

THERAPHOSIDAE OF THE MOJAVE DESERT WEST AND NORTH OF THE COLORADO RIVER (ARANEAE, MYGALOMORPHAE, THERAPHOSIDAE)

Thomas R. Prentice: Department of Entomology, University of California, Riverside
California 92521 USA

ABSTRACT. Two new species of *Aphonopelma* from the Mojave Desert are described, *A. joshua* and *A. mojave*. Four nominal species, *Aphonopelma iodium* (*A. iodius*), *A. melanium* (*A. melanius*), *A. angusi*, *A. nevadanum*, described from the Mojave Desert and the Great Basin are treated as a single species; *Aphonopelma iodium* (Chamberlin 1939) is proposed as the species name since it is one of two possible senior synonyms (the other, *A. melanium* (*A. melanius*) in the same publication) and is the specific name of the first Theraphosidae to be described from the Mojave Desert; *A. iodium* is redescribed. Generic, subgeneric, and specific characters previously used to separate *Aphonopelma* are reviewed. *Aphonopelma* is redefined; *Clavopelma* is removed from the synonymy of *Aphonopelma*. The status of the following eight species described prior to 1939 with type localities either in the United States or in Baja, California is discussed: *Aphonopelma californica*, *A. leiogaster* (Doleschall), *A. steindachneri* (Ausserer), *A. rusticum*, *A. marxi*, *A. helluo* (Simon), *A. rileyi* (Marx), and *A. pseudoroseum* (Strand). *Aphonopelma steindachneri*, *A. rusticum*, *A. marxi*, and *A. helluo* are considered as valid species; *A. californica*, *A. leiogaster*, *A. rileyi*, and *A. pseudoroseum* are considered as *nomina dubia*.

The *Aphonopelma* of North American are poorly known. Although many species have been described few specimens can be properly identified either by using available keys or by wading through species descriptions. Most identifiable specimens belong to species found in Mexico or Central America that are easily recognized by unique color patterns, such as that of *A. seemanni*. Correct identification of specimens collected within the United States is often suspect since determinations must be based on the process of elimination using collection dates and locality data in combination with coloration, coxal setation, and metatarsal scopulation.

Chamberlin & Ivie (1939), Chamberlin (1940) and Smith (1994) described the majority of the currently recognized *Aphonopelma* species. Since many of their descriptions were based on one or two specimens variational limits were unknown to them with the consequential result of species determination by highly variable, artificial characters. It is my intention in this paper to describe the theraphosid species of the Mojave Desert using reliable taxonomic characters, established as such only after thorough analyses of variation within each putative species. Ecological, geo-

graphical, and behavior data are included and support morphologically-based species determinations.

The species redescribed here, *A. iodium*, belongs to a species group that are virtually impossible to differentiate by unaided visual examination: all are very similar in size, color, and extent of metatarsal scopulation and all share a common fall breeding season (breeding season determination was based on the time of year that both type males and males from type localities were collected). I will refer to the group collectively as 'eutylenum types' or as the 'eutylenum group' since *A. eutylenum*, as member of this assemblage, is referred to in the literature more than any of the other species and since preliminary data suggest that many of these species (other than those considered *A. iodium*) belong to a single widely distributed species, in which case *A. eutylenum* would be considered the senior subjective synonym based both on page priority and usage in the literature.

METHODS

All specimens analyzed in this study were mature individuals. Males of the different species were collected while searching for fe-

males during their respective breeding seasons. Breeding season is defined as the period of time between which the first males of a given species abandon their burrows, becoming itinerants, and the vast majority have died from senescence or predation to the point that individuals are rarely found until the following year. The majority of males collected were taken between the years 1989–1993; and borrowed specimens other than types were collected as early as 1966. The system for collection was to drive slowly down least traveled backroads or powerline roads on a weekly basis (often 2–3 days a week) starting 1–2 weeks before the perceived beginning of a particular breeding season and ending when no males were found for two consecutive weeks.

The east and west Mojave Desert are defined as east and west, respectively, of a north-south line through Death Valley, Silurian Valley, Silver Dry Lake, Soda Dry Lake, the Bristol Mountains, Devil's Playground, Bristol Dry Lake, Cadiz Valley, and Danby Dry Lake. Joshua Tree National Park and Death Valley National Park are, respectively, referred to as Joshua Tree National Monument and Death Valley National Monument in this manuscript because they were so-named while this study was in progress.

Measurements were performed using an American Optical 570 stereomicroscope equipped with an eyepiece micrometer. Measurements are all in millimeters and are accurate to 0.05 mm except for tarsal measurements which are accurate to 0.1 mm. Leg and pedipalp measurements were taken from the left side unless some or all segments of a given leg were missing or it was apparent that an appendage was in the process of regeneration. All segment measurements were performed from the retrolateral aspect; this measurement equal to the distance from the proximal point of articulation to the distal most point of the segment (Coyle 1971, 1989). Carapace and sternum lengths were taken with anterior and posterior margins in the same horizontal plane; width measurements were performed in the same fashion. Measurements of femur width in males were taken from the dorsal aspect at the widest pro- to retrolateral point other than at the base; in femur I & IV that point is preapical of its articulation with the patella; in femur III that point is basad of the

preapical point for femur I in the distal half of the segment. Extent of metatarsal scopulation was determined by using maximum extent of complete metatarsus I scopula as the proximal point for measurement in metatarsi II-IV.

Because tarsal measurements were difficult to perform without removing much of the distal scopulae and claw tufts, measurements were performed by depressing the apical scopulae and claw tufts against the integument with a flattened forceps. Because of a greater possibility of error in measuring the tarsi, leg I-IV ratios were calculated by adding the lengths of the femur, patella, tibia, and metatarsus only to represent the length of each leg; palp length was calculated by adding the lengths of the femur, patella, and tibia only. Cheliceral length measurements also were difficult to perform because of relaxation and over-extension of chelicerae as a result of preservation. These measurements were omitted except in type specimens of *A. joshua* new species and *A. mojave* new species because accurate measurements generally required dissection of chelicerae and because in living conspecific specimens chelicerae can be relatively more distended in some individuals of a smaller size than in other individuals of a larger size. Abdominal measurements were also omitted, except in type specimens and in largest and smallest specimens, due to dependence of abdominal size on nutritional state of the specimen. Carapace length was found to be the most reliable indicator of overall size.

All ink drawings were done with the aid of a camera lucida fitted on a Wild Heerbrugg M5 stereomicroscope. Spermathecae were cleared in 20% NaOH prior to illustration. Scanning electron micrographs were taken with a JEOL JSM C35 scanning electron microscope.

Characters and quantitative character values in Tables 1 and 2 are an essential part of each species description. These tables should be referred to unless specific values are given in the text.

Specimens examined.—Specimens examined other than samples of the species described here, are as follows: types: *Clavopelma tamaulipecum*, *Chaunopelma radinum*, *Aphonopelma angusi*, *A. iodium* (*iodius*), *A. melanium* (*melanius*), *A. nevadanum*, *A. eutylenum*, *A. paloma*, *A. phanus*, *A. phasmus*, *A. reversum*, *A. simulatum*, *A. zionis*

(AMNH), *Eurypelma steindachneri* [syntype-BMNH and (2) presumed types-NHMW], *E. rusticum* [cotype #1585, 47(36)-USNM], non-types: *E. marxi* [45(30), 43(20)-USNM] and *E. helluo* [50(44)-USNM], and specimens from the type localities of the following species: *A. anax*, *A. apacheum*, *A. behlei*, *A. brunnium* (*brunnius*), *A. chalcodes*, *A. clarum*, *A. coloradanum* (*coloradana*) *A. cratium* (*cratius*), *A. cryptethum* (*cryptethus*), *A. echinum* (*echina*), *A. helluo*, *A. lithodonom*, and *A. seemanii*.

Abbreviations used.—*Spination abbreviations*: a = apical; b = basal; d = dorsal half; e = preapical; Fe = femur; L = left; m = medial; Me = metatarsus; p = prolateral direction; Pt = patella; r = retrolateral direction; R = right; Ti = tibia; v = ventral half; 0.25, 0.80, etc. = approximate location of a spine taken as a fraction of the segment length from the proximal end.

Tabular character table abbreviations: Atten = attenuate; bas swln = basally swollen; CxI = coxa I; E = east Mojave; LAI, LAII, LAIII, LAIV = lengths of legs I, II, III, IV, respectively; LC = carapace length; LFI, LFIII, LFIV, LFP = lengths of femora I, III, IV, palp, respectively; LMI, LMII = lengths of metatarsi I and II, respectively; LTI, LTII, and LTIV = lengths of tibiae I, II, and IV, respectively; par div = partially divided; retr bnd = retrolateral bend; S&Cx = sternal and coxal; ScMIV = scopula of metatarsus IV; ScTaIV = scopula of tarsus IV; sht = short; swln = swollen; undiv = undivided; unif = uniform; v = ventral; W = west Mojave; WC = carapace width; WCh = chelicerae width; WFI, WFIII = widths of femora I and III, respectively; WS = sternal width.

Museum abbreviations: AMNH = American Museum of Natural History, New York; BMNH = The Natural History Museum, London; MNHN = Museum National d'Histoire Naturelle, Paris; NHMW = Naturhistorisches Museum, Wien; USNM = National Museum of Natural History, Washington.

Other abbreviations: BDM = Beaver Dam Mountains, southwestern Utah; JTNM = Joshua Tree National Monument, California. Abbreviations for eyes are standard for Araneae.

TAXONOMY

Synonymy of *Rhechostica* = *Aphonopelma*.—Raven (1985) placed the following gen-

era in the synonymy of *Rhechostica* Simon 1892, a senior subjective synonym of *Aphonopelma* Pocock 1901: *Aphonopelma*, *Dugesia* Pocock 1901, *Pterinopelma* Pocock 1901, *Delopelma* Petrunkevitch 1939, *Chaunopelma* Chamberlin & Ivie 1939, and *Clavopelma* Chamberlin 1940. He concluded that they shared the form of the double tibial spur and the thorn-like setae on the prolateral coxae and that there were no other characters known that merited their continued separation. Because of the extensive usage of *Aphonopelma* in the literature Levi & Kraus (1989) petitioned the ICZN to give *Aphonopelma* precedence over *Rhechostica*. By Opinion 1637 of the ICZN (June 1991) *Aphonopelma* was given precedence whenever the two were considered to be synonyms.

Review of generic characters.—Pocock (1901) erected six genera during his dismemberment of *Eurypelma*, two of which had members north of Mexico, *Aphonopelma* and *Dugesia*. These two genera were respectively distinguished by the absence and presence of a plumose scopula on the prolateral surface of femur I and the retrolateral surface of the palpal trochanter and by spiniform and thorn-like setae on prolateral coxa I. Petrunkevitch (1939) erected *Delopelma* which he differentiated from *Dugesia* by the complete absence of plumose hairs and from *Aphonopelma* by the presence of simple, recumbent hairs on coxae and trochanters. Chamberlin (1940) apparently recognized the presence of plumose setae in all genera and considered *Delopelma* (retaining only the type *D. marxi*) a subgenus of *Aphonopelma* based on the similar form of setae on prolateral coxa I. He, in turn, erected *Chaunopelma* which differed from both *Aphonopelma* and *Dugesia* by the presence of fine, soft prone hairs on the anterior coxa and trochanter of leg I and on the posterior palpal trochanter. Raven considered the differences in coxa I setation artificial.

Other than by the setation of prolateral coxa I and the form of the double tibial spur, Raven distinguished *Aphonopelma* (*Rhechostica*) by the following characters: scopula of tarsus IV integral (no setal division), an area of plumose or spatulate hairs on retrolateral maxillae or palpal trochanter, and males with a slender and tapering embolus. The type species of two of the genera in the synonymy of *Aphonopel-*

ma, *Clavopelma* and *Pterinopelma*, are endowed with setae on the retrolateral palpal trochanter that may be termed spatulate in form. In *Pterinopelma*, Pocock likened these setae to those found in *Euathlus* (*Brachypelma*) which are stout, finely plumose (often long plumed), and lanciform. Although less stout in *Clavopelma* these lanciform setae are distinctly different from the relatively slender, plumose, hair-like or spiniform setae (in some species finely plumose) of the remaining *Aphonopelma*.

Smith characterized *Aphonopelma* by the following: no organs of stridulation or plumose setae/hairs on trochanter or coxa of palp or leg I or on femur I, no plumose pad present on femur IV, a tapering embolus (more stout and shorter in material from Mexico and Central America) with a simple keel on dorsal surface or on apex (sometimes ribbed or toothed), spermathecae composed of separate seminal receptacles, integral tarsus IV scopula, scopula of metatarsus IV ranging from $\frac{1}{5}$ – $\frac{2}{3}$, and no swollen leg segments. One of the character distinctions that Smith used to separate *Euathlus* (*Brachypelma*) and *Aphonopelma* was the presence of plumose setae on the prolateral trochanter and basal femur of leg I in *Euathlus* and the presence of non-plumose setae in *Aphonopelma*. It is not clear whether Smith was referring to the absence of lanciform setae (believed to have a stridulatory function) in *Aphonopelma* or had not detected the plumose condition of the hair-like or spiniform setae in the genus. Smith removed *Aphonopelma paloma* from the genus as the type of his newly erected monotypic genus, *Apachepelma*, based on partial division by setae of the tarsus IV scopula in combination with small size. Of the known *Aphonopelma* species, only *A. joshua* shares this character combination with *Apachepelma paloma* although it is usually slightly larger (Table 1). However, both species are morphologically more similar to *A. mojave* (eastern race), a species in which the tarsus IV scopula is entire, than to each other. Males of an undescribed *Aphonopelma* species (females not known) from southeast Arizona appear to be, otherwise, very similar to *A. paloma* males except that in this species the tarsus IV scopula is entire. *Aphonopelma crinita* is a considerably larger species than *A. paloma* but also shows partial division of the tarsus IV scopula (Perez-Miles 1994). In size, prolateral coxal se-

tation, and palpal bulb morphology it is more similar to congeneric species with entire tarsus IV scopula than to the other species with partially divided scopulae. Because *Apachepelma* was erected on characters not recognized as generically significant and because the type species shares with *Aphonopelma* all characters diagnostic of the genus, *Apachepelma* is here considered a synonym of *Aphonopelma*. In addition to males of *A. paloma*, males of both *A. joshua* and eastern *A. mojave* have the third femur swollen to a degree that is easily recognized and that is non-overlapping with species in which the third femur is slightly swollen. The extent of the scopula of metatarsus IV within the genus was found to vary from a few scattered distal hairs (*A. paloma*) to over 80% scopulate distolaterally. Setation of the retrolateral femur IV in all *Aphonopelma* examined was found to be similar or identical to that of the prolateral femur I. Male emboli were found to have two marginal or lateral keels (usually indistinct in males with slender emboli) and one or two prominent medial keels.

Although Raven did not consider the form of setae on anterior coxa I to warrant generic division, it does appear to be of value in distinguishing species groups within those *Aphonopelma* in which males have a slender embolus. For instance, hair-like setae, as in *A. radinum*, are also characteristic of three similar small species, *A. paloma*, *A. joshua* (Fig. 7) and *A. mojave* (Fig. 8); basally swollen spiniform setae are characteristic of *A. iodium* (Figs. 9, 10) and most other southwestern species; thorn-like, apically filiform setae, very distinct from the homologous setae of *A. iodium*, are characteristic of most species east of Utah and Arizona. To my knowledge, specimens with thorn-like setae have not been collected in the United States west of Globe, Arizona.

Critical review of subgeneric taxonomic characters.—Chamberlin considered *Aphonopelma* to consist of three subgenera, *Delopelma*, *Gosipelma*, and *Aphonopelma*. *Delopelma* and *Gosipelma* were differentiated on the basis of the number of spines on the anterior face of the male palpal tibia (two and four, respectively). Several species within these subgenera were additionally distinguished by spination of the ventral palpal tibia and of the palpal patella. Smith (1994) also used spination characters in diagnoses of new

species. For example, he separated *A. chamberi* Smith from *A. cryptethum* Chamberlin by the presence of four and five prolateral spines, respectively, on the palpal tibia, differences in the shape of the posterior half of the basal segment of the palpal bulb, and differences in the shape of the cuspules on the labium. However, in *Aphonopelma paloma* the numbers of spines on the ventral and prolateral palpal tibia and on the palpal patella were shown to be variable and in all species described herein tibial and patellar spination varied more intraspecifically than between or among Chamberlin's *Delopelma* and *Gosipelma* species. For example, in *A. joshua* new species males (from one locality) the palpal tibiae were armed with 3–6 prolateral and 1–3 ventral spines and the palpal patellae with 0–2 spines; in *A. mojave* new species males tibiae were armed with 2–7 prolateral and 0–4 ventral spines and patellae with 0–2 spines; in *A. iodium* males (from BDM) tibiae were armed with 4–8 prolateral and 1–3 ventral spines and patellae with 0–3 spines. As a result of the high variability in spination, distinctions between species based on these characters are considered artificial differences.

Chamberlin separated *Aphonopelma* from *Delopelma* and *Gosipelma* by relative lengths of metatarsus and tibia I; "tibia I longer than metatarsus I" in *Delopelma* and *Gosipelma*; "tibia I not longer than metatarsus I, usually clearly shorter" in *Aphonopelma*. Males of both *A. joshua* new species and western *A. mojave* new species have been found in which the ratio is reversed from the usual condition; in both species tibia I can be longer than, equal to, or shorter than metatarsus I within a single population. These conditions invalidate the *Aphonopelma* subgenus distinction. Although the length ratio of tibia I to metatarsus I has been discarded as a subgeneric character in this study it is taxonomically significant because it distinguishes the southern Utah population of *A. mojave* from other eastern populations, reveals generalities of reversal between *A. joshua* and western *A. mojave*, and is one of the quantitative characters that distinguishes *A. mojave* from *A. radinum* and *A. iodium* from similar types described prior to 1939.

Critical review of specific taxonomic characters.—All ocular characters used by Chamberlin to separate subgroups within the

subgenus *Aphonopelma* were found to be highly variable in this study and are considered to be artificial differences. For instance, *A. clarum* and *A. eutylenum* were distinguished from the other *Aphonopelma* (subgenus) species in Chamberlin's key on the basis of "lateral eyes separated by the diameter of a posterior one or nearly so" versus separated "at most but little more than the radius of the posterior eye". Lateral eyes of the *A. eutylenum* holotype are separated by approximately $0.70 \times$ PLE length. This criterion would place two apparently conspecific Red Mountain, California males in separate species; distance between lateral eyes in one is $0.44 \times$ PLE length and in the other is $0.83 \times$ PLE length.

Specimen size and coarseness of setae on the anterior face of coxae were used by Chamberlin to separate *A. clarum* and *A. eutylenum*. The ratio of carapace length of the former species to the latter is 0.73 which is less of a difference than the ratio of 0.66 for the smallest to largest *A. iodium* males from the BDM. Although size can be an important character in separating species, range values are needed before its discriminating value can be determined. The spiniform setae on prolateral coxa I in both *A. clarum* and *A. eutylenum* are of the same form found in *A. iodium* (Figs. 9, 10). The coarseness of these setae was found to be relative to specimen size in *A. iodium* and their dispersion over the prolateral surface varied slightly within a given population.

Chamberlin used general color of legs and abdomen to separate *A. melanium* and *A. iodium*. The former holotype, collected in September toward the beginning of the breeding season, was described as "gunmetal brown or blackish", and the latter, collected in late November toward the end of the breeding season, was described as "lighter brown or yellowish". North American tarantulas are darker in color shortly after a molt than they are at any other time prior to a subsequent molt (pers. obs.). A reasonable assumption is that *A. melanium* was darker in color because it was collected closer to the time of its definitive molt than *A. iodium*, which had faded substantially by the time it was collected in late November. Although coloration can be a reliable character in separating some species, distinction between shades of a particular color can be highly subjective because of temporal changes in a specimen's color.

Table 1.—Males of *Aphonopelma*: Taxonomic characters and quantitative character values which separate the Mojave Desert *Aphonopelma* and distinguish them from the most similar species; °—species with hairlike setae on prolateral coxa I, distinguished by superscript only from *A. joshua*(¹) and *A. mojave*(²). *—included in the synonymy of *A. iodium*; ¹—no overlap with *A. joshua*; ²—no overlap with *A. mojave*; ³—no overlap with *A. iodium*; [Type]—holotype; USNH—non-types, Marx collection. Mean and standard deviation shown in parentheses (8.33, 0.56). Abbreviations defined in Methods section of text. Carapace measurements are in millimeters.

