Muma: Ground-Surface Spiders


THE PALLIPES SPECIES-GROUP OF EREMOBATES BANKS (SOLPUGIDA: ARACHNIDA) IN THE UNITED STATES1,2,3

John O. Brookhart4 and Martin H. Muma5

ABSTRACT

The pallipes species-group of Eremobates Banks is reviewed following an investigation of the stability of diagnostic characters utilized in distinguishing species of the group and the discovery of new reliable specific characters. Three new species are described: E. docolora from western Colorado, Utah, Montana, and Wyoming; E. dentilis from southeastern Arizona; and E. woodruffi from the Big Bend region of Texas. Eremobates arizonica (Roewer) is resurrected from synonymy with E. pallipes (Say), and Eremothera barberi Muma from southern Texas is reassigned to this group of the genus Eremobates.

RESUMEN

Se presenta una revisión del grupo de especies cerca de pallipes del género Eremobates Banks siguiendo la investigación de la estabilidad de caracteres diagnósticos utilizados en distinguir las especies del grupo y el descubrimiento de nuevos caracteres específicos y consistentes. Se describen 3 nuevas especies: E. docolora del oeste de Colorado, Utah, Montana y Wyoming; E. dentilis del sureste de Arizona; y E. woodruffi de la región de Big Bend de Tejas. Se resucita E. arizonica (Roewer) de sinonimia con E. pallipes (Say), y Eremothera barberi Muma del sur de Tejas se reasigna a este grupo del género Eremobates.

This review of the pallipes species-group of Eremobates Banks (1900) is the result of an investigation of the diagnostic characters utilized in distinguishing members of this group of the genus.

The pallipes group was established by Muma (1951) for those species of

1Partially supported by NSF Grant No. 43566.
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the genus *Eremobates* Banks with the following common characters; males with a constriction but not distinct notch at the base of the fixed finger from a dorsal view, a mesoventral groove dilated basally from a mesal view, and the first post-stigmatic abdominal sternite with or without ctenidia. Females with roughly triangular genital opercula that have mesal margins adjacent for the anterior third to half of their length but slightly to moderately separated posteriorly. Both sexes with fonal teeth graded in size I, III, II, IV.

When the group was erected by Muma, 6 species were recognized; *E. pallipes* (Say), *E. durangonus* Roewer, *E. californicus* (Simon), *E. dilatatus* (Putnam), *E. putnami* (Banks), and *E. suspectus* Muma. *E. pallipes* was designated the typical species of the group. Characters utilized in distinguishing these species included: for males, the presence or absence of a palpal scopula, the number of papillae in the palpal scopula, width of the fonal notch, presence or absence of abdominal ctenidia, number of abdominal ctenidia, and color of the malleoli; for females, the form and size of the caudal notch of the genital opercula, and color of the malleoli. Other characters such as general coloration patterns, curvature of the male fixed cheliceral finger, and the presence of denticules on the lower margin of the male fixed finger were cited but not stressed.

After examination of solpugid types in European museums, Muma (1970) maintained the same number of group species, distinguished by the above characters but placed more stress on palpal coloration and curvature of the male fixed cheliceral finger. Muma (1970) renamed as *E. simoni* Muma, the species he had called *californicus* in 1951, after determining that the specimen in the type vial of the latter species was an unidentifiable immature.

Brookhart (1972) reported that previously identified Colorado specimens showed intergrades among *E. pallipes*, *E. durangonus*, and *E. suspectus* on the basis of established diagnostic characters. He dropped *durangonus* from the Colorado fauna on the bases of palpal coloration and curvature of the male fixed cheliceral finger. After discussing character intergradation and seasonal reproductive isolation of Colorado specimens of *pallipes* and *suspectus*, he questioned the validity of *suspectus*.

In 1973 additional variations among Colorado specimens of the species-group were noted, and a peculiar overlapping of the specific ranges of specimens identified as *pallipes* and *durangonus* was discovered in southwestern New Mexico. At that time, the 2 authors conferred on the problem and submitted a request to National Science Foundation for a grant to collect additional specimens, study known diagnostic characters, search for new diagnostic characters, and statistically test the numerical findings. The present paper is the result of these studies.

