

OCCASIONAL PAPERS
OF THE
CALIFORNIA ACADEMY OF SCIENCES

No. 87, 62 pages, 55 figures, 9 tables.

A SYSTEMATIC REVISION OF THE GIANT HAIRY-SCORPION
GENUS HADRURUS (SCORPIONIDA: VEJOVIDAE)

By

Stanley C. Williams

Research Associate in Entomology, California Academy
of Sciences and Department of Biology,
San Francisco State College, San
Francisco, California, U.S.A.

SAN FRANCISCO
PUBLISHED BY THE ACADEMY
September 18, 1970

COMMITTEE ON PUBLICATION

Dr. George E. Lindsay, *Chairman*
Dr. Edward L. Kessel, *Editor* Dr. Leo G. Hertlein

OCCASIONAL PAPERS
OF THE
CALIFORNIA ACADEMY OF SCIENCES

No. 87, 62 pages, 55 figures, 9 tables.

A SYSTEMATIC REVISION OF THE GIANT HAIRY-SCORPION
GENUS HADRURUS (SCORPIONIDA: VEJOVIDAE)

By

Stanley C. Williams

Research Associate in Entomology, California Academy
of Sciences and Department of Biology,
San Francisco State College, San
Francisco, California, U.S.A.

ABSTRACT: Scorpions of the genus Hadrurus are limited to North America where they show greatest species diversity and most dense population sizes in desert habitats. Seven species and three subspecies are known, including one new species, Hadrurus obscurus Williams, and two new subspecies Hadrurus arizonensis pallidus Williams and Hadrurus arizonensis austrinus Williams which are here described. One species, Hadrurus thayeri Stahnke is here placed in synonymy under Hadrurus hirsutus (Wood), and new taxonomic interpretation is here given to a major part of the Hadrurus fauna. Because of the major confusion which has been caused by the Hadrurus genus, all species and subspecies are discussed including specimen photographs, technical character illustrations, keys, and distributional maps.

INTRODUCTION

Scorpions of the genus Hadrurus are among the largest, most heavy-bodied, and most conspicuous looking scorpions in North America. The first specimen of this group known to science was collected in the Cape region of Baja California, Mexico, sometime between 1859 and 1861 by John Xantus de Vesey. This naturalist collected at least two large specimens which eventually found their way to the collections of the Smithsonian Institution. In 1863, Horatio Wood described two new species which he called Buthus hirsutus and Buthus emarginaticeps based on these specimens. In 1876, Thorell recognized the uniqueness of these species and erected the new genus Hadrurus with

Hadrurus hirsutus and Hadrurus emarginaticeps being the only known members. In 1887, Marx, after studying Wood's types, concluded that Hadrurus emarginaticeps was actually an aberrant specimen of H. hirsutus and therefore should be considered only as a synonym.

During the next 100 years some dozen authors discussed H. hirsutus, but probably few based their study on specimens which actually belonged to this species, which is clearly endemic to the Cape region of Baja California. In addition, five additional species were described; some of these descriptions based on unique specimens and juveniles. This has caused considerable misunderstanding of this group. Recently a taxonomic review of the genus was published by Stahnke (1969). This work was far from comprehensive, and recognized no literature published since 1945. Therefore, several old erroneous assumptions of classification were perpetuated.

Because of the confused status of the genus Hadrurus at this time, all of the known species of Hadrurus are here discussed. One new species and two new subspecies are here described. One species, Hadrurus thayeri Stahnke, is here placed in synonymy and revised taxonomic status is given to a major element of the North American fauna.

Specimens collected during our field work were preserved according to the methods recently recommended by Williams (1968a). The large and impermeable body of Hadrurus specimens creates special problems of fixative penetration, thus it is especially important to inject fixative directly into the mesosoma or to facilitate penetration by slitting the pleural membranes of the mesosoma. The measurements reported in this paper are the standard ones used in scorpion taxonomy with the exceptions discussed by Williams (1968c).

ACKNOWLEDGMENTS

Much appreciation is due the following individuals and their respective institutions for cooperation and loan of specimens which materially aided this study (abbreviations here designated correspond to depository citation records in text): D. M. Allred, Brigham Young University (BYU); P. H. Arnaud, California Academy of Sciences (CAS); J. Bigelow and M. A. Cazier, Arizona State University (ASU); R. C. Bechtel, Nevada Department of Agriculture (NDA); J. A. Chemsack, California Insect Survey, University of California Berkeley (CIS); F. Ennik, California Bureau of Vector Control (CBVC); W. J. Gertsch, American Museum of Natural History (AMNH); C. F. Harbison, San Diego Museum of Natural History (SDMNH); C. L. Hogue, Los Angeles County Museum (LACM); I. La Rivers, University of Nevada (UN); H.W. Levi, Harvard Museum of Comparative Zoology (MCZ). The following people kindly loaned specimens from their private collections: P. Craig, V. F. Lee, K. Lucas, and B. R. Vogel. Thanks are due Richard and Mary Lou Adcock for providing transportation to islands in the Gulf of California aboard their boat Marisla in 1968, and to the Thomas P. Hearnes

who sponsored another expedition to study the Gulf-islands scorpion fauna aboard their boat Muy Pronto in 1969. The following are gratefully acknowledged for assistance in the field: M. A. Cazier, J. Davidson, N. Leppla, W. K. Fox, M. M. Bentzien, H. L. Heringhi, V. F. Lee; and thanks to C. F. Williams and C. A. Steketee for clerical assistance. Much appreciation is due D. T. Okamoto for assistance in making technical drawings and maps and to W. Azevedo for technical assistance in the laboratory. This study was partially supported by the National Science Foundation through research grant GB 7679, by the California Academy of Sciences through the use of the research facilities of the Department of Entomology, and by San Francisco State College by a Faculty Research Leave.

Genus Hadrurus Thorell

(Figures 1 to 30)

Hadrurus. Thorell, 1876a, p. 11 (original description).
Thorell, 1876b, p. 189. Karsch, 1879, pp. 97, 135-136.
Thorell, 1893, p. 373. Pocock, 1893, pp. 304, 306, 309.
Pocock, 1894, p. 360. Kraepelin, 1894, pp. 204-206.
Kraepelin, 1899, p. 188. Pocock, 1902, pp. 5-6. Ewing, 1928, p. 7. Hoffmann, 1931, pp. 334-335. Werner, 1934, p. 282. Stahnke, 1945, pp. 1-4. Gertsch and Allred, 1965, p. 12. Stahnke, 1969, pp. 57-58.

DIAGNOSIS. Genus of large sized and conspicuously hirsute scorpions belonging to the subfamily Vejovinae, second-instar nymphs about 28 millimeters, mature individuals usually 100 to 127 millimeters in total body length. Walking legs, dorsal keels of posterior metasomal segments, and telson densely hirsute with long conspicuous hairs; anterior surface of brachium and humerus densely hirsute. Chelicerae with inferior border of movable finger with 1 long, dark, conspicuous tooth, this border otherwise lacking denticles; superior border of movable finger with 3 major simple teeth and usually several inconspicuous denticles; fixed finger with 1 row of teeth, distal 2 teeth (including terminus of finger) simple, proximal tooth bicuspid. Pedal spurs with distinctly denticulate spines. Carapace with anterior margin broadly convex, some individuals with subtle median emargination; median eyes 2 in number, on raised ocular tubercule, slightly anterior to center of carapace; this diad large, width of diad about 1/5 carapace width at that point; lateral eyes 3 per group; carapace surface granular, granules irregular in dispersion and size. Mesosoma with tergites granular; dorsal median and dorsal lateral keels approaching obsolescence or completely absent; stigma long and slit-like, each stigma set in oval depression in posterolateral region of sternite. Metasoma with dorsal and dorsolateral keels granular; inferior median and inferior lateral keels on segments II to IV always present, these smooth, crenular or serrate; segments II to V longer than wide. Telson with vesicle large and bulbous; aculeus

stout, well curved, dark reddish to black. Pectines long and thick, with numerous teeth; middle lamellae with elongate proximal piece and numerous subcircular distal sclerites; fulcra sub-triangular; males with distinctly larger pectines containing more numerous teeth than females; male teeth extend closer to basal plate than in female. Genital operculum completely divided longitudinally in both sexes; genital papillae absent in both sexes. Pedipalps with dorsolateral aspect of hand with broadly arranged, granular keels; opposing borders of fingers not distinctly scalloped; opposing border of each finger with 8 or 9 non-overlapping, short, oblique rows of denticles, each row terminating anteriorly in a slightly enlarged tooth, these rows flanked inwardly by 8 supernumerary teeth; brachium longer than humerus.

TYPE OF GENUS. Buthus hirsutus Wood, 1863a.

GEOGRAPHICAL DISTRIBUTION. The genus Hadrurus is limited to North America where it is irregularly found from 18° to 45° north latitude, and ranges from 95° to 123° west longitude. It is most abundantly found in the more desert regions of western North America and on the desert islands in the Gulf of California. The most extensive populations yet found have been in southern California, Arizona, Baja California, and Sonora.

USEFUL TAXONOMIC CHARACTERISTICS. The following characteristics have been considered useful as species criteria: color pattern on carapace and mesosomal dorsum; coloration of metasoma; hirsuteness of frontal border of carapace, of dorsal keels of metasoma, of telson, of inner palm of pedipalps, and of spaces between inferior median keels of metasoma; structure of inferior keels of metasoma; structure of dorsal keels of pedipalp palm; pectine tooth counts; dorsal vesicle glands at base of aculeus on sexually mature males.

Key to the Species and Subspecies of the Genus Hadrurus

1. Interocular region of carapace completely blackish in color (fig. 14)..... 2
 Interocular region of carapace not completely blackish, carapace may have anterior non-melanic yellow area or may be completely yellow (figs. 15-21)..... 3
2. Metasoma completely light yellow, never distinctly brownish or blackish (fig. 26); (figs. 37, 38, 39)....
 Hadrurus spadix Stahnke
 Metasoma not completely light yellow, but brown to blackish, (fig. 25), young individuals with distinctive melanic mottling (figs. 43, 44, 45).....
 Hadrurus pinteri Stahnke
3. Inferior keels of metasoma darkly outlined, outlining usually deep brown or black (fig. 11); (figs. 34, 35, 36)..... Hadrurus aztecus Pocock
 Inferior keels of metasoma not darkly outlined, but

- essentially same color as surrounding cuticle (fig. 12)..... 4
4. Pedipalp fingers light yellow, similar to palm in color (figs. 46, 49, 51)....(Hadrurus arizonensis).. 5
 Pedipalp fingers not light yellow and similar to palm in color, fingers reddish or brownish (fig. 31)..... 7
5. Mesosomal dorsum dark olive in color (fig. 19); (figs. 46, 47, 48).... Hadrurus arizonensis arizonensis Ewing
 Mesosomal dorsum not dark olive in color, but light yellowish (figs. 18, 21)..... 6
6. Dorsal keels of metasomal segment III of males distinctly hirsute to unaided eye (females somewhat variable) (fig. 28); females with metasoma I distinctly longer than wide (figs. 48, 49, 50).....
 Hadrurus arizonensis pallidus Williams, n. ssp.
 Dorsal keels of metasoma III of male or female not hirsute to unaided eye (fig. 29); females with metasoma I length approximating width or slightly wider (figs. 48, 51, 52).....
 Hadrurus arizonensis austrinus Williams, n. ssp.
7. Space between inferior median keels of metasomal segments I, II, or III set with about 8 or more stout reddish hairs (fig. 12); dorsum of mesosoma dark olive (fig. 20), but with metasoma V not melanic (fig. 30); (figs. 53, 54, 55).....
 Hadrurus obscurus Williams, n. sp.
 Space between inferior median keels of metasomal segments I, II, or III not hirsute (this space completely lacks hairs or has fewer than 6 hairs per segment); mesosomal dorsum reddish or yellowish (fig. 16) with metasoma V non-melanic, or if mesosoma dorsum melanic, metasoma V also melanic..... 8
8. Adult males with one pair of swollen glandular patches visible to unaided eye on dorsal surface of vesicle at base of aculeus (glands as in fig. 10); females with dorsal keels of metasoma V not conspicuously hirsute to unaided eye; males with metasoma I longer than wide; usually yellow or rusty color on dorsum (fig. 16) but a melanic phase also exists (figs. 40, 41, 42).....
 Hadrurus concolorous Stahnke
 Adult males without pair of swollen, oval glandular patches visible on dorsal surface of vesicle, at base of aculeus (fig. 9); females with dorsal keels of metasoma V conspicuously hirsute to unaided eye; males with metasoma I wider than long; dorsum dark olive with melanic metasoma V (figs. 15, 24); (figs. 31, 32, 33).....
 Hadrurus hirsutus (Wood)

Hadrurus hirsutus (Wood).
(Figures 1-9, 13, 15, 24, 31, 32, 33.)

Buthus hirsutus Wood, 1863a, p. 108 (original description).
Wood, 1863b, p. 367.

Buthus emarginaticeps Wood, 1863a, p. 109. Wood, 1863b, p. 367.

Hadrurus emarginaticeps Marx, 1887, p. 91. Kraepelin,
1899, p. 188.

Hadrurus hirsutus Thorell, 1876a, p. 11. Thorell, 1876b,
p. 189. Thorell, 1893, p. 373.

Hadrurus thayeri Stahnke, 1969, p. 62-65.

DIAGNOSIS. Carapace and mesosoma with dark olive central color, this laterally bordered by yellow, region anterior to ocular tubercule yellow, dark pigmentation does not extend to lateral eyes; metasomal segment V with contrasting dark pigment, this most noticeable on ventral surface; pedipalp palm light yellow with light reddish fingers; body otherwise light yellow; adults attained total body length of up to 110 millimeters; pectine tooth counts 28 to 35 in males, 22 to 27 in females (based on 20 males, 20 females). Metasoma of most individuals with space between inferior median keels, without bristles, no segment with more than 5 such bristles; telson of adult male lacks externally visible dorsal glands at base of aculeus; internal surface of pedipalp palm with about 2 to 6 long hairs, usually males with more hairs than females; metasomal segment III not hirsute in either sex; male metasomal segments IV and V and telson distinctly more hirsute than those of female.

Appears most like the dark phase of Hadrurus concolorous Stahnke in general appearance but differs in the following ways: Distinctly reduced pectine count in both sexes; female telson more hirsute; hairs on female metasomal segment V relatively longer (30 to 35 percent of segment depth); dorsal surface of male telson slightly more hirsute; adult male lacks visible dorsal telson glands at base of aculeus.

REDESCRIPTION BASED ON PRESUMED TOPOTYPE (male). Coloration: Carapace with central dark olive to dusky pigmentation, this dark area with yellow margin laterally and anteriorly, yellow markings extend from anterior margin to base of ocular tubercule; dark markings grade gradually into yellow with no clear dividing line. Mesosomal tergites with dark markings except for lateral yellow border, dark markings marbled in appearance; seventh tergite with dark markings approaching obsolescence. Pedipalps, walking legs, metasoma, telson, ventral surface of prosoma and mesosoma uniform yellow except with following exception: metasomal segment V with distinctive dark pigmentation, pigment distinctly darker on inferior surface; pedipalp fingers reddish brown, pedipalp keels with reddish granules; cheliceral fingers, pretarsal claws and aculeus reddish brown to black.

Carapace: Anterior margin broadly convex, set with 6 pairs stout reddish hairs; interocular area densely covered with fine granules except much of median groove is smooth and agranular.

Mesosoma: Tergites 1 to 6 finely granular except for sub-posterior agranular bands, tergite 7 densely set with coarse and fine granules; no dorsal median or lateral keels; last sternite with median coarse and lateral fine granulation; last sternite with one pair obsolescent median keels, these smooth to crenulate and one pair of smooth to crenulate lateral keels.

Metasoma: Dorsal keels of segment V set with broadly arranged large granules, dorsal keels of segments IV and V conspicuously hirsute to unaided eye. Inferior lateral keels of segment I smooth, segment II and III smooth to crenulate, segment IV and V serrate. Inferior median keels of segment I smooth, segment II smooth to crenulate, III crenulate, IV and V serrate. Inferior intercarinal spaces of segment V coarsely granular, space between inferior median keels on segments I to IV lacking stout reddish hairs; inferior median keels laterally set with 3,4,4,4 pairs of stout reddish hairs on segments I to IV respectively. Inferior intercarinal spaces of segment V with 4 pairs of stout reddish hairs.

Telson: Ventral surface bulbous and densely hirsute with long reddish hairs, this surface with numerous granules, these largest and most conspicuous anteriorly; dorsal surface of vesicle hirsute except for anterior margin.

Pedipalps: Each inner palm with 5 or 6 long conspicuous red hairs (excluding long hairs on dorsal and ventral margins).

Standard measurements and photographs: Table 1 and figures 31 and 32.

PRESUMED TOPOTYPE (female). Very similar to male in coloration and morphology with the following significant exceptions: carapace and mesosoma distinctly larger; dorsal keels of segment IV not distinctly hirsute to unaided eye (but with 3 visible pairs of hairs); dorsal keels of segment V and telson hirsute to unaided eye but with conspicuously fewer and shorter hairs than male; carapace with very subtle median emargination; genital operculum with 3 pairs reddish hairs (not 4 to 6 pairs).

Standard measurements: Table 1.

DATA FOR PRESUMED TOPOTYPES USED IN ABOVE REDESCRIPTION. Mexico: Baja California Sur, 3 miles east of Cabo San Lucas, 22 July 1968, S. C. Williams, M. A. Cazier, and party, (S. C. W. # 118).

TYPE DATA. The type data reported by Wood at the time of the original description were vague: "Lower California, J. Xantus de Vesey." Research on de Vesey indicates that he was stationed at Cabo San Lucas, Baja California Sur from 1859 to 1861, and that he spent most of his time in this region, but made a few brief excursions into some more northern areas of the peninsula. It is almost certain that the holotype of H. hirsutus was collected during this time, and most probably from his home base at Cabo San Lucas (a locality where the species was very abundant in 1968 and 1969). The type is reputedly deposited in the Smithsonian

Museum.

GEOGRAPHICAL DISTRIBUTION. Known only from the southern end of the Baja California peninsula from the La Paz area (24°N. lat.) south to Cabo San Lucas (23°N. lat.) (figure 33).

RECORDS. Known from the following 29 localities in BAJA CALIFORNIA SUR, MEXICO: 14 miles northeast of La Paz, Balandra Cove, 14 July 1968, S. C. Williams, M. A. Cazier, and party, 1 female (CAS); Pichilingue Bay, 1 male (AMNH); La Paz, 2-3 February 1966, V. Roth, 1 female (AMNH); Las Cruces, 29 July 1968, S. C. Williams, M. A. Cazier, and party, 8 males, 12 females (CAS); 7.3 miles northwest of Los Planes, 21 December 1958, H. B. Leech, 1 male (CAS); 7 miles west of El Triunfo, 24 July 1968, S. C. Williams, M. M. Bentzien, 1 male (CAS); 6.8 miles southeast of San Antonio, 24 July 1968, S. C. Williams, M. M. Bentzien, 1 male (CAS); 2.9 miles northwest of San Antonio, 24 July 1968, S. C. Williams, M. M. Bentzien, 1 female (CAS); Tescalama, 1 female (AMNH); 2.5 miles east of San Bartolo, 24 July 1968, S. C. Williams, M. M. Bentzien, 3 males, 1 female (CAS); 0.5 mile east of San Bartolo, 24 July 1968, S. C. Williams, M. M. Bentzien, 1 female (CAS); 0.25 mile south Rancho Buena Vista, 6 May 1969, S. C. Williams, H. L. Heringhi, 1 male, 1 female (CAS); Las Animas, Sierra Laguna, 12 October 1941, Ross and Bohert, 3 females (CAS); Bahia de los Frailes, 10 March 1947, I. La Rivers, 1 male, 1 female (CIS); La Ribera, 10 February 1966, V. Roth, 1 female (AMNH); 3.5 miles south of El Pescadero, 23 July 1968, S. C. Williams, M. A. Cazier, and party, 7 males, 3 females (CAS); Todos Santos, 13 December 1928, 1 female (LACM); San Jose del Cabo, before 1962, N. Banks, 1 male, 2 females (MCZ); 11 miles west of Punta Palmilla, 9 May 1969, S. C. Williams, C. F. Williams, H. L. Heringhi, 3 males (CAS); 3.9 miles southwest of Punta Palmilla, 17 July 1968, S. C. Williams, M. A. Cazier, and party, 9 males, 8 females (CAS); 3.5 miles southwest of Punta Palmilla, 17 July 1968, S. C. Williams, M. A. Cazier, and party, 2 females (CAS); 2.2 miles southwest of Punta Palmilla, 17 July 1968, S. C. Williams, M. A. Cazier, and party, 12 males, 11 females (CAS); 1.5 miles northeast of Punta Palmilla, 16 July 1968, S. C. Williams, M. A. Cazier, and party, 9 males, 10 females (CAS); 6 miles north of Cabo San Lucas, 21 July 1968, S. C. Williams, M. A. Cazier, and party, 13 males, 14 females (CAS); 5 miles north of Cabo San Lucas, 21 July 1968, S. C. Williams, M. A. Cazier, and party, 14 males, 27 females (CAS); 4 miles north of Cabo San Lucas, 21 July 1968, S. C. Williams, M. A. Cazier, and party, 7 males, 14 females (CAS); 2 miles north of Cabo San Lucas, 20 July 1968, S. C. Williams, M. A. Cazier, and party, 11 males, 28 females (CAS); 1 mile east of Cabo San Lucas, 18 July 1968, S. C. Williams, M. A. Cazier, and party, 16 males, 7 females (CAS); Cabo San Lucas, 19 July 1968, S. C. Williams, M. A. Cazier, and party, 3 males, 8 females (CAS).

