REVISIONARY STUDIES IN THE GENUS ARENIVAGA

(ORTHOPTERA, BLATTIDAE, POLYPHAGINAE)

BY MORGAN HEBARD

Since our treatment of this genus in "The Blattidae of North America, North of the Mexican Boundary",[1] material of a new Floridian species received by Mr. A. N. Caudell for the National Museum caused him to examine the material of the genus belonging to that institution, which had been studied and reported on by us. That author, recognizing constant male genitalic features of difference in the material we had identified as *apacha*, separated his series of the undescribed type, and described the two new species, which he therefore had before him, as *floridensis* and *genitalis*.[2]

In order to separate our series of the superficially similar species, *genitalis* and *apacha*, we have re-examined closely the material in the Philadelphia Collections and, carrying this analytical examination further than was done in the preparation of our monograph, we find that superficially similar, though distinct, species were also included by us both under *erratica* and under *rehni*.

Such radical changes as the above, from assignments as recent as those given in our monograph, are much regretted by us, but seeing that we were seriously in error, we are most anxious to admit this and present what we believe to be a correct analysis of the species of *Arenivaga*.[3] We feel that in the other genera of the Polyphaginae, as well as elsewhere throughout the North American species monographed by us, the nomenclature is on a stable footing.

[1] Mem. Am. Ent. Soc., 2, pp. 223–239, (1917).

[2] Proc. Ent. Soc. Washington, xx, pp. 154–157, (1918).

[3] The Polyphaginae was the first subfamily studied in our monographic treatment, and for the first time the concealed genitalia of the male had been used for specific diagnostic purposes. After much more intimate knowledge of these features, gleaned from the study of the Blattidae of both temperate and tropical North America, we can readily see that originally fear of going too far and of too great heterodoxy caused us to make the mistakes in question.

All of the species of *Arenivaga* are subject to unusual individual variation. The two specimens recorded by us from the states of Morelos and Guerrero, Mexico, as *rehni*, we believe will probably be found to represent a distinct species. Until further material can be examined from that region, however, we do not feel able to diagnose these individuals properly. We were influenced in our originally too conservative attitude by the fact that as many features, usually constant in the Blattidae, were subject to considerable variation in the genus, we hesitated to use certain male genitalic differences as bases for further specific division. The fact that females of two of the already recognized species were most difficult to separate gave us further reason for caution. It is unfortunate that females of all the species excepting *bolliana* and *floridensis* are so difficult to separate. It is hoped that the constant addition of material will eventually make it possible to ascertain features of difference, by which this sex can also be determined definitely for all of the species. Due to their distribution, females of *rehni*, *floridensis* and *tonkawa* can be determined from locality alone.[4] The problem of determining females of *grata*, *erratica*, *apacha* and *genitalis* is, however, most difficult.

In addition to assigning correctly the material previously recorded, and discussing the important features of the species now recognized, we have recorded in the present paper the few additional specimens subsequently added to the Philadelphia Collections or received by us for study. In preparing the present paper the three hundred and fifty-one specimens of *Arenivaga* in the Philadelphia Collections, as well as a number of individuals sent us for study, have been examined.

Key to Males of the Species of Arenivaga,[5] *based on the Concealed Genitalia:*[6]

[4] Though the distribution of *tonkawa* is largely coincident with that of *bolliana*, the distinctive features of females of the latter species prevent confusion between these.

[5] So much individual variation occurs in the species of this genus, in the features normally used for specific separation, that we feel it is imperative for the student to examine the concealed genitalia of all males to be recorded. The other features which we consider of some diagnostic value, and the degrees of variation known, are discussed under the species.

A. Sinistral genital hook strongly recurved distad to the acute apex.
  B. Dextro-ventral genital plate rotundato-quadrate, not showing deep emargination. Dextro-dorsal genital plate small, but with sinistro-distal portion produced and lobate.
    C. Surface of dextro-ventral genital plate concave, distal margin very broadly and conspicuously shagreenous.....1. **bolliana** (Saussure)
    CC. Surface of dextro-ventral genital plate weakly concave, distal margin very narrowly and weakly roughened or smooth.
      2. **rehni** Hebard
  BB. Dextro-ventral genital plate cleft to near base dextrad, the sinistral portion rotundato-rectangulate and longer than broad, the distal margins smooth, the dextral portion a stout chitinous rounded projection, which curves sinistrad, with apex touching the dextral margin of the sinistral portion mesad. Dextro-dorsal genital plate relatively very small, narrowly transverse, with exposed surface rounded.
    3. **grata** new species
AA. Sinistral genital hook barbed distad, like a fish-hook, and in consequence slightly thicker above the barb than in median portion of shaft.
  B. Dextro-ventral genital plate without projections.
    C. Dextro-dorsal genital plate small and sausage-shaped, with ventral surface concave and in consequence separated a uniform and considerable distance from the dextro-ventral genital plate. (Dextro-ventral genital plate small, with margins rounded and surface smooth.).....4. **floridensis** Caudell
    CC. Dextro-dorsal genital plate with ventral surface not concave and partially in contact with dextro-ventral genital plate.
      D. Dextro-ventral genital plate vertically broad, with margins rounded and surface smooth.....5. **erratica** Rehn

[6] The intricate character of the dextral genital plates is by no means fully characterized in this key. We here attempt to describe only those portions which are visible when the subgenital plate has been removed. These, we believe, are quite sufficient for specific determination. The portions of these plates which are concealed when in normal position, will afford an interesting subject when detailed studies of the genitalia are made, but should not be added to the diagnoses, already intricate, necessary for purely systematic purposes. In our dissections we have found that the dextro-dorsal genital plate is always produced in a long narrow curving process which, directed ventrad along the dextral wall of the anal chamber, connects with the dextro-ventral plate near its basal portion dextrad. Moreover the dextro-dorsal plate is, at least in some species, produced inward from its sinistro-basal portion (see plate VII, figures 15 to 17), while in others the dextro-ventral plate has an appendage sinistrad, which, while usually concealed, must not be mistaken for an abnormality when visible (see plate VII, figure 7A).

