

A REVIEW OF THE *GEOMYDOECUS CALIFORNICUS* COMPLEX (MALLOPHAGA: TRICHODECTIDAE) FROM *THOMOMYS* (RODENTIA: GEOMYIDAE)¹

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Abstract. Sixteen species and subspecies of the *Geomydoecus californicus* complex are described and illustrated: *G. californicus* from 14 subspecies of *Thomomys bottae* (type-host: *T. b. bottae*); *G. centralis*, n. sp. from 59 subspecies of *T. bottae* and 1 of *T. umbrinus* (type-host: *T. b. centralis*); *G. albatii*, n. sp. from 4 subspecies of *T. bottae* (type-host: *T. b. albatii*); *G. angularis*, n. sp. from 9 subspecies of *T. bottae* (type-host: *T. b. angularis*); *G. bajanensis*, n. sp. from 16 subspecies of *T. bottae* (type-host: *T. b. abbotti*); *G. clausonae*, n. sp. from 2 subspecies of *T. bottae* (type-host: *T. b. anitae*); *G. limitaris limitaris*, n. sp. from 9 subspecies of *T. bottae* (type-host: *T. b. limitaris*); *G. l. bakeri*, n. subsp. from 7 subspecies of *T. bottae* and 1 of *T. umbrinus* (type-host: *T. b. fulvus*); *G. l. halli*, n. subsp. from 3 subspecies of *T. bottae* (type-host: *T. b. proximus*); *G. l. tolteci*, n. subsp. from 5 subspecies of *T. bottae* (type-host: *T. b. toltecus*); *G. aurei aurei*, n. sp. from 9 subspecies of *T. bottae* (type-host: *T. b. aureus*); *G. a. grahamensis*, n. subsp. from 6 subspecies of *T. bottae* and 1 of *T. umbrinus* (type-host: *T. b. grahamensis*); *G. actuosus*, n. sp. from 13 subspecies of *T. bottae* (type-host: *T. b. actuosus*); *G. sinaloae*, n. sp. from 2 subspecies of *T. bottae* (type-host: *T. b. sinaloae*); *G. crovelloi*, n. sp. from 2 subspecies of *T. umbrinus* (type-host: *T. u. sonoriensis*); and *G. warmanae*, n. sp. from 1 subspecies of *T. bottae* and 13 of *T. umbrinus* (type-host: *T. u. madrensis*). Distinctions among taxa are shown using qualitative and quantitative characters. Discriminant functions for 2 or 3 characters are provided in instances where they are shown to offer enhanced differentiation over single characters. A key is provided for the identification of these 16 taxa.

Price & Emerson (1971) reported *Geomydoecus californicus* (Chapman) from 10 subspecies of *Thomomys bottae* (Eydxoux & Gervais) from the southwestern USA and Mexico. Subsequently, Price (1972) expanded the known host range of this louse taxon to include 54 subspecies of *T. bottae* and 10 of *T. umbrinus* (Richardson). Additional ex-

tensive collecting of lice off pocket gophers of the *T. bottae-umbrinus* complex has revealed that what had been initially considered as *G. californicus* actually is composed of a number of separable taxa. It is our intent here to redescribe *G. californicus*, to describe 15 new specific and subspecific taxa, to present their known distributions, and to give a key for the identification of these lice.

This represents the final, largest, and most complex paper treating the taxonomy of the *Geomydoecus* of this gopher complex. As with our other studies (Price & Hellenthal 1979, 1980a, 1980b, 1980c, 1981; Hellenthal & Price 1980), we have restricted the scope of this paper to louse descriptions and associated host and locality data. The significance of these distributions will be dealt with in a later work.

Quantitative data for the lice of the *californicus* complex combined with their host and locality information are included as part of a computerized pocket gopher louse data base maintained at the University of Minnesota. The retrieval and analysis of these data were performed with an integrated group of computer programs that we developed and called the BUG system. A description and explanation of our data handling and analysis procedures may be found in Hellenthal & Price (1980).

In the following descriptions, counted or measured characters are followed by the minimum and maximum observed values, then the sample size, mean, and standard deviation in parentheses. Measurements are in millimetres. Illustrations are for specimens from the type-host. In evaluating character usefulness for specific discrimination, critical values for each character were calculated at the point where the likelihood of single character misidentification of the 2 compared taxa was equal, given normality and equal variance, and ignoring

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probability of collection. For characters offering moderately good discriminating ability, these critical values and the corresponding probabilities of misidentification are given. Comparative descriptions for closely related species are abbreviated, with quantitative data given only for those characters whose means differ at a significance level of $P \leq 0.01$. In the specimens examined section, a number in parentheses following a locality represents the total number of gophers from which lice were taken. Original locality data expressed in miles are followed parenthetically by the metric equivalent to the nearest 0.1 km; the English figure, rather than the metric, expresses the precision of the location estimate. Full locality information, including latitude, longitude, and, in many cases, elevation, for any host collection is available from the authors. The designation of the type-specimen includes the location and accession number of the host skin. Although most paratypes will be retained in the collection of the University of Minnesota, representatives will be deposited in the U.S. National Museum of Natural History, British Museum (Natural History), and occasionally other major collections.

The discriminant functions given in this paper were calculated using the U.C.L.A. Biomedical Computer Program BMD04M (Discriminant Analysis for Two Groups), as described in Dixon (1973). Discriminant analyses were performed when the best single character differences between taxa showed high probabilities of misidentification. Generally, discriminant functions were calculated using the best 4 quantitative characters and all combinations of 2 and 3 of these characters. Those discriminant functions offering substantial improvement in identification over single characters are given in species and subspecies descriptions or are used in the key. An explanation of the use of discriminant functions for louse identification is given in Price & Hellenthal (1975).

The species within the *californicus* complex may be separated into 4 groups based on the details of the male genitalia and the chaetotaxy of the female subgenital plate; these will be called the *californicus* group, the *bajaiensis* group, the *limitaris* group, and the *aurei* group. The following 4 taxa form the *californicus* group; they differ from all members of the other 3 groups by the male genitalia having a marked asymmetrical appearance of the medioanterior pair of genital sac spines, with 1 spine recessed posteriorly and different in shape from the other (Fig. 10, 11). The female of the *californicus* group has slender lateral setae on each side of the

subgenital plate (Fig. 8), thereby resembling that of the *limitaris* and *aurei* groups but differing from that of the *bajaiensis* group (Fig. 17, 19).

Geomydoecus californicus (Chapman)

FIG. 1-11

Trichodectes californicus Chapman, 1897, Entomol. News 8: 186. Type-host. *Thomomys bottae bottae* (Eydoux & Gervais).

♀. As in Fig. 1. Temple width (TW) 0.405-0.475 (230: 0.441 \pm 0.0159); head length (HL) 0.270-0.335 (230: 0.306 \pm 0.0121); submarginal and inner marginal temple setae (STS, MTS; Fig. 3) 0.070-0.115 (178: 0.095 \pm 0.0086) and 0.040-0.060 (226: 0.048 \pm 0.0044) long, respectively, with STS lateroanterior to inner MTS. Prothorax width (PW) 0.285-0.370 (231: 0.327 \pm 0.0155). Tergal setae. I, 2; II, 13-24 (232: 17.8 \pm 1.83); III, 20-31 (232: 25.2 \pm 2.16); IV, 21-36 (232: 27.8 \pm 2.44); V, 18-35 (228: 25.6 \pm 2.82); VI, 17-32 (228: 24.3 \pm 2.56); tergal and pleural setae on VII, 31-43 (228: 37.3 \pm 2.65); medial setae on VIII, 2. Longest seta of medial 10 on tergite VI, 0.080-0.120 (231: 0.099 \pm 0.0071); on tergite VII, 0.070-0.115 (221: 0.095 \pm 0.0076), with 0-4 (221: 0.2 \pm 0.62) of these longer than 0.100. Longest seta of medial pair on tergite VIII, 0.045-0.110 (210: 0.077 \pm 0.0128). Last tergite with 3 lateral setae (LS; Fig. 8) close together on each side; outer seta generally shorter, 0.045-0.095 (183: 0.066 \pm 0.0090) long, and middle and inner setae subequal in length, 0.045-0.095 (182: 0.077 \pm 0.0084) and 0.065-0.110 (194: 0.083 \pm 0.0075) long, respectively. Sternal setae. II, 13-21 (227: 16.2 \pm 1.75); III, 12-21 (226: 16.9 \pm 1.62); IV, 13-22 (227: 17.1 \pm 1.49); V, 10-18 (228: 13.7 \pm 1.32); VI, 10-16 (225: 12.9 \pm 1.14); VII, 8-16 (230: 12.1 \pm 1.39). Subgenital plate. As in Fig. 8 (SGP), with 15-28 (232: 20.1 \pm 2.26) setae, with distribution and lengths as shown, with 1 seta on each side distinctly longer and thicker than others. Postvulval sclerite (PVS; Fig. 8) as in Fig. 6, with 2 subequal short setae on each side. Genital sac as in Fig. 7. width (GSW) 0.210-0.315 (232: 0.258 \pm 0.0201), length (GSL) 0.145-0.245 (228: 0.208 \pm 0.0161), with 3-12 (231: 7.2 \pm 1.73) well-defined curved loops, posteriormost loop situated 0.045-0.135 (231: 0.096 \pm 0.0136) back from anterior sac margin. Total length 1.070-1.520 (227: 1.279 \pm 0.0657).

♂. As in Fig. 5. Temple width 0.370-0.430 (201: 0.403 \pm 0.0128); head length 0.280-0.340 (201: 0.311 \pm 0.0132); submarginal and inner marginal temple setae (STS, MTS; Fig. 4) 0.075-0.130 (138: 0.105 \pm 0.0115) and 0.020-0.035 (194: 0.026 \pm 0.0030) long, respectively, with STS lateroanterior to inner MTS; both inner and outer MTS blunt, spiniform. Antenna (Fig. 2) with scape length (SL) 0.150-0.180 (186: 0.165 \pm 0.0069), scape medial width (SMW) 0.090-0.130 (185: 0.110 \pm 0.0073), scape distal width (SDW) 0.120-0.165 (184: 0.141 \pm 0.0101). Prothorax width 0.270-0.330 (200: 0.305 \pm 0.0130). Tergal setae. I, 2; II, 9-19 (200: 11.4 \pm 1.75); III, 17-28 (202: 21.8 \pm 2.14); IV, 18-32 (198: 21.7 \pm 2.44); V, 17-29 (196: 23.1 \pm 2.47); VI, 14-25 (190: 17.3 \pm 1.81); tergal and pleural setae on VII, 18-31 (201: 24.2 \pm 2.78). Sternal setae. II, 10-20 (201: 15.2 \pm 1.72); III, 12-21 (198: 16.6 \pm 1.66); IV, 11-22 (199: 17.0 \pm 1.58); V, 9-18 (197: 11.2 \pm 1.30); VI, 10-17 (202: 13.0 \pm 1.17); VII, 7-14 (200: 10.3 \pm 1.31); VIII, 4-9 (198: 6.3 \pm 0.73). Total length 1.200-1.485 (193: 1.345 \pm 0.0574). Genitalia. As in Fig. 11; sac having 6 large spines (GSS), shaped and aligned much as in Fig. 10; parameral arch (PA) width (PAW) 0.145-0.180 (195: 0.160 \pm 0.0068); endomerale plate (EP) triangular (Fig. 9), with apical division, width (EPW) 0.070-0.095

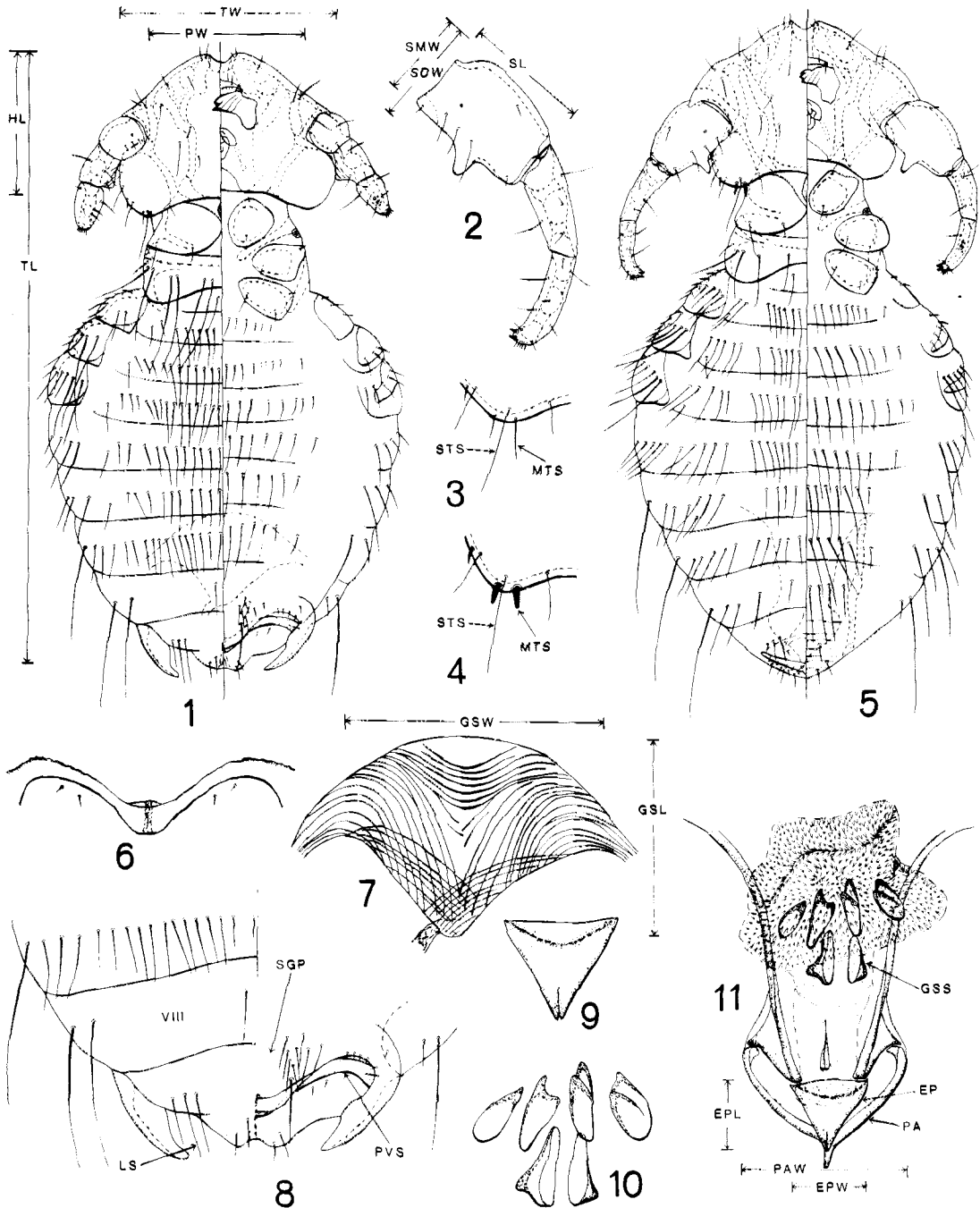


FIG. 1-11. *Geomydoecus californicus*: (1) ♀ (TW, temple width; PW, prothorax width; HL, head length; TL, total length); (2) ♂ dorsal antenna (SL, scape length; SMW, scape medial width; SDW, scape distal width); (3) ♀ temple margin (MTS, marginal temple seta; STS, submarginal temple seta); (4) ♂ temple margin (MTS, marginal temple seta; STS, submarginal temple seta); (5) ♂; (6) ♀ postvulval sclerite; (7) ♀ genital sac (GSL, genital sac length; GSW, genital sac width); (8) ♀ terminalia (LS, lateral setae; SGP, subgenital plate; PVS, postvulval sclerite); (9) ♂ endomerale plate; (10) ♂ genital sac spines; (11) ♂ genitalia (GSS, genital sac spines; EP, endomerale plate; PA, parameral arch; EPL, endomerale plate length; EPW, endomerale plate width; PAW, parameral arch width).

(200: 0.084 ± 0.0041), length (EPL) $0.060-0.080$ (192: 0.069 ± 0.0051).

Remarks. Chapman (1897) described *Trichodectes californicus* from 1 female taken off a pocket mouse, *Perognathus* sp., from Baja California, Mexico. The description is so generalized as to make specific placement impossible; the illustration agrees in general with *Geomydoecus*. Assuming this identification is correct, the listed host is obviously in error and the louse represents a straggler or contaminant. Upon trying to locate this type-specimen, we found it was apparently missing as early as 1916 and has not been found since. It is not now in the Kellogg Collection at the University of California, Berkeley, and must be presumed lost. Werneck (1945) apparently recognized that this specimen no longer existed; at that time he identified some lice from *T. b. bottae* from California as *G. californicus*. This action has resulted in the adoption of this gopher subspecies as the type-host, even though to do so one must overlook the fact that the original louse came from Baja California and *T. b. bottae* occurs only in California.

Price & Emerson (1971) accepted Werneck's identification, doing nothing further to stabilize the identity of *G. californicus* other than giving a redescription of the species. However, now that we have found this presumed single species to represent a complex of 16 taxa, it is imperative to erect a neotype for *G. californicus*. Fortunately, we found the *Geomydoecus* from the southern range of *T. b. bottae* to be conspecific with lice ranging south into northern Baja California. This being the case, we are able to leave *T. b. bottae* as the type-host.

Neotype ♀, *T. b. bottae* (University of California Museum of Vertebrate Zoology—125698), USA: California: Los Angeles Co.: Los Angeles, 8.IV.1954, N. B. McCulloch; in collection of University of California, Berkeley. Neoparatypes: 28♀, 27♂, *T. b. bottae*, USA: California: Kern Co.: Old Fort Tejon (2); Los Angeles Co.: Bellflower (1), Hyperion (1), Long Beach (2), Los Angeles (2), South Gate (1).

Other specimens examined. USA: California: 52♀, 78♂, *T. b. alpinus* Merriam, Inyo Co.: Cottonwood Lakes, Sierra Nevada Mts (2); Los Angeles Co.: Pine Creek on Ridge Route (1); Tulare Co.: Sierra Nevada Mts: Jackass Meadow (1), Kennedy Meadows (2), Lamont Meadow (2), Long Meadow (1), Taylor Meadow (1), 32♀, 42♂, *T. b. altivallis* Rhoads, San Bernardino Co.: San Bernardino Mts: Bear Lake (1), Big Pine Flat (2), Bluff Lake (2), Camp Radford (1), Fawnskin Valley (1), 8 mi. (12.9 km) SSE of Hesperia (1), Holcomb Valley (1), Sugarloaf (4), 16♀, 21♂, *T. b. avahuee* Merriam, Fresno Co.: Horse Corral Meadow, Sierra Nevada Mts (1), Hume (1); Mariposa Co.: Yo-

semit Valley (1); Tulare Co.: Big Meadow (2), Halstead Meadows, Sequoia Nat Pk (3), Giant Forest, Sequoia Nat Pk (1), 24♀, 18♂, *T. b. jacintus* Grinnell & Swarth, Riverside Co.: San Jacinto Mts: Fullers Mill (1), Garner Valley (2), Round Valley (2), Strawberry Valley (1), 17♀, 43♂, *T. b. newa* Merriam, Fresno Co.: Shaver Ranger Sta (7), 16♀, 10♂, *T. b. mohavensis* Grinnell, Los Angeles Co.: Fairmont (1); Riverside Co.: 1.25 mi. (2.0 km) W, 0.5 mi. (0.8 km) S of Pinyon Wells (1), 13 mi. (20.9 km) SW of Twentynine Palms, Joshua Tree Nat Mon (1); San Bernardino Co.: 18 mi. (29.0 km) N of Ludlow (1), 13♀, 20♂, *T. b. neglectus* V. Bailey, Kern Co.: 1.6 mi. (2.6 km) W (1), 6 mi. (9.7 km) W (1) of Lebec; Los Angeles Co.: Pleasant View Ridge, Juniper Hills (1), 5 mi. (8.0 km) SE of Valyermo, San Gabriel Mts (1); San Bernardino Co.: Bear Flat, San Gabriel Mts (1); Ventura Co.: Mt Pinos (2), 78♀, 102♂, *T. b. nigricans* Rhoads, Riverside Co.: 3 mi. (4.8 km) SSE of Temecula (1); San Diego Co.: 4 mi. (6.4 km) NE (1), 3 mi. (4.8 km) S (1), at (2) Escondido, Jamacha Jet (2), Laguna Mts (3), San Marcos (2), Witch Creek (4), 27♀, 15♂, *T. b. pallescens* Rhoads, Kern Co.: Willow Springs (1); Los Angeles Co.: Covina (1), San Gabriel (1), Temple City (1); Riverside Co.: 5 mi. (8.0 km) SW of Arlington (1), Riverside (1), 6♀, 7♂, *T. b. piuteensis* Grinnell & Hill, Kern Co.: Piute Mts (2), Sorrell Ranch, Kelso Valley (2), 35♀, 43♂, *T. b. sanctidiegi* Huey, San Diego Co.: 5 mi. (8.0 km) S of Fallbrook (1), National City (1), San Diego (3). MEXICO: Baja California: 48♀, 45♂, *T. b. juarezensis* Huey, Sierra Juarez: El Progreso (2), El Rayo (2), 14 mi. (22.5 km) N (1), at (3) Laguna Hanson, 44♀, 68♂, *T. b. martirensis* J. A. Allen, San Pedro Mártir Mts: La Grulla (5), Vallecitos (2), 12♀, 13♂, *T. b. nigricans*, Agua Hechicera (1), 31♀, 50♂, *T. b. sanctidiegi*, 5 mi. (8.0 km) S of Misión San Miguel (2), W coast, 5 mi. (8.0 km) S of Monument 258 (1).