REMARKS. This species was most abundantly found in the

areas characterized by the coarse gravelly soils of the Cape region. In the southern part of its distribution the populations are very homogeneous in color pattern and morphology. However, in the northern part of the distribution, (Las Cruces to La Paz), the populations become more variable in color and morphology. At Las Cruces, a distinctive color dimorphism occurs in which a dark phase and a non-melanitic phase occur together. The reason for this conspicuous breakdown in color and morphological stability in the northern habitats is uncertain, but perhaps reflects the operation of some isolating mechanism which was serving as an effective genetic barrier within the range of this species sometime within the recent past. Hadrurus thayeri Stahnke does not appear to differ significantly from H. hirsutus (Wood) and is, therefore, here placed as a synonym of H. hirsutus (Wood). In fact, the holotype of H. thayeri Stahnke is in all probability a topotype of H. hirsutus (Wood).

Hadrurus aztecus Pocock.
(Figures 11, 17, 22, 34, 35, 36.)

Hadrurus aztecus Pocock, 1902, pp. 5-7 (original description). Ewing, 1928, p. 9. Hoffmann, 1931, pp. 340-346. Stahnke, 1945, pp. 8-9. Stahnke, 1969, p. 59.

DIAGNOSIS. Dark species of Hadrurus with most southern distribution of all known species in genus. Carapace and mesosoma dorsum dark reddish to blackish brown, anterior area of carapace usually distinctly lighter, in males usually light yellow; venter of mesosoma brownish yellow; metasoma light yellow except inferior surface sometimes brownish (especially in females); inferior keels of metasoma outlined with contrasting black lines; walking legs and pedipalps yellow except fingers dark reddish brown. Frontal area of carapace sparsely studded with large rounded granules with intervening smooth spaces, females often with reduced granulation. Last sternite of mesosoma with single pair of keels, these lateral and granular; most sternites with fine punctiform depressions. Metasoma with segment I longer than wide in males, wider than long in females; inferior lateral keels of male smooth on I and II, smooth to weakly granular posteriorly on III and IV (IV sometimes granular along entire length), females with this keel entirely smooth on I to IV; inferior median keels of male faint but smooth on segment I, smooth on II, smooth to weakly granular posteriorly on III, IV irregularly granular, females with these keels smooth on I to III, smooth with a few posterior granules on IV. Movable pedipalp fingers always distinctly shorter than carapace in females, males with movable finger approximating carapace in length. Males with metasomal segment V distinctly longer than carapace, females with carapace distinctly longer than metasomal segment V. Pectines with 32 to 37 teeth in male, 27 to 32 teeth in female. Males with greater contrast between dark and light color patterns than females.

Related to Hadrurus arizonensis from which it differs in the following ways: anterior region of carapace lightly

melanic (not pale yellow); metasomal segment V with inferior keels more deeply denticulate; metasoma with median inferior keels obsolete on I, smooth to obsolete on II to III, smooth with a few irregular granules on IV; dorsal keels of metasomal segments III to V distinctly less hirsute; carapace with frontal margin set with about 30 long hairs (not approximately 15); entire carapace surface covered by large rounded granules; pedipalp hand with 2 dorsal keels narrow and extending distally to near base of fixed finger (not broad, and becoming obsolete on posterior half of hand).

Standard measurements and photographs: Table 2 and figures 34 and 35.

TYPE DATA. "Holotype from Jalapa, Mexico." In a recent personal communication, D. J. Clark verified that the holotype is still in the British Museum of Natural History (registration number 81.88) and is in good condition. However, he states that the type is recorded as a female. This is interesting because the pectine tooth counts reported in the original description are obviously those of a male specimen. The holotype was collected "by Hoege" and later purchased from a Mr. Godman.

GEOGRAPHIC DISTRIBUTION. Center of distribution is reported by Hoffmann (1931) to be the Mexican state of Guerrero, but also common in northern and eastern Oaxaca and in southern Pueblo (fig. 36). Hoffmann also claims never to have been able to verify the occurrence of this species from Jalapa, Veracruz (the type locality).

RECORDS. Reported from the following 7 localities in Mexico. VERACRUZ: Jalapa, 1 male holotype (reported by Pocock, 1902). PUEBLA: Zapotitlan, 1 male, (reported by Hoffmann, 1931). GUERRERO: Iguala, 1 female, (reported by Hoffmann, 1931); Chilpancingo, 1 female (reported by Hoffmann, 1931); Mexcala, 9 August 1946, Goodnight, Bolivar, Bonet, 1 male, (AMNH). OAXACA: Tomellin, 1 male (reported by Hoffmann, 1931); Cuicatlan, 1 female (reported by Hoffmann, 1931).

REMARKS. In the state of Guerrero, this large dark scorpion is called "alacran de caballo" which means scorpion of the horse. In this state this species is feared by the residents because it is believed to possess a sting mortal to people and horses. Studies carried out by Dr. Luis Gutierrez at the Mexican Instituto de Higiene indicated that this species has a venom of very low virulence to man and horses. The initial sting is accompanied by a burning sensation but 24 hours later there is no indication of proteolytic or systemic effects (Hoffmann, 1931, pp. 345-346).

It is interesting that only two specimens of this species could be located in research collections in the United States. Both of these were in the American Museum of Natural History (one from the Hoffmann collection which contained "Mexico" as the only data). It is also interesting that attempts to borrow specimens from Mexican collections produced no results.

Hoffmann (1931) apparently had managed to gather a small series of specimens from various localities. Comparison of these led him to the conclusion that this species may be represented by several subspecies, but lack of sufficient material prevented him from completing definitive study on this. Examination of the specimen measurements published in Hoffmann's monograph clearly supported the suspicion that this species may be polytypic or polymorphic.

Stahnke (1969, p. 59) reported this species as occurring in "Mexico and southern Arizona." This species, however, does not appear to occur in northern Mexico, much less in the United States.

Hadrurus spadix Stahnke.

(Figures 14, 26, 37, 38, 39.)

Hadrurus spadix Stahnke, 1940, p. 102 (original description). Stahnke, 1945, p. 4. Gertsch and Allred, 1965, p. 14. Stahnke, 1969, p. 62.

DIAGNOSIS. Conspicuously dark species of Hadrurus with dark olive to black color completely covering all dorsal surfaces of carapace and mesosoma; metasoma, telson, and walking legs all yellow; pedipalp hands yellow with red dorsal keel areas, fingers dark reddish brown; ventral surface of body yellow. Adults up to 107 millimeters in total body length. Metasoma with space between inferior median keels of segments I to III conspicuously hirsute, each segment with 10 to 20 stout bristles; adult males without externally visible oval glands on telson dorsum at base of aculeus; males with metasomal segments IV, V and telson slightly but distinctly more hirsute than those of females; dorsal surface of telson hirsute. Metasomal segments IV and V with dorsal keels always conspicuously hirsute to the unaided eye; segment III may or may not have dorsal keels hirsute to the unaided eye.

Closely related to Hadrurus obscurus Williams from which it differs in having the area anterior to the ocular tubercle all black. Also similar in general appearance to Hadrurus pinteri Stahnke from which it differs in the following ways: metasomal segments nonmelanic; no oval glands visible on dorsal surface of telson at base of aculeus; hand light yellow.

Standard measurements and photographs: Table 3 and figures 37 and 38.

TYPE DATA. Syntypes from the following 3 localities in Arizona: Kingman, Mohave County; Grand Canyon, Coconino County; and Wupatki National Monument, Coconino County. According to Gertsch and Allred (1965, p. 14) one of these syntypes has been designated "Type" and deposited in the U. S. National Museum.

DISTRIBUTION. Occurs in arid regions of the following states: Oregon, Idaho, California, Nevada, Utah, Arizona, and Colorado (figure 39).

RECORDS. Known from the following 46 localities in western North America. OREGON: Baker County: 3 miles south of Durkee, 28 June 1952, B. Malkin, 1 female, (AMNH). IDAHO: Ada County: Snake Falls, Swan Falls, 27 May 1923, R. P. Erwin, 1 female (MCZ); Canyon County: one mile south of Roswell, 16 August 1969, M. A. Cazier and party, 4 males, 6 females (ASU); Elmore County: 12 miles south of Mountain Home, 6 August 1969, M. A. Cazier and party, 1 male, 4 females (ASU); Owahee County: Hot Creek Falls near north end of Bruneau Canyon, 30 June 1952, B. Malkin, 1 male (AMNH); Hammett State Park, Bruneau Dunes, 6 August 1969, M. A. Cazier and party, 1 female (ASU); Hot Creek Falls, 11 miles south of Bruneau, 9 August 1969, Cazier, Barr, Bigelow, Mortenson, 16 males, 10 females (ASU). CALIFORNIA: Inyo County: Saline Valley, 19 collections from pit traps from May to August 1959, B. Banta, 13 males, 11 females (CAS); Antelope Springs, 24 August 1960, J. W. MacSwain, 1 male (CIS); Death Valley National Monument, Grapevine Springs, 12 April 1968, S. C. Williams, V. F. Lee, J. Bigelow, 2 males, 4 females (SCW); Death Valley National Monument, 3 miles north of Grapevine Ranger Station, 15 April 1965, V. F. Lee, 1 female (SCW); Death Valley National Monument, Scotty's Ranch, 13 April 1968, G. Lytle, J. Bigelow, M. A. Cazier, 1 female (SCW); 7.4 miles east of Deep Springs College, along highway 168, 10 September 1968, F. Ennik, C. R. Smith, 2 males, 2 females (CBVC). NEVADA: Humboldt County: Sulphur Spring, 14 September 1965, R. C. Bechtel, D. C. Martinelli, 2 females (NDA); Lander County: 30 miles from Beowawa, between Elko and Battle Mountain, August 1949, H. Steven, 1 female (AMNH); Lincoln County: Hiko Lake, Pahrnagat Valley, 10 May 1954, Ira La Rivers, 1 female (UN); Lyon County: Silver Springs, 5 July 1969, 1 female (NDA); Mineral County: Tonopah Junction, 18 April 1949, Ira La Rivers, 1 male (UN); Nye and Lincoln Counties: Mercury, Atomic Energy Commission - Nevada Test Site, many specimens collected at various sites during 1961 and 1962 (AMNH); Pershing County, Dixie Valley, June 1969, T. Brinkerhoff, 1 male, 1 female (NDA); Washoe County, Pyramid Lake, 1 August 1964, V. F. Lee, 2 males, 1 female (SCW); Spanish Springs, 11 February 1960, R. Gallaway, 1 female (NDA); 7 miles south of Nixon, 19 July 1969, M. A. Cazier and party, 2 juveniles (ASU); 7.5 miles west of Nixon, 19 August 1969, M. A. Cazier and party, 3 males, 1 female (ASU). UTAH: Garfield County: North Wash, May 1955, Mary Dumas and party, 2 females (BYU); Grand County: 13 miles south of Moae, 30 July 1969, M. A. Cazier and party, 2 females (ASU); 7 miles east of junction of highways 128 and 160 on highway 128, 30 July 1969, M. A. Cazier and party, 9 males, 4 females (ASU); Arches National Monument, Headquarters area, August 1950, D. M. Allred, 1 female (BYU); Kane County: Hole in the Rock, 16 May 1953, D. E. Beck, 1 male (BYU); San Juan County: 0.5 mile north of Bluff, 29 July 1969, M. A. Cazier, 2 juveniles (ASU); Navajo Mountain Trading Post, 2 May 1955, Black, Haywood, and King, 2 specimens (BYU); Washington County, Zion National Park, 7 July

1928, Vasco M. Tanner, 1 female (BYU); Hurricane, 5 July 1931, W. J. Gertsch, 1 male, 1 female (AMNH); 8 miles north, 3 miles west of Saint George, in Snow Canyon, 17 May 1968, R. Winokur, 2 males, 3 females (SCW). COLORADO: Mesa County: Colorado National Monument, Grand Junction Entrance, 14 June 1962, C. J. McCoy, 1 male (B. Vogel); Pollock Canyon, west of Colorado National Monument, 11 May 1963, C. J. McCoy, 3 males, 2 females (B. Vogel). ARIZONA: Coconino County: Vermillion Cliffs, 11 July 1967, M. A. Cazier, 1 male (SCW); Wupatki National Monument, Headquarters area, 9 September 1968, M. A. Cazier and party, 4 males (ASU); 1 mile south of Hualapai Hilltop, Kaibab National Forest, Grand Canyon, 6 June 1969, M. A. Cazier and party, 7 males, 2 females (ASU); Mohave County: 13 miles southwest of Wolf Hole, 1 June 1969, M. A. Cazier and party, 1 female (ASU); 25.5 miles southwest of Wolf Hole, 1 June 1969, M. A. Cazier, J. Bigelow, 4 males, 2 females (ASU); Goldroad, 30 May 1969, M. A. Cazier, J. Bigelow, 1 male (ASU); Grand Canyon National Monument, Red Sandstone Cliffs, Toroweup, 3 June 1969, M. A. Cazier and party, 5 males, 6 females (ASU); Lime Kiln Pass, Virgin Mountains, Arizona Strip, 31 May 1969, M. A. Cazier, J. Bigelow, 6 males, 7 females (ASU).

REMARKS. The species is relatively homogeneous in basic structure and color throughout its range; however, some phenotypic variability develops on the eastern edge of the range. The southeastern Utah and northeastern Arizona populations have pedipalp fingers dark reddish and dorsal keels of the third metasomal segment not visibly hirsute on either sex. In contrast, the California and southern Nevada populations have pedipalp fingers more yellow (or completely so) and have the dorsal keels of the third metasomal segment always distinctly hirsute to the unaided eye on males (usually so on females, but more variable). These differences appear to develop clinally; therefore, it is difficult to visualize this variation as subspecific.

Hadrurus concolorous Stahnke.
(Figures 16, 23, 40, 41, 42.)

Hadrurus concolorous Stahnke, 1969, pp. 59-60.

Hadrurus hirsutus Kraepelin, 1894, pp. 205-206. Kraepelin, 1899, p. 188. Stahnke, 1969, pp. 60-61 (part).

DIAGNOSIS. Variable species of Hadrurus in size and color, adults up to 119 millimeters total body length. Forms local color races throughout range; entire body reddish yellow in most localities; on dark soils, and in areas of volcanic influence, with dark dorsal markings and dark metasomal segment V (similar to Hadrurus hirsutus). Pedipalp palm basically yellow with light reddish brown fingers. In many areas the color is a continuous variable from the dark phase to the light concolorous phase. A few local

populations occur with a color dimorphism expressed as dark phase and light phase but no known intermediates. Juveniles and adults similar in color. Adult males with conspicuous pair of glands visible externally on dorsum of telson at base of aculeus. Telson densely hirsute on all aspects, females with hairs distinctly shorter than on male; pectines with 34 to 40 teeth in males, 27 to 33 in females (based on 20 males, 20 females). Dorsal keels of female metasoma not conspicuously hirsute on segment III, segments IV and V with numerous short inconspicuous bristles; those of male not conspicuously hirsute on segment III, densely hirsute with long conspicuous hairs on segments IV and V. Space between inferior median keels of metasomal segments I to III with 0 to 5 stout hairs; inner surface of pedipalp palm with less than 8 long conspicuous hairs. Definite sexual dimorphism in caudal and telson hirsuteness - males with longer and more abundant hairs.

Related to Hadrurus pinteri Stahnke from which it differs in the following ways: Metasoma and telson light yellow; pedipalp palms yellowish with light reddish brown fingers; telson venter of female with fewer and shorter hairs; dorsal keels of female metasomal segments IV and V set with short inconspicuous bristles (not long conspicuous hairs); dorsum of telson distinctly more hirsute; inferior median intercarinal spaces of metasomal segments I to III not conspicuously hirsute, at times with up to 5 stout bristles but these are irregular and often completely lacking.

Standard measurements and photographs: Table 4 and figures 40 and 41.

TYPE DATA. Holotype female, ASU 68-602, was collected 54.2 miles north of La Paz, Baja California Sur, Mexico, 14 June 1968, L. L. and H. L. Stahnke. Allotype male, ASU 56-175, Isla San Marcos, Baja California, Mexico, 31 March 1953, Figg-Hoblyn. The holotype was apparently retained in the Stahnke collection; the allotype has been returned to its permanent depository in the California Academy of Sciences. Both the holotype and allotype are obviously juvenile. Two unpublished specimens labeled as paratypes by Stahnke are also in the California Academy of Sciences collection, from Baja California, Mexico.

DISTRIBUTION. Widely distributed in Baja California Norte, Baja California Sur, and many associated islands in the Gulf of California (fig. 42).

RECORDS. Known from 58 localities in Baja California, Mexico. BAJA CALIFORNIA NORTE: Bahia de los Angeles, 17 June 1968, S. C. Williams, M. A. Cazier, 44 males, 47 females (CAS); Mission San Borjas, 20 June 1968, S. C. Williams, M. A. Cazier, and party, 7 males, 7 females (CAS); 38 miles southwest of Mission San Borjas, 21 June 1968, S. C. Williams, M. A. Cazier, and party, 1 male, (CAS); 2 miles northwest of Miller's Landing, 21 June 1968, S. C. Williams, 1 male, 3 females (SCW); 34 miles northwest of Manuela, 22 June 1968, S. C. Williams, M. A. Cazier, and party, 1 female (CAS): 3 miles north of Manuela, 22 June

1968, S. C. Williams, M. A. Cazier, and party, 6 males, 2 females (CAS); 11 miles north Rancho Mezquital, 15 April 1969, S. C. Williams, H. L. Heringhi, 1 female (CAS); north shore of Scammon's Lagoon, 14 miles south of Guerrero Negro, 16 April 1969, S. C. Williams, H. L. Heringhi, 3 females (CAS); 4 miles east of Guerrero Negro, 16 April 1969, S. C. Williams, H. L. Heringhi, 1 female (CAS); 1 mile east of Las Bombas, 16 April 1969, S. C. Williams, H. L. Heringhi, 2 females (SCW). BAJA CALIFORNIA SUR: 26 miles south of El Arco, 17 April 1969, S. C. Williams, H. L. Heringhi, 2 males, 4 females (CAS); 3 miles south of Rancho Tablon, 23 June 1968, S. C. Williams, M. A. Cazier, and party, 13 males, 10 females (CAS); San Angel, 13 miles west of San Ignacio, 27 June 1968, S. C. Williams, M. A. Cazier, and party, 14 males, 5 females (CAS); 5 miles north La Laguna, on east shore of Laguna de San Ignacio, 29 June 1968, S. C. Williams, M. A. Cazier, and party, 3 males, 5 females (CAS); San Ignacio, 26 June 1968, S. C. Williams, M. A. Cazier, and party, 5 males, 6 females (CAS); 5 miles west of San Ignacio, 19 January 1965, V. Roth, 1 female (AMNH); 17 miles east of San Ignacio, 25 January 1965, V. Roth, 1 female (AMNH); 11 miles south of Santa Rosalia, 17 February 1966, V. Roth, 1 male, 1 female (AMNH); Mulege, 26 January 1965, V. Roth, 2 males (AMNH); 1 mile southwest of Rancho Canipole, 15 May 1969, 2 males, 1 female (CAS); 1 mile south of Loreto, 17 May 1969, S. C. Williams, H. L. Heringhi, 2 males, 1 female (CAS); 5 miles south of Loreto, 16 May 1969, S. C. Williams, H. L. Heringhi, 3 females (CAS); Puerto Escondido, Rancho Chenque, 1 female (AMNH); Punta San Telmo, 26 May 1969, S. C. Williams, 1 female (CAS); Comondu, 22 July 1938, Michelbacher, E. S. Ross, 1 female (CAS); 3 miles southwest of San Miguel de Comondu, 21 April 1969, S. C. Williams, H. L. Heringhi, 2 males, 1 female (CAS); 4 miles southwest of San Miguel de Comondu, 15 May 1969, 1 male (CAS); 5 miles southwest of San Miguel de Comondu, 2 July 1968, S. C. Williams, M. A. Cazier, and party, 24 males, 29 females (CAS); 24 miles northeast of San Jose de Comondu, 15 May 1969, S. C. Williams, H. L. Heringhi, 1 male, 6 females (CAS); 4 miles south of Mission San Javier, 18 May 1969, S. C. Williams, H. L. Heringhi, 5 males, 4 females (CAS); 4 miles west of La Purisima, 1 July 1968, S. C. Williams, M. A. Cazier, and party, 3 females (CAS); 8 miles northwest of San Raymundo, 30 June 1968, S. C. Williams, M. A. Cazier, and party, 10 males, 6 females (CAS); 28.9 miles west of El Crucero, 26 July 1968, S. C. Williams, M. A. Cazier, and party, 1 male, 4 females (CAS); 26.8 miles west of El Crucero, 26 July 1968, S. C. Williams, M. A. Cazier, and party, 1 male (CAS); 10.3 miles southeast of Santa Rita, 27 July 1968, S. C. Williams, M. M. Bentzien, J. Bigelow, 15 males, 11 females (CAS); 27.3 miles southeast of Santa Rita, 27 July 1968, S. C. Williams, M. M. Bentzien, J. Bigelow, 4 males, 5 females (CAS); 44 miles south of Villa Constitucion, 30 January 1965, V. Roth, 1 female (AMNH); 75 miles northwest of La Paz, 4 July 1968, S. C. Williams, M. A. Cazier, and party, 2 females (CAS); 5 miles west of Mission San Luis Gonzaga, 14 February 1966, V. Roth (AMNH); 35.3 miles northwest of Los Aripes, 27 July 1968, S. C.

