

Notes on *Polyphylla* Harris with a description of a new species. (Coleoptera: Scarabaeidae: Melolonthinae)

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Abstract: *Polyphylla aeolus* La Rue, new species, is described from the Kelso Sand Dunes, Mojave Desert, San Bernardino County, California, U.S.A. Illustrations of dorsal habitus, significant morphological details, and adult genitalic forms are provided. A description of the type locality including geographical and ecological parameters is presented. Taxonomic problems within the genus and limitations of recently proposed methods of species identification are discussed. A modified key is provided to distinguish the new species.

The heretofore undescribed females of *Polyphylla anteronivea* Hardy, *P. mescalerensis* Young, *P. nubila* Van Dyke, and *P. pottorum* Hardy, are described. The larval host of *P. erratica* Hardy is reported, and the adult female is redescribed from pristine specimens. A dorsal habitus illustration of each female is provided.

Bionomic and distributional data are presented for *Polyphylla avittata* Hardy, *P. cavifrons* LeConte, *P. hirsuta* Van Dyke, *P. monahansensis* Hardy, *P. petiti* Guérin, *P. stellata* Young, and *P. squamiventris* Cazier

Introduction

Continued investigations of sand dune areas in western North America by the author and others have yielded an abundance of field data regarding the behavior, ecology, and distribution of the genus *Polyphylla* Harris. The most significant is the discovery of a new species from the Kelso Sand Dunes, California, U.S.A., described herein. Many of these wind-generated dune systems act as natural reservoirs for moisture from infrequent desert rains and, consequently, are a habitat for many rare and endemic Coleoptera (Andrews and Gilbert 1992). Hardy (1981), Hardy and Andrews (1978), and Young (1966, 1986, 1988) have previously described *Polyphylla* species from this distinctive ecological niche.

Origin and ecology of Kelso Sand Dunes

The Kelso Sand Dunes (Fig. 1) lie in the eastern Mojave Desert of southeastern California, at an average elevation of 610m. (2,000 ft.). The valley in which they occur is bordered on the south, east, and north by the Granite, Providence, and Kelso Mountain ranges respectively. The Bristol Mountains partly block the western margin of the valley, leaving a gap that allows wind-blown sand to enter. The dunes cover approximately 1,178 km² (Bowers 1984) and are located at the southwestern end of an elongated sand mass called "Devils Playground" (Fig. 2). Sharp (1966) suggested that the source of sand is a broad alluvial apron formed by

the Mojave River as it emerges from the east end of Afton Canyon; however, studies conducted by Meek (1989) indicate that a large perennial lake occupied the Soda Basin and Mojave River wash prior to the incision of Afton Canyon. Such a lake basin may have been an important source of sand for the Kelso Dunes.



1. Partial northward view of Kelso Dunes near type locality of *P. aeolus* new species.

The ability of sand dunes to conserve water has been well documented, (Chadwick and Dalke 1965, Hardy and Andrews 1987, Norris and Norris 1961, Prill 1968, Sharp 1966, and Shreve 1938, among others). Consequently, even in late summer, months after any rainfall, wet sand exists at

depths of only 15-20 cm below sun-baked dune slopes (Sharp 1966, Tinkham 1962).

The mean annual precipitation, which includes occasional snowfall, is 140mm (Bowers 1984). Temperature mean in summer is 26.6°-32.2°C. (80°-90°F.), in winter 4.5°-10.0°C. (40°-50°F), with frequent periods of frost of several days duration (Axelrod 1950:262).

The Kelso Dunes, together with other isolated Mojave Desert dune fields, form a well defined floristic community. The flora is characterized by species with Mohavean (15%), Sonoran-Mohavean (39%), Southwestern (23%), and endemic (9%) affinities (Bowers 1982). The floral composition fluctuates annually in response to winter precipitation. In years of abundant rain, the dunes are covered with a blanket of annuals, and the perennials support a profusion of vegetative growth. Vegetational surveys have been compiled by Bowers (1984), Dean (1978), Thorne, *et al.* (1981), and Tinkham (1973).

Preliminary surveys of the entomofauna inhabiting these dunes were compiled by Tinkham (1973, 1975) and Andrews, *et al.* (1979).

Polyphylla aeolus La Rue, new species

(Figs. 3-17)

Type material: Holotype male (California Academy of Sciences #17132): U.S.A., *California*: San Bernardino County, Kelso Sand Dunes, 2.6 mi. west of junction Kelbaker Rd. and sand dunes, 31 May 1986, R. A. Cunningham and R. W. Duff collectors, at blacklight. Allotype female (CAS): same locality as holotype, 24 May 1986, D. A. La Rue collector; 721 additional paratypes, same locality as holotype: 24 and 27 May 1986, D. A. La Rue (159 males, 19 females); 31 May 1986, R. A. Cunningham and R. W. Duff (238 males, 22 females); 1-2 June 1990, B. D. Streit, T. H. Weiser, R. H. Weiser and W. S. Weiser (143 males, 28 females); 24 May 1993, D. E. Russell (111 males, 1 female). Paratypes deposited in these institutional collections: California Academy of Sciences (San Francisco, CA), United States National Museum of Natural History (Washington, D.C.), Los Angeles County Museum of Natural History (Los Angeles, CA), University of Nebraska State Museum (Lincoln, NE), University of California, Berkeley (Berkeley, CA), University of California, Riverside (Riverside, CA), and the private collections of the following: R. Alten (Rancho Cucamonga, CA) D. C. Carlson (Orangevale, CA), R. A. Cunningham (Chino, CA), R. W. Duff (Downey, CA), B. D. Gill

(Ottawa, Ontario, Canada), H. F. Howden (Ottawa, Ontario, Canada), M. L. Jameson (Lincoln, NE), P. K. Lago (University, MS), R. H. McPeak (Battle Ground, WA), S. McCleve (Douglas, AZ), G. H. Nelson (Blue Spring, MO), B. C. Ratcliffe (Lincoln, NE), A. J. Reifschneider (Sierra Madre, CA), E. G. Riley (College Station, TX), D. E. Russell (Oxford, OH), J. Saulnier (Yucaipa, CA), P. E. Skelley (Gainesville, FL), B. D. Streit (Tucson, AZ), D. W. Sundberg (San Antonio, TX), W. B. Warner (Chandler, AZ), G. Walters, (La Puente, CA), C. S. Wolfe (Fort Worth, TX), and the author.

Description: Holotype: Male (Fig.3). Length: 30.5mm. Greatest width: 13.2mm. (12.5mm. at elytral humeri). Body elongate, parallel-sided; head with integumentary color of vertex, front, anterior and lateral clypeal margins and angles black; thoracic integument, clypeal disk, pygidium, and abdominal segments rufopiceous; elytra, scutellum, remainder of venter and appendages rufotestaceous; antennal club testaceous. Head: Clypeus 2X wider than long, anterior margins sharply reflexed, slightly emarginate; disk sunken behind strongly reflexed anterior margin, lateral margins narrowing to base, not as strongly reflexed, more strongly narrowed in posterior 1/3 to accommodate antennal scape; interior edge of clypeal margins provided with dense contiguous recumbent elliptical white scales intermixed with pale yellow acuminate scales; scale configuration imbricate; clypeal suture slightly emarginate; clypeal disk with large punctures; each puncture provided with a suberect long pale yellow seta, occasionally interspersed with white scales. Ocular canthi slightly spatulate, approximately 2X longer than wide, extending 1/3 distance across exposed portion of eye, with white scales and long testaceous setae concentrated at apex; frons with small round punctures, each with long pale yellow setae or elliptical white scales, scales becoming dense and imbricate in a weak flexuous pattern at lateral margins above eyes; vertex smooth, glabrous, shining. Pronotum: Evenly convex; approximately 2X wider than long, widest at posterior 1/3; anterior angles obtuse; posterior angles rounded and slightly explanate; marginal bead weakly reflexed, with sparse erect testaceous setae anteriorly and laterally; lateral marginal bead distinctly serrate; pronotum anteriorly and posteriorly with dense, continuous mat of short, testaceous setae, especially at articulation; disk sunken at midline at anterior margin; with small, glabrous, oblong, shallow depression mediolaterally; disk clothed