Geomydoecus centralis Price & Hellenthal, new species FIG. 12

Type-host. *Thomomys bottae centralis* Hall.

♀. Much as for *G. californicus*, except as follows. Submarginal and inner marginal temple setae 0.070–0.110 (601: 0.090 ± 0.0077) and 0.030–0.060 (702: 0.045 ± 0.0048) long, respectively. Prothorax width 0.285–0.375 (722: 0.323 ± 0.0137). Longest seta of medial pair on tergite VIII, 0.040–0.105 (690: 0.070 ± 0.0115). Last tergite with outer seta 0.025–0.080 (596: 0.060 ± 0.0090), middle seta 0.045–0.095 (613: 0.075 ± 0.0074), inner seta 0.060–0.100 (619: 0.080 ± 0.0071) long. Sternal setae. II, 10–21 (734: 14.9 ± 1.67); VII, 8–15 (727: 11.7 ± 1.20). Subgenital plate. With 15–28 (729: 19.5 ± 1.94) setae. Genital sac width 0.190–0.305 (732: 0.252 ± 0.0176), length 0.145–0.260 (723: 0.213 ± 0.0160), with 3–13 (729: 7.9 ± 1.54) loops, posteriormost loop situated 0.070–0.140 (726: 0.102 ± 0.0115) back from anterior sac margin. Total length 1.060–1.495 (712: 1.261 ± 0.0652).

♂. Much as for *G. californicus*, except as follows. Temple width 0.370–0.430 (603: 0.398 ± 0.0105); head length 0.280–0.355 (604: 0.308 ± 0.0120); submarginal temple seta 0.070–0.130 (450: 0.102 ± 0.0102) long. Antenna with scape length 0.145–0.185 (583: 0.161 ± 0.0068), scape medial width 0.090–0.135 (582: 0.108 ± 0.0065), scape distal width 0.115–0.170 (581: 0.135 ± 0.0085). Prothorax width 0.270–0.340 (619: 0.302 ± 0.0120). Tergal setae. II, 10–20 (617: 14.0 ± 1.60); III, 13–28 (615: 21.3 ± 1.99); IV, 17–31 (610: 24.2 ± 2.26); VI, 12–23 (611: 16.9 ± 1.62); tergal and pleural setae on VII, 18–31 (617: 24.7 ± 2.27). Sternal setae. II, 10–20 (614: 14.3 ± 1.68); III, 11–22 (613: 16.1 ± 1.53); V, 9–19 (616: 13.8 ± 1.27); VI, 7–16 (617: 12.7 ± 1.25); VII, 6–13 (618: 9.8 ± 1.38). Genitalia. Parameral arch width 0.135–0.180 (606: 0.156 ± 0.0069); en-

domeral plate (FIG. 12) with narrowed apical portion and width of 0.065–0.085 (618: 0.077 ± 0.0038).

Remarks. Qualitatively, the male of *G. centralis* is separated from that of *G. californicus* by the shape of the genitalic endomeral plate, with the former having this plate apically narrowed (FIG. 12) instead of being essentially triangular (FIG. 9). There are no known qualitative or quantitative features for separating the females. For males, the best quantitative character for distinguishing *G. centralis* from *G. californicus* and its critical value for discrimination and probability of misidentification was the width of the genitalic endomeral plate 0.081 (0.161).

Holotype ♂, *T. b. centralis* (University of California Museum of Vertebrate Zoology—44839), USA: Nevada: Lincoln Co.: Alamo, 29.V.1930, L. Kellogg; in collection of University of Minnesota. Paratypes: 75♀, 122♂, *T. b. centralis*, USA: California: San Bernardino Co.: 2.5 mi. (4.0 km) S of California-Nevada line, Colorado River (3); Nevada: Clark Co.: 0.5 mi. (0.8 km) N of California-Nevada Monument, Colorado River (1), Indian Springs (1), 26 mi. (41.8 km) N of Las Vegas (2), Durban Ranch, 14 mi. (22.5 km) E of Searchlight, Colorado River (1); Lincoln Co.: Alamo (1), 1 mi. (1.6 km) N of Ash Spring, Pahrnagat Valley (2), Panaca (1); Nye Co.: Ash Meadows, 4.8 mi. (7.7 km) NW of Devils Hole (2), 4 mi. (6.4 km) NE (1), at (1) Beatty, White River Valley, 15 mi. (24.1 km) WSW of Sunnyside (1); White Pine Co.: Cleveland Ranch, Spring Valley (1); Utah: Millard Co.: 1 mi. (1.6 km) E of Garrison (4), Tule Springs (1).

Other specimens examined. USA: 105♀, 103♂, *T. b. absonus* Goldman, Arizona: Coconino Co.: 0.5 mi. (0.8 km) W of Fredonia (1), Jacobs Pools, House Rock Valley (4), 12 mi. (19.3 km) W of Navajo Bridge, Colorado River (3); Mohave Co.: near S boundary of Kaibab Indian Reservation (2); Utah: Garfield Co.: 8 mi. (12.9 km) E (1), 8 mi. (12.9 km) W (1) of Boulder; Kane Co.: 1 mi. (1.6 km) S (1), 2.2 mi. (3.5 km) N (2), at (1) Kanab, 25♀, 18♂, *T. b. abstrusus* Hall & Davis, Nevada: Nye Co.: 2 mi. (3.2 km) SE of Tulle Peak, Fish Spring Valley (3), 53♀, 53♂, *T. b. albicaudatus* Hall, Utah: Juab Co.: 2 mi. (3.2 km) S of Nephi (1); Salt Lake Co.: 4 mi. (6.4 km) SE (1), at (3) Salt Lake City; Tooele Co.: Bauer (1), Clover Creek, Onaqui Mts (1), 1 mi. (1.6 km) S of Grantsville (1), St. John (3); Utah Co.: Fairfield (2), Provo (1), 4♂, *T. b. argusensis* Huey, California: Inyo Co.: 16 mi. (25.7 km) SSE of Darwin (1), 60♀, 36♂, *T. b. aureiventris* Hall, Utah: Box Elder Co.: Kelton (2), S end of Terrace Mts (2), E side of Tecoma Range at Utah-Nevada line (3); Juab Co.: Trout Creek (1); Tooele Co.: Irapah (4), 14♀, 15♂, *T. b. aureus* J. A. Allen, Utah: Kane Co.: Bullfrog Basin, Glen Canyon NRA (1); Sevier Co.: Richfield (1), 15♀, 10♂, *T. b. birdseyei* Goldman, Utah: Washington Co.: Mountain Meadows (1), Pine Valley, Pine Valley Mts (4), 20♀, 22♂, *T. b. bonnevilliei* Durrant, Utah: Juab Co.: Fish

Spring (6), 4♀, 1♂, *T. b. boreorarius* Durham, Arizona: Coconino Co.: N rim of Grand Canyon (2), 15♀, 17♂, *T. b. brevidens* Hall, Nevada: Nye Co.: Breen Creek, Kawich Range (1), 3.5 mi. (5.6 km) E of Nyala (3), 50♀, 71♂, *T. b. canus* V. Bailey, California: Lassen Co.: 2.4 mi. (3.9 km) S, 1.5 mi. (2.4 km) W (4), 3.0 mi. (4.8 km) S, 1.7 mi. (2.7 km) W (3), 2.1 mi. (3.4 km) S, 0.8 mi. (1.3 km) W (1) of Herlong, High Rock Ranch (2); Nevada: Churchill Co.: 4 mi. (6.4 km) W of Fallon (3); Lyon Co.: 1 mi. (1.6 km) N of Wadsworth (1); Storey Co.: 9.5 mi. (15.3 km) E of Reno, S side of Truckee River (1); Washoe Co.: Clark, Truckee River (1), Deep Hole (1), 15♀, 5♂, *T. b. cedrinus* Huey, Arizona: Mohave Co.: Chemehuevi Mts (2), 14♀, 34♂, *T. b. cinereus* Hall, Nevada: Lyon Co.: W Walker River, Smiths Valley (1), Wichman (1), 12 mi. (19.3 km) S of Yerington (1); Mineral Co.: 3 mi. (4.8 km) S (1), 8 mi. (12.9 km) NW (2) of Schurz, 5 mi. (8.0 km) NW of Morgatus Ranch, E Walker River (1), 31♀, 48♂, *T. b. concisor* Hall & Davis, Nevada: Nye Co.: Potts Ranch, Monitor Valley (4), 42♀, 47♂, *T. b. contractus* Durrant, Utah: Beaver Co.: 2 mi. (3.2 km) E of Adamsville (2), Beaver (2); Millard Co.: Oak City (3), Scipio (5), 13♀, 10♂, *T. b. convexus* Durrant, Utah: Millard Co.: E side of Clear Lake (6), 12♀, 21♂, *T. b. curtatus* Hall, Nevada: Nye Co.: San Antonio (3), 18♀, 30♂, *T. b. depressus* Hall, Nevada: Churchill Co.: Dixie Meadows (4), 15 mi. (24.1 km) SW of Fallon (1), 1.4 mi. (2.3 km) NE of Ocala (1), 36♀, 39♂, *T. b. desertorum* Merriam, Arizona: Mohave Co.: 4 mi. (6.4 km) SW of Dolan Spring (2), Kingman (2), Mud Spring, 12 mi. (19.3 km) SW of Chloride (1), 1 mi. (1.6 km) S (1), 12 mi. (19.3 km) S (1) of Yucca, 1♀, 1♂, *T. b. dissimilis* Goldman, Utah: Garfield Co.: Henry Mts (2), 12♀, 16♂, *T. b. extenuatus* Goldman, Arizona: Cochise Co.: Willcox (3), 37♀, 30♂, *T. b. fulvus* (Woodhouse), Arizona: Graham Co.: Juniper (1); New Mexico: Catron Co.: 2 mi. (3.2 km) N of Glenwood (1), 12♀, 14♂, *T. b. fumosus* Hall, Nevada: Lander Co.: Kingston Ranch, 16 mi. (25.7 km) N of Millett (1); Nye Co.: Milman Ranch, 19 mi. (30.6 km) SE of Millett (2), Peavine Ranch, 7 mi. (11.3 km) N of San Antonio (1), 24♀, 38♂, *T. b. howelli* Goldman, Utah: Grand Co.: 13.3 mi. (21.4 km) N of Moab (4), 25♀, 14♂, *T. b. lacrymalis* Hall, Nevada: Esmeralda Co.: Arlemont (2), McNett Ranch (1); Mineral Co.: Cat Creek, 4 mi. (6.4 km) W of Hawthorne (1), 14♀, 18♂, *T. b. latus* Hall & Davis, Nevada: White Pine Co.: Cherry Creek (2), 6.5 mi. (10.5 km) SE of Ely (4), 28♀, 82♂, *T. b. lewis* Goldman, Utah: Millard Co.: Lymndyl (3); Piute Co.: 12 mi. (19.3 km) E of Kingston (2); Sevier Co.: Belknap Ranger Sta., Tushar Mts (1), 0.5 mi. (0.8 km) N of Elsinore (1), 8♀, 3♂, *T. b. levidensis* Goldman, Utah: Sanpete Co.: Spring City (1), 19♀, 37♂, *T. b. lucrificus* Hall & Durham, Nevada: Churchill Co.: Eastgate (3), 44♀, 24♂, *T. b. mearnsi* V. Bailey, New Mexico: Hidalgo Co.: Animas Valley: Grays Ranch (6), 4 mi. (6.4 km) NW of San Luis Pass (2), 83♀, 85♂, *T. b. melanotis* Grinnell, California: Inyo Co.: Deep Springs Valley, 1 mi. (1.6 km) W of Lake (1), Marble Canyon, White Mts (1), Carl Walters Ranch, 2 mi. (3.2 km) N of Independence (1); Mono Co.: 5 mi. (8.0 km) N of Benton (2), Campito Meadow, White Mts (2), Crooked Creek, White Mts (2), 5♀, 10♂, *T. b. minimus* Durrant, Utah: Tooele Co.: Stansbury I (3), 11♀, 16♂, *T. b. modicus* Goldman, Arizona: Pima Co.: S slope of Molino Basin, Santa Catalina Mts (2), 27♀, 20♂, *T. b. nanus* Hall, Nevada: Lincoln Co.: E slope of Irish Mt (1); Nye Co.: 5.5 mi. (8.8 km) NW of Whitecrock Spring, S end of Belted Range (1), Burned Corral Canyon (1), 2 mi. (3.2 km) SE of Oak Spring (1), 32♀, 30♂, *T. b. mesophilus* Durrant, Utah: Davis Co.: Antelope I (4), 14♀, 9♂, *T. b. nicholi* Goldman, Arizona: Mohave Co.: Diamond Butte (1), 4 mi. (6.4 km) N (2), at (1) Wolf Hole, 47♀, 59♂, *T. b. operarius* Merriam, California: Inyo Co.: 4 mi. (6.4 km) N (2), at (5) Keeler, 63♀, 14♂, *T. b. opulentis* Goldman, New Mexico: Socorro Co.: San Marcial (3), Socorro (3), 21♀, 25♂, *T. b. oreocus* Burt, Cal-

ifornia: Inyo Co.: Greenwater, Panamint Mts (2), Summit of Salsbery Pass (1); Nevada: Nye Co.: 2.5 mi. (4.0 km) E, 1.0 mi. (1.6 km) S of Grapevine Peak (2). 25♀, 24♂, *T. b. osgoodi* Goldman, Utah: Carbon Co.: 0.5 mi. (0.8 km) NE (1), at (1) Spring Glen; Emery Co.: 5 mi. (8.0 km) S of Castle Dale (2), Green River (1), 32.5 mi. (52.3 km) NE of Hanksville (2); Wayne Co.: Notom (1). 37♀, 40♂, *T. b. perpex* Merriam, California: Inyo Co.: Lone Pine (3), Tuttle Creek (1); Kern Co.: Onyx (1), Rosamond (1), 2.6 mi. (4.2 km) SE of Walker Pass, Freeman Canyon (2). 36♀, 45♂, *T. b. phelleoecus* Burt, Nevada: Clark Co.: Hidden Forest, Sheep Mts (5). 48♀, 76♂, *T. b. pinalensis* Goldman, Arizona: Pinal Co.: Oak Flat (3), 5 mi. (8.0 km) E of Superior (1). 53♀, 50♂, *T. b. planirostris* Burt, Utah: Washington Co.: 0.5 mi. (0.8 km) W of Grafton (1), 3 mi. (4.8 km) SW (3), at (2) St. George, Springdale (1), 1 mi. (1.6 km) E of Virgin (2), Zion Natl Park (1). 74♀, 56♂, *T. b. providentialis* Grinnell, California: San Bernardino Co.: 3 mi. (4.8 km) S, 7 mi. (11.3 km) E of Cima (1), Gold Valley Ranch, Providence Mts (4), 1 mi. (1.6 km) N, 1 mi. (1.6 km) W of Horse Thief Springs (1), 8 mi. (12.9 km) E of Mountain Springs (1), 29 mi. (46.7 km) S of Needles, Colorado River (2), Providence Mts (3); Nevada: Clark Co.: 8 mi. (12.9 km) S of Dead Mts (1). 34♀, 20♂, *T. b. robustus* Durrant, Utah: Tooele Co.: Orrs Ranch, Skull Valley (10). 10♀, 15♂, *T. b. severi* Durrant, Utah: Millard Co.: Swasey Spring, House Mt (4). 12♀, 12♂, *T. b. solitarius* Grinnell, Nevada: Esmeralda Co.: 4 mi. (6.4 km) NE of Arlemont (2), Lone Mt, 12.5 mi. (20.1 km) W, 2.5 mi. (4.0 km) S of Tonopah (1); Mineral Co.: Fingerrock Wash, Stewart Valley (1). 12♀, 12♂, *T. b. stansburyi* Durrant, Utah: Tooele Co.: S Willow Creek, Stansbury Mts (4). 26♀, 14♂, *T. b. suboles* Goldman, Arizona: Mohave Co.: Searchlight Ferry, Colorado River (4). 12♀, 21♂, *T. b. tivius* Durrant, Utah: Millard Co.: Oak Creek Canyon: 6 mi. (9.7 km) E of Oak City (4), Canyon Mts (1). 26♀, 24♂, *T. b. trumbullensis* Hall & Davis, Arizona: Mohave Co.: 4 mi. (6.4 km) S of Nixon Spring, Trumbull Mts (6). 15♀, 18♂, *T. b. vescus* Hall & Davis, Nevada: Nye Co.: Toquima Mts: 1.5 mi. (2.4 km) E of Jefferson (1), Meadow Creek Ranger Sta (2), 5 mi. (8.0 km) E of Meadow Valley Ranger Sta (1). 53♀, 36♂, *T. b. wahwahensis* Durrant, Utah: Beaver Co.: Wah Wah Springs, 30 mi. (48.3 km) W of Milford (4); Millard Co.: Pine City (3). 6♀, 12♂, *T. b. subsp.*, Utah: Sevier Co.: 0.5 mi. (0.8 km) W of Sigurd (1); Tooele Co.: Indian Spring, Simpson Mts (1), NE end of Stansbury I (1), N base of Little Granite Mt (1). 42♀, 14♂, *T. umbrinus emotus* Goldman, New Mexico: Hidalgo Co.: 30.5 mi. (49.1 km) S of Animas on St Hwy 180 (1), Bear Canyon near Double Adobe Canyon (1), 5 mi. (8.0 km) E of Cloverdale (1), Guadalupe Canyon, 2 mi. (3.2 km) E of Arizona-New Mexico line (1). MEXICO: 34♀, 28♂, *T. b. camoaa* Burt, Sonora: Camoaa, Río Mayo (4), 14 mi. (22.5 km) N of Ciudad Obregón (1), Presa Obregón (1). 4♀, 8♂, *T. b. estanciae* Benson & Tillotson, Sonora: La Estancia, 6 mi. (9.7 km) N of Nacori (3). 16♀, 16♂, *T. b. sinaloa* Merriam, Sinaloa: 5 mi. (8.0 km) N of San Blas (3). 22♀, 15♂, *T. b. toltecus* J. A. Allen, Chihuahua: 1 mi. (1.6 km) W of El Carmen (1), 5 mi. (8.0 km) SE of Galeana (2). 1♂, *T. b. subsp.*, Sinaloa: 7.5 mi. (12.1 km) N of Higuera de Zaragoza (1). 23♀, 31♂, *T. u. subsp.*, Sonora: 2 mi. (3.2 km) E of Guiricoba (2).

Geomydoecus albatii Price & Hellenthal, new species

Type-host. *Thomomys bottae albatius* Grinnell.