**METHODS**

Study specimens were obtained by recalling previously identified material from major museums and collectors, by utilizing ecological and biological study specimens collected by the authors, and by conducting collecting trips into western Texas, southern Colorado, New Mexico, and eastern and southern Arizona. Not all of the study specimens were included in the statistical studies.
Preliminary diagnoses were made using only material that had been collected in the same geographic area at approximately the same time. Collections of this type were available from the San Simon valley near Portal, Arizona; White River, Arizona; Craig, Colorado; Denver, Colorado; Peyton Road near Colorado Springs, Colorado; southeastern Colorado from Pueblo to Lamar; Wet Mountains in Colorado; and from the Deming, Lordsburg, Silver City area in New Mexico (Fig. 1). Miscellaneous specimens from the same geographic regions also were used, if they fitted an a posteriori assessment of species suitability. This was done for the most part for areas in central and southern Texas and to augment meager collections from Craig, Colorado and White River, Arizona.

Quantitative data consisted of counts of abdominal ctenidia and palpal papillae; measurements of male cheliceral fonder notch; of female opercula; of the lengths of palpi, leg I, and leg IV; of the length and width of propeltidiae; and of the length and width of chelicerae. These latter measurements were analyzed both alone and as ratios, i.e., cheliceral L/W, propeltidal L/W, and A/CP. The latter was obtained by summing the length of

Fig. 1. Study areas and presently known ranges of 9 species of the pallipes-species group of *Eremobates* Banks.
the palpus, leg I and leg IV, and dividing by the length of the propeltidium plus the length of a chelicera. The number was expressed as a ratio, i.e. 3.56:1 and 4.25:1.

The A/CP was established to demonstrate the relationship of appendages (A) to body length (CP). As considered here, body length is the combined lengths of the chelicerae and propeltidium excluding the abdomen which is subject to size variability caused by the presence or absence of food, eggs, or semen.

Analysis of variance (Sokal and Rohlf 1973) was used to determine those computations that were statistically useful in this study. We considered differences at or above the 95% level of confidence to be significant. In order to check validity of samples collected from year to year or from month to month, 2 sample groups, Portal, Arizona, 1963-64, and Deming, etc. New Mexico, 1973-74 were tested for variance between years and between months in terms of palpal papillae number and A/CP ratio.

Qualitative data consisted of notation of coloration of palpi, malleoli, propeltidia, and legs; dentition of male and female chelicerae; location and shape of the mesoventral groove and basal flange of the mesoventral groove of the male fixed finger; and the shape, notch, and sclerotization of the female opercula.

Results

The A/CP ratio proved to be a reliable species indicator for both males and females (Table 1).

Grouped males from Portal, Arizona and from Deming, New Mexico, analyzed for variance of the A/CP ratio and the number of palpal papillae, exhibited no significant difference either between years or between months, indicating that the specimens could be considered members of the same population. We then assumed this to be true of populations from other geographic areas.

Males from different collection areas exhibited the following similarities or differences at or above the 95% level of confidence for the same characters. Those from Colorado were similar for all measurements and counts except those from Laramie Basin, Craig, Colorado, which differed in both A/CP ratio and number of abdominal ctenidia and those from the Peyton Road area, which differed in number of palpal papillae from all other Colorado specimens. All of the Colorado males differed from those from New Mexico and Arizona. Males from Deming, Lordsburg, and Silver City, New Mexico were all similar, but differed from those from the San Simon valley and White River, Arizona. Males from the San Simon valley differed from those from White River. Texas males from the 2 collection areas differed from each other and from all other males in the A/CP. Comparative data from both male and female A/CPs for the 10 major collection areas are cited in Table 1.

Peyton Road, Colorado males complicated the analysis of palpal papillae variation among populations. If the Peyton Road populations were included in the total population, there was no significant difference between Colorado and New Mexico populations for this character. However, if this population was excluded, then a significant difference in both A/CP ratio and number of papillae existed between the 2 populations.
TABLE 1. Sample areas, number of specimens studied, means, and standard deviations of the means of the A/CP for male and female samples of the *pallipes* species-group of *Eremobates* Banks.