Williams, M. M. Bentzien, J. Bigelow, 1 male, 2 females (CAS); 31.0 miles west of Los Aripes, 25 July 1968, S. C. Williams, M. M. Bentzien, J. Bigelow, 3 females (CAS); 21.4 miles west of Los Aripes, 25 July 1968, S. C. Williams, M. M. Bentzien, J. Bigelow, 8 males, 9 females (CAS); 15 miles northwest of Los Aripes, 27 July 1968, S. C. Williams, M. M. Bentzien, J. Bigelow, 2 males, 2 females (CAS); 9.6 miles west of Los Aripes, 25 July 1968, S. C. Williams, M. M. Bentzien, J. Bigelow, 1 male, 6 females (CAS); 11.9 miles west of Los Aripes, 25 July 1968, S. C. Williams, M. M. Bentzien, J. Bigelow, 2 males, 6 females (CAS); 1 mile east of Los Aripes, 8 July 1968, M. A. Cazier, J. Bigelow, J. Davidson, 2 males, 2 females (CAS); 5 miles southwest of La Paz, 3 August 1968, S. C. Williams, M. A. Cazier, J. Bigelow, 1 female (CAS); 0.25 mile north of La Paz airport, 13 July 1968, S. C. Williams, M. A. Cazier, and party, 28 males, 34 females (CAS); Balandra Cove, 14 miles northeast of La Paz, 10 July 1968, M. A. Cazier, J. Davidson, J. Bigelow, 4 females (CAS); Rancho de la Ventana, Bahia de la Ventana, 19 December 1958, H. B. Leech, 1 female (CAS).

ISLANDS IN THE GULF OF CALIFORNIA: Isla Espiritu Santo, southwest shore, 7 July 1968, S. C. Williams, M. M. Bentzien, W. K. Fox, 5 females (CAS); Isla Partida, Central Valley, 9 July 1968, S. C. Williams, M. M. Bentzien, W. K. Fox, 13 males, 16 females (CAS); Isla San Francisco, 1 male (AMNH); Isla San Jose, Ostiones, 1 female (AMNH); Isla Carmen, Bahia Marquer, 5 April 1962, 1 female (AMNH); Isla Coronados, 3 April 1962, C. F. Harbison, I. L. Wiggins, 2 males (AMNH); Isla San Marcos, Arroyo de Chevas, 29 March 1962, M. E. Soule, C. F. Harbison, 3 males (AMNH); Cedros Island, 1 mile east, 4 miles south of north end of island, 11 March 1957, R. Zweifel, 1 female (AMNH).

REMARKS. Very widely distributed species of Had-rurus over most of the Baja California peninsula. Found most abundantly in areas with sandy soils such as well drained regions of the Viscaïno desert and Magdalena plain. Penetrates the volcanic regions of the peninsula along river drainages where it occupies old stabilized flood plains and the lower slopes of valleys with a significant deposit of sandy sediment. In these volcanic valleys H. concolorous may coexist with its very close relative H. pinteri. Had-rurus concolorous occupies a wide variety of habitat situations over its wide range and has become a variable species. Light phases, dark phases, and all degrees of intermediates occur. These do not appear to form distinct subspecies, but instead local color races. Usually the dark races tend to occur in areas where the soils are volcanic in origin. Rusty red races predominate in areas where marine sedimentary or wind-deposited soils predominate (for example, Magdalena plain and Viscaïno desert). In some habitats the population is very homogeneous in coloration; in other habitats the populations are variable; while in still others (for example, San Miguel de Comondu) the population forms a color dimorphism with a dark phase and a light rusty phase, but with no intermediates.

This very common species was described only recently,

and was based on only a few juveniles. At the time of the description, Stahnke had an adult male of H. concolorous from Isla Carmen which he assigned to Hadrurus hirsutus.

Hadrurus pinteri Stahnke.
(Figures 10, 25, 43, 44, 45.)

Hadrurus pinteri Stahnke, 1969, pp. 61-62 (original description). Williams, 1970.

DIAGNOSIS. Large species of Hadrurus with mesosoma and carapace brownish black. Juveniles and subadults with conspicuous bright yellow telson and sometimes with yellow mottling of dark metasoma. Pedipalp palm brownish yellow with dark reddish brown to black fingers. Adults with total body length up to 120 millimeters. Vesicle densely hirsute except on superior surface; pectines with 28 to 35 teeth in females, 38 to 44 teeth in males (based on 20 males, 20 females). Metasoma with about 15 or more stout bristles in space between inferior median keels of segments I to III. Adult males with 1 pair of conspicuous oval glands on telson dorsum at base of aculeus.

Related to Hadrurus concolorous from which it differs in the following characteristics: Metasoma melanic; pedipalp palms brownish with dark reddish brown fingers; telson venter of female more hirsute and hairs longer; dorsal keels of female metasomal segments IV and V set with long conspicuous hairs (not short and bristle-like ones); dorsum of telson with less than half the number of hairs (approximately 6); inferior median intercarinal spaces of metasomal segments I to III conspicuously hirsute.

Superficially similar to Hadrurus spadix from which it differs in the following ways: presence of oval pair of dorsal telson glands on adult males; dorsal surface of telson not conspicuously hirsute; metasoma melanic; middle segment of chelicerae with dusky dorsal markings; tendency toward greater numbers of pectinal teeth in both sexes.

Standard measurements and photographs: Table 5 and figures 43 and 44.

TYPE DATA. Holotype female, ASU 68-0090, collected at Puertecitos, Baja California Norte, Mexico, 24 February 1968, P. J. Pinter. Allotype male, ASU 68-1276, collected at Mission de Calamyget, Baja California, Mexico, 16 April 1962, E. L. Sleeper. The holotype is presumed to be in the Stahnke collection; the allotype depository is reported to be California State College at Long Beach, but this institution would not verify this. Both holotype and allotype are obviously juveniles. Three paratypes, all juvenile females, also exist.

DISTRIBUTION. Found in volcanic regions of the Baja California peninsula from Puertecitos south to Puerto Escondido (26° to 30° north latitude). Also found on islands associated with the Baja California peninsula (fig. 45).

RECORDS. Known from 16 localities in Baja California Norte and Baja California Sur, Mexico. BAJA CALIFORNIA NORTE: Oakies Landing, 12 June 1968, S. C. Williams, M. A. Cazier, and party, 4 males, 5 females (CAS); 5 miles north of Bahia San Luis Gonzaga, 14 June 1968, S. C. Williams, M. A. Cazier, and party, 2 males, 2 females (CAS); 6 miles north of Bahia San Luis Gonzaga, 13 June 1968, S. C. Williams, M. A. Cazier, and party, 1 male (CAS); 7 miles north of Bahia San Luis Gonzaga, 14 June 1968, S. C. Williams, M. A. Cazier, and party, 1 female (CAS); El Marmol, June 1946, 1 male (SDMNH); 4 miles southeast of El Marmol, 12 January 1965, V. Roth, 1 female (AMNH); 0.5 miles south of La Virgen, 9 April 1969, S. C. Williams, 1 male (CAS); Calamajue Arroyo, 16 June 1968, S. C. Williams, M. A. Cazier, and party, 5 males, 3 females (CAS); Bahia de Los Angeles, 19 June 1968, S. C. Williams, M. A. Cazier, and party, 1 male, 7 females (CAS); Mission San Borjas, 20 June 1968, S. C. Williams, M. A. Cazier, and party, 1 male, 1 female (CAS). BAJA CALIFORNIA SUR: San Ignacio, 26 June 1968, S. C. Williams, M. A. Cazier, and party, 2 females (CAS); Bahia Concepcion, near El Coyote, 17 February 1966, V. Roth, 1 male (AMNH); 5-10 miles southwest of San Miguel de Comondu, 3 July 1968, S. C. Williams, M. A. Cazier, and party, 6 males, 3 females (CAS); Puerto Escondido, 6 April 1962, C. F. Harbison, 1 female (AMNH). ISLANDS IN THE GULF OF CALIFORNIA: Isla Coronados, 3 April 1962, C. F. Harbison, 1 male, 1 female (AMNH); Isla Danzante, 7 April 1962, R. Banks, 1 female (AMNH).

REMARKS. This species was never found in predominantly sandy habitats or away from habitats of volcanic origin. It was never abundant in any of the samples, and was mainly collected by ultraviolet detection methods. Hadrurus pinteri is known from only two of the Gulf islands but probably occurs on others. The two island populations differed somewhat from the populations collected on the peninsula in the following ways: adults with lighter telson coloration; hirsuteness of dorsal keels on metasomal segments IV and V reduced to obsolescent (only a few long hairs present); tendency for reduction of the number and length of hairs associated with the metasomal inferior median keels.

Hadrurus arizonensis Ewing.

Hadrurus hirsutus var. arizonensis Ewing, 1928, pp. 8-9 (original description).

Hadrurus arizonensis Stahnke, 1945, pp. 6-8. Stahnke, 1956, p. 18. Gertsch and Allred, 1965, pp. 12-14. Stahnke, 1969, p. 58.

Hadrurus hirsutus Kraepelin, 1899, (part), p. 188. Banks, 1900, (part), p. 424. Pocock, 1902, pp. 6-7. Banks, 1909-10, p. 188. Hoffmann, 1931, pp. 335-340. Stahnke, 1940, p. 101. Stahnke, 1945, pp. 5-6. Diaz Najera, 1964, p. 27. Williams and Hadley, 1967, pp. 107-108. Stahnke, 1969, pp. 60-61.

DIAGNOSIS. Polytypic species of Hadrurus forming three

subspecies based on color, pattern, and hirsuteness of metasomal dorsal keels. Adults up to 127 millimeters in total body length. No externally visible oval glands on dorsal surface of adult male telson; 10 to 15 long conspicuous hairs on inner surface of pedipalp palm. Interocular area on carapace always yellow, never melanic; pedipalp palms and fingers always yellow; posterior of carapace and dorsum of mesosoma may be light yellow to dark olive. Telson hirsute on all aspects; metasoma with space between inferior median keels lacking hairs or with fewer than 5 stout hairs per segment. Metasomal segments IV and V with dorsal keels distinctly hirsute to unaided eye, females distinctly less hirsute than males.

Appears similar to Hadrurus aztecus from which it can be readily distinguished by lack of dark stripes underlining the inferior median and inferior lateral keels of the metasoma. Also similar to Hadrurus obscurus from which it differs in the following ways: fingers not reddish brown; space between inferior median keels of metasomal segments I to III not densely covered with stout bristles.

Hadrurus arizonensis arizonensis Ewing.

(Figures 19, 27, 46, 47, 48.)

Hadrurus hirsutus Kraepelin, 1899, (part?), p. 188.

Stahnke, 1940, (part), p. 101. Diaz Najera, 1964, (part), p. 27.

Hadrurus hirsutus variation arizonensis Ewing, 1928, pp. 8-9 (original description).

Hadrurus arizonensis Stahnke, 1945, pp. 6-8. Gertsch and Allred, 1965, pp. 12-14. Stahnke, 1969, p. 58.

DIAGNOSIS. Dorsum of carapace and mesosoma dark olive color except for broad, lunate, yellow marking covering interocular area; dark markings extend anterolaterally through lateral eyes, this dark area is laterally bordered by a narrow band of yellow; dark markings often lighter on last mesosomal segment. Pectine tooth count 32 to 37 in males, 24 to 31 in females; adult specimens up to 112 millimeters in total length. Metasoma with dorsal keels distinctly hirsute to unaided eye on segment III of male, this somewhat variable in females.

Standard measurements and photographs: Table 6 and figures 46 and 47.

TYPE DATA. The female "type" was collected in Papago Saguaro National Monument, Pima County, Arizona, and is reported to be deposited in the U. S. National Museum.

DISTRIBUTION. The center of distribution appears to be the Sonoran Desert of Arizona, but ranges north into southern Nevada and southern Utah and south to around Guaymas, Sonora (28° to 38° north latitude). Ranges as far east as central Arizona and as far west as Death Valley, California (110° to 117° west longitude). Generally this species does not effectively penetrate the Colorado Desert regions (fig.

48).

RECORDS. Known from 81 localities in California, Nevada, Arizona, and Sonora. CALIFORNIA: Inyo County: Death Valley National Monument, 2 miles north of Bennett's Well, 15 April 1968, C. G. Lytle, J. Bigelow, B. Nevelyn, M. A. Cazier, 5 males, 8 females (SCW); San Bernardino County: California bank of Colorado River, across from Parker, Arizona, 7 September 1967, S. C. Williams, M. A. Cazier, 4 males (SCW); Pisgah Lava flow, various collections in 1959 and 1960, B. Banta, 13 males, 7 females (CAS); Kern County: Mojave, F. Russell, 1 male (AMNH); Los Angeles County, Antelope Valley, near Fairmont, 6-7 May 1916, 1 male, 1 female (SDMNH); Palmdale, Joshua forest, 8 May 1954, S. F. Wood, 2 juveniles (SDMNH); Riverside County: 1 mile west of Paloverde, 8 September 1967, S. C. Williams, M. A. Cazier, 1 male (SCW); Andreas Canyon, Palm Springs, 26 March 1960, W. J. Gertsch, Ivie and Schrammel, 1 female (AMNH); San Diego County: Borego, 11 April 1952, J. W. MacSwain, 1 female (CIS); Imperial County: 10 miles northeast of Glamis, 28 October 1967, M. A. Cazier, S. Gorodenski, J. Bigelow, 1 male (SCW); 9 miles northeast of Glamis, 28 October 1967, M. A. Cazier, S. Gorodenski, J. Bigelow, 1 male (SCW); 2 miles west of Glamis, 21 August 1968, 1 male (K. Lucas); Midway Well, 10 August 1968, 2 males (K. Lucas). NEVADA: Clark County: Boulder City, R. K. Grater, 2 males, 1 female (reported by Stahnke, 1945, p. 8); Alvarado Canyon, 40 miles east of Las Vegas, along Colorado River, 11 April 1952, C. I. Ferm, 1 female (SDMNH); Las Vegas, August 1963, 1 female (NDA); 8 miles northeast of Las Vegas, January and June 1944, D. J. Zinn, 5 males (AMNH); Nye County: Fairbanks Springs, 3 July 1961, R. C. Bechtel, F. D. Parker, 1 male (NDA); Mercury, Atomic Energy Commission - Nevada Test Site, many collections in 1961, 17 males, 1 female (AMNH); Lathrop Wells, 28 August 1965, V. F. Lee, 1 male (SCW). UTAH: Garfield County: Calf Creek, November 1946, B. R. Lemora, 1 female (BYU); Kane County: Kanab, 6 May 1966, S. C. Daines, 1 male (BYU); Washington County: Saint George, 1920, V. L. Tanner, 1 male (BYU). ARIZONA: Maricopa County: 2 miles southwest of Cave Creek, August 1966, 5 males, 1 female (MCZ); 6 miles northeast of Cave Creek, August 1966, W. Eberhard, 2 males, 2 females (MCZ); 12 miles south of Cave Creek, 14 September 1964, M. A. Nickerson, 1 male (SCW); Bartlett Lake, August 1966, 3 males, 1 female (MCZ); 1 mile north of New River, September 1966, 3 females (MCZ); Buckeye, L. Barron, 1 male (reported by Stahnke, 1945, p. 8); Stewart Mountain Dam, Le Baron, 1 male (reported by Stahnke, 1945, p. 8); Gila Bend, J. K. Osgood, 1 male (reported by Stahnke, 1945, p. 8); Sugar Loaf Mountain, 11 September 1965, S. C. Williams, 1 female (SCW); Usery Pass, 23 August 1965, L. Honetschlager, 1 female (SCW); Pleasant Valley, 11 October 1964, 1 female (SCW); 0.2 mile north of Granite Reef Dam, 22 April 1967, K. Brown, 1 female (SCW); Paradise Valley, 17 May 1967, K. Brown, 1 female (SCW); Scottsdale, 10 May 1967, K. Brown, 1 female (SCW); 6 miles southwest of Wickenburg, Lucky Day Mine, 30 August 1965, V. F. Lee, 1 male (SCW); Lucky Day Mine, 6 miles southwest of

Wickenburg, 30 August 1965, V. F. Lee, 1 female (SCW); Granite Reef Dam, on Salt River, 5 August 1967, S. C. Williams, 6 males, 6 females (SCW); Tempe, 1 July 1967, S. C. Williams, 3 males, 1 female (SCW); Phoenix North Mountain Park, 18 September 1965, G. Fernald, 3 males (SCW); 2 miles east of Scottsdale, 28 September 1965, T. Paca, 1 female (SCW); Blue Point, crossing of Bush highway over Salt River, 15 August 1967, S. C. Williams, 2 males (SCW); Gilbert, 29 October 1965, S. C. Williams, 1 female (SCW); Phoenix South Mountain Park, many collections in 1965 and 1966, S. C. Williams, several hundred specimens (SCW); Mohave County: Kingman, E. Railsback, 1 male, 1 female (reported by Stahnke, 1945, p. 8); Red Lake, Havlapai Valley, Grand Wash Cliffs, 16 May 1969, M. A. Cazier and party, 2 juveniles (ASU); Goldroad, Black Mountain, 17 May 1969, M. A. Cazier and party, 1 female (ASU); 17.5 miles southeast of Yucca, 29 May 1969, M. A. Cazier, 2 females (ASU); 3 miles north of Topock, 11 April 1969, A. Hulse, 5 males, 8 females (ASU); Pima County: Tucson, Old Tucson movie set, 28 September 1965, S. C. Williams, G. Fernald, 1 male (SCW); 20 miles southwest of Casa Grande, 4 August 1967, M. A. Nickerson, 1 male (SCW); 16 miles east of Tucson, 2 September 1950, W. J. Gertsch, 1 male, 1 female (AMNH); Organ Pipe Cactus National Monument, 1 mile west of junction of Puerto Blanco road and state highway 85, 31 August 1965, V. F. Lee, 1 female (SCW); Organ Pipe Cactus National Monument, Quitobaquito, 2 April 1965, C. J. McCoy, 1 male, 2 females (B. Vogel); Pinal County: Sacaton, L. Tibbet, 1 female (reported by Stahnke, 1945, p. 8); San Tan, Betterton, 1 male (reported by Stahnke, 1945, p. 8); Casa Grande National Monument, Coolidge, N. N. Dodge, 2 males, 1 female (reported by Stahnke, 1945, p. 8); Yavapai County: Bumble Bee, L. Conaway, 1 female (reported by Stahnke, 1945, p. 8); 100 yards north of Kirkland Bridge crossing at Kirkland Junction on highway 89, 1 October 1965, M. Itzkowitz, J. Johnson, 1 male (SCW); Yuma County: Dateland, 13 October 1967, M. A. Cazier, J. Bigelow, S. Gorodenski, 22 males, 7 females (SCW); Brenda, 15 miles west of Hope, 27 October 1967, J. Bigelow, S. Gorodenski, M. A. Cazier, 3 males, 5 females (SCW); 1 mile south of Wellton, 27 April 1968, M. A. Cazier, Foster, Smoot, 1 female (SCW); McAllister Wash, 29 March 1961, R. Young, 1 female (K. Lucas); Adobe Lake, 4 January 1957, V. Roth, 1 female (AMNH); Gila Valley, 1 female (AMNH); 11 miles south of Cibola, 1 mile east of Colorado River, 3-4 April 1969, M. A. Cazier and party, 2 males, 3 females (ASU); 10 miles south of Cibola, 3 April 1969, M. A. Cazier and party, 1 female (ASU); 15 miles south of Cibola, 3-4 April 1969, M. A. Cazier and party, 6 males, 10 females (ASU); 2 miles west of Palm Canyon, Kofa Mountains, 12 October 1968, M. A. Cazier and party, 1 male, 1 female (ASU); Palm Canyon, Kofa Mountains, 11 October 1968, M. A. Cazier, 1 male, 1 female (ASU); 3 miles east of Imperial Dam, Yuma Proving Grounds, 14 July 1969, J. Bigelow, Johnson, 6 males, 1 female (ASU); 6 miles south of Parker, 5 September 1967, M. A. Cazier, S. C. Williams, 11 males, 11 females (SCW); 3 miles northeast of Parker, 7 September 1967, S. C. Williams, M. A. Cazier, 1 male (SCW);

1 mile northeast of Parker, 7 September 1967, S. C. Williams, M. A. Cazier, 1 male (SCW); 0.25 mile north of Parker, 7 September 1967, S. C. Williams, M. A. Cazier, 2 males, 1 female (SCW); Ehrenberg, H. L. Stahnke, 1 male (reported by Stahnke, 1945, p. 8). SONORA: Buena Vista, 100 kilometers west of Hermosillo, 28 July 1953, B. Malkin, 1 female (AMNH); Isla Tiburon, Punta Willard, 1 female (AMNH); Guaymas, 8 April 1966, T. Paca, 1 female (SCW).

REMARKS. Most abundant in the open desert basins of the Sonoran Desert characterized by Larrea - Franseria plant associations. In these areas the soils are fine textured and moderately well compacted. This species has also been found on the slopes of desert mountains, especially on the relatively bare south facing slopes, and in river beds. Hadrurus arizonensis arizonensis is closely related to H. arizonensis pallidus with which it freely interbreeds in the zone where the Colorado Desert grades into the Sonoran and Mohave deserts.

Hadrurus arizonensis pallidus Williams, new subspecies.
(Figures 21, 28, 48, 49, 50.)

Hadrurus hirsutus Kraepelin, 1899, (part?), p. 188. Banks, 1900, p. 424. Pocock, 1902, pp. 6-7. Banks, 1909 - 1910, p. 188. Ewing, 1928, p. 8. Hoffmann, 1931, pp. 335-340. Stahnke, 1940, (part), p. 101. Stahnke, 1945, pp. 5-6. Diaz Najera, 1964, p. 27. Williams and Hadley, 1967, pp. 107-108. Stahnke, 1969, pp. 60-61.

DIAGNOSIS. Entire body bright yellow and nonmelanic except for thin dusky crescent through interocular area; body may appear greenish yellow on some individuals, some individuals with interocular crescent faint to obsolescent, this condition most common in older individuals. Pectine teeth 32 to 37 in males, 24 to 31 in females (based on 20 males, 20 females). Metasoma with dorsal keels of segment III densely hirsute to unaided eye in males, this usually so, but variable, in females. Up to 127 millimeters in total body length.

DESCRIPTION OF HOLOTYPE. Male. Coloration: Entire body light yellow with following exceptions: dusky crescent centering on ocular tubercule with horns extending anteriorly through lateral eyes; cheliceral fingers and aculeus dark reddish brown; tips of pretarsal claws and tibial spurs lighter reddish brown.

