan, 2006; Wiens and Donoghue). Despite these limitations, methodology of ENMs is improving (Elith et al., 2006) and such models may be successfully used to discover and quantify parameters that define the habitat of organisms of interest. This information is useful for development of conservation efforts, prediction of a species' possible response to climate change, or delimiting unsurveyed territory in which that species may be found (Gibbons et al., 2011). Here patterns revealed by each of the eight ecological variables that account for more than 95% of the niche of the genus *Arenivaga* and 27 of its species are examined, as well as the similarity of niche (niche conservation) between species (Fig. 3). From this analysis it can be concluded that while the proportion of influence exerted by each variable changes, sometimes considerably, between species of *Arenivaga*, there is nevertheless discernible consistency between many species.

Soil

A subterranean taxon such as *Arenivaga* is expected to show considerable preference for certain soil types, and soil does contribute 10% to the ecological niche of the genus. Figure 3 demonstrates that soil is not just an important abiotic variable in determining species boundaries in this genus, in 11 of the 27 species examined it contributes 50% or more to the niche. The species *Arenivaga rehni, A. investigata, A. trypheros,* and *A. darwini* appear to have little sensitivity to the soil in their habitats. A closer look at the ranges of *A. trypheros* and *A. darwini* reveals a topography of sand, rocky buttes, and very sparse flora. *Arenivaga investigata* occurs over a much larger adjacent acreage, but still one of the driest in the genus and one comprised principally of sand and rock. Perhaps these species must accept any soil type they find in order to find adequate nutrients and/or mates in their harsh habitats. *Arenivaga rehni* occupies the entirety of the Baja peninsula which is comprised of many soil types. This species may also be a generalist able adapt to any soil it finds in Baja, the result of which is an inability of this model to discern soil as a major player in the niches of these taxa.

Ground Cover

It is apparent that ground cover, the sole biotic variable in the analysis, plays only a small role in determining the species boundaries of *Arenivaga*, and contributes less than 5% to the analyzed niche of the genus as a whole. A pair of species in southern and western Arizona, (*A. impensa* and *A. hopkinsorum*), show a niche reliance of a little more than 10% on ground cover. All other species analyzed register a dependence upon ground cover of less than 10%. Such results indicate that for the most part this detritivorous taxon is a generalist in its feeding habits and has no habitat restrictions due to type of plant growth. These animals are known to be fungivores, in addition to which pollen has been found in the gut of certain species (Hawke and Farley, 1973; H. Hopkins, pers. obs.) indicating that like most cockroaches, *Arenivaga* are omnivorous and opportunistic feeders. This is an important discovery in understanding the ecological niche of any taxon since it has been clear to biologists for some time that a taxon's pursuit of nutrients and its position in the food chain are central to its evolutionary ecology (Hutchinson, 1959).

Isothermality

Isothermality contributes less than 10% to the niche of the genus but is important to the niche of *A. aquila* (32%) and also to *A. apacha, A. rehni, A. erratica, A. genitalis,* and *A. tonkawa*. *Arenivaga aquila* is the species with the smallest sample size in this study, and *A. rehni, A. erratica*, and *A. tonkawa* have large and heterogeneous ranges. Isothermality seems to have an increased impact on a species' niche when studied terrains are either very small (which could be the case with *A. aquila*) or when studied terrains are very large and varied. *Arenivaga apacha*, which also shows some sensitivity to this variable, is known to cohabit with *Neotoma* (Cohen and Cohen, 1976); so the 12% contribution of isothermality to the niche of this species may actually reflect the niche requirements of the facilitating species to which the cockroach has adapted.

Minimum Temperature of the Coldest Month

Arenivaga, as either oothecae or immatures, must overwinter. Many live in places with low winter temperatures. Minimum temperature of the coldest month factors less than 10% to the genus, but registers 10% or more in the species *A. tenax, A. pumila, A. bolliana*, *A. erratica,* and *A. gumperzae* indicating their increased sensitivity to cold. *Arenivaga pumila* is the smallest of all *Arenivaga* species and occurs in a restricted range on the Baja peninsula. Their sensitivity to cold may be a function of their small size. *Arenivaga bolliana* is the largest of all *Arenivaga* species and is found in the wettest parts of the genus' range in Texas and Florida. *A. bolliana*'s restriction to habitats with higher precipitation levels may indicate that this species is not entirely desert-adapted, and retains the sensitivity to cold of most cockroach species. The possible reasons for cold sensitivity in the other three species is less readily apparent; *A. erratica* is a wide-ranging species across three states and Mexico, *A. tenax* occurs primarily in New Mexico and far northwestern Texas bordering New Mexico, and *A. gumperzae* is found in Texas and Mexico.