<table>
<thead>
<tr>
<th>Sample area</th>
<th>Males</th>
<th></th>
<th></th>
<th>Females</th>
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<tr>
<td></td>
<td>No. spms.</td>
<td>Mean</td>
<td>SD</td>
<td>No. spms.</td>
<td>Mean</td>
<td>SD</td>
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<td></td>
<td></td>
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<tr>
<td>Larimer Resin</td>
<td>6</td>
<td>5.80</td>
<td>0.17</td>
<td>3</td>
<td>5.50</td>
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<tr>
<td>Denver</td>
<td>23</td>
<td>5.47</td>
<td>0.20</td>
<td>15</td>
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<tr>
<td>Peyton Road</td>
<td>21</td>
<td>6.45</td>
<td>0.49</td>
<td>10</td>
<td>4.75</td>
<td>0.22</td>
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<td>Wet Mountains</td>
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<td>5.66</td>
<td>0.51</td>
<td>14</td>
<td>4.61</td>
<td>0.18</td>
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<tr>
<td>Southern</td>
<td>22</td>
<td>5.74</td>
<td>0.30</td>
<td>10</td>
<td>5.01</td>
<td>0.25</td>
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<tr>
<td><strong>New Mexico</strong></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Deming, Lordsburg, Silver City Area</td>
<td>32</td>
<td>6.18</td>
<td>0.34</td>
<td>36</td>
<td>5.26</td>
<td>0.29</td>
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<td></td>
<td></td>
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<tr>
<td>San Simon Valley</td>
<td>20</td>
<td>5.35</td>
<td>0.25</td>
<td>10</td>
<td>4.55</td>
<td>0.32</td>
</tr>
<tr>
<td>White River Area</td>
<td>6</td>
<td>6.00</td>
<td>0.26</td>
<td>2</td>
<td>5.11</td>
<td>0.15</td>
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<tr>
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<td></td>
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<tr>
<td>Central</td>
<td>4</td>
<td>5.60</td>
<td>0.38</td>
<td>3</td>
<td>4.78</td>
<td>0.66</td>
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<tr>
<td>Southern</td>
<td>5</td>
<td>6.29</td>
<td>0.40</td>
<td>3</td>
<td>5.10</td>
<td>0.65</td>
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</table>

*Ratio of the combined length of the palpus, leg 1, and leg 4 to the combined lengths of the chelicerae and propodidia.

Careful examination of the mesoventral groove and basal flange of the mesoventral groove of the male fixed finger revealed subtle but consistent differences among populations examined. These differences were helpful in separating and identifying specimens where aberrant patterns of dentition or palpal papillae existed. The size of the mesal tooth on the movable finger of the male was also useful when combined with other characters.

Likewise we were able to recognize a consistent pattern in the female opercula that we had overlooked in previous studies. The opercula of each species are shown in the species figures. This morphology was consistent for all localities except for a population in northern Colorado near Denver where nearly one-half of all females displayed female opercula similar to those of *E. arizonica* (Roewer), although they were *E. pallipes* in all other respects.

These observations combined with statistical data and numerical counts not requiring statistical treatment have resulted in the recognition of the following diagnosed and illustrated group-species.

**CHARACTERS OF pallipes SPECIES-GROUP**

**MALES:** Fixed cheliceral finger straight or slightly curved upward with a constriction but no distinct notch or spur at the base. Mesovenral groove of fixed finger dilated basally into a cup-like structure. Basal flange of meso-
ventral groove of fixed finger distinct but variable in length, width, and pitch. Movable cheliceral finger with a large principal tooth, an anterior tooth, 2 small intermediate teeth, and a mesal tooth. Palpi with or without a scopula of papillae. First post-stigmatic abdominal sternite with or without ctendia. A/CP 5.45-6.20.

**FEMALES**: Fixed cheliceral finger with principal and medial teeth large, an anterior tooth half as large as principal tooth, 2 intermediate teeth between principal and medial teeth, and 1 between medial and anterior teeth. Movable cheliceral finger with a large principal tooth, an anterior tooth, 2 intermediate teeth, and a mesal tooth. Palpi usually without a scopula and first post-stigmatic abdominal sternite without distinct ctendia. Genital opercula roughly triangular and adjacent anteriorly but slightly to moderately separated posteriorly. A/CP 4.55-5.50.

Both sexes have the fondal teeth graded in size I, III, II, IV.

Diagnostic characters utilized in distinguishing species are presented in Table 2.