DD. Dextro-ventral genital plate vertically narrow, broadly and roundly angulate-emarginate to near its base sinistrad of median point, the dextral portion thus formed a small smooth rounded lobe, the sinistral portion an irregularly rounded angulate projection of equal height.....6. **tonkawa** new species

BB. Dextro-ventral genital plate with productions. (Dextro-dorsal genital plate large and lobiform, but with sinistral margin concave and subchitinous.)[7]

C. Dextro-ventral genital plate armed sinistro-distad with a moderately elongate, slightly curved, heavy spike, directed meso-distad. 7. **apacha** (Saussure)

CC. Dextro-ventral genital plate armed meso-distad with an elongate, straight, heavy spike, adjacent to which sinistrad is a chitinous process of equal length, which is enlarged distad, with apex rounded, and bears on the meso-distal portion of the dextral margin a minute tooth.....8. **genitalis** Caudell

Key to Females of the Species of Arenivaga[8]

(Head remarkably different from that of male, transverse clypeal swelling of face deep. Ocelli minute. Body covered with minute hairs; longer hairs along the margin, particularly cephalad. Tegmina and wings absent. Subgenital plate broadly convex in general form, without a sulcus or any decided production meso-distad. Cephalic femora with ventro-cephalic margin hairy proximad, succeeded in distal half by a row of rather closely-set, short, chaetiform spines.)

A. Form suborbicular. Size large to medium. (General color blackish. Cephalic margin of pronotum often rather narrowly buff, the caudal margin of this marking brace-shaped.) Central Texas. 1. **bolliana** (Saussure)

AA. Form narrower, broad oval to oval. Size medium to rather small.

B. General color blackish. (Cephalic margin of pronotum rather broadly reddish yellow.) Greatest width of body more nearly mesad. Central-western Florida.....4. **floridensis** Caudell

[7] In *apacha* this plate is produced inward from its sinistro-distal portion in an elongate heavy spike, the internal margin beyond the base of this spike armed with two small teeth (see plate VII, figure 15).

In *genitalis* this plate is produced inward from its sinistro-distal portion in a heavy, chitinous, rounded process, the dorsal surface of which is shagreenous, bearing on its dextral margin two small but heavy teeth (see plate VII, figures 16 and 17). These portions, as they are directed inward, are normally concealed and can not be seen without dissection of portions of the concealed genitalia.

[8] As we have stated elsewhere, great difficulty in determining females of some of the species of this genus is experienced. At the present time the female sex of *genitalis* has not been recognized.

BB. General color reddish brown. (Cephalic margin of pronotum usually rather narrowly paler.)
C. Limbs more elongate and slender.
D. Pronotum with a small, weakly defined, triangular, yellowish suffusion on each side cephalad. Interocular space slightly narrower than that between the ocelli. Extreme southern Arizona, Coahuila.....3. **grata** new species
DD. Pronotum narrowly pale cephalad. Interocular space slightly broader than that between the ocelli.
E. Lower California.....2. **rehni** Hebard
EE. Southwestern States east to Pecos River in Texas; Sonora. 5. **erratica** Rehn
EEE. Central Texas, east of Pecos River...6. **tonkawa** new species
CC. Limbs shorter and stouter. (Segments of abdomen normally immaculate.) Arizona, southern California, Chihuahua, Sonora. 7. **apacha** (Saussure)

Though we are now satisfied with the status of at least all of the species found in the United States, we can state definitely that the present genus is easily the most difficult of the genera of Blattidae found in this country.

Arenivaga bolliana (Saussure) (Plate VII, figures 1 and 13)

1893. [*Homoeogamia*] *bolliana* Saussure, Rev. Suisse Zool., i, fasc. 2, p. 298. [♂, Texas.]

1904. *Homoeogamia bolliana* variety *nigricans* Caudell, Mus. Brooklyn Inst. Arts and Sci., Bull. i, p. 107. [♂; Esperanza Ranch, Brownsville, Texas.]

1917. *Arenivaga bolliana* Hebard, Mem. Am. Ent. Soc., 2, p. 223, pl. ix, figs. 3 to 5. [♂, ♀; Dallas, Waco, Bosque County, Shovel Mountain in Burnet County, San Marcos, Victoria, Corpus Christi, Brownsville, Esperanza Ranch near Brownsville, Mission, Ringgold Barracks near Rio Grande, Kerrville, Sabinal, Knippa, Uvalde, Neuces River in Zavalla County, Carrizo Springs, Eagle Pass, Devils River, High Bridge of Pecos River, Texas.]

1918. *Arenivaga bolliana* variety *nigricans* Caudell, Proc. Ent. Soc. Washington, xx, p. 157. (Evidence indicating specific value suggested.)

We have little to add to our remarks on the species given in 1917. We believe that *nigricans* should be unreservedly assigned to synonymy. The Brownsville material before us is decidedly smaller than any other specimens of *bolliana* we have seen and individuals in the series are of the maximum intensive coloration, which we have not found in other material of the genus, though every gradation to the normal type occurs. Careful comparison with typical material of the species shows no feature worthy of nominal recognition of any kind.