throughout with broad, white and pale yellow scales rising from scattered to contiguous, round punctures; with slender, long, pale yellow, erect to suberect setae rising medially, becoming sparse mediolaterally, concentrated at center of midline to form small tuft or feeble scopula (Fig. 9); pronotum trivittate, with a mixture of dense, contiguous to imbricate, elliptical, white and pale yellow scales forming narrow vitta at midline; lateral vittae formed as irregular, crescentic mass of contiguous to imbricate white and pale yellow scales; a small area of contiguous white scales medially between lateral vittae and pronotal marginal bead, appearing as white, subreniform, elliptical spot to unaided eye. Scutellum: Posterolateral margins glabrous, slightly sunken medially, covered at center with dense patch of contiguous to imbricate white, acuminate scales; with sparse, decumbent, pale yellow setae present anteromedially. Elytra: Elytra approximately 1.5X longer than wide; narrowing posteriorly and broadly rounded, margin explanate at elytral humeri, slightly so posterolaterally; marginal bead slender, provided with 1-3 rows of minute pale yellow spiculae posteriorly; elytral suture with short pale yellow setae, becoming dense and longer at elytral declivity; elytral surface with deep rugose punctures and noticeable vittae; elytral vittae appearing distinct and nearly continuous to unaided eye, microscopically discontinuous and reduced to irregularly shaped clumps of imbricate white lanceolate scales; sutural vittae continuous, formed of white contiguous scales; vestiture of white scales nearly contiguous below elytral declivity near external margins; intervals uniformly covered with pale yellow lanceolate scales, scales rarely contiguous or imbricate, appearing slightly larger than those forming the elytral vittae, frequently meeting elytral vittae; elytral surface with short, suberect, scattered pale yellow setae that are more evident at humeral declivity and along lateral elytral margins, more evident microscopically (30X). Pygidium: Length subequal to width; margins reflexed, basal portion, including strongly reflexed margin, with numerous, erect, pale yellow setae, setae continuing towards base along margin to posterolateral 1/3; disk nearly contiguously covered with white scales, scales becoming sparse at midline and mediolaterally mesad of outer margin. Venter: Head and thorax densely pilose, setae pale, testaceous, obscuring ventral surface; abdominal segments connate, each segment with basal glabrous band of scattered to contiguous white scales and pale yellow short erect setae; surface of clypeus

glabrous and shining; distal segment of maxillary palpus conical, subequal in length to basal segments combined; clypeopleuron with nearly contiguous white scales that form feeble flexuous pattern; anterior tibiae strongly bidentate; femora, tibiae and tarsomeres intermittently covered with heavy to sparse, white scales and pale yellow setae; antennal scape with dense pile of long pale yellow setae, antennal club 2.7 (linear measurement) or 4 (along curve) times length of basal segments combined. Genitalia: (Figs. 11-14).

Allotype: Female (Fig. 4). Length: 29.5 mm. Greatest width: 14mm. (12.5mm. at elytral humeri). Differs from holotype in these respects: more robust; thoracic integument, clypeal disk, and pygidium rufotestaceous; antennal club and appendages rufopiceous. Head: Anterior clypeal margin not as strongly reflexed, especially medially, disk more shallowly sunken; vestiture reduced on frons and clypeus. Pronotum: Discal setae more pronounced (Fig. 10), lateral marginal bead not as coarsely serrated; mat of short, testaceous setae at articulation approximately 2X longer than in male. Scutellum: Pale yellow setae medially forming feeble scopula. Elytra: Submarginal vittae continuous and unbroken. Venter: Basal segment of maxillary palpus slightly longer, apical segment slightly flattened apically; antennal club with 5 antennomeres, with 5 antennomeres composing basal stem; anterior tibiae strongly tridentate; metafemora enlarged, flattened, subequal in length to those of male. Genital plates: (Fig. 15).

Variation in paratype series

Males (651) (Figs. 5-8). Length: 23.0-32.5mm. Greatest width: 9.5-13.7mm. Differ from holotype in following respects: color of clypeus rufotestaceous to piceous; pronotum and abdominal segments rufotestaceous; antennal club and minor appendages rufotestaceous; elytral humeri piceous; Head: Anterior clypeal margin sinuous, not as strongly reflexed; scale vestiture of disk pronounced, obscuring integument beneath, or reduced to clypeal margins; vertex with scattered large punctures. Pronotum: Serration of lateral marginal beads reduced; erect to suberect, pale yellow setae of disk more pronounced or reduced (abrasion?). Scutellum: Scale vestiture reduced; pale yellow, decumbent setae reduced or absent. Elytra: Rarely, pale yellow interstitial scales so abundant as to give specimen olivaceous-colored cast; short, pale yellow setae absent (abrasion?);

vittae not as broken, discontinuous, forming identifiable lines, or broken and fragmented, forming a scattered pattern of irregular clumps. Pygidium: Scale vestiture uniformly reduced; pale yellow setae reduced to basal tip. Venter: Heavy, dense pile of testaceous setae slightly obscuring surface.

Females (70). Length: 27.5-33.0mm. Greatest width: 13.0-16.5mm. Differ from allotype in following respects: Clypeal and thoracic integument rufopiceous; antennal club rufotestaceous. Pronotum: Serration of lateral marginal beads reduced; pale yellow setae on disk forming dense scopula. Scutellum: Pale yellow setae reduced or absent. Elytra: White interstitial scales; vitta reduced to scattered, irregular clumps.

Remarks. *Polyphylla aeolus* is externally similar to *P. arguta* Casey, which has a primarily Great Basin distribution. However, *P. aeolus* may be distinguished from *P. arguta*, and all other known species in the genus, by the combination of pronotal and elytral setae, pale yellow interstitial squamae, consistent reddish-brown elytral color, and imbricate squamae. All these character states are lacking in *P. arguta* (Young 1988:39-40). *Polyphylla aeolus* is the 3rd species to have the imbricate scale configuration specifically noted in the literature, the others being *P. erratica* Hardy, and *P. anteronivea* Hardy (Hardy and Andrews 1978:4-5; Young 1988:78). Furthermore, ecological parameters of both species differ significantly: *P. arguta* is a montane species that primarily occupies piñon-juniper woodlands, generally in, but not restricted to, the upper latitudes of the Great Basin; *P. aeolus* inhabits an isolated sand mass surrounded by xeric desert in the lower latitudes of the Mojave Desert.

Etymology: This species is named after *Aeolus*, keeper of the winds in Greek mythology; in reference to the natural forces which have created and formed Kelso Sand Dunes, the type locality.

Distribution: Despite intensive entomological exploration in the Mojave Desert of California, this large, unique, psammophilous species has been collected only at the southern edge of the Kelso Sand Dunes. This may indicate that it is endemic to these particular dunes. More than half of the known North American *Polyphylla* are restricted to a unique, isolated habitat (Young 1988).