Carapace: Anterior margin broadly convex with very subtle median emargination, set with 8 pair stout reddish hairs. Entire surface finely granular, granules irregular in dispersion.

Mesosoma: Tergites 1 to 6 finely granular, tergite 7 densely set with coarse and fine granules; no dorsal median or lateral keels; last sternite with lateral fine granulation and medially with several broad obsolescent granules; last sternite with 1 pair of obsolescent smooth median

keels and 1 pair of crenulate lateral keels, central area bordered by lateral keels with 2 pairs reddish hairs.

Metasoma: Dorsal keels of segments III to V conspicuously hirsute to unaided eye; dorsal intercarinal spaces granular. Inferior lateral keels of segment I smooth, segments II and III smooth to crenulate, segment IV crenulate to serrate, segment V serrate. Inferior median keels of segment I smooth, segment II smooth to faintly crenulate, segment III smooth to crenulate, segment IV irregularly serrate, segment V serrate. Inferior intercarinal spaces of segment V granular, this space set with 5 pairs long reddish hairs. Space between inferior median keels on segment I has 1 hair, segment II no hairs, segment III 1 hair, segment IV no hairs; inferior median keels laterally set with 3, 4, 5, and 6 pairs of stout reddish hairs on segments I to IV respectively.

Genital operculum: With 6 to 7 pairs of conspicuous reddish hairs.

Pedipalps: Each inner palm with 10 or 11 long conspicuous red hairs (excluding long hairs on dorsal and ventral margins).

Standard measurements and photographs: Table 7 and figures 49 and 50.

DESCRIPTION OF ALLOTYPE. Female. Very similar to holotype in coloration and morphology with the following significant exceptions: mesosoma broader; dorsal keels of segments III to V and telson hirsute to unaided eye, but with distinctly fewer hairs (segment III with only 4 or 5 pairs of long hairs).

Standard measurements: Table 7.

VARIATION WITHIN PARATYPES. Study of the 19 paratopotypes indicated little significant variation from the holotype and allotype. Males varied from 55 to 126 millimeters, while females varied from 89 to 101 millimeters in total body length. Adult and juveniles, except the earliest several instars, were represented in the samples. Pectine tooth counts varied from 26 to 32 in females and from 32 to 39 in males. Little sexual dimorphism was apparent but males differed from females in the following ways: dorsal metasomal keels were distinctly more hirsute, adults with longer metasoma, fixed finger of pedipalp distinctly shorter than metasomal segment IV (these measurements approximate each other in females). Juveniles were essentially similar to adults with the following exceptions: body much smaller, not as conspicuously hirsute, pedipalp chela more elongate and less swollen; dusky crescent more contrasting, this sometimes fading to obsolescence in older instars.

TYPE DATA AND ETYMOLOGY. The holotype, allotype, and 19 paratopotypes (13 males, 6 females) were collected 26 miles east of San Luis, Sonora, Mexico, 4 June 1968 by M. A. Cazier and party. The holotype and allotype are permanently deposited in the collection of the California Academy of Sciences.

This subspecies is named "pallidus" because of its pale

yellow basic body coloration

DISTRIBUTION. Occurs only in the Colorado Desert region of southern California, western Arizona, northeastern Baja California, and northwestern Sonora (fig. 48).

RECORDS. Known from 56 localities in California, Arizona, Sonora, and Baja California Norte. **CALIFORNIA:** Imperial County: Ogilby, L. Hedgpeth, 1 female (reported from Stahnke, 1945, p. 6); Brawley, 11 October 1961, R. Greer, 1 male (AMNH); Imperial Valley, near Salton Sea, 1 female (SDMNH); Andrade, U. S. entrance station, 6 July 1969, S. C. Williams, V. F. Lee, 3 males, 1 female (SCW); 2 miles west of Glamis, 21 August 1968, 10 males, 4 females (K. Lucas); 6 miles northeast of Glamis, 14 October 1967, J. Bigelow, S. Gorodenski, M. A. Cazier, 1 female (SCW); 8 miles west of Glamis, 14 October 1967, J. Bigelow, S. Gorodenski, M. A. Cazier, 2 males, 2 females (SCW); 10 miles northeast of Glamis, 28 October 1967, M. A. Cazier, 1 male; 15 miles west of Glamis, Findlay E. Russell, 1 male (AMNH); Niland, 25 April 1949, J. E. Gillaspay, 1 male (CIS); 7 miles west of Winterhaven, 26 July 1967, M. A. Cazier, J. D. Davidson, J. M. Davidson, 2 males, 2 females (SCW); El Centro, 15 January 1962, N. Stanley, 1 male (AMNH); Riverside County: La Quinta, before 1962, D. McKeldey, 3 females (MCZ); 5 miles east of Mecca, 29 September 1967, M. A. Cazier, J. Bigelow, S. Gorodenski, 1 female (SCW); 3 miles east of Mecca, 29 September 1967, M. A. Cazier, J. Bigelow, S. Gorodenski, 1 female (SCW); 1 mile east of Mecca, 29 September 1967, M. A. Cazier, J. Bigelow, S. Gorodenski, 1 male, 2 females (SCW); 1 mile west of Paloverde, 8 September 1967, S. C. Williams, M. A. Cazier, 4 males, 1 female (SCW); Paloverde, 23 July 1967, M. A. Cazier, J. D. Davidson, J. M. Davidson, 3 males, 1 female (SCW); Palm Springs, 1 May 1949, L. M. Smith, 1 female (CIS); 3 miles east of Indio, 31 August 1956, M. Wasbauer, 1 male (CIS); Blyth, 27 August 1946, W. F. Barr, 1 male (CIS); San Gorgonio Pass, Cotton Wood Canyon, 20 April 1963, H. W. Campbell, 1 male (P. Craig); 2 miles north of Indian Wells, Coachella Valley, 20 April 1937, 2 males, 1 female (AMNH); Cathedral City, before 1938, 2 males, 3 females (AMNH); Mojave desert near Snow Creek Village, San Bernardino National Forest, near Palm Springs, 20 March 1967, V. F. Lee, 1 female (SCW); San Bernardino County: 2 miles north of Newberry, 18 May 1968, Foster, J. Bigelow, M. A. Cazier, 1 female (SCW); 3 miles west of Amboy, 11 May 1968, J. Bigelow, Foster, M. A. Cazier, 1 male (SCW); Cronise Station, 29 April 1956, M. Wasbauer, 1 male (CIS); Pisgah Lava Flow, 18 April 1959, B. Banta, 1 male, 1 female (CAS); Twentynine Palms, July - August 1945, J. H. Branch, 3 males, 2 females (AMNH); San Diego County: Borego Valley, Borego Store, 2 September 1965, S. C. Williams, 1 male, 3 females (SCW). **ARIZONA:** Pima County: Organ Pipe National Monument, 22 August 1968, 2 males (K. Lucas); Yuma County: 3 miles northeast of Parker, 7 September 1967, S. C. Williams, M. A. Cazier, 1 male (SCW); 6 miles south of Parker, 5 September 1967, M. A. Cazier, S. C. Williams, 8

males, 6 females (SCW); San Luis, 22 July 1967, J. M. Davidson, J. D. Davidson, M. A. Cazier, 3 males, 1 female (SCW); 1 mile east of Somerton, 29 July 1967, M. A. Cazier, J. M. Davidson, 2 males, 6 females (SCW); 1 mile south of Wellton, 27 April 1968, Smoot, Foster, M. A. Cazier, 1 female (SCW). SONORA: Desemboque, 17-31 July 1953, B. Malkin, 1 female (AMNH); Laguna Prieta, 20 miles southeast of San Luis river crossing, 12 October 1958, V. Roth, 1 male (AMNH); Punta Sargento, 1 female (AMNH); Cholla Bay, near Puerto Penasco, 7 October 1967, N. F. Hadley, 11 males, 1 female (SCW); 6.5 miles north of Puerto Penasco, 3 June 1968, M. A. Cazier, J. Bigelow, J. Davidson, N. Leppla, 13 males, 20 females (SCW); 5 miles north of El Golfo, 5 June 1968, M. A. Cazier and party, 8 males, 9 females (SCW); 26 miles east of San Luis, 4 June 1968, M. A. Cazier and party, 13 males, 6 females (SCW). BAJA CALIFORNIA NORTE: San Felipe, 9 June 1968, S. C. Williams, M. A. Cazier, and party, 4 males, 5 females (CAS); Punta Diggs, south of San Felipe, 20 December 1953, W. A. McDonald, 1 male (AMNH); Puertecitos, 11 June 1968, S. C. Williams, M. A. Cazier, and party, 7 males, 6 females (CAS); 1 mile north of San Felipe, 6 June 1968, M. A. Cazier and party (CAS); Laguna Salada, north end, 31 March 1969, S. C. Williams, H. L. Heringhi, 1 female (CAS); 2 miles west of Colonia Progreso, 8 July 1969, S. C. Williams, V. F. Lee, 1 male (CAS); 5 miles west of Colonia Progreso, 8 July 1969, S. C. Williams, V. F. Lee, 1 male (CAS); 0.25 mile east of Algodones, 18 July 1969, S. C. Williams, V. F. Lee, 12 males, 14 females (CAS); 4 miles north of Rio Hardy Camp, 19 July 1969, S. C. Williams, V. F. Lee, 7 males, 7 females (CAS); Southern loop of Pinto Canyon, approximately 10 miles south of U. S. Border, 28 December 1968, M. Hamn, S. Hamn, 1 female (SDMNH). GULF OF CALIFORNIA: Patos Island, 7 April 1928, 1 male (LACM).

REMARKS. This large pale subspecies seems particularly well adapted to the sandy and often wind blown soils of the Colorado Desert. It is often abundant on unstabilized and semistabilized sand dunes. This subspecies has continually been mistaken for H. hirsutus. For this reason it has been well known by this inappropriate name for many years. It is a conspicuous element in the southern California deserts where adult males may sometimes be seen in large numbers crossing highways, presumably during their courtship migrations.

Hadrurus arizonensis (arizonensis X pallidus hybrids).

Along the zone where the Colorado Desert meets the Mojave and Sonoran deserts, H. arizonensis arizonensis hybridizes freely with H. arizonensis pallidus. In most of these predominantly hybridizing populations, the hybrids are extremely variable in color pattern, varying from dark (essentially H. arizonensis arizonensis form) to completely nonmelanic (H. arizonensis pallidus form), with the complete array of intermediates well represented. Toward the eastern edge of the zone of intergradation the populations usually tend more toward the predominance of the darker

forms, while on the southwestern edge of the intergradation zone the less melanic forms tend to be more predominant (fig. 48).

RECORDS. Hybrids have been found in 25 localities in California, Nevada, Arizona, Sonora, and Baja California Norte. CALIFORNIA: San Bernardino County: Pisgah Crater, 11 November 1961, Norris and Heath, 2 males (AMNH); Yucca Valley, 19 April 1960, W. J. Gertsch, Ivie, Schrammel, 1 female (AMNH); Twentynine Palms, March - April, 1945, J. H. Branch, 1 female (AMNH); Kern County: Red Rock Canyon, 25 miles north of Mojave, 13 April 1968, S. C. Williams, V. F. Lee, 1 male (SCW); Riverside County: Paloverde, 23 July 1967, M. A. Cazier, J. M. Davidson, J. D. Davidson, 4 males, 3 females (SCW); 2 miles north of Indian Wells, Coachella Valley, 20 April 1937, 1 female (AMNH); Los Angeles County: Big Peak Creek, 6 miles east of Palmdale, 20 July 1956, S. F. Wood, 2 males, 1 female (SDMNH); Imperial County: Andrade, 6 July 1969, S. C. Williams, V. F. Lee, 2 males (SCW); California Agricultural Entrance Station, 3 miles west of Andrade, 6 July 1969, S. C. Williams, V. F. Lee, 1 female (SCW); Glamis, east of Algodones sand hills, 14 October 1967, J. Bigelow, S. Gorodenski, M. A. Cazier, 3 males, 1 female (SCW); Midway Well, 20 August 1968, 1 male, 1 female (K. Lucas); San Diego County: Borego Valley, Borego Store, 2 September 1965, S. C. Williams, 1 female (SCW). NEVADA: Clark County: Las Vegas, February - June 1945, D. J. Zinn, 2 males, 1 female (AMNH). ARIZONA: Yuma County: 3 miles northeast of Parker, 7 September 1967, S. C. Williams, M. A. Cazier, 1 male (SCW); 6 miles south of Parker, 5 September 1967, M. A. Cazier, S. C. Williams, 10 males, 6 females (SCW); 6 miles southeast of Parker, 20 July 1967, J. M. Davidson, M. A. Cazier, 1 male (SCW); 6 miles east of Parker, 5 April 1969, M. A. Cazier and party, 9 males, 8 females (ASU); 5 miles north of Yuma, September 1957, V. Roth, 1 male (AMNH); near Sierra Pinto, 21 February 1958, V. Roth, 1 male (AMNH); Pima County: Organ Pipe National Monument, 22 August 1968, 9 males, 6 females (K. Lucas); Quitobaquito, 13 June 1952, Cazier, Gertsch, Schrammel, 1 male (AMNH). BAJA CALIFORNIA NORTE: 0.25 miles east of Algodones, 18 July 1969, S. C. Williams, V. F. Lee, 4 males, 1 female (CAS). SONORA: Puerto Kino, December 1963, W. Eberhard, 1 male (MCZ); Desemboque, 1-10 September 1953, B. Malkin, 1 male (AMNH); Isla San Pedro Nolasco, 16 August 1964, Dixon, Taft, 1 female (LACM).

Hadrurus arizonensis austrinus Williams, new subspecies.
(Figures 18, 29, 48, 51, 52.)

DIAGNOSIS. Large pale subspecies of Hadrurus arizonensis closely resembling Hadrurus arizonensis pallidus Williams in color pattern and in general appearance. Entire body pale yellow except for thin dusky interocular crescent. Differs from H. arizonensis pallidus in having dorsal keels of metasomal segment III not distinctly hirsute to unaided eye. Dorsal keels of metasomal segments IV and V about half as hirsute as other two subspecies. Pectine

tooth count 35 to 41 in males, 28 to 32 in females (based on 20 males, 20 females). Adults up to 109 millimeters in total body length.

DESCRIPTION OF HOLOTYPE. Male. Coloration: Entire body light yellow with following exceptions: dusky crescent centering on ocular tubercule with horns extending anteriorly through lateral eyes; cheliceral fingers and aculeus dark reddish brown; tips of pretarsal claws and tibial spurs lighter reddish brown.

Carapace: Anterior margin broadly convex, set with 8 stout pairs reddish hairs. Entire surface finely granular.

Tergites 1 to 6 finely granular, tergite 7 densely set with coarse and fine granules; no dorsal median or lateral keels; last sternite with lateral fine granulation and medially with several broad obsolescent granules; last sternite with 1 pair of obsolescent, smooth median keels and 1 pair of crenulate lateral keels, central area bordered by lateral keels with 3 pairs reddish hairs.

Metasoma: Dorsal keels of segments IV and V conspicuously hirsute to unaided eye; dorsal intercarinal spaces granular. Inferior lateral keels of segments I to III smooth to crenulate, segment IV crenulate to serrate, V serrate. Space between inferior median keels on segments I to IV completely lacking hairs; inferior median keels laterally set with 4, 4, 4, and 7 pairs of stout reddish hairs on segments I to IV respectively.

Genital operculum: With 5 or 6 pairs of conspicuous reddish hairs.

Pedipalps: Each inner palm with 14 or 15 long conspicuous reddish hairs.

Standard measurements and photographs: Table 8 and figures 51 and 52.

DESCRIPTION OF ALLOTYPE. Female. Very similar to holotype in coloration and morphology with the following significant exceptions: Carapace larger; metasomal segments definitely broader in relation to length, metasomal segment I broader than long; dorsal keels of segments IV and V and telson hirsute to unaided eye but with fewer hairs.

Standard measurements: Table 8.

VARIATION WITHIN PARATYPES. Study of the 26 paratopotypes (11 males, 15 females) indicated little significant variation from the descriptions of the holotype and allotype. Males varied in total length from 46 to 115 millimeters, while females varied from 46 to 117 millimeters. Adults and juveniles were represented in the samples except for the youngest instars. Pectine tooth counts varied from 28 to 32 in females and from 35 to 41 in males. Little sexual dimorphism occurred except for the following: male carapace shorter than metasomal segment V, these two approximate each other in females; metasomal segment I definitely longer than wide in male, length approximates width in females; movable finger of pedipalp approximates length of metasomal segment V in males, females with movable finger definitely longer; fixed finger of pedipalp shorter

than metasomal segment IV in males, these two approximate each other in females. Juveniles essentially the same as adults with the following exceptions: sexual dimorphism may not be clear; dusky ocular crescent more distinct, this may fade in older individuals.

TYPE DATA AND ETYMOLOGY. The holotype, allotype, and 26 paratopotypes (11 males, 15 females) were collected 8 miles north of Bahia San Luis Gonzaga, Baja California Norte, Mexico, 13 June 1968 by S. C. Williams, M. A. Cazier, and party. The holotype and allotype are permanently deposited in the California Academy of Sciences.

This subspecies is named "austrinus" because of its extreme southern distribution for the species.

DISTRIBUTION. Occurs only in Baja California Norte along the Gulf coast from Oakies Landing to Bahia San Luis Gonzaga (fig. 48).

RECORDS. Known from 6 records in BAJA CALIFORNIA NORTE, MEXICO: Oakies Landing, 12 June 1968, S. C. Williams, M. A. Cazier, and party, 7 males, 10 females (CAS); 7 miles north of Bahia San Luis Gonzaga, 14 June 1968, S. C. Williams, M. A. Cazier, and party, 7 males, 9 females (CAS); 6 miles north of Bahia San Luis Gonzaga, 13 June 1968, S. C. Williams, M. A. Cazier, and party, 3 males, 2 females (CAS); 6 miles north of Bahia San Luis Gonzaga, 14 June 1968, S. C. Williams, M. A. Cazier, and party, 4 males, 14 females (CAS); 5 miles north of Bahia San Luis Gonzaga, 14 June 1968, S. C. Williams, M. A. Cazier, and party, 2 females (CAS); 1 mile north of Bahia San Luis Gonzaga, 14 June 1968, S. C. Williams, M. A. Cazier, and party, 2 females (CAS).

Hadrurus obscurus Williams, new species.
(Figures 12, 20, 30, 53, 54, 55.)

DIAGNOSIS. Body pale yellow except for dark pigmentation on carapace and mesosoma; anterior region of carapace light yellow, but yellow extends to ocular tubercle only along median groove; pedipalp fingers reddish brown. Inferior lateral keels smooth to lightly crenulate on metasoma I to III, serrate on IV and V; inferior median keels smooth to crenulate on I and II, irregularly crenulate on III, crenulate to serrate on IV; space between inferior median keels of segments I to III with many conspicuous stout hairs. Pectines with 34 to 37 teeth in males, 24 to 30 in females.

Related to Hadrurus spadix from which it differs in the following ways: anterior region of carapace not melanic; tendency for formation of thin longitudinal, nonmelanic stripe down dorsal median line of mesosoma; females with carapace longer than metasoma V (these approximate in H. spadix); females with metasoma I longer than wide (these approximate in H. spadix).

Also appears related to Hadrurus arizonensis from which it can be distinguished by the hirsuteness of the space

between the inferior median keels of the metasoma, by the more extensive dark pigmentation of the interocular area, and by reddish brown pedipalp fingers.

DESCRIPTION OF HOLOTYPE. Male. Coloration: Dorsum of carapace brownish black, laterally bordered by yellow, with yellow area extending halfway to ocular tubercule except along median groove where yellow extends to base of ocular tubercule. Dorsum of mesosoma brownish black to dusky except lateral borders with yellow margin and with thin yellow line running along median plane of each tergum; last tergum with dark pigment obsolescent; metasoma, walking legs, pedipalps, telson and ventral surface pale yellow. Pedipalp fingers light reddish brown.

Carapace: Anterior margin broadly convex with 7 to 8 pairs of stout reddish bristles. Carapace surface coarsely granular.

Mesosoma: Tergites 1 to 6 finely granular, tergite 7 with large coarse granules; obsolescent dorsal median keels, no dorsal lateral keels; sterna 1 to 4 very finely granular, sternum 5 with large rounded granules and 1 pair of weak crenulate lateral keels.

Metasoma: Inferior lateral keels smooth to lightly crenulate on I to III, serrate on IV and V; dorsal keels of segments III to V densely hirsute to unaided eye; inferior median keels smooth to crenulate on I and II, irregularly crenulate on III, crenulate to serrate on IV, irregularly serrate on V; space between inferior median keels set with stout reddish hairs, segment I with 13, segment II with 16, segment III with 10, segment IV with 7.

Telson: Ventral surface bulbous, densely hirsute with long reddish hairs, this surface coarsely granular, these granules most conspicuous posteriorly; dorsal surface densely hirsute except for anterior margin; no visible dorsal glands at base of aculeus.

Genital operculum: With 5 to 6 pairs of conspicuous reddish hairs.

Pedipalps: Each inner palm with 7 to 9 long conspicuous red hairs (excluding long hairs on dorsal and ventral margins).

Standard measurements and photographs: Table 9 and figures 53 and 54.

DESCRIPTION OF ALLOTYPE. Female. Very similar to holotype in coloration and morphology with the following significant exceptions: Pedipalp palm not as deep; dorsal keels of segments III to V and vesicle hirsute to unaided eye but with conspicuously fewer hairs.

VARIATION WITHIN PARATYPES. Study of the 20 paratopotypes (9 males, 11 females) indicated little significant variation from the descriptions of the holotype and allotype. Males varied in total length from 36 to 107 millimeters, while females varied from 35 to 98 millimeters. Adults and juveniles, except for the youngest instars, were represented in the samples. Pectine tooth counts varied from 34 to 37 in males and from 24 to 30 in females. Males

from Saline Valley and from Panoche had homogeneous pectine tooth counts; however, females from Panoche and from Saline Valley had somewhat different counts (24 to 27 and 26 to 30 respectively). Little sexual dimorphism occurred except for the following: male carapace definitely shorter than movable finger of pedipalp, these approximate in females; carapace longer than metasoma V in males, carapace shorter than metasoma V in females; movable finger of pedipalp longer than metasoma V in female, these approximate in male; fixed finger of pedipalp shorter than metasoma IV in male, these approximate in female.