Key to the *pallipes* species-group of *Eremobates* Banks

1. Pale species; propeltidia pale, at most, dusky marginally; legs pale to slightly dusky; palpi pale, at most slightly dusky on tarsi and apical ends of metatarsi. Males with cheliceral fondal notch slightly longer than wide. Female opercula with median notch obscure .................................................. 2

1'. Dusky or dark species; propeltidia dusky or dark with a pale median stripe; legs dusky with 1 or more segments decidedly darker than metatarsi and/or tarsi; palpi dusky throughout and/or dark on 2 or more segments. Males with fondal notch wider than long or much longer than wide. Female opercula with median notch small to large but distinct ................................. 5

2(1). Males with 2 ctendia on first post-stigmatic abdominal sternite. Females with mesal margins of the opercula sclerotized for 70% or more of their length. A western Colorado, Utah, Montana, and Wyoming species .................. *docolora* new species

2'. Males without ctendia. Females with mesal margins of the opercula sclerotized for no more than 60% of their length ........... 3

3(2). Male mesoventral groove of fixed cheliceral finger distinctly narrowed above first fondal teeth. Female opercular mesal margins sclerotized for 50-60% of their length and curved posteriorly. An eastern Colorado, Nebraska, Kansas, Oklahoma, N.W. Texas, eastern New Mexico, and eastern Wyoming species ............................................................ *pallipes* (Say)

3'. Male mesoventral groove broad throughout its length. Female opercular mesal margins sclerotized for 40-50% of their length and truncate posteriorly. New Mexico and Arizona species ............... 4

4(3). Male fixed cheliceral finger with a distinct ventral tooth. Females unknown. A S.E. Arizona species .................. *dentilis* new species

4'. Male fixed cheliceral finger without teeth. Females diagnosed in couplet 3. A western New Mexico and eastern Arizona species .................................. *arisonica* (Roewer)


<table>
<thead>
<tr>
<th>Species</th>
<th>pellipes</th>
<th>docolora</th>
<th>arizonica</th>
<th>dentite</th>
<th>duranganus</th>
<th>spectabilis</th>
<th>simoni</th>
<th>barberi</th>
<th>woodruffi</th>
<th>dilatatus</th>
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<tr>
<td>MALES: Mean A/CP*</td>
<td>5.6±.38</td>
<td>5.8±.17</td>
<td>6.2±.34</td>
<td>5.3</td>
<td>5.4±.25</td>
<td>6.0±.26</td>
<td>5.4±.26</td>
<td>5.6±.38</td>
<td>5.2±.39</td>
<td>6.4</td>
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<td>No. ctenidia</td>
<td>None</td>
<td>2</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
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<td>40-80</td>
<td>40-70</td>
<td>30-60</td>
<td>43-50</td>
<td>10-40</td>
<td>0-6</td>
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<td>56±18.1</td>
<td>49±7.6</td>
<td>48±19.9</td>
<td>?</td>
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<td></td>
<td>1.3/1</td>
<td>1.2/1</td>
<td>1.2/1</td>
<td>1/1.2</td>
<td>1/1.1</td>
<td>1/1.2</td>
<td>1.7/1</td>
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<td>Straight</td>
<td>Straight</td>
<td>Straight</td>
<td>Straight</td>
<td>Straight</td>
<td>Straight</td>
<td>Sinuate</td>
<td>S. nuate</td>
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<td>Mesal tooth size</td>
<td>Normal</td>
<td>Small</td>
<td>Normal</td>
<td>Large</td>
<td>Small</td>
<td>Large</td>
<td>Normal</td>
<td>Small</td>
<td>Normal</td>
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<td>FEMALES: Mean A/C?</td>
<td>4.8±.33</td>
<td>5.5±.30</td>
<td>5.3±.29</td>
<td>—</td>
<td>4.6±.32</td>
<td>5.1±.15</td>
<td>4.8±.36</td>
<td>5.2±.06</td>
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<td>Opercula notch</td>
<td>Obscure</td>
<td>Obscure</td>
<td>Obscure</td>
<td>—</td>
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<td>Large</td>
<td>Large</td>
<td>—</td>
<td>Small</td>
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<td>Mesal length scleritized</td>
<td>60%</td>
<td>70%</td>
<td>40%</td>
<td>—</td>
<td>80%</td>
<td>70%</td>
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<td>60%</td>
<td>—</td>
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<td>No</td>
<td>No</td>
<td>—</td>
<td>No</td>
<td>No</td>
<td>No</td>
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*Mean ratio of combined lengths of the palpus, leg 1, and leg 4 to the combined length of the chelicerae and propeltidium, plus or minus 1 SD.
5(1). Dusky species; propeltidia light to distinctly dusky with pale median stripe often indistinct; legs more distinctly dusky at union of femora and tibia; palpi dusky throughout and slightly to distinctly darker on metatarsi and tarsi. Males with cheliceral fondal notch slightly wider than long; fixed cheliceral finger straight or lightly curved mesally; no abdominal ctenidia. Females with median notch delineated by mesally curved posterior margin ................................................................. 6