The type locality is located approximately 4.2 km. west of Kelbaker Road, and slightly north of a graded dirt road that provides ingress to this portion of the dunes (Fig. 2). The area consists of semistabilized dune hummocks that support abundant growths of *Hilaria rigida* (Thurber)

Bentham (Big Galleta grass), *Croton mojavenis* Ferguson (Croton), *Petalonyx thurberi* Gray (Sandpaper Plant), and scattered *Larrea tridentata* (Mociño and Sessé) Coville (Creosote Bush). Range cattle heavily utilize the *Hilaria* for grazing purposes; to what extent their activity has impacted the ecology of this area has not been ascertained.

Taxonomy. *Polyphylla aeolus* will run to couplet 20 of Young's (1988) key to the species of *Polyphylla* ("Aedeagal Characters Primarily Excluded"). The following modification will serve to separate *P. aeolus*:

- 20 (19'). Elytra with long erect setae, excluding suture; yellow interstitial scales meeting vitta without glabrous area between
 *rugosipennis* Casey
 20' Elytra without long erect setae, excluding suture; white (or rarely yellow) interstitial scales not meeting vitta, area between glabrous
 *diffRACTA* Casey
 20" Elytra with sparsely scattered short sub-erect pale yellow setae, excluding suture; yellow interstitial scales frequently meeting vitta, areas between discontinuously glabrous to unaided eye *aeolus* La Rue, n. sp.

The large size, dorsal vestiture, and distribution of this species indicates that it is a member of the *P. decemlineata* species complex (*sensu* Young 1988) which includes *P. arguta*, *P. decemlineata* (Say), and *P. monahansensis* Hardy. However, examination of the male aedeagus appears to contradict these conclusions because it displays similarities to those of *P. anteronivea* and *P. erratica* of the *P. hammondi* species group which are distinguished by "the lack of setae over the entire pronotal surface, lack of clumped squamae, unique reddish-brown elytral color, and the aedeagus which does not broaden at the cleft, with the apex parallel-sided to broadly spatulate, and appearing truncated when viewed dorsally" (Young 1988). *Polyphylla aeolus* exhibits only the reddish-brown elytral color, but has pronotal setae, clumped squamae, and a gradually rounded aedeagal apex, (Figs. 11-14). These latter characters would clearly exclude it from this complex and raise a question to the taxonomic validity of species groups (*sensu* Young 1988) based upon the male aedeagus.

Adult behavior: Most sand dune inhabitants possess physiological, morphological, and behavioral adaptations allowing them to exist in such environments (Andrews and Gilbert 1992). Many

dune-inhabiting species of Scarabaeidae seem to be otherwise unable to survive in desert areas (Hardy and Andrews 1987). *Polyphylla aeolus* is apparently an obligate to this pattern.

The following notes of adult behavior are summarized from observations by several collectors over several years:

In late afternoon, male activity began as rapid, irregular flights several meters above the sand surface. Females were evident in open areas away from vegetation, partially emerged from the sand with only the head and pronotum exposed (Fig. 16).

As dusk approached, male flights became less erratic and more purposeful, and females were found fully emerged and resting on the sand surface. Males flew rapidly upwind, returning in a slow zig-zag flight (indicative of osmoclinotaxic orientation). Males ultimately alighted within a few centimeters of a female, and several matings were observed (Fig. 17). Copulation ranged from 75 to 120 seconds, after which the females immediately began to burrow into the sand. In a few instances, females began to re-enter the sand with the male still *in copula* (R. A. Cunningham, pers. comm.). Evidently, females attract males via a sex pheromone as several males were drawn to a single female elytron (B. D. Streit, pers. comm.).

After twilight, males were readily attracted in large numbers to black-light, white-light, and the glow of a Coleman lantern. In these cases, visible adult activity ceased several hours after sunset, because no additional specimens were found at the lights nor could be located anywhere on the sand surface. On other dates, male flight activity ceased shortly after sunset (B.D. Streit, pers. comm.).

Females were not observed to fly, and most were encountered on the sand surface. However, a number of females were excavated at depths of 10-20 cm by locating the distinctive burial points on the sand similar to those illustrated by Hardy and Andrews (1986:135, Fig. 7.) (R. W. Duff, pers. comm.). These measurements coincide with the varied depth of the damp sand interface, where females presumably spend the daylight hours.

Discussion: Further aedeagal analysis of *P. anteronivea* (38 male topotypes) and *P. erratica* (50 male topotypes) displays significant differences from those illustrated by Young (1988:11, Figs. 8a and 8d). Young's illustrations show that, in dorsal aspect, the parameres meet from the basal 1/2 (*P. anteronivea*) or basal 1/3 (*P. erratica*) to the distal tip, which is truncated; in caudal aspect, the dorsal ridge of the parameres, which gradually curve

down and outward, and the distal tip are depicted as guttiform, suggesting the parameres are cylindrical for their outer length. My observations indicate, in dorsal aspect, the parameres of *P. anteronivea* and *P. erratica* are clearly separated and scarcely touch at the anteroventral recurved portion of the distal tip, which terminates to a gradually rounded point and is clearly not truncated. In caudal view, the dorsal ridge is elevated into a sharp carina, and the dorsal portion of the parameres is slightly obliquely flattened giving the distal tip an elongated, trapezoidal appearance.

The apparent variability of the male aedeagal structure may give some justification and comprehension to Hardy's statement (1981), with which I agree, that a species complex based upon this character "is not entirely accurate."

Additional collecting in sand dune areas and similar habitats in the southwestern United States has yielded several heretofore unknown female *Polyphylla*. Their descriptions follows:

***Polyphylla anteronivea* Hardy**
(Fig. 18)

Description of female: Length: 27.5mm
Greatest width: 14.5mm (12.5mm at elytral humeri). Differs from male in the following respects: robust, parallel-sided, somewhat wider at posterior third; integumentary color including appendages deep rufotestaceous; outer margins of clypeus, protibia, and pygidium, rufopiceous. Head: Clypeus subquadrate, anterior margin not as reflexed, disk shallowly depressed, provided with deep large punctures more pronounced; clypeal suture slightly emarginate; scale vestiture limited to outer marginal areas of clypeus and frons; long, pale yellow setae abundant throughout disk; ocular canthi conical, slightly spatulate. Pronotum: Strongly convex, elevated and appearing swollen, widest at anterior 1/3; uniformly covered with white oval scales except weakly reduced at anterior 1/2, scale vestiture of disk not obscuring pronotal integument as in male, forming single medial vitta with symmetrical areas of heavy imbricate white scales; with dense area of long, recumbent, pale yellow setae posterolaterally between central vitta and lateral pronotal margins, additional long, recumbent, white and pale yellow setae located anteromedially within central vitta. Scutellum: Transverse; covered with contiguous white, lanceolate scales, heavily so in some areas; pale yellow setae present medially, posterolateral margins glabrous. Elytra: 1.5X longer than wide;

margins glabrous. Elytra: 1.5X longer than wide; scale vestiture reduced to scattered individual white, lanceolate scales, except in sunken area above humeri, along lateral margins and length of sutural area, where they are close to contiguous; setae absent except along suture. Pygidium: Slightly transverse; uniformly covered with white scales, except for faint glabrous midline; yellow setae sparsely scattered throughout disk, becoming more dense at posterior marginal bead. Venter: Head and thorax with dense pile of testaceous setae which obscures ventral surface, except for area of glabrous metasternal midline; abdominal segments lacking heavy scalation as in male; apical maxillary palpomere conical, subequal in length to basal 2 palpomeres combined; antennae reduced to 5 antennomere club, with 5 antennomeres in basal stem. Profemora and protibiae shorter in length than male; metafemora enlarged, flattened, subequal to length in male; combined length of tarsomeres shorter; meso-, metafemora and meso-, metatibiae densely covered with long testaceous setae.