♀. Much as for *G. californicus*, except as follows. Temple width 0.385–0.460 (66: 0.421 ± 0.0135); head length 0.265–0.320 (66: 0.295 ± 0.0134); submarginal and inner marginal

temple setae 0.065–0.095 (55: 0.083 ± 0.0054) and 0.040–0.060 (66: 0.045 ± 0.0042) long, respectively. Prothorax width 0.280–0.330 (66: 0.310 ± 0.0122). Tergal setae. II, 12–19 (66: 15.6 ± 1.53); III, 19–28 (66: 23.4 ± 2.02); IV, 22–32 (66: 26.4 ± 2.26); V, 19–31 (66: 24.3 ± 2.53); VI, 18–29 (66: 22.9 ± 2.32); tergal and pleural setae on VII, 27–39 (65: 32.7 ± 2.54). Longest setae of medial 10 on tergite VI, 0.075–0.100 (64: 0.092 ± 0.0057); on tergite VII, 0.075–0.105 (61: 0.091 ± 0.0068). Longest seta of medial pair on tergite VIII, 0.055–0.085 (59: 0.069 ± 0.0079). Sternal setae. II, 12–19 (66: 15.5 ± 1.38). Subgenital plate. With 15–25 (66: 19.0 ± 1.97) setae. Genital sac width 0.215–0.280 (66: 0.251 ± 0.0138), length 0.180–0.245 (66: 0.216 ± 0.0160), with 7–11 (66: 8.7 ± 1.08) loops, posteriormost loop situated 0.070–0.145 (66: 0.105 ± 0.0125) back from anterior sac margin. Total length 0.995–1.365 (64: 1.231 ± 0.0644).

♂. Much as for *G. californicus*, except as follows. Temple width 0.355–0.415 (47: 0.384 ± 0.0110); head length 0.280–0.330 (47: 0.304 ± 0.0126); submarginal temple seta 0.085–0.115 (37: 0.100 ± 0.0075) long. Antenna with scape length 0.145–0.180 (44: 0.159 ± 0.0083), scape medial width 0.090–0.120 (44: 0.106 ± 0.0067), scape distal width 0.110–0.150 (44: 0.134 ± 0.0081). Prothorax width 0.270–0.330 (46: 0.295 ± 0.0120). Tergal setae. II, 10–16 (46: 13.0 ± 1.25); III, 16–24 (47: 20.5 ± 2.02); tergal and pleural setae on VII, 19–27 (47: 22.3 ± 2.05). Sternal setae. IV, 14–22 (46: 18.4 ± 1.88). Genitalia. Parameral arch width 0.140–0.170 (45: 0.153 ± 0.0065); endomerale plate width 0.065–0.080 (46: 0.072 ± 0.0038).

Remarks. Qualitatively, there are no known characters for separating *G. albatii* from *G. californicus*. The male of *G. albatii*, in having a triangular genitalic endomerale plate (FIG. 9), may be distinguished from that of *G. centralis*, but females of these 2 taxa are apparently qualitatively inseparable. Quantitatively, for males of *G. albatii* compared to those of *G. californicus*, the best characters and their critical values for discrimination and probabilities of misidentification were the genitalic endomerale plate width 0.078 (0.064) and the temple width 0.394 (0.227); compared to *G. centralis*, the best were the temple width 0.391 (0.254) and the endomerale plate width 0.074 (0.263). For females of *G. albatii* compared to those of *G. californicus*, the best were the number of tergal and pleural setae on VII (STG7) 35.00 (0.190), the length of the submarginal temple seta (STS) 0.089 (0.222), the temple width 0.431 (0.254), and the number of setae on tergite II (STG2) 16.69 (0.270); the use of STS, STG2, and STG7 in combination provided a probability of misidentification of 0.140, with respective discriminant function coefficients of 0.69, 0.0018, and 0.0020 and a critical value for the discriminant of 0.161 (discriminant means and standard deviations for *G. albatii* were 0.150 ± 0.0083 and for *G. californicus* 0.171 ± 0.0099). Compared to *G. centralis*, the best quantitative characters were the temple width 0.431 (0.216) and the number of tergal and pleural setae on VII 34.80 (0.232).

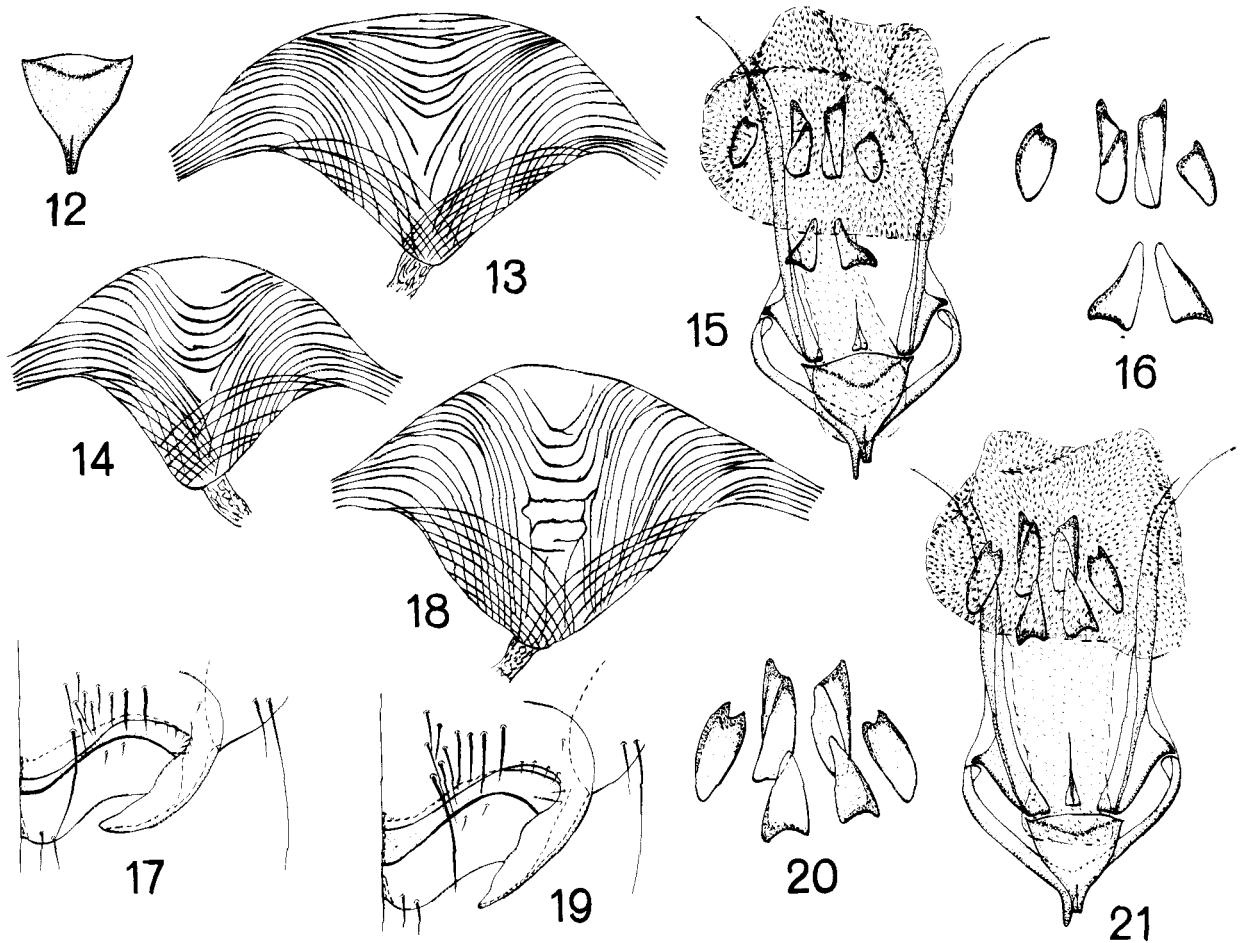


FIG. 12-21. (12) *Geomydoecus centralis* ♂ endomerale plate. (13) *G. angularis* ♀ genital sac. 14-17. *G. bajaiensis*: (14) ♀ genital sac; (15) ♂ genitalia; (16) ♂ genital sac spines; (17) ♀ ventral terminalia. 18-21. *G. clausmae*: (18) ♀ genital sac; (19) ♀ ventral terminalia; (20) ♂ genital sac spines; (21) ♂ genitalia.

Holotype ♂, *T. b. albatu*s (University of California Museum of Vertebrate Zoology—62031), USA: Arizona: Yuma Co.: 1 mi. (1.6 km) N of San Luis, 5.I.1934, A. M. Alexander; in collection of University of Minnesota. Paratypes: 95 ♀, 133 ♂, *T. b. albatu*s, USA: Arizona: Yuma Co.: 4 mi. (6.4 km) S of Gadsden (4), 1 mi. (1.6 km) N of San Luis (2), 4 mi. (6.4 km) E (2), 4 mi. (6.4 km) S (2), 5 mi. (8.0 km) S (4), 13.5 mi. (21.7 km) SW (1), at (1) Yuma; California: Imperial Co.: Fort Yuma (1), 3 mi. (4.8 km) E of Holtville (1).

Other specimens examined. 16 ♀, 27 ♂, *T. b. depauperatus* Grinnell & Hill, USA: Arizona: Yuma Co.: 2 mi. (3.2 km) N (2), at (2) Tinajas Altas. 60 ♀, 62 ♂, *T. b. phasma* Goldman, USA: Arizona: Yuma Co.: S end of Tule Desert, 3 mi. (4.8 km) N of Monument 182 (1), Tule Desert, 8 mi. (12.9 km) NW of Monument 179 (1), Tule Well (1); MEXICO: Sonora: Pozo de San Emeterio, 8.5 mi. (13.7 km) N of Quitovac (1), 1 mi. (1.6 km)

E of Rio Sonoita at Batamote, 30 mi. (48.3 km) SW of Sonoita (2). 12 ♀, 8 ♂, *T. b. varrosemi* Huey, Sonora: Punta Peñasco (5).

Geomydoecus angularis Price & Hellenthal, new species FIG. 13

Type-host. *Thomomys bottae angularis* Merriam.

♀. Much as for *G. californicus*, except as follows. Temple width 0.405–0.485 (192: 0.450 ± 0.0133); inner marginal temple seta 0.035–0.055 (188: 0.045 ± 0.0054) long. Prothorax width 0.295–0.370 (196: 0.331 ± 0.0146). Longest seta of medial pair on tergite VIII, 0.045–0.105 (187: 0.080 ± 0.0110). *Sternal setae.* II, 10–21 (195: 15.2 ± 1.88); III, 13–21 (194: 16.4 ± 1.53); IV, 12–22 (190: 16.5 ± 1.70); V, 10–17 (189: 13.2 ± 1.23). *Subgenital plate.* With 16–28 (197: 20.9 ± 2.23) setae. *Genital sac* as in FIG. 13, width 0.185–0.325 (198: 0.263 ± 0.0207), with 2–11 (196: 6.5 ± 1.55) loops or transverse lines across anterior portion of sac, posteriormost loop situated 0.050–0.115 (196: 0.081 ± 0.0137) back from anterior sac margin.

♂. Much as for *G. californicus*, except as follows. Temple width 0.380–0.435 (198: 0.410 ± 0.0101). Prothorax width 0.285–0.340 (199: 0.312 ± 0.0111). *Sternal setae*. II, 10–29 (200: 14.5 ± 2.12); III, 12–21 (197: 16.0 ± 1.45); IV, 10–20 (197: 16.4 ± 1.69); V, 10–17 (199: 13.5 ± 1.24); VIII, 5–8 (199: 6.5 ± 0.79). Total length 1.150–1.490 (193: 1.362 ± 0.0653). *Genitalia*. Endomeral plate length 0.055–0.085 (193: 0.071 ± 0.0056).

Remarks. Qualitatively, the female of *G. angularis* is recognizable from that of the other 3 taxa of this group by its genital sac having transverse lines across the anterior portion (FIG. 13) as compared to the others having evenly rounded loops (FIG. 7). The male of *G. angularis* is similar to that of *G. californicus* and *G. albatii*, but differs from *G. centralis* by the triangular shape of its genitalic endomeral plate (FIG. 9). We could find no quantitative means for separating *G. angularis* from *G. californicus*. For the female of *G. angularis* compared to that of *G. centralis*, the best quantitative character was distance of the posteriormost genital sac loop back from the anterior margin 0.092 (0.200); for the male, the width of the genitalic endomeral plate 0.080 (0.161). For the female of *G. angularis* compared to that of *G. albatii*, the best were the temple width (TW) 0.435 (0.140), the distance of the posteriormost genital sac loop back from the anterior margin (GSLPL) 0.093 (0.187), the length of the submarginal temple seta (STS) 0.088 (0.220), and the number of genital sac loops 7.62 (0.224); the use of STS, GSLPL, and TW in combination provided a much improved separation, giving a probability of misidentification of 0.039, with respective discriminant function coefficients of -1.02 , 1.01 , and -0.98 and a critical value for the discriminant of -0.423 (discriminant means and standard deviations for *G. angularis* were -0.453 ± 0.0183 and for *G. albatii* -0.392 ± 0.0147). For the male of *G. angularis* compared to that of *G. albatii*, the best quantitative characters were the width of the endomeral plate (EPW) 0.078 (0.058), the temple width (TW) 0.397 (0.109), and the prothorax width 0.304 (0.221); the use of EPW and TW in combination gave a probability of misidentification of 0.037, with respective discriminant function coefficients of 2.97 and 0.72 and a critical value for the discriminant of 0.517 (discriminant means and standard deviations for *G. angularis* were 0.545 ± 0.0149 and for *G. albatii* 0.490 ± 0.0172).

Holotype ♀, *T. b. angularis* (University of California Museum of Vertebrate Zoology—14157), USA: California: Merced Co.: Los Banos, San Joa-

quin Valley, 24.III.1911, W. I. Chandler; in collection of University of Minnesota. Paratypes: 91♀, 100♂, *T. b. angularis*, USA: California: Kings Co.: 3 mi. (4.8 km) S of Avenal (1); Merced Co.: 2 mi. (3.2 km) E (1), San Joaquin Valley, at (4) Los Banos, 6.2 mi. (10.0 km) SSW of Merced (1), 0.5 mi. (0.8 km) W of San Luis Ranch (1); Monterey Co.: Hog Canyon (1), Sugarloaf Peak, 3 mi. (4.8 km) NNE of Natividad (1), near Stone Canyon, 6.5 mi. (10.5 km) NW of Parkfield (1), 2 mi. (3.2 km) E of San Lucas (2), 4 mi. (6.4 km) S of Soledad (1); San Benito Co.: 1.2 mi. (1.9 km) E of Panoche (2), 1 mi. (1.6 km) S of New Idria (1), Butts Ranch, 5 mi. (8.0 km) NNE of San Benito (1); San Joaquin Co.: Tracy (1); San Luis Obispo Co.: 7 mi. (11.3 km) E (3), 10 mi. (16.1 km) E, 3 mi. (4.8 km) S (2) of Shandon; Santa Clara Co.: Gilroy (1), 10 mi. (16.1 km) N of Hollister (1), Mt View (1).

Other specimens examined. USA: California: 97♀, 82♂, *T. b. bottae*, Alameda Co.: Berkeley (2), Oakland (1); Contra Costa Co.: Richmond (1); Monterey Co.: 1 mi. (1.6 km) W of Pacific Grove (1), Monterey (1); San Mateo Co.: Palo Alto (1), Golden Gate Park, San Francisco (3); Santa Barbara Co.: Santa Barbara (1), 9 mi. (14.5 km) ENE of Santa Maria (2); Ventura Co.: 0.5 mi. (0.8 km) W of Fillmore (2). 15♀, 31♂, *T. b. diabolii* Grinnell, Contra Costa Co.: NW of Kirker Pass, 2.25 mi. (3.6 km) NNW of Clayton (1), Wardens Hdqtrs, Mt Diablo St Park (1); Fresno Co.: 8 mi. (12.9 km) W of Coalinga (1), Waltham Creek, 4.5 mi. (7.2 km) SE of Priest Valley (1); Merced Co.: Herrero Canyon, 22 mi. (35.4 km) WSW of Los Banos (2). 30♀, 30♂, *T. b. infra-pallidus* Grinnell, San Luis Obispo Co.: Carrizo Plain (1), Carrizo Plain, 5 mi. (8.0 km) N of Painted Rock (1), San Juan Creek, E of La Panza (1), 3 mi. (4.8 km) NE of Poso Ortega (1), 7 mi. (11.3 km) SW (1), 10 mi. (16.1 km) NW (1) of Simmler. 32♀, 32♂, *T. b. ingens* Grinnell, Kern Co.: 5 mi. (8.0 km) E of Buena Vista Lake, 1.5 mi. (2.4 km) E of Millux (2), Buena Vista Lake (2), 12 mi. (19.3 km) S, 5 mi. (8.0 km) W of Bakersfield (1). 23♀, 22♂, *T. b. lorenzi* Huey, Santa Cruz Co.: 1 mi. (1.6 km) NE of Ben Lomand (1), 5 mi. (8.0 km) N of Santa Cruz (2). 22♀, 17♂, *T. b. meva*, Fresno Co.: 0.6 mi. (1.0 km) NW (2), 1.4 mi. (2.3 km) N, 1.2 mi. (1.9 km) E (7) of Academy, Dunlap (1). 49♀, 86♂, *T. b. minor* V. Bailey, Marin Co.: 3.5 mi. (5.6 km) N of Bolinas (1), Dillon Beach (1), Greenhill Rd, S of Mill Valley (1), Indian Valley Rd, 3 mi. (4.8 km) W of Novato (2), 1 mi. (1.6 km) SE (1), 5 mi. (8.0 km) NW (1), at (2) Inverness; Mendocino Co.: 2 mi. (3.2 km) S of Gualala (1), Point Arena (2); Sonoma Co.: 0.5 mi. (0.8 km) SE of Jenner (1). 105♀, 121♂, *T. b. pascalis* Merriam, Fresno Co.: 2.9 mi. (4.7 km) N, 1.4 mi. (2.3 km) E (3), 4.4 mi. (7.1 km) N, 1.4 mi. (2.3 km) E (7), 4.6 mi. (7.4 km) N, 1.4 mi. (2.3 km) E (2) of Clovis, 3 mi. (4.8 km) N of Fresno (2); Kern Co.: Buttonwillow (2), 3 mi. (4.8 km) W of McKittrick (1), Woodford (1); Merced Co.: Snelling (2); Stanislaus Co.: Turlock (2); Tulare Co.: 2 mi. (3.2 km) N of Earliwart (1), 4 mi. (6.4 km) ESE of Porterville (1).

The 2 species that comprise the *bajaiensis* group are distinctive from all others by the female having conspicuously thicker setae laterally on each side of the subgenital plate (FIG. 17, 19). The male has a symmetrical alignment and fairly similar shape

for the medioanterior pair of genital sac spines (FIG. 16, 20), thereby differing from that of the *californicus* group and resembling that of the *limitaris* and *aurei* groups. Both taxa of the *bajaiensis* group are restricted to Baja California.

***Geomydoecus bajaiensis* Price & Hellenthal, new species** FIG. 14-17

Type-host. *Thomomys bottae abbotti* Huey.