5'. Dark species; propeltidia dark for all or most of length with pale median stripe distinct; legs distinctly dusky or dark on 3 or more segments; palpi distinctly dusky or dark from apical ends of femora through tarsi. Males with fondal notch variable; tip of fixed cheliceral finger lightly curved ectally; 2 abdominal ctenidia. Females with median notch wide but not well delineated ........................................................................... 9

6(5). Males with fixed cheliceral finger distinctly curved upward. Females with median notch of the opercula occupying more than 1/2 of the opercular length. A northerncentral Texas species simoni Muma

6'. Males with fixed cheliceral finger straight or indistinctly curved upward. Females with notch occupying less than 1/2 of the opercular length ................................................................. 7

7(6). Males with mesoventral groove of fixed finger narrowed for most of its length. Females with median opercular notch small, only 1/5 of the opercular width ......................................................... 8

7'. Males with mesoventral groove wide for most of its length. Females with median opercular notch moderate in size, about 1/3 the opercular width; an east-central Arizona species suspectus Muma

8(7). Males diagnosed in couplet 5, 6, 7. Females with median opercular notch variable in form but not invading vulva. A southeaster Arizona and southwestern New Mexico species durangonus Roewer

8'. Males unknown. Females with the mesal margins of the median opercular notch apparently invading vulva. Distribution unknown dilatatus (Putnam)

9(5). Males with fixed cheliceral finger bearing 3-5 tiny denticules. Females diagnosed in couplet 5. A southern Texas species barbe (Muma)

9'. Male fixed finger without denticules. Females unknown. Positively known only from type locality in Big Bend National Park, Texas woodruff, new species

Eremobates pallipes (Say)

(Fig. 2-14)

Galeodes pallipes Say, 1823, footnote on p. 3 (♀).
Galeodes subnuda Say, 1823, footnote on p. 3 (♂).
Eremobates pallipes, Fichter, 1940: 335, Fig. 1-4; Muma, 1951: 72, Fig. 106-114; Muma, 1970: 22 (♂ and ♀).
Fig. 2, 3. *Eremobates pallipes* (Say), ♀, scanning electron micrographs.
2. Fixed cheliceral finger showing mesoventral groove and apical plumose seta, mesal view 60X. 3. Fixed cheliceral finger showing basal cup and mesal flange of mesoventral groove, mesal view 120X.
TYPES: Say's specimens cannot be located in North American (Muma 1951) or European (Muma 1970) type depositories and are presumed lost. We hereby designate the following: male neotype from Highway 205c, Byers, Colorado, 17-VII-1973 by J. O. Brookhart; female allotype from Castle Rock, Colorado, 27-VI-1973 by J. O. Brookhart. Both are deposited in the American Museum of Natural History, New York, N. Y.

DIAGNOSIS: Males and females pale yellow to light amber; palpi pale except slightly dusky tarsal tips; other appendages pale (Fig. 7, 9-13). Malleoli white. Males with mesoventral groove narrow, flared on the ventral side, and a deep basal cup (Fig. 2, 3, 5, 6). Basal flange elongate forming a shallow ventral hollow the entire length of finger. Mesal tooth medium. A/CP 5.56 ± 0.38, fondal notch (Fig. 4) L/W 1.3/1. Palpal papillae 55.6-40.5 ± 13.8-18.1. Ctenidia absent (Fig. 8). Female genital opercula triangular with the anterior margins slightly separated, somewhat bowed posteriorly, and the posterior edge curved (Fig. 14). A/CP 4.84 ± 0.37.

REMARKS: Species statistics were compiled from 4 populations ranging from Denver, Colorado southward to Lamar, Colorado. There is more inconsistency in this species than in any other member of the group. Occasionally a male will have a ctenidia and a female will have a scopula. The species may be highly variable or presently undergoing speciation. The population from Peyton Road near Colorado Springs was variant in many respects and may well represent a still unrecognized sibling species.