The specimens from Inyo County differed from those in the type locality in the following ways: females with tendency for slightly increased number of pectine teeth; underside of last mesosomal segment more generally granular; inferior surface of vesicle more coarsely granular.

TYPE DATA AND ETYMOLOGY. The holotype, and 20 paratopotypes (9 males, 11 females) were collected east of Panoche, 3.5 miles west of the Fresno County line, along the road between Panoche and Mendota, San Benito County, California. The holotype and 18 of the paratopotypes were collected on 14 August 1969 by S. C. Williams, V. F. Lee, and M. M. Bentzien. The allotype and 2 paratopotypes were collected in the same location on 18 May 1968 by S. C. Williams, J. R. Gabel, and K. C. Schroen. The holotype and allotype are permanently deposited in the California Academy of Sciences.

This species is named "obscurus" because of its dark coloration.

DISTRIBUTION. Found on the arid slopes of the southern part of the Central Valley of California, and along the southeastern base of the Sierra Nevada (fig. 55).

RECORDS. Known from 8 localities in CALIFORNIA. Inyo County: 7 to 10 miles west of Lone Pine, 29 August 1968, J. Haddock, 1 female (SCW); Tungsten City Mine, 6.2 miles west of Bishop, 26 August 1965, V. F. Lee, 2 females (SCW); 6.2 miles west of Bishop, 26 August 1965, K. Hom, A. Jung, 1 male (AMNH); Saline Valley, 4 July 1957, B. Banta, 1 male (CAS); Saline Valley, 27 November 1959, B. Banta, 1 female (CAS); Saline Valley, 8 April 1960, B. Banta, 1 female (CAS); Saline Valley, 14 June 1960, B. Banta, 1 male (CAS); Kern County: May 1960, W. J. Gertsch, 1 female (AMNH); Fresno County: Double "C" ranch, 8 miles southeast of Mendota, 13 August 1965, R. R. Montucci, 1 male (AMNH); Tulare County: Steve Barton Point, near Lemon Cove, 8 April 1966, V. F. Lee, 1 female (SCW).

REMARKS. Specimens of this species from the eastern slopes of the Sierra Nevada appeared somewhat different morphologically from those studied from the San Joaquin Valley. These differences, however, appear to be minor and, at most, probably indicate some degree of race formation. In Saline Valley this species occurs with Hadrurus arizonensis arizonensis and with Hadrurus spadix, with no evidence of interbreeding.

DISCUSSION AND CONCLUSIONS

Kraepelin, in his works of 1894 and 1899, had some question regarding the exact species status of his specimen in the Berlin Museum, but classified it as Hadrurus hirsutus. His specimen was from "La Paz" and most probably was a specimen of Hadrurus concolorous judging by the reported reddish yellow color of the trunk and large pectine tooth counts. In 1894, he mentioned that the fifth caudal segment sometimes may be dark, but in 1899 this is not mentioned in his diagnosis. This color characteristic may have been an extrapolation from Wood's original description. Kraepelin's specimen was apparently a juvenile judging by the size measurements given.

Pocock's works on Hadrurus were apparently based on his study of 3 specimens in the British Museum of Natural History. Although Pocock identified these as Hadrurus hirsutus, they now appear to have been Hadrurus arizonensis pallidus judging by pectine tooth counts and color descriptions. All 3 of these specimens apparently were subadults based on the size measurements. Only one of these specimens had basic locality data.

Thorell included Guatemala within the distributional range of Hadrurus hirsutus. Pocock (1902, p. 6) believed this to be an error in data since Hadrurus had never before been reported from Central America, combined with the fact that Thorell's specimen was supplied by Dr. Gustav Eisen of San Francisco who had supplied other specimens with data of questionable validity. Today it is clear that Hadrurus hirsutus does not occur in Guatemala, and that even the genus Hadrurus probably does not extend into Central America.

The following 5 species were at one time assigned to the genus Hadrurus: Hadrurus maculatus Thorell (1876), Hadrurus parvulus Karsch (1879), Hadrurus charcasus Karsch (1879), Hadrurus paaschi Karsch (1881), and Hadrurus robustus Boeris. These species are not properly members of the genus Hadrurus and have been placed within the genus Hadruroides.

It seems strange that most of our knowledge of the Hadrurus scorpions for the last 70 or so years has been based on very early observations of very few specimens. These specimens, mainly in collections of British, German, and Italian museums, were often without reliable data, and were often apparently juveniles. The interpretations of these early pioneer workers have essentially been accepted without question or verification, thus perpetuating and even sometimes magnifying misconceptions.

Study of comparative morphology indicates that Hadrurus is composed of three subgroups. Within each subgroup the members share such characteristics in common that a closer relation by descent is apparent. The first group is composed of one species, H. aztecus. Because of its relatively unique structures, this species appears to be only distantly related to the other species of the genus. It differs from all other Hadrurus species in the following important characteristics: dorsal keels of pedipalp palm are

narrower, tending to be more smooth than granular (somewhat granular proximally); carapace conspicuously covered with large rounded granules; anterior margin of carapace very hirsute; inferior median keel of metasomal segment I obsolete; all inferior median and inferior lateral keels underlined with dark pigment.

The second subgroup is composed of three species, H. arizonensis, H. spadix and H. obscurus. These are all similar in basic structure. Specifically, these species tend to be somewhat more hirsute than the other species. The males have dorsal keels of metasomal segment III conspicuously and densely hirsute to the unaided eye, with the exception of one subspecies which may have secondarily lost this hirsuteness. This group also lacks the externally visible dorsal telson glands found on adult males of some other species.

The third subgroup is composed of H. concolorous, H. pinteri, and H. hirsutus. These three species are similar in basic structure. Two of these, H. pinteri and H. concolorous, have a unique characteristic not found in other groups; this is the development of a pair of large oval glandular masses at the base of the aculeus and on the dorsal aspect of the telson (fig. 10). Hadrurus hirsutus lacks the development of this gland, at least in the form present in the other two species of this group (fig. 9), but other similarities of structure and coloration indicate that it is related to H. concolorous and H. pinteri more than it is to any of the other species.

The genus Hadrurus appears to be exclusively a North American genus. The center of distribution, areas of highest species diversity, and habitats of densest occupation today appear to be the arid habitats of subtropical and temperate North America. The question therefore arises whether this is a temperate and subtropical genus which has secondarily invaded the more tropical areas which it occupies today or whether it originally evolved in the tropics and secondarily invaded the more northern habitats. That this genus today is most diverse and most abundant in habitats which are among the most recent terrestrial formations in North America indicates that its species are relatively recent invaders of these habitats. Since the genus Hadrurus is not an important component of the arthropod fauna of older terrestrial land forms and habitats in temperate and subtropical North America, it seems logical that it is a relatively recent invader of the temperate and subtropical areas, coming originally from more tropical areas. Hadrurus aztecus perhaps most closely represents the ancestral Hadrurus stock which has given rise to the modern species. Today, H. aztecus appears relatively distant from the other related species in unique coloration and morphology and in geographical distribution.

Much evolution at the species and subspecies level must have occurred during the Pleistocene and Recent periods. This is indicated in that the habitats now utilized by the endemic H. arizonensis pallidus and H. arizonensis austrinus had not yet originated during the Pliocene when most of the Colorado and Mojave deserts were under northern

extensions of the Gulf of California. The habitats now inhabited by H. obscurus and H. spadix were also not widely available for terrestrial occupation until relatively recently because of the occurrence of the extensive system of fresh-water lakes which covered much of this part of North America.

It is important to note that H. concolorous has successfully invaded, and now inhabits, the Magdalena Plain and the Viscaïno Desert of the Baja California peninsula. These records are especially interesting because these are among the newest terrestrial habitats in North America. This ability to invade, adapt to, and successfully occupy new habitats indicates that this genus is composed of highly adaptable species. Furthermore, the predominant occurrence of the species of this genus in relatively new habitats indicates that many of the species and all of the known subspecies are of relatively recent origin and that the genus has perhaps come into its current numerical prominence and species diversity by its ability to pioneer the invasion of new habitats and to withstand seemingly harsh and extremely cyclic desert conditions.

All of the known modern species are obligate carnivores, preying on a wide variety of small vertebrates (such as lizards, small snakes, and mice), larger insects, and various arachnids, including other scorpions. In this capacity, species of Hadrurus are predatory engorgers which can and probably do spend long intervals between meals. In the laboratory it is not uncommon to have a large Hadrurus individual go up to six months between meals without any apparent harm (if water is supplied). The apparently low metabolic rate combined with the periodic and opportunistic feeding habits perhaps accounts for the unexpectedly high population density of up to 1 individual per 2 square meters which has been observed in some habitats in the Colorado and Viscaïno deserts.

Species belonging to the genus Hadrurus appear to spend most of their life cycle underground either in their own burrows or in the burrow systems of other animals. Systematic sampling has demonstrated that juveniles are uncommon on the ground surface in comparison to the adults. Individuals normally spend most of the time underground, coming to the surface shortly after sunset and returning underground generally before midnight. During some seasons of the year, Hadrurus adults of at least some species, such as H. arizonensis, show conspicuously accelerated surface activity. During these brief periods, large specimens may be seen crossing roads in great numbers during the early evening. Specimens so collected have usually been mature males, thus suggesting a courtship migration similar to that known in other arachnids such as the tarantulas.

LITERATURE CITED

BANKS, NATHAN

1900. Synopses of North American invertebrates. IX.
The Scorpions, Solpugids, and Pedipalpi.
American Naturalist, vol. 34, no. 401, pp.

421-427.

1910. The scorpions of California. Pomona College Journal of Entomology and Zoology, vol. 2, pp. 185-190.

DIAZ NAJERA, A.

1964. Alacranes de la Republica Mexicana: Identificacion de ejemplares capturados en 235 localidades. Revista del Instituto de Salubridad y Enfermedades Tropicales de la SSA - Mexico, D. F., vol. 24, pp. 15-30.

EWING, H. E.

1928. Scorpions of the western part of the U. S. with notes on those occurring in northern Mexico. Proceedings of the United States National Museum, vol. 73, art. 9, pp. 1-24.

GERTSCH, WILLIS J., and DORALD M. ALLRED

1965. Scorpions of the Nevada Test Site. Brigham Young University Science Bulletin. Biological Sciences, vol. 6, no. 4, pp. 1-15.

HOFFMAN, CARLOS C.

1931. Monografias para la entomologia medica de Mexico, Monografia Numero 2 -- Los scorpiones de Mexico. (Primera Parte). Diplocentridae, Chactidae, Vejovidae. Universidad Nacional de Mexico, Anales del Instituto de Biologia, vol. 2, no. 4, pp. 291-408.

KARSCH, F.

1879. Scorpionologische Beitrage. Muenchener Entomologischer Verein, Mittheilungen, vol. 3, pp. 97-136.

KRAEPELIN, K.

1894. Revision der Skorpione. II. Scorpionidae und Bothriuridae. Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten, vol. 11, pp. 1-248.
1899. Das Tierreich - Archnoidea, Scorpiones und Pedipalpi. 8. Lieferung. R. Friedlander und Sohn, Berlin. 265 pp.

MARX, GEORGE

1887. Remarks on the types of Scorpionidae described by Wood. Proceedings of the Entomological Society of Washington, vol. 1, pp. 90-94.

POCOCK, REGINALD I.

1893. Contributions to our knowledge of the arthropod fauna of the West Indies. Part I. Scorpiones and Pedipalpi; with a supplementary note upon the freshwater Decapoda of St. Vincent. Journal of the Linnean Society of Zoology, vol. 24, pp. 374-409.
1894. Scorpions and their geographical distribution. Natural Science, vol. 4, no. 24, pp. 353-364.
1902. Arachnida, Scorpiones, Pedipalpi and Solifugae. Biologia Centrali-Americana, pp. 1-45.

STAHNKE, HERBERT L.

1940. Scorpions of Arizona. Iowa State College

- Journal of Science, vol. 15, pp. 101-103.
1945. Scorpions of the genus Hadrurus Thorell. American Museum Novitates, no. 1298, pp. 1-9.
1956. Scorpions. Poisonous Animals Research Laboratory, Arizona State College, Tempe, Arizona, pp. 1-36.
1969. Review of Hadrurus scorpions (Vejovidae). Entomological News, vol. 80, no. 3, pp. 57-65.
- THORELL, T.
- 1876a. On the classification of scorpions. Annals and the Magazine of Natural History, series 4, vol. 17, no. 97, pp. 1-15.
- 1876b. Etudes scorpologiques. Atti della Societa Italiana di Scienze Naturali, vol. 19, pp. 77-272.
1893. Scorpiones exotici R. Musei Historiae Naturalis Florentini. Bulletino della Societa Entomologica Italiana, vol. 25, pp. 356-387.
- WERNER, FRANZ
1935. Scorpiones, Pedipalpi. (In) Bronns, H. G., Klassen und Ordnungen des Tierreichs; 5. Band: Arthropoda; IV. Abteilung: Arachnoidea; 8. Buch. Akademische Verlagsgesellschaft M.B.H., Leipzig, 316 pp.
- WILLIAMS, STANLEY C.
- 1968a. Scorpion preservation for taxonomic and morphological studies. Wasmann Journal of Biology, vol. 26, no. 1, pp. 133-136.
- 1968b. Methods of sampling scorpion populations. Proceedings of the California Academy of Sciences, Fourth Series, vol. 36, no. 8, pp. 221-230.
- 1968c. Scorpions from northern Mexico: Five new species of Vejovis from Coahuila, Mexico. Occasional Papers of the California Academy of Sciences, vol. 68, pp. 1-24.
1970. A redescription of Hadrurus pinteri Stahnke based on the adult (Scorpionida: Vejovidae). Wasmann Journal of Biology, vol. 28, no. 1, pp. 169-174.
- WILLIAMS, STANLEY C., and NEIL F. HADLEY
1967. Scorpions of the Puerto Penasco area (Cholla Bay), Sonora, Mexico, with description of Vejovis baergi, new species. Proceedings of the California Academy of Sciences, Fourth Series, vol. 35, no. 5, pp. 103-116.
- WOOD, HORATIO C.
- 1863a. Descriptions of new species of North American Pedipalpi. Proceedings of the Academy of Natural Sciences of Philadelphia, pp. 107-112.
- 1863b. On the Pedipalpi of North America. Journal of the Academy of Natural Sciences of Philadelphia, series 2, vol. 5, pp. 357-376.

TABLE 1. Measurements (in millimeters) of Hadrurus hirsutus (Wood), topotypes.

	Male	Female
Total length	107.4	98.7
Carapace, length	12.5	13.1
width (at median eyes)	10.0	10.6
Mesosoma, length	24.2	27.8
Metasoma, length	57.6	44.4
segment I (length/width)	6.8/7.0	6.5/7.2
segment II (length/width)	8.4/6.5	8.1/6.8
segment III (length/width)	8.8/6.6	8.2/6.5
segment IV (length/width)	10.6/6.6	9.8/6.3
segment V (length/width)	13.0/6.2	11.8/5.7
Telson, length	13.1	13.4
Vesicle (length/width)	8.6/6.2	8.2/5.8
depth	5.6	5.3
Aculeus, length	4.5	5.2
Pedipalp		
Humerus (length/width)	9.5/3.3	9.6/3.2
Brachium (length/width)	11.3/4.5	11.3/4.6
Chela (length/width)	9.4/4.8	9.6/5.0
depth	6.4	6.2
movable finger, length	13.2	13.0
fixed finger, length	9.7	10.4
Pectines		
teeth (left/right)	33/33	25/27

TABLE 2. Measurements (in millimeters) of Hadrurus aztecus Pocock, from Hoffman collection.

	Female
Total length	102
Carapace, length	13
width (at median eyes)	9
Metasoma, length	39.8
segment I (length/width)	6.2/6.4
segment II (length/width)	7.0/6.3
segment III (length/width)	7.4/6.2
segment IV (length/width)	8.7/6.0
segment V (length/width)	10.5/5.6
Telson, length	10.9
Vesicle (length/width)	7.0/5.2
depth	4.4
Aculeus, length	3.9
Pedipalp	
Humerus (length/width)	8.0/3.0
Brachium (length/width)	9.5/4.0
Chela (length/width)	18/4.4
depth	5.6
movable finger, length	11.5
fixed finger, length	8.7
Pectines	
teeth (left/right)	29/29

TABLE 3. Measurements (in millimeters) of Hadrurus spadix Stahnke, from Coconino County, Arizona.

	Male	Female
Total length	108.6	107.4
Carapace, length	12.3	13.7
width (at median eyes)	9.7	10.2
Mesosoma, length	29.9	28.8
Metasoma, length	53.6	50.5
segment I (length/width)	8.2/6.0	7.7/7.7
segment II (length/width)	9.6/5.8	8.8/6.5
segment III (length/width)	10.1/5.8	9.5/7.4
segment IV (length/width)	12.0/5.8	11.0/6.2
segment V (length/width)	13.7/5.5	13.5/5.7
Telson, length	13.0	14.4
Vesicle (length, width)	7.8/5.8	8.4/6.1
depth	5.2	5.7
Aculeus, length	5.2	6.0
Pedipalp		
Humerus (length/width)	11.8/3.2	11.4/4.5
Brachium (length/width)	12.2/4.4	12.7/4.4
Chela (length/width)	9.8/5.0	9.9/5.1
depth	6.0	6.7
movable finger, length	14.9	13.8
fixed finger, length	11.2	11.4
Pectines		
teeth (left/right)	38/39	30/30

TABLE 4. Measurements (in millimeters) of Hadrurus concolorous Stahnke, topotypes.

	Male	Female
Total length	103.7	104.8
Carapace, length	12.6	14.4
width (at median eyes)	9.7	11.4
Mesosoma, length	26.0	29.2
Metasoma, length	51.7	47.3
segment I (length/width)	7.7/7.3	7.0/7.2
segment II (length/width)	9.0/6.8	8.4/6.8
segment III (length/width)	9.7/6.7	9.0/6.8
segment IV (length/width)	11.6/6.9	10.2/6.5
segment V (length/width)	13.7/6.3	12.7/6.3
Telson, length	13.4	13.9
Vesicle (length/width)	8.4/5.6	8.7/6.3
depth	5.2	5.6
Aculeus, length	5.0	5.2
Pedipalp		
Humerus (length/width)	10.0/3.5	10.2/4.7
Brachium (length/width)	11.8/4.6	12.2/5.3
Chela (length/width)	9.3/4.5	9.7/4.9
depth	6.5	7.4
movable finger, length	12.7	13.7
fixed finger, length	9.5	10.8
Pectines		
teeth (left/right)	37/38	29/29

TABLE 5. Measurements (in millimeters) of Hadrurus pinteri Stahnke, from Bahia de Los Angeles, Baja California Norte, Mexico.

	Male	Female
Total length	119.2	116.2
Carapace, length	14.2	14.5
width (at median eyes)	11.5	11.3
Mesosoma, length	29.5	33.0
Metasoma, length	59.7	53.4
segment I (length/width)	8.5/7.3	7.8/7.3
segment II (length/width)	10.4/7.0	9.4/7.0
segment III (length/width)	11.4/7.0	9.8/6.8
segment IV (length/width)	13.4/7.1	11.9/6.8
segment V (length/width)	16.0/6.5	14.5/6.6
Telson, length	15.8	15.3
Vesicle (length/width)	10.2/7.0	9.7/7.3
depth	6.2	6.2
Aculeus, length	5.6	5.6
Pedipalp		
Humerus (length/width)	11.8/3.6	11.4/3.6
Brachium (length/width)	13.7/5.0	13.3/5.0
Chela (length/width)	22.5/6.4	22.4/6.0
depth	7.4	8.0
movable finger, length	15.0	15.4
fixed finger, length	11.2	11.3
Pectines		
teeth (left/right)	42/41	31/31

TABLE 6. Measurements (in millimeters) of Hadrurus arizonensis arizonensis Ewing, from Phoenix, Arizona.

	Male	Female
Total length		96.8
Carapace, length	12.8	13.3
width (at median eyes)	10.0	11.0
Mesosoma, length	24.4	23.8
Metasoma, length	50.9	47.4
segment I (length/width)	7.3/6.7	6.8/6.6
segment II (length/width)	8.9/6.3	8.3/6.4
segment III (length/width)	9.7/6.3	8.9/6.3
segment IV (length/width)	11.5/6.2	10.7/6.3
segment V (length/width)	13.5/5.7	12.7/5.8
Telson, length	12.6	12.3
Vesicle (length/width)	8.4/5.7	7.8/5.9
depth	4.9	5.1
Aculeus, length	4.2	4.5
Pedipalp		
Humerus (length/width)	10.0/3.1	10.0/3.3
Brachium (length/width)	11.5/4.2	11.3/4.4
Chela (length/width)	8.8/4.5	8.7/4.4
depth	6.2	5.5
movable finger, length	12.7	12.5
fixed finger, length	9.4	9.2
Pectines		
teeth (left/right)	34/34	29/28

TABLE 7. Measurements (in millimeters) of Hadrurus arizonensis pallidus Williams, new subspecies, holotype and allotype.