Description based on one example with the following data: U.S.A., California: Inyo County, Saline Valley Dunes, 26-27 May 1990, R. A. Cunningham, D. E. Russell, B. D. Streit collectors, "taken on surface of sand dune *in copulo*." (B. D. Streit collection).

Remarks: The presence of pronotal setae would exclude this species from the "*P. hammondi* complex," as defined by Young (1988:5). Since many females in the genus were unknown at the time of his monograph, Young's species groups are based solely on male characters.

Until recently, *P. anteronivea* males were known to exhibit only nocturnal flight behavior. At the time the female was collected, in mid afternoon, males had been flying for some time. The mating pair was located on the leeward side of the dune mass, approximately 1.5 meters above the sand-hardpan interface. Additional males were collected out on the hardpan substrate, far removed from the dune influence (B. D. Streit, pers. comm.).

Presence of strong winds and airborne sand does not curtail flight activity. Males were observed flying at midday in a sand storm with 65-80 kph (40-50 mph) winds. During these conditions, flight was slow and laborious several centimeters above the wind protected leeward dune face. Beetles reaching the dune crest, directly in the prevailing wind's path, tumbled several centimeters down the leeward slope. After several seconds, an

individual would regain flight posture and repeat the activity. (D. E. Russell, pers. comm.).

Polyphylla mescalerensis Young

(Fig. 19)

Description of female: Length: 23.5mm. Greatest width: 12.0mm (9.5mm at elytral humeri). Differs from male in the following respects: robust, widest at posterior third; pronotal integument posterolaterally piceous, ventral pubescence pale testaceous, pygidium and abdominal segments rufopiceous. Head: Clypeus distinctly transverse, 2X wider than long, anterior margin not strongly reflexed, anterior angles acute and elevated, disk weakly depressed, suture slightly emarginate; vertex and frons convex; ocular canthi not as elongate; pale testaceous setae of surfaces not as coarse and shorter in length. Pronotum: Anteromedially with shiny glabrous area; scale vestiture of vittae and lateral margins reduced; shallow punctures of disk larger in diameter, nearly contiguous, coarser posteromedially. Scutellum: Slightly longer, longitudinal midline with pale testaceous setae. Elytra: Sutural costa scarcely indicated; scales on lateral marginal vittae and posterior elytral declivity larger. Pygidium: Laterally with scales and pale setae reduced, revealing integument. Venter: Head and thorax covered with a dense pile of pale testaceous setae which obscures ventral surface; terminal segment of maxillary palpus short, flattened dorsally, subequal in length to 2 basal palpomeres combined; antennae reduced to 5 antennomere club, with 5 antennomeres in basal stem; protibial dentition distinctly more developed, closer together in distribution; metafemora enlarged, flattened, shorter than in male; tarsi shorter; 2 distal spines of meso-, metatibiae noticeably developed; metatibial spines somewhat flattened, rectangular, projecting obliquely; meso-, metafemora, meso-, metatibiae covered with long, pale testaceous setae.

Description based on one example with the following data: U.S.A., New Mexico, Chaves County, 9.5 miles W. of Caprock, 27 July 1989, E. G. Riley and C. S. Wolfe collectors (E. G. Riley collection).

Remarks. The female was discovered on the side of a dune swale, approximately one hour after dark. The area consisted of active dune hummocks with *Quercus harvardii* Rydberg (Shinnery Oak) distributed on the dune crests (E. G. Riley, pers. comm.).

Polyphylla nubila Van Dyke

(Fig. 20)

Description of female: Length: 25.5mm. Greatest width: 12.5mm (11.0mm at elytral humeri). Differs from male in the following respects: robust, subparallel, widest at posterior 1/3; color of elytra, pygidium, ventral surfaces, lateral margins of prothorax, clypeal disk, and antennal scape deep rufotestaceous; frons, anterior clypeal margin, central thoracic disk, elytral humeri, and outer margin of protibia rufopiceous; tarsi, and minor appendages testaceous. Head: Clypeus distinctly transverse, angles quadrate, anterior margin not as reflexed, disk weakly depressed, with scattered large punctures; clypeal suture slightly emarginate; vertex with long, pale testaceous setae and large coarse, nearly contiguous punctures and 1 or 2 rows of white, lanceolate scales at outer margin above eyes; Pronotum: Distinctly convex, somewhat impressed at midline and anterolaterally; long testaceous setae of pronotal disk concentrated anteromedially to form scopula; appearing univittate to the unaided eye, distinctly trivittate microscopically. Scutellum: Transverse, disk with contiguous oval white scales and sparse pale testaceous setae medially. Elytra: Approximately 1.5X longer than wide; vittae reduced; pale yellow lanceolate scales and sparse, suberect, pale yellow, setae more evident at lateral declivity. Pygidium: Covered with short recumbent sparse pale testaceous setae and white oval scales. Venter: Head and thorax with dense, pale testaceous setae that obscure ventral surface; terminal palpomere short, truncate, slightly flattened dorsally, shorter in length than 2 basal palpomeres combined; antennae reduced to 5 antennomere club, with 5 antennomeres in basal stem; profemora and protibiae shorter in length; metafemora enlarged, flattened; combined length of tarsomeres shorter; meso-metapomera and meso-, metatibiae with long, testaceous setae.

Description based on one example with the following data: U.S.A., California: San Luis Obispo County, Atascadero, 15 June 1991, D. E. Russell collector (D. E. Russell collection).

Remarks: Adults of this species normally become active following the first warm weather in June, occasionally as early as April, with some populations active until late July. The type series was collected in late May (Van Dyke 1947).

Specimens were collected in an area of sandy, loose soil with *Adenostoma* (chamise), *Quercus* (oak), and scattered grasses and annuals. The fe-

male and a pair *in copulo* were found crawling on the sand surface with no evident burrow or vegetation in the immediate vicinity. Males emerged a few hours after sunset and were readily attracted to a 175 watt mercury vapor light. A number of males were found hidden among dried grass up to ten meters away from the light source. Males of *Polyphylla decemlineata* (Say) were collected at the same light station (D. E. Russell, pers. comm.).

Additional specimens examined, add distributional, and phenological data: California, San Luis Obispo County: Atascadero, 25 July 1967, S. Allen collector; San Luis Obispo, 26 April 1956, W.A. Wallace collector; Poly Grove, 18 May 1956, R. Goo collector; Paso Robles, 10 April 1956, C. Blundell collector; (all in D. A. La Rue collection).

Polyphylla pottsorum Hardy

(Fig. 21)

Description of female: Length: 21.5mm. Greatest width: 9.0mm (8.5mm at elytral humeri). Differs from male in the following respects: slightly more robust; color of elytra and appendages rufotestaceous, pygidium rufopiceous. Head: Clypeus quadrate, anterior margin not as strongly reflexed, slightly bisinuate, disk weakly depressed; vestiture reduced, vertex slightly wider; setae of ocular canthi reduced in number. Pronotum: Widest at anterior third; appearing univittate, reduced testaceous setae at articulation shorter in length. Scutellum: Subglabrous except for small area of white lanceolate scales medially. Elytra: White scales scattered sparsely throughout disk, disk appearing glabrous to unaided eye. Pygidium: Covered with scattered, sparse, white, lanceolate scales and short, recumbent, pale setae. Venter: Surface of head and thorax not as densely setose; abdominal segments sparsely covered with short white scales and long pale setae; terminal maxillary palpomere short, indistinctly truncate, equal in length to basal 2 palpomeres combined; antennae reduced to 5 antennomere club, with 5 antennomeres in basal stem; combined length of tarsomeres shorter, metafemora enlarged, flattened.