Mean Temperature of the Driest Quarter

This variable impacts the niche of the genus more than 15%, yet contributes only 10% to the niches of only two studied species, *A. apacha* and *A. tonkawa*. Therefore, the significance of this variable to the genus must be found in the 21 species of *Arenivaga* not included in this study due to inadequate sampling. Previous studies show that *A. apacha* is not well adapted to high temperatures (Cohen and Cohen, 1981); therefore they may be particularly sensitive to multiple simultaneous physiological stressors such as heat (or cold) and lack of moisture. Such studies have not been conducted upon *A. tonkawa* but its similarity to *A. apacha* in the niche contribution of this variable may indicate a similar sensitivity.

Annual Precipitation

Annual precipitation contributes the most of all eight variables to the ecological niche of *Arenivaga* as a genus at just over 30%. There are species whose ranges are restricted to some of the driest habitat of the genus to which this is also a significant factor (*A. tenax, A. erratica, A. investigata,* and *A. grata*), which is not surprising for a desert species. What is more surprising is how few species report this variable as a major contributor to their niche. Rather precipitation of the driest month and precipitation of the wettest quarter are much more impactful (discussed below).

Precipitation of the Driest Month

To *Arenivaga* as a genus, and to 23 of the 27 species analyzed, precipitation of the driest month is a contributing factor of 10% or more to their ecological niche, contributing as much as 75% in some instances. Along with soil this is the most widely and strongly contributing variable to the habitats of these species. Since *Arenivaga* live in some of the driest places on earth, (Death Valley, the Mojave Desert, parts of the Baja peninsula), it is expected that their survival would depend on their ability to get through the driest part of the year. An interesting pattern is revealed in this variable in that all the species niches to which it contributes most significantly are found on Baja (*A. rehni, A. diaphana, A. pumila*), or in far northern Baja and into southeast California (*A. darwini, A. trypheros*). The group impacted just slightly less than these occur just north of the first group, in the central California valley and Mojave desert (*A. investigata, A. nalepae, A. sequoia, A. gaiophanes, A. estelleae, A. mckittrickae*) and in Mexico along the eastern side of the Gulf of California (*A. adamsi*). This very likely reflects the amount of precipitation in the driest month in those two geographic areas, and the speciation that has taken place in *Arenivaga* may also reflect the adaptive ability to this ecological variable. It is worth noting those species that show little to no dependence on this variable, (*A. tonkawa, A. genitalis, A. impensa,* and *A. tenax*) because one or more of these has shown a similar lack of dependence on others of the eight variables (soil, annual precipitation, mean temperature of the driest quarter, ground cover and isothermality).

Precipitation of the Wettest Quarter

It is believed that the peak of *Arenivaga* breeding season is during the warmest quarter of the year, and that successful reproductive efforts require adequate precipitation to prevent dessication of oothecae and dehydration of fragile first instars. Over much of the habitat of *Arenivaga* the warmest quarter is also the wettest quarter. This translates into abundant nutrients for the rapid growth of immatures and fat storage for overwintering. This ecological variable is the third most important overall, and contributes 10% or more to the niches of the genus and to ten of the included species. There is some geographic cohesion among these species: several for which this variable is important occur in southern and central California (*A. trypheros, A. darwini, A. belli, A. delicata, A. milleri*) and another pair occur in Texas (*A. tonkawa, A. bolliana*). These two groups occur in quite diverse habitats; therefore, these results may indicate that the wettest quarter of the year occurs at different times of year and has a different set of impacts between the two groups.

Niche Overlap Within 27 Species of Arenivaga

This examination of the distribution of species across the landscape according to the relative contributions of niche variables (Figure 5) revealed that most *Arenivaga* species have niches that are overlapping in their makeup. This is demonstrated by the concentration of species names around the center point of Figure 5. The lack of congruence between a dendrogram of species niche composition and the phylogeny of the genus (Figure 6) confirms that sister species do not share identical niches but rather occupy a neighboring terrain that has some measurable difference in one or more ecological factors (Hoffman and Blows, 1994; Zink, 2013). The role of ecology in speciation is well documented (Hoffman and Blows, 1994; Schluter, 2000; Wiens and Graham, 2005; Butlin et al., 2012). *Arenivaga* species are impacted by a limited set of ecological variables (Table 1) but the relative contributions of those variables to the niche of each species is distinctly, if often narrowly, different (Figure 3). This taxon appears to be almost universally adapted to life in the desert, but each species has carved out its own space. Sometimes those niches are remarkably similar in their composition *(A. floridensis* and *A. delicata, A. hopkinsorum* and *A. grata, A. nalepae* and *A. gaiophanes, A. mckittickae* and *A. estelleae, A. rehni* and *A. pumila*) but the species with such similar niches are neither closely related nor adjacent geographically. An exception to this pattern is *A. trypheros* and *A. darwini* which have parapatric distibutions with a considerable area of overlap, very similar niche composition, and are sister species. There are only fine distinctions between their habitats though this may be enough to create reproductive isolation between the two species (Zink, 2013). This curious pair of species continues to generate questions (Hopkins, 2014; Hopkins and Miller, in prep.)