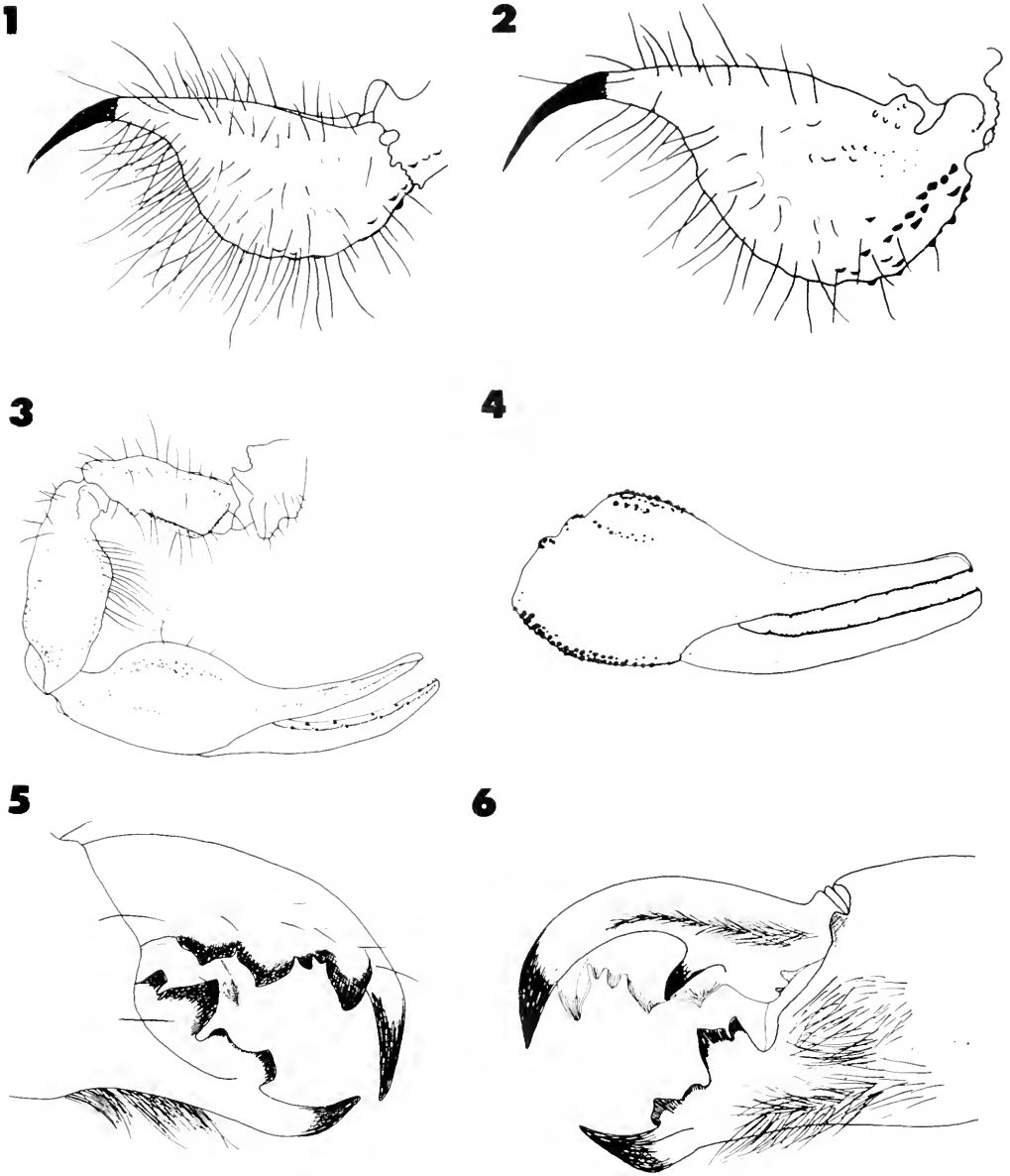
	Holotype (Male)	Allotype (Female)
Total length	122.3	112.7
Carapace, length	14.4	14.3
width (at median eyes)	11.2	11.8
Mesosoma, length	33.2	30.8
Metasoma, length	59.9	53.1
segment I (length/width)	8.7/7.2	7.9/7.4
segment II (length/width)	10.4/6.7	8.5/6.7
segment III (length/width)	11.2/6.7	10.2/6.7
segment IV (length/width)	13.3/6.5	11.8/6.5
segment V (length/width)	16.3/6.4	14.8/6.3
Telson, length	14.8	14.5
Vesicle (length/width)	9.6/6.2	9.0/6.3
depth	5.8	5.7
Aculeus, length	5.2	5.5
Pedipalp		
Humerus (length/width)	12.2/3.5	10.9/3.8
Brachium (length/width)	13.8/4.9	12.7/4.9
Chela (length/width)	10.0/4.8	9.2/4.8
depth	7.4	7.3
movable finger, length	16.3	15.0
fixed finger, length	12.4	11.7
Pectines		
teeth (left/right)	36/37	30/30

TABLE 8. Measurements (in millimeters) of Hadrurus arizonensis austrinus Williams, new subspecies, holotype and allotype.

	Holotype (Male)	Allotype (Female)
Total length	99.1	99.8
Carapace, length	12.7	13.7
width (at median eyes)	9.9	10.8
Mesosoma, length	23.4	23.7
Metasoma, length	50.8	49.3
segment I (length/width)	7.3/6.4	7.0/7.2
segment II (length/width)	9.0/5.8	8.6/6.7
segment III (length/width)	9.7/5.7	9.2/6.7
segment IV (length/width)	11.4/6.0	11.0/6.3
segment V (length/width)	13.6/5.5	13.5/6.0
Telson, length	12.2	13.1
Vesicle (length/width)	7.8/5.8	8.6/6.1
depth	5.0	5.7
Aculeus, length	4.4	4.5
Pedipalp		
Humerus (length/width)	10.6/3.4	10.8/3.4
Brachium (length/width)	12.3/4.8	12.7/4.6
Chela (length/width)	9.7/4.6	9.5/4.9
depth	6.5	7.3
movable finger, length	13.6	14.7
fixed finger, length	10.4	10.8
Pectines		
Teeth (left/right)	37/39	30/30

TABLE 9. Measurements (in millimeters) of Hadrurus obscurus Williams, new species, holotype and allotype.

	Holotype (Male)	Allotype (Female)
Total length	103.7	96.2
Carapace, length	13.0	13.0
width (at median eyes)	9.6	9.7
Mesosoma, length	23.8	24.0
Metasoma, length	51.9	45.6
segment I (length/width)	7.2/6.8	7.0/6.7
segment II (length/width)	8.8/6.7	7.8/6.5
segment III (length/width)	9.7/6.6	8.3/6.3
segment IV (length/width)	11.8/6.6	10.0/6.4
segment V (length/width)	14.2/6.3	12.5/6.2
Telson, length	15.0	13.6
Vesicle (length/width)	9.5/6.3	8.3/6.3
depth	5.6	5.7
Aculeus, length	5.5	5.3
Pedipalp		
Humerus (length/width)	10.8/3.3	10.2/3.4
Brachium (length/width)	11.8/4.3	11.7/4.2
Chela (length/width)	9.1/3.9	8.4/3.8
depth	5.4	5.4
movable finger, length	14.1	13.2
fixed finger, length	10.8	10.0
Pectines		
teeth (left/right)	36/36	27/27



FIGURES 1 to 6. Hadrurus hirsutus (Wood) from Cabo San Lucas, Baja California Sur, Mexico. FIGURE 1. Telson of mature male. FIGURE 2. Telson of adult female. FIGURE 3. Pedipalp of mature male. FIGURE 4. Pedipalp chela of mature male. FIGURE 5. Dorsal aspect of chelicera of adult male. FIGURE 6. Ventral aspect of chelicera of adult male.

FIGURES 7 and 8. Hadrurus hirsutus (Wood) from Cabo San Lucas, Baja California Sur, Mexico. FIGURE 7. Pectines of mature male. FIGURE 8. Pectines of mature female.

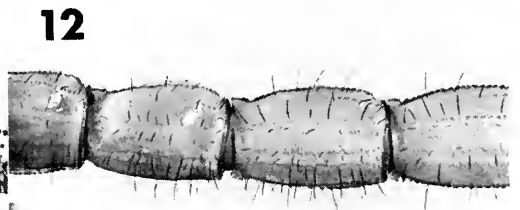
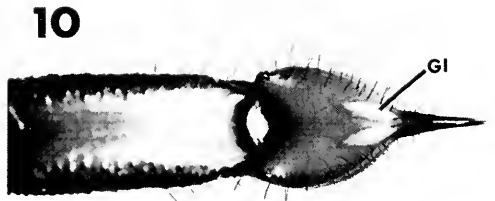
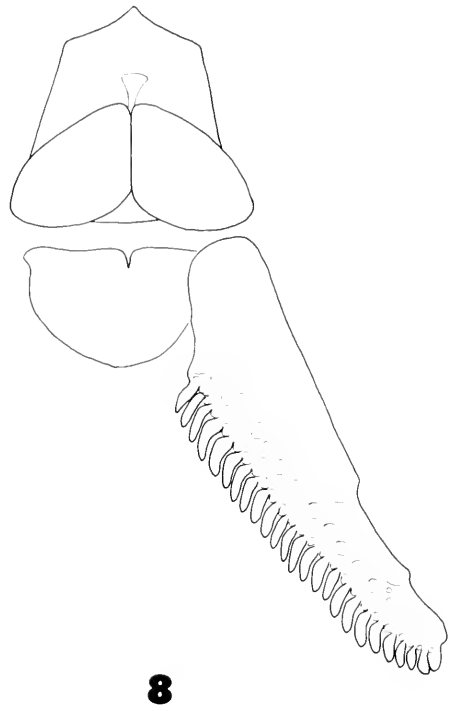
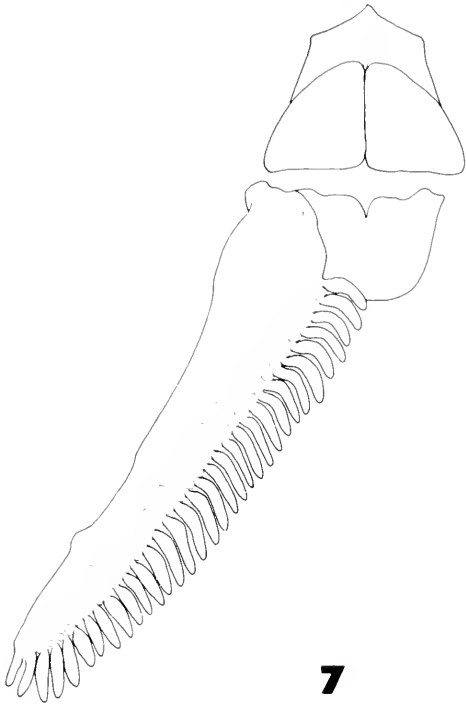
FIGURE 9. Hadrurus hirsutus (Wood) from Cabo San Lucas, Baja California Sur, Mexico, dorsal view of vesicle of mature male.

FIGURE 10. Hadrurus pinteri Stahnke from Bahia de los Angeles, Baja California Norte, Mexico, dorsal view of vesicle of mature male showing dorsal telson glands (Gl).

FIGURE 11. Hadrurus aztecus Pocock, mature female from "Mexico -- Hoffmann Collection", ventral surface of metasoma showing dark underlining of inferior keels.

FIGURE 12. Hadrurus obscurus Williams, holotype male, inferior surface of metasoma showing hirsuteness of space between inferior median keels.

FIGURE 13. Hadrurus hirsutus (Wood) from Cabo San Lucas, Baja California Sur, Mexico, walking legs showing characteristic hirsuteness.



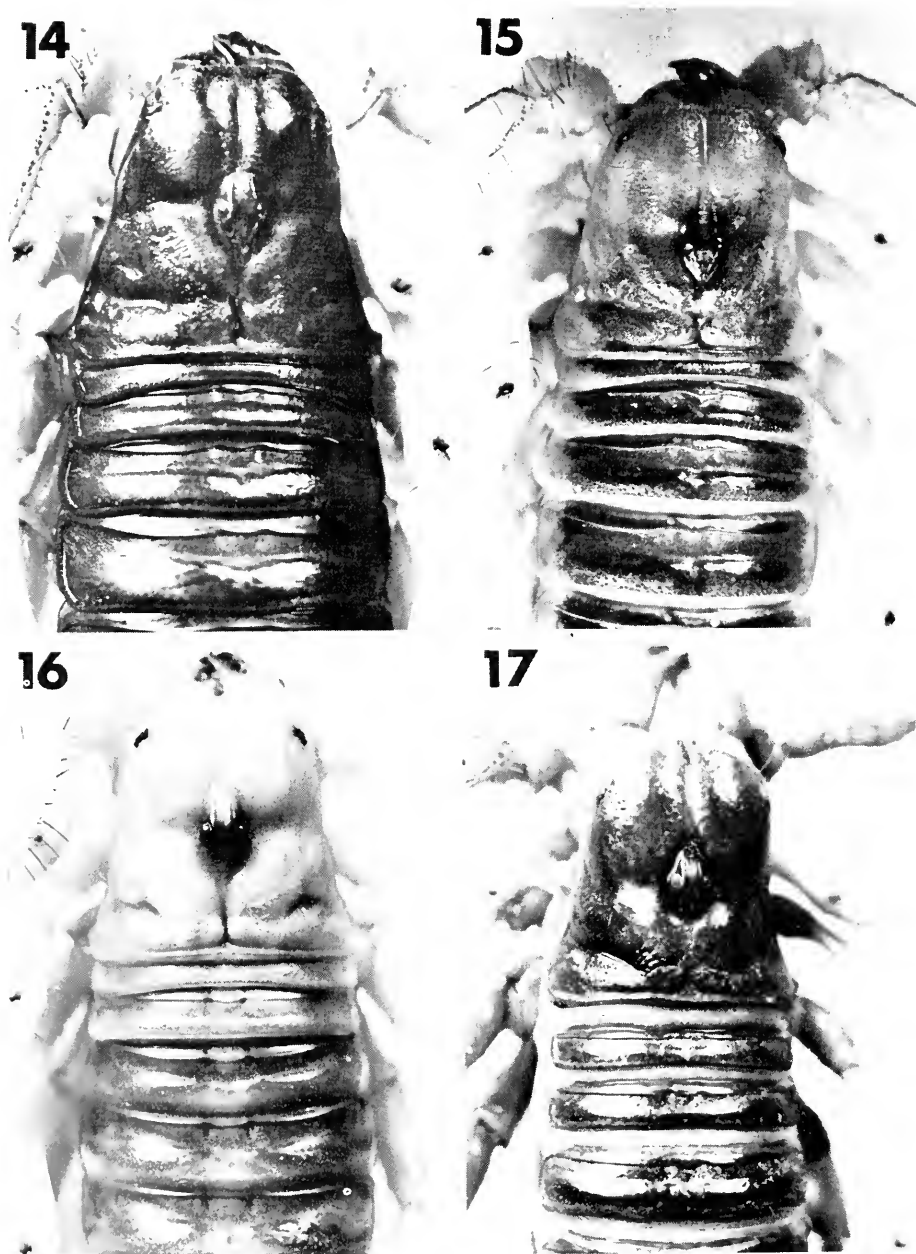


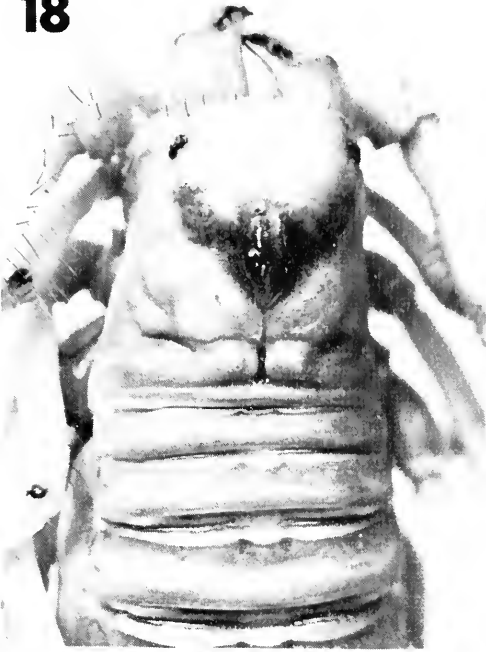
FIGURE 14. Hadrurus spadix Stahnke, adult male from Cliff Dwellers Lodge, Coconino County, Arizona, showing characteristic dorsal markings.

FIGURE 15. Hadrurus hirsutus (Wood), adult male from Cabo San Lucas, Baja California Sur, Mexico, showing characteristic dorsal markings.

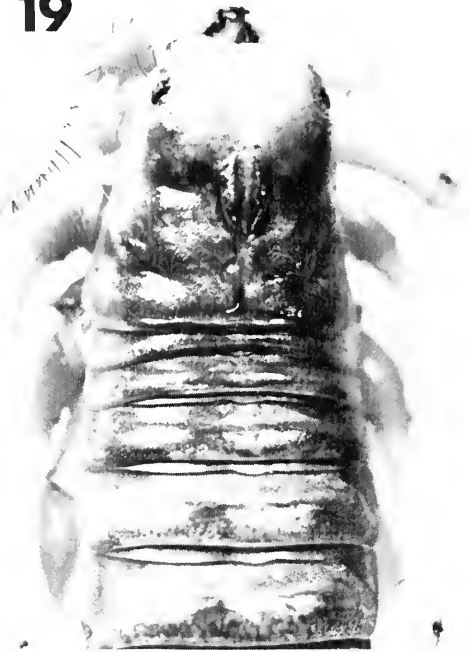
FIGURE 16. Hadrurus concolorous Stahnke, adult male from Santa Rita, Baja California Sur, Mexico, showing markings of "concolorous" phase.

FIGURE 17. Hadrurus aztecus Pocock, adult male from Mexcala, Guerrero, Mexico, showing dorsal markings.

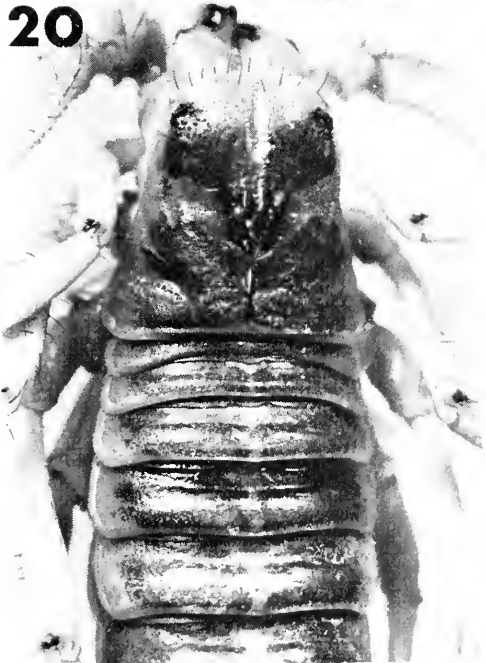
18



19



20



21



FIGURE 18. Hadrurus arizonensis austrinus Williams, holotype male, showing dorsal markings.

FIGURE 19. Hadrurus arizonensis arizonensis Ewing, adult male from Phoenix, Maricopa County, Arizona, showing dorsal markings.

FIGURE 20. Hadrurus obscurus Williams, holotype male, showing dorsal markings.

FIGURE 21. Hadrurus arizonensis pallidus Williams, holotype male, showing dorsal markings.

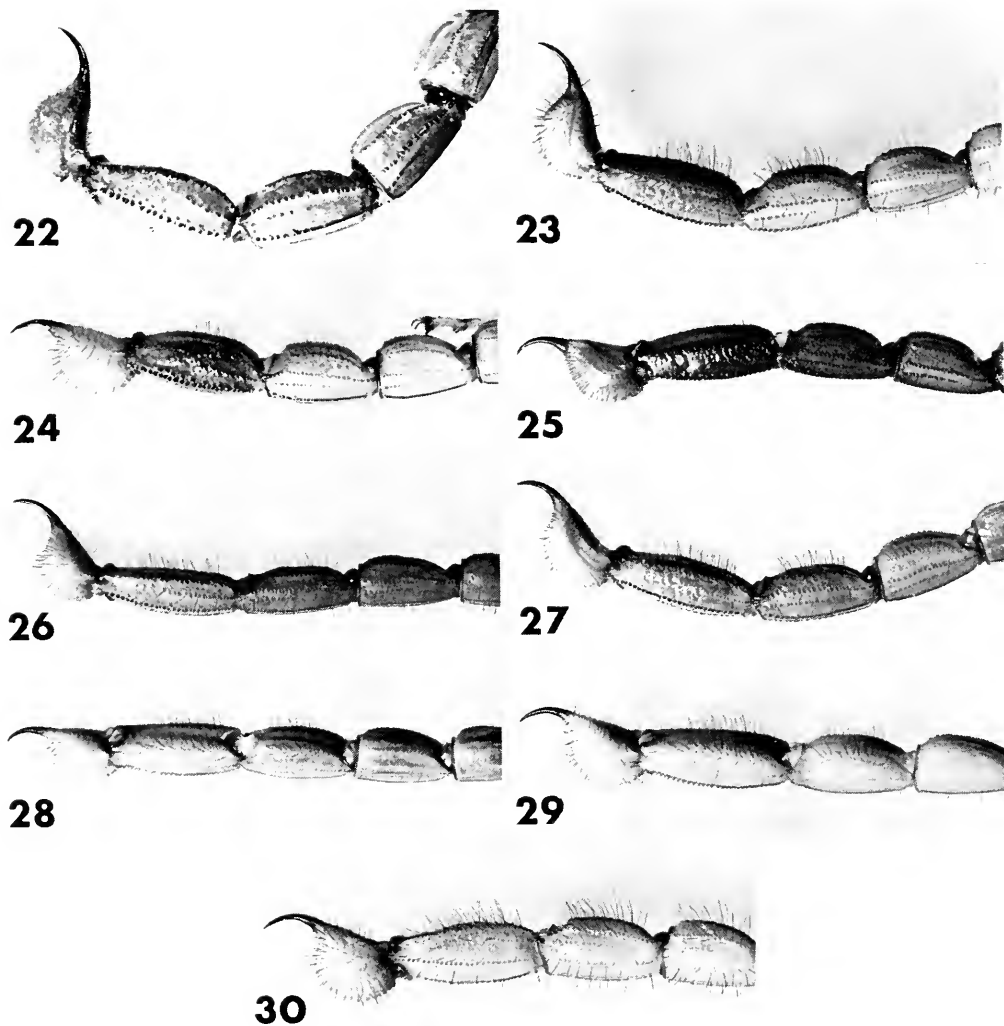


FIGURE 22. Hadrurus aztecus Pocock, adult male, Mexcala, Guerrero, Mexico, metasoma.