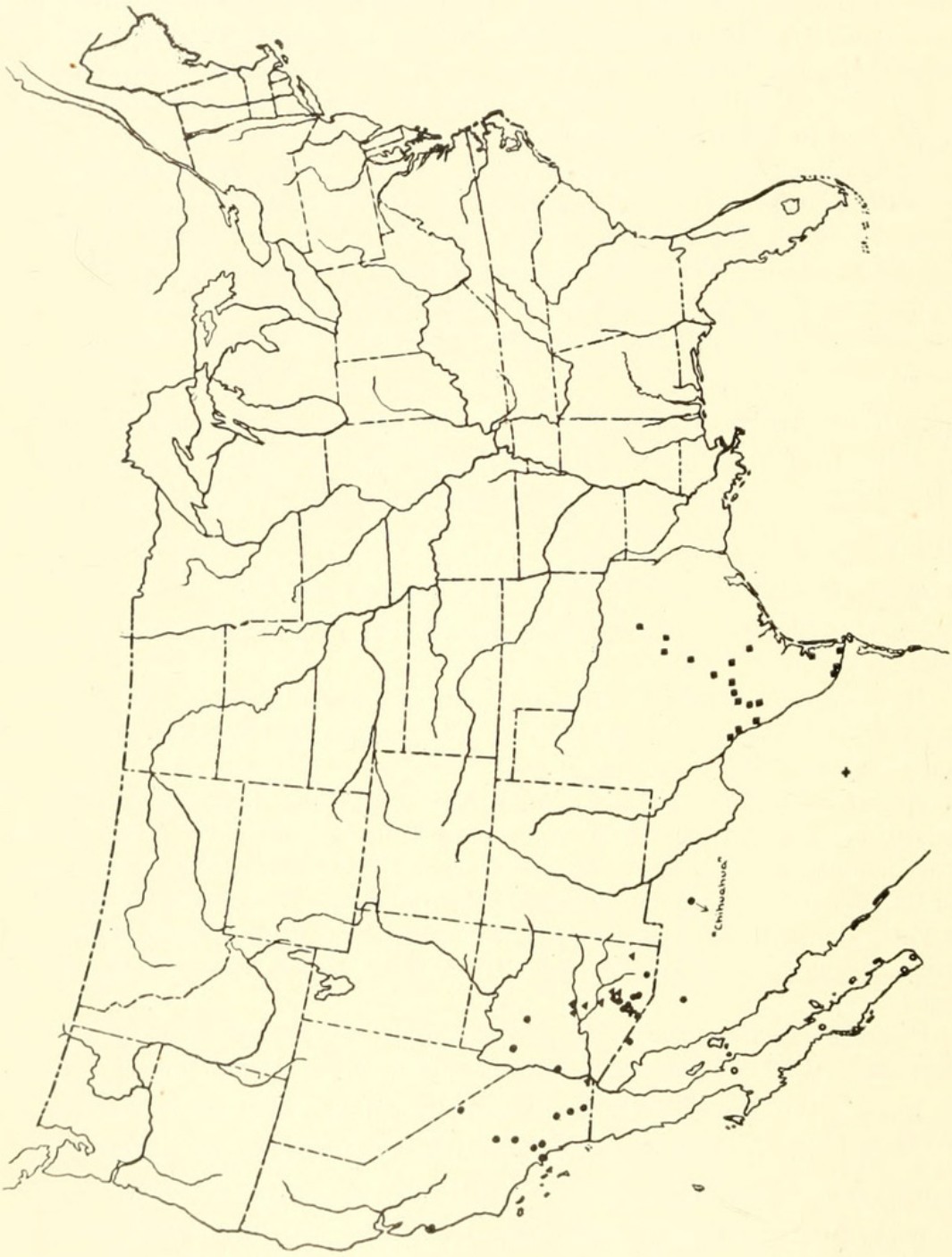

Figure 1—Map showing the known distribution of *Arenivaga bolliana* (Saussure) (by a square), of *Arenivaga grata* new species (by a cross), of *Arenivaga apacha* (Saussure) (by a circle) and of *Arenivaga genitalis* Caudell (by a triangle).

Though normally much the largest species of *Arenivaga*, males are separated with greatest certainty by examination of the concealed genitalia, since some of the males before us from Brownsville, Texas, are even slightly smaller than the males of *grata* here described.

The female sex is readily recognized by its suborbicular form, large size and blackish general coloration. In this sex the interocular space is very slightly narrower than that between the ocelli.

The species is found through central Texas from near the northern border to Brownsville. Its distribution is therefore practically co-extensive with that of *tonkawa* here described. The latter, being a smaller paler species in both sexes, closely related to *erratica* Rehn, is readily separated in both sexes from *bolliana*.

Arenivaga rehni Hebard (Plate VII, figure 2)

1917. *Arenivaga rehni* Hebard, Mem. Am. Ent. Soc., 2, p. 227, pl. ix, figs. 6 to 10. [♂, ♀; San Pedro, Sierra El Tosti, Comondu, San José del Cabo, all Lower California, Mexico.[9]]

From careful examination of the series, we are satisfied that the only material which can be referred definitely to this species is that from Lower California. As our original descriptions of both sexes and all the figures given are from material from that region, we have little further to add at the present time. We would note, however, that, though variable, the present species by no means shows the very great extremes of variation which we supposed existed, when we believed that other Mexican specimens also represented this species.

Arenivaga grata new species (Plate VII, figures 3 and 4)

1917. *Arenivaga rehni* Hebard, (in part), Mem. Am. Ent. Soc., 2, p. 227. [♂, ♀; San Lorenzo, Coahuila, Mexico; Kits Peak Rincon, Baboquivari Mountains, Arizona.]

The present species, with *bolliana* and *rehni*, forms the first group of the genus, which we term the Bolliana Group. The species in this group agree in the type of the concealed sinistral male genital hook, which is sharply recurved distad near its acute apex, not barbed as in the other species.

[9] The material recorded at that time from Arizona and Coahuila is referred in the present paper to *A. grata* here described, while that from Morelos and Guerrero we can not determine with certainty, as stated on page 198.

The dextro-ventral concealed genital plate in males of this species is very distinctive. The species would, however, appear to be nearest in relationship to *rehni*. Compared with females of *rehni*, those of the present species before us are distinguished only by the interocular space being slightly but distinctly greater, instead of slightly but distinctly narrower than that between the minute ocelli. Closer agreement with *bolliana* is suggested merely by the general appearance of males.

Type.—♂; San Lorenzo, Coahuila, Mexico. May. (E. Palmer.) [Hebard Collection, Type no. 530.]

Size medium for the genus, form elongate elliptical. Head with interocular space nearly four-fifths as wide as that between the ocelli.[10] Area from between ocelli to labrum depressed with lateral margins narrowly raised, surface concave between the large projecting ocelli. Pronotum broad, the caudal margin broadly convex, the cephalic margin more strongly convex, the angles formed latero-caudad rather sharply rounded; surface covered with minute hairs, cephalic margin more thickly clothed with longer stouter hairs. Tegmina elongate for the genus, subcoriaceous and glossy, apex well rounded, marginal and scapular fields narrow. Costal margin of tegmina and wings supplied with minute hairs, on the tegmina these become as heavy proximad as on the cephalic margin of the pronotum. Supra-anal plate produced and delicate, bilobate. Cerci small, with joints strongly moniliform meso-distad, tapering to acute apex. Sinistral genital hook very slender, elongate, curving gently inward to near distal extremity, which is sharply recurved inward, very slightly enlarged, with acute apex directed proximad. Dextro-dorsal genital plate very small, narrowly transverse, with exposed surface rounded. Dextro-ventral genital plate cleft to near base dextrad, the sinistral portion rotundato-rectangulate and longer than broad, the distal margins smooth, the dextral portion a stout chitinous rounded projection, which curves sinistrad, with apex touching the dextral margin of the sinistral portion mesad, in such a way that a subcircular open area is enclosed. Subgenital plate bulbous, without styles, hairy toward the asymmetrical and shallowly concavo-emarginate distal margin. Limbs and armament of same as characteristic of the genus. Caudal metatarsus elongate and slender, equalling combined length of succeeding tarsal joints. Tarsal claws elongate and slender. Pulvilli and arolia absent.