♀. Close to FIG. 1. Temple width 0.410-0.480 (205: 0.447 ± 0.0160); head length 0.275-0.340 (205: 0.309 ± 0.0149); submarginal and inner marginal temple setae 0.075-0.130 (176: 0.100 ± 0.0087) and 0.030-0.055 (201: 0.044 ± 0.0047) long, respectively. Prothorax width 0.305-0.380 (204: 0.338 ± 0.0171). *Tergal setae.* II, 14-25 (204: 18.6 ± 2.18); III, 21-33 (205: 26.8 ± 2.39); IV, 23-38 (204: 29.4 ± 2.63); V, 20-37 (203: 26.1 ± 2.68); VI, 19-32 (203: 24.3 ± 2.56); tergal and pleural setae on VII, 27-46 (206: 36.5 ± 2.91). Longest seta of medial 10 on tergite VI, 0.075-0.115 (202: 0.096 ± 0.0067); on tergite VII, 0.075-0.110 (199: 0.092 ± 0.0070), with 0-2 (199: 0.08 ± 0.35) of these longer than 0.100. Longest seta of medial pair on tergite VIII, 0.040-0.085 (199: 0.062 ± 0.0099). Last tergite with outer seta 0.050-0.095 (172: 0.069 ± 0.0083), middle seta 0.055-0.095 (173: 0.079 ± 0.0072), inner seta 0.070-0.105 (186: 0.083 ± 0.0071) long. *Sternal setae.* II, 13-22 (205: 17.2 ± 2.01); III, 14-22 (205: 18.1 ± 1.58); IV, 14-22 (206: 17.8 ± 1.45); V, 10-17 (205: 13.7 ± 1.32); VI, 9-16 (204: 12.9 ± 1.18); VII, 8-15 (205: 11.8 ± 1.08). *Subgenital plate.* With 16-28 (206: 20.5 ± 1.91) setae (FIG. 17). Genital sac as in FIG. 14, width 0.190-0.300 (204: 0.241 ± 0.0212), length 0.175-0.260 (202: 0.219 ± 0.0160), with 2-8 (204: 5.0 ± 1.13) well-defined widely-spaced loops, posteriormost loop situated 0.070-0.140 (204: 0.102 ± 0.0129) back from anterior sac margin. Total length 1.095-1.510 (200: 1.293 ± 0.0807).

♂. Close to FIG. 5. Temple width 0.380-0.455 (183: 0.417 ± 0.0152); head length 0.280-0.360 (182: 0.313 ± 0.0151); submarginal and inner marginal temple setae 0.080-0.140 (147: 0.111 ± 0.0115) and 0.020-0.035 (181: 0.027 ± 0.0026) long, respectively. Antenna with scape length 0.155-0.195 (179: 0.176 ± 0.0098), scape medial width 0.095-0.135 (179: 0.116 ± 0.0087), scape distal width 0.120-0.165 (179: 0.142 ± 0.0100). Prothorax width 0.280-0.355 (182: 0.318 ± 0.0151). *Tergal setae.* II, 10-19 (182: 14.1 ± 1.76); III, 16-28 (184: 22.8 ± 2.03); IV, 19-32 (181: 26.1 ± 2.34); V, 17-30 (182: 24.1 ± 2.46); VI, 14-22 (180: 17.0 ± 1.61); tergal and pleural setae on VII, 17-29 (182: 22.6 ± 2.29). *Sternal setae.* II, 12-21 (182: 16.2 ± 1.90); III, 12-21 (183: 17.0 ± 1.54); IV, 14-22 (183: 17.8 ± 1.46); V, 10-19 (184: 14.4 ± 1.39); VI, 10-16 (182: 12.8 ± 1.12); VII, 8-14 (183: 10.6 ± 1.24); VIII, 4-10 (182: 6.5 ± 0.85). Total length 1.185-1.615 (174: 1.384 ± 0.0827). *Genitalia.* As in FIG. 15; sac spines shaped and aligned much as in FIG. 16, with 1 of medioanterior spines often more tapered than other and with lateral spines usually shorter than these, anterior margin flattened and single outer point; parameral arch width 0.140-0.180 (179: 0.164 ± 0.0084); endomerale plate apically narrowed, width 0.070-0.095 (182: 0.080 ± 0.0048), length 0.060-0.090 (179: 0.074 ± 0.0059).

Holotype ♀, *T. b. abbotti* (University of California Museum of Vertebrate Zoology-49593), MEXICO: Baja California: San Fernando, I.I.1931,

C. C. Lamb; in collection of University of Minnesota. Paratypes: 98♀, 121♂, *T. b. abbotti*, MEXICO: Baja California: 1 mi. (1.6 km) E (6), at (2) El Rosario, 0.5 mi. (0.8 km) S (1), 1.5 mi. (2.4 km) S (1) of Rancho El Socorro, San Fernando (3).

Other specimens examined. MEXICO: Baja California: 61♀, 53♂, *T. b. aphrastus* Elliot, 10 mi. (16.1 km) SE of Alamo (1), Las Cabras (1), San Jose (1), Santo Domingo (1), W end (2), at (1) Valle de la Trinidad, 3 mi. (4.8 km) SW of La Zapopita (1). 9♀, 3♂, *T. b. borjasensis* Huey, Misión San Borja (1). 37♀, 40♂, *T. b. brazierhowelli* Huey, Misión San Fernando (3). 62♀, 44♂, *T. b. cactophilus* Huey, 4.5 km S, 14 km W of Rosarito (3), 16 km S, 5 km W (1), at (4) Punta Prieta. 17♀, 28♂, *T. b. cataviniensis* Huey, Catavina (3), 12.5 mi. (20.1 km) S of El Marmol (1), Misión Sta Maria (1). 9♀, 15♂, *T. b. cunicularius* Huey, SE base of Sierra Juarez, Los Palmitos (2). 25♀, 21♂, *T. b. homorus* Huey, Calmelli (1), 1 mi. (1.6 km) E of Rancho Lagunitas (2), Rancho Huely, 15 mi. (24.1 km) E of Calmelli (2). 11♀, 8♂, *T. b. imitabilis* Goldman, LaPaz (4). 72♀, 53♂, *T. b. incomptus* Goldman, San Gregorio Ranch, NW of La Purisima (1), San Jorge (2), Santo Domingo (3). 45♀, 52♂, *T. b. litoris* Burt, 3 km W (6), 34 mi. (54.7 km) W (2) of Villa Constitución. 2♀, 9♂, *T. b. martirensis*, 40 mi. (64.4 km) E of San Quintin (1). 8♀, 17♂, *T. b. rhizophagus* Huey, Las Flores, 7 mi. (11.3 km) S of Bahía Los Angeles (2). 12♀, 16♂, *T. b. ruricola* Huey, Rancho Ramona (2). 42♀, 19♂, *T. b. russeobus* Nelson & Goldman, Arroyo San Ruiz, 8 mi. (12.9 km) W of Calmelli (1), Campo Los Angeles (2), 10 mi. (16.1 km) SE (1), at (2) Mesquital. 80♀, 73♂, *T. b. xerophilus* Huey, Valle de la Trinidad: Aguajita Spring (3), near Diablito Spring (1), 0.25 (0.4 km) N of Zapopita (1), 6 km S, 17 km E (3). 21♀, 20♂, *T. b. subsp.*, Mangrove I, Magdalena Bay (3).

***Geomydoecus clausonae* Price & Hellenthal, new species** FIG. 18-21

Type-host. *Thomomys bottae anitae* J. A. Allen.

♀. Much as for *G. bajaiensis*, except as follows. Temple width 0.430-0.470 (63: 0.455 ± 0.0092); submarginal and inner marginal temple setae 0.080-0.110 (58: 0.097 ± 0.0061) and 0.035-0.055 (61: 0.046 ± 0.0046) long, respectively. Tergal and pleural setae on VII, 28-46 (64: 35.2 ± 3.43). Longest seta of medial 10 on tergite VII, 0.080-0.120 (63: 0.103 ± 0.0081), with 0-8 (63: 1.4 ± 2.09) of these longer than 0.100. Longest seta of medial pair on tergite VIII, 0.055-0.105 (58: 0.071 ± 0.0092). Last tergite with middle seta 0.070-0.095 (53: 0.082 ± 0.0072), inner seta 0.070-0.100 (57: 0.086 ± 0.0078). *Sternal setae.* II, 13-21 (64: 18.0 ± 1.87); IV, 14-22 (63: 18.3 ± 1.52). *Subgenital plate.* With 19-30 (64: 22.6 ± 2.70) setae, most of these heavy (FIG. 19). Genital sac as in FIG. 18, width 0.225-0.290 (62: 0.259 ± 0.0140), length 0.175-0.240 (60: 0.210 ± 0.0150), with 4-12 (60: 5.8 ± 1.47) loops or posteriorly placed transverse lines.

♂. Much as for *G. bajaiensis*, except as follows. Temple width 0.400-0.455 (71: 0.424 ± 0.0108); submarginal temple seta 0.075-0.135 (59: 0.102 ± 0.0106) long. *Tergal setae.* II, 12-19 (70: 14.9 ± 1.40); III, 19-28 (69: 24.1 ± 1.84); IV, 24-33 (70: 27.4 ± 1.98); V, 20-31 (69: 25.1 ± 2.21). *Sternal setae.* II, 13-22 (70: 17.0 ± 1.81); IV, 15-24 (71: 19.1 ± 1.65). *Genitalia.* As in FIG. 21; sac spines shaped and aligned much as in FIG. 20, lateral spines longer in relation to size of medioanterior pair, with markedly concave anterior margin flanked by well-

developed points; parameral arch width 0.155–0.185 (68: 0.169 ± 0.0077).

Remarks. Qualitatively, both sexes of *G. clausonae* may be separated from those of *G. bajaiensis*. The female of *G. clausonae* has widely-spaced parallel transverse lines on the central portion of the genital sac, giving it a ladder-like appearance, instead of only evenly-rounded loops (FIG. 18 vs. FIG. 14), and has all setae thicker on the subgenital plate instead of only several thicker lateral setae (FIG. 19 vs. FIG. 17). The males are separable by the difference in the size and shape of the latero-anterior genital sac spines, with those of *G. clausonae* being longer and with a pronounced anterior concavity (FIG. 20 vs. FIG. 16). For the female of *G. bajaiensis* compared to that of *G. clausonae*, the best quantitative character and its critical value for discrimination and probability of misidentification was the length of the longest seta of the medial 10 on tergite VII 0.097 (0.234); we could find no useful quantitative means for separating males of these 2 species.

This species is named for Barbara L. Clauson in recognition of her faithful patience in the accumulation of the quantitative data for this study.

Holotype ♀, *T. b. anitae* (University of California Museum of Vertebrate Zoology—153744), MEXICO: Baja California: 6 km N, 10 km E of Santiago, 16.VII.1977, M. S. Hafner; in collection of University of Minnesota. **Paratypes:** 166 ♀, 168 ♂, *T. b. anitae*, MEXICO: Baja California: Eureka (2), Miraflores (2), San José del Cabo (4), 6 km N, 10 km E of Santiago (7), Todos Santos (3), 5 km W of El Triunfo (1).

Other specimens examined. MEXICO: Baja California: 57 ♀, 112 ♂, *T. b. alticolus* J. A. Allen, El Sauce, Victoria Mts (3), Laguna Valley, Victoria Mts (4), 7 mi. (11.3 km) NW of San Bartolo (1), Sierra de la Laguna (5).

The 4 taxa within the *limitaris* group may be distinguished from those of the other 3 groups by the male having the lateroanterior genital sac spines with their principal margin directed toward the midline (FIG. 22, 23). The female of the *limitaris* group has a subgenital plate chaetotaxy resembling that of the *californicus* and *aurei* groups.

***Geomydoecus limitaris* Price & Hellenenthal, new species** FIG. 22–24

Type-host. *Thomomys bottae limitaris* Goldman.

♀. Close to FIG. 1. Temple width 0.380–0.460 (313: 0.419 ± 0.0146); head length 0.250–0.325 (314: 0.285 ± 0.0137); submarginal and inner marginal temple setae 0.070–0.110

(246: 0.089 ± 0.0064) and 0.035–0.060 (310: 0.047 ± 0.0050) long, respectively. Prothorax width 0.270–0.355 (309: 0.305 ± 0.0145). **Tergal setae.** II, 12–23 (312: 16.4 ± 1.64); III, 18–29 (313: 22.9 ± 2.05); IV, 19–35 (314: 24.8 ± 2.50); V, 17–32 (312: 22.8 ± 2.65); VI, 15–30 (311: 22.1 ± 2.48); tergal and pleural setae on VII, 29–44 (313: 35.3 ± 2.61). Longest seta of medial 10 on tergite VI, 0.070–0.125 (311: 0.092 ± 0.0077); on tergite VII, 0.075–0.120 (300: 0.093 ± 0.0076), with 0–4 (300: 0.12 ± 0.47) of these longer than 0.100. Longest seta of medial pair on tergite VIII, 0.050–0.105 (289: 0.073 ± 0.0098). Last tergite with outer seta 0.040–0.090 (275: 0.064 ± 0.0091), middle seta 0.065–0.110 (273: 0.087 ± 0.0081), inner seta 0.070–0.115 (278: 0.090 ± 0.0081) long. **Sternal setae.** II, 10–22 (311: 15.0 ± 1.78); III, 12–21 (312: 15.5 ± 1.59); IV, 11–21 (309: 14.9 ± 1.91); V, 8–17 (310: 11.8 ± 1.54); VI, 8–16 (312: 10.4 ± 1.19); VII, 7–14 (312: 10.0 ± 1.14). **Subgenital plate.** With 15–27 (313: 19.8 ± 1.96) setae. Genital sac much as in FIG. 7 or 24, width 0.170–0.280 (311: 0.225 ± 0.0213), length 0.140–0.245 (308: 0.201 ± 0.0191), with 1–16 (310: 8.2 ± 2.97) loops, posteriormost loop situated 0.060–0.165 (310: 0.103 ± 0.0185) back from anterior margin. Total length 0.985–1.400 (311: 1.194 ± 0.0699).

♂. Close to FIG. 5. Temple width 0.345–0.410 (249: 0.379 ± 0.0121); head length 0.255–0.325 (248: 0.291 ± 0.0135); submarginal and inner marginal temple setae 0.065–0.110 (178: 0.089 ± 0.0087) and 0.020–0.035 (247: 0.026 ± 0.0027) long, respectively. Antenna with scape length 0.140–0.180 (233: 0.157 ± 0.0072), scape medial width 0.090–0.125 (233: 0.105 ± 0.0066), scape distal width 0.115–0.160 (233: 0.134 ± 0.0085). Prothorax width 0.250–0.315 (251: 0.284 ± 0.0135). **Tergal setae.** II, 9–18 (247: 13.3 ± 1.53); III, 15–25 (247: 19.7 ± 2.05); IV, 16–29 (248: 21.6 ± 2.19); V, 14–26 (248: 20.0 ± 2.07); VI, 11–19 (245: 15.1 ± 1.59); tergal and pleural setae on VII, 17–25 (251: 21.3 ± 1.68). **Sternal setae.** II, 10–19 (248: 14.4 ± 1.80); III, 11–20 (252: 15.0 ± 1.46); IV, 10–22 (251: 14.5 ± 1.83); V, 8–15 (251: 10.9 ± 1.39); VI, 7–17 (252: 10.0 ± 1.27); VII, 6–11 (251: 8.4 ± 1.10); VIII, 4–8 (251: 6.1 ± 0.63). Total length 1.025–1.440 (245: 1.243 ± 0.0726). **Genitalia.** As in FIG. 22; sac spines much as in FIG. 23; parameral arch width 0.130–0.175 (251: 0.148 ± 0.0089); endomerale plate apically narrowed (FIG. 12), width 0.060–0.090 (252: 0.073 ± 0.0049), length 0.060–0.080 (241: 0.072 ± 0.0046).

Types. See nominate subspecies.

***Geomydoecus limitaris limitaris* Price & Hellenenthal** FIG. 22, 23

Type-host. *Thomomys bottae limitaris* Goldman.

♀. Close to FIG. 1. Temple width 0.380–0.445 (114: 0.411 ± 0.0135); head length 0.250–0.315 (115: 0.280 ± 0.0139); submarginal and inner marginal temple setae 0.075–0.100 (85: 0.089 ± 0.0052) and 0.035–0.060 (114: 0.046 ± 0.0048) long, respectively. Prothorax width 0.270–0.335 (111: 0.301 ± 0.0141). **Tergal setae.** II, 13–20 (115: 15.6 ± 1.42); III, 18–25 (115: 21.6 ± 1.53); IV, 19–29 (115: 23.3 ± 2.07); V, 17–28 (114: 21.4 ± 2.20); VI, 15–28 (113: 21.1 ± 2.44); tergal and pleural setae on VII, 30–43 (115: 35.0 ± 2.79). Longest seta of medial 10 on tergite VI, 0.075–0.100 (113: 0.087 ± 0.0056); on tergite VII, 0.075–0.110 (111: 0.092 ± 0.0074), with 0–2 (111: 0.07 ± 0.29) of these longer than 0.100. Longest seta of medial pair on tergite VIII, 0.055–0.090 (109: 0.072 ± 0.0090). Last tergite with outer seta 0.040–0.080 (104: 0.064 ± 0.0084), middle seta 0.070–0.105 (102: 0.088 ± 0.0080), inner seta 0.070–0.110 (103: 0.091 ± 0.0081) long. **Sternal setae.** II, 10–19 (112:

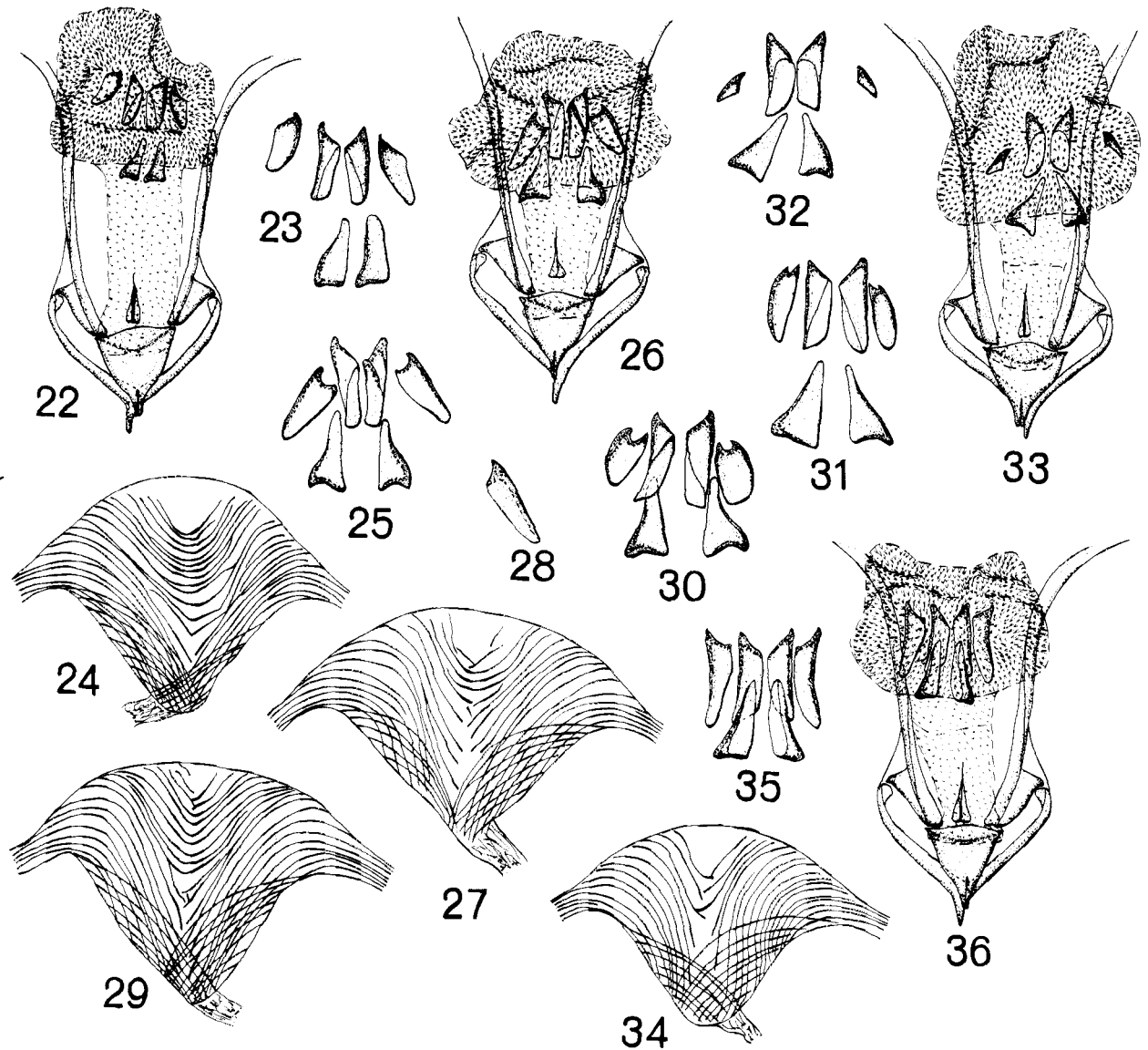


FIG. 22-36. 22-23. *Geomydoecus limitaris limitaris*: (22) ♂ genitalia; (23) ♂ genital sac spines. (24) *G. l. tollcei* ♀ genital sac. 25-27. *G. aurei aurei*: (25) ♂ genital sac spines; (26) ♂ genitalia; (27) ♀ genital sac. (28) *G. a. grahamensis* right anterior ♂ genital sac spine. 29-30. *G. actuosi*: (29) ♀ genital sac; (30) ♂ genital sac spines. (31) *G. sinaloae* ♂ genital sac spines. 32-34. *G. crovelloi*: (32) ♂ genital sac spines; (33) ♂ genitalia; (34) ♀ genital sac. 35-36. *G. warmanae*: (35) ♂ genital sac spines; (36) ♂ genitalia.