Muma's records (1951) probably are valid for all of Colorado, Kansas, Oklahoma, Nebraska, North and South Dakota, and northern New Mexico east of the Rocky Mountains. His records from Idaho and Utah probably are E. docolora new species. The single record from Kirkwood, Missouri may be an error in locality label.

Since this study has demonstrated that species of the pallipes group are geographically isolated, the synonyms of pallipes suggested by Muma (1951, 1970) must be considered to be largely invalid. At the present time only Galeodes subulata Say can be validly cited as a synonym of pallipes. On the bases of type examinations and original descriptions the following are Mexican species: Gluvia cinerascens L. L. Koch (1842), Gluvia formicarius C. L. Koch (1842), Datames lentiginosus Kraepelin (1899, 1901), and Eremostata dinamita Roewer (1934). Eremostata arizonica Roewer (1934), and Eremostata californica Roewer (1934) are recognized here as separate distinct species, but E. californica may well be the female of Eremothera sculpturata Muma (see Muma 1962), so is not considered here.

STUDY SPECIMENS: Colorado: Arapahoe Co., 27 δ, 14 Φ; El Paso Co., 32 δ, 17 Φ. Wet Mtns., 12 δ, 14 Φ; Pueblo Co., 10 δ, 5 Φ; Otero Co., 9 δ, 9 Φ; Powers Co., 2 δ, 2 Φ. Boulder, 3 δ, 1 Φ. Nebraska: Alliance, 1 δ; DAWSON, 1 Φ; Chadron, 1 Φ; McCook, 1 Φ. Montanna: Culbertson, 1 Φ. South Dakota: Rapid City, 1 δ. Texas: Palo Duro Canyon, 1 Φ; Colorado City, Mitchell Co., 1 δ; Salt Flats, 1 δ. Wyoming: Cheyenne, 1 δ; Douglas, 1 δ.

Eremobates docolora Brookhart and Muma, NEW SPECIES (Fig. 15-25)

TYPES: Male holotype from 1 mi. N. W. Craig, Colorado, Moffet Co., 26-VI-1971 by J. O. Brookhart; female allotype from 8 mi. S. W. Encampment,
**Brookhart & Muma:** Eremobates pallipes Group

Wyoming, Carbon Co., 5-VIII-1967 by F. P. & M. Rindge. These localities may represent the easternmost extension of its range. Types are deposited in the American Museum of Natural History, New York, N. Y.

**Diagnosis:** Males and females pale yellow to ivory in coloration with palpi and legs pale except for slightly dusky palpal tarsus and metatarsus (Fig. 18, 20-24). Malleoli white. Male fixed finger as in *E. pallipes* with a narrow mesoventral groove. The shallow ventral hollow formed by the basal flange is traceable the entire length of the finger, (Fig. 16, 17), and is more rounded than in *pallipes*. Meso tooth small. A/CP 5.78±0.17. Fondal notch (Fig. 15) L/W 1.2/1, palpal papillae 49±7.4; two short flat ctenidia (Fig. 19). Female genital opercula with straight, only slightly separated, interior margins and an almost straight posterior edge (Fig. 25). A/CP 5.5±0.30.

**Remarks:** This species is closely related to *E. pallipes* and *E. arizonica* (Roewer). It is identified by pale coloration, 2 ctenidia on the male, and shape of the female genital opercula. The specific name is an anagram of the word Colorado. Canadian records of *E. pallipes* (Muma 1951) may well be this species.

**Study Specimens:** Colorado: Craig, 5 ♂; Montana: Baker, 1 ♀; Bossman, 1 ♂; Columbus, 1 ♀; Wyoming: Encampment, 1 ♀; Laramie, 1 ♂.

**Eremobates arizonica** (Roewer)

(Fig. 26-36)

*Eremostata arizonica*, Roewer, 1934: 572, Fig. 324w, 324e (♀).

*Eremobates pallipes* (Say), Muma, 1951: 73. Muma, 1970: 34, Fig. 27 (misidentification).

**Types:** Female type (here designated holotype) of *Eremostata arizonica* from Arizona, Roewer No. 2481, is deposited in Zoologisches Staatsinstitut ad Museum, Hamburg, West Germany. Male allotype from under cow dung, Hurley, New Mexico, 17-VIII-1974, Martin H. Muma. The allotype is deposited, along with a typical female, in the American Museum of Natural History, New York, N.Y.