FIGURE 23. Hadrurus concolorous Stahnke, adult male from Santa Rita, Baja California Sur, Mexico, metasoma.

FIGURE 24. Hadrurus hirsutus (Wood), adult male from Cabo San Lucas, Baja California Sur, Mexico, metasoma.

FIGURE 25. Hadrurus pinteri Stahnke, adult male from Bahia de los Angeles, Baja California Norte, Mexico, metasoma.

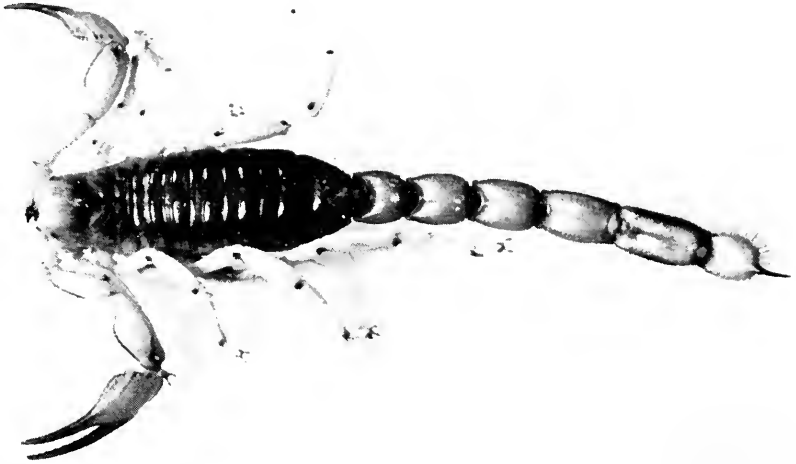
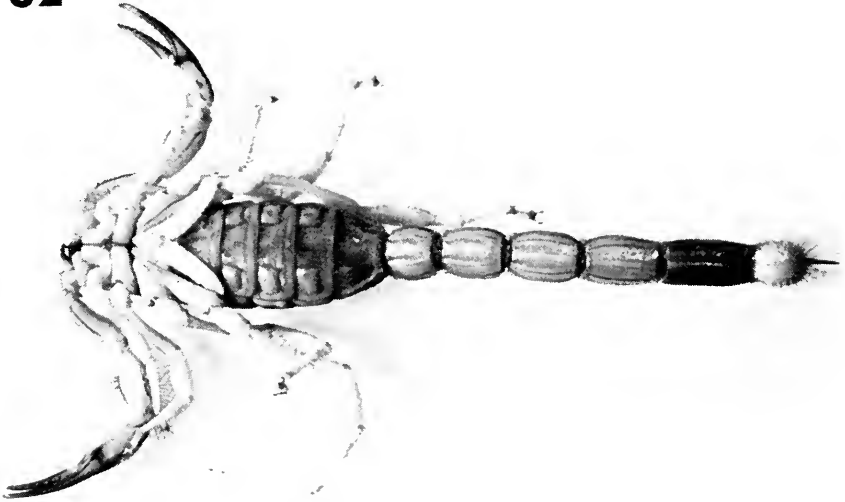
FIGURE 26. Hadrurus spadix Stahnke, adult male from Cliff Dwellers Lodge, Coconino County, Arizona, metasoma.

FIGURE 27. Hadrurus arizonensis arizonensis Ewing, adult male from Phoenix, Maricopa County, Arizona, metasoma.

FIGURE 28. Hadrurus arizonensis pallidus Williams, holotype male, metasoma.

FIGURE 29. Hadrurus arizonensis austrinus Williams, holotype male, metasoma.

FIGURE 30. Hadrurus obscurus Williams, holotype male, metasoma.

31**32**

FIGURES 31 and 32. Hadrurus hirsutus (Wood), adult male from Cabo San Lucas, Baja California Sur, Mexico. FIGURE 31. Dorsal view. FIGURE 32. Ventral view.

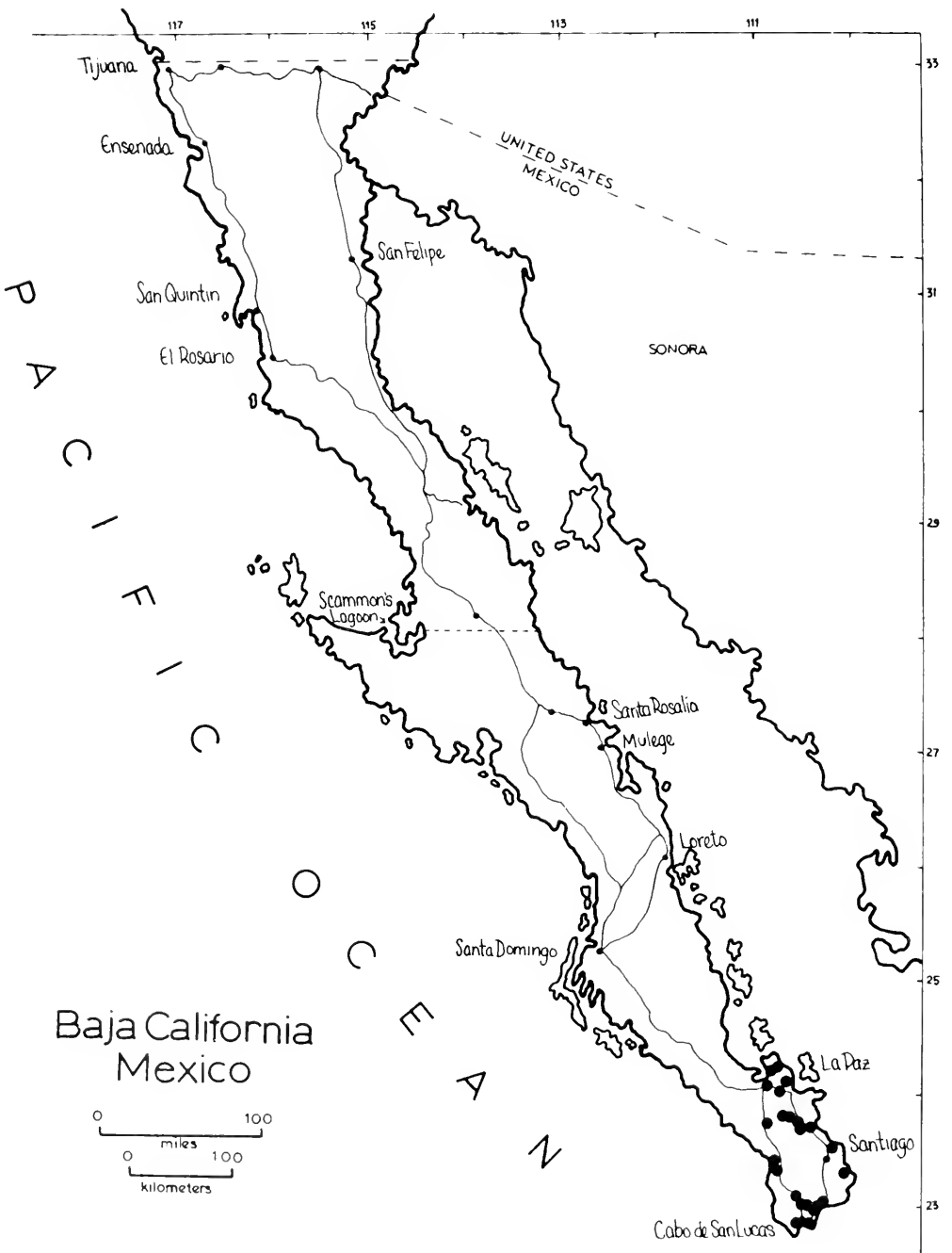
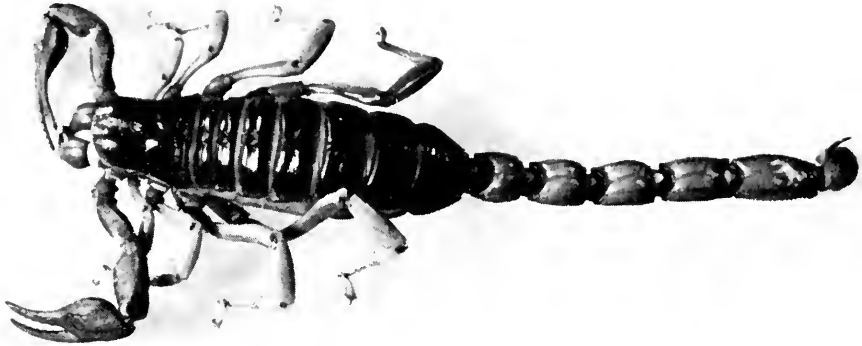
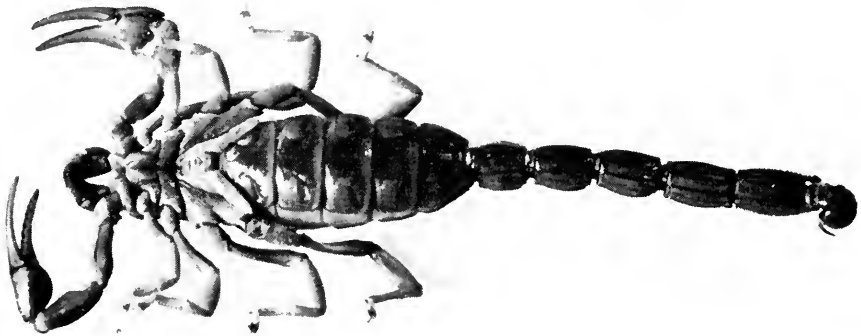


FIGURE 33. Distribution of *Hadrurus hirsutus* (Wood).

34**35**

FIGURES 34 and 35. Hadrurus aztecus Pocock, adult female, from "Mexico, Hoffmann Collection". FIGURE 34. Dorsal view. FIGURE 35. Ventral view.

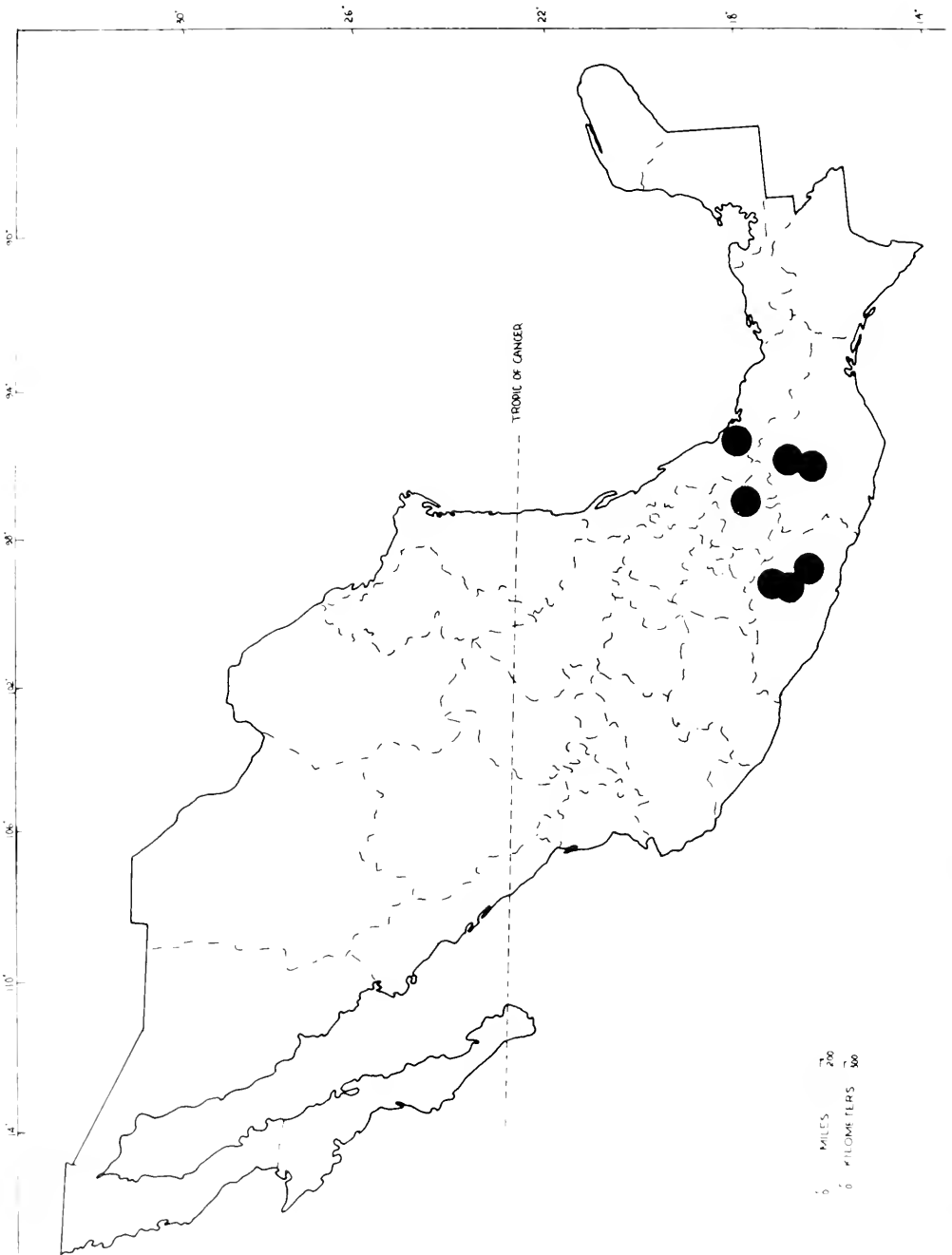


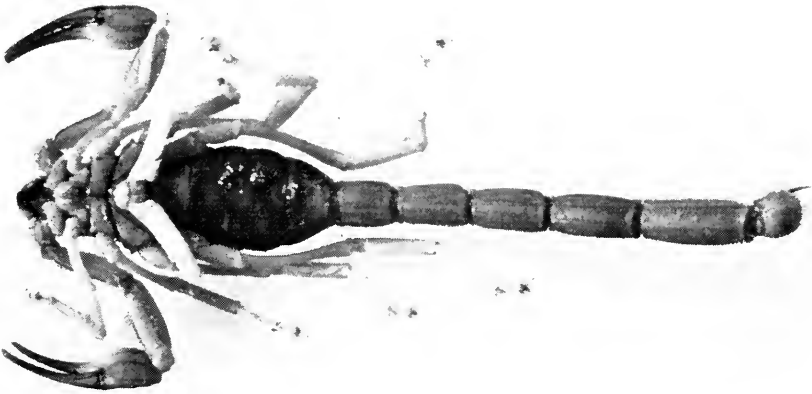
FIGURE 36. Distribution of Hadrurus aztecus Pocock.



37



38



FIGURES 37 and 38. Hadrurus spadix Stahnke, adult male from Cliff Dwellers Lodge, Coconino County, Arizona. FIGURE 37. Dorsal view. FIGURE 38. Ventral view.

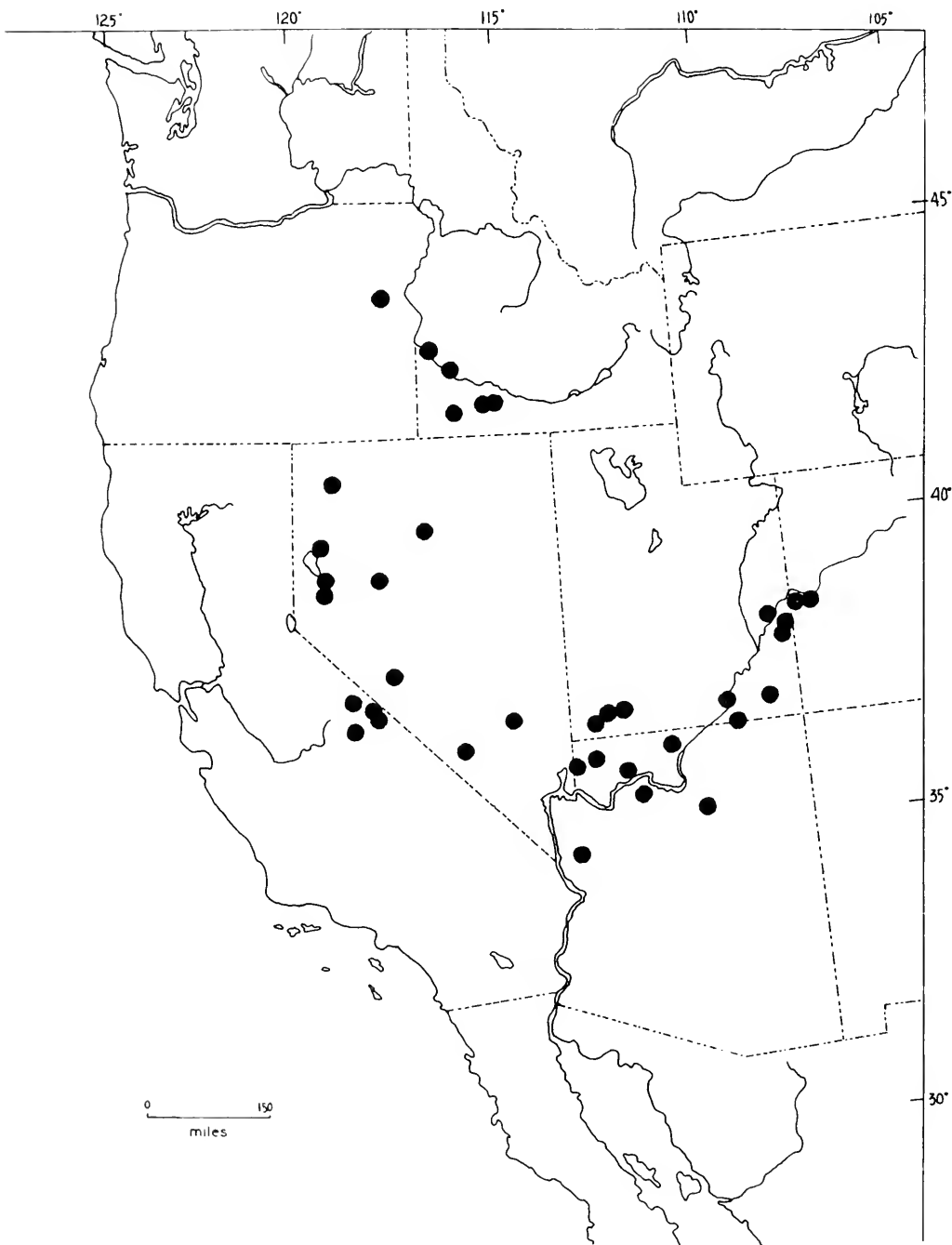
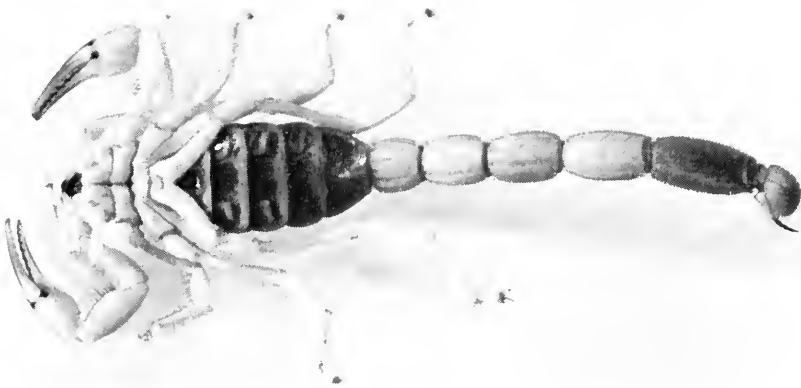


FIGURE 39. Distribution of *Hadrurus spadix* Stahnke.

40**41**

FIGURES 40 to 41. Hadrurus concolorous Stahnke, adult male from Santa Rita, Baja California Sur, Mexico. FIGURE 40. Dorsal view. FIGURE 41. Ventral view.