	[°] <i>joshua</i> [n = 25]	[°] <i>mojave</i> [n = 42]	<i>iodium</i> [n = 32]	[°] <i>paloma</i> [n = 9]	<i>marxi</i> [2-USNH]	<i>simulatum</i> (Type)	[°] <i>radinum</i> [Type]
LC	7.00–9.70 (8.33, 0.56)	6.70–9.60 (8.25, 0.72)	9.35–16.90 (13.0, 2.05)	²¹ 4.10–6.20 (5.33, 0.51)	³ 9.10 ³ 9.00	²¹ 9.85	7.50
LT I/LMI	0.91–1.01 (0.97, 0.03)	0.92–1.07 (1.00, 0.04)	0.85–1.01 (0.92, 0.04)	¹ 1.04–1.11 (1.08, 0.02)	³²¹ 1.25 ³²¹ 1.30	³²¹ 1.27	²¹ 1.10
LT II/LM II	0.84–0.91 (0.87, 0.02)	0.86–0.96 (0.91, 0.02)	0.82–0.91 (0.87, 0.03)	0.88–0.94 (0.92, 0.02)	³²¹ 1.12 ³²¹ 1.09	³²¹ 1.09	²¹ 0.98
LFI/LTI	1.12–1.19 (1.15, 0.02)	1.18–1.28 (1.22, 0.02)	1.17–1.33 (1.24, 0.04)	¹ 1.22–1.31 (1.26, 0.03)	²¹ 1.31 ²¹ 1.29	¹ 1.22	²¹ 1.10
LFI/LT II	1.22–1.33 (1.25, 0.03)	1.30–1.41 (1.35, 0.02)	1.31–1.41 (1.36, 0.02)	¹ 1.41–1.53 (1.48, 0.04)	³²¹ 1.53 ³²¹ 1.53	³²¹ 1.44	²¹ 1.27
LFI/LMI	1.05–1.19 (1.12, 0.03)	1.15–1.29 (1.21, 0.04)	1.07–1.24 (1.15, 0.04)	¹ 1.28–1.40 (1.36, 0.04)	³²¹ 1.63 ³²¹ 1.67	³²¹ 1.55	¹ 1.21
LFI/LM II	1.05–1.18 (1.10, 0.03)	1.16–1.31 (1.22, 0.04)	1.11–1.25 (1.18, 0.04)	¹ 1.28–1.42 (1.36, 0.04)	³²¹ 1.71 ³²¹ 1.67	³²¹ 1.58	¹ 1.25
LAI/LC	3.06–3.58 (3.39, 0.11)	2.87–3.36 (3.07, 0.11)	2.95–3.46 (3.23, 0.11)	2.79–3.24 (3.09, 0.15)	³²¹ 2.82 ³²¹ 2.87	³²¹ 2.81	3.19
LAI I/LC	2.87–3.40 (3.25, 0.13)	2.70–3.18 (2.90, 0.10)	2.73–3.27 (3.05, 0.09)	2.58–2.98 (2.83, 0.13)	³²¹ 2.52 ³²¹ 2.60	³²¹ 2.64	2.95
LAI V/LC	3.64–4.15 (3.89, 0.13)	3.11–3.71 (3.34, 0.12)	¹ 3.09–3.60 (3.42, 0.10)	¹ 3.06–3.55 (3.36, 0.16)	³²¹ 2.88 ³²¹ 2.96	³²¹ 2.94	3.41
LAI I/LAI V	²⁰ 0.81–0.89 (0.87, 0.02)	¹⁰ 0.90–0.95 (0.92, 0.01)	¹⁰ 0.92–0.96 (0.94, 0.01)	¹⁰ 0.90–0.95 (0.92, 0.01)	³²¹⁰ 0.97 ³²¹⁰ 0.97	²¹⁰ 0.96	¹⁰ 0.93
LAI I/LAI III	²¹ 1.02–1.08 (1.04, 0.01)	¹¹ 0.99–1.14 (1.11, 0.01)	¹¹ 1.10–1.16 (1.13, 0.02)	²¹ 1.15–1.19 (1.17, 0.01)	³²¹ 1.24 ³²¹ 1.25	³²¹ 1.22	²¹ 1.16
LAI I/LP	²² 2.28–2.42 (2.35, 0.04)	¹² 2.04–2.23 (2.12, 0.05)	¹² 2.05–2.21 (2.12, 0.04)	¹¹ 1.96–2.07 (2.02, 0.04)	³²¹ 1.87 ³²¹ 1.90	³²¹ 1.85	¹² 2.21
WF III/WFI							
swln ≥ 1.19 normal ≤ 1.15	swln	normal (W) swln (E)	¹ normal	swln	¹ normal	¹ normal	¹ normal
Scopula							
MIV (%)	³ distal 25–50	distal 25–55	²¹ distal 70–85	²¹ distal 0–20	³ distal 40, 45	³ distal 35	distal 45
Division	² par div	¹ undiv	¹ undiv	² par div	¹ undiv	¹ undiv	¹ undiv
Sc TaIV (%)	25–60			50–100			
S & Cx(v) setae	² sht, stout, conicform	¹ long, atten	¹ long, atten	¹ long, atten	¹ long, atten	¹ long, atten	¹ long, atten
Cx I setae prolateral	bas unif hairlike	bas unif hairlike	²¹ bas swln spinifm	bas unif hairlike	²¹ bas swln spinifm	²¹ bas swln spinifm	bas unif hairlike
Palpal bulb	² retr bnd uniform	¹ retr bnd angular	² retr bnd uniform	² retr bnd uniform	² retr bnd uniform	² retr bnd uniform	¹ retr bnd angular
Carapace color	black	black	²¹ paper-bag brown	black	chestnut	chestnut	chestnut and black

Smith (1994) described 25 new species of *Aphonopelma*, 14 of which were described from single specimens, eight from two specimens each, and only three from several specimens each. Most of these descriptions were

based on taxonomic characters that either were determined to be highly variable intra-specifically and widely overlapping interspecifically or are subjective in nature. Characters most consistently used in his diagnoses were

Table 1.—Extended.

<i>phasmus</i> [Type]	<i>zionis</i> [Type]	* <i>melanium</i> [Type]	<i>iodium</i> [Type]	* <i>angusi</i> [Type]	* <i>nevadanum</i> [Type]	<i>helluo</i> [USNH]	<i>rusticum</i> [cotype]
³ 8.20	² 9.70	²¹ 13.50	²¹ 14.30	²¹ 10.70	²¹ 15.90	³²¹ 17.30	²¹ 14.10
³¹ 1.04	1.01	0.94	0.94	0.97	²¹⁰ 0.87	³¹ 1.03	—
³¹⁰ 0.93	0.91	0.86	0.89	0.91	²⁰ 0.85	³¹⁰ 0.94	0.89
²¹ 1.17	³²¹ 1.15	¹¹ 1.25	¹¹ 1.22	¹¹ 1.23	¹¹ 1.27	³²¹ 1.35	—
1.33	1.31	1.36	1.33	¹¹ 1.38	1.32	³²¹ 1.46	¹¹ 1.41
¹¹ 1.22	1.15	1.17	1.15	¹¹ 1.20	1.10	³²¹ 1.38	—
¹¹ 1.24	¹¹ 1.19	1.16	1.18	¹¹ 1.25	²¹ 1.13	³²¹ 1.36	¹¹ 1.25
3.25	3.30	3.21	²³ 3.39	3.29	3.24	³²¹ 2.80	—
3.02	3.05	3.06	3.20	3.07	3.12	³²¹ 2.67	³²¹ 2.57
3.55	¹³ 3.56	¹³ 3.40	¹³ 3.55	¹³ 3.45	¹³ 3.42	³²¹ 3.02	³²¹ 2.96
³¹⁰ 0.91	¹⁰ 0.93	¹⁰ 0.94	²¹⁰ 0.96	¹⁰ 0.95	¹⁰ 0.95	¹⁰ 0.93	—
²¹ 1.15	²¹ 1.16	¹¹ 1.13	¹¹ 1.14	²¹ 1.16	¹¹ 1.11	¹¹ 1.13	—
¹² 0.09	¹² 0.15	¹² 0.11	¹² 0.18	¹² 0.08	¹² 0.17	³²¹ 0.95	—
¹ normal							
³²¹ distal 60	³²¹ distal 65	²¹ distal 72	²¹ distal 79	²¹ distal 70	²¹ distal 71	³²¹ distal 60	²¹ distal 0.75
¹ undiv							
¹ long, atten							
²¹ bas swln spinifm							
² retr bnd angular	² retr bnd uniform						
²¹ light brown	²¹ light brown	²¹ yellow gray	²¹ pale buff	²¹ yellow gray	²¹ golden yellow	—	—

shape of the basal division of the palpal bulb, extent of metatarsus IV scopula, number and/or position of megaspines of the lower process of the tibial spur, and prolateral spination of the palpal tibia. Of these characters the shape

of the basal division of the palpal bulb was weighted most heavily in separating males of new species. In examining the *Aphonopelma*, including type and non-type males and males collected from the type localities of 12 nom-

inal species, I found relatively minor variation in the general shape (form) of the basal division. Intraspecific variation (also see Perez-Miles 1989) was found to be as great as interspecific variation in all species described herein and in the following species: *A. paloma*, *A. reversum*, *A. chalcodes*, and *A. coloradanum* (Canon City, Colorado). Conversely, males of three very dissimilar species (*A. iodium*, *A. reversum*, and *A. coloradanum*) were found in which corresponding divisions of the bulb were nearly identical. Major differences, such as in several illustrations by Smith, may have been the result of molting difficulties, damage to the bulb (through the effects of preservation or during the immediate post-molt sclerotization process), or genetic mutation but are only doubtfully indicative of species distinctions, especially in light of locality data.

A second primary character that Smith used to diagnose males was the number and/or position of stout apical or subapical megaspines on the lower process of the male tibial spur. In *A. mojave* the inner megaspine (preapical spine on the inner or concave surface of process) was always present while the outer megaspine (spine on the outer or convex surface of process) was frequently absent; both spines varied considerably in size, shape, and their position on the process, their articulation varying from almost apical to decidedly preapical. One or more less stout apical spines were occasionally present between the larger megaspines. On the upper process the armature was also found to be variable; the inner surface of the process was always equipped with one megaspine but occasionally with two subequal megaspines and/or one to several additional lesser spines. A similar degree of variation was also found in both *A. joshua* new species and *A. iodium*.

The extent of the scopula of metatarsus IV (weighted heavily by Smith) proved to be a reliable character in this study after range values were established, especially in combination with size and color characters and locality data. Length values from museum specimens were often difficult to determine because much of the metatarsal pubescence and scopulae had been worn away through repetitive examination. However, under high magnification scopular extent could usually be determined by cuticular examination. In species

such as *A. iodium* the lateral extent of the scopula was found to be greater than the medial extent but this condition appeared to have been overlooked by Smith in his measurements of various type specimens. For the Chamberlin holotypes, *A. angusi*, *A. iodium*, *A. melanium*, and *A. nevadanum*, Smith illustrated the approximate extent of metatarsus IV scopula as, the distal 35, 40, 60, and 60% of the segment, respectively. According to Smith's criteria, this placed the former two species in a different species group than the latter two species. My own measurements of metatarsus IV scopula of the same holotype specimens are as follows (in approximate percentage): *A. angusi*, 40 medial, 70 retrolateral; *A. iodium*, 50 medial, 80 retrolateral; *A. melanium*, 50 medial, 70 retrolateral; *A. nevadanum*, 60 medial, 70 retrolateral. For the species *A. iodium* (not including above types) scopula extent ranged from 40–60% medially and from 70–85% retrolaterally (maximum extent). Medial extent was usually greatest in *A. joshua* and *A. mojave* and in both ranged from 25–50%.

Other male characters that Smith considered of lesser weight included number of megaspines of the upper process of the tibial spur, prolateral spination of tibia I, shape of the labial and maxillary (used less often) cuspules, condition of distal embolus (keeled or not), shape of the embolus tip, and shape of the posterior half of the palpal bulb (basal portion of the middle division). The number of labial cuspules in *A. joshua* varied from 33–78, in *A. mojave* from 26–90, and in *A. iodium* from 70–140 (in specimens collected from one locality). Distribution of the cuspules, hence, shape of the distribution varied considerably within all three species with substantial interspecific overlap. Differences in this character are considered to be artificial due to high variability in number and distribution and to the subjective nature in the interpretation of such highly irregular shapes.

The shape, orientation, and keeled condition of the embolus have been found to be relatively constant in males with slender emboli; shape and orientation are essentially as in the palpal bulbs in Figs. 14–21, 29–44 and as described below under the additional diagnostic characters for *Aphonopelma*. Even in such diverse species as *A. reversum*, *A. behlei*, and *A. coloradanum* the apical emboli were

often indistinguishable and the accentuation of the median keel no more variable interspecifically than intraspecifically. No males examined in this study were found with significant variation in embolic characters. Rather than attributing the major differences described and illustrated by Smith as characteristic of new species, I would suggest that such conditions were anomalies resulting from genetic abnormalities, molting problems, or damage to bulbs. If they were representative shapes then such species are indeed rare and distinguished only by the condition of the embolus.

The basal portion of the middle division of the palpal bulb was found to be variable within all species described here, primarily in the region of the basal cuticular protrusion (proximal prolateral protuberance) of the prolaterodorsal surface. Interspecific variation in this character was found to be greater between some species than intraspecific variation within the compared species (Figs. 14–21, odd numbered figures) although was negligible between 'eutylenum types' (Figs. 29–44, even figures) and between several other species such as *A. coloradanum* and *A. reversum*.

In diagnosing females Smith primarily used two characters, shape of the spermathecae and scopulation of metatarsus IV; other characters used were setation of prolateral coxa I and spination of the palpal tibia. Spermathecae of six *A. iodium* females (two from one locality and two from a second locality) in Figs. 45–50 illustrate conspecific variation. Spermathecae of two other species, *A. joshua* and *A. mojave*, are illustrated in Figs. 22–28 to show interspecific similarity as well as intraspecific variation. Clearly, shape of the spermathecae can vary considerably within a species but, conversely, can be very similar among females of different species. Consequently, this character is not considered to have specific discriminating value.

Primary taxonomic characters.—In this study the taxonomic characters with the highest discriminating value were present in both genders; they are: (1) form of setae on the prolateral face of coxa I, (2) extent of metatarsal scopulation (primarily, metatarsus IV), (3) condition of tarsal scopula (entire or divided), (4) lengths of both legs III and IV relative to length of leg I, (5) lengths of both leg III and IV relative to carapace length, and (6) color of the carapace (in living specimens).

Additional characters that were weighted heavily separated males only; they are: (1) lengths of tibia I and metatarsus I relative to each other, (2) lengths of tibia II and metatarsus II relative to each other, (3) lengths of both tibiae I and II relative to femur I, (4) lengths of both metatarsi I and II relative to femur I, and (5) condition of femur III (swollen or normal).

Status of some old 'Eurypelma' species.—

I have included eight *Aphonopelma* species in this study (seven with type localities in the U.S. and one from Baja California) that were described prior to 1939 (described as *Theraphosa* or *Eurypelma*) because of the possibility of synonymy in name with *A. iodium* and/or *A. mojave* which would preclude the use of one or both as species names for the Mojave Desert tarantulas; they are as follows: *Theraphosa californica*, *T. leiogaster* Doleschall 1852 (*Eurypelma*, in Ausserer 1871), *E. steindachneri* Ausserer 1875, *E. rileyi* Marx 1888, *E. rusticum*, *E. marxi*, *E. helluo* Simon 1891, and *E. pseudoroseum* Strand 1907. Although all of these species are now considered *Aphonopelma* (consult Raven 1985), I will refer to them in this section as *Eurypelma*.

Eurypelma rileyi was described on the basis a single female, type locality, Santa Barbara, California. The type is believed to no longer exist (N.I. Platnick, pers. comm. 1995) although Smith (1994) redescribed the species from a specimen in the USNM, maintaining that it was the female holotype. In my examination of the specimen, I found the spination armature (of all legs) to be grossly incongruent with that described by Marx, leg IV slightly greater than, rather than slightly shorter than, the carapace length (if Marx included coxa IV in his measurement), and no indication on the labeling that the specimen was part of the Marx collection (no data other than that on the label exists). Given these conditions, the likeliness that this specimen is the type of *E. rileyi* is controvertible. In addition, the epigastric region is missing rendering the gender of the fragmented alcohol specimen indeterminate (the specimen was formerly pinned and dried and the abdomen stuffed with cotton wool).

The carapace color of *E. pseudoroseum* was described as reddish-yellow or pinkish (translocation), an obvious condition in living specimens but one almost impossible to determine

in specimens preserved for any length of time. Unfortunately, types of *E. pseudoroseum* (two females) do not exist and except for carapace color the species description could be equally applicable to a number of species.

A male (#1589-BMNH) from the Koch collection, type locality Pecos River, Texas, was considered by D.J. Clark (1961) to be the specimen figured by Ausserer in his original description of *E. steindachneri* (the specimen is fragmented and is missing leg III and IV except for the right trochanter and femur of leg IV; leg II (R) and tibia and metatarsus IV (R) from a larger specimen(s) are mixed in with the type). Smith (1994) also considered this male to be the holotype, assuming that Ausserer described a male from Pecos River, Texas rather than from San Diego, California. In a personal communiqué that I received from Dr. Jurgen Gruber (NHMW) concerning two male and one female specimens labeled *Eurypelma californicum* the following information was conveyed: (1) the original labeling of the three Austrian specimens is feared to have been discarded but museum acquisition records state that two specimens are types of *E. steindachneri* (California: San Diego) although the presumed type series was mixed up with later material and (2) since Ausserer described both genders, the non-type specimen is suggested to be a male collected in California (circa 1892) which apparently was lumped together with the types. Upon examination of these specimens I discovered that one of the males and the female were, decidedly, the specimens on which Ausserer based his description of *Eurypelma steindachneri*. Carapace and leg measurements that I performed on both genders were in agreement with those of Ausserer's, the ocular deformity described of the type female was present in the NHMW female, and the dorsal coverage of the urticating patch and the relatively straight cut and armature of the apical superior tibial spur described of the type male were in congruence with the respective characters of the NHMW male. Contrarily, measurements that I performed on the BMNH specimen were not in agreement with those in Ausserer's original description. The coloration of the types, as described by Ausserer, is typical of males and faded females, respectively, of specimens I have collected near the Mexican border, just southeast of San Ysidro, Califor-

nia. The limited extent of the scopulae of metatarsi III and IV in these San Ysidro specimens is very diagnostic of this species (approx.-distal $\frac{1}{2}$ - $\frac{2}{3}$ and $\frac{1}{3}$ or less, respectively) and agrees both in character with the NHMW specimens (Ausserer did not include data on the extent of scopulae) and in the general locality data of specimens collected near the Mexican border and provided to Ausserer by Dr. Steindachner. The non-type male is of the same species as the types.

Additional information conveyed to me by Dr. Gruber is as follows: (1) of the original specimens of Doleschall, according to Doleschall, the type of *Theraphosa (Eurypelma) californica* (female) was a dry specimen and according to Ausserer that of *T. (Eurypelma) leiogaster* (male) was also a dry specimen and (2) types of these species no longer exist (also verified by Gertsch (1978) in a personal communication to W. Icenogle).

In the original description of *E. rusticum*, Simon noted type localities as both Ft. Yuma and Williams, Arizona. It is not entirely clear from which of these localities the described specimen was collected. The holotype and other material from Ft. Yuma are believed to have been lost or destroyed. However, a male in USNM (#1585, cotype, *E. rusticum*, Collection: Marx, type locality Williams, Arizona) may be one of the original specimens in Simon's series (there are also leg segments of a smaller specimen mixed in with the fragmented type; the male is missing the patella, tibia, metatarsus, and tarsus of leg I). Smith (1994), apparently unaware of the existence of the cotype, redescribed *Aphonopelma rusticum* based on "Simon designated paratype material from northern Mexico". Although Simon clearly stated in his description that the species also occurred in northern Mexico, Smith selected, as the lectotype, a specimen (#5873, male, MNHP-Paris) from Mazatlan, Mexico, a locality distinctly not in northern Mexico. Since this male is not believed to be of the same species as the cotype male (#1585), the precise identity of *E. rusticum* = *A. rusticum* is uncertain. Reexamination of all type material will be necessary before a lectotype can be objectively designated. The *A. rusticum* of Chamberlin (type locality, Apache Trail, Arizona) is clearly not the *E. rusticum* of Simon; Smith redescribed this species as *A. rothi*.

In his 1940 work, Chamberlin indicated that the name 'marxi' had previously been used to cover several different species including *A. simulatum* (Chamberlin & Ivie 1939) and that the precise identity of the species would remain in question until either the types were critically restudied or ample material from the San Bernardino Mountains (California) was examined. The labeling of the Marx specimens, from which Simon described *E. marxi*, apparently indicated type localities of California: San Bernardino Mountains and New Mexico: Punta-del-Aqua (Marx' labeling was often suspect (Gertsch 1961)); Chamberlin discounted New Mexico as a type locality of *E. marxi* but, interestingly, considered June Springs, New Mexico a second locality for *A. simulatum* (male and female). Although no labeled *E. marxi* types are known to exist, two *E. marxi* non-type males in USNM (localities: 1-#43(20), California, 1-#45(30), New Mexico) from the Marx collection match, closely enough, Simon's original description of the species; the *A. simulatum* holotype is indistinguishable from these specimens in all characters examined (Table 1). Furthermore, I have spent a considerable amount of time collecting in and around the San Bernardino Mountains and have found no specimens exhibiting the combination of characters present in the non-type *A. marxi* and in the *A. simulatum* holotype. In light of the above, I suggest that Marx mislabeled one of two New Mexico specimens and conclude here that *Eurypelma marxi* = *Delopelma marxi* = *Aphonopelma marxi* is a valid species name, that the New Mexico male be considered the neotype, and that *A. simulatum* be considered a junior synonym of *A. marxi* (NEW SYNONYMY).

E. helluo = *Delopelma helluo* = *A. helluo* (Table 1) is also considered here as a valid species name represented by the holotype (#17707, MNHN, type locality, Cape Lucas, Baja California); only one other *A. helluo* specimen (examined) from the Marx collection (non-type male, USNM, #50(44), locality, Cape Lucas) is known to exist.

Nomina dubia.—Because of the inadequacy of the original *Eurypelma* descriptions which could be equally applicable to a number of species combined with the loss of type specimens and/or appropriately labeled non-type specimens from collections from which

types were described, *Theraphosa californica* = *E. californica* = *Dugesiella californica* = *Aphonopelma californica*, *E. rileyi* = *A. rileyi*, *T. leiogaster* = *E. leiogaster* = *A. leiogaster*, and *E. pseudoroseum* = *Delopelma pseudoroseum* = *A. pseudoroseum* should be considered as nomina dubia, "in the interest of promoting" nomenclatural stability.