14.5 ± 1.65); III, 12-20 (115: 15.2 ± 1.49); IV, 11-18 (114: 14.2 ± 1.43); V, 8-15 (115: 11.7 ± 1.22); VI, 8-12 (115: 10.2 ± 1.04); VII, 7-12 (115: 9.8 ± 0.99). *Subgenital plate*. With 16-25 (115: 19.5 ± 1.80) setae. Genital sac much as in FIG. 7, width 0.175-0.280 (115: 0.220 ± 0.0191), length 0.140-0.245 (112: 0.188 ± 0.0174), with 6-16 (111: 9.3 ± 1.71) loops, posterior-most loop situated 0.060-0.125 (113: 0.092 ± 0.0125) back from anterior margin. Total length 1.020-1.365 (114: 1.186 ± 0.0688).

♂. Close to FIG. 5. Temple width 0.345-0.400 (96: 0.373 ± 0.0114); head length 0.255-0.310 (95: 0.284 ± 0.0137); submarginal and inner marginal temple setae 0.075-0.110 (62:

0.093 ± 0.0079) and 0.020-0.030 (96: 0.026 ± 0.0029) long, respectively. Antenna with scape length 0.140-0.175 (89: 0.154 ± 0.0069), scape medial width 0.090-0.120 (89: 0.103 ± 0.0062), scape distal width 0.115-0.155 (89: 0.131 ± 0.0082). Prothorax width 0.250-0.310 (96: 0.280 ± 0.0133). *Tergal setae*. II, 9-16 (96: 12.8 ± 1.25); III, 15-22 (96: 18.8 ± 1.59); IV, 16-24 (95: 20.4 ± 1.70); V, 14-23 (94: 18.9 ± 1.76); VI, 11-17 (94: 14.5 ± 1.49); tergal and pleural setae on VII, 17-25 (96: 21.0 ± 1.60). *Sternal setae*. II, 10-17 (97: 14.0 ± 1.52); III, 12-18 (97: 14.8 ± 1.16); IV, 11-17 (97: 13.9 ± 1.21); V, 8-14 (97: 10.3 ± 1.12); VI, 7-11 (96: 9.5 ± 0.96); VII, 6-10 (96: 8.0 ± 0.93); VIII, 4-8 (96: 6.0 ± 0.57). Total length 1.055-1.380 (96: 1.221 ± 0.0646). *Genitalia*. As in FIG. 22; sac spines much

as in FIG. 23; parameral arch width 0.130–0.160 (96: 0.144 ± 0.0070); endomeral plate apically narrowed (FIG. 12), width 0.060–0.080 (96: 0.072 ± 0.0044), length 0.060–0.080 (90: 0.072 ± 0.0044).

Holotype ♂, *T. b. limitaris* (University of California Museum of Vertebrate Zoology—80355), USA: Texas: Brewster Co.: E base of Burro Mesa, Big Bend, 29.III.1937, A. E. Borell; in collection of University of Minnesota. **Paratypes**: 26♀, 41♂, *T. b. limitaris*, USA: Texas: Brewster Co.: Boquillas, Rio Grande, Big Bend (1), E base of Burro Mesa, Big Bend (2), 0.25 mi. (0.4 km) W of Mt Emory, Chisos Mts (1), 10 mi. (16.1 km) W, 4 mi. (6.4 km) N of Marathon (1); Presidio Co.: 3 mi. (4.8 km) S, 6 mi. (9.7 km) E of Presidio (1); Terrell Co.: 15 mi. (24.1 km) S, 6 mi. (9.7 km) E of Dryden (1); Val Verde Co.: 8 mi. (12.9 km) E of Comstock (1).

Other specimens examined. USA: Texas: 71♀, 81♂, *T. b. confinalis* Goldman, Crockett Co.: 4 mi. (6.4 km) N of Ozona (1); Sutton Co.: 7 mi. (11.3 km) E of Sonora (4), 83♀, 101♂, *T. b. limpiae* Blair, Jeff Davis Co.: 1 mi. (1.6 km) N (4), 11.5 mi. (18.5 km) NE (1), 11.6 mi. (18.7 km) NNE (1), 8.2 mi. (13.2 km) N, 6.5 mi. (10.5 km) E (4) of Ft Davis, 21♀, 23♂, *T. b. pervarius* Goldman, Presidio Co.: 8 mi. (12.9 km) NE of Candelaria (1), 35 mi. (56.3 km) S of Marfa (1), 12 mi. (19.3 km) E of Ruidosa (2), 6 mi. (9.7 km) S, 1 mi. (1.6 km) W of Shafter (1), 6♂, *T. b. scotophilus* Davis, Hudspeth Co.: Carrizo Mts, 6 mi. (9.7 km) W of Van Horn (1), 15♀, 33♂, *T. b. texensis* V. Bailey, Jeff Davis Co.: Davis Mts (3), 5 mi. (8.0 km) E of Mt Livermore (3). MEXICO: Coahuila: 15♀, 18♂, *T. b. angustidens* Baker, Sierra del Pino: 5 mi. (8.0 km) S, 3 mi. (4.8 km) W (2), 6 mi. (9.7 km) N, 6 mi. (9.7 km) W (1) of Acebuches, 7♀, 10♂, *T. b. humilis* Baker, 9 mi. (14.5 km) W, 1 mi. (1.6 km) S of Villa Acuna (2), 6♀, 4♂, *T. b. villai* Baker, 7 mi. (11.3 km) S, 2 mi. (3.2 km) E of Boquillas del Carmen (1).

***Geomydoecus limitaris bakeri* Price & Hellenthal, new subspecies**

Type-host. *Thomomys bottae fulvus* (Woodhouse).

♀. Much as for *G. l. limitaris*, except as follows. Temple width 0.390–0.460 (101: 0.422 ± 0.0131); head length 0.265–0.315 (101: 0.287 ± 0.0111); inner marginal temple seta 0.040–0.060 (98: 0.049 ± 0.0049) long. Prothorax width 0.285–0.355 (100: 0.306 ± 0.0130). *Tergal setae*. II, 13–21 (100: 16.8 ± 1.45); III, 20–28 (101: 23.3 ± 1.94); IV, 20–32 (101: 25.4 ± 2.20); V, 18–31 (100: 23.3 ± 2.42); VI, 17–30 (101: 22.3 ± 2.38). Longest seta of medial 10 on tergite VI, 0.070–0.125 (101: 0.095 ± 0.0074). *Sternal setae*. IV, 11–21 (100: 15.2 ± 2.09); VII, 8–14 (100: 10.2 ± 1.23). Genital sac width 0.185–0.280 (99: 0.232 ± 0.0203), length 0.165–0.235 (100: 0.206 ± 0.0159), with 2–11 (101: 5.9 ± 1.93) loops, posteriormost loop situated 0.060–0.145 (100: 0.100 ± 0.0145) back from anterior margin.

♂. Much as for *G. l. limitaris*, except as follows. Temple width 0.360–0.410 (93: 0.382 ± 0.0099); head length 0.275–0.320 (93: 0.296 ± 0.0103); submarginal temple seta 0.065–0.105 (71: 0.085 ± 0.0088) long. Antenna with scape length 0.140–0.170 (87: 0.158 ± 0.0059), scape medial width 0.095–0.115 (87: 0.106 ± 0.0050), scape distal width 0.120–0.150 (87:

0.135 ± 0.0065). Prothorax width 0.265–0.315 (96: 0.286 ± 0.0126). *Tergal setae*. II, 10–18 (93: 13.3 ± 1.73); III, 15–25 (91: 19.9 ± 2.11); IV, 18–29 (93: 22.3 ± 2.16); V, 15–25 (95: 20.5 ± 1.99); VI, 12–19 (91: 15.4 ± 1.55). *Sternal setae*. IV, 10–22 (96: 14.7 ± 2.04); V, 9–15 (95: 11.3 ± 1.43); VI, 8–17 (96: 10.3 ± 1.50); VII, 6–11 (95: 8.5 ± 1.21). Total length 1.025–1.440 (90: 1.251 ± 0.0742). *Genitalia*. Parameral arch width 0.135–0.170 (95: 0.151 ± 0.0080); endomeral plate width 0.060–0.080 (96: 0.074 ± 0.0049).

Remarks. There are no known qualitative features for separating *G. l. bakeri* from the nominate subspecies. Quantitatively, for females of these 2 subspecies, critical values for discrimination and probabilities of misidentification for the best discriminating characters were the number of genital sac loops (GSLP) 7.62 (0.178), the length of the longest seta of the medial 10 on tergite VI (LSTG6) 0.091 (0.279), and the genital sac length 0.197 (0.294); the use of LSTG6 and GSLP in combination provided a probability of misidentification of 0.143, with respective discriminant function coefficients of -0.84 and 0.0048 and a critical value for the discriminant of -0.040 (discriminant means and standard deviations for *G. l. bakeri* were -0.051 ± 0.0117 and for *G. l. limitaris* -0.029 ± 0.0091). There are no useful quantitative characters for separating the males of these 2 taxa.

This taxon is named for Dr Robert J. Baker, Texas Tech University, for his pocket gopher studies which have provided a valuable framework for consideration of host-louse relationships.

Holotype ♀, *T. b. fulvus* (University of California Museum of Vertebrate Zoology—146924), USA: New Mexico: Grant Co.: Iron Creek, Black Range, 8.VIII.1974, J. L. Patton; in collection of University of Minnesota. **Paratypes**: 159♀, 248♂, *T. b. fulvus*, USA: Arizona: Coconino Co.: Little Spring, San Francisco Mt (1), Fern Mt, W slope of San Francisco Pk (1); Greenlee Co.: Rose Peak (4); Navajo Co.: 2.8 mi. (4.5 km) SW of Heber (2), 4 mi. (6.4 km) W (2), 7.3 mi. (11.7 km) W (2) of Show Low; Yavapai Co.: Mingus Mt, 5 mi. (8.0 km) SW of Jerome (3), Prescott (2), Wolf Creek, 0.5 mi. (0.8 km) E of Ponderosa Park, Bradshaw Mts (2); New Mexico: Catron Co.: 15.8 mi. (25.4 km) N of Apache Creek, Gallo Mts (2), 5 mi. (8.0 km) N of Glenwood (1), 6.7 mi. (10.8 km) S of Luna (2), 9 mi. (14.5 km) E of State line on Hwy 60 (1), Willow Creek, Mogollon Mts (3); Grant Co.: Iron Creek, Black Range (3), Rocky Canyon, Black Range (3), Trout Creek, Pinos Altos Mts (2); Socorro Co.: Bear Trap, San Mateo Mts (2).

Other specimens examined. USA: 20♀, 41♂, *T. b. hualpaiensis* Goldman, Arizona: Mohave Co.: Hualpai Mts: Hualpai Peak (2), Democrat Mine (2). 41♀, 47♂, *T. b. modicus*, Arizona: Santa Cruz Co.: 2 mi. (3.2 km) W of Lochiel (1), 7 mi. (11.3 km) W of Patagonia (3). 8♀, 11♂, *T. b. muralis* Goldman, Arizona: Coconino Co.: Grand Canyon, Prospect Valley, Hualpai Indian Reservation (3). 11♀, 13♂, *T. b. mutabilis* Goldman, Arizona: Gila Co.: Peterson Ranch, Sierra Ancha (1), Pine (1), Rose Creek, Sierra Ancha (2), S fork Workman Creek, Sierra Ancha (1). 15♀, 16♂, *T. b. opulentis*, 0.8 mi. (1.3 km) S of Radium Springs (6). 6♀, 8♂, *T. b. toltecus*, New Mexico: Grant Co.: 1 mi. (1.6 km) S, 3 mi. (4.8 km) W of Wilna (2); Hidalgo Co.: 3.5 mi. (5.6 km) W of Upper Corner Monument 40 (1). 9♀, 28♂, *T. u. intermedius* Mearns, Arizona: Santa Cruz Co.: Lyle Canyon, Canelo Hills, 5.2 mi. (8.4 km) S of Canelo (3). MEXICO: 5♀, 4♂, *T. b. modicus*, Sonora: Santa Cruz (1). 24♀, 24♂, *T. b. toltecus*, Chihuahua: 2 mi. (3.2 km) W of Villa Ahumada (1).

Geomysdocus limitaris halli Price & Hellenthal, new subspecies

Type-host. *Thomomys bottae proximus* Burt & Campbell.

♀. Much as for *G. l. limitaris*, except as follows. Temple width 0.425–0.455 (26: 0.438 ± 0.0079); head length 0.285–0.325 (26: 0.303 ± 0.0105); inner marginal temple seta 0.045–0.060 (26: 0.052 ± 0.0045) long. Prothorax width 0.310–0.355 (26: 0.325 ± 0.0108). *Tergal setae.* II, 15–19 (25: 17.1 ± 1.13); III, 22–29 (26: 24.6 ± 1.53); IV, 23–35 (26: 26.9 ± 2.28); V, 19–31 (26: 25.2 ± 2.26); VI, 17–27 (26: 23.2 ± 2.20); tergal and pleural setae on VII, 31–41 (26: 36.9 ± 2.40). Longest seta of medial 10 on tergite VI, 0.090–0.110 (26: 0.100 ± 0.0055). *Sternal setae.* II, 13–22 (26: 16.7 ± 2.26); III, 15–21 (25: 17.3 ± 1.49); IV, 14–20 (26: 17.3 ± 1.44); V, 11–17 (26: 13.4 ± 1.39); VI, 9–16 (26: 11.2 ± 1.36); VII, 9–14 (26: 11.0 ± 1.13). Genital sac width 0.220–0.280 (26: 0.247 ± 0.0148), length 0.185–0.245 (26: 0.216 ± 0.0169), with 1–7 (26: 4.2 ± 1.19) loops, posteriormost loop situated 0.075–0.130 (26: 0.103 ± 0.0134) back from anterior margin. Total length 1.115–1.380 (26: 1.267 ± 0.0656).

♂. Much as for *G. l. limitaris*, except as follows. Temple width 0.390–0.410 (17: 0.398 ± 0.0051); head length 0.295–0.325 (17: 0.306 ± 0.0106); inner marginal temple seta 0.025–0.035 (17: 0.029 ± 0.0023) long. Antenna with scape length 0.160–0.180 (16: 0.169 ± 0.0053), scape medial width 0.100–0.125 (16: 0.116 ± 0.0068), scape distal width 0.130–0.160 (16: 0.149 ± 0.0089). Prothorax width 0.290–0.315 (16: 0.304 ± 0.0072). *Tergal setae.* II, 13–16 (16: 14.4 ± 1.26); III, 18–24 (17: 21.4 ± 1.80); IV, 21–26 (17: 23.5 ± 1.66); V, 18–26 (17: 21.6 ± 2.12); VI, 13–18 (17: 15.8 ± 1.47); tergal and pleural setae on VII, 19–24 (17: 22.5 ± 1.23). *Sternal setae.* II, 13–19 (17: 16.1 ± 1.58); III, 15–19 (17: 16.5 ± 1.42); IV, 14–21 (16: 16.8 ± 2.04); V, 10–15 (17: 11.7 ± 1.21); VI, 10–13 (17: 11.3 ± 1.05); VII, 8–11 (17: 9.4 ± 0.87); VIII, 6–8 (17: 6.6 ± 0.80). Total length 1.235–1.435 (17: 1.340 ± 0.0474). *Genitalia.* Parameral arch width 0.150–0.175 (17: 0.164 ± 0.0074); endomer-plate width 0.075–0.090 (17: 0.081 ± 0.0038), length 0.065–0.080 (16: 0.077 ± 0.0047).

Remarks. There are no known qualitative characters that will separate *G. l. halli* from *G. l. limitaris* or *G. l. bakeri*. Quantitatively, for females of *G. l.*

halli and *G. l. limitaris*, critical values for discrimination and probabilities of misidentification for the best discriminating characters were the number of genital sac loops (GSLP) 6.73 (0.057), the length of the longest seta of the medial 10 on tergite VI 0.094 (0.124), the number of setae on sternite IV (SST4) 15.76 (0.140), and the temple width (TW) 0.425 (0.145); the use of GSLP, TW, and SST4 in combination provided a probability of misidentification of 0.014, with respective discriminant function coefficients of 0.015, -1.48 , and -0.0093 and a critical value for the discriminant of -0.676 (discriminant means and standard deviations for *G. l. halli* were -0.749 ± 0.0273 and for *G. l. limitaris* -0.603 ± 0.0348). For females of *G. l. halli* and *G. l. bakeri*, the best discriminating characters were the prothorax width 0.316 (0.232), the head length (HL) 0.295 (0.246), the temple width 0.430 (0.255), and the number of setae on sternite III (SST3) 16.30 (0.263); the use of HL and SST3 in combination provided a probability of misidentification of 0.179, with respective discriminant function coefficients of 0.98 and 0.0062 and a critical value for the discriminant of 0.391 (discriminant means and standard deviations for *G. l. halli* were 0.405 ± 0.0133 and for *G. l. bakeri* 0.377 ± 0.0154). For males of *G. l. halli* and *G. l. limitaris*, the best were the genitalic parameral arch width 0.154 (0.078), the temple width 0.385 (0.124), the genitalic endomer-plate width 0.077 (0.136), and the antennal scape length 0.162 (0.136). For males of *G. l. halli* and *G. l. bakeri*, the best were the antennal scape medial width 0.111 (0.153), the scape distal width 0.142 (0.156), the genitalic parameral arch width 0.157 (0.200), and the temple width 0.390 (0.201).

This taxon is named for Dr E. Raymond Hall, University of Kansas, in appreciation of his many contributions to mammalian systematics and his interest in our work.

Holotype ♂, *T. b. proximus* (University of California Museum of Vertebrate Zoology—137807), USA: Arizona: Pima Co.: 1 mi. (1.6 km) N of Greaterville, 26.VII.1969, J. L. Patton; in collection of University of Minnesota. Paratypes: 15♀, 14♂, *T. b. proximus*, USA: Arizona: Pima Co.: 1 mi. (1.6 km) N of Greaterville (2).

Other specimens examined. USA: Arizona: 9♀, 12♂, *T. b. caneloensis* Lange, Santa Cruz Co.: Canelo, 10 mi. (16.1 km) S of Elgin, W foot of Huachuca Mts (3). 40♀, 25♂, *T. b. operosus* Hatfield, Yavapai Co.: Hays Ranch, Peebles Valley, 6 mi. (9.7 km) N of Yarnell (2).

Geomydoecus limitaris tolteci Price & Hellenthal,
new subspecies FIG. 24

Type-host. *Thomomys bottae toltecus* J. A. Allen.

♀. Much as for *G. l. limitaris*, except as follows. Temple width 0.390–0.440 (72: 0.418 ± 0.0119). Tergal setae. II, 12–23 (72: 16.8 ± 1.91); III, 19–28 (71: 23.8 ± 1.95); IV, 21–32 (72: 25.6 ± 2.28); V, 18–32 (72: 23.6 ± 2.65); VI, 17–28 (71: 23.1 ± 2.21). Longest seta of medial 10 on tergite VI, 0.075–0.110 (71: 0.094 ± 0.0071); on tergite VII, 0.080–0.120 (67: 0.095 ± 0.0081). Last tergite with outer seta 0.040–0.075 (62: 0.060 ± 0.0087) long. Sternal setae. II, 11–19 (72: 15.1 ± 1.46). Subgenital plate. With 17–27 (72: 21.0 ± 2.13) setae. Genital sac much as in FIG. 24, length 0.180–0.240 (70: 0.209 ± 0.0139), with 7–15 (72: 11.3 ± 1.80) loops, posteriormost loop situated 0.080–0.165 (71: 0.125 ± 0.0144) back from anterior margin.