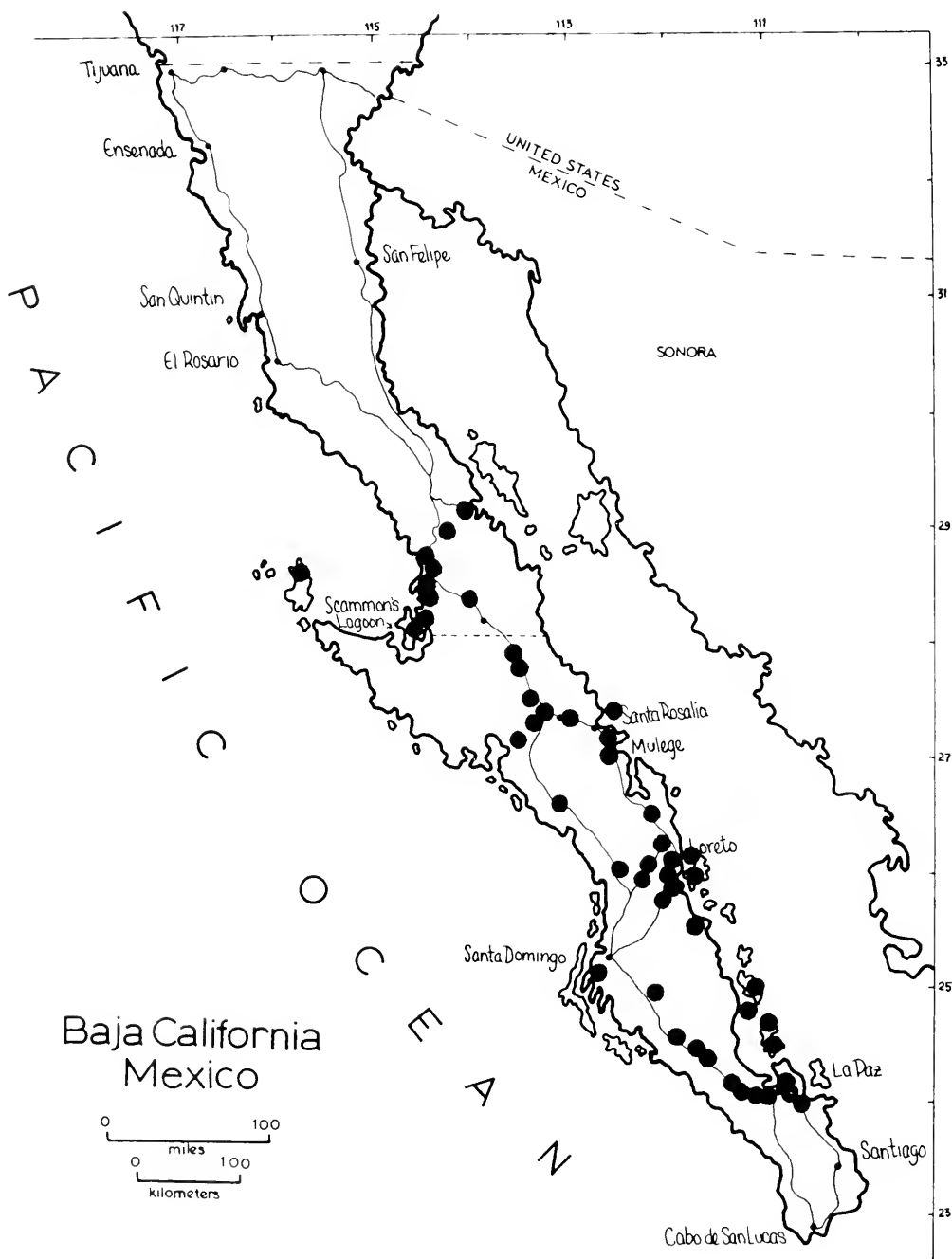
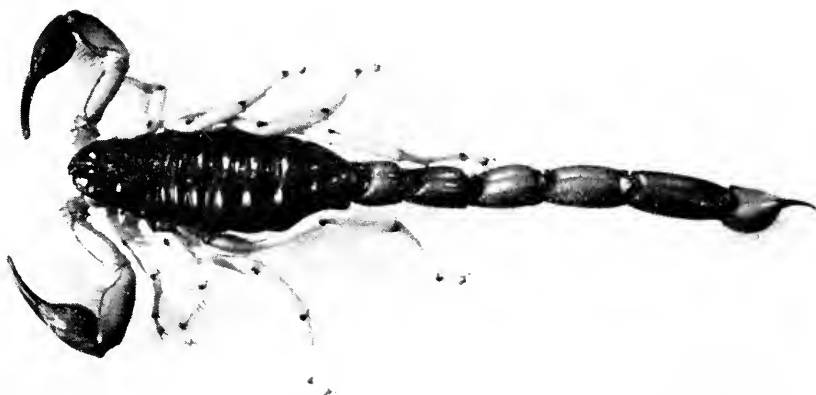


FIGURE 42. Distribution of *Hadrurus concolorous* Stahnke.

43**44**

FIGURES 43 and 44. Hadrurus pinteri Stahnke, adult male from Bahia de los Angeles, Baja California Norte, Mexico. FIGURE 43. Dorsal view. FIGURE 44. Ventral view.

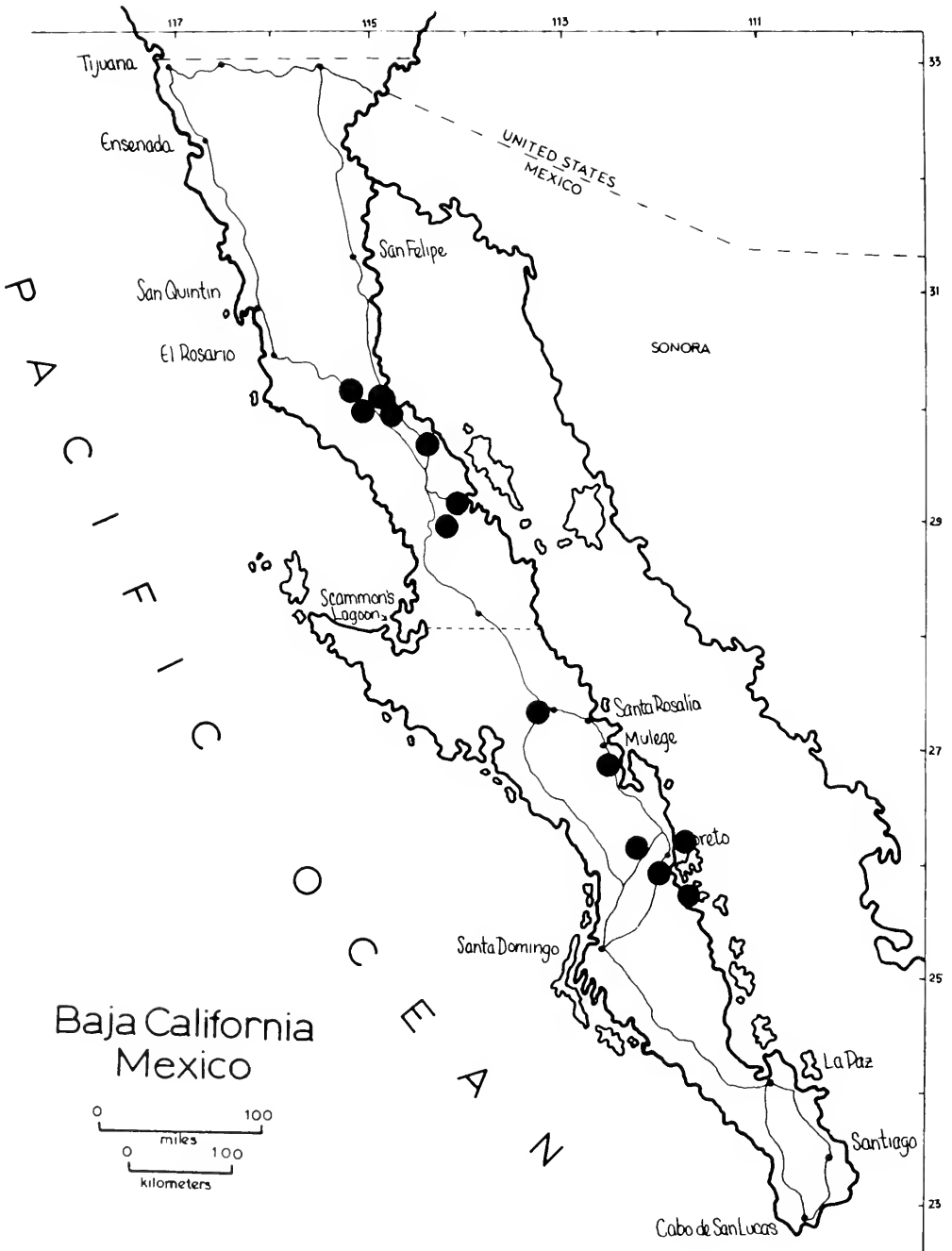
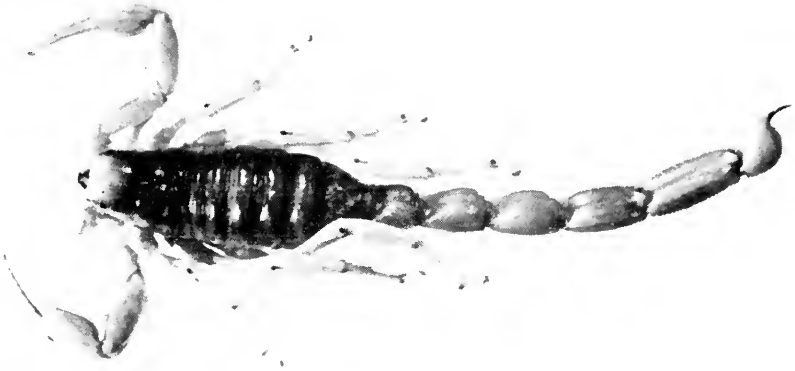
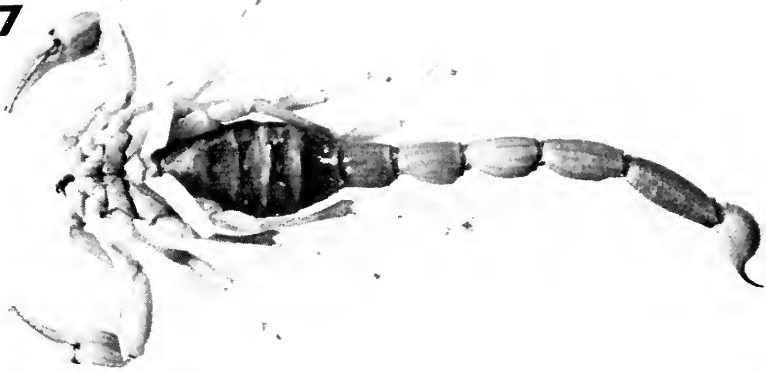


FIGURE 45. Distribution of Hadrurus pinteri Stahnke.

46**47**

FIGURES 46 and 47. Hadrurus arizonensis arizonensis Ewing, adult male from Phoenix, Maricopa County, Arizona. FIGURE 46. Dorsal view. FIGURE 47. Ventral view.

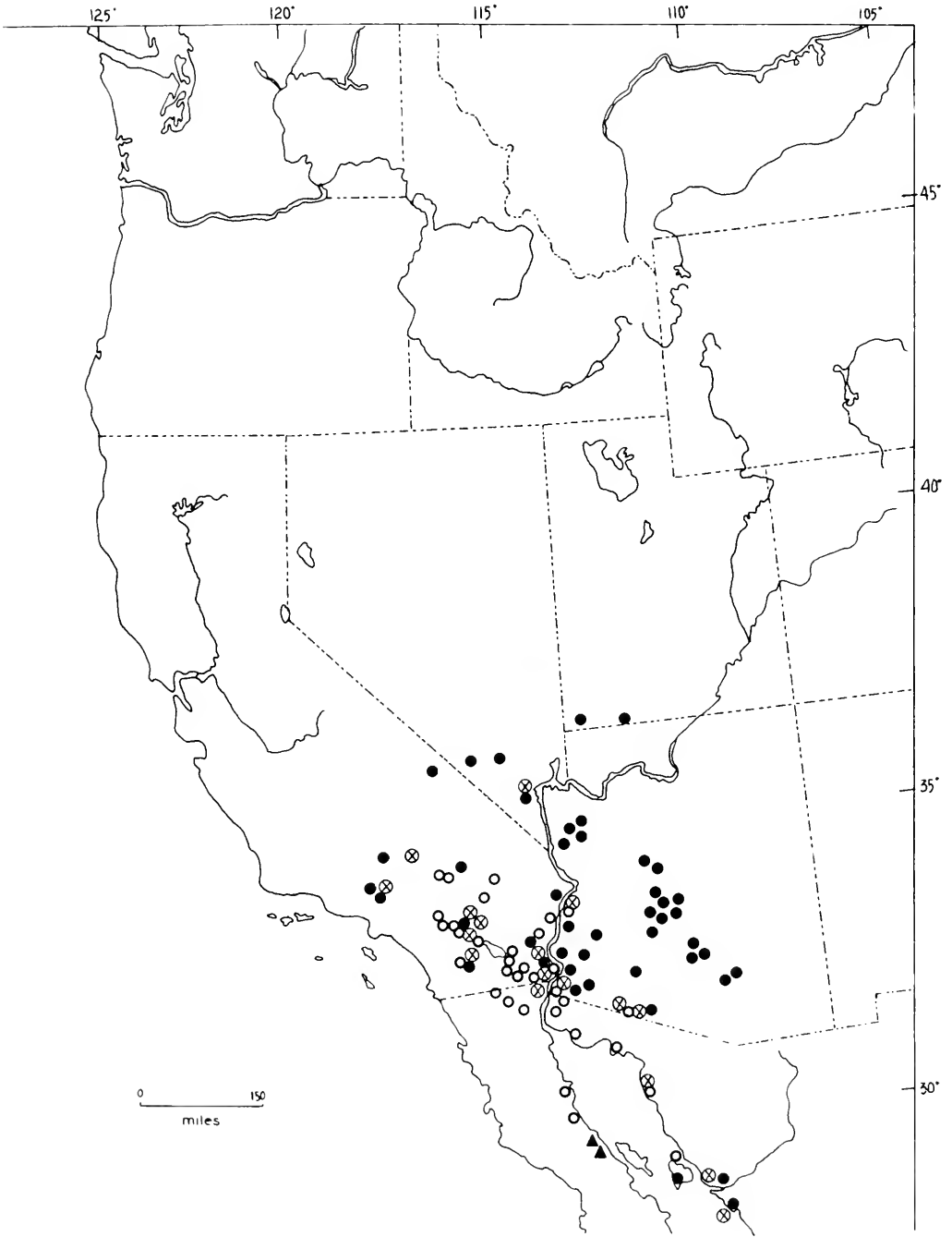
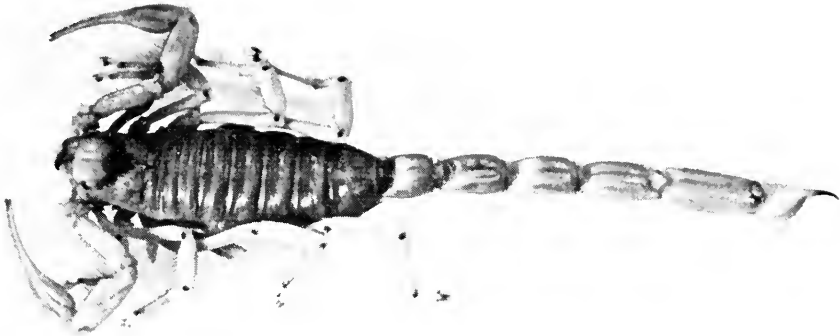
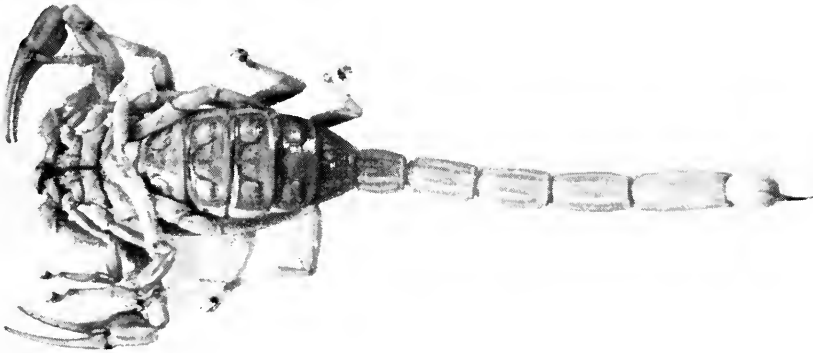
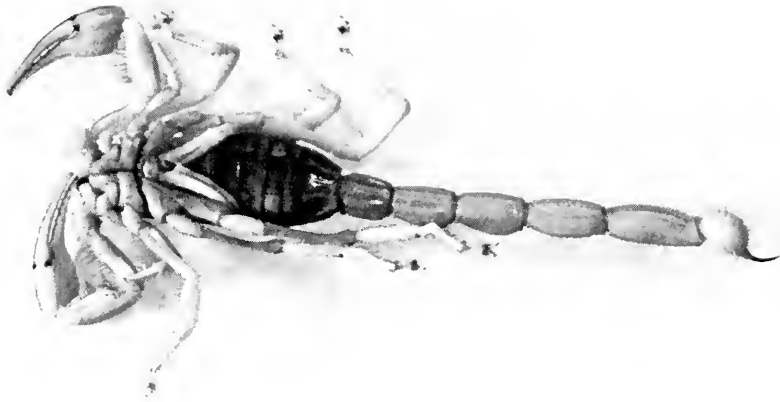


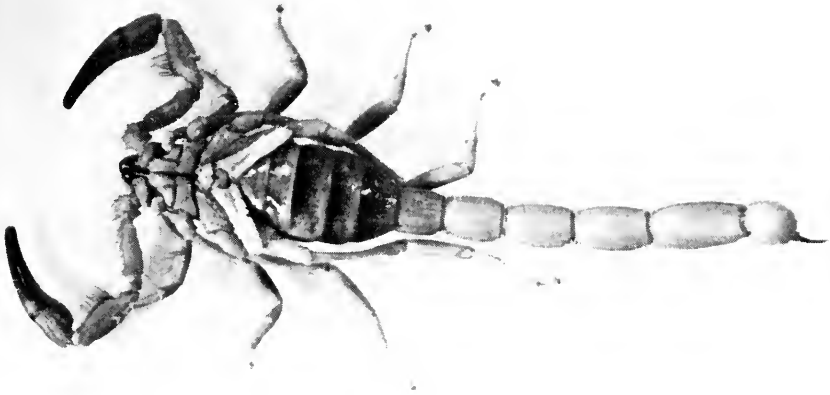
FIGURE 48. Distribution of Hadrurus arizonensis arizonensis Ewing (●), Hadrurus arizonensis pallidus Williams (○), Hadrurus arizonensis (H. arizonensis X H. pallidus intergrades) (⊗), and Hadrurus arizonensis austrinus Williams (▲).

49**50**

FIGURES 49 and 50. Hadrurus arizonensis pallidus Williams, new subspecies, holotype male from 26 miles east of San Luis, Sonora, Mexico. FIGURE 49. Dorsal view. FIGURE 50. Ventral view.

51**52**

FIGURES 51 and 52. Hadrurus arizonensis austrinus Williams, new subspecies, holotype male from eight miles north of Bahia San Luis Gonzaga, Baja California Norte, Mexico. FIGURE 51. Dorsal view. FIGURE 52. Ventral view.

53**54**

FIGURES 53 and 54. Hadrurus obscurus Williams, new species, holotype male from near Panoche Pass, San Benito County, California. FIGURE 53. Dorsal view. FIGURE 54. Ventral view.

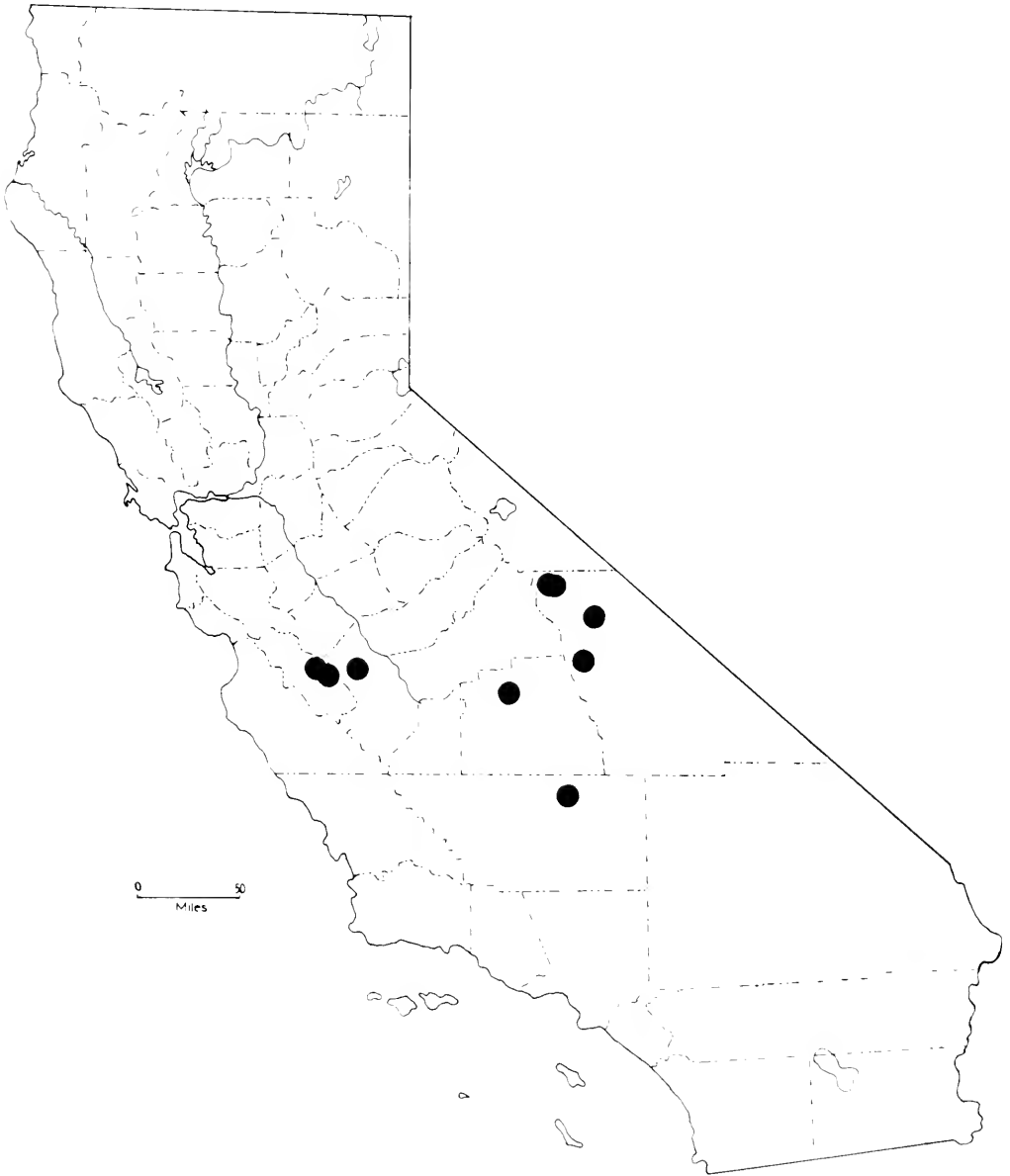


FIGURE 55. Distribution of Hadrurus obscurus Williams.

THE *HOL LIBRARY
WH 19FX L