Genus *Aphonopelma* Pocock

Rhecostica Simon 1892: 162 (type species by original designation *Homoeomma texense* Simon 1891). Suppressed as a senior synonym of *Aphonopelma* by ICZN Opinion 1637.

Aphonopelma Pocock 1901: 553 (type species by original designation *Eurypelma seemanni* F.O. Pickard-Cambridge 1897). First synonymized with *Rhecostica* by Raven 1985: 149.

Dugesiella Pocock 1901: 551 (type species by original designation *D. crinita* Pocock 1901). First synonymized with *Rhecostica* by Raven 1985: 152.

Delopelma Petrunkevitch 1939: 567 (type species by original designation *Eurypelma marxi* Simon 1891). First synonymized with *Rhecostica* by Raven 1985: 151.

Gospelma Chamberlin 1940: 4 (type species by original designation *G. angusi* Chamberlin 1940). Originally described as a subgenus of *Aphonopelma*; never elevated to full genus status. First synonymized with *Rhecostica* by Raven 1985: 153.

Chaunopelma Chamberlin 1940: 30 (type species by original designation *Delopelma radinum* Chamberlin & Ivie 1939). First synonymized with *Rhecostica* by Raven 1985: 151.

Apachepelma Smith 1994: 45 (type species by original designation *Aphonopelma paloma* Prentice 1992). NEW SYNONYMY.

Diagnosis.—The genus *Aphonopelma* is distinguished from all other genera by the following combination of characters: (1) no known external organs of stridulation (males do stridulate, however); (2) normal, relatively slender (hair-like or spiniform) plumose setae on pro-lateral trochanter and femur of leg I and on the retrolateral coxa and trochanter of palp (in some species these setae are finely plumose); no 'large' plumose (lanciform or spatulate) setae such as those on the prolaterobasal femur of leg I in *Euathlus* or those on the prolateral coxa of leg I in *Grammostola*; (3) type I urticating hair only; (4) corresponding segments of all legs approximately the same width in females; femur III in males of some species laterally swollen; (5) scapula of tarsus IV usually

entire, if divided then only partially and narrowly by line of setae; (6) setae of prolateral coxa I hairlike and not basally swollen (known only in small species), spiniform and basally swollen, or distinctly thornlike (apically filiform), with all forms at least distally plumose; (7) metatarsus I flexing against lower process of tibial spur, with either apex of spur contacting ventral surface of metatarsus or outer edge of spur in the apical half contacting the prolateral metatarsus; (8) lower (outer) process of tibial spur curving prolaterodistally and widening apically, usually equipped with at least one apical or preapical megaspine, and upper (inner) shorter process less stout basally, relatively uniform in diameter throughout its length, and equipped on its inner surface with at least one (several not uncommon) stout, basally articulated megaspine.

Additional diagnostic characters.—Based on preliminary data, (1) ventral retro-marginal setae of maxillae and ventral marginal setae of coxae (other than distal margins) similar in form (and usually size) to prolateral setae of coxa I, or, similar to other ventral setae of coxae (more common); (2) extent of metatarsus IV scopula usually from distal 20–85%, rarely less than 20% or with scattered scopula hairs (*A. paloma* and undescribed species from southeast Arizona); (3) anterior sternal margin smoothly procurved or rarely with a broad but slight medial projection; (4) labiosternal suture recessed; labium rising steeply from suture; (5) male embolus tapering with inward and ventral curve, with strong ventrally directed bend near apex (in all species with slender emboli), embolus either very slender with three apical keels (medial keel most prominent), or, relatively wide with four prominent keels of which the distomedial and proximomedial keels are either convergent or closely parallel just basad of apex, with proximomedial or convergent keel serrate

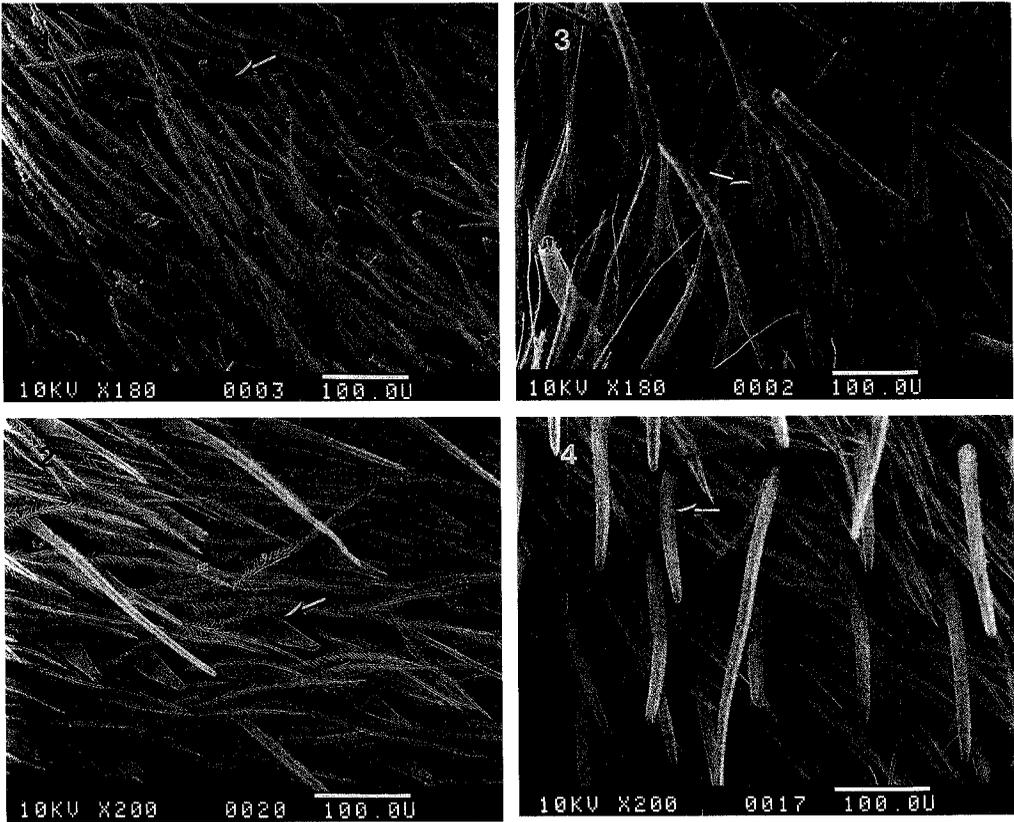
and/or extending the full or nearly full length of embolus in some species; (6) transition of valley between processes of tibial spur considerably offset (protruding) from longitudinal plane of tibia; (7) tibiae I and II of females with at least one ventral spine (other than apical), rarely none and then only in species where male embolus is relatively broad apically; usually also with at least one prolateral spine, rarely absent on tibia II; (8) paired spermathecae separated and with capitate bulbs, variable in shape.

Genera removed from synonymy.—Two genera placed in the synonymy of *Aphonopelma*, *Clavopelma* and *Pterinopelma*, differ from the remaining *Aphonopelma* in characters here considered generic in value (above). *Clavopelma* Chamberlin (monotypic genus) is here removed from the synonymy of *Aphonopelma* because of the following differences: both types I and III urticating hairs, lanciform setae (similar to those in *Euathlus* (*Brachypelma*)) but relatively smaller) on the prolateral trochanter and femur of leg I and on retrolateral trochanter of the palp, and a relatively straight (slender) embolus without a sharp ventrally directed bend near apex. *Pterinopelma* Pocock, as defined, is similar to *Euathlus* in the form of scopular setae on the posterior face of the palpal trochanter and the anterior face of the trochanter of leg I but dissimilar to both *Euathlus* and *Aphonopelma* in lacking a similar scopula of hairs on the anterior face of femur I. The presence of both types I and III urticating hairs, characteristic of *Euathlus*, is also characteristic of *Pterinopelma*. The anterior lateral eyes of *Pterinopelma* are proportionately larger relative to AME than in other genera in the synonymy of *Aphonopelma*. *Pterinopelma* is here not considered a synonym of *Aphonopelma* but its final disposition is reserved until all *Pterinopelma* species have been examined.

PARTIAL KEY TO MALES OF *APHONOPELMA*

Phylogenetic relationships are not implied by the couplets. Also, the asterisk (*) indicates that key is for types only, and does not account for variation.

1. Setae on prolaeral coxa I hairlike, not basally swollen (Figs. 7, 8); small species 2
- Setae on prolateral coxa spiniform, basally swollen (Figs. 9, 10) 5



Figures 1-4.—Sternal and coxal setae, males (arrows indicate setae). 1, 2, *Aphonopelma joshua* new species; 1, Sternum, medial; 2, Coxa I, ventral, proximo-medial; 3, 4, *Aphonopelma mojave* new species; 3, Sternum, medial; 4, Coxa I, ventral, proximo-medial.

- 2(1). Tarsus IV scopula as least partially divided by setae (Fig. 5) 3
- Tarsus IV scopula complete, not divided by setae (Fig. 6) 4
- 3(2). Medial sternal setae hairlike or attenuate (refer to Fig. 3); Arizona *paloma*
- Medial sternal setae short, stout, basally thickened, and conicform (Fig. 1)
- *joshua* new species
- 4(2). Length ratios tibia I/metatarsus I, 0.92-1.07, femur I/tibia I, 1.18-1-.28 (Table 1)
- *mojave* new species
- Both ratios = 1.10 (Table 1); California, Manhattan Beach (type locality doubtful) *radinum*
- 5(1). Extent of metatarsus IV scopula less than distal 40% 6
- Metatarsus IV scopula at least distal 55% 7
- 6(5). Carapace length >13 mm; California, Baja; in life carapace and legs medium brown to black *steindachneri*
- Carapace length <10 mm; Utah, New Mexico (*stimulatum*) = *marxi*
- 7(5). Scopula metatarsus IV, distal 55-65% 8
- Scopula metatarsus IV ≥ distal 70% 10
- 8(7). Palpal bulb retrolateral bend uniform (as in Figs. 14, 29) 9
- Bulb with retrolateral bend angular (as in Fig. 18); Grand Canyon, Phantom Ranch *phasmus*
- 9(8). Length carapace <10 mm; length ratio leg IV/carapace approximately 3.6; Arizona *zionis*
- Length carapace >15 mm; length leg IV/carapace approximately 3.0; Baja *helluo*
- 10(7). Length ratio leg IV/carapace = 3.09-3.60; California *iodium*
- Ratio leg IV/carapace <3.0; Arixon, Mexico *rusticum*

PARTIAL KEY TO FEMALES OF *APHONOPELMA*

Phylogenetic relationships are not implied by the couplets. Also, the asterisk (*) indicates that key is for types only, and does not account for variation.

- 1. Setae on prolaeral coxa I hairlike, not basally swollen (Figs. 7, 8); small species 2
- Setae on prolateral coxa spiniform, basally swollen (Figs. 9, 10) 4
- 2(1). Tarsus IV scopula partially divided by setae (Fig. 5) 3
- Tarsus IV scopula complete, not divided by setae (Fig. 6) *mojave* new species
- 3(2). Metatarsus IV scopula >30 distal percent and almost always <50% *joshua* new species
- General reduction of metatarsal scopulation, metatarsus scopula <20%; Arizona *paloma*
- 4(1). Metatarsus IV scopula < 35%; carapace and legs dark in color (Table 2) **steindachneri*
- Metatarsus IV scopula ≥ 70%; carapace and patellae and tibiae I, II, pale buff (Table 2) *iodium*

Aphonopelma joshua new species

Figs. 1, 2, 5, 7, 12-15, 22, 23, 51; Map 1.

Types.—Holotype male from San Bernardino County, allotype female from Riverside County, California, both from the Covington Flats area of Joshua Tree National Monument. Holotype collected at 10:09 PM, 6 September 1992, 2.3 mi. below the Covington Flats entrance to JTNM, elevation 3660 ft. Allotype excavated from a mounded burrow 21 October 1989, 5.6 mi. into the Monument in the Upper Covington Flat area, elevation 5140 ft. Paratype males (12): 24 July 1989 (1), 3 August 1989 (1), 10 August 1989 (2); 27–28 July 1990 (2); 27–28 July 1992 (5), 12 August 1992 (1). Paratype females (2): 3 May 1989 (1); 30 July 1992 (1). All paratypes collected by author in the Covington Flats area or near the JTNM entrance to this area. Types deposited in AMNH.

Etymology.—The specific name is a noun in apposition taken from the type locality, Joshua Tree National Monument.

Diagnosis.—*A. joshua* new species can be distinguished from all other species by the following combination of characters: small size, hair-like form of setae on prolateral coxa I (Fig. 7), partial division of tarsus IV scopula by setae (Fig. 5), and extent of metatarsus IV scopula. Males (Table 1) are most easily recognized by their unique coniciform setae of the sternum (Fig. 1), maxillae (similar to sternal setae), and coxae (Fig. 2) and the laterally swollen third femur (Fig. 13). They are separated from males of the most similar species, *A. mojave* new species, *A. radinum* and *A. paloma*, by the following: from *A. mojave* and

A. radinum by partial division of tarsus IV scopula (Fig. 5) and form of the palpal bulb (Figs. 14, 15) and from *A. paloma* by more extensive scopula of metatarsus IV (also III), respectively. Females (Table 2) are distinguished from those of all other species except *A. paloma* by partial division of tarsus IV scopula and from *A. paloma* by the more extensive scopula of metatarsus IV (all metatarsi).

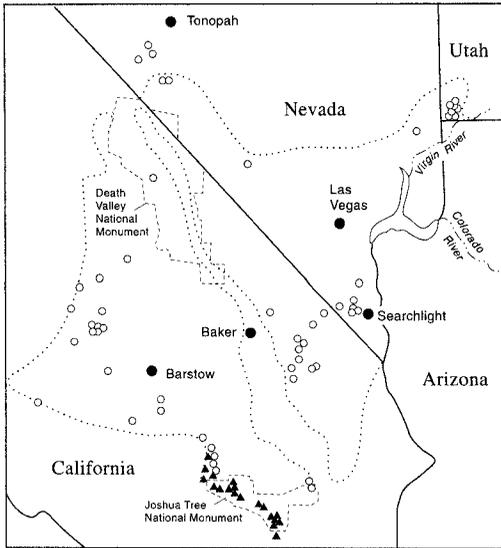
Description.—*Male:* Holotype. Overall length, 23.80; carapace, length, 8.80 width, 7.65; chelicerae, length, 2.80, width, 3.70. Cheliceral macroteeth, 8, denticles, 14 right, 15 left; sternum, length, 3.80, width, 3.60. Labial cuspules, 73; maxillary cuspules, 89 right, 98 left. Color of entire tarantula appears black; carapace pubescence black with a silver or gray-black sheen, appressed and moderately dense; chelicerae black with a silver sheen; abdominal pubescence gray-black, somewhat lighter than carapace. Abdominal anterodorsal setae black and relatively stout; lateral setae black, slender and shorter than dorsal setae; ventral setae black and finer than lateral setae; circular patch of dark black, type I (Cooke et al. 1972) urticating hairs (as in Fig. 11) covering posterodorsal half of abdomen, clearly visible; longest setae hairlike, pale orange-buff, basally dark, interspersed mostly within, just outside and caudally below urticating patch. Legs with black pubescence (legs appear gray-black), femora slightly darker; longest leg setae black with distal half pale orange-buff, other leg setae black. Ventral aspect black except red-orange labium and anterior palpal coxae and orange scopulae of palpal coxae. Cephalic region of carapace rising gradually

Table 2.—Females of *Aphonopelma*: Taxonomic characters and quantitative character values which separate the Mojave Desert *Aphonopelma* and *A. paloma*. °—species sharing the hairlike form of setae on proteral coxa I, distinguished by superscript only from *A. joshua* (¹) and *A. mojave* (²). *—include in the synonymy of *A. iodium*; ¹—no overlap with *A. joshua*; ²—no overlap with *A. mojave*; ³—no overlap with *A. iodium*; gen dedu all—general reduction of all metatarsal scopulae; other abbreviations defined in Methods section of text. Mean and standard deviation shown in parentheses, i.e., (7.76, 1.34). Carapace measurements are in millimeters.

	° <i>joshua</i> [n = 10]	° <i>mojave</i> [n = 30]	<i>iodium</i> [n = 14]	° <i>paloma</i> [n = 11]	* <i>angusi</i> [allotype]
LC	6.00–9.70 (7.76, 1.34)	6.00–10.25 (8.03, 1.03)	²¹ 10.80–22.05 (15.02, 2.65)	4.10–6.10 (5.05, 0.57)	³ 9.10
LFI/LTI	1.26–1.32 (1.29, 0.02)	1.27–1.36 (1.31, 0.02)	1.32–1.38 (1.36, 0.02)	1.29–1.39 (1.35, 0.03)	1.32
LFI/LTII	1.44–1.50 (1.48, 0.02)	1.48–1.60 (1.54, 0.03)	1.50–1.57 (1.53, 0.02)	²¹ 1.63–1.74 (1.68, 0.04)	¹ 1.56
LFI/LMI	1.41–1.55 (1.49, 0.05)	1.41–1.55 (1.48, 0.04)	1.29–1.47 (1.40, 0.04)	²¹ 1.56–1.71 (1.64, 0.04)	³ 1.52
LFI/LMII	1.40–1.57 (1.50, 0.06)	1.49–1.63 (1.55, 0.04)	1.33–1.52 (1.46, 0.05)	²¹ 1.70–1.82 (1.76, 0.05)	³ 1.56
LMIII/LMI	1.09–1.19 (1.15, 0.03)	0.99–1.10 (1.05, 0.03)	¹ 1.01–1.07 (1.04, 0.02)	¹ 1.00–1.07 (1.02, 0.30)	¹ 1.07
LAI/LC	2.26–2.43 (2.37, 0.06)	2.21–2.74 (2.39, 0.10)	2.23–2.51 (2.42, 0.09)	¹ 1.94–2.23 (2.13, 0.09)	2.39
LAIV/LC	2.59–2.84 (2.75, 0.07)	2.36–3.06 (2.63, 0.19)	2.41–2.70 (2.64, 0.11)	²¹ 1.94–2.23 (2.13, 0.10)	2.68
LAI/LAIV	² 0.85–0.88 (0.86, 0.01)	¹ 0.89–0.94 (0.91, 0.01)	¹ 0.89–0.93 (0.92, 0.01)	0.88–0.94 (0.90, 0.02)	¹ 0.89
LAI/LAIII	1.08–1.15 (1.12, 0.02)	1.14–1.23 (1.18, 0.03)	1.11–1.15 (1.14, 0.01)	¹ 1.22–1.27 (1.25, 0.02)	³¹ 1.16
Scopula	30–65 (40)	25–50 (35)	²¹ 75–85 (lat) 45–60 (med)	²¹ 0–17 gen redu all	²¹ >70 (worn) 45 (med)
Division Sc TaIV (%)	² par div 40–70	¹ undivided	¹ undivided	² divided 40–67	¹ undivided
Proteral CxI setae	hairlike bas uniform	hairlike bas uniform	²¹ spiniform bas swollen	hairlike bas uniform	²¹ spiniform bas swollen
Carapace color	black	black	²¹ paper-bag brown	black	²¹ paper-bag brown
Legs I, II, Palp (Ti, Pt color)	black	black	²¹ paper-bag brown	black	²¹ paper-bag brown

from thoracic groove, slightly less than twice the height of thoracic region. Ocular turret relatively high, compact, and steep resulting in a more lateral rather than dorsolateral inclination of lateral eyes, ocular area width 0.28× maximum width of cephalic region. AME circular, AME-AME, 0.6× AME diameter, AME-ALE, 0.15, 0.20× (left, right, respectively) AME diameter, AME-PME, 0.05, 0.10× AME diameter; ALE, PLE roughly ovoid (somewhat flat-

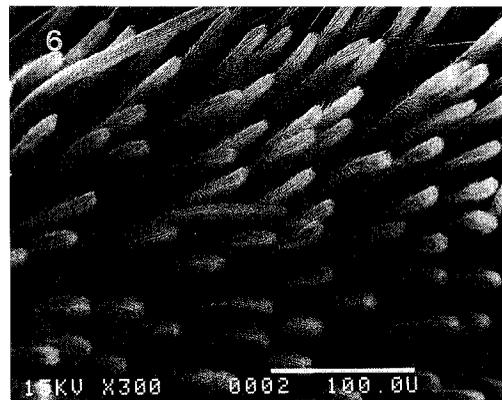
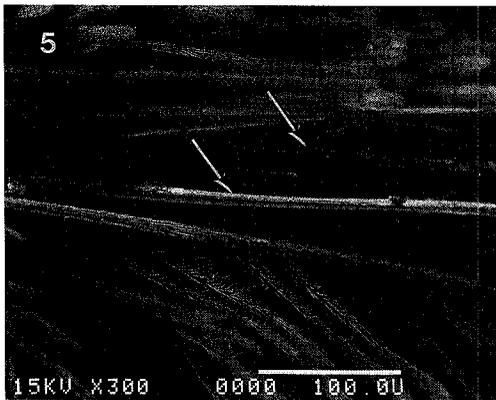
tened ventrally), ALE length, 1.00× AME diameter, ALE-PLE, 0.20, 0.30× AME diameter, PLE, 0.90, 0.95× AME diameter, PLE-PME contiguous; PME ovoid, 0.70, 0.80× AME diameter. Thoracic groove a transverse pit with anterior border straight. Sternum widest between bases of coxae II & III; unique medial sternal setae short, basally swollen, and sharply constricted toward apex, some with hairlike apical portion but in most appear to be broken off;