♂. Much as for *G. l. limitaris*, except as follows. Head length 0.270–0.310 (43: 0.292 ± 0.0102). Antenna with scape distal width 0.120–0.150 (41: 0.136 ± 0.0069). Tergal setae. II, 12–17 (42: 14.0 ± 1.20); III, 16–25 (43: 20.6 ± 2.00); IV, 17–27 (43: 22.4 ± 1.98); V, 17–24 (42: 20.7 ± 1.65); VI, 13–19 (43: 15.5 ± 1.52). Sternal setae. IV, 11–18 (42: 14.6 ± 1.64); V, 8–15 (42: 11.0 ± 1.43); VI, 9–12 (43: 10.2 ± 0.84); VII, 6–10 (43: 8.6 ± 0.93).

Remarks. The female of *G. l. tolteci* has the largest number of loops on the genital sac (FIG. 24) of any taxon in this group and many specimens may be recognized because of this. We do not know of any qualitative feature that will distinguish the male of *G. l. tolteci* from that of the other 3 taxa of this group. Quantitatively, for females of *G. l. tolteci* and *G. l. limitaris*, critical values for discrimination and probabilities of misidentification for the best discriminating characters were the distance of the posteriormost genital sac loop from the anterior sac margin (GSLPL) 0.109 (0.109), the genital sac length (GSL) 0.199 (0.255), and the number of setae on tergite III (STG3) 22.69 (0.259); the use of GSL, GSLPL, and STG3 in combination provided a probability of misidentification of 0.082, with respective discriminant function coefficients of 0.31, -1.27 , and -0.0042 and a critical value for the discriminant of -0.170 (discriminant means and standard deviations for *G. l. tolteci* were -0.192 ± 0.0171 and for *G. l. limitaris* -0.149 ± 0.0146). For females of *G. l. tolteci* and *G. l. bakeri*, the best discriminating characters were the number of genital sac loops 8.61 (0.078) and the distance of the posteriormost loop from the anterior sac margin 0.113 (0.194). For females of *G. l. tolteci* and *G. l. halli*, the best were the number of genital sac loops 7.72 (0.016), the temple width 0.428 (0.178), the genital sac width 0.231 (0.180), and the prothorax width 0.314 (0.186). For males of *G. l. tolteci* and *G. l. halli*, the best were genitalic en-

domeral plate width 0.076 (0.044), the genitalic parameral arch width 0.155 (0.094), the antennal scape length 0.163 (0.135), and the scape medial width 0.110 (0.138). We do not know of any quantitative features for separating males of *G. l. tolteci* from those of *G. l. limitaris* or *G. l. bakeri*.

The morphological, geographical, and host relationships among the *G. limitaris* subspecies are complicated. *G. l. tolteci* is the most morphologically distinct taxon, with females easily identifiable from all other *G. limitaris* subspecies. Males of *G. l. tolteci* are separable from *G. l. halli*, but not from *G. l. limitaris* and *G. l. bakeri*. While none of the localities where *G. l. tolteci* occurred were found to have other *G. limitaris* lice, the geographical distribution of *G. l. tolteci* substantially overlaps those of *G. l. halli* and *G. l. bakeri*, and 3 of 5 host taxa with *G. l. tolteci* also contained *G. l. bakeri*.

G. l. limitaris is morphologically distinct from *G. l. halli* in both sexes and has females which are distinct from *G. l. tolteci*; both sexes are difficult to separate from *G. l. bakeri*. *G. l. limitaris* is the only subspecies with a geographical range which does not overlap with the other *G. limitaris* taxa. It shares no host taxa with other members of the group.

G. l. halli is morphologically distinct from *G. l. limitaris* and *G. l. tolteci* in both sexes. It has a geographical distribution which overlaps those of *G. l. bakeri* and *G. l. tolteci*, but does not share host taxa with any of the other *G. limitaris* subspecies.

G. l. bakeri is readily separable from only females of *G. l. tolteci*. It has a geographical distribution which overlaps those of both *G. l. halli* and *G. l. tolteci*, and shares 3 of its 8 host taxa with *G. l. tolteci*.

While *G. l. halli* and *G. l. tolteci* appear to be morphologically distinct, their overlapping distributions and small sample sizes make us reluctant to consider them as species. *G. l. limitaris*, though geographically well separated from the other subspecies, shows only weak morphological differences from *G. l. bakeri*, which in turn is the least distinct of the *G. limitaris* subspecies and also shows morphological affinities with *G. l. halli*.

Holotype ♀, *T. b. toltecus* (University of California Museum of Vertebrate Zoology—50401), USA: New Mexico: Grant Co.: Fort Webster, 3 mi. (4.8 km) SW of Santa Rita, 17.VIII.1931, A. M. Alexander; in collection of University of Minnesota. Paratypes: 62♀, 109♂, *T. b. toltecus*, USA: New Mexico: Grant Co.: Fort Webster, 3 mi. (4.8 km)

SW of Santa Rita (2); MEXICO: Chihuahua: Casas Grandes Viejo (2), Rancho El Peñasco, 5.6 mi. (9.0 km) E of Janos (2).

Other specimens examined. USA: 10♀, 18♂, *T. b. collinus* Goldman, Arizona: Cochise Co.: Turkey Creek Canyon, Chiricahua Mts (3). 21♀, 13♂, *T. b. extenuatus*, Arizona: Cochise Co.: El Coronado Ranch, Chiricahua Mts (3). 32♀, 37♂, *T. b. fulvus*, Arizona: Coconino Co.: Pivot Rock Spring (1); Gila Co.: 7.4 mi. (11.9 km) S of Colcord Lookout, Colcord Mt (3); Greenlee Co.: 2 mi. (3.2 km) N (1), at (1) Blue; New Mexico: Grant Co.: 1 mi. (1.6 km) S of Cliff (1), 7 mi. (11.3 km) E of Silver City (1). 17♀, 15♂, *T. b. modicus*, Santa Cruz Co.: 4 mi. (6.4 km) N of Nogales (1). MEXICO: 10♀, 17♂, *T. b. modicus*, Sonora: 2 mi. (3.2 km) S of La Casita (1), 40 km S of Nogales (1).

The *aurei* group contains 6 taxa that are separable from those of the other 3 groups by the combination of the male having symmetrically placed similar medioanterior genital sac spines and the lateral spines with their principal margin directed toward the outside (FIG. 25, 28, 30–32, 35) and the female with a subgenital plate chaetotaxy without thicker lateral setae on each side (FIG. 8).

***Geomydoecus aurei* Price & Hellenthal, new species** FIG. 25–28

Type-host. *Thomomys bottae aureus* J. A. Allen.

♀. Close to FIG. 1. Temple width 0.400–0.455 (202: 0.425 ± 0.0111); head length 0.265–0.325 (203: 0.292 ± 0.0122); submarginal and inner marginal temple setae 0.075–0.110 (177: 0.088 ± 0.0066) and 0.040–0.060 (202: 0.048 ± 0.0050) long, respectively. Prothorax width 0.280–0.345 (211: 0.308 ± 0.0118). *Tergal setae.* II, 12–21 (209: 16.7 ± 1.52); III, 18–29 (209: 22.7 ± 1.87); IV, 20–33 (207: 25.0 ± 2.32); V, 18–28 (206: 22.4 ± 2.07); VI, 17–28 (205: 21.5 ± 2.13); tergal and pleural setae on VII, 28–41 (209: 34.5 ± 2.62). Longest seta of medial 10 on tergite VI, 0.080–0.110 (209: 0.094 ± 0.0062); on tergite VII, 0.075–0.115 (208: 0.093 ± 0.0071), with 0–5 (208: 0.14 ± 0.52) of these longer than 0.100. Longest seta of medial pair on tergite VIII, 0.050–0.100 (202: 0.077 ± 0.0104). Last tergite with outer seta 0.045–0.095 (186: 0.069 ± 0.0096), middle seta 0.070–0.120 (192: 0.091 ± 0.0083), inner seta 0.075–0.120 (195: 0.092 ± 0.0077) long. *Sternal setae.* II, 10–21 (211: 14.4 ± 1.70); III, 11–18 (206: 14.3 ± 1.48); IV, 12–19 (209: 14.2 ± 1.37); V, 7–15 (207: 11.4 ± 1.38); VI, 7–13 (210: 9.9 ± 1.03); VII, 8–14 (211: 10.0 ± 0.99). *Subgenital plate.* With 15–28 (212: 20.2 ± 2.08) setae. Genital sac much as in FIG. 27, width 0.185–0.290 (211: 0.238 ± 0.0181), length 0.165–0.240 (209: 0.199 ± 0.0144), with 1–10 (210: 4.8 ± 1.56) loops varying from smooth to deeply V-shaped, posteriormost loop situated 0.060–0.130 (209: 0.092 ± 0.0124) back from anterior margin. Total length 1.020–1.360 (201: 1.199 ± 0.0614).

♂. Close to FIG. 5. Temple width 0.355–0.420 (216: 0.385 ± 0.0102); head length 0.275–0.325 (216: 0.298 ± 0.0113); submarginal and inner marginal temple setae 0.070–0.110 (145: 0.089 ± 0.0086) and 0.020–0.035 (214: 0.025 ± 0.0031) long, respectively. Antenna with scape length 0.150–0.180 (199: 0.160 ± 0.0060), scape medial width 0.090–0.120 (199: 0.107 ± 0.0057), scape distal width 0.115–0.160 (199: 0.137 ±

0.0079). Prothorax width 0.245–0.315 (217: 0.288 ± 0.0118). *Tergal setae.* II, 9–16 (216: 12.9 ± 1.27); III, 14–24 (216: 19.2 ± 1.69); IV, 17–30 (211: 21.7 ± 2.01); V, 16–25 (215: 20.3 ± 1.76); VI, 11–19 (211: 15.6 ± 1.46); tergal and pleural setae on VII, 14–27 (216: 21.4 ± 1.80). *Sternal setae.* II, 9–17 (217: 13.1 ± 1.53); III, 11–19 (216: 14.0 ± 1.39); IV, 10–19 (213: 13.6 ± 1.43); V, 8–16 (213: 10.6 ± 1.29); VI, 8–13 (215: 9.5 ± 0.97); VII, 5–11 (216: 8.3 ± 1.00); VIII, 4–8 (218: 6.1 ± 0.56). Total length 1.090–1.435 (209: 1.250 ± 0.0605). *Genitalia.* As in FIG. 26; sac spines much as in FIG. 25 or 28, lateroanterior pair with distinct anterior concavity or tapered and with relatively straight outer margin; parameral arch width 0.135–0.170 (216: 0.152 ± 0.0063); endomeral plate apically narrowed (FIG. 12), width 0.060–0.085 (217: 0.073 ± 0.0037), length 0.060–0.085 (204: 0.075 ± 0.0059).

Types. See nominate subspecies.

***Geomydoecus aurei aurei* Price & Hellenthal**
FIG. 25–27

♀. Temple width 0.405–0.455 (117: 0.428 ± 0.0107); head length 0.270–0.325 (118: 0.294 ± 0.0112); submarginal temple seta 0.075–0.110 (100: 0.087 ± 0.0065) long. Prothorax width 0.285–0.345 (124: 0.311 ± 0.0125). *Tergal setae.* II, 14–21 (121: 17.3 ± 1.47); III, 19–29 (122: 23.1 ± 1.81); IV, 20–33 (120: 25.4 ± 2.53). Longest seta of medial 10 on tergite VII, 0.080–0.115 (121: 0.095 ± 0.0071). Longest seta of medial pair on tergite VIII, 0.060–0.100 (116: 0.080 ± 0.0086). Last tergite with outer seta 0.050–0.095 (104: 0.074 ± 0.0079), middle seta 0.070–0.120 (110: 0.093 ± 0.0079), inner seta 0.075–0.120 (114: 0.094 ± 0.0078) long. *Sternal setae.* IV, 12–19 (123: 14.4 ± 1.50). Genital sac width 0.195–0.290 (124: 0.245 ± 0.0171), with 1–9 (122: 4.2 ± 1.30) loops.

♂. Temple width 0.370–0.420 (117: 0.388 ± 0.0092); head length 0.280–0.325 (117: 0.301 ± 0.0109); submarginal and inner marginal temple setae 0.070–0.105 (75: 0.087 ± 0.0085) and 0.020–0.030 (116: 0.025 ± 0.0031) long, respectively. Antenna with scape length 0.150–0.180 (110: 0.162 ± 0.0062), scape medial width 0.095–0.120 (110: 0.108 ± 0.0051), scape distal width 0.120–0.160 (110: 0.139 ± 0.0072). Prothorax width 0.270–0.315 (119: 0.292 ± 0.0106). *Tergal setae.* II, 10–16 (118: 13.1 ± 1.22); III, 16–24 (118: 19.6 ± 1.70); IV, 18–30 (116: 22.1 ± 1.97). *Genitalia.* Outer sac spines as in FIG. 25, with concave anterior margin; endomeral plate width 0.065–0.080 (119: 0.074 ± 0.0034), length 0.060–0.085 (114: 0.077 ± 0.0056).

Holotype ♂, *T. b. aureus* (University of California Museum of Vertebrate Zoology—150350), USA: Colorado: La Plata Co.: Bayfield, 15. VIII.1976, J. L. Patton; in collection of University of Minnesota. Paratypes: 92♀, 98♂, *T. b. aureus*, USA: Arizona: Navajo Co.: Polacca (2); Colorado: La Plata Co.: Bayfield (3); Montezuma Co.: 1 mi. (1.6 km) E of Cahone (3), 4.5 mi. (7.2 km) S (1), 15 mi. (24.1 km) W (1) of Cortez, Park Point, Mesa Verde Natl Pk (1); San Miguel Co.: 19 mi. (30.6 km) N of Dove Creek (1); New Mexico: Rio Arriba Co.: 1 mi. (1.6 km) N, 1 mi. (1.6 km) W of Llaves (2); San Juan Co.: Aztec (1); Utah: San Juan Co.: Bluff (4), Monticello (1).

Other specimens examined. USA: 8♀, 13♂, *T. b. alexandrae* Goldman, Arizona: Coconino Co.: Navajo Mts: 2 mi. (3.2 km) SE of Endische Spring (1), Soldier Spring (1), Rainbow Lodge (2), 5 mi. (8.0 km) S of summit (4). 31♀, 22♂, *T. b. apache* V. Bailey, Colorado: La Plata Co.: 7 mi. (11.3 km) N (1), at (3) Florida; New Mexico: Rio Arriba Co.: Jicarilla Indian Res. 1 mi. (1.6 km) S of Lake La Jara (2). 56♀, 69♂, *T. b. connectens* Hall, New Mexico: Bernalillo Co.: 4.5 mi. (7.2 km) S (1), 5 mi. (8.0 km) N (2), at (2) Albuquerque, Pajarito (1); Sandoval Co.: Sandoval (2); Socorro Co.: 1 mi. (1.6 km) S (1), 1.2 mi. (1.9 km) E (3) of Bernardo. 31♀, 14♂, *T. b. fulvus*, Arizona: Apache Co.: Springerville (2); New Mexico: Catron Co.: Davenport Spring, Datil Mts (2), 4.5 mi. (7.2 km) E, 2 mi. (3.2 km) S of Madre Mt (1); McKinley Co.: Sawmill Canyon, Zuni Mts (3); Valencia Co.: 2 mi. (3.2 km) E of El Moro, Zuni Mts (1). 28♀, 18♂, *T. b. latirostris* Merriam, Arizona: Navajo Co.: Keams Canyon (1), Segi-ot-Sosi Canyon, 11 mi. (17.7 km) NW of Kayenta (1), Winslow (1), Zuni Well, 7.5 mi. (12.1 km) N of Adamana (2). 4♀, 3♂, *T. b. optabilis* Goldman, Colorado: Montrose Co.: Coventry (1). 16♀, 26♂, *T. b. peramplus* Goldman, Arizona: Apache Co.: Tunicha Mts (1); New Mexico: San Juan Co.: Chuska Mts (3). 6♀, 7♂, *T. b. rufidulus* Hoffmeister, New Mexico: McKinley Co.: Gallup (2).

Geomydoecus aurei grahamensis Price & Hellenenthal, new subspecies FIG. 28

Type-host. *Thomomys bottae grahamensis* Goldman.

♀. Temple width 0.400–0.455 (85: 0.420 ± 0.0098); head length 0.265–0.320 (85: 0.288 ± 0.0128); submarginal temple seta 0.075–0.105 (77: 0.090 ± 0.0063) long. Prothorax width 0.280–0.330 (87: 0.304 ± 0.0096). *Tergal setae*. II, 12–19 (88: 16.0 ± 1.25); III, 18–27 (87: 22.0 ± 1.74); IV, 21–29 (87: 24.3 ± 1.82). Longest seta of medial 10 on tergite VII, 0.075–0.105 (87: 0.090 ± 0.0060). Longest seta of medial pair on tergite VIII, 0.050–0.095 (86: 0.072 ± 0.0108). Last tergite with outer seta 0.045–0.080 (82: 0.063 ± 0.0075), middle seta 0.070–0.105 (82: 0.088 ± 0.0080), inner seta 0.075–0.105 (81: 0.089 ± 0.0067). *Sternal setae*. IV, 12–16 (86: 13.8 ± 1.06). Genital sac width 0.185–0.270 (87: 0.228 ± 0.0147), with 2–10 (88: 5.5 ± 1.59) loops.

♂. Temple width 0.355–0.410 (99: 0.384 ± 0.0098); head length 0.275–0.315 (99: 0.294 ± 0.0106); submarginal and inner marginal temple setae 0.070–0.110 (70: 0.091 ± 0.0084) and 0.020–0.035 (98: 0.026 ± 0.0030) long, respectively. Antenna with scape length 0.150–0.170 (89: 0.159 ± 0.0054), scape medial width 0.090–0.120 (89: 0.105 ± 0.0058), scape distal width 0.115–0.160 (89: 0.135 ± 0.0082). Prothorax width 0.245–0.315 (98: 0.284 ± 0.0119). *Tergal setae*. II, 9–15 (98: 12.6 ± 1.25); III, 14–23 (98: 18.7 ± 1.56); IV, 17–28 (95: 21.3 ± 1.98). *Genitalia*. Outer sac spines as in FIG. 28, anteriorly tapered and somewhat narrowed; endomeral plate width 0.060–0.085 (98: 0.072 ± 0.0039), length 0.060–0.080 (90: 0.073 ± 0.0053).

Remarks. The only qualitative feature enabling separation of *G. a. grahamensis* from the nominate subspecies involves the shape of the male latero-anterior genital sac spines. These spines for *G. a. aurei* usually have a distinct anterior concavity (FIG. 25), whereas those for *G. a. grahamensis* tend to be anteriorly narrower and more or less tapered from a single point (FIG. 28). For females, the best quan-

titative characters and their critical values for discrimination and probabilities of misidentification were the length of the outer seta on the last tergite (OSLTG) 0.069 (0.230), the genital sac width (GSW) 0.236 (0.304), the number of setae on tergite II 16.63 (0.322), and the temple width (TW) 0.424 (0.343). The use of OSLTG, GSW, and TW in combination provided a probability of misidentification of 0.160, with respective discriminant function coefficients of 1.20, 0.34, and 0.36 and a critical value for the discriminant of 0.316 (discriminant means and standard deviations for *G. a. grahamensis* were 0.304 ± 0.0115 and for *G. a. aurei* 0.327 ± 0.0115). There were no quantitative features for aiding in separation of the males.

The geographical distributions of the 2 subspecies of *G. aurei* are well separated, with *G. a. grahamensis* restricted to SE Arizona and *G. a. aurei* to NE Arizona, SE Utah, SW Colorado, and NW New Mexico. These lice have no host taxa in common.