Allotype.—♀; same data as type, with no date given. [Hebard Collection.]

Almost identical with females of *rehni*, except for the interocular space, which is slightly but distinctly narrower than that between the minute ocelli, and differently shaped marginal markings of the pronotum cephalad. Very

[10] The Arizona males have this interspace decidedly narrower, only two-fifths as wide as that between the ocelli.

unlike male, apterous, size much larger, form more broadly acute elliptical. Dorsal surface finely roughened, clothed with very short, minute hairs, along the margins these hairs being longer and heavier, particularly in the cephalic half. Pronotum broad, cephalic margin arcuate at an angle of about ninety degrees, caudal margin weakly produced mesad, with sides broadly and weakly concave. Supra-anal plate transverse, weakly trapeziform; caudal margin broadly convex with immediate apex transverse, truncate, showing a very feeble indication of projection at each of the weakly defined, lateral angles thus formed.[11] Limbs with armament differing from that of male as given under key heading, as characteristic of genus.

Measurements (in millimeters)

♂	Length of body	Length of pronotum	Width of pronotum	Length of tegmen	Width of tegmen
San Lorenzo, Coahuila, Mexico, *type*	18.4	5	7[12]	21.6	8.4
Kits Peak Rincon, Arizona	18	5	7.7	23.6	8.6
Kits Peak Rincon, Arizona	18	5	7.8	22.2	8.1

♀				Width of mesonotum	Width of metanotum
San Lorenzo, Coahuila, Mexico, *allotype*	17.7	6.1	8.6	10.3	11.3
San Lorenzo, Coahuila, Mexico, *paratype*	18.8	6.1	8.7	10.8	11.2
San Lorenzo, Coahuila, Mexico, *paratype*	16.8	6	8.4	10	11.1
San Lorenzo, Coahuila, Mexico, *paratype*	16	5.8	8	9.8	10.8

Coloration.—Males. Pronotum bone brown, individually varying to carob brown shading to hazel laterad, excepting cephalic margin which is in all broadly buffy. Tegmina transparent, tinged faintly with buffy brown, with scattered minute transparent flecks of bone brown, which become numerous proximad, clouding heavily the proximal portion of the anal fields, a broad immaculate band running along the humeral trunk proximad in the discoidal field. Head with occiput bone brown, this extending to labrum in type, to antennal sockets in Arizonan males. Other portions of body buffy, with a brownish yellow tinge.

Females. General coloration bay, deepening to liver brown on pronotum, lateral and caudal portions of mesonotum and metanotum and caudad on dorsal abdominal segments. Pronotum with a small, weakly defined, triangular, yellowish suffusion on each side cephalad. Occiput and swollen portion of face above labrum shining bay. Underparts buffy tinged with yellowish brown, the abdomen shining, shading through burnt sienna to bay distad on the slightly less smooth surface of the subgenital plate.

[11] This type occurs also in *rehni*.

[12] The type has been dried from some liquid preservative and the pronotum has in consequence buckled somewhat. In life we believe this diameter was about 7.5 mm.

In addition to the type and allotype, the following material is before us:

San Lorenzo, Coahuila, Mexico, (E. Palmer), 3 ♀, *paratypes*, [Hebard Cln. and A. N. S. P.].

Kits Peak Rincon, Baboquivari Mountains, Arizona, about 4050 feet, viii, 1 to 4, 1916, (Lutz and Rehn), 2 ♂, [A. M. N. H. and A. N. S. P.].

Arenivaga floridensis Caudell (Text figure 2 and plate VII, figure 5)

1908. *Arenivaga floridensis* Caudell, Proc. Ent. Soc. Washington, xx, p. 156. [♂, ♀; Dunedin and Auburndale, Florida.]

This species, remarkable for its broad form, particularly in the male sex, dark coloration and distinctive male concealed genitalia, is the only representative of the genus known from the humid eastern portion of the United States.

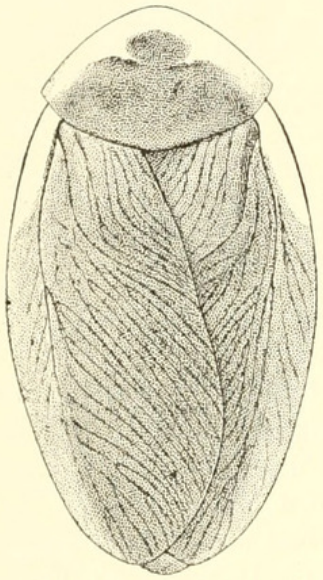

Figure 2. *Arenivaga floridensis* Caudell. Dorsal view of male. Lakeland, Florida. (×3)

In linear arrangement we place it after *grata* here described, and before *erratica* Rehn. This insect is a member of the Erratica Group, the species of which agree in the type of the concealed sinistral male genital hook, which is barbed like a fish-hook distad. To this group belong four other species, of which *tonkawa* is more closely related to *erratica* and *genitalis* to *apacha*.

A single male, taken by Wm. T. Davis at Lakeland, Florida, May 4, 1912, is in the Hebard Collection.[13] Like the type, this specimen is broad, very dark, blackish chestnut brown in general coloration, with space between the eyes barely narrower than that between the ocelli. The distinctive dextral genital plates are here figured for the first time. Length of body, 14.5 mm.; length of pronotum, 4.7; width of pronotum, 7.7; length of tegmen, 15; greatest width of tegmen (meso-distad), 6.6.

The species is known only from the three localities in central-western Florida noted above. It is apparently a spring form, which would account for our not having found the species in the fall, during which season we have done extensive field work in the region from which it is known.

[13] Mr. Davis' great generosity in presenting this fine specimen, which was unique in his own excellent collection, is most deeply appreciated.