Map 1.—Distribution of *Aphonopelma joshua* new species (▲) and *Aphonopelma mojave* (○). The boundaries of the Mojave Desert (as perceived by the author) are indicated by the outer-most dotted lines; the area delimited by the inner-most dotted line indicates the geographic barrier that separates eastern and western populations of *A. mojave*.

marginal setae stout, slightly swollen basally, longer than medial setae; intermediate setae similar to marginal setae but less stout. Medial coxal setae (coxae I-IV) stout, thickened basally, similar to medial sternal setae although more elongate; distal and marginal setae similar to marginal sternal setae, proximal setae similar to intermediate and medial sternal setae. Distal maxillary setae similar to marginal sternal setae;

basomarginal, retromarginal, and medial setae similar to medial sternal setae but slightly less stout and usually apically filiform; most anterior setae relatively fine, hair-like. Femur III laterally swollen, at widest point 2.35, femur I, 1.70 (widest point other than at base just preapical of articulation with patella), WFIII/WFI = 1.36. Prolateral face of coxa I with pad of fine hair-like, distally plumose setae both above and below suture. Tibia I arcuate, somewhat less than average condition. Leg and palp segment lengths in Table 3. Extent of scopulae ($\times 100 =$ percent): metatarsi I & II complete; metatarsus III, prolaterodistal 0.75 (0.95 if scattered individual scopula hairs are considered), retrolaterodistal, left, 0.60, right, 0.55; metatarsus IV, 0.40 mediiodistal. Metatarsus IV scopula completely divided by setae; tarsus IV scopula divided by setae proximal, left, 0.50, right, 0.60. Spination: metatarsus I, 1v(am), tibia I, L2d(1p0.30 1p0.70) R1d(1p0.30) L5v(1r0.10 1er 1r0.50 1p0.45 1p0.55) R3v(1er 1p0.50 1r0.55), femur I, 1d(p0.85); metatarsus II, L4v(1ap 1am 1ar 1r0.30) R2v(1am 1r0.35), tibia II, 2d(10.33 1p0.67) L4v(1ap 1ar 1r0.50 1r0.55) R5v(1ap 1ar 1p0.50 1r0.15 1r0.55), patella II, L1d(p0.50), femur II, 1d(p0.85); metatarsus III, 4d(1ep 1er 1p0.35 1r0.40) L6v(1ap 1am 2ar 1p0.45 1r0.20) R7v(1ap 1am 1ar 1p0.50 1r0.20 1r0.45), tibia III, L4d(1p0.25 1p0.65 1r0.15 1r0.90) R4d(1p0.60 1r0.20 1r0.60 1r0.90) L5v(2ap 1ar 1p0.50 1r0.50) R4v(1ap 1ar 1p0.50 1r0.45), femur III, R1d(1r0.80); metatarsus IV, L4d(1ep 1er 1p0.40 1r0.40) R3d(1ep 1er 1r0.45) L14v(1ap 1am 2ar 3p0.10–0.50 7r0.15–0.65) R14v(1ap 1am 1ar 2p0.30–0.50 8r0.10–0.80),



Figures 5, 6.—Tarsus IV scopulae. 5, *Aphonopelma joshua* new species, division of scopulae by setae (setae indicated by arrows); 6, *Aphonopelma mojave* new species, scopula undivided.

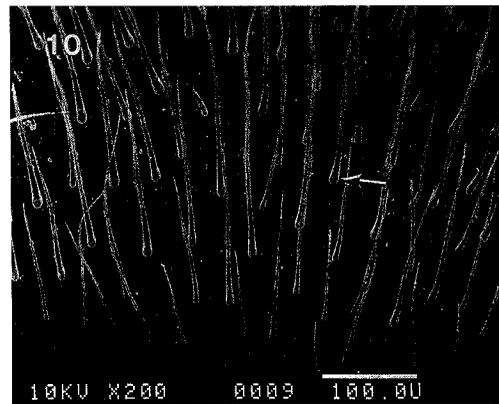
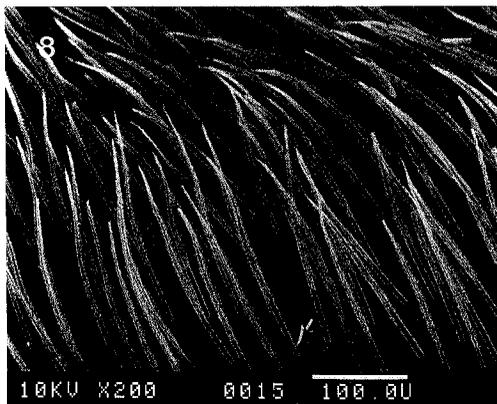
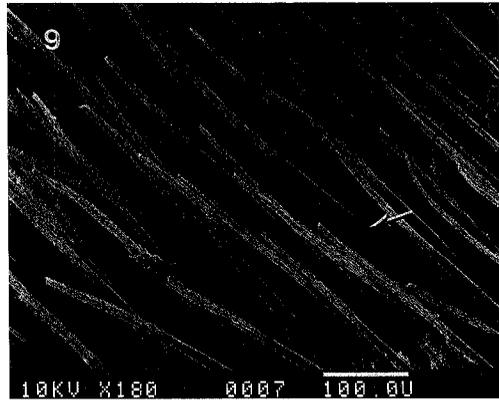
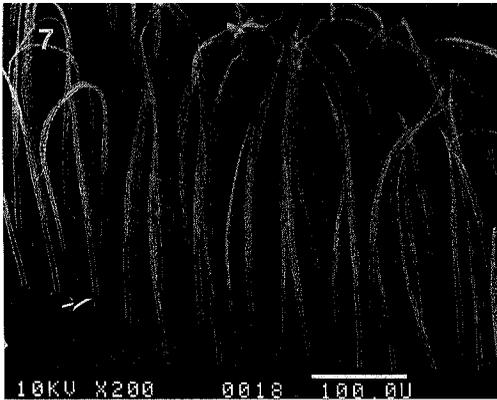
Table 3.—*Aphonopelma joshua* new species, holotype male: leg and pedipalp segment lengths.

	I	II	III	IV	Palp
Femur	9.20	8.75	8.40	9.80	5.20
Patella	4.25	3.90	3.60	3.80	2.80
Tibia	8.00	7.50	6.90	8.50	4.65
Metatarsus	8.20	8.30	9.60	11.75	
Tarsus	5.30	5.30	5.40	6.00	1.90
Total length	34.95	33.75	33.90	39.85	14.55

tibia IV, L1d(1r0.40) R3d(1p0.65 1r0.45 1r0.75) L5v(1ap 1ar 1p0.50 1r0.10 1r0.50) R4v(1ap 1ar 1p0.65 1r0.55); palpal tibia, 3d(1p0.35 1p0.60 1p0.85) L4v(1p0.55 1p0.80 1p0.85 1r0.50) R3v(1p0.55 1p0.80 1r0.45), palpal patella, L1d(p0.50), palpal femur, 1d(p0.85).

Female: Allotype. Overall length, 28.0; carapace, length, 9.70, width, 8.70; sternum, length, 4.35, width, 4.00; chelicerae, length, 3.70,

width, 5.30. Cheliceral macroteeth, 7 right, 8 left; denticles, 9 right, 12 left. Labial cuspules, 50; maxillary cuspules, 72 right, 79 left. General color dark gray-black or black; carapace with bronze or gray-green sheen, pubescence appressed, medium density; chelicerae black with silver sheen; abdominal pubescence mouse gray or gray-black, oblong patch of urticating hairs black, clearly visible; legs gray, darker than abdomen, transitional between abdomen and carapace colors; ventral aspect dark gray-black (abdomen slightly less black) except orange color of labium, palpal coxae and scopulae of palpal coxae. Abdominal anterodorsal setae black, relatively long, with distal portion pale buff, less stout than homologous setae in male; long, basally dark pale orange-buff setae generally longer and slightly more slender than anterodorsal setae, interspersed mostly within and just outside of urticating patch; anterolateral, lower posterolateral, and ventral setae generally shorter



Figures 7–10.—Prolateral setae of coxa I (arrows indicate setal bases). 7, Hairlike setae of *Aphonopelma joshua* new species; 8, Hairlike setae of *Aphonopelma mojave* new species; 9, Spiniform, basally thickened setae, *Aphonopelma iodum*, Red Mountain, California; 10, Spiniform, basally thickened setae, *Aphonopelma iodum*, Beaver Dam Mountains, Utah.

and more slender than dorsal setae, similar in color to anterodorsal setae; dark ventral setae often very fine. Oblong patch of black urticating hairs covering posterodorsal 60% of abdomen. Legs with gray-black pubescence, shortest setae mostly black, longer setae with proximal half black, distal half pale orange-buff. Cephalic region of carapace rising from thoracic region at a steeper slope than in male, almost three times height of lowest area of thoracic region. Ocular turret intermediate in height, width $0.24 \times$ maximum cephalic region width; lateral eyes with relatively normal dorsolateral orientation. AME circular, AME-AME, $0.9 \times$ AME diameter, AME-ALE, $0.4 \times$ AME diameter, AME-PME, $0.15 \times$ AME diameter; ALE and PLE roughly ovoid, somewhat flattened ventrally; ALE length, $1.0 \times$ AME diameter, ALE-PLE, $0.5 \times$ AME diameter; PLE length, $0.6, 0.7 \times$ AME diameter, PLE-PME almost contiguous; PME sub-circular, $0.5 \times$ AME diameter. Thoracic groove transverse, slightly procurved. Sternum widest between bases of coxae II & III. Contrary to condition in male all sternal setae relatively fine and attenuate, medial setae generally longer but relatively slender compared to stout, spiniform marginal setae. Medial setae of coxae III & IV and most basal, promarginal, and retromarginal setae of all leg coxae intermediate between medial and marginal sternal setae in basal diameter; medial setae of coxae I & II similar to medial sternal setae. Basomarginal, retromarginal, and distal setae of palpal coxae intermediate in basal diameter, setae becoming more slender toward promargin. Femur III not swollen as in male. All leg segments shorter than carapace length; femur IV and metatarsus IV longer than femur I. Setation on prolateral face of coxa I as in holotype. Leg and palp segment lengths are in Table 4. Extent of scopulae ($\times 100 = \%$): metatarsi I & II scopulae as in holotype; metatarsus III, prolaterodistal 0.60, retrolaterodistal 0.50; metatarsus IV, prolaterodistal 0.35, retrolaterodistal 0.25. Metatarsus IV scopula divided by setae; tarsus IV scopula divided by setae proximal 55 percent. Spination: metatarsus I, 1v(am), tibia I, L2d(1p0.25 1p0.60) (R2d(1p0.20 1p0.60) L5v(2ap 1ar 1p0.15 1p0.45) R5v(2ap 1ar 1p0.15 1p0.40), patella I, 1d(p0.50) R1v(m0.75), femur I, 1d(p0.80); metatarsus II, R1d(p0.35) 3v(1ap 1am 1r0.35), tibia II, L2d(1p0.25 1p0.60) L5v(2ap 1ar 1p0.15 1p0.45) R3d(1p0.20 1p0.60 1p0.85) R6v(2ap 1ar 1p0.35 1r0.15 1r0.40), patella II, 1d(p0.50)

Table 4.—*Aphonopelma joshua* new species, allotype female: leg and pedipalp segment lengths.

	I	II	III	IV	Palp
Femur	7.70	7.00	6.50	8.20	5.60
Patella	4.00	3.80	3.50	3.80	3.10
Tibia	5.90	5.20	4.70	6.40	4.20
Metatarsus	5.40	5.30	6.00	8.05	
Tarsus	4.00	4.00	4.20	4.70	4.00
Total length	27.00	25.30	24.90	31.15	16.90

1v(m0.85), femur II, 1d(p0.75); metatarsus III, L5d(1p0.15 1p0.35 1ep0.85 1r0.40 1er0.80) L6v(1ap 1am 1ar 1p0.25 1p0.40 1r0.40) R6d(1p0.15 1p0.45 1ep0.85 1r0.45 2er0.85) R5v(1ap 1am 2ar 1r0.40), tibia III, L6d(1p0.20 1p0.55 1p0.85 1r0.15 1r0.55 1r0.80) L6v(2ap 1ar 1p0.40 1r0.15 1r0.50) R5d(1p0.25 1p0.55 1r0.25 1r0.55 1r0.85) R10v(2ap 1ar 1p0.40 1p0.70 1r0.15 1r0.25 1r0.40 1r0.60 1r0.65), femur III, L2d(1r0.70 1r0.85) R2d(1p0.80 1r0.80); metatarsus IV, L4d(1p0.40 1ep0.90 1r0.45 1er0.90) L11v(1ap 1am 2ar 1p0.30 1p0.55 5r0.15–0.70) R4d(1p0.45 1ep0.85 1r0.40 1r0.90) R14v(1ap 1am 2ar 1p0.15 1p0.30 1p0.50 7r0.15–0.85), tibia IV, L4d(1p0.65 1r0.15 1r0.65 1r0.85) L7v(2ap 1ar 1p0.45 1r0.15 1r0.36 1r0.60) R4d(1p0.65 1r0.15 1r0.65 1r0.85) R6v(2ap 1ar 1p0.45 1r0.15 1r0.40), femur IV, L1d(r0.75); palpal tibia, 2d(1p0.55 1p0.90) L8v(3ap 1ar 1p0.25 1p0.60 1r0.45 1er0.85) R9v(2ap 1ar 1p0.25 1p0.60 1r0.20 1r0.45 1r0.60 1er0.90), palpal patella, 1d(p0.25), palpal femur, 1d(p0.85).

Variation.—*Males*: Total length 19.00–26.75. Cheliceral macroteeth, 7–9, 8 most common (60%), 9 least common (6%), denticles, 5–17. Labial cuspules, 33–78, $\bar{x} = 54$; maxillary cuspules, 69–117 (each side), $\bar{x} = 88$. Coloration of new males tends to fade over time to dark brown-gray, carapace often with a bronze sheen. In some specimens the long pale orange-buff setae, normally interspersed within or just outside urticating patch, are sparsely interspersed on the venter, lateral surfaces, and slightly more anterior of urticating patch. Patch of type I urticating hair (as in Fig. 11) covering distal 40–60% of abdomen. Femur I and metatarsus III almost always longer than, rarely equal to or shorter than, carapace; tibia I usually shorter than, rarely equal to or longer than, metatarsus I; metatarsus I slightly to moderately arcuate

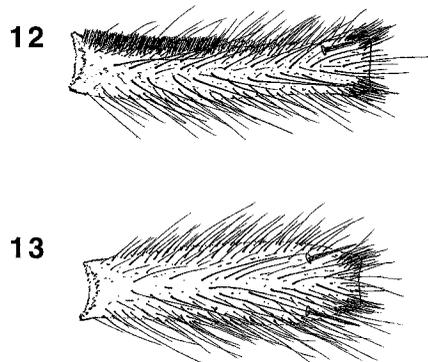
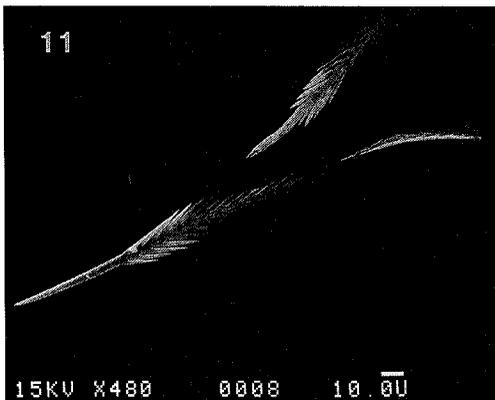
Table 5.—*Aphonopelma joshua* new species, males (25 including holotype): range of leg and pedipalp segment lengths.

	I	II	III	IV	Palp
Femur	7.85–9.85	7.40–9.40	7.20–9.00	8.35–10.50	4.30–5.60
Patella	3.60–4.50	3.40–4.20	3.00–3.80	3.20–4.00	2.30–2.90
Tibia	6.75–8.40	6.10–7.80	5.90–7.20	7.30–8.90	4.00–4.95
Metatarsus	6.85–9.00	6.80–9.20	8.10–10.55	10.20–12.70	
Tarsus	4.40–5.60	4.40–5.60	4.50–5.80	5.10–6.50	1.50–2.00

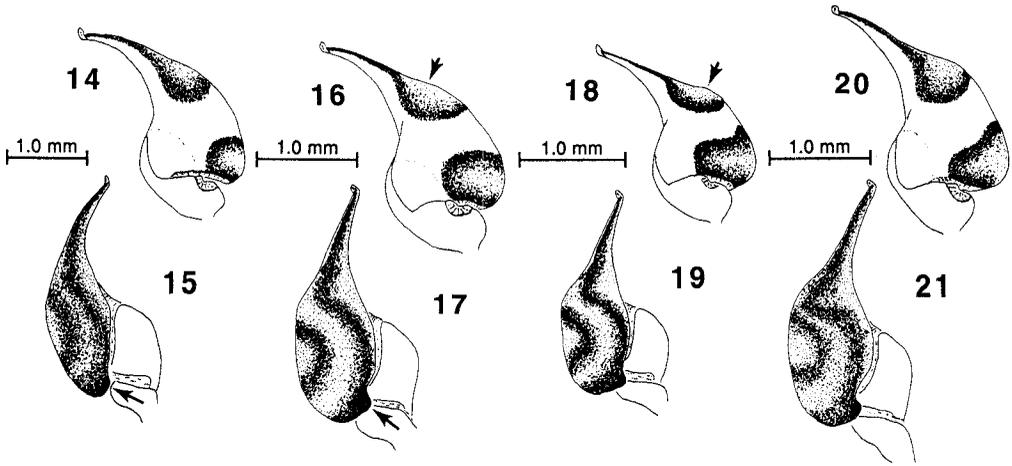
proximal portion of segment (in comparison to *A. mojave*); femur III laterally swollen (Figs. 12, 13), variable in degree. Ranges of leg and pedipalp segment lengths are in Table 5. Basal division of palpal bulb variable in shape; bulb itself and embolus (Fig. 14) relatively constant in shape; proximal prolateral protuberance of middle division slight (Fig. 15) or absent. Extent of scopulae ($\times 100 = \%$): metatarsus II complete prolaterally but often very sparse or short of base retrolaterally and medially, metatarsus III prolaterodistal 0.50–0.85, $\bar{x} = 0.63$ (often scattered hairs past 0.75), slight retrolateral reduction metatarsus IV 0.25–0.50, $\bar{x} = 0.36$ (medial). Ventroapical metatarsal spination: I, 1–2, II, 2–3, III, 3–5 (usually 4), IV, 4–6 (usually 4).

Females: Total length 15.70–28.00. Cheliceral macroteeth, 7–9, 8 most common (70%), 9 least common (20%), denticles, 5–25 (each side). Labial cuspules, 50–97, $\bar{x} = 69$; maxillary cuspules, 67–154 (each maxilla), $\bar{x} = 93$. Coloration of females tends to fade over time, carapace and chelicerae to bronze, gray-green, or brown-gray (chelicerae somewhat

darker), abdomen to mouse gray or faded carapace color (usually lighter), and legs to brown-gray (intermediate in color between carapace and abdomen) with femora and tarsi darker. In some females, the long, pale orange-buff abdominal setae are sparsely interspersed more anterior of the urticating patch, on the venter, and on the lateral abdominal surfaces. Spermathecae variable in shape and relative distance between bulbs (Figs. 22, 23). Although spermathecal characters have been found useful in distinguishing between other closely related mygalomorph species they appear to be of no diagnostic value in separating females of *A. joshua* from those of *A. mojave* (Figs. 24–28). Range of leg and pedipalp segment lengths in Table 6. Extent of scopulae ($\times 100 = \%$): metatarsus III, prolaterodistal 0.55–0.85, $\bar{x} = 0.65$ (only one specimen greater than 0.75), slight retrolateral reduction, metatarsus IV, distal 0.30–0.65 (usually medial), $\bar{x} = 0.40$, lateral extent slightly reduced, prolateral extent usually greater than retrolateral. Ventroapical metatarsal spination: I, 1–2, II, 2–3, III, 4–5 (rarely 5), IV, 4.



Figures 11–13.—11, Type I urticating hair, (*Aphonopelma mojave* new species, male, east Mojave); 12, 13, Femora of *Aphonopelma joshua* new species showing comparative widths; 12, Femur I (normal); 13, Femur III (swollen).



Figures 14–21.—Palpal bulbs of *Aphonopelma joshua* new species and *Aphonopelma mojave* new species, right; even, ventral (short arrows show retrolateral bend into apical portion); odd, dorsal (long arrows show position and degree of protrusion of proximal prolateral protuberance). 14, 15, *A. joshua*; 16, 17, *A. mojave*, east Mojave, near Kelso, California; 18, 19, *A. mojave*, east Mojave, BDM, Utah; 20, 21, *A. mojave*, west Mojave, Red Mountain, California.

Distribution.—*A. joshua* has a relatively limited distribution, primarily, in Joshua Tree National Monument between the northern flanks of the Eagle, Cottonwood and Little San Bernardino Mountains and the southern flanks of the Pinto Mountains (excluding the eastern Pinto Mountains and Pinto Basin), Queen Mountain, and Wonderland of Rocks. Outside of the monument, the species occurs south of the juncture of the Eagle and Cottonwood Mountains in a very limited area above 550 m in elevation, west of the northwestern boundary of the Monument in upper Morongo Valley, and north of Yucca Valley in two foothill desert valleys (San Bernardino Mountains), one serviced by Pipes Canyon Rd. (roughly parallels Pipes Wash), the other by New Dixie Mine Road, approximately 10 km north of Pipes Canyon Road, south of the Big-horn Mountains. This latter area appears to be the northern-most limit of the species. *A. josh-*

ua would be considered rare north of a diagonal connecting Queen Mountain and New Dixie Mine Rd. The distribution of *A. joshua* is shown on Map 1.