In contrast to the above are those species of *Arenivaga* that have unique ecological niches. These are indicated in Figure 5 by their position far from the center point, and in most instances equally far from any other species: *A. bolliana, A. apacha, A. aquila,* and *A. estelleae*. *Arenivaga* bolliana occurs in habitat with high precipitation relative to all other species except A. floridensis. It also lacks the unusual wing brace character that is thought to be required for successful subterranean movement by adult males (Hopkins, 2014). This species may be one of the least desert-adapted of the *Arenivaga,* and this fact may be demonstrated by their very divergent and unique ecological niche. *Arenivaga apacha* is the only species of *Arenivaga* known to cohabit with another desert species, and this has been shown to greatly ameliorate their niche (Cohen and Cohen, 1981). Their niche composition reflects this facilitated relationship. *Arenivaga aquila* and *A. estelleae* are new species recently described (Hopkins, 2014). Their unusual niche composition when compared to the rest of the genus makes them interesting subjects for future study. It is not known whether one or both of these species also cohabits with a desert mammal.

Conclusion

These analyses reveal that only eight ecological variables contribute more than 95% to the niche of *Arenivaga.* When these eight variables were used to examine the niches of individual species in the genus, three variables stood out as dominant in the niches of many species: soil, precipitation of the driest month, and precipitation of the wettest quarter. The organisms studied here are fossorial, mostly desert-dwelling, detritivorous, extremophiles and it was anticipated that soil, precipitation, and ground cover (as a proxy for food) would be important to their environment. Soil is the most significant, and the most universally important ecological factor to *Arenivaga* niches. Precipitation of the driest month is also highly significant and nearly universal in its importance. Precipitation of the wettest quarter is of slightly less significance and not as widely important. Ground cover did not prove to be an important contributor to the niches of the 27 species studied.

The adaptive abilities of *Arenivaga* in a heating, drying planet are manifest by the radiation of the genus across Mexico, Baja and the American southwest. The geologic history of the land encompassed by *Arenivaga*'s distribution is complex. Much of the

American southwest and portions of northern Mexico have been subject to regional uplift and orogenesis, extensive volcanism, and erosion over the past 45 million years that have resulted in the complex basin and range, plateau and trough, mountain and canyon topography that we see today (http://semken.asu.edu/teaching/GeolHistSw.pdf, and citations therein). The San Andreas fault which opened up the proto Bay of California and originated the Baja peninsula began its work only 15 million years ago (Kumar, 2013). Both the Baja Peninsula and the American southwest are heterogeneous in their topography, flora, and weather regimes which have led to high levels of endemism and diversity (Hopkins, 2014; Kumar, 2013; McLaughlin, 1986; 1989; Calsbeek et al., 2003). In addition to the geologic forces upon the landscape, alternating wet and dry periods, and more recently cold and hot oscillations, have resulted in present day deserts interspersed with mountains, canyons, relic water sheds, playas, alluvial fans, eolian dune fields, as well as plant-stabilized dunes, (http://pubs.usgs.gov/of/2004/1007/geologic.html, and citations therein) all of which are inhabited by *Arenivaga.*

Given the geologic history of the land they inhabit, it is not surprising that soil, precipitation of the driest month, and precipitation of the wettest quarter are the three most influential ecological factors in the niches of many species in this group today. These are the elements with which the niche of *Arenivaga* may be described as conserved. It is also not surprising that they have spread to occupy such a large expanse. They currently inhabit a world that is hot and dry, and have sought refuge from the elements in the soil. But in their evolutionary history they have also lived in a world of lush abundance. In this respect, the niches of *Arenivaga* species may be described as evolving. *Arenivaga*, a highly successful desert-dweller, appears to be something of a chameleon or chimera in its true nature, reflecting its fluctuating climatic past. It would be easy to label this a genus of extremophiles with known physiological adaptations for life in the harshest deserts, and there are species for which this description would be accurate. But it is also true that *Arenivaga* has exploited the varied climate regimes and other vicariant events over its evolutionary history in an extraordinarily successful manner, as indicated by its wide-ranging distribution, and the surprising variety of species' ecological niches as revealed in this analysis. A recent survey of *A. floridensis* reveals that this species has expanded into the broadest habitat of any Florida sand ridge endemic (Lamb et al., 2006).*Arenivaga* do not only occur in deserts, they aren't only found in sand dunes, they show almost no dependence on ground cover, and while not cohabiting with humans, they apparently are not bothered by anthropogenic constructs (H.Hopkins, R.Rice, K.Wright, R.Thornhill, per. obs.).