Holotype ♂, *T. b. grahamensis* (University of California Museum of Vertebrate Zoology—137778), USA: Arizona: Graham Co.: Turkey Flat, Graham Mts, 19.VII.1969, J. L. Patton; in collection of University of Minnesota. Paratypes: 81♀, 124♂, *T. b. grahamensis*, USA: Arizona: Graham Co.: Graham Mts: Arcadia Campground (2), Hospital Flat (8), Marijilda Canyon (1), Treasure Park (2), Turkey Flat (2).

Other specimens examined. USA: Arizona: 4♀, 4♂, *T. b. curvi* Lange, Cochise Co.: Carr Peak, Huachuca Mts (2). 59♀, 61♂, *T. b. catalinae* Goldman, Pima Co.: Santa Catalina Mts: Soldier Camp, Spencer Mt (3), Summerhaven (3), Upper Bear Wallow (1), unspecified (4). 50♀, 48♂, *T. b. collinus*, Cochise Co.: Chiricahua Mts: 1 mi. (1.6 km) below (2), at (6) Rustlers Park, Upper Pinery Canyon (1). 26♀, 21♂, *T. b. hueyi* Goldman, Cochise Co.: Huachuca Mts: Head of Miller Canyon (2), unspecified (1); Pima Co.: Rincon Mts (3). 5♀, 6♂, *T. b. proximus*, Cochise Co.: Ramsey Canyon, Huachuca Mts (1). 67♀, 50♂, *T. u. intermedius*, Cochise Co.: Huachuca Mts: Brown Canyon (1), Peterson Ranch, 2 mi. (3.2 km) N of Sunnyside (2), Ramsey Canyon (3), Sunnyside (2).

Geomydoecus actuosi Price & Hellenenthal, new species FIG. 29, 30

Type-host. *Thomomys bottae actuosus* Kelson.

♀. Much as for *G. aurei*, except as follows. Submarginal and inner marginal temple setae 0.075–0.105 (166: 0.090 ± 0.0065) and 0.035–0.060 (194: 0.047 ± 0.0048) long, respectively. *Tergal setae*. II, 12–20 (199: 15.8 ± 1.30); tergal and pleural setae on VII, 30–43 (199: 35.3 ± 2.44). Longest seta of medial 10 on tergite VII, 0.075–0.120 (196: 0.096 ± 0.0080), with 0–5 (196: 0.34 ± 0.87) of these longer than 0.100. Last tergite with outer seta 0.045–0.095 (175: 0.066 ± 0.0088) long. *Sternal setae*. III, 11–19 (198: 14.9 ± 1.37); VI, 8–13 (194: 10.2 ± 0.99). Genital

sac as in FIG. 29, length 0.150–0.255 (198: 0.208 ± 0.0186), with 2–13 (199: 7.9 ± 1.70) loops, most of these smoothly curved, posteriormost loop situated 0.070–0.150 (197: 0.105 ± 0.0140) back from anterior margin.

♂. Much as for *G. aurei*, except as follows. Head length 0.270–0.330 (172: 0.301 ± 0.0138); submarginal and inner marginal temple setae 0.070–0.120 (126: 0.093 ± 0.0094) and 0.025–0.035 (169: 0.026 ± 0.0024) long, respectively. Antenna with scape length 0.145–0.180 (160: 0.157 ± 0.0072), scape distal width 0.110–0.155 (159: 0.132 ± 0.0080). *Tergal setae*. II, 8–18 (174: 13.2 ± 1.44). *Sternal setae*. II, 10–17 (175: 13.6 ± 1.37); III, 11–19 (172: 14.5 ± 1.53). Total length 1.090–1.485 (164: 1.279 ± 0.0766). *Genitalia*. Sac spines as in FIG. 30, lateroanterior pair shorter than medioanterior spines and anteriorly with deep concavity and converging corners, outer margin often curved; endomerale plate width 0.065–0.080 (171: 0.076 ± 0.0039).

Remarks. The best qualitative features for separating *G. actuosus* from *G. aurei* involve the female *G. actuosus* having a larger number of smoothly rounded genital sac loops (FIG. 29 vs. FIG. 27) and the male having the lateroanterior pair of genital sac spines shorter, with the outer margin often curved, and anteriorly with a deep concavity and converging corners (FIG. 30 vs. FIG. 25 or 28). The best quantitative feature for recognition of the female of *G. actuosus* from that of *G. aurei* and its critical value for discrimination and probability of misidentification was the number of loops on the genital sac 6.33 (0.169). There were no useful quantitative characters for aiding in male identification.

Holotype ♂, *T. b. actuosus* (University of California Museum of Vertebrate Zoology—150289), USA: New Mexico: San Miguel Co.: 3.0 mi. (4.8 km) N of Pecos, 9.VIII.1976, J. L. Patton; in collection of University of Minnesota. Paratypes: 146♀, 154♂, *T. b. actuosus*, USA: New Mexico: Bernalillo Co.: La Madera Ski Run (1); Lincoln Co.: 0.3 mi. (0.5 km) E (1), 1.2 mi. (1.9 km) S, 7 mi. (11.3 km) E (1), 4 mi. (6.4 km) S, 11 mi. (17.7 km) E (1), 5.5 mi. (8.8 km) S, 4.5 mi. (7.2 km) E (1), 2.7 mi. (4.3 km) N, 6.5 mi. (10.5 km) W (1), 7.2 mi. (11.6 km) N, 6.8 mi. (10.9 km) E (3) of Capitan, 2 mi. (3.2 km) S (1), 1.4 mi. (2.3 km) W, 1.3 mi. (2.1 km) E (4) of Nogal, 5 mi. (8.0 km) S, 5 mi. (8.0 km) W of Glencoe (1), Red Cloud Canyon, 2 mi. (3.2 km) S of Rough Mt (4), 2.4 mi. (3.9 km) N, 9 mi. (14.5 km) E (1), 5.7 mi. (9.2 km) N, 15 mi. (24.1 km) E (1) of Ruidoso; San Miguel Co.: 3.0 mi. (4.8 km) N of Pecos (5); Torrance Co.: 7 mi. (11.3 km) NW of Tajique, Manzano Mts (4).

Other specimens examined. USA: 55♀, 45♂, *T. b. cultellus* Kelson, New Mexico: Colfax Co.: Philmont Ranch, Cimarroncito (2); Union Co.: 5.9 mi. (9.5 km) SE of Des Moines (7), 93♀, 62♂.

T. b. internatus Goldman, Chaffee Co.: 2 mi. (3.2 km) N of Salida (1); Custer Co.: 2.5 mi. (4.0 km) S of Wetmore (1); El Paso Co.: 1.25 mi. (2.0 km) S of Colorado Springs (1); Fremont Co.: 1 mi. (1.6 km) E of Coaldale (1); Huerfano Co.: Gardner (3), 4.1 mi. (6.6 km) W of Walsenburg (5), 20♀, 11♂, *T. b. lachugilla* V. Bailey, New Mexico: Dona Ana Co.: 4 mi. (6.4 km) E of San Augustin Pass (1), 10.5 mi. (16.9 km) NE of University Park (1); Otero Co.: 2 mi. (3.2 km) N of Alamogordo (1), 1♀, 2♂, *T. b. pectoralis* Goldman, New Mexico: Eddy Co.: Carlsbad Cave Natl Pk, 4 mi. (6.4 km) W of White City (2), Carlsbad Cave (1), 74♀, 69♂, *T. b. pervagus* Merriam, Colorado: Conejos Co.: 5 mi. (8.0 km) W of Antonito (1), 3.1 mi. (5.0 km) W of Las Mesitas (2); New Mexico: Rio Arriba Co.: Alcalde (2), 4.5 mi. (7.2 km) N of El Rito (1), 2 mi. (3.2 km) N of Espanola (1); Santa Fe Co.: 2 mi. (3.2 km) N (1), at (1) Santa Fe; Taos Co.: 3 mi. (4.8 km) NE of Questa (1), 6♀, 5♂, *T. b. rubidus* Youngman, Colorado: Fremont Co.: 3 mi. (4.8 km) E of Canon City (2), 65♀, 68♂, *T. b. ruidosae* Hall, New Mexico: Lincoln Co.: Eagle Creek, 4 mi. (6.4 km) W of Alto (2), 2.8 mi. (4.5 km) S, 2.0 mi. (3.2 km) W of Nogal (2), Bomita Lake, 14 mi. (22.5 km) N of Ruidoso (3), 1 mi. (1.6 km) S (1), at (3) Ruidoso; Otero Co.: Jct of Willie White & Peñasco Canyons, Sacramento Mts (2), 4 mi. (6.4 km) E, 3.25 mi. (5.2 km) N of Mescalero (3), 82♀, 85♂, *T. b. tularosae* Hall, New Mexico: Otero Co.: Alamogordo (2), Cook Ranch, 0.5 mi. (0.8 km) W of Tularosa (3). MEXICO: 47♀, 48♂, *T. b. analogus* Goldman, Coahuila: La Carbonera (1), Sierra Guadalupe, 11 mi. (17.7 km) S, 4 mi. (6.4 km) W of General Cepeda (3); Nuevo León: 22 mi. (35.4 km) S of Galeana (2), 4.5 mi. (7.2 km) S of Pablillo (1), 7♀, 3♂, *T. b. perditus* Merriam, Coahuila: 9 mi. (14.5 km) E of Hermanas (1); Nuevo León: Lampazos (1), 10 mi. (16.1 km) S of Villadama (1), 15♀, 15♂, *T. b. retractus* Baker, Coahuila: 1 mi. (1.6 km) N (1), 6 mi. (9.7 km) NW (1), at (3) Las Margaritas, 9♀, 9♂, *T. b. sturgisi* Goldman, Coahuila: Sierra del Carmen, 8 mi. (12.9 km) SW of Piedra Blanca (4).

Geomydoecus sinaloae Price & Helleenthal, new species FIG. 31

Type-host. *Thomomys bottae sinaloae* Merriam.

♀. Much as for *G. aurei*, except as follows. Temple width 0.425–0.460 (34: 0.442 ± 0.0095). Prothorax width 0.290–0.355 (34: 0.320 ± 0.0161). *Tergal setae*. III, 20–31 (34: 24.6 ± 2.19); IV, 23–33 (33: 26.9 ± 2.34); VI, 20–29 (33: 22.8 ± 2.37). Longest seta of medial pair on tergite VIII, 0.045–0.080 (32: 0.067 ± 0.0091). *Sternal setae*. II, 12–20 (34: 15.9 ± 1.74); III, 14–20 (34: 16.5 ± 1.48); IV, 13–22 (34: 16.2 ± 1.63); V, 9–17 (33: 12.2 ± 1.64). *Subgenital plate*. With 16–25 (34: 21.3 ± 2.16) setae. Genital sac length 0.200–0.255 (34: 0.222 ± 0.0118), with 6–15 (34: 11.5 ± 1.89) loops smoothly curved as in FIG. 24 or 29, posteriormost loop situated 0.080–0.165 (34: 0.146 ± 0.0182) back from anterior margin. Total length 1.075–1.355 (33: 1.239 ± 0.0742).

♂. Much as for *G. aurei*, except as follows. Temple width 0.385–0.425 (31: 0.399 ± 0.0093); inner marginal temple seta 0.025–0.035 (30: 0.029 ± 0.0026) long. Antenna with scape length 0.150–0.180 (31: 0.166 ± 0.0055), scape medial width 0.100–0.125 (31: 0.111 ± 0.0071), scape distal width 0.120–0.160 (30: 0.144 ± 0.0087). Prothorax width 0.285–0.320 (31: 0.299 ± 0.0128). *Tergal setae*. II, 12–17 (31: 14.1 ± 1.50); III, 18–25 (31: 21.3 ± 1.75); IV, 20–28 (30: 24.2 ± 1.68); V, 18–29 (30: 21.8 ± 2.48). *Sternal setae*. II, 13–20 (30: 15.4 ± 1.75); III, 14–18 (30: 16.3 ± 1.34); IV, 13–18 (30: 15.4 ± 1.13). Total length 1.205–1.385 (31: 1.297 ± 0.0501). *Genitalia*. Sac spines as in FIG. 31, close to those of *G. actuosus* but lateroanterior ones

longer and with narrower anterior concavity; parameral arch width 0.145–0.170 (30: 0.158 \pm 0.0052).

Remarks. The female of *G. sinaloae* has a larger number of genital sac loops extending farther posteriorly on the sac than either of the foregoing species; the male of *G. sinaloae* has genitalic features close to those of *G. actuosi*, but with the lateroanterior pair of sac spines somewhat longer and with a narrower anterior concavity (FIG. 31 vs. FIG. 30). Quantitatively, for females of *G. sinaloae* and *G. aurei*, critical values for discrimination and probabilities of misidentification for the best discriminating characters were the number of genital sac loops 8.15 (0.018) and the distance of the posteriormost loop from the anterior margin of the sac 0.119 (0.022); for females of *G. sinaloae* and *G. actuosi*, the distance of the posteriormost genital sac loop from the anterior sac margin (GSLPL) 0.125 (0.085), the number of genital sac loops (GSLP) 9.71 (0.147), the number of setae on sternite IV (SST4) 15.16 (0.241), and the temple width 0.433 (0.245). The use of GSLPL, GSLP, and SST4 in combination provided a probability of misidentification of 0.041, with respective discriminant function coefficients of 0.79, 0.0037, and 0.0045 and a critical value for the discriminant of 0.204 (discriminant means and standard deviations for *G. sinaloae* were 0.231 \pm 0.0212 and for *G. actuosi* 0.176 \pm 0.0146). For males of *G. sinaloae* and *G. aurei*, the best were the number of setae on sternite III (SST3) 15.15 (0.204), the number of setae on sternite II 14.27 (0.234), the temple width (TW) 0.392 (0.236), and the length of the inner marginal temple seta (MTS) 0.027 (0.266); the use of MTS, TW, and SST3 in combination provided a probability of misidentification of 0.123, with respective discriminant function coefficients of 1.62, 0.51, and 0.0040 with a critical value for the discriminant of 0.303 (discriminant means and standard deviations for *G. sinaloae* were 0.314 \pm 0.0096 and for *G. aurei* 0.292 \pm 0.0097). For males of *G. sinaloae* and *G. actuosi*, the best discriminating characters were the number of setae on tergite IV (STG4) 22.96 (0.262), the number of setae on sternite II (SST2) 14.50 (0.266), and the length of the antennal scape (SL) 0.162 (0.266); the use of SL, STG4, and SST2 in combination provided a probability of misidentification of 0.176, with respective discriminant function coefficients of 0.70, 0.0025, and 0.0036 and a critical value for the discriminant of 0.224 (discriminant means and standard devia-

tions for *G. sinaloae* were 0.234 \pm 0.0109 and for *G. actuosi* 0.215 \pm 0.0102).

Holotype ♂, *T. b. sinaloae* (University of Kansas Museum of Natural History—96639), MEXICO: Sinaloa: 0.5 mi. (0.8 km) E of San Lorenzo, I.V.1965: in collection of University of Kansas. **Paratypes:** 101♀, 142♂, *T. b. sinaloae*, MEXICO: Sinaloa: 7.5 mi. (12.1 km) ENE of Altata (1), 2 km S of El Dorado (3), 6 km E (1), 2.5 mi. (4.0 km) S, 4 mi. (6.4 km) W (2) of El Fuerte, 5 km SW of Los Mochis (1), S side of Río Sinaloa, Sinaloa de Leyva (3), 1 mi. (1.6 km) E of Sinaloa de Leyva (1), 0.5 mi. (0.8 km) E of San Lorenzo (2).

Other specimens examined. MEXICO: Sinaloa: 3♀, 3♂, *T. b. simulus* Nelson & Goldman, 16 km NNE of Choix (2).

Geomydoecus crovelloi Price & Hellenthal, **new species** FIG. 32–34

Type-host. *Thomomys umbrinus sonoriensis* Nelson & Goldman.

♀. Much as for *G. aurei*, except as follows. Temple width 0.405–0.435 (64: 0.419 \pm 0.0077); head length 0.260–0.305 (64: 0.281 \pm 0.0100). Prothorax width 0.285–0.320 (64: 0.303 \pm 0.0085). Longest seta of medial 10 on tergite VI, 0.080–0.100 (63: 0.091 \pm 0.0052); tergite VII with 0–3 (62: 0.39 \pm 0.91) setae of medial 10 longer than 0.100. Longest seta of medial pair on tergite VIII, 0.050–0.090 (55: 0.070 \pm 0.0086). Last tergite with outer seta 0.050–0.080 (55: 0.064 \pm 0.0082), middle seta 0.065–0.105 (57: 0.084 \pm 0.0074), inner seta 0.070–0.105 (59: 0.089 \pm 0.0070) long. **Sternal setae.** II, 12–20 (64: 15.6 \pm 1.52); III, 13–19 (64: 15.9 \pm 1.26); IV, 13–18 (64: 15.4 \pm 1.22). Genital sac as in FIG. 34, width 0.180–0.250 (63: 0.220 \pm 0.0176), length 0.160–0.240 (63: 0.194 \pm 0.0151), with 2–6 (63: 3.7 \pm 0.86) deep irregular loops, posteriormost loop situated 0.075–0.135 (63: 0.099 \pm 0.0097) back from anterior margin. Total length 1.035–1.230 (62: 1.158 \pm 0.0460).

♂. Much as for *G. aurei*, except as follows. Head length 0.270–0.305 (47: 0.288 \pm 0.0096); inner marginal temple seta 0.025–0.030 (47: 0.027 \pm 0.0024) long. Antenna with scape length 0.145–0.170 (46: 0.157 \pm 0.0071). **Tergal setae.** III, 18–24 (46: 20.4 \pm 1.36); IV, 20–27 (46: 23.3 \pm 1.85); V, 18–28 (45: 21.3 \pm 2.12); tergal and pleural setae on VII, 18–26 (47: 20.6 \pm 1.79). **Sternal setae.** II, 13–19 (46: 15.6 \pm 1.57); III, 14–20 (46: 16.0 \pm 1.34); IV, 12–19 (47: 15.9 \pm 1.45); V, 9–16 (47: 11.2 \pm 1.59); VI, 8–12 (47: 10.0 \pm 0.99). **Genitalia.** As in FIG. 33; sac spines as in FIG. 32, lateroanterior pair much reduced; parameral arch width 0.135–0.155 (47: 0.147 \pm 0.0051); endomeral plate width 0.065–0.075 (47: 0.071 \pm 0.0033), length 0.060–0.080 (46: 0.069 \pm 0.0052).

Remarks. The female of *G. crovelloi* is qualitatively closest to that of *G. aurei* in having the genital sac with a small number of irregular deep loops (FIG. 34 vs. FIG. 27), thereby differing from that of *G. actuosi* (FIG. 29) and *G. sinaloae*; the male of *G. crovelloi* is markedly different from all other taxa of this group by having much reduced latero-

anterior spines on the genital sac (FIG. 32 vs. FIG. 25, 28, 30, 31, 35). Quantitatively, for females of *G. crovelloi* and *G. aurei*, critical values for discrimination and probabilities of misidentification for the best discriminating characters were the number of setae on sternite III (SST3) 15.11 (0.283), the width of the genital sac (GSW) 0.229 (0.306), and the head length (HL) 0.286 (0.321); the use of HL, GSW, and SST3 in combination provided a probability of misidentification of 0.197, with respective discriminant function coefficients of 0.29, 0.17, and -0.0032 and a critical value for the discriminant of 0.075 (discriminant means and standard deviations for *G. crovelloi* were 0.069 ± 0.0065 and for *G. aurei* 0.080 ± 0.0067). For females of *G. crovelloi* and *G. actuosi*, the best were the number of genital sac loops (GSLP) 5.77 (0.085), the head length (HL) 0.287 (0.305), and the number of setae on sternite IV (SST4) 14.78 (0.319); the use of HL, GSLP, and SST4 in combination provided a probability of misidentification of 0.046, with respective discriminant function coefficients of 0.44, 0.0080, and -0.0041 and a critical value for the discriminant of 0.113 (discriminant means and standard deviations for *G. crovelloi* were 0.090 ± 0.0099 and for *G. actuosi* 0.136 ± 0.0145). For females of *G. crovelloi* and *G. sinaloae*, the best were the number of genital sac loops 7.59 (0.001), the distance of the posteriormost loop from the anterior sac margin 0.122 (0.040), and the temple width 0.430 (0.081).