Description based on one example with the following data: U.S.A., Texas: Ward County, Monahans Sand Dunes, 19 July 1976, R. W. Duff collector (R. W. Duff collection).

Remarks: The female was located crawling at night on the sand surface in an area of active parabolic dunes with scattered *Calamovilfa gigantea* (Nuttall) Scribner and Merrill (Giant Sand Reed) and *Quercus harvardii* Rydberg (Shinnery

Oak) (R. W. Duff, pers. comm.).

This species was previously known from the Monahans Sand Dunes in Ward and Winkler Counties, Texas, and the Mescalero Dunes, Chaves County, New Mexico. Collecting in intervening and adjacent sand habitats indicates the distribution of *P. pottsorum* is far more extensive: Texas: Andrews County, 1.5 miles S. Junction Highways 115 and 181, 6 July 1991, C. S. Wolfe and E. G. Riley collectors; New Mexico: Lea County, 23.5 miles and 26.5 miles W. of Hobbs, 4 July 1991, C. S. Wolfe and E. G. Riley collectors; Eddy County, 5 miles E. of Loco Hills, 5 July 1991, C. S. Wolfe collector.

The Andrews County, Texas, locality is a continuation of the Monahans Sand Dune system, with similar sand composition and plant community (C. S. Wolfe, pers. comm.; see remarks under *P. monahansensis* below).

The Lea and Eddy County, New Mexico, localities are composed of extensive deep reddish dunes that are distinct from those found in the Monahans system, suggesting they are of an older, finer grained composition (*sensu* Norris and Norris 1961:612). However, the floral community does not differ significantly (C. S. Wolfe, pers. comm.).

Polyphylla pottsorum is herein defined as a complex of geographical phenotypes differing principally by male dorsal coloration. Although some specimens appear to be quite distinctive, they invariably represent intrapopulational phenotype extremes.

Populations from New Mexico differ significantly from the nominate phenotype of west Texas and are briefly characterized as follows:

Chaves County, Mescalero Sand Dunes ("9.5 miles W. Caprock, 1.7 mi. S.E. of Highway 380"). The coloration of the pronotal integument is a pale reddish brown rather than the typical piceous, and the elytra are more of a golden yellow.

Lea County, "23.5 miles and 26.5 miles W. Hobbs." The elytral coloration ranges from deep reddish brown to black (appearing dark chestnut brown microscopically) with an even gradient between the two. A female from "26.5 miles west of Hobbs" differs from the nominate phenotype described above by a rufopiceous pronotal integument and deep chestnut brown elytra.

Eddy County, "5 miles E. Loco Hills." The coloration of the pronotal integument ranges from deep chestnut brown to black; the elytra from yellowish brown, as in the Mescalero Dunes population, to a deep chestnut brown, with an even gradient between the 2.

Polyphylla erratica Hardy

(Figs. 22-23)

Young's description and illustration of the female of *Polyphylla erratica* Hardy (1988:78 and Fig. 72) was based on an abraded, damaged specimen and does not accurately depict the true form. It is here redescribed and illustrated from pristine specimens.

Length: 27.0-28.5mm. Greatest width: 12.0-14.5mm (11.5-12.0mm at elytral humeri). Differs from male in the following respects: robust, widest at posterior 1/2; color of head, clypeal disk, antennal club, and protibial dentition piceous. Pronotum: With nearly contiguous to imbricate, oval, white scales, becoming sparse anteromedially, leaving small, crescentic, glabrous area on either side of central vitta. Venter: Surface of head and thorax covered with dense, pale, testaceous setae and lanceolate, white scales, weakly obscuring surface; terminal maxillary palpomere short, conical, shorter in length than basal 2 palpomeres combined; metafemora enlarged, flattened, tarsi shorter.

Description based on 5 examples with the following data: U.S.A., California, San Bernardino County: Amargosa River near Hwy. 127, 4 May 1986 (1), R. A. Cunningham collector (R. A. Cunningham collection); 30 April 1986 (3), 6 May 1986 (1), D. A. La Rue collector (D. A. La Rue collection).

Remarks: Aside from sexually dimorphic characters, females are remarkably similar to males in this species.

Females were located by observing small aggregations of 3 to 8 males hovering above or crawling on the soil surface. Examination of these locations yielded a female still within or partially emerged from a burrow. In one instance, a male was noted to physically displace a partially emerged female from the burrow to attain a copulatory position (personal observation).

Polyphylla erratica is a halophytic species, with larvae, pupae, and adults occurring in moist, salt encrusted soil. Larvae were taken at the roots of *Distichlis divaricata* Beetle (Salt Grass), which is abundant throughout the Amargosa River bottom. *Polyphylla erratica* is undoubtedly restricted to this unique ecotone as the known distribution follows the moist environs of the Amargosa River system.

Males of this species exhibit a variety of flight behaviors. Active flight has been observed from late morning to early afternoon (R. A. Cunn-

ham, pers. comm.), and from late afternoon to well into dusk (pers. observation). Specimens have also been taken in a blacklight trap (D. E. Russell, pers. comm.) indicating that males are not restricted to diurnal or crepuscular flights as was previously assumed (Hardy and Andrews 1978). As with *P. anteronivea*, strong prevailing winds do not seem to curtail flights but may reduce the number of active adults (pers. observation).

Ravens, shrikes, and coyotes were observed to opportunistically feed on the adults of this species. Specimens were found impaled on vegetation by shrikes, and coyote scats examined were composed almost entirely of undigested adult *P. erratica* fragments (R. A. Cunningham and R. W. Duff, pers. comm.).

Distribution records: The following data hopefully will provide additional knowledge toward understanding the ecology and distributions of those species considered. Unless otherwise indicated, specimens are in the collections of the respective collectors.

Polyphylla avittata Hardy

U.S.A., UTAH: Washington County, Snow Canyon State Park, 14 and 15 July 1978, 30 June 1986, G. H. Nelson collector, at blacklight.

Remarks: This area is composed of white and red Navajo sandstone with numerous black lava beds. The sand dunes are lighter in color and not as extensive as those comprising the type locality, Hurricane Dunes, approximately 30 km. to the east. The plant community is essentially *Artemisia* (sagebrush), with scattered scrub oaks (G. H. Nelson, pers. comm.). Hardy and Andrews (1978:2) noted that the predominant vegetation at the type locality was *Artemisia filifolia* Torrey (cited as "*filiiformis*").

Polyphylla cavifrons LeConte

U.S.A., Arizona: Maricopa County, Coon's Bluff, near Gila River, 20 July 1987, 22 July 1990, 16 August 1990, R. W. Duff collector; Yuma County, Ehrenberg, rest area, 22 August 1989, R. W. Duff collector;

U.S.A., California: Imperial County, 6 miles E. of Holtville, East Highline Canal, 10 June 1989, J. Beierl and E. Barchet collectors (R. A. Cunningham collection); Titsworth Road and East Highline Canal, 24 July 1992, R.W. Duff collector; Junction of Highway 111 and Alamo River, 19 July 1987, R. A. Cunningham collector; Two Rivers rest area, 20

July 1984, R. W. Duff collector; Highway 78, vicinity of Green Road, 19 July 1982, R. W. Duff collector; 19 July 1987, R. A. Cunningham collector; 2.1 miles N. of Laguna Dam, 24 July 1984, R.W. Duff collector; San Bernardino County, 13 road miles NE of Earp, Highway 62, 3 August 1973, R.W. Duff collector; Riverside County, Dos Palmas Spring, Coachella Valley, 30 May 1992, R.W. Duff collector.