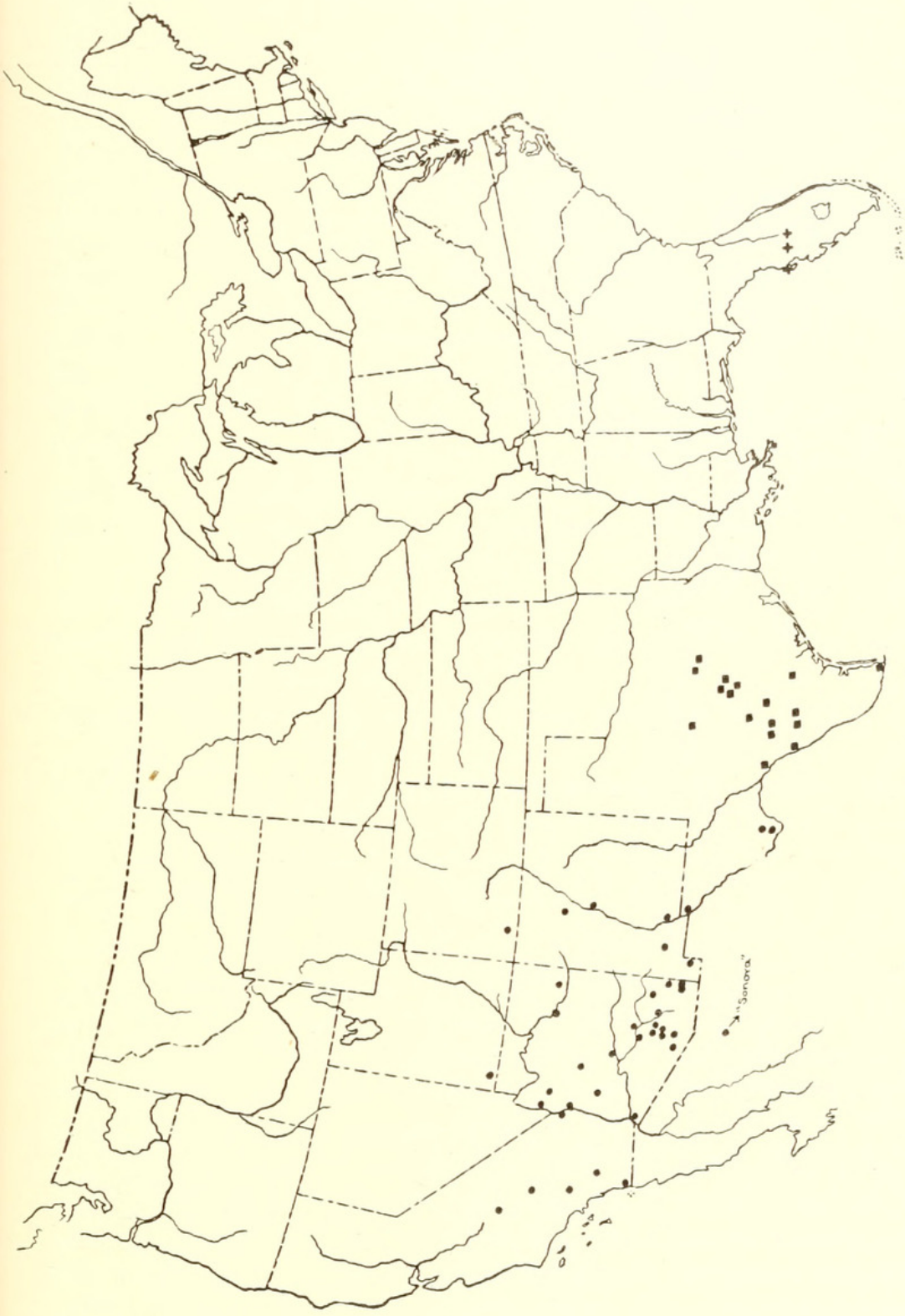

Figure 3—Map showing the known distribution of *Arenivaga floridensis* Caudell (by a cross), of *Arenivaga tonkawa* new species (by a square) and of *Arenivaga erratica* Rehn (by a circle).

Arenivaga erratica Rehn (Plate VII, figures 6, 7 and 14)

1903. *Homoeogamia (Arenivaga) erratica* Rehn, Proc. Acad. Nat. Sci. Phila., 1903, p. 187. [♂; Prescott, Arizona.]

1917. *Arenivaga erratica* Hebard, (in part),[14] Mem. Am. Ent. Soc., 2, p. 231, pl. ix, figs. 11 and 12. [♂, ♀; Hackberry Creek in Brewster County, Chisos Mountains, El Paso, Texas; Durango, Colorado; Mescalero Apache Reservation, Highrolls in Sacramento Mountains, Jemez Hot Springs, Albuquerque, Las Cruces, Deming, New Mexico; Adamana, Winslow, Fort Grant, San Simon, Paradise, Chiricahua Mountains, Roosevelt, Redington, Sheridan Canyon in Huachuca Mountains, Lowell Ranger Station in Pima County, Sabino Basin in Santa Catalina Mountains, Sabino Canyon in Santa Catalina Mountains, Tucson, San Xavier, Snyder's Hill in Pima County, Roebles Ranch in Pima County, Palo Alto Ranch in Pima County, Coyote Mountains, Kits Peak Rincon in Baboquivari Mountains, Santa Cruz Village in Cobabi Mountains, Prescott, Florence, Phoenix, Fort Mojave, Yuma, Arizona; St. George, Utah; Cottonwood in San Bernardino County, Riverside, California; Sonora, Mexico.]

1917. *Arenivaga apacha* Hebard, (in part, not of Saussure, 1893), Mem. Am. Ent. Soc., 2, p. 236. [♂; Kern County, Strawberry Valley in San Jacinto Mountains and San Diego, California.][15]

This species is apparently the most numerous and has the widest distribution of the forms of the genus found in the United States.

The following material has been received subsequent to our monographic study:

Sawmill Canyon, Hualapai Mountains, Arizona, VIII, 30 to IX, 22, 1919, (O. C. Poling), 6 ♂, [Hebard Cln.].

Topock, Arizona, X, 9, 1917, (O. C. Poling), 4 ♂, [Hebard Cln.].

Wenden, Yuma County, Arizona, IX, 28, 1913, (Mrs. W. W. Gnash), 1 ♂, [A. M. N. H.].

Needles, California, X, 10, 1919, (O. C. Poling), 1 ♂, [Hebard Cln.].