Material examined.—Type specimens and the following: **CALIFORNIA:** *Riverside County:* JTNM, Fried Liver Wash, 27 August 1965 (E.L.S. & S.L.J.), 1♀. Squaw Tank, 3500 ft. elev., 1♂, 9 September 1966 (E.L. Sleeper & S.L. Jenkins). Pleasant Valley, 1ma, 23 September 1967 (E.L. Sleeper & S.L. Jenkins). Lost Horse Valley, 1.1 mi. S of Quail Springs Rd. on Keys View Rd., 1 mi. W of K. V. Rd., 4383 ft. elev., definitive molt, 7 July 1989; 1♂, 3 May 1989. 4400 ft. elev., 1♀, Cottonwood Springs, near visitor's center, 3100 ft. elev., 3♂, 23 August 1989; Cottonwood Springs Rd, Smoke Tree Wash, 4.4 mi. N of visitor's center, 2710 ft. elev., 1♂, 31 August 1989. *San Bernardino County:* JTNM, west of Wonderland of Rocks, 4.5 mi. SE of monument entrance on Quail Springs Rd., 3950 ft. elev., definitive molt, 7 July 1989; 1♂, 28 March 1989; Pipes Canyon Rd. (Pipes Wash), 4.5

Table 6.—*Aphonopelma joshua* new species, females (10 including allotype): range of leg and pedipalp segment lengths.

	I	II	III	IV	Palp
Femur	4.90–7.70	4.40–7.00	4.00–6.50	5.15–8.20	3.60–5.60
Patella	2.60–4.00	2.40–3.80	2.20–3.50	2.40–3.80	2.00–3.10
Tibia	3.90–5.90	3.30–5.20	2.90–4.70	4.20–6.40	2.70–4.20
Metatarsus	3.20–5.40	3.15–5.30	3.60–6.00	5.10–8.05	
Tarsus	2.50–4.00	2.50–4.00	2.65–4.20	3.10–4.70	2.60–4.00

mi. W of Hwy 247, 4270 ft. elev., definitive molt, 24 June 1991; 1♂, 4 November 1989; 4300 ft. elev., 1♂, 1 August 1992; 2.5 mi. W of Hwy 247, 4000 ft. elev., definitive molt, July 1992; 1♂, 18 April 1990; 8.3 mi. W of Hwy 247 toward Burns Canyon, 4350 ft. elev., 3♀, 2 Nov. 1991; 5.9 mi. W of Hwy 247 toward Burns Canyon Rd., 4240 ft. elev., 1♀, 13 Sept. 1992; New Dixie Mine Rd., 10.5 mi. N Yucca Valley on Hwy 247, 6.3 mi. W, 5000 ft. elev., 1♀, 11 Sept. 1992; Morongo Valley, 5.1 mi. NE of Post Office off Hwy 62, 2890 ft. elev., 1♀, 6 Sept. 1993. Specimens collected by the author deposited in AMNH.

Aphonopelma mojave new species

Figs. 3, 4, 6, 8, 11, 16–21, 24–28; Map 1

Types.—Holotype male, allotype female, 9 paratype males, and 5 paratype females from San Bernardino County and Kern County California, south of Red Mtn., 20 mi. N of Kramer Jct. on Hwy 395, 1–2 mi. W of Hwy 395. Holotype collected 28 October 1989, 12:45 PM, 3450 ft. elev. Allotype lured out of burrow after dark 20 October 1991, 3250 ft. elev. Paratype males: 1974, 10 October 1989 (2) (W. Icenogle); 28 October 1991 (1); 14 October (1), 26 October (5), 2990–3450 ft. elev. Paratype females: 13 October 1991 (1), 20 October 1991 (1); 1992, 25 January 1992 (1), 4 October 1992 (1), 13 October 1992 (1), 3220–3280 ft. elev. All types except those specified collected by author. Types deposited in AMNH.

Etymology.—The specific name is a noun in apposition taken from the name of the desert within which the species appears to be almost totally contained.

Diagnosis.—*A. mojave* new species is distinguished from other species by the following combination of characters: carapace color, hair-like setae of proteral coxa I (Fig. 8), undivided tarsus IV scopula (Fig. 6), limited extent of metatarsus IV scopula, and proportional lengths of tibiae and metatarsi I and II and leg III. In only three other species, *A. joshua*, *A. paloma*, and *A. radinum*, are the proteral setae of coxa I hair-like. *A. mojave* is easily distinguished from the two former species by entire scopula of tarsus IV and again from *A. joshua* by the spiniform setae of the sternum (Fig. 3) and ventral coxae (Fig. 4) in males and from *A. radinum* (female unknown) by proportionately shorter tibiae I and II and longer leg III. In one other similar species, *A. marxi* (= *A. simulatum*), the proteral

setae of coxa I are slightly swollen basally; *A. mojave* is distinguished from this species (females unknown) by proportionately much longer metatarsi I and II and legs III and IV. *A. mojave* is easily distinguished from two other small species, *A. phasmus* and *A. zionis*, by characters in Table 1.

Description.—*Male*: Holotype. Total length, 19.70; carapace, length, 8.50, width, 7.50; sternum, width, 3.65, length, 3.70; chelicerae, width, 3.80, length, 2.50. Cheliceral macroteeth, right 9, left 8; each side with 10 denticles. Labial cuspules, 33; maxillary cuspules, 90 right, 95 left. General color black with a faint bluish sheen; carapace with black pubescence, not appressed, moderately dense in cephalic region, increasing in density toward posterolateral and caudal margins. Abdomen clothed with blue-black pubescence; long, basally dark, orange-buff (or orange-tan) setae interspersed over entire dorsal, posterolateral, and caudal surfaces; slightly shorter versions of these setae on anterolateral and ventral surfaces, least dense on venter; circular patch of black type I urticating hairs (Fig. 11) covering posterodorsal 45 percent of abdomen, not clearly visible because of pubescence coloration and extensive interspersation of long orange-buff setae. Leg pubescence black, longer setae similar in color to abdominal setae, shorter setae dark with pale orangish-buff apices. Cephalic region rising gradually from thoracic region, slightly more than one and a half times higher. Ocular turret width slightly greater than 20 percent of maximum cephalic width, intermediate in height. AME circular, approximately 2.5, AME-AME, 0.6× AME diameter, AME-ALE, 0.15× AME diameter, AME-PME, 0.1× AME diameter; ALE roughly ovoid, somewhat flattened ventrally, 0.9× AME diameter, ALE-PLE, 0.4× AME diameter, ALE-PME, 0.5× AME diameter; PLE, subcircular, 0.55× AME diameter, PLE-PME contiguous; PME irregular to elongate ovoid, slightly longer and narrower than PLE. Thoracic groove a transverse pit with anterior edge procurved. Medial sternal setae slender, attenuate; marginal setae basally stout, more spiniform; setae between medial and marginal setae intermediate in basal diameter. Promarginal and retromarginal setae of coxae I-IV similar in basal diameter to marginal sternal setae; medial setae similar to intermediate sternal setae. Baso- and retromarginal setae of palpal coxa similar to

Table 7.—*Aphonopelma mojave* new species, holotype male: leg and pedipalp segment lengths.

	I	II	III	IV	Palp
Femur	8.20	7.70	7.10	8.35	4.90
Patella	3.85	3.60	3.15	3.40	2.60
Tibia	6.60	5.95	5.30	6.85	4.50
Metatarsus	6.60	6.55	7.10	9.00	
Tarsus	4.50	4.50	4.50	5.00	2.00
Total length	29.75	28.30	27.15	32.60	14.00

intermediate sternal setae; distal setae similar to marginal sternal setae, setae becoming finer toward promargin of coxa. Femur III only slightly wider than femur I, WFIII/WFI = 1.09. Metatarsus I basally arcuate, bend moderate. Prolateral face of coxa I with fine, hairlike, distally plumose setae both above and below suture. Leg and palp segment lengths in Table 7. Extent of scopulae ($\times 100 = \%$): metatarsi I and II to base (retrolateral scopula of metatarsus II, distal 0.85), metatarsus III, prolaterodistal 0.70, 0.75 (right and left, respectively), retrolaterodistal 0.55, 0.60, metatarsus IV, distal 0.40 medial, 0.25 lateral. Tarsus IV scopula entire, not divided by setae; metatarsus IV scopula divided proximal, right, 25, left, 40 percent. Spination: metatarsus I, 1v(am), tibia I, 2d(1p0.30 1p0.70) R4v(1br 1r0.20 1r0.50 1er) L4v(1br 1r0.50 2er), femur I, 1d(ep>0.80); metatarsus II, R3v(1r0.30 1ap 1am) L2v(1ap 1am), tibia II, 2d(1p0.25 1p0.65) R5v(1br 1r0.35 2ap 1ar) L5v(1br 1r0.50 2ap 1ar), femur II, 1d(ep>0.80); metatarsus III, R4d(1p0.35 1ep 1r0.40 1er) R5v(1p0.40 1r0.35 1ap 1am 1ar) L4d(1p0.45 1ep 1r0.40 1er) L5v(1p0.35 1r0.35 1ap 1am 1ar), tibia III, R4d(1p0.25 1p0.65 1r0.25 1r0.60) R3v(1r0.40 1ap 1ar) L3d(1p0.65 1r0.35 1r0.65) L4v(1p0.40 1r0.40 1ap 1ar), femur III, R1d(er); metatarsus IV, R3d(1r0.50 1ep 1er) R8v(1p0.15 1p0.50 1r0.15 1r0.50 1r0.60 1ap 1am 1ar) L4d(1p0.45 1r0.45 1ep 1er) L9v(1p0.30 1p0.50 1r0.15 1r0.45 1r0.55 1ap 2ar), tibia IV, R1d(1r0.70) R4v(1p0.40 1r0.45 1ap 1ar) L3d(1r0.25 1r0.70 1r0.85) L3v(1r0/35 1ap 1ar); palpal tibia, R1d(p0.65) R3v(1p0.55 1p>0.80 1r0.40) L1d(p0.50) L3v(1p0.50 1p>0.80 1r0.45), palpal patella, 1d(p0.60), palpal femur, 1d(ep).

Female: Allotype. Total length, 26.40; carapace, length, 9.00, width, 7.75, LC/WC = 1.16; sternum, width, 4.05, length, 4.00; chelicerae, width, 4.80, length, 3.40. Cheliceral macroteeth,

8 each side, denticles, 19 right, 17 left. Maxillary cuspules, 101 right, 115 left; labial cuspules, 66. WCh/WC = 0.62. General color black, carapace with a blue-green-black sheen, pubescence moderately dense, not appressed. Black pubescence of abdomen with dull green cast, slightly darker than carapace. Long, basally dark, pale orange-buff setae interspersed over entire dorsum and posterolateral surfaces, anterodorsal setae with dark coloration extending further up shaft; anterolateral setae similar to anterodorsal setae. Most ventral setae short and black, longer ventral setae sparsely interspersed and similar to anterolateral setae. Patch of black, type I urticating hair covering posterodorsal half of abdomen, not clearly visible because of dark color of pubescence and extensive interspersed of long orange-buff setae. Legs with black pubescence similar in color to abdomen; shortest setae mostly black with distal portion pale tan, longer setae pale orange-buff with basal portion black. Cephalic region slightly higher and rising more abruptly from thoracic region than in male; thoracic groove transverse, anterior margin procurved; ocular turret occupying 23% of maximum cephalic width. AME circular, approximately 3.5, AME-AME, $0.9 \times$ AME diameter, AME-ALE, $0.4 \times$ AME diameter, AME-PME, $0.3 \times$ AME diameter; ALE ovoid, somewhat flattened on bottom, length, $1.0 \times$ AME diameter, ALE-PLE, 0.6, $0.75 \times$ AME diameter; PLE, right irregular, length, $0.7 \times$ AME diameter, left subcircular, $0.6 \times$ AME diameter, PLE-PME, 0.1, $0.15 \times$ AME diameter; PME elongate ovoid, length, $0.5 \times$ AME diameter. Ventral setae of sternum as in holotype although homologous setae slightly less stout. Setae of ventral coxa and prolateral coxa I as in holotype. Femur III not swollen. Leg and palp segment lengths are in Table 8. Extent of scopulae ($\times 100 = \%$): metatarsi I & II, to base (retrolateral scopula of metatarsus II, distal 0.80, medial scopula absent at very base); metatarsus III, left, prolaterodistal 0.85 (0.50 dense), retrolateral 0.70 (0.55 dense), right, prolaterodistal 0.80 (0.65 dense), retrolateral 0.55 (0.45 dense); metatarsus IV, left, distal 0.40 medial, 0.25 prolateral, 0.20 retrolateral, right, distal 0.40 medial, 0.30 prolateral, 0.20 retrolateral. Tarsus IV scopula entire, not divided by setae; metatarsus IV scopula, left, divided by setae proximal 40%, right, proximal 42 percent. Spination: metatarsus I, 1v(am), tibia I, 1d(p0.65) R5v(1r0.10 1r0.50 2ap 1ar) L4v(1r0.40 2ap 1ar), femur I,

Table 8.—*Aphonopelma mojave* new species, allotype female: leg and pedipalp segment lengths.

	I	II	III	IV	Palp
Femur	7.05	6.45	5.90	7.30	5.20
Patella	3.80	3.50	3.10	3.40	2.85
Tibia	5.50	4.75	4.20	5.75	3.85
Metatarsus	4.75	4.65	5.20	7.10	
Tarsus	3.70	3.60	3.60	4.00	3.60
Total length	24.80	22.95	22.00	27.55	15.50

1d(ep); metatarsus II, R1d(p0.35) L1d(p0.80) 3v(1r0.30 1ap 1am), tibia II, R2d(1p0.20 1p0.60) R5v(1r0.15 1r0.45 2ap 1ar) L2d(1p0.25 1p0.65) L3v(1r0.41 2ap 1ar), femur II, 1d(ep); metatarsus III, R3d(1r0.40 1ep 1er) L4d(1p0.35 1r0.40 1ep 1er) 5v(1p0.40 1r0.35 1ap 1am 1ar), tibia III, R3d(1p0.60 1r0.45 1r0.85) L5d(1p0.20 1p0.55 1r0.15 1r0.55 1r0.85) 6v(1p0.50 1r0.15 1r0.35 2ap 1ar), femur III, R1d(ep) L2d(1ep 1r0.60); metatarsus IV, 3d(1r0.45 1ep 1er) R8v(1p0.30 1p0.50 1r0.20 1r0.35 1r0.65 1ap 1am 1ar) L8v(1p0.50 1r0.15 1r0.25 1r0.40 1r0.50 1ap 1am 1ar), tibia IV, 3d(1r0.15 1r0.65 1r0.85) R6v(1r0.15 1r0.45 1r0.65 2ap 1ar) L5v(1p0.40 1r0.45 2ap 1ar), femur IV, L1d(er); palpal tibia, R2d(1p0.45 1p0.85) L2d(1p0.55 1p0.85) R8v(1p0.50 1p0.75 1r0.35 1r0.55 1er 2ap 1ar) L7v(1p0.20 1p0.55 1r0.40 1er 2ap 1ar), palpal femur, 1d(ep).

Variation.—*A. mojave* consists of an eastern and western race, geographically isolated from one another in the eastern and western Mojave Desert, respectively, by the Death Valley drainage. Eastern males have swollen third femora, and, although there is slight swelling in some western males there is no overlap in this character between the eastern and western races. The lower process of the tibial spur in eastern males is generally articulated at a lesser angle and is apically more angular or curved than in western males. The

smallest males of the species, found in Southern Utah, differ from other eastern males in having tibia I longer than metatarsus I instead of the usual reversed condition. While both conditions exist in western males there is quotient overlap only with eastern males from southern Utah. Eastern females have a relatively shorter metatarsus III than western females. In eastern specimens the carapace has a green-black or golden black (more common) sheen, the abdomen and chelicerae a green-black cast; in western specimens the carapace has black or blue-black sheen, the abdomen and chelicerae a blue-black cast.

Males: Total length, 15.1-21.1. Sternum length usually greater than but sometimes equal to width. Cheliceral macroteeth, eastern, 7-9, 7 most common (86%), 9 least common (2%), western, 6-9, 8 most common (55%), 7 (33%), 6 and 9 equally common (5%); denticles 4-20. Maxillary cuspules, western, 65-130 (\bar{x} = 101), eastern, 48-107 (\bar{x} = 82); labial cuspules, western, 33-90 (\bar{x} = 59), eastern, 26-68 (\bar{x} = 50). Long, pale orangish-buff setae of ventral abdomen may be sparse to moderately dense. Patch of type I urticating hairs covering distal 40-60% of abdominal dorsum. Tibia I arcuate, proximal bend moderate to strong, western males often with more pronounced bend. Ranges of leg and pedipalp segment lengths in Table 9. Little variation in morphology of the middle and apical portions of the palpal bulb (Figs. 16-21) and in form and articulation of basal division although significant variation in the shape of the basal division. ALE, PLE, and PME vary considerably in relative size, PLE and PME in shape also; AME circular, most consistently shaped, AME-AME less than their diameter apart; ALE generally ovoid with ventral perimeter of eye somewhat flattened, in western specimens length usually equal to or slightly less than, seldom greater than AME diameter, in eastern

Table 9.—*Aphonopelma mojave* new species, males (42 including holotype): range of leg and pedipalp segment lengths.

	I	II	III	IV	Palp
Femur	6.40-9.35	6.00-8.80	5.55-8.10	6.40-9.60	3.75-5.60
Patella	2.95-4.45	2.80-4.20	2.50-3.70	2.70-3.95	2.10-3.05
Tibia	5.35-7.65	4.85-6.95	4.25-6.10	5.60-7.85	3.60-5.25
Metatarsus	5.25-7.70	5.30-7.65	5.75-8.40	7.15-10.50	
Tarsus	3.70-5.10	3.60-5.10	3.50-5.20	3.80-5.80	1.60-2.40

Table 10.—*Aphonopelma mojave* new species, females (30 including allotype): range of leg and pedipalp segment lengths.

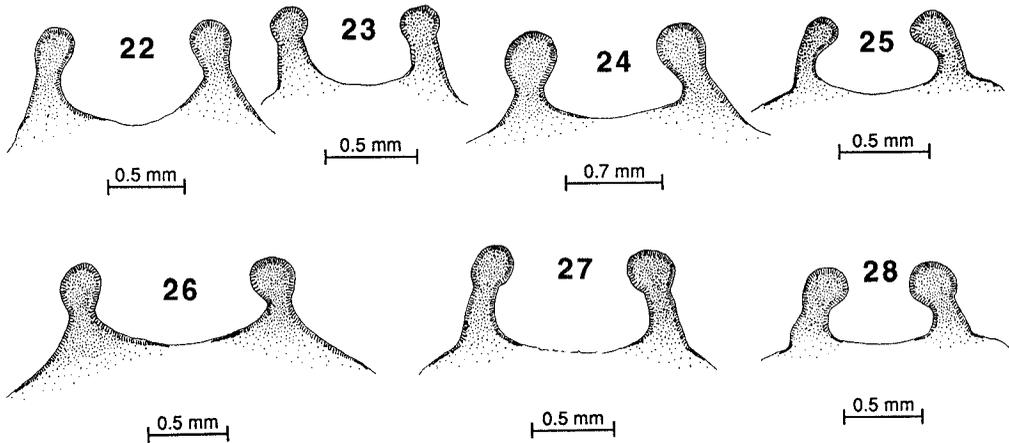
	I	II	III	IV	Palp
Femur	4.55–7.85	4.00–7.20	3.55–6.65	4.55–8.15	3.35–5.75
Patella	2.55–4.60	2.30–3.90	1.95–3.35	2.30–3.65	1.90–3.05
Tibia	3.45–5.85	2.90–5.15	2.45–4.50	3.70–6.30	2.35–4.05
Metatarsus	2.95–5.30	2.80–5.20	3.00–5.70	4.15–7.85	
Tarsus	2.40–4.00	2.30–4.00	2.30–4.10	2.60–4.50	2.30–4.00

specimens length usually greater than, seldom less than AME diameter; PLE usually smaller than ALE and larger than PME, usually ovoid, sometimes subcircular or irregular, PLE-PME barely removed or contiguous; PME often elongate ovoid or irregular, sometimes subcircular, generally smaller than PLE. Extent of scopulae ($\times 100 = \%$): retrolateral scopula of metatarsus II often short of base; metatarsus III, western, distal 0.60–0.85, eastern, 0.55–0.85 (prolateral maximum); metatarsus IV, western, distal 0.30–0.45, $\bar{x} = 0.39$, eastern, 0.25–0.55 (medial usually maximum), $\bar{x} = 0.33$. Metatarsus IV scopula entire to divided, western, proximal 71%, eastern, proximal 86%. Ventroapical metatarsal spination: I, 1, II, 1–3 (usually 2), III, 2–6 (eastern, usually 4, western, usually 3), IV, 3–8 (eastern, usually 4 or 5, western, usually 4).