Wiens and Donoghue (2004) observe that it is the interplay between niche conservatism and niche evolution that is a major theme in the exploration of the biogeography of a clade(s). They point out that ENMs may answer the 'how many' question of species occurrence in present-day conditions. But combining what we learn from ENMs with historical geology and vicariant biogeography can answer additional "who did what, where, when and why", thereby incorporating the forces of speciation, dispersal and extinction into biogeographic analyses (e.g. Smith et al., 2005). *Arenivaga* would be a fruitful subject of such research and this paper takes a first step. While *Arenivaga* appears to readily adapt to the vagaries of most of the abiotic conditions tested, it is at the same time considerably sensitive to soil composition and precipitation in the driest month, and relatively impervious to ground cover. There are species of *Arenivaga* whose niche composition is strikingly divergent from the majority of species. Are these species basal or recently derived within the genus? Do any of them cohabit with members of another phylum? Are their lives less subterranean than other species? How desert-adapted are they? How stenotopic are they? These small animals may have much to teach us about how to survive and thrive through global climate change since it is evident they have done so many times.

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Summary

The research in this dissertation provides a comprehensive revision of the genus *Arenivaga* (Blattodea, Corydiidae). In it are described 39 new species, as well as redescriptions of the original nine species. A distribution map for the genus as well as for each of 48 species was created, in addition to a database of over 5200 specimens. An illustrated key to the males of the genus was written. The first total evidence phylogeny was produced for 24 species in the genus. Several clades as well as a species basal to the genus were revealed. Monophyly was tentatively established as well as the outgroup position of the closely related genus *Eremoblatta*. An ecological niche assessment was made using the presence data of 27 species of *Arenivaga* and data for 23 biotic and abiotic variables. This revealed that only eight ecological variables contribute to more than 95% of the niche of *Arenivaga* species. The most important contributing variables to the niche of *Arenivaga* are discussed, as well as how the analysis reveals that *Arenivaga* species do not conserve their habitat as the radiate across the landscape, but rather are highly adaptable organisms that can tolerate considerable differences in these eight variables.

It is a wonder to discover the most species rich genus of cockroaches in the US at this late date of 2014. This research reveals that there are many groups of organisms in desperate need of study, and much life still to be discovered on this planet. The Corydiid family of cockroaches are unusual extremophiles and have much to teach us about how to survive on a changing planet. Indeed, cockroaches are ancient animals that have occupied this planet for more than 400 million years. Their adaptive abilities are extraordinary and deserving of far greater attention from science.