[14] The material recorded at that time from east of the Pecos River in Texas we find represents a distinct species, which we describe in the present paper as *tonkawa*. The description of the female, as well as the figure given of that sex, apply to that species.

[15] The small size, strikingly maculate pronotum and wide interocular space, led us to mistake the San Diegan specimen for *apacha*, under which species we included material of the then undescribed *genitalis*, the normal type of which species is very similar to the present example in these features. Examination of the concealed genitalia has revealed our mistake. This is an excellent illustration of the absolute necessity to examine the concealed genitalia to determine correctly males of these species. After having become familiar with the very large series we had before us, we, at that time depending on external characters, felt no uncertainty in making this assignment.

The males from Topock, Arizona, and Needles and San Diego, California, are the smallest of any before us and, in addition, differ from the usual type in having the pronotal marking dark and striking, solid caudad with dots and lines cephalad much as in paler examples of *genitalis*. In these the interocular space varies from one-half to four-fifths as wide as the interocellar space, excepting in the San Diegan individual, in which the interocular space is slightly but distinctly wider than that between the ocelli. It is, therefore, clear that, in the regions where the distributions of *erratica*, *apacha* and *genitalis* coincide, determination of males can be made with safety by relying on the character of the concealed genitalia alone.

The extremes of size variation in males of this species is shown by the following table, as well as an approximately average series from Deming, New Mexico. The species ranges from what we term medium, to very small for the genus.

Measurements (in millimeters)

♂	Length of body	Length of pronotum	Width of pronotum	Length of tegmen	Width of tegmen
San Diego, California.	10.9	3.5	4.7	14.1	5
Topock, Arizona (4)...	11–11.8	3.5–3.8	4.9–5.1	12.7–13.7	4.4–4.9
Deming, New Mexico (11).....	13.3–14.8	3.9–4.2	5.7–6	17.3–18.7	7–7.3
Roosevelt, Arizona....	16	4.9	7.6	19.7	7.8
Sabino Basin, Santa Catalina Mountains, Arizona.....	18	5.3	8.6	21.1	8.9

We find that *erratica* very seldom approaches the minimum or maximum given. In the latter extreme the size approximates that of individuals of the maximum size developed in *tonkawa*, which in that species, however, are apparently of frequent occurrence, particularly in northern Texas.

In males of *erratica* the interocular space is usually about three-fifths as wide as that between the ocelli, but varies from one-half as wide to distinctly wider than that dimension, the latter condition being, however, very rare. In females the interocular space is very slightly greater than that between the ocelli,

Arenivaga tonkawa[16] new species (Plate VII, figures 8 and 9)

1902. *Homoeogamia bolliana* Rehn, (not of Saussure, 1893), Trans. Am. Ent. Soc., xxvii, p. 331. [♂; Round Mountain, Texas.]

1903. *Homoeogamia bolliana* Rehn, (not of Saussure, 1893), Proc. Acad. Nat. Sci. Phila., 1903, p. 187. [♂; Austin and Round Mountain, Texas.]

1917. *Arenivaga erratica* Hebard, (in part, not of Rehn, 1903), Mem. Am. Ent. Soc., 2, p. 231, pl. ix, fig. 13. [♂, ♀; Waco, Bosque County, Ballinger, Shovel Mountain in Burnet County, Austin, Round Mountain, Georgetown, Goliad, Brownsville, Kerrville, San Antonio, Cotulla, Esperanza Ranch near Brownsville, Sabinal, Knippa, Carrizo Springs, Ringgold Barracks near Rio Grande, Devils River, Texas.]

The present species is very closely related to *erratica*, replacing that species east of the Pecos River in Texas, in which territory it is distributed through the semi-arid area from Waco south to Brownsville.

No indication of intergradation is shown, specimens from the Big Bend region of the Rio Grande being typical of *erratica* and those from east of the Pecos typical of *tonkawa*.

Were either of these species constant in the features usually employed for specific separation, our previous assignment would be reprehensible. We find, however, that in all usually reliable external structural characters a decided amount of variation occurs, *tonkawa* being distinguished readily and, as far as we can see, only, by the distinctive form of the concealed dextroventral genital plate in the male sex. Though some variation occurs in the form of this plate (see plate VII, figures 8 and 9), the general character remains the same and is very distinct from the type developed in *erratica*.

Unfortunately, the greatly simplified female sex appears to have no structural differences by which it can be separated from that sex of *erratica*. No difficulty is experienced in assigning females, however, as this species and *bolliana* are the only forms of the genus *Arenivaga* which occur in Texas east of the Pecos River; females of *bolliana* being readily separated by their suborbicular form, blackish general coloration and average much larger size.

Type.—♂; Carrizo Springs, Dimmit County, Texas. (A. Wadgymar.) [Hebard Collection, Type no. 531.]

[16] The Tonkawa Indians once inhabited the region where this species occurs.

Size medium[17] for the genus, form moderately broad. Head with interocular space three-fifths as wide as that between the ocelli.[18] Area from between ocelli to labrum weakly depressed, transversely wrinkled. Tegmina broader than in *grata* and subcoriaceous, showing very little gloss, as in *erratica*. Other features as described for *grata*, except the concealed genitalia. Concealed sinistral genital hook very slender, elongate, curving gently inward to apex, which is slightly enlarged and barbed like a fish-hook, as is characteristic of the Erratica Group of the genus.

Dextro-dorsal genital plate with ventral surface not concave and partially in contact with dextro-ventral genital plate. Dextro-ventral genital plate vertically narrow, broadly and roundly angulate emarginate to near its base sinistrad of median point, the dextral portion thus formed a small smooth rounded lobe, the sinistral portion an irregularly rounded angulate projection of equal height.

Allotype.— ♀ ; same data as type. [Hebard Collection.]

Identical with females of *erratica*, apparently separable only by the fact that the areas of geographic distribution of these two species do not appear to overlap. Very unlike male, apterous, size much larger, form broad ovate. Interocular space slightly broader than that between the ocelli. Dorsal surface rugulose, covered with very short, but stout, minute reddish hairs, these longest along the margins of the body, particularly cephalad. Pronotum moderately broad, cephalic margin evenly arcuate, caudal margin almost transverse, very weakly produced mesad, with sides showing a slight concavity. Each abdominal segment with a dot of darker brown mesolaterad, both above and below.[19] Supra-anal plate transverse, weakly trapeziform; caudal margin weakly convex laterad, with mesal fifth subtruncate, showing an indication of mesal emargination. Subgenital plate very large, roundly produced. Limbs and armament differing from that of male as given under key heading, as characteristic of genus.