Females: Total length, 14.6–24.1. Sternum widest between coxae I and II; width greater than (in more than 50% of specimens), \leq length in western race; width less than length in eastern race. Cheliceral macroteeth, west, 7–9, 8 most common (63%), 9 least common, east 6–9, 7 most common (57%), 8 (33%), 9 least common. Maxillary cuspules each side, western, 79–149 ($\bar{x} = 111$), eastern, 58–114 ($\bar{x} = 83$); labial cuspules, western, 35–100 ($\bar{x} = 74$), eastern, 26–85 ($\bar{x} = 54$). Carapace pubescence usually not closely appressed although frequently more appressed than in males. Long orangish-buff abdominal setae varies in density, often more sparse ventrally than in males. Patch of type I urticating hairs covering distal 40–70% of abdominal dorsum. Ranges of leg and pedipalp segment lengths in Table 10. Spermathecae variable in both shape and distance between spermathecal bulbs (Figs. 24–28), variation not correlated with geography. Eye arrangement as in male, posterior eyes most variable in relative size and shape, AME least variable; distance be-

tween adjacent eyes variable. Extent of scopulae ($\times 100 = \%$): metatarsi I and II as in allotype, metatarsus III, distal 0.55–0.85, western, $\bar{x} = 0.73$, eastern, $\bar{x} = 0.62$, metatarsus IV, distal 0.25–0.50 (western $\bar{x} = 0.38$, eastern $\bar{x} = 0.32$). Tarsus IV scopula entire, not divided by setae; metatarsus IV scopula usually partially divided by setae, less often, entire or completely divided. Ventroapical metatarsal spination: I, 1–2 (eastern, 1 or 2, western, usually 1) II, 1–3 (usually 2), III, 2–6 (eastern, usually 4, western, usually 3), IV, 3–6 (eastern, most often 4, less often 5, western, most often 4, less often 3).

Distribution.—*A. mojave* is found throughout the Mojave Desert except in certain regions of south-central Nevada, areas that geographically isolate the eastern and western races and BDM populations from other eastern populations, and most of JTNM. Only the northern-most populations near Goldfield Summit (western Nevada) inhabit biomes not characteristic of the Mojave Desert. East of Goldfield Summit toward the Beaver Dam Mountains, populations may exist in some of the less rocky valleys between the southern Nevada north-south mountain ranges although I am unaware of specimens collected in these areas. The Virgin Mountains, the rugged terrain toward the Grand Canyon, and decreasing elevations toward the Colorado River apparently bound the distribution of the eastern race. The (apparently) isolated populations of southern Utah and adjacent Arizona and Nevada were found as far south as the southern bajadas of the Mormon Mountains. The only known population in JTNM barely extends across the Monument's boundary in the extreme northeastern corner, just west of the Coxcomb Mountains where Pinto Basin exceeds 550 m elevation. *A. mojave* is considered rare in the southwestern Mojave south of the diagonal from Queen Mountain (JTNM)

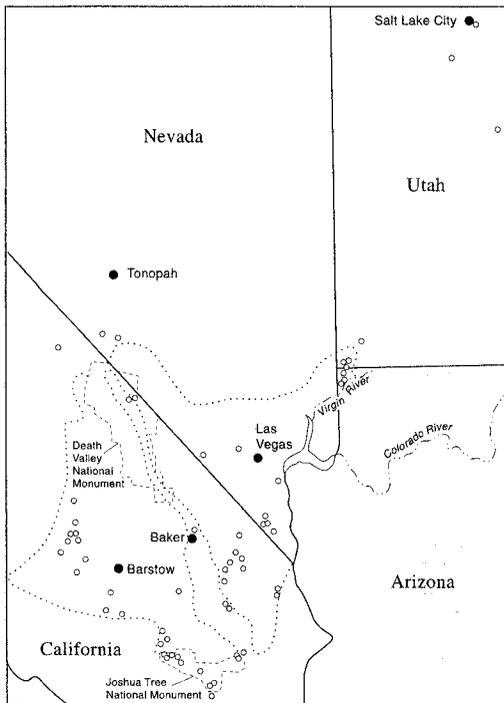


Figures 22–28.—Spermathecae of *Aphonopelma joshua* new species and *Aphonopelma mojave* new species. 22, 23, *A. joshua*, JTNM; 22, Covington Flats; 23, Fried Liver Wash, Pleasant Valley; 24, 25, *A. mojave*, west Mojave, Red Mountain, California; 26, *A. mojave*, west Mojave, NE Coxcomb Mountains, JTNM; 27, *A. mojave*, west Mojave, Yucca Valley, La Contenta Rd.; 28, *A. mojave*, east Mojave, Searchlight, Nevada.

to Pipes Canyon (foothills of the San Bernardino Mountains). The distribution of the species is shown on Map 1.

Material examined.—Type specimens and the following: **CALIFORNIA:** *San Bernardino County:* Halloran Summit, 0.5 mi. NW of I-15, 4125 ft. elev., 1♀, 24 September 1989. Hwy 247, Rattlesnake Springs Rd. W of Johnson Valley, 3140 ft. elev., 1♀, 1 November 1989. Apple Valley, S of A. V. toward Rattlesnake Mtn., 4060 ft. elev., 1♀, 4 November 1989. NE JTNM inside and outside of monument boundary, just west of Coxcomb Mtns. off Hwy 62, 12.2 mi. W of jct. Hwy 177, 2320 ft. elev., 1♀, 12 November 1989; 2050–2130 ft. elev., 3♂, 24 November 1989; 2050 ft. elev., 1♀, 31 January 1991; 2300 ft. elev., 1♀, 2 November 1991. Honda Rd., N of Yucca Valley off Hwy 247, 3890 ft. elev., 1♀, 14 April 1990; 3870 ft. elev., 1♀, 14 April 1991. Hwy 247, 20 mi. S of Barstow, 3200 ft. elev., 2♂, 16 October 1990 (S. Kutcher); 1♂, 26 October 1991. 7.5 mi. N of Pipes Canyon Rd. (Pipes Wash), 3680 ft. elev., definitive molt, late September–early October 1991; 1♂, 14 April 1991. 3.7 mi. N of Pipes Canyon Rd., 3400 ft. elev., 1♀, 18 April 1991. E of Yucca Valley, La Contenta Rd. between Hwy 62 and Yucca Trail Rd., 3275 ft. elev., 1♀, 2 November 1991. Apple Valley, 2 mi. S on Milpas Dr. off Hwy 78, 3040 ft. elev., 1♀, 5 May 1992. Cima, N of Cima, 4.6 mi. W on power line road, 4350 ft. elev., 1♂, 10 October 1992. 2.9 mi. W on power line road, 4590 ft. elev., 2♀, 11 October 1992. Black Canyon Rd., 2.8 mi. N of Essex Rd. jct., 3240 ft. elev., 1♀, 11 October 1992; 1♀, 25 October 1992. Kelbaker Rd., 9.4 mi. S of Kelso, 3120 ft. elev., 1♂, 31 October 1992. Cima,

1.5 mi. W of Kelso-Cima Rd. W of Cedar Canyon Rd., 3800 ft. elev., 1♂, 31 October 1992. Kelbaker Rd., 8 mi. S of Kelso, 2880 ft. elev., 1♂, 1 November 1992. Kelso-Cima Rd., 10 mi. N of Kelso, 3300 ft. elev., 1♂, 1 November 1992. Morning Star Mine Rd., 3.1 mi. SW of Ivanpah Rd. 3005 ft. elev., 1♂, 1 November 1992. Nipton, between Nipton and Nevada state line, 3245 ft., 3705 ft. elev., 2♂, 1 November 1992. *Kern County:* Hwy 395, 8.1 mi. N into Kern Co., 3500 ft. elev., 1♂, 20 October 1991. *Inyo County:* Death Valley National Monument, jct. Harrisburg Flats, Skidoo Rd., 5000 ft. elev., 2♂, 18 October 1963 (R. Hardy). *Los Angeles County:* San Gabriel Mtns. foothills, north slope off N2, 1♂, 21 October 1976 (M.E. Thompson). Canyon Country, N on Hwy 14, 1♂, 30 October 1978 (M. Wilkerson). Valyermo, Bob's Gap Rd., 1.5 mi. N of N4, 4050 ft. elev., 1♂, 28 October 1989. **NEVADA:** *Clark County:* Searchlight, 0.5–3.0 mi. W of SL., 3300 ft. elev., 4♂, 23 October 1976 (W. Icenogle). 8.2 mi. W of SL., 0.5–1.5 mi. N of Hwy 164, 4280 ft. elev., 2♀, 7 October 1989; 4365 ft. elev., 1♀, 12 October 1990; 4180–4260 ft. elev., 3♀, 12 October 1991. *Nye County:* 10 mi. W of Mercury, 2♂, 3 November 1972 (W. Icenogle). Scotty's Jct., 10 mi. S on Hwy 95, 4000 ft. elev., 2♂, 28 October 1978 (W. Icenogle). Lida (Hwys 266 and 95 jct.), 5.5 mi. S, 4500 ft. elev., 1♂, 28 October 1978 (W. Icenogle). *Esmeralda County:* Goldfield Summit, 8 mi. S on Hwy 95, 5000 ft. elev., 1♂, 28 October 1978 (W. Icenogle). **UTAH:** *Washington County:* Beaver Dam Mtns., Summit Springs off old Hwy 91, 4140 ft. elev., 1♀, 6 October 1993; 3960–4120 ft. elev., 3♀, 12 October 1993. Old Hwy 91, 2.7–3.5 mi. N of Utah-Arizona line, 3140–3300 ft. elev.,



Map 2.—Distribution of *Aphonopelma iodium*. The boundaries of the Mojave Desert (as perceived by the author) are indicated by the outer-most dotted lines.

4♂, 19–20 October 1993. W of Hwy 91, 2.4 mi. W of Welcome Springs Rd. turnoff, 3680 ft. elev., 1♂. Specimens collected by the author deposited in AMNH.

Aphonopelma iodium (Chamberlin & Ivie)
Figs. 9, 10, 29–50; Map 2

Delopelma iodius Chamberlin & Ivie 1939: fig. 3 (male holotype from Washington County, Utah, 2 miles west of Castle Cliffs (Beaver Dam Mountains), 27 November 1936, in AMNH, examined).

Aphonopelma iodius: Chamberlin 1940: 7.

Aphonopelma iodium: Smith 1994: 115. Spelling change, gender neuter.

Delopelma melanius Chamberlin & Ivie 1939: fig. 1 (male holotype from Salt Lake County, Utah, University of Utah campus, September 1925, in AMNH, examined; female allotype lost).

Aphonopelma melanius: Chamberlin 1940: 6. NEW SYNONYMY.

Aphonopelma melanium: Smith 1994: 120. Spelling change, gender neuter.

Aphonopelma nevadanum Chamberlin 1940: 13 (male holotype from Clark County, Nevada, collected by G. Carter, searchlight, 2 December

1930, in AMNH, examined). NEW SYNONYMY.

Aphonopelma angusi Chamberlin 1940: 21–22 (male holotype and female allotype from Washington County, Utah, collected by A.M. Woodbury, R. Hardy, H. Higgins, and R. Pendleton, 2 miles west of Beaver Dam Mountains, 7 October 1939, in AMNH, examined). NEW SYNONYMY.

Synonymy.—*Aphonopelma melanium*, *A. angusi*, and *A. nevadanum* are placed in the synonymy of *A. iodium* (one of two possible senior synonyms) with which they share all characters of specific significance (Tables 1, 2); there are no other characters known that merit their continued separation. The *A. angusi* allotype has a shorter carapace (carapace length 9.10) than any other conspecific female examined in this study; the ratio of its carapace length to that of a larger female from the type locality is 0.64. However, corresponding ratios of the smallest to largest females in *A. joshua* and *A. mojave* and males in *A. iodium* are 0.64, 0.59, and 0.66, respectively (smallest and largest of each species from the same locality). Metatarsi I and II are proportionately shorter relative to femur I in the *A. angusi* allotype than in other *A. iodium* females. Although no other correlation between the size and proportional leg or leg segment length was found within the combined sample, the proportionately shortest metatarsi I and II (excluding *A. angusi* allotype female) were found in the smallest female (carapace length 10.80) and the proportionately longest metatarsi in the largest female (carapace length 22.05). Therefore, both carapace and relative metatarsal lengths in the allotype are believed to be extensions of the female range for these characters. Leg and pedipalp segment lengths of the *A. angusi* allotype are in Table 13. All 'eutylenum type' tarantulas of the Mojave Desert are considered *A. iodium*, sharing with the type all specifically significant characters. Ecological, behavioral, and distribution data gathered from this assemblage support the synonymy of *A. iodium*.

Diagnosis.—*Aphonopelma iodium* is easily distinguished from *A. joshua*, *A. mojave*, and *A. steindachneri* by extensive scopula of metatarsus IV and by the pale-buff color of the carapace and of the patella and tibiae of legs I and II in females. There are only two valid species ('eutylenum types'?) described

prior to 1939, *A. rusticum* (Simon) and *A. helluo* (Simon), in which the carapace coloration (as described) and extent of metatarsus IV scopula are similar to the corresponding characters in *A. iodium* (ambiguity in proper type representation of *A. rusticum* is discussed in the 'Status of some old *Eurypelma* species' subsection above). *A. iodium* is distinguished from *A. rusticum* (USNM, cotype #1585) by longer legs relative to carapace length (Table 1); although most segments of leg I of the cotype are missing, $LFI/LC = 0.88$; in *A. iodium* $LFI/LC = 0.93-1.07$. The *A. rusticum* paratype specimen (MNHP-Paris, #5873), considered the lectotype by Smith, is doubtfully of the same species as the USNM cotype specimen since the length of the patella plus tibia IV (also patella plus tibia I) is less than the length of the carapace in the former ($LP + TIV/LC < 1.00$) and greater than the carapace length in the latter ($LP + TIV/LC = 1.11$); in *A. iodium* males $LP + TIV/LC = 1.18-1.32$ which clearly distinguishes it from both specimens. Proportionately longer legs in *A. iodium* males further distinguishes the species from that of the Mazatlan paratype male. Based on Simon's locality data, I believe that *A. rusticum* is most likely a summer breeder. *A. iodium* is distinguished from *A. helluo* (holotype male #17707 and non-type male #50(44)) by a shorter carapace and longer legs relative to carapace length and again from the non-type male by more extensive scopulae of metatarsi III and IV and proportionately longer metatarsi I and II (measurements of the holotype were taken from Smith; numerical and character data from the non-type male are in Table 1). Other species in the '*eutylum* group' include *A. eutylum*, *A. clarum*, *A. brunnium* (*brunnius*), *A. cryptethum* (*cryptethus*), *A. cratium* (*cratius*), *A. prosoicum* (*prosoicus*), and *A. griseum*. Although *A. iodium* can be distinguished from all of these types by various leg and palpal length proportions (or segment proportions), the character differences in the types of *A. eutylum*, *A. clarum*, *A. brunnium*, *A. cryptethum*, and *A. cratium* appear to be minimal. Consequently, the unambiguous separation of *A. iodium* from any of the five species will remain questionable until the variational limits of these quantitative characters have been determined for various populations of inland and coastal '*eutylum* types'.

Description.—*Males*: Carapace, length 9.35–16.90 ($\bar{x} = 13.0$), width 8.10–15.60; smallest males found in southern Utah. Sternum, length 4.20–7.60, width 3.80–6.85; usually longer than wide, length equal to width in one male from JTNM. Chelicerae, width 4.20–7.95. Cheliceral macroteeth 7–9, denticles 4–16. Labial cuspules 55–140 ($\bar{x} = 102$); maxillary cuspules 103–234 (each side) ($\bar{x} = 181$). Color of carapace pubescence pale buff or paper-bag brown (usually darker with greenish-bronze sheen following molt, most pronounced in cephalic region); black to dark brown abdomen and appendages; chelicerae similar in color to carapace but usually slightly darker. Patch of black type I urticating hairs covering posterodorsal 45–65% of abdomen, difficult to distinguish because of pubescence coloration and interspersions of long orange-tan setae. Abdominal anterodorsal setae spiniform, stout, and uniformly black or dark reddish-brown; anterolateral setae also dark but shorter and more slender than dorsal setae; longest setae filiform, orange-tan with dark basal portions, interspersed on posterodorsal, posterolateral, and caudal surfaces, the longest inside and just outside of patch of urticating hair, the shortest toward ventral margins; abdominal venter usually with sparse interspersions of similar setae and a dense covering of short, fine, dark setae. Sternum with relatively slender, attenuate medial setae and more stout, spiniform marginal setae; setae intermediate in position also intermediate in basal diameter. Coxae (I-IV) with retromarginal, promarginal, and distal setae similar to marginal sternal setae; most basomarginal and medial setae similar to intermediate and medial setae of sternum. Baso- and retromarginal setae of palpal coxae similar to medial or intermediate sternal setae. Sternal and ventral setae of coxae very similar to, if not indistinguishable from, homologous setae of *A. mojave* males (Figs. 3, 4, respectively). Setae on prolateral surface of coxa I spiniform and basally swollen (Figs. 9, 10). Leg setae attenuate, mostly pale buff with dark basal portion, the shortest mostly dark with pale distal ends. Metatarsus IV almost always longer than length of carapace, rarely equal to and always longer than femur I; metatarsus I generally longer than tibia I but can be slightly shorter than tibia I in males from southern Utah. Leg and pedipalp segment lengths of the holotype are in Table 11;

Table 11.—*Aphonopelma iodium*, holotype male: leg and pedipalp segment lengths.

	I	II	III	IV	Palp
Femur	15.40	14.60	13.35	15.20	9.15
Patella	7.10	6.60	5.80	6.20	4.75
Tibia	12.60	11.55	9.90	12.40	8.30
Metatarsus	13.35	13.00	13.60	16.90	
Tarsus	8.10	7.90	7.60	8.40	3.30
Total length	56.55	53.65	50.25	59.10	25.50

ranges of segment lengths in Table 12. Retro-lateral bend into apical division of the palpal bulb uniform rather than abrupt and bulb relatively slender (Figs. 29, 31, 33, 35, 37, 39, 41, 43) compared to bulb of *A. mojave*; proximal prolateral protuberance on the dorsal aspect prominent (Figs. 30, 32, 34, 36, 38, 40, 42, 44) as in *A. mojave* males. Extent of scopulae ($\times 100 = \%$): metatarsi I and II to base, metatarsus III, prolateral, usually to base or near to base, medial, 0.60–0.80, metatarsus IV, retrolateral, distal 0.70–0.85, medial, 0.40–0.55. Tarsal scopulae entire, not divided by setae. Ventroapical metatarsal spination: I, 1–3 (usually 2), II, 1–4 (usually 3), III, 2–5 (often 4, less often 3), IV, 2–5 (almost always 4).

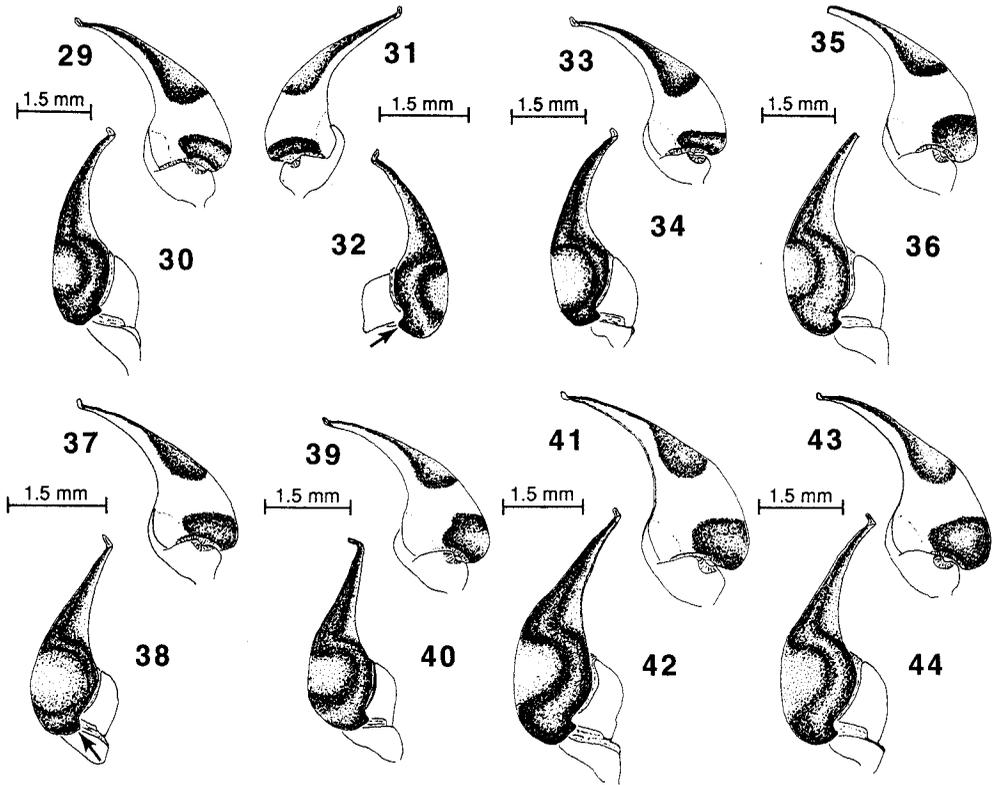
Females: Carapace, length, 10.80–22.05 ($\bar{x} = 15.02$), width, 9.65–18.70. Sternum, length, 4.60–8.70, width, 4.70–7.80, usually longer than wide but slightly wider than long in smallest female. Chelicerae, width, 6.25–12.65. Cheliceral macroteeth, 7–10, denticles, 7–15 ($\bar{x} = 11$). Labial cuspules, 100–138 ($\bar{x} = 114$); maxillary cuspules 129–267 (each side), $\bar{x} = 195$. Color of carapace and chelicerae as in males; color of tibiae and patellae of legs I, II, and palps similar to carapace (color varying in degree), corresponding segments of legs III & IV less accentuated but usually slightly lighter than the remaining leg segments. Patch of black type I urticating hairs covering posterior $\frac{1}{2}$ – $\frac{3}{4}$ of abdominal dorsum.