Quantitatively, for males of *G. crovelloi* and *G. aurei*, critical values for discrimination and probabilities of misidentification for the best discriminating characters were the number of setae on sternite II (SST2) 14.38 (0.208), on sternite IV (SST4) 14.73 (0.214), and on sternite III (SST3) 14.99 (0.238); the use of SST2, SST3, and SST4 in combination provided a probability of misidentification of 0.141, with respective discriminant function coefficients of 0.0029, 0.0022, and 0.0030 and a critical value for the discriminant of 0.118 (discriminant means and standard deviations for *G. crovelloi* were 0.127 ± 0.0093 and for *G. aurei* 0.109 ± 0.0083). For males of *G. crovelloi* and *G. actuosi*, the best were the number of setae on sternite II (SST2) 14.62 (0.237), on sternite IV (SST4) 14.76 (0.256), the genitalic endomeral plate width (EPW) 0.073 (0.267), and endomeral plate length 0.072 (0.276); the use of EPW, SST2, and SST4 in combination provided a probability of misidentification of 0.124, with respective discrim-

inant function coefficients of 1.99, -0.0047 , and -0.0032 and a critical value for the discriminant of 0.031 (discriminant means and standard deviations for *G. crovelloi* were 0.018 ± 0.0120 and for *G. actuosi* 0.044 ± 0.0108). For males of *G. crovelloi* and *G. sinaloae*, the best discriminating characters were the genitalic parameral arch width (PAW) 0.152 (0.151), the temple width (TW) 0.392 (0.190), and the endomeral plate length (EPL) 0.073 (0.210); the use of EPL, PAW, and TW in combination provided a probability of misidentification of 0.083, with respective discriminant function coefficients of 3.87, 4.11, and 2.04 and a critical value for the discriminant of 1.709 (discriminant means and standard deviations for *G. crovelloi* were 1.657 ± 0.0392 and for *G. sinaloae* 1.761 ± 0.0347).

This species is named for Dr Theodore J. Crovello, University of Notre Dame, for his many contributions to numerical taxonomy and for his interest and help in our studies.

Holotype ♂, *T. u. sonoriensis* (University of California Museum of Vertebrate Zoology—148910), MEXICO: Sonora: 1 mi. (1.6 km) N of Sahuaripa, 19.VII.1975, J. L. Patton; in collection of University of Minnesota. Paratypes: 157♀, 275♂, *T. u. sonoriensis*, MEXICO: Sonora: 3.5 mi. (5.6 km) S of Moctezuma (1), E bank (3), W bank (2) of Río Yaqui at El Novillo, 1 mi. (1.6 km) N of Sahuaripa (4).

Other specimens examined. USA: Arizona: Santa Cruz Co.: 115♀, 100♂, *T. u. intermedius*, Patagonia Mts: Italian Canyon (1), Sycamore Canyon (13).

***Geomydoecus warmanae* Price & Hellenthal, new species** FIG. 35, 36

Type-host. *Thomomys umbrinus madrensis* Nelson & Goldman.

♀. Much as for *G. aurei*, except as follows. Temple width 0.380–0.455 (250: 0.412 ± 0.0118); head length 0.255–0.325 (250: 0.280 ± 0.0128); inner marginal temple seta 0.035–0.060 (248: 0.047 ± 0.0056) long. Prothorax width 0.265–0.340 (248: 0.299 ± 0.0120). *Tergal setae.* II, 13–21 (250: 16.1 ± 1.39); IV, 19–30 (249: 24.2 ± 2.23). Longest seta of medial 10 on tergite VI, 0.075–0.115 (248: 0.092 ± 0.0064); on tergite VII, 0.080–0.120 (248: 0.096 ± 0.0075). Longest seta of medial pair on tergite VIII, 0.045–0.095 (242: 0.065 ± 0.0086). Last tergite with outer seta 0.040–0.095 (230: 0.066 ± 0.0091), middle seta 0.070–0.115 (233: 0.088 ± 0.0088) long. *Sternal setae.* III, 12–19 (246: 14.9 ± 1.43); V, 7–14 (249: 10.6 ± 1.48); VII, 7–13 (251: 9.7 ± 0.93). *Subgenital plate.* With 15–27 (249: 19.6 ± 1.88) setae. Genital sac close to FIG. 7, width 0.190–0.285 (248: 0.231 ± 0.0165), length 0.150–0.245 (247: 0.194 ± 0.0160), with 4–13 (248: 8.8 ± 1.56) loops, posteriormost loop situated

0.065–0.155 (248: 0.105 ± 0.0143) back from anterior margin. Total length 0.990–1.345 (245: 1.172 ± 0.0614).

♂. Much as for *G. aurei*, except as follows. Temple width 0.350–0.410 (222: 0.371 ± 0.0101); head length 0.260–0.325 (222: 0.288 ± 0.0129); inner marginal temple seta 0.020–0.035 (219: 0.026 ± 0.0027) long. Antenna with scape length 0.135–0.180 (219: 0.152 ± 0.0068), scape medial width 0.090–0.120 (219: 0.103 ± 0.0061), scape distal width 0.115–0.160 (219: 0.134 ± 0.0078). Prothorax width 0.250–0.315 (222: 0.279 ± 0.0114). Tergal setae. IV, 16–27 (219: 20.6 ± 1.77); V, 15–22 (218: 18.8 ± 1.64); VI, 10–21 (217: 14.6 ± 1.54); tergal and pleural setae on VII, 16–25 (221: 20.9 ± 1.66). Sternal setae. II, 9–20 (222: 13.6 ± 1.57); III, 11–19 (223: 14.4 ± 1.48); V, 7–14 (222: 10.0 ± 1.13); VII, 6–11 (223: 8.1 ± 0.92). Total length 1.090–1.445 (218: 1.230 ± 0.0651). Genitalia. As in FIG. 36; sac spines much as in FIG. 35, lateroanterior pair on line with medioanterior pair and appearing much as those spines; parameral arch width 0.130–0.170 (222: 0.146 ± 0.0064); endomerical plate width 0.060–0.080 (223: 0.071 ± 0.0038), length 0.060–0.080 (216: 0.073 ± 0.0045).

Remarks. Qualitatively, the female of *G. warmanae* has more evenly rounded genital sac loops than either *G. aurei* or *G. crovelloi*, but has no good features for separating it from *G. sinaloae* or *G. actuosi*. The male of *G. warmanae* is recognized from all other taxa of the group by having the lateroanterior pair of genital sac spines similar in size and shape to those of the medioanterior pair and aligned evenly with them (FIG. 35).

Quantitatively, for females of *G. warmanae* compared to those of *G. aurei*, the best characters and their critical values for discrimination and probabilities of misidentification were the number of genital sac loops (GSLP) 6.79 (0.097), the temple width (TW) 0.418 (0.284), and the distance of the posteriormost loop from the anterior genital sac margin 0.098 (0.306); the use of GSLP and TW in combination provided a probability of misidentification of 0.075, with respective discriminant function coefficients of -0.0038 and 0.23 and a critical value for the discriminant of 0.070 (discriminant means and standard deviations for *G. warmanae* were 0.061 ± 0.0062 and for *G. aurei* 0.079 ± 0.0069). For females of *G. warmanae* and *G. actuosi*, the best discriminating character was the longest seta of the medial pair on tergite VIII 0.072 (0.224). For females of *G. warmanae* and *G. sinaloae*, the best were the distance of the posteriormost genital sac loop from the anterior sac margin (GSLPL) 0.125 (0.086), the temple width (TW) 0.427 (0.094), the genital sac length 0.208 (0.182), and the number of genital sac loops 10.17 (0.198); the use of GSLPL and TW in combination provided a probability of misidentification of 0.047, with respective discriminant function coef-

ficients of 0.52 and 0.64 and a critical value for the discriminant of 0.340 (discriminant means and standard deviations for *G. warmanae* were 0.320 ± 0.0121 and for *G. sinaloae* 0.360 ± 0.0120). For females of *G. warmanae* and *G. crovelloi*, the best discriminating character was the number of genital sac loops 6.23 (0.037).

For males of *G. warmanae* compared to those of *G. sinaloae*, the best quantitative characters were the temple width (TW) 0.385 (0.080), the antennal scape length 0.159 (0.152), the number of setae on tergite IV (STG4) 22.40 (0.157), and the genitalic parameral arch width 0.152 (0.185); the use of TW and STG4 in combination provided a probability of misidentification of 0.055, with respective discriminant function coefficients of 1.03 and 0.0036 and a critical value for the discriminant of 0.480 (discriminant means and standard deviations for *G. warmanae* were 0.459 ± 0.0133 and for *G. sinaloae* 0.501 ± 0.0118). For males of *G. warmanae* and *G. crovelloi*, the best were the number of setae on sternite IV (SST4) 14.58 (0.195), on tergite IV 21.98 (0.225), on tergite V (STG5) 20.06 (0.235), and the temple width (TW) 0.378 (0.256); the use of TW, STG5, and SST4 in combination provided a probability of misidentification of 0.140, with respective discriminant function coefficients of 0.34, 0.0022, and 0.0034 and a critical value for the discriminant of 0.221 (discriminant means and standard deviations for *G. warmanae* were 0.212 ± 0.0084 and for *G. crovelloi* 0.230 ± 0.0090). There were no useful quantitative features for separating *G. warmanae* from *G. aurei* or *G. actuosi*.

This species is named for Debra J. Warman in appreciation of her reliable perseverance in gathering the quantitative data used in this study.

Holotype ♂, *T. u. madrensis* (University of California Museum of Vertebrate Zoology—140992), MEXICO: Chihuahua: 3.5 mi. (5.6 km) NE of Colonia Garcia, 11.IX.1971, J. L. Patton; in collection of University of Minnesota. Paratypes: 185 ♀, 290 ♂, *T. u. madrensis*, MEXICO: Chihuahua: 2.4 mi. (3.9 km) NE (4), 1 mi. (1.6 km) W (4), 3.5 mi. (5.6 km) NE (3), at (2) Colonia Garcia, Water Canyon, 3 mi. (4.8 km) S of Colonia Garcia (1), Valle Moctezuma, 11.6 mi. (18.7 km) SE of Colonia Garcia (3), 3 mi. (4.8 km) SW (2), 3 mi. (4.8 km) S, 10 mi. (16.1 km) E (1) of Pacheco, Río Gavilan, 9 mi. (14.5 km) SW (2) and, 7 mi. (11.3 km) SW (2) of Pacheco, Cañon del Oro, 12 mi. (19.3 km) E of Pacheco (1).

Other specimens examined. MEXICO: 69♀, 115♂, *T. u. arriagensis* Dalquest, San Luis Potosí: 1 km S (2), 4 mi. (6.4 km) E (2), 11 km N, 12 km E (2) of Arriaga. 78♀, 57♂, *T. u. camargensis* Anderson, Chihuahua: 1 mi. (1.6 km) NW (3), 1 mi. (1.6 km) S (2), 14 mi. (22.5 km) SW (2) of Ciudad Camargo. 29♀, 38♂, *T. u. chihuahuae* Nelson & Goldman, Chihuahua: 9.6 mi. (15.4 km) W of Tomochic (4). 2♀, 6♂, *T. u. evexus* Nelson & Goldman, Durango: Villa Ocampo (2). 18♀, 7♂, *T. u. goldmani* Merriam, Coahuila: 3 mi. (4.8 km) SE of Torreón (L); Durango: 4 mi. (6.4 km) WSW of Lerdo (1). 135♀, 142♂, *T. u. juntae* Anderson, Chihuahua: 2 mi. (3.2 km) SW of Babicora (1), Cañon del Alamo, Sierra del Nido (1), Cañon del Potrero, 7 mi. (11.3 km) W of El Sauz (2), Cañon Santa Clara, Sierra del Nido (2), 5 mi. (8.0 km) N (1), at (1) Chihuahua, 5 mi. (8.0 km) N of Cerro La Campana (2), 8.4 mi. (13.5 km) W of Cuauhtemoc (1), 1 mi. (1.6 km) S of Delicias (3), 5 mi. (8.0 km) N, 5 mi. (8.0 km) E of Meoqui (1). 40♀, 123♂, *T. u. nelsoni* Merriam, Chihuahua: Jimenez (2), 10 mi. (16.1 km) SE of Hdgo Del Parral (2); Durango: 14.7 mi. (23.7 km) N of Las Nieves (4). 41♀, 55♂, *T. u. potosinus* Nelson & Goldman, San Luis Potosí: 24 mi. (38.6 km) NE of Ciudad San Luis Potosí (1), La Tinaja (3), Ventura (4). 172♀, 200♂, *T. u. sonoriensis*, Sonora: 10 mi. (16.1 km) NE of Chinapa (3), 1 mi. (1.6 km) S (3), 3 km NE (2), at (3) Moctezuma. 22♀, 42♂, *T. u. zacatecae* Nelson & Goldman, Zacatecas: 2 mi. (3.2 km) ESE of Trancoso (2). 20♀, 25♂, *T. u. subsp.*, Sonora: 1 mi. (1.6 km) W of Yecora (2); Zacatecas: 20 km S, 30 km E of Guadalupe (2). USA: Arizona: 20♀, 28♂, *T. b. modicus*, Santa Cruz Co.: 7.5 mi. (12.1 km) E, 1 mi. (1.6 km) S (1), 9 mi. (14.5 km) E (1), 10 mi. (16.1 km) E, 3 mi. (4.8 km) S (1) of Amado, Peña Blanca Spring (1). 29♀, 25♂, *T. u. burti* Huey, Pima Co.: Santa Rita Mts (6). 18♀, 41♂, *T. u. quercinus* Burt & Campbell, Santa Cruz Co.: 6 mi. (9.7 km) W, 1 mi. (1.6 km) N (3), 9 mi. (14.5 km) W, 1 mi. (1.6 km) N (2) of Nogales.

The keys given by Price & Emerson (1971) for identification of the species of *Geomydoecus* cannot be modified conveniently to include the taxa of the *californicus* complex. Therefore, if the complex is defined as including the lice predominantly from *T. bottae* (and less often from *T. umbrinus*) that have males with a process on the posterior scape margin and 6 prominent spines on the genital sac, females with conspicuous transverse loops on the genital sac, and both sexes with the submarginal temple seta usually more than 0.075 long, then the following keys may be used for identification of these taxa. It should be borne in mind that characters used in these keys, while not qualified with such terms as "often" or "usually," are not absolute characters and a small percentage of lice may be misidentified.

Successful use of the following key requires a series of both sexes of the louse taxon being identified, along with adequate host and locality data. Morphological separations are based primarily on details of the male genitalia. However, in instances where males of compared taxa are inseparable or where females offer useful differentiating structures, female characteristics are included. Where

meaningful, geographical and/or host data are given to confirm the proper identification.

KEY TO TAXA OF *Geomydoecus californicus* COMPLEX

1. Medioanterior pair of ♂ genital sac spines with 1 recessed posteriorly and different in appearance (FIG. 10) *californicus* group ... 2
- Medioanterior pair of ♂ genital sac spines similar in position and appearance 5
2. ♂ genitalic endomeral plate apically attenuate, narrowed (FIG. 12) ... (widely distributed in Nevada, Utah, SW New Mexico, NW & SE Arizona, E California, N Sinaloa, SE Sonora, NW Chihuahua) ... **centralis n. sp.**
- ♂ genitalic endomeral plate essentially triangular (FIG. 9) ... (limited to California, SW Arizona, NW Sonora, N Baja California) 3
3. ♂ endomeral plate width less than 0.078 ... (on *T. b. albatius*, *T. b. depauperatus*, *T. b. phasma*, *T. b. vanrossemi*; in SW Arizona, NW Sonora, extreme SE California) **albatii n. sp.**
- ♂ endomeral plate width more than 0.078 ... (on other *T. b.* subsp.; in California, Baja California) 4
4. ♀ genital sac with shallowly curved transverse lines extending to medioanterior margin (FIG. 13) ... (on hosts mostly N and/or W of Los Angeles, California) **angularis n. sp.**
- ♀ genital sac with curved loops not extending to medioanterior margin (FIG. 7) ... (on hosts mostly S and/or E of Los Angeles, California) **californicus**
5. Lateral ♂ genital sac spines relatively large and with principal margin directed mediad (FIG. 23) *limitaris* group; **limitaris n. sp.** ... 6
- Lateral ♂ genital sac spines with principal margin directed laterad, or, if not, these spines very small (FIG. 32) 9
6. ♀ genital sac with 6 or more loops ... (on hosts in Texas, Coahuila) **l. limitaris**
- ♀ genital sac with 1–15 loops ... (on hosts in Arizona, New Mexico, Sonora, Chihuahua) 7
7. ♂ antennal scape medial width more than 0.111 ... (on *T. b. proximus*, *T. b. cane-*

- loensis*, *T. b. operosus*) . . . **1. halli n. subsp.**
 ♂ antennal scape medial width less than 0.111 . . . (on other host subspp.) 8
8. ♀ with only up to 8 genital sac loops
 **1. bakeri n. subsp.**
 ♀ with 9 or more genital sac loops
 **1. tolteci n. subsp.**
9. ♀ subgenital plate with heavy setae laterally (FIG. 17, 19) . . . (on hosts in Baja California) *bajaiensis* group. . . 10
 ♀ subgenital plate with only thin setae laterally (FIG. 8) . . . (on hosts elsewhere in USA, Mexico) *aurei* group. . . 11
10. Lateral ♂ genital sac spines relatively long compared to medioanterior pair, with markedly concave anterior margin (FIG. 20); ♀ genital sac with transverse subparallel lines on posterior portion (FIG. 18) . . . (on *T. b. anitae*, *T. b. alticolus*) **clausonae n. sp.**
 Lateral ♂ genital sac spines relatively short, with flatter anterior margin (FIG. 16); ♀ genital sac without such lines (FIG. 14) . . . (on other *T. b.* subspp.) **bajaiensis n. sp.**
11. Lateral pair of ♂ genital sac spines very small (FIG. 32); ♀ with only up to 6 genital sac loops (FIG. 34) . . . **crovelloi n. sp.**
 Lateral pair of ♂ genital sac spines larger; ♀ with variable number of genital sac loops 12
12. Lateral and medioanterior pairs of ♂ genital sac spines of similar size, transversely aligned (FIG. 35); ♀ genital sac with 6 or more loops . . . (mostly on *T. u.* subspp.) **warmanae n. sp.**
 Lateral ♂ genital sac spines smaller than medioanterior pair, somewhat posteriorly displaced; ♀ genital sac with variable number of loops . . . (mostly on *T. b.* subspp.) 13
13. Lateral ♂ genital sac spines relatively short, outer margin curved, with deep anterior concavity and converging corners (FIG. 30, 31); ♀ genital sac with 7 or more loops 14
 Lateral ♂ genital sac spines longer, outer margin straighter, with no more than a shallow anterior concavity (FIG. 25, 28); ♀ genital sac with up to 6 loops
 **aurei n. sp.** . . . 15
14. ♂ with sum of $(0.70 \times \text{antennal scape length}) + (0.0025 \times \text{number of setae on tergite IV}) + (0.0036 \times \text{number of setae on sternite II})$ larger than 0.224; lateral genital sac spines as in FIG. 31. ♀ with sum of $(0.79 \times \text{distance of posterior-most genital sac loop from anterior sac margin}) + (0.0037 \times \text{number of genital sac loops}) + (0.0045 \times \text{number of setae on sternite IV})$ larger than 0.204 . . . (on *T. b. sinaloae*, *T. b. simulus*; in Sinaloa) **sinaloae n. sp.**
 ♂ with above sum less than 0.224; lateral genital sac spines as in FIG. 30. ♀ with above sum less than 0.204 . . . (on other *T. b.* subspp.; in USA, Coahuila, Nuevo León) **actuosi n. sp.**
15. Lateral ♂ genital sac spines with shallow anterior concavity (FIG. 25) **a. aurei**
 Lateral ♂ genital sac spines without such anterior concavity (FIG. 28)
 **a. grahamensis n. subsp.**

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