Remarks: Young's (1988:78) statement "... this is a species of the true xeric desert" is misleading and conveys the impression that *P. cavifrons* inhabits the open, arid desert. Ecologically, it is nearly entirely restricted to desert riparian or similar habitats. The recorded distribution follows, or is adjacent to, natural or manmade watercourses and drainage ways that include rivers, canals, and irrigation ditches. A unique record is from Dos Palmas Spring, an isolated area of spring-fed ponds and extensive *Washingtonia filifera* (Linden) Wendland (California Fan Palm).

Polyphylla hirsuta Van Dyke

U.S.A., Arizona: Santa Cruz County, Patagonia Mountains, Mt. Washington, vic. Forest Service Road #128 and Duquesne Road, 5300' elev., 12 August 1991, R.A. Cunningham collector, 15 watt BL; Duquesne Road (Forest Service Road #61) 7.8 miles E. Junction Highway 82, 4800' elev., 13 August 1991, L. G. Bezark, R. A. Cunningham, D. E. Russell collectors (D. E. Russell collection).

Remarks: Both localities are in the Patagonia Mountains near the type locality, Mt. Washington (Van Dyke 1933). However, the localities differ ecologically. Males were taken at 1,590 m. (5,300 ft.) elevation, in predominately oak woodland with some scattered pines and junipers. Specimens were taken at 1,440 m. (4,800 ft.) elevation, in a sandy area best described as oak-mesquite transition with several large *Juglans major* (Torrey) Heller (Arizona Walnut). *Polyphylla hammondi* LeConte was sympatric at the lower elevation. The first significant summer monsoons had recently drenched the area comprising both localities, resulting in a phenomenal number of insects at mercury vapor and blacklight stations during subsequent nights (R. A. Cunningham, D. E. Russell, pers. comm.).

Young's (1988:63) record of this species from "Patagonia Mountain" (singular) is probably a typographical error. This name comprehensively applies to the mountain range; no singular mountain peak by this name exists in Arizona or adjacent Mexico.

Polyphylla monahansensis Hardy

U.S.A., TEXAS: Winkler County, Junction of State Highway 115 and Farm Road 874, NE of Kermit, rest area, 28 July 1978, R. W. Duff collector; Andrews County, 1.5 miles south of Junction Highways 115 and 181, 6 July 1991, C. S. Wolfe and E. G. Riley collectors.

U.S.A., NEW MEXICO: Lea County, 4 miles south of Jal, Highway 18, 6 July 1991, C. S. Wolfe and E. G. Riley collectors.

Remarks: The Texas localities are a continuation of the Monahans Dune system, with similar plant community (R. W. Duff, C. S. Wolfe, pers. comm.). *Polyphylla pottsorum* was sympatric at both sites.

The New Mexico locality consists of extensive deep reddish dunes as described above for *P. pottsorum* in Lea and Eddy Counties. *Polyphylla pottsorum* was not collected at this site (C. S. Wolfe, pers. comm.). Aside from this locality, *P. monahansensis* was known to be sympatric with *P. pottsorum* throughout its distribution. This represents a new state record for this species in New Mexico.

Young (1988:52) recorded *P. monahansensis* from Mexico based on a single example with the following data: "Mexico, Chihuahua, between Yepachic and Tomachic (correct spelling: Temosachic), large canyon bottom, 31 July 1984, Doug Mullins collector" (S. McCleve collection, on loan to R. M. Young, Cody, WY). According to the collector, this locality is in the Sierra Madre Occidental range in west-central Chihuahua at an elevation of 1,500-1,650 m. (5,000-5,500 ft.). The habitat consists of oak-pine woodlands surrounding a small stream. The specimen in question was taken at blacklight with *Plusiotis beyeri* Skinner, *Diploptaxis* sp., and *Phyllophaga* sp., all of which are generally associated with this ecotone (D. Mullins, pers. comm.).

Polyphylla monahansensis is a sand obligate restricted to regions of arid climate in southeastern New Mexico and adjacent western Texas. While it would not be surprising for this species to occur in suitable habitats in northern Mexico, it is extremely unlikely that it would exist in a montane environment as described above. Taking into account the striking disparity of ecological parameters, I consider this record to be erroneous.

Polyphylla petiti Guérin

NICARAGUA, Nueva Segovia: 15 km. N. of Jalapa, (no date), J. S. Maes collector, U.V. light

(D. A. La Rue collection).

Remarks: Young (1988) reported that the genus *Polyphylla* occurs worldwide between 15° and 53° North latitude, with the southern-most New World record as "Honduras, 3.2 miles SW of Valle de Angeles."

The Nicaragua record represents a considerable distributional extension as it is south of 14° North latitude. It also represents a new country record for the genus.

Polyphylla stellata Young

U.S.A., California: Sacramento County, Sloughhouse, 20 June 1961, Rooney Brothers collectors, Japanese Beetle Survey (D. A. La Rue collection); same county, Carmichael, American River, near Ancil Hoffman State Park, 24 July 1989, 25 July 1992, D. E. Russell collector, mercury vapor light.

Remarks: This species inhabits native grass and oak woodlands often adjacent to riparian habitats in the Sacramento Valley.

At Carmichael, males were abundant in areas of "manicured" grass with scattered oaks (*i.e.*, picnic and golf course areas). This suggests *P. stellata* may be remarkably tolerant ecologically. Specimens have also been collected at Discovery Park, Sacramento County, and the Antioch Dunes, Contra Costa County (D. E. Russell, pers. comm.). The undescribed females of this species have been collected from the Antioch locality. Unfortunately, these specimens were not made available to the author for this study.

Polyphylla squamiventris Cazier

U.S.A., Texas: Presidio County, Redford, Highway 170, 6 June 1992, C. S. Wolfe collector, below streetlight.

Remarks: A male of this uncommon species was taken in an area surrounded by cultivated fields bordering the Rio Grande River, approximately 24 km. east of Presidio, the type locality (C. S. Wolfe, pers. comm.). Possibly, *P. squamiventris* continues to inhabit undisturbed remnants of native vegetation remaining along the river. *Polyphylla hammondi* was also collected under the same streetlight.