Abdominal anterodorsal setae similar to those of males but less stout and distally pale buff; longest setae basally dark, orange-tan, distributed as in males relative to patch of urticating hair but often dispersed further anteriorly. Sternal, coxal, and leg setae as in males although homologous setae often slightly less stout. Metatarsus IV and femur I always shorter than length of carapace; metatarsus I usually shorter than tibia I but longer than in largest female (JTNM); femur IV longer than femur I; metatarsus III longer than metatarsus I. Ranges of leg and palpal segment lengths are in Table 14. Variations in the shape of spermathecae and relative distance between bulbs (Figs. 45–50) are inconsistent with population geography (it is not currently known if spermathecal characters adequately distinguish any *Aphonopelma* species). Extent of scopulae ($\times 100 = \%$): metatarsi I and II, to base, metatarsus III, lateral, to base or close to base, medial, distal 0.70–0.80, metatarsus IV, retrolateral, 0.75–0.85, medial, 0.50–0.60. Tarsal scopulae entire, not divided by setae. Ventroapical metatarsal spination: I, 1–3 (usually 2), II, 1–3 (often 3, less often 2), III, 3–4 (equally common), IV, 4.

Distribution.—*A. iodium* is common throughout the Mojave Desert west of the Colorado River, its distribution continuous to the north into the Great Basin in Utah and Nevada. Its distribution to the south and to the west of the Mojave Desert and to the northern-most limits in Nevada and Utah has not yet been determined. However, preliminary data from extensive fieldwork suggest that to the south (excluding the low desert) and west *A. iodium* is replaced by an inland and coastal species ('*eutylenum* type') while to the north it is the only theraphosid species, other than *A. mojave*, found in Nevada and the only '*eutylenum* type' found in Utah. The known distribution of the species within the Mojave Desert is shown on Map 2.

Table 12.—*Aphonopelma iodium*, males (32): range of leg and pedipalp segment lengths.

	I	II	III	IV	Palp
Femur	9.70–17.55	9.20–16.80	8.50–15.50	9.65–17.70	6.00–10.45
Patella	4.70–8.25	4.25–7.60	3.70–6.85	3.95–7.20	3.30–5.50
Tibia	8.15–13.75	7.15–12.90	6.15–11.45	7.85–13.80	5.40–9.95
Metatarsus	8.15–16.10	8.10–15.75	8.45–16.35	10.75–20.60	
Tarsus	5.30–9.30	5.10–8.80	5.00–8.80	5.70–9.70	2.45–3.80



Figures 29–44.—Palpal bulbs of *Aphonopelma idium*, right; odd, ventral; even, dorsal (arrow-proximal proteral protuberance). 29, 30, Holotype, *A. idium*; 31, 32, Holotype, *A. angusi* (left bulb); 33, 34, Holotype, *A. melanium*; 35, 36, Holotype, *A. nevadanum* (tip of embolus broken); 37–44, Mojave Desert; 37, 38, Mojave Desert, BDM, Utah; 39, 40, Mojave Desert, Searchlight, Nevada; 41, 42, Mojave Desert, Quail Mountain, JTNM; 43, 44, Mojave Desert, Red Mountain, California.

Specimens examined.—Holotype male, holotypes: *A. melanium*, *A. angusi*, and *A. nevadanum*, allotype: *A. angusi*, and the following: CALIFORNIA: *Riverside County*: JTNM: Cottonwood Springs, 3000 ft. elev., definitive molt, 21–22 September 1986; 1♂, 25 February 1985. 1.0–1.5 mi. E of Cottonwood Springs, 3300 ft. elev., 1♀, 4 April 1989. Hexie Mtns. W of Cholla Cactus Gardens on Pinto Basin Rd., 2760 ft. elev., 1♀, 16 April 1989. Quail Mtn., 5.7 mi. SE of monument entrance off

Quail Mtn. Rd., 0.5 mi. SW of picnic area, 4080 ft. elev., 1♀, 5 August 1989. *San Bernardino Co.*: Reche Rd., 4.5 mi. E of Landers, 2950 ft. elev., 1♂, 18 October 1981 (W. Icenogle). NE Coxcomb Mtns., 8 mi. W of jct. Hwy. 177 on Hwy 62, 1600 ft. elev., 2♀, 4 February 1990. East Mojave, Mid Hills toward campground, 5700 ft. elev., definitive molt, 2 August 1989; 1♂, 13 May 1989. JTNM: Quail Springs Rd., 2.7 mi. SE of monument entrance, 4000 ft. elev., 1♂, 3 August 1989. Covington Flats, 0.4 mi. N of Monument boundary, 4220 ft. elev., 1♂, 10 August 1989. Kelso-Cima Rd., 6.3–11.5 mi. N of Kelso, 2820–3480 ft. elev., 2♂, 1 November 1992. Hwy 247, 10 mi. S of I-15 at Barstow, 2840 ft. elev., 1♂, 7 November 1992. Kramer Jct., 3.1 mi. E on Hwy 58, 2470 ft. elev., 1♂, 8 November 1992. *San Bernardino and Kern Co. lines (Red Mtn. area)*: 19–23 mi. N of Kramer Jct. on Hwy 395, 0.5–1.5 mi. W of highway, 3220–3400 ft. elev., 2♂, 20 October 1989; 3200–3280 ft. elev., 4♀, 12–14 October 1991; 3♂, 26 October 1991; 1♂1♀, 13 October 1992; 1♀, 22 January 1994. *Kern County*: California City, 7.6 mi. E on

Table 13.—*Aphonopelma angusi*, allotype female (= *A. idium*): leg and pedipalp segment lengths.

	I	II	III	IV	Palp
Femur	7.35	6.70	6.15	7.55	5.40
Patella	4.00	3.65	3.30	3.60	3.10
Tibia	5.55	4.70	4.15	5.90	4.00
Metatarsus	4.85	4.70	5.20	7.30	
Tarsus	4.00	3.80	3.90	4.50	4.10
Total length	25.75	23.55	22.70	28.85	16.60

Table 14.—*Aphonopelma iodium*, females (14): range of leg and pedipalp segment lengths.

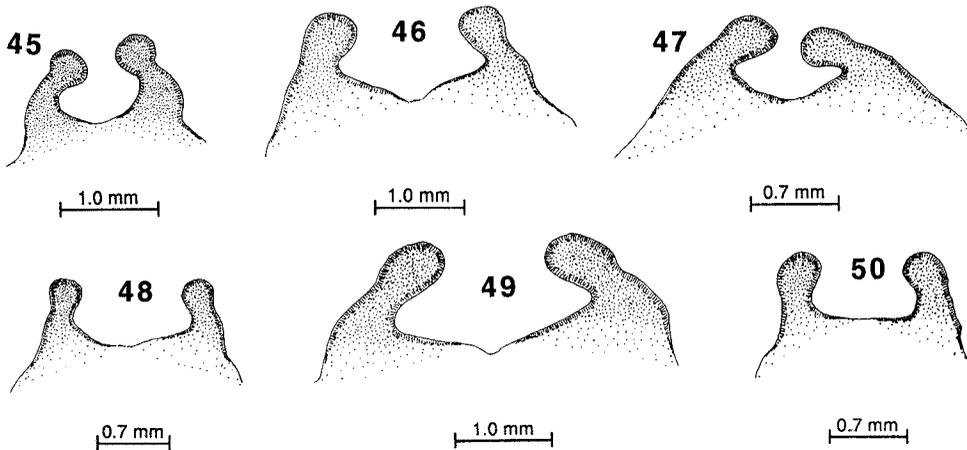
	I	II	III	IV	Palp
Femur	9.10–17.00	8.40–15.85	7.90–14.60	9.65–17.30	6.90–12.50
Patella	4.95–9.10	4.55–8.60	4.15–7.85	4.55–8.30	3.65–6.80
Tibia	6.80–12.40	5.90–11.20	5.35–10.00	7.30–12.40	4.90–9.00
Metatarsus	6.20–13.30	6.00–12.80	6.65–13.70	9.05–17.95	
Tarsus	4.70–8.80	4.50–8.60	4.70–8.60	5.10–9.30	5.00–9.00

Twenty Mule Team Rd., 2710 ft. elev., 1♂, 20 October 1991. *Inyo County*: Deep Springs Valley, approx. 2 mi. E of Westgard Pass on Hwy 168, approx. 5000 ft. elev., 1♂, 16 October 1976 (Frank Hovore); Big Pine, 2.3 mi. E on Hwy 168, 4320 ft. elev., 1♂, 20 October 1993. **NEVADA**: *Clark County*: Pahrump, 17–19 mi. SE on Hwy 160, 3400 ft. elev., 1♂, 11 October 1974 (W. Icenogle). Searchlight, 3 mi. S on Hwy 95, 3250 ft. elev., 1♂, 2 October 1981 (W. Icenogle). 8.2 mi. W on Hwy 164, 2 mi. N to foothills of Highland Range, 4330 ft. elev., 1♂2♀, 7 October 1989. **UTAH-ARIZONA**: *Washington County, UTAH and Mohave County, ARIZONA*: Male specimens collected between 2320–4330 ft. elev. in Castle Cliffs, Summit Springs, and Welcome Springs areas on southern slope of Beaver Dam Mountains and close to Utah-Arizona border on both sides of state line off old Hwy 91, limm♂, 4 July 1989; definitive molt, 8 September 1989; 1♂, 16 September 1989; 1♂, 23 September 1989; 3♂, 6 October 1993; 1♂, 12 October 1993; 5♂, 19 October 1993; 1♂, 20 October 1993. Female specimen collected in Summit Springs area in Beaver Dam Mountains, 3650 ft. elev., 1♀, 5 October 1993. All specimens collected

by the author unless otherwise indicated. Specimens collected by the author deposited in AMNH.

NATURAL HISTORY

Habitat.—*A. joshua* new species and *A. mojave* new species, only narrowly sympatric (near Yucca Valley, California), appear to have similar ecological requirements throughout their ranges. Both burrow in soil of like composition, inhabit comparable vegetation communities, and occur at elevations between 550–1600 m. *A. mojave* has been found at slightly lower elevations near Trona, California, and *A. joshua* also inhabits biomes characteristic of the Sonoran Desert (southeastern JTNM). Both species prefer flat or gently sloping terrain composed of sandy soil of various particle size. *A. iodium*, sympatric with both *A. joshua* and *A. mojave* throughout their respective ranges, occurs at elevations below 300 m in the basins and above 1700 m on the



Figures 45–50.—Spermathecae of *Aphonopelma iodium*. 45, *A. angusi* allotype (= *A. iodium*); 46, Searchlight, Nevada; 47, 48, Red Mountain, California; 49, Quail Mountain, JTNM; 50, Pleasant Valley, JTNM.

inter-desert and perimeter mountain slopes and is equally common on steeper and/or rockier hillslopes and in regions where the substrate is rich in clay content. Because of the increased tolerances of *A. iodium* to varied substrate consistencies, xeric conditions, and cooler, mildly hydric climates, it has succeeded in accessing regions that are unsuitable for *A. mojave*, both within the Mojave and to the north, in the Great Basin Desert. The xeric drainages that divide *A. mojave* into eastern and western races, the rocky, rugged terrain between Las Vegas and the Mormon Mountains that apparently isolates northeastern *A. mojave* populations, and the mountainous regions to the north of St. George were not found to be geographic barriers for *A. iodium* (a corridor, 1700 m in elevation, snakes through Utah from the BDM to the Idaho border (Salt Lake City to Provo to Nephi, west to Jericho, south to Delta, to Black Rock, to Milford, to Lund, east to Cedar City, and finally south to St. George between the Pine Valley Mountains and the Hurricane Cliffs); two specimens from Utah and one from California were found at elevations greater than 1670 m.

All Mojave species are common in vegetation communities dominated by Creosote Bush (*Larrea*), often in pure stands or in association with either bursage (*Ambrosia*), brittlebush (*Encelia*), or Joshua-tree (*Yucca*), and by Joshua-tree and perennial bunchgrass in association with Creosote Bush and/or sparsely distributed blackbrush (*Coleogyne*). Communities within which *A. iodium* is relatively common (but not usually abundant) but *A. joshua* and *A. mojave* rare or absent, are dominated by saltbrush or bursage at low elevations (below 600 m) and by Blackbrush, Big Sagebrush (*Artemisia*), and juniper or mixed juniper and pinon at high elevations (above 1500 m).

Daily activity patterns.—After initially unplugging their burrows following the cool winter months, the Mojave *Aphonopelma* deposit silk around entrance perimeters to a greater or lesser extent; and over time many layers of silk accumulate. During daylight hours of the ensuing months most burrows have a sheet-like layer of silk (common in all three species) or a loose plug of silk-bound earth (less common and only in *A. joshua* and *A. mojave*) blocking the entrance (obstruction

of the entrance may ward off certain potential day-time predators such as ants and help maintain higher humidity in the burrow). Usually after dark or, less frequently, just before sunset when overcast or cloudy, females and immatures were commonly seen just inside their burrows or a few centimeters below the entrance. Only after dark (all observations) were the silken coverings and plug removed, the silken sheets torn down and flattened against the perimeter and inside wall of the burrow, the plugs either pushed with forelegs or carried in the chelicerae (with the aid of the palps) to the outside of the burrow. After removal of these obstructions the majority of spiders, initially, remained motionless within the burrow confines, completely submerged in the upper level or with forelegs resting over the perimeter. After varying intervals of time many individuals then exited their burrows, eventually to assume a waiting position. Deposition of additional silk around the entrance perimeter was one of the first activities of the resident, once above ground, followed by (rarely preceded by) intermittent, brief periods of wandering, between which the waiting posture was assumed. *A. joshua* and *A. mojave* rarely ventured more than several cm from the entrance (except when in pursuit of prey) although individuals of both species were observed at distances of up to 30 cm. The larger *A. iodium* were commonly observed at distances of 30 cm or less and, rarely, of up to one meter.

Seasonal activity.—Seasonal activity is defined by the period of time between which burrows of a given species are first unplugged after winter and then replugged for the following winter. The presence of fresh silk around the entrance perimeter, recently excavated material around the burrow, or a thin sheet of silk covering the burrow's entrance were indicative of desert *Aphonopelma* activity. Conversely, an open burrow lacking silk around the entrance, accumulated dust on the perimeter silk, or a burrow with a hardened plug or turret were indicative of inactivity.

Active burrows of *A. joshua* were found between the end of March and the last week of October, those of *A. mojave* between the first week of April and the first week of January, and those of *A. iodium* throughout the year. In *A. joshua* the vast majority of burrows were plugged by early October but in *A. mojave* not



Figure 51.—Burrow of *Aphonopelma joshua* new species (female) showing typical turret made by the species; the shadow cast by the turret gives an indication of its height (*A. mojave* new species turrets are indistinguishable from those of *A. joshua* new species).

until middle or late November. Activity within *A. joshua* was abundant by mid-spring and through the species summer breeding season but steadily declined thereafter. In contrast, activity within *A. mojave* was minimal until close to the beginning of the species fall breeding season, peaking by mid-October; winter plugging coincided with the termination of the breeding season. *A. idium* was commonly found between early March and mid-December, but activity was most abundant in late summer and during the species fall breeding season. Open burrows were infrequently discovered in January and February, and then, only in the central and southern portions of the species range.

Usually prior to or during respective breeding seasons, excavations composed of silk-bound soil, sclerotized remnants of prey, and old exuviae were deposited outside of the burrows in a species dependent fashion; only a few individuals excavated (any material) in spring. Both *A. joshua* and *A. mojave* formed indistinguishable turrets (Fig. 51) with the excavations that surrounded and elevated the entrance (the vast majority of turrets formed within a given year were washed away by the hard winter rains leaving no trace of the burrow's location; the few that were not destroyed had become hardened mounds that were built upon with new excavations prior to or during the subsequent breeding season).

Turrets as high as 13 cm were found although most were less than 6.5 cm, with the average outside diameters approximately 5–6 cm. The inside turret walls were usually lined with silk which continued over the entrance and partially or completely blanketed the top of the mound. *A. idium*, on the other hand, scattered excavations loosely around (rarely, appearing slightly mounded) or to one side of the burrow, often at some distance from the entrance; excavations were infrequently found by burrows known to contain medium to large size females. Entrance perimeters were generally lined with copious layers of silk which extended up to several centimeter both over the substrate and into the burrow; the entrance almost always opened at substrate level. Excavation by all species, although often intermittent, generally appeared to be a continuous process throughout respective breeding seasons. A proportion of each species replugged their burrows on a routine (observed only during a breeding season), irregular (for relatively short durations), or extended period (observed for up to two months) basis during their seasonally active months. Minch (1979) reported both intermittent and extending plugging by *A. chalcodes* Chamberlin. In the Red Mountain area several *A. mojave* burrows were regularly plugged (from one to three days observed) and reopened (only one night observed) during the fall breeding season; plugs were usually in place well before sunrise and pushed aside only after dark. Other burrows, previously not plugged but covered by a sheet of silk during the day, were plugged in late September and early October, reopened in late October toward the end of the breeding season, and shortly thereafter, replugged for the winter. One burrow, found plugged at the beginning of the breeding season, appeared to have been recently active because of its only slightly hardened turret (turrets that were plugged or otherwise inactive for long periods of time developed a windblown, smoothed appearance and very hardened outside walls; new silk and excavation were lacking); and its occupant removed the plug and began to excavate in the last week of October. Summer plugging (Minch 1979) by *A. mojave* was observed only in captives, several of which plugged their burrows prior to a subsequent summer molt, one prior to producing an egg sac; several others simply sealed the entrance

with silk before molting. Since gravid females and females with egg sacs were rarely found during the summer months (and then, in burrows with only silken sheets covering the entrance), I suspect that most do not become seasonally active until their young are ready to disperse. Summer plugging by *A. iodium* was not uncommon but burrows were rarely found plugged during the species breeding season. One burrow (in JTNM) plugged before 5 August was reopened between late September and 12 October and remained open for the duration of the breeding season.

Minch (1979) reported that the maximum duration of winter plugging by *A. chalcodes* (female) was between 644–674 consecutive days. One immature and two female *A. paloma* were taken from inactive burrows (burrows were not detectable other than by my markings and had been monitored monthly) on 19 November 1992 (near Sentinel, Arizona), at least 711 days after they were plugged prior to 9 December 1990. Although these data are lacking for the Mojave *Aphonopelma*, burrows (and wandering males) of all species were abundant throughout the Mojave in 1989 but were difficult to locate in 1990. Again in 1991 burrows were abundant, found in even greater numbers than in 1989. Yearly burrow density fluctuations at all study sites (for each species) followed this larger scale trend. Such observations lead me to believe that extended plugging within desert species may be similar in duration to that observed in *A. chalcodes* and *A. paloma*.

Burrow construction and remodeling.—

Although all observed *Aphonopelma* species can construct their own burrows, evidence indicates that most individuals that have abandoned or been displaced from their burrows will adapt any suitable cavity. In captive situations intentional burrow damage by the investigator initiated new burrow construction by the former occupant only if no other cavities were available. In similar field experiments, a 'homeless' spider sought shelter in the first sufficiently large unoccupied burrow or subterranean cavity encountered. Recent occupancy was suggested when a burrow was found with unplugged side tunnels or was significantly wider in diameter than usual for the size of the resident. Whether growing tarantula spiderlings (under natural conditions) continue to enlarge and remodel initial bur-

rows or seek larger burrows as needed is not known although all *Aphonopelma* I have had in captivity continued to utilize initial burrows through their frequent enlargement.

Most desert captives eventually plugged pre-existing burrows only to resurface either back through the plugs or through new shafts. Entrance and upper burrow diameters were consequentially reduced and in the majority of burrows were correlated with occupant size. Natural entrance diameters for *A. iodium* ranged from approximately 1.2–2 times greater than the width of the carapace and those for *A. joshua* and *A. mojave* from 1.5–2 times greater. Minimal diameters may prevent intrusion by slightly larger, more powerful predators or conspecifics, lessen the effects of erosion, especially when burrows are reopened through a plug, and help to maintain optimal humidity within the burrow.

Burrows of *A. joshua* and *A. mojave* extended more or less vertically to depths between 25–53 cm. Well established burrows (those with side chambers packed with discarded food remains and pieces of old exuviae) were usually the deepest. Throughout most of their length typical burrows were larger in diameter than at subsurface and entrance levels although were commonly constricted in up to several regions, one of which was usually near or adjacent to the horizontally inclined terminal chamber. Side tunnels and shafts beyond certain depths were usually plugged with silk-bound earth and shallow burrows were presumed to have been excavated to appropriate depths based on the varying quantities of excavated material found outside the entrances (other than during breeding seasons). The average depth of *A. iodium* burrows was approximately 45 cm, ranging from 30 cm to 1 m. Their tortuous burrows commonly ended in horizontal chambers similar to those of *A. joshua* and *A. mojave*. Short side chambers in well established burrows were generally located near the bottom and were used as dumpsites for accumulating food debris, old exuviae, and discarded egg sacs.