Supplementary Materials

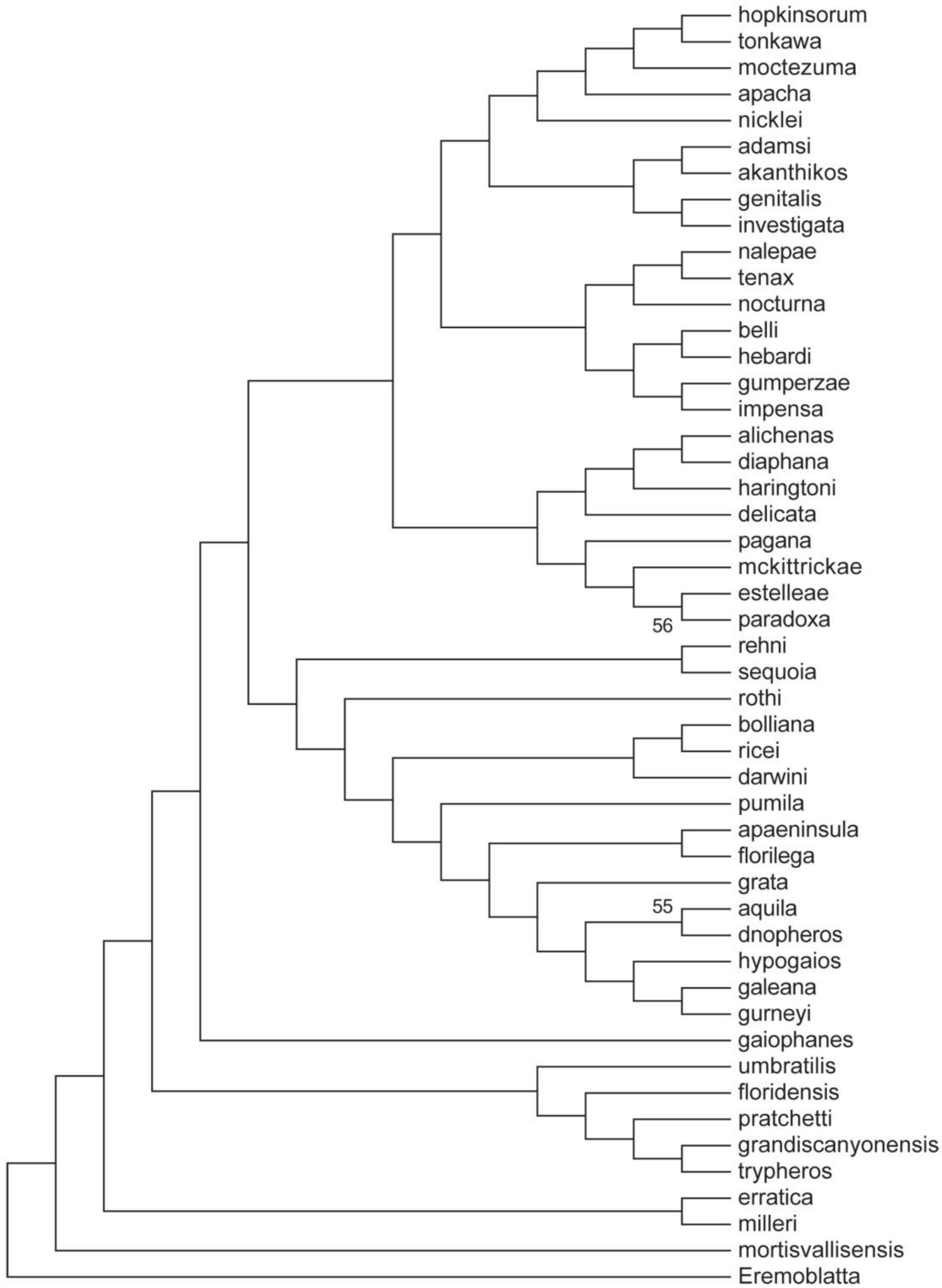

Figure S1. Morphology Parsimony Tree of the genus *Arenivaga*. Bootstrap values above 50 are shown.