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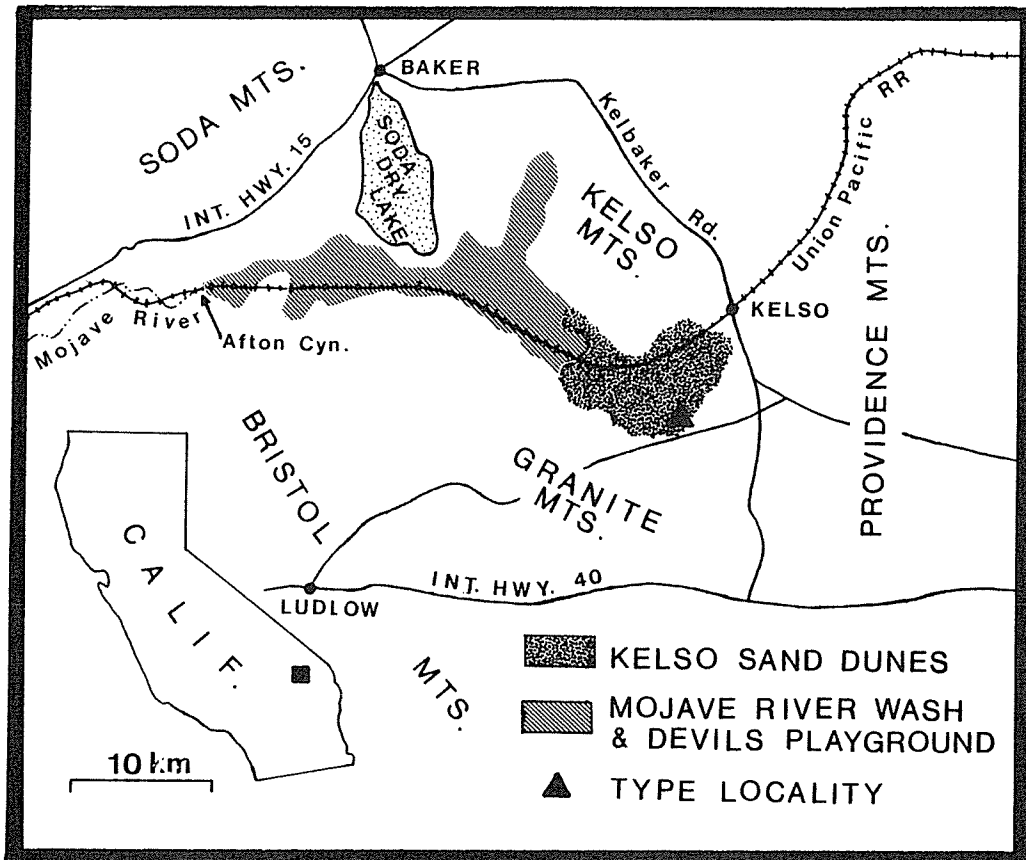


Fig. 2. Map of Kelso Dunes and vicinity.

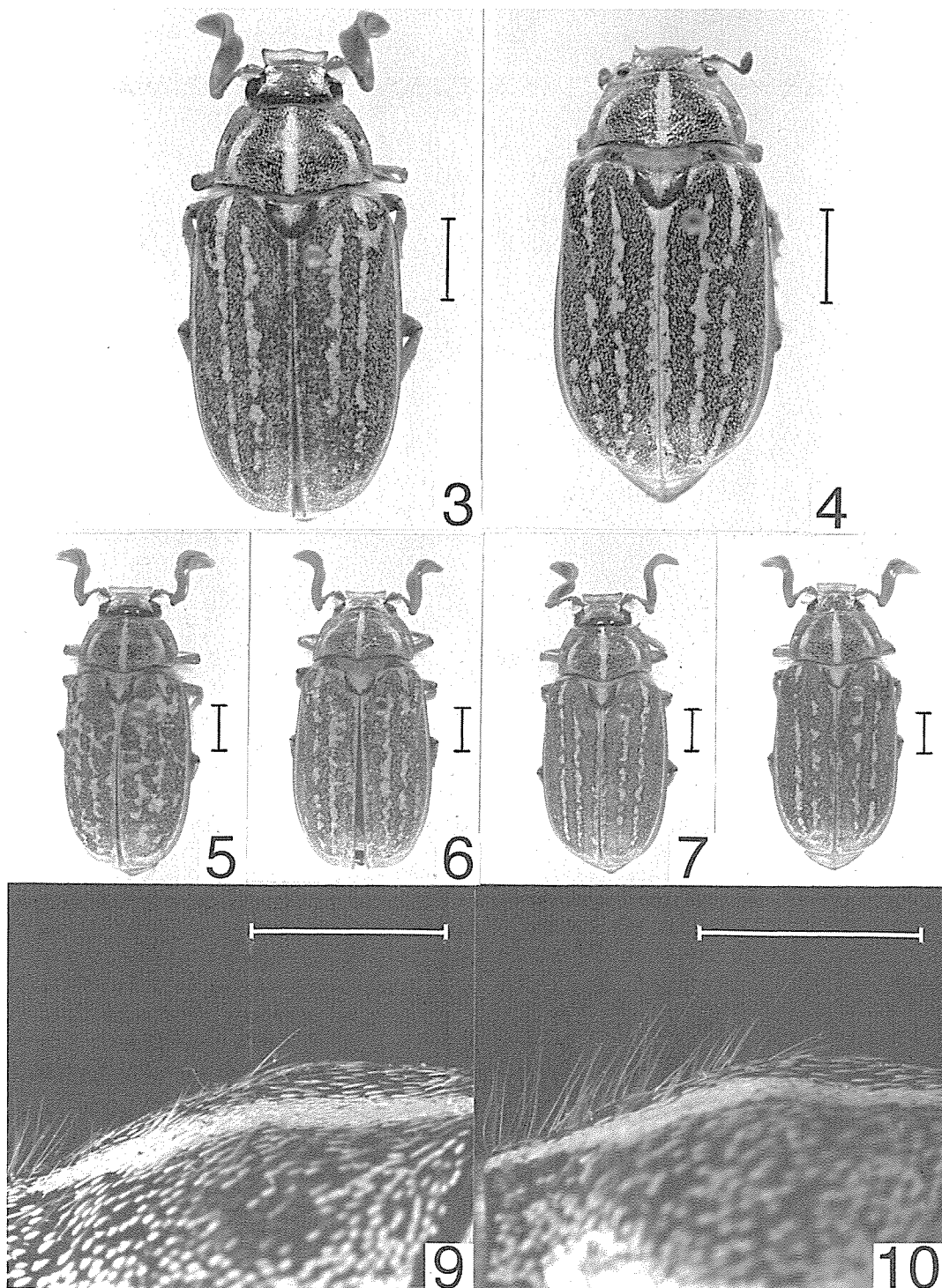


Fig. 3-10. Fig.3, *Polyphylla aeolus*, holotype male, dorsal habitus (0.75X); scale equals 5mm. Fig. 4, *Polyphylla aeolus*, allotype female, dorsal habitus (0.75X); scale equals 5mm. Fig. 5-8, *Polyphylla aeolus*, male paratype variation (0.75X); scale equals 5mm. Fig. 9. *Polyphylla aeolus*, holotype male, left lateral view of pronotum (5X); scale equals 2.5mm. Fig. 10. *Polyphylla aeolus*, allotype female, left lateral view of pronotum (5X); scale equals 2.5mm.