Molting cycles.—Molting cycles are known primarily from captive specimens (observation over several years for most juveniles). Immature and adult female *A. mojave* (16 adult) generally molted between mid-July and mid-August. However, one immature female molted as early 22 May and two females

molted after 11 August, one immature and one adult on 7 and 9 September, respectively. Definitive molts of three males occurred between late August and the first week of October. Immature male cycles were coordinated with female cycles. In *A. joshua*, penultimate males collected within 7–8 months of maturity molted between 7 July–1 August (just prior to or during their breeding season). Subadult males collected within two or three molts of maturity molted as early as 24 June and as late as 1 September. Juveniles (except those molting more than once a year) and females molted between 8 June–7 August. In *A. iodium* juveniles and females were known to molt between late May and early October, the majority molting in July. One immature female was found in its natural burrow 23 September 1989 (BDM) with not yet fully sclerotized fangs, indicating a very recent molt. Two captive males (penultimate instars when collected), one from the BDM (Utah) and one from the Mid Hills area (east Mojave), molted 8 September and 2 August, respectively.

Both Minch (1979) and Baerg (1958) found molting to be predominantly an annual event except in rapidly growing spiderlings and young juveniles (Baerg and Minch), in females producing eggs (Minch), and in older females (Baerg). However, a proportion of juveniles and subadults and an even larger proportion of adult females in captive Mojave *Aphonopelma* failed to molt annually. Under natural conditions it was not uncommon to find unusually faded specimens, a condition indicative of a skipped molt. Old females (age estimated by relative size) were infrequently found not only with pubescence very bleached but worn away in various areas on the legs, carapace, and chelicerae. Such females may have weathered two or more consecutive years without molting. Baerg observed that Arkansas females (*A. hentzi*) producing egg sacs delayed molting until shortly after dispersal of the young. Minch noted that female *A. chalcodes* producing egg sacs failed to molt in that same year. In agreement with Minch, I observed that captive females (*A. joshua* and *A. mojave*) subsequently failed to molt in the year they produced egg sacs but molted the following year. Similarly, females (*A. joshua*-1, *A. mojave*-3, *A. iodium*-1) taken from the field with egg sacs failed to molt until the following year. When burrows were unearthed

during or shortly after a breeding season, recently discarded egg sacs were not found with females appearing to have molted within the year; coloration of females was faded when such egg sacs were found, indicating skipped molts. Apparently most Mojave Desert females are not able to acquire the nutritional reserves necessary for egg production and subsequent molting activity.

Sperm webs.—Sperm webs of the desert species are typical of those described by Baerg (1958) of *A. hentzi*. In using his detailed accounts of male behavior during web construction as a comparative reference I found no distinguishable differences between corresponding behaviors of *A. hentzi* and the Mojave species (captive males).

Initial webs of *A. joshua* males were constructed inside the burrow, if sufficiently wide in any region or, otherwise, outside the burrow between three and twelve days after definitive molts (this agrees with Baerg's field observations). Most natural burrows, however, did not appear to have the necessary space for such activity. Baerg observed individual males constructing as many as 17 sperm webs in the course of six weeks and others as few as one in their mature life. From eight males I reared to maturity the number of webs constructed per individual varied from one to four. One male produced two webs within four days while a second produced four webs within 19 days, both without exposure to females. Several field collected males produced one or more webs in captivity while others failed to spin a single web. One male collected 28 July 1992 spun two webs without exposure to a female, one shortly after confinement and a second almost a year later in June 1993 (this specimen, incidentally, seemed to be an exception to the general rule of longevity among males of most *Aphonopelma* species; even captive males rarely last through the year in which they matured).

Initial sperm webs of three captive-reared *A. mojave* males were produced within 10–21 days after definitive molts; only one produced a second web (date unknown). One field-collected male produced a maximum of three webs, each spun within two days after successive matings; a second male produced two webs without introduction of a female while a third male produced one web two days after mating but failed to produce another web after

mating with second female. Other males spinning only one web were never exposed to females in the laboratory.

Seasonal mating activity.—Within temperate region *Aphonopelma* there are two basically distinct breeding seasons: one commencing in summer and the other in fall. Males of the summer breeding species generally search for females between mid-July and early September. Males of most fall breeding species are first seen in middle or late September but are infrequently found after mid-November. However, in two fall breeding species (*A. paloma* and an undescribed species from SE Arizona) the onset of male activity is delayed until late October or early November; most activity has ceased in these species by late November and by mid-December (late December in undescribed species) males are rarely seen. I have noticed that within most California and Arizona *Aphonopelma*, irrespective of breeding season, stragglers are occasionally found long after other conspecifics have perished. Early males (Baerg 1958), on the other hand, seem to occur only in the fall breeding species but are found in significantly reduced numbers from those occurring during the fall months. Two of the three Mojave species, *A. iodium* and *A. mojave*, are fall breeders; early males are known to occur only in *A. iodium*. The third species, *A. joshua*, is strictly a summer breeder.

A. mojave males were seen searching for females from early October until nearly the end of November. The earliest collection record for a male is 5 October (1973, W. Icenogle) and the latest, 24 November (1991). All observed mating activity was diurnal. Males were found between 0800 h and late afternoon shortly before sunset; a single male was collected after sunset on a warm, humid evening (25 °C). On cooler days (when early morning and late afternoon temperatures were below 15 °C) males became active later in the morning and took shelter earlier in the evening.

A. iodium males (fall males only) were collected between 16 September (BDM) and 29 November (southern Nevada, by W. Icenogle). Breeding activity in this species is believed to be primarily diurnal although some nocturnal mating may also occur; the majority of males were collected between 0900–1600 h, a few as late as 2230 h on warm evenings (over 20

°C). Summer males, believed to be nocturnal breeders, were collected in August (of three different years in JTNM) and only after dark between 2200–0100 h. Baerg believed that early males were survivors from the previous year that had somehow managed to overwinter and that their success in mating at this time was doubtful. All summer males collected in JTNM were in excellent condition and appeared to have molted quite recently. Since Baerg observed that mature female and immature Arkansas tarantulas begin their molting cycles toward the end of July and I have recorded molting periods of captive *A. iodium* from mid-June to mid-September, it seems quite possible that these summer males had not overwintered but had, instead, recently matured. Since many females have molted and become active by August it seems likely that early males are successful in their breeding attempts. Observations of two captive males (molting 2 August and 8 September, respectively) suggest that differences in temporal spacing between maturing molts and burrow abandonment and in the timing of the molt itself, in combination, may account for both the presence of summer males and the duration of the primary breeding interval. Following its September molt the latter male remained in its burrow for six weeks, emerging only for relatively short periods of time to eat, drink, and, eventually, construct its first sperm web. Its behavior in conjunction with its maturation date may be typical of circumstances leading to the emergence of the more prevalent fall males. On the other hand, the former male became very active within two weeks of its early August molt, rarely returning to its burrow. Its early maturation and hastened restless behavior may be indicative of events leading to the presence of the much less common summer males. In captive males prolonged lingering between definitive molts and burrow abandonment is the more commonly observed behavior.

A. joshua is the only Mojave Desert species known to be strictly a summer breeder. Of the males that I have collected the earliest was taken 20 July (1989), the latest 6 September (1992). However, E.L. Sleeper and S.L. Jenkins collected one male 9 September (1966) and a second 23 September (1967), both from pit-traps in JTNM. All observed mating activity was nocturnal. Males were collected be-

tween 2100–0245 h (only two after 0100 h) and were generally seen in greater numbers on warm, humid evenings.

Mating behavior.—Most mating behaviors such as male courtship, female response, and post contact performance were correspondingly indistinguishable between the desert species and from the respective behaviors of *A. paloma* (Prentice 1992). Duration of copulatory contact under natural conditions varied within all species although the respective ranges were very similar; the maximum time value of sustained contact for each species was observed under laboratory conditions. Male exploration of contacted burrows varied slightly with the entrance type; males generally located non-turreted burrow entrances more quickly than those atop turrets. Males stridulated periodically during frequent pauses in their search for female burrows.

In their initial inspection of female burrows typical *A. mojave* males slowly circled the outer turret wall, systematically pausing with palps in direct substrate contact as if chemically assessing female receptivity. Whether turrets function as pheromone beacons is not known although males sometimes left turreted burrow after brief investigation without initiating courtship. Males continuing their inspections usually proceeded toward the top of the turrets, frequently arresting their forward progress to alternately stridulate (characterized by bobbing up and down) and forcefully tap the turret walls with both front legs and palps simultaneously. Tapping and stridulation were executed with more regularity once female entrances were located, with one to several spaced taps alternating between stridulatory pulses. If there was no immediate female response, males frequently extended their forelegs into the turret or crawled partially or completely inside while continuing to tap and to stridulate if the hind two pairs of legs were free of the entrance. At various stages of courtship, receptive females generally emerged. A drumming response (Prentice 1992) by the female before emergence was observed in several instances when females could be seen in their burrows and in captive situations after male courtship had been initiated. Female drumming (with both pairs of forelegs) was always observed to follow male stridulation but not leg tapping. Once contact between a pair was made, the female com-

monly rushed the male pushing him backwards a few centimeters until he secured her fangs. In one instance, a Red Mountain female, courted by a male having his front legs inside the burrow, exploded from the entrance backing the male almost instantaneously to a distance of 20 cm; after much leg grappling the male finally managed to secure the female's fangs. Copulatory contact in several field matings was sustained for slightly less than one minute to just under three minutes.

In pairings of *A. joshua* differences in laboratory (when females were in burrows) and field behavior could not be detected except in duration of copulatory contact. Contact between several laboratory pairs was sustained for 1–10 minutes. For field observation males were released at night by female burrows under artificial, dim light conditions which made accurate observation difficult. Contact under these conditions was sustained for 1–1½ minutes in two pairings. In all observations uncoupling proceeded with the male releasing one of the female's fangs while simultaneously pulling away to position himself for rapid departure (true of all Mojave *Aphonopelma*). All other associated behaviors appeared to be identical to those of *A. mojave* when the courted female was in a turreted burrow. Male stridulation was audible in the laboratory when background noises were at a minimum and was nearly comparable in amplitude to that generated by the much larger *A. reversum* Chamberlin; I have not heard male stridulation in the field.

Under natural conditions, *A. idium* males usually initiated courtship more rapidly after detecting female silk than males of either *A. joshua* or *A. mojave*. At times, females emerged during the initial stages of courtship before the male had physically located the burrow entrance, generally a rapid process for these males. Duration of copulatory contact was maintained for as little as 30 sec and for as long as 3 min; under laboratory conditions contact was sustained for up to 6 min. Females pursued males after uncoupling much more often than did females of either *A. joshua* or *A. mojave* although pursuit, in general, was relatively rare. In no field observation (all species) was a male caught by a female; under laboratory conditions, males with limited running space were occasionally caught and killed by females.

Egg sacs, fecundity, and spiderlings.—Data for *A. joshua* were gathered from two females producing egg sacs in the laboratory and from one female guarding an egg sac when collected. One female (carapace length, 6.5), collected 19 April (1989), excavated and promptly plugged a new burrow in mid-May. A cocoon was produced in the burrow between 23–25 June which, when finished, was a wrinkled, spherical mass approximately 12 mm in diameter. By 26 July the egg sac was very swollen and smooth, suggesting that the eggs had hatched. Between the end of July and 12 August darkened forms appeared inside of the cocoon; third instar (fourth post-embryonic stage; third stage free of chorion; first mobile stage – Galiano, 1969, 1973) develop most leg spines and urticating hair patches beneath the semi-transparent integument, molting to fourth instar within the egg sac (pers. obs.; also consult Galiano 1973). On 19 August the first of the young appeared on the outside of the egg case beside a small exit hole. On 21 August approximately 40 young were counted, a few of which were observed outside of the burrow less than 1 cm from the entrance. By 25 August approximately half of the spiderlings were roaming about in the terrarium, periodically returning to the burrow to take refuge. More than three-quarters of the young had permanently dispersed by 30 August. A total of 51 young was counted, all of which had successfully escaped the egg sac. A second female (allotype), collected 21 October (1989) from a plugged burrow, produced an egg sac between 22–27 April (1990) in the burrow she had excavated shortly after confinement; she consumed the eggs two weeks later. Neither of the preceding females was observed without at least one of its fore-appendages in contact with the egg sac (also Minch 1979). A third female (carapace length, 7.60, following its 1993 molt) was guarding an egg sac when excavated from its burrow 30 July (1992). There was a small emergence hole in the cocoon but only two spiderlings were observed on the visible surface. Forty-one 4th instar, three 3rd instar spiderlings that failed to molt successfully, and four desiccated eggs were counted when the cocoon was opened. Due to the breached condition of the egg sac, the actual number of viable young may have been higher. Fourth instar spiderlings of the female that produced a cocoon in the labora-

tory began to appear outside the egg sac approximately seven weeks after eggs were deposited. If it may be assumed in this case that field conditions roughly paralleled laboratory conditions, the female producing a cocoon in the wild would have deposited her eggs during early June, seven weeks prior to the appearance of the first young. Baerg (1958) observed that females of *Dugesia hentzi* deposited eggs in late June or early July with an incubation time of 45 and 65 days under laboratory conditions; Gertsch (1979) roughly estimated an incubation time of 6–7 weeks for ‘local’ tarantulas in general.

Dissection of an *A. mojave* female (carapace length, approximately 8.5) revealed a complement of 186 developed eggs and 150–200 small developing eggs. Three females produced egg sacs in the laboratory but cannibalized them before they could be removed; all were produced between the last week in June and the second week of July. Of three females that were excavated from their burrows 7 October (1989) near Searchlight, Nevada, two were accompanied by what appeared to be fourth instar young, one with 18 (not preserved), the second with 15 (carapace lengths, 1.7–1.8). The third female had a complement of 20 young, 5 with carapace lengths of 2.5–2.8, 14 with lengths of 3.0–3.3, and one with a carapace length of 4.1. Data from laboratory reared spiderlings suggest that the young of this female were at least second year spiderlings, or third year in case of the largest young, that were still tolerated or even guarded by the female. Carapace lengths of reared spiderlings of three species did not reach 2.5 until the second year for the two larger species, *A. behlei* and *A. iodium*, and until the third year for *A. joshua* (closely approximating *A. mojave* in size).

Only fecundity data were obtained for *A. iodium*. The larger of two females (carapace length, 15.8), collected 7 October (1989) near Searchlight, Nevada, was dissected and contained an estimated 800–1000 developed and developing eggs. The smaller female (carapace length, 11.5) was collected while guarding her brood, many of which were on or near the cocoon. My initial estimation of spiderling numbers was approximately twice that of the 65 eventually retrieved; a substantial portion may have escaped into subterranean crevices when the cocoon was removed. Another factor

that may have lowered the natural count was the possible dispersal of young before the burrow was disturbed. Nevertheless, data suggest that larger females are capable of producing more offspring.

Prey capture and prey.—Tarantulas, as in other poor sighted hunting/ambushing spiders, detect their prey through substrate vibrations generated by movement. Capture methods of all Mojave *Aphonopelma* were, typically, indistinguishable. Once vibratory information was received, *Aphonopelma* usually turned toward the direction of the source. If the prey was relatively near and produced vibrations of the appropriate magnitude, it was quickly rushed, scooped toward the spider's unfolding fangs with fore-legs (or with larger prey with all legs), and impaled almost simultaneously. Once the quarry was secured, *Aphonopelma* typically extended their legs, raising the sometimes struggling victim well above the substrate, thus minimizing its chances of escape by using the ground surface for leverage. Most spiders then immediately returned to their burrows, inside of which the meals were consumed. If vibratory stimuli were further away, *Aphonopelma* moved toward the source through a series of discreet advances, reassessing direction, proximity, and magnitude of the vibration with each movement of the prey; the attack sequence was the same once initiated. Prey was pursued by *A. joshua* and *A. mojave* for distances up to 20 cm (rarely, up to 30 cm) and by *A. iodium* for up to 50 cm (rarely, up to greater distances) from the burrow entrance. Both *A. mojave* and *A. iodium* were lured out of their burrows (by using a twig or blade of grass to imitate prey movement) when nighttime temperatures were as low as 7 °C (2 °C in *A. paloma*), suggesting that threshold temperatures for feeding are lower than those required for initiation of male wandering and courtship behavior.

Sclerotized remains of beetles (primarily in the family Tenebrionidae), small-to-medium size scorpions, spiders of other families, and orthopterans were found in both burrow chambers and excavations of *A. iodium*; beetles comprised the bulk of the recognizable remains. Prey of both *A. joshua* and *A. mojave* included various species of beetles (primarily tenebrionids), harvester ants (Myrmicinae), small orthopterans, and, occasionally, small scorpions. Soft bodied insects, centipedes, and

small lizards were consumed by captive *Aphonopelma*. Evidence of neither congeneric nor conspecific cannibalism was detected among any of the sclerotized food remnants examined although S. Kutcher (16 October 1990) collected a male *A. iodium* clutching a male *A. mojave* in its fangs during the species common breeding season. In the laboratory, captive spiderlings past dispersal age occasionally cannibalized each other under overcrowded conditions; males with insufficient space to escape were sometimes killed by females after mating and, presumably, would have been consumed if not removed.

Isolating mechanisms in sympatric species.—A widely accepted paradigm is that, for the maintenance of closely related species in sympatry, some form of isolating mechanism must be in place. Because of their adaptive value premating mechanisms are believed to be of greater evolutionary significance than postmating mechanisms. Since the morphologies of both the male palpal bulb and the female spermathecae in *Aphonopelma* species (those in which male embolus is slender), doubtfully, preclude copulatory success, significant size differences in concurrently breeding species would reduce the likelihood of interbreeding attempts both because of physical constraints and differences in the magnitude of vibrational stimuli produced, the latter possibly eliciting a feeding response in the larger species and a flight response in the smaller species. Males may distinguish conspecific female burrows by entrance diameter although chemical cues, undoubtedly, play a more important role in species recognition. One possible mechanism among species of subequal size is a behavioral skew in breeding seasons; with this energy conservative mechanism in place, such species could coexist with minimal contact.

Field observations suggested the presence of such mechanisms among temperate North American sympatric *Aphonopelma*. Species of similar size had distinct, non-coinciding breeding seasons as well as morphological dissimilarities in metatarsal scopulation and/or coloration or in condition of tarsus IV scopula (entire or partially divided). Concurrently breeding species were found to be significantly different in size and generally distinctive in carapace and leg (in females) coloration and in degree of metatarsal scopulation.

The following examples illustrate the breeding season/size related mechanisms and associated morphological differences in known sympatric species (no species other than those referred to have been found in the stated areas of sympatry): (1) *A. joshua* and western *A. mojave* are narrowly sympatric and completely overlap in size (also sympatric with *A. iodinium*); the former is a summer breeder, the latter a fall breeder; partial division of tarsus IV scopula, limited distribution of red-orange dorsoabdominal setae, and swollen third femur of males are the obvious character differences that distinguish *A. joshua*. (2) *A. iodinium* and *A. mojave* are both fall breeders (also sympatric with *A. joshua* near Yucca Valley); the former are usually much larger than the latter (the smallest *A. iodinium* have been found in southern Utah but are substantially larger than the largest *A. mojave* in that region); extent of metatarsal scopulation and carapace coloration are obvious dissimilarities. (3) Two species, very similar in size, inhabit the coastal and inland regions south of the southern California transverse mountain ranges; one is a fall breeding 'eutylum type' (preliminary data suggest that Chamberlin names for 'eutylum type' species described from these areas are synonyms), with typical coloration and extensive metatarsal scopulation; the other is a summer breeder (*A. reversum* Chamberlin) is solid black (unless faded but is still unicolorous), and has limited metatarsus III and IV scopulation. (4) In Arizona *A. chalcodes* Chamberlin and *A. behlei* Chamberlin are narrowly sympatric in several regions at elevations approaching 1800 m (females overlap in size while *A. chalcodes* males are larger); *A. behlei* (mountain top or high elevation species) is solid black in color, has limited metatarsus IV scopula, and breeds in fall while *A. chalcodes* (primarily a desert dweller) has accentuated 'eutylum type' coloration, more extensive metatarsus IV scopula, and breeds in summer.

The following examples illustrate the responses of Mojave Desert tarantula pairs in situations where both supposed conspecific and interspecific pairings were made: (1) In laboratory breeding experiments two *A. joshua* males were introduced to *A. mojave* females, and two males of the latter species were paired with females of the former species. Pairings were made in both August and

October to even out seasonal bias. Males of both species began courtship displays and females responded by typical drumming in three instances, two of which were by *A. joshua* females. In all four pairings both genders quickly withdrew when contact was made by moving rapidly in opposite directions. That post-contact mating attempts were never initiated suggests that each species may have unique contact pheromones that function in species recognition and as a secondary isolating mechanism in areas of sympatry. (2) Eastern and western *A. mojave* males readily courted females of the differing race both in the laboratory and under natural conditions. Once females indicated receptivity, copulatory contact was made and sustained in all pairings for varying periods of time. (3) In similar experiments with 'eutylum types' from various regions of the Mojave Desert courtship and response behaviors were succeeded by sustained contact during which copulation occurred; the following males and females were paired: two male from the Beaver Dam Mountains with females from Red Mountain (west Mojave) and the Providence Mountains (east Mojave), respectively (the latter pairing was in mid-October at the female's natural burrow); a male from Searchlight, Nevada with a Red Mountain female; a male from Joshua Tree National Monument with a female from Lucerne Valley, California. When paired with *A. mojave*, female *A. iodinium* exhibited only predatory behavior; similar behavior was seen in male *A. iodinium* although they infrequently ignored females; *A. mojave* exhibited only a flight response.

Expected responses to interspecific pairings between sympatric 'eutylum type' species and between species similar to *A. mojave* would be on the order of those seen in pairings of *A. joshua* with *A. mojave*. Instead, the above pairs freely mated, supporting both the synonymy of *A. iodinium* and the conspecificity of eastern and western *A. mojave*.

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