[17] Individual size variation is decided in this species. The series from Carrizo Springs varies from the size of the type, which is as large as Brownsville males of *bolliana*, to a size rather small for the genus, this latter being of about the size normal for *erratica*.

[18] Individually variable, in the series at hand ranging from one-third to three-fifths as wide as that between the ocelli, the majority being approximately two-fifths.

[19] This feature is rarely absent in *ton awa* and *erratica*, rarely present in *apacha*.

Measurements (in millimeters)

♂	Length of body	Length of pronotum	Width of pronotum	Length of tegmen	Width of tegmen
Round Mountain, Texas (3)	15.4–17.5	5.1–5.3	7.7–8	20.3–21	7.5–7.8
Carrizo Springs, Texas, *type*	18	5.7	8.7	22	8.8
Carrizo Springs, Texas, *paratypes* (5)	13.5–16	4.2–5	6–7.3	16.6–18.8	6.3–7.2
Sabinal, Texas	15	5	7.3	18.8	7.2
Brownsville, Texas (9)	14.8–15.3	4.6–4.9	6.4–6.8	16.9–17.6	6.3–6.4
♀				Width of mesonotum	Width of metanotum
Round Mountain, Texas	16	5.4	8.6	11	11.6
Carrizo Springs, Texas, *allotype*	14.4	4.8	7	9.1	9.8
Carrizo Springs, Texas, *paratypes* (3)	13.8–15.3	4.8–5.3	6.8–7.8	8.7–9.7	9.4–10.6
Sabinal, Texas (4)	13.8–14.8	5–5.2	6.7–7.9	8.9–9.5	9.7–10.3

Larger series will, we believe, show even greater size variation, apparently not due to geographic distribution but produced by local environmental influences. Such is true for the related *erratica*, of which species we have much larger series.

General coloration of male ochraceous buff. Pronotum with a light brown shield-shaped marking meso-caudad, usually showing points of darker brown, often with the ground color paling latero-cephalad. In recessive examples this marking is pale yellowish brown, with darker points subobsolete. The tegmina, as in *erratica*, are ochraceous buff, obscurely marbled with a slightly darker shade and showing very little gloss. Head with eyes and occiput to antennal sockets dark brown.

General coloration of female above burnt umber to tawny, the cephalic margin of the pronotum usually vaguely paler. All but the darkest individuals faintly maculate on the pronotum, mesonotum and metanotum with a darker shade. Meso-laterad on each abdominal segment, both above and below, a dot of darker brown is usually present. Covering of minute hairs tawny. Underparts, particularly head and limbs, somewhat paler.

In addition to the type and allotype, five males and three females, bearing the same data, and in the Hebard Collection and that of the Academy of Natural Sciences of Philadelphia, are designated paratypes.

No additional material of this species has been received since our monographic study, the ninety-four specimens there recorded as *erratica*, from east of the Pecos River in Texas, being wholly referable to the present species.

Arenivaga apacha (Saussure) (Plate VII, figures 10, 11 and 15)

1893. [*Homoeogamia*] *apacha* Saussure, Rev. Suisse Zool., i, fasc. 2, p. 296. [♂; Chihuahua, Mexico.]

1905. [*Homoeogamia*] *apacha infuscata* Caudell, Proc. U. S. Nat. Mus., xxviii, p. 462. [♂; Phoenix, Arizona.]

1917. *Arenivaga apacha* Hebard, (in part), Mem. Am. Ent. Soc., 2, p. 236, pl. ix, fig. 16. [♂, ♀; Huachuca, Oracle, Tucson, Santa Rita Mountains, Coyote Mountains, Kits Peak Rincon in Baboquivari Mountains, Sycamore Canyon in Baboquivari Mountains, Ehrenberg, Arizona; Death Valley, Monterey, Kern County, Lancaster, Mount Wilson, Claremont, Salton, California; La Sierra de San Francisco, Sonoita, Sonora, Mexico.]

We have noted above the material which we believe to have been correctly recorded as this species in our monograph. Under *apacha* we confused the subsequently described species *genitalis*, as well as three specimens of *erratica*.

We are unable to determine whether any of the females here assigned should be referred to *genitalis*, the female sex of that species apparently being unknown.

We are fully as confident as before that Caudell's varietal name *infuscata* is valueless. That author has recently stated that "in *infuscata* the character, in addition to the blackish general coloration, pointing to at least incipient specific distinction, is the spine of the inferior dextral plate of the concealed genitalia of the male, which is scarcely more than one-half as long as usual in *apacha*."[20] We have examined the series in the Philadelphia Collections, which includes five specimens of the maximum intensive coloration, two are slightly paler but very dark, seven are dark, about as dark as is normal in *genitalis*, while three are pale, quite as pale as normal in *erratica*. We find the length of the spine in question to be individually variable, irrespective of the coloration of the insect. The form of the concealed male genital plates also varies individually to some extent (see plate VII, figures 10 and 11).

In addition to the previously recorded material, we now have before us the following specimens.

[20] Proc. Ent. Soc. Washington, xx, p. 157, (1918).

Sawmill Canyon, Hualapai Mountains, Arizona, IX, 10, 1919, (O. C. Poling), 2 ♂, (maximum intensive coloration), [Hebard Cln.].

Prescott, Arizona, VIII, 20 and 22, 1917, (O. C. Poling), 2 ♂, (maximum intensive coloration), [Hebard Cln.].

La Puerta, Imperial County, California, XI, 1911, 1 ♀, [Cal. Acad. Sci.].

Hermosa, California, (J. O. Martin), 1 ♀, [Hebard Cln.].

We would remark that all of the males now referred to *apacha* are of about the same size as the mean in *erratica*, none being very small, as is normal for *genitalis* and rare, but found to occur, in *erratica* as well.

We regret that the figures of the male genitalia given for *apacha* in our monographic study[21] apply instead to *genitalis*, the spine only of the dextro-ventral concealed genital plate having been drawn while the adjacent clubbed process was omitted. This spine is always smaller and somewhat curved in *apacha*, larger and straight in *genitalis*.

In the series of males before us, the interocular width varies from three-fifths as wide to fully as wide as that between the ocelli, the majority having the former dimension very slightly less than the latter.