H3 Parsimony Tree

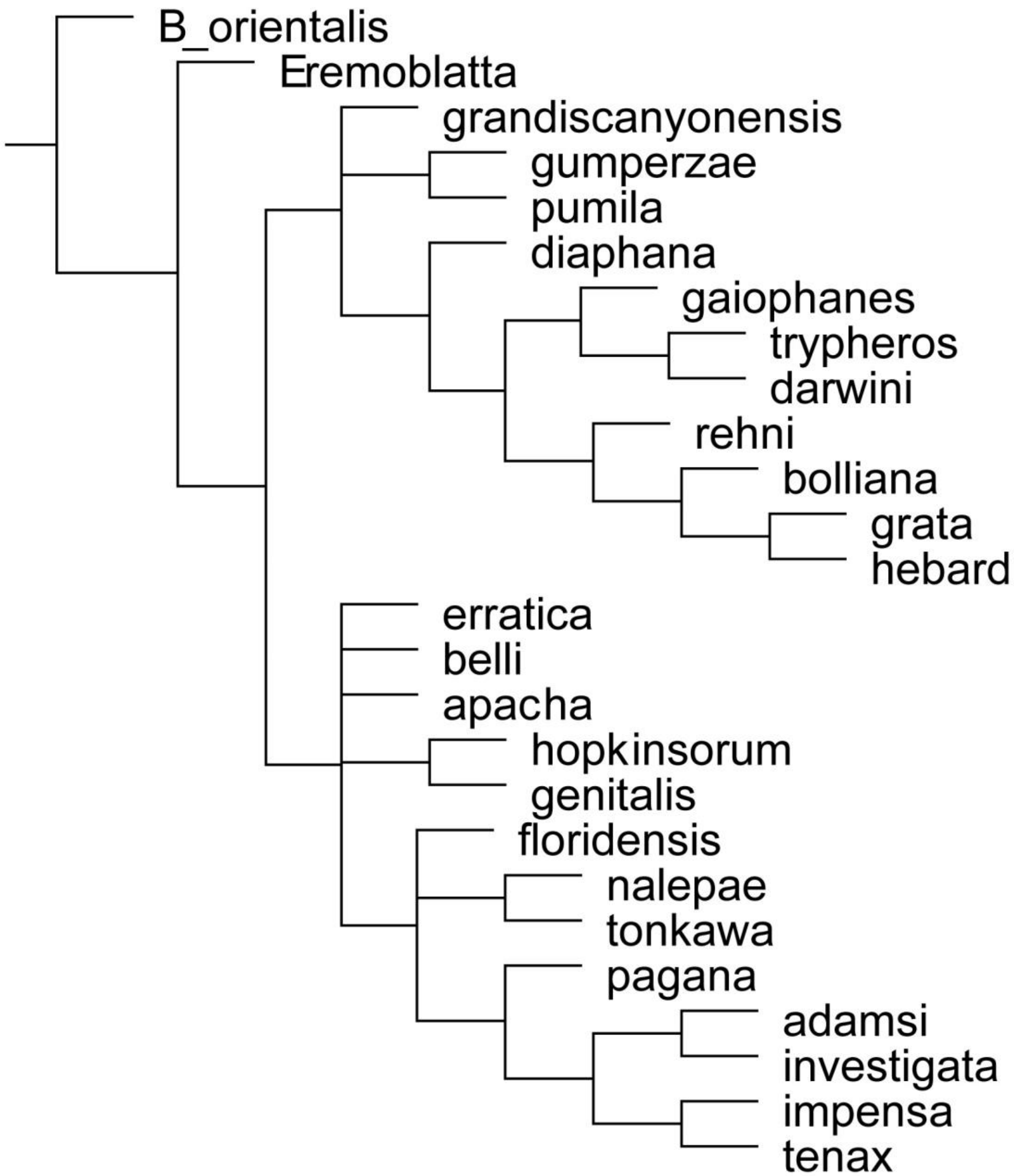

Figure S2. H3 Parsimony Tree.

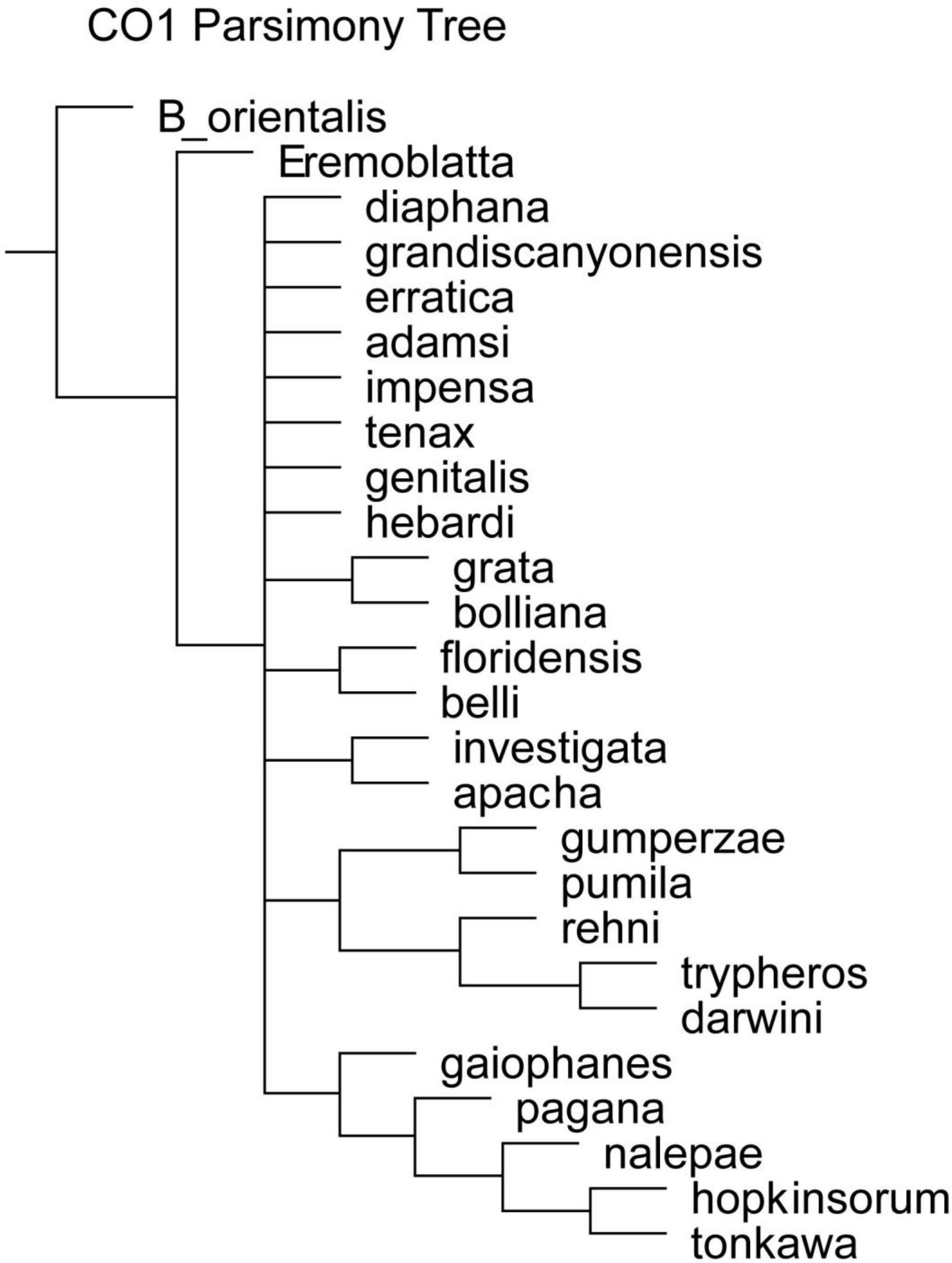

Figure S3. CO1 Parsimony Tree.