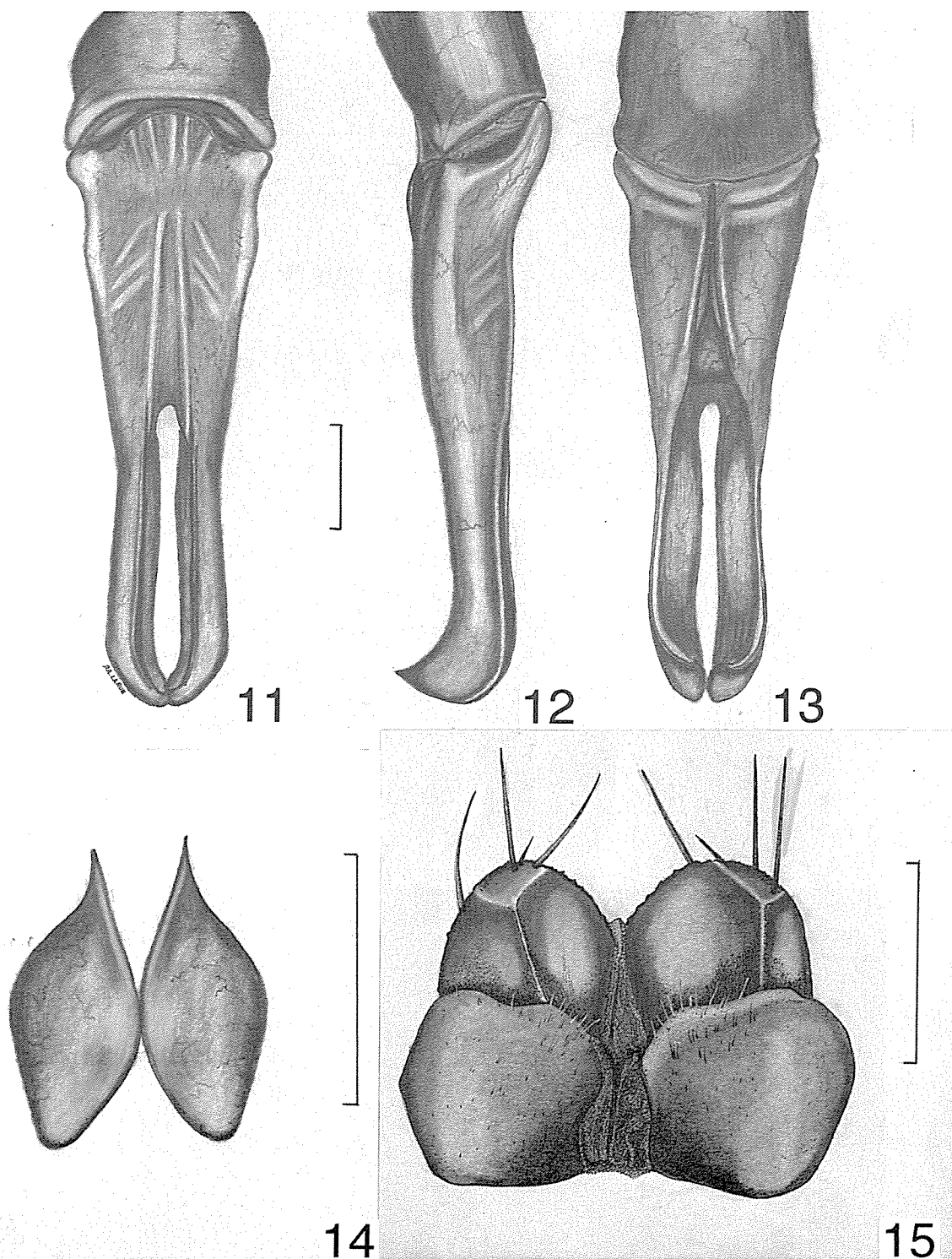


Fig. 11.-15. *Polyphylla aeolus*, holotype male, parameres; scales equal 1mm. Fig. 11, dorsal view; fig. 12, lateral view; fig. 13, ventral view; fig. 14, caudal view; fig. 15, allotype female, ventral view of genital plates; scale equals 1mm.

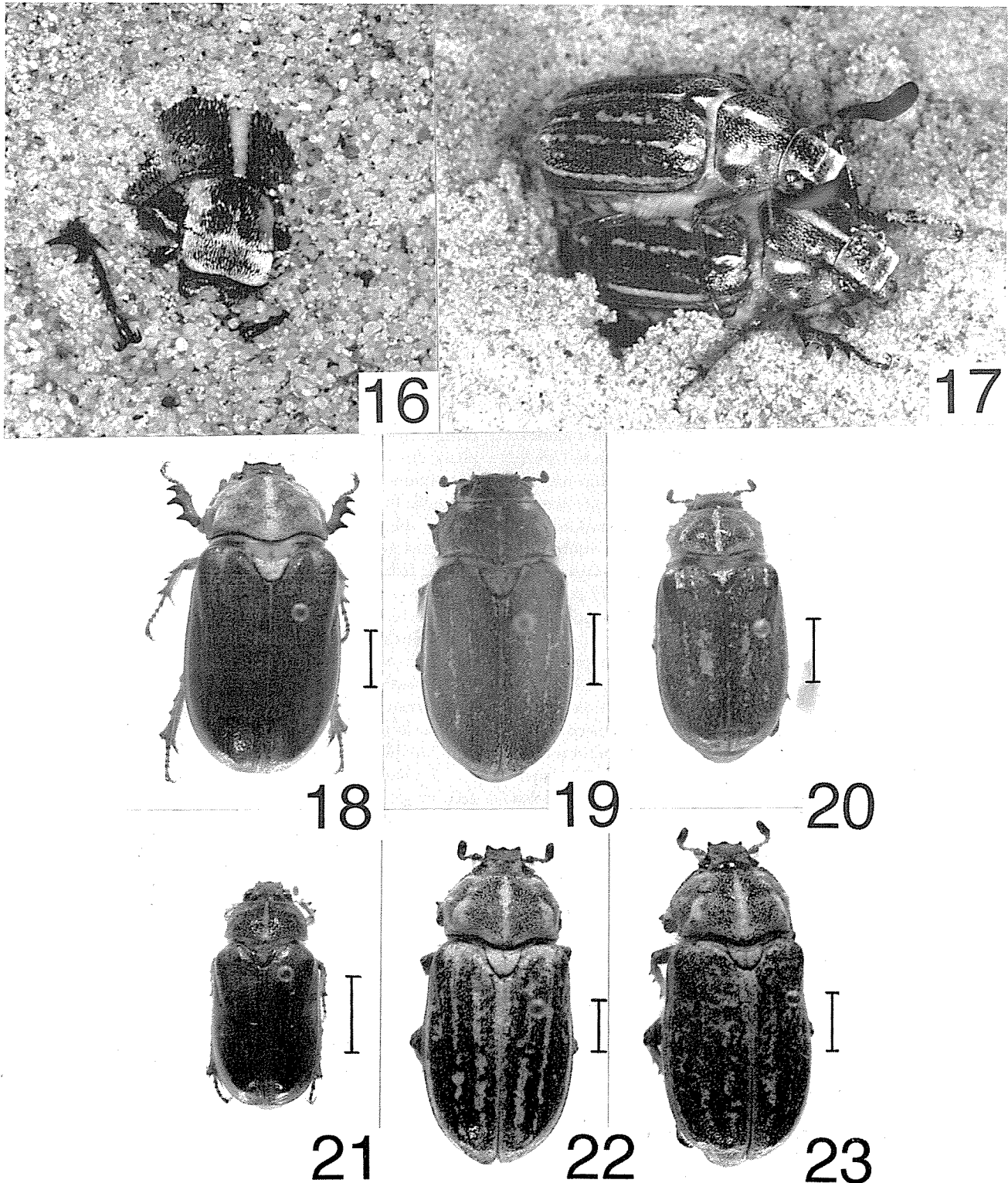


Fig. 16-21. Fig. 16. *Polyphylla aeolus*, female emerging from sand substrate; fig. 17. *Polyphylla aeolus*, male and female *in copulo*; fig. 18. *Polyphylla anteronivea* Hardy, dorsal habitus of female (0.75X); scale equals 5mm; fig. 19. *Polyphylla mescalerensis* Young, dorsal habitus of female (0.75X); scale equals 5mm; fig. 20. *Polyphylla nubila* Van Dyke, dorsal habitus of female (0.75X); scale equals 5mm; fig. 21. *Polyphylla pottsorum* Hardy, dorsal habitus of female (0.75X); scale equals 5mm; fig. 22-23. *Polyphylla erratica* Hardy, dorsal habitus of females showing variation (0.75X); scales equal 5mm.