As we have previously stated, females of *apacha* agree very closely with those of *erratica*, the difficulty in determining this sex is now augmented by the fact that we have *genitalis* as well to consider, the female of which species apparently is yet unknown. All three of these species have large coincident areas of distribution.

Arenivaga genitalis Caudell (Plate VII, figures 12, 16 and 17)

1903. *Homoeogamia apacha* Rehn, (not of Saussure, 1893), Proc. Acad. Nat. Sci. Phila., 1903, p. 188. [♂; Fort Grant, Phoenix and Tempe, Arizona.]

1903. *Homoeogamia apacha* Rehn, (not of Saussure, 1893), Ent. News, xiv, p. 327 [♂; Florence, Arizona.]

1917. *Arenivaga apacha* Hebard, (in part not *Homoeogamia apacha* Saussure, 1893), Mem. Am. Ent. Soc., 2, p. 236, pl. ix, figs. 14 and 15. [♂: Fort Grant, Catalina Springs, Lowell Ranger Station in Pima County, Sabino Canyon in Santa Catalina Mountains, Phoenix, Tempe, Florence, Arizona; Yuma, California.]

1918. *Arenivaga genitalis* Caudell, Proc. Ent. Soc. Washington, xx, p. 155. [♂; Phoenix, Higley and Catalina Springs, Arizona.]

[21] Mem. Am. Ent. Soc., 2, pl. ix, figures 14 and 15, (1917).

This species averages smallest of the genus, the largest of the twenty-eight males in the Philadelphia Collections being no larger than the smallest of the eighteen males of *apacha* at hand. In size the smallest individuals are approached only by the smallest examples of *erratica*, in which species the greatest size variation occurs.

Measurements (in millimeters)

♂	Length of body	Length of pronotum	Width of pronotum	Length of tegmen	Width of tegmen
Florence, Arizona (12).	10.6–12	3.1–3.9	4.8–5.3	12–13.9	4.8–5.7
Phoenix, Arizona (7)..	10–11.8	3.7–3.9	4.8–5.7	12.7–16.3	5–6.3
Yuma, California.....	11.8	3.9	5.6	14.7	6

The striking features of the dextro-ventral concealed genital plate of the male are described by Caudell. These are figured in the present paper and serve readily to distinguish males of the species. We note that in one specimen the minute tooth at the side of the clubbed process is absent, this being apparently of no diagnostic significance.

The interocular width in the males at hand varies from four-fifths as wide to one and one-fifth times as wide as that between the ocelli. The majority of specimens have these dimensions subequal.

All of the males before us have the dark markings of the pronotum sharply contrasting and the tegminal maculations distinct. The species does not appear to develop a striking intensive type of coloration, such as occurs in *apacha*.

The female sex of *genitalis* is apparently unknown.

Explanation of Figures

Plate VII

All of the figures are greatly enlarged. Though the type is constant, the general form of the dextral concealed male genitalic plates is subject to some individual variation within each species. The character of such individual variation is shown by figures 3 and 4, 6 and 7,[22] 8 and 9, 10 and 11.

Dextral concealed male genitalic plates[23]

Fig. 1—*Arenivaga bolliana* (Saussure). Carrizo Springs, Texas.

Fig. 2—*Arenivaga rehni* Hebard. San José del Cabo, Lower California, Mexico. *Type.*

Fig. 3—*Arenivaga grata* new species. San Lorenzo, Coahuila, Mexico. *Type.*

Fig. 4—*Arenivaga grata* new species. Kits Peak Rincon, Baboquivari Mountains, Arizona.

Fig. 5—*Arenivaga floridensis* Caudell. Lakeland, Florida.

Fig. 6—*Arenivaga erratica* Rehn. Prescott, Arizona. *Paratype.*

Fig. 7—*Arenivaga erratica* Rehn. Fort Grant, Arizona. (See footnote 22.)

Fig. 8—*Arenivaga tonkawa* new species. Carrizo Springs, Texas. *Type.*

Fig. 9—*Arenivaga tonkawa* new species. Carrizo Springs, Texas. *Paratype.*

Fig. 10—*Arenivaga apacha* (Saussure). Santa Rita Mountains, Arizona.

Fig. 11—*Arenivaga apacha* (Saussure). Prescott, Arizona.

Fig. 12—*Arenivaga genitalis* Caudell. Phoenix, Arizona. *Topotype.*

Sinistral concealed male genital hook

Fig. 13—*Arenivaga bolliana* (Saussure). Carrizo Springs, Texas. This type is developed also in *rehni* and *grata.* It is characteristic of the Bolliana Group.

Fig. 14—*Arenivaga erratica* Rehn. Prescott, Arizona. *Paratype.* This type is developed also in *floridensis*, *tonkawa*, *apacha* and *genitalis.* It is characteristic of the Erratica Group.

[22] This figure shows, in addition, the chitinous finger which springs from a point adjacent to the sinistro-basal portion of the dextro-dorsal plate, and is normally concealed by the soft integument which lies sinistrad in the anal chamber. In the specimen figured, as well as in a few others before us, this finger is partially, though not wholly, visible when the subgenital plate has been removed. In three Californian males at hand, however, it is more slender and wholly exposed.

[23] As they appear without further dissection than the removal of the subgenital plate.

Inward production of sinistro-basal portion of dextro-ventral concealed male genitalic plate[24]

Fig. 15—*Arenivaga apacha* (Saussure). Kits Peak Rincon, Baboquivari Mountains, Arizona.

Fig. 16—*Arenivaga genitalis* Caudell. Lowell Ranger Station, Pima County, Arizona.

Fig. 17—*Arenivaga genitalis* Caudell. Lowell Ranger Station, Pima County, Arizona.[25]

[24] These portions can not be examined without dissecting out completely the genitalic plates. This we have not done for the majority of species considered, as we feel that sufficient features are revealed by simply removing the subgenital plate and that further injury to the material is unnecessary for specific diagnostic purposes.

[25] This is the obverse aspect of the production shown in figure 16, it is from this side only that we are able to see the teeth, homologous to those shown for *apacha* in figure 15.

Hebard, Morgan. 1920. "Revisionary Studies in the Genus Arenivaga (Orthoptera, Blattidae, Polyphaginae)." *Transactions of the American Entomological Society* 46, 197–217.

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