12S Parsimony Tree

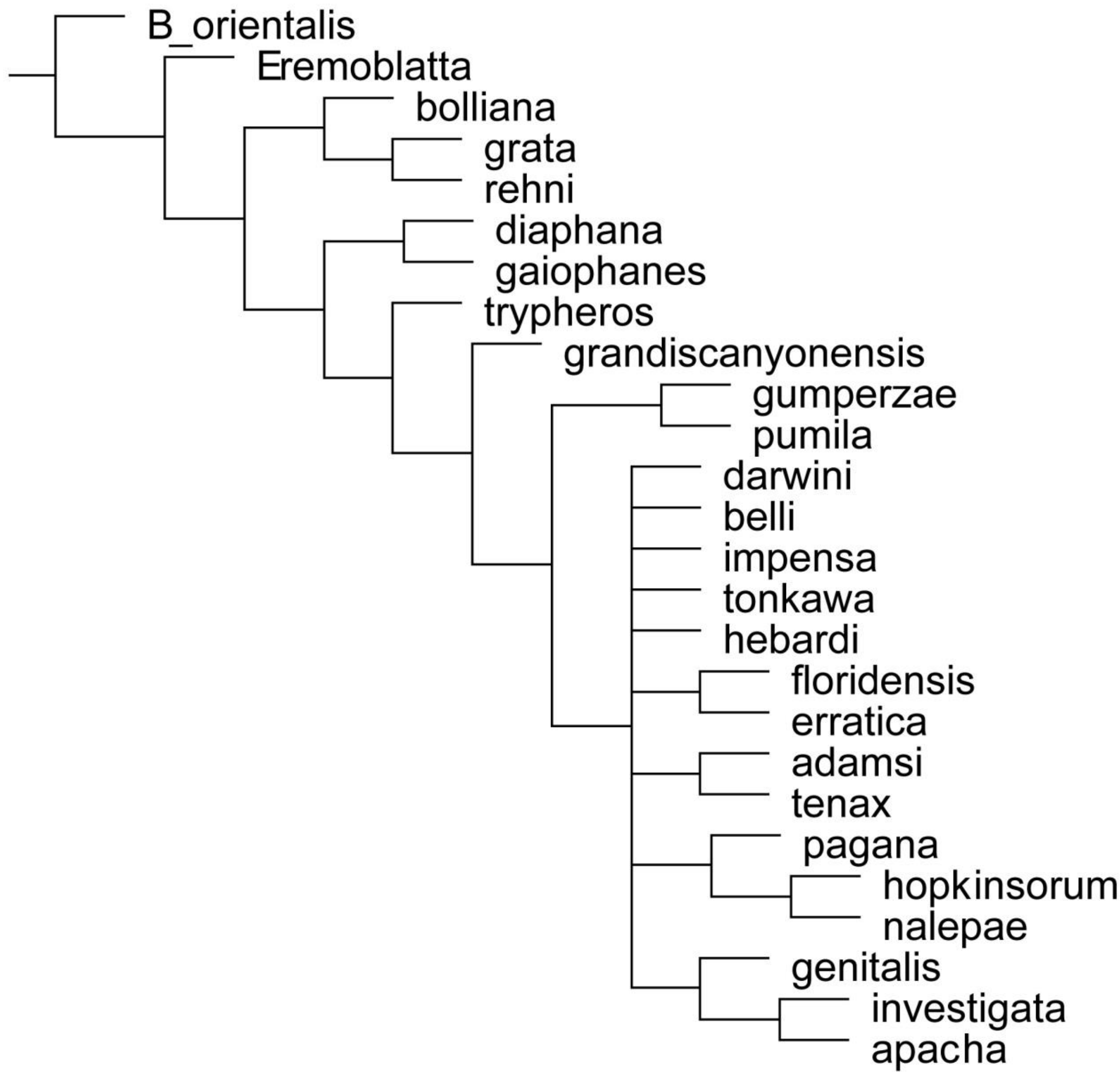

Figure S4. 12S Parsimony Tree.

Table S1. Morphological character coding for 48 species of *Arenivaga* and outgroups *Eremoblatta* and *Blatta orientalis*. Characters which are not present for that species are coded "-".

Taxon	**Characters**
	000000000111111111122
	123456789012345678901
Blatta orientalis	- -
Eremoblatta	23201101 - -10000001001
A. adamsi	111001211011101201100
A. akanthikos	211001211011301101100
A. alichenas	110111111010000100000
A. apacha	121111211011201001000
A. aepeninsula	121000200000010110001
A. aquila	212110100010000000010
A. belli	112011211111100001000
A. bolliana	002100210010000010000
A. darwini	000001010000000200000
A. delicata	110011211010000001000
A. diaphana	221111111010000101000
A. dnopheros	212110200010010010010
A. erratica	221001211010000001000
A. estelleae	011001211010000201010
A. floridensis	021101201110011201000
A. florilega	122010200010010000001
A. gaiophanes	122001211010000211000
A. galeana	202110200010010110001
A. genitalis	211001211011101001000
A. grandiscanyonensis	131001110100000101000
A. grata	222100200000010011000
A. gumperzae	110001211011100001000
A. gurneyi	002110200010010200001
A. haringtoni	110101211110000001000
A. hebardi	112001211111100001000
A. hopkinsorum	112101111111201001100
A. hypogaios	212010210010010100000
A. impensa	112001211011100001000
A. investigata	111001211011101001000
A. mckittrickae	212001211010000201011
A. milleri	001001211010000001000
A. moctezuma	121101211011201101100
A. mortisvallisensis	220011210010000001000
A. nalepae	201011210111100001000
A. nicklei	122001211011201001010
A. nocturna	212001211011100101000
A. pagana	012011211110000001000
A. paradoxa	011001211010000101010
A. pratchetti	121001011110000001000
A. pumila	122000110010010100000
A. rehni	222100210010000200000

Table S2. Primers used for amplification and sequencing.

Gene	Primer	Direction	Sequence (5'-3')
12S	12Sai[1]	For	AAA CTA CGA TTA GAT ACC CTA TTA T
	12Sbi[1]	Rev	AAG AGC GAC GGG CGA TGT GT
COI	C1-J-1718 ("Mtd6")[2]	For	GGA GGA TTT GGA AAT TGA TTA GTT CC
	C1-N-2191("Nancy")[2]	Rev	CCC GGT AAA ATT AAA ATA TAA ACT TC
	C1-J-2195[2]	For	TTG ATT TTT TGG TCA TCC AGA AGT
	TL2-N-3014 ("Pat")[2]	Rev	TCC AAT GCA CTA ATC TGC CAT ATT A
H3	Haf[3]	For	ATG GCT CGT ACC AAG CAG ACG GC
	Har[3]	Rev	ATA TCC TTG GGC ATG ATG GTG AC

[1]Svenson and Whiting (2004)
[2]Simon *et al.* (1994)
[3]Colgan *et al.* (1998)

Table S3: Species and GenBank accession numbers of the taxa included in this molecular phylogeny.

Species Name	MSB Voucher #	H3	12S	CO1
Blatta orientalis	---			
Eremoblatta sp.	---			
A.adamsi	32850			
A.apacha	30796			
A.belli	30617			
A.bolliana	30797			
A.darwini	32851			
A.diaphana	32852			
A.erratica	30798			
A.floridensis	30799			
A.gaiophanes	32853			
A.genitalis	30800			
A.grandiscanyonensis	32854			
A.grata	30801			
A.gumperzae	32855			
A.hebardi	30618			
A.hopkinsorum	32856			
A.impensa	32857			
A.investigata	30802			
A.nalepae	32858			
A.pagana	30805			
A.pumila	32859			
A.rehni	30803			
A.tenax	32860			
A.tonkawa	30804			
A.trypheros	32861			

Table S4. Partitioned Bremer Results. Complete bootstrap support values and posterior probablilites are also given for the maximum likelihood and Bayesian inference trees.

ML	*Bayes*	Clade #	12S	H3	CO1	Morphology	Total
	100	1	6	3	28	2	39
84	*98*	2	3.3	-2.3	3.8	0.3	5.1
100	*100*	3	-0.3	2.2	11.2	1	14.1
99	*100*	4	-6.8	-7.5	25.5	-2.2	9
99	*100*	5	4.9	-0.1	21.6	1.6	28
		6	1.9	-5.4	7.1	-0.6	3
		7	1.7	-4.5	5.5	-0.7	2
44	*74*	8	1.9	-5.4	7.1	-0.6	3
85	*99*	9	-1.4	-3.1	6.9	-0.4	2
100	*100*	10	14.4	-8.7	44.9	0.4	51
92	*100*	11	1.9	-5.4	7.1	-0.6	3
65	*75*	12	0.3	-2.0	1.8	1	1.1
89	*99*	13	-0.5	-1.0	-0.5	3	1
		14	1.7	0.7	3	-1.3	4.1
	53	15	2	-5.5	2.5	2	1
75	*99*	16	2	-5.5	2.5	2	1
		17	6	-21.5	17.3	2.2	4
		18	1	5.3	-2.2	-1.1	3
92	*100*	19	-1.0	0.5	5.5	0	5
93	*99*	20	-3.0	0.5	7.5	0	5
62	*99*	21	4.5	1	-1.5	-2.0	2
Total Support			40.5	-64.7	204.6	6	186.4
% Support			21.7	0	75.1	3.2	100.0
# Informative			95	74	220	21	410
% Informative			23.2	18.0	53.7	5.1	100.0
Support/Informative			0.43	0	0.93	0.29	1.65
Normalized % Support			26	0	56.4	17.6	100.0