**Diagnosis:** Males and females yellow to dusky in coloration with lightly dusky legs and palpi and a darker tip on the palpal tarsus (Fig. 29, 30-35); ventral hollow shallow, rotated mesially and joining the mesoventral groove just posterior to the tip. Meso tooth medium. A/CP 6.8±0.34. Fondal notch (Fig. 26). L/W 1.2/1. Palpal papillae 48.1±19.3. No ctenidia (Fig. 30).

Female genital operculae with mesal margin straight and only slightly separated, and with the posterior edge truncate, (Fig. 36). A/CP 5.26±0.29.

**Remarks:** This species is closely related to *E. pallipes*.

**Study Specimens:** Arizona: Holbrook, 2 ♂, 1 ♀. New Mexico: Hurley, 14 ♂, 12 ♀; Lordsburg, 5 ♂, 11 ♀; Jemez Springs, 2 ♂, 1 ♀; Elephant Butte St. Park, 2 ♂, 2 ♀; Newcomb, 1 ♀; Pleasanton, 1 ♂.

**Eremobates dentilis** Brookhart and Muma, New Species

(Fig. 95-104)

**Type:** Male holotype yellow with anterior and posterior edges of propeltidium dusky purple; palpal tarsus tinged purple; legs yellow (Fig. 98, 100-104); malleoli white. Mesoventral groove wide and deep, without a widely flared ventral edge, (Fig. 96, 97). Ventral hollow shallow and rotated
Fig. 26-36. *Eremobates arizonica* (Roewer). 26-35, ♂. 26. Right chelica, ectal view. 27. Right chelical fixed finger, mesal view. 28. Right chelical fixed finger, dorsal view. 29. Propeltidium, dorsal view. 30. First post-stigmatic abdominal sternite. 31. Palpus, anterolateral view. 32. Leg 1, anterolateral view. 33. Leg 2, anterolateral view. 34. Leg 3, anterolateral view. 35. Leg 4, anterolateral view. 36. Female genital opercula, ventral view.
Brookhart & Muma: Eremobates pallipes Group

mesially. Fixed finger slightly recurved with a conspicuous denticule located above the principal tooth (Fig. 85). A smaller denticule is visible on the fixed finger in the fon (Fig. 97). One large and 2 minute denticules are located on the lower margin of the fon. Movable finger typical of the group. Mesal tooth large and distinct. A/CP 5.33. Fondal notch L/W, 1/1.2; no abdominal ctenidia, (Fig. 99). Palpal papillae 50-43.

Remarks: The species is known only from the type and what may be an immature female in the type vial. This species keys out with, and seems to be more closely related to the pallipes lineage. It appears to be most closely related to E. arizonica.

Eremobates durangoensis Roewer
(Fig. 37-47)

Eremobates durangoensis Roewer, 1934: 557, Fig. 323a, 324b (♀).
Eremobates durangoensis Muma, 1951: 78, Fig. 119-23; Muma 1970: 22 (♂ and ♀).

Types: The 2 female types from Durango, Mexico cannot be located and must be presumed to be lost (Muma 1970). However, we have no specimens from Durango, so will refrain from designating a neotype until such are available.

Diagnosis: Males and females yellow to dark amber in coloration with propeltidia dark anteriorly, dusky laterally and light medially; palpi dark on tarsus and dusky on the apical half to two thirds of metatarsus; legs pale to lightly dusky (Fig. 40, 42-46). Malleoli white. Male mesoventral groove deep without flared ventral edge as in E. pallipes (Fig. 38, 39); ventral hollow rotated mesially. Mesal tooth small to indistinct. A/CP 5.35 ± 0.25. Fondal notch (Fig. 37), L/W 1/1.1. Palpal papillae 22.5 ± 9.1. Ctenidia absent (Fig. 41). Female genital opercula with separated sclerotized interior margins and a small distinct notch or caudal indentation at the posterior edge (Fig. 47). Posterior edges otherwise nearly straight (Fig. 47). A/CP 4.55 ± 0.32.

Remarks: This is a sonoran species possibly ranging from the type locality in Durango, Mexico to its northern limits in southeast Arizona and southwest New Mexico. It is closely related to E. suspectus. We expect to find other closely related species in Mexico.

It is probable that Muma's (1951) records of this species from California and Texas are erroneous. The female from the White Mountains is probably E. suspectus. Muma's (1951) opercular variations (Fig. 121, 123) have not been located.

Study Specimens: Arizona: Portal, 23 ♂, 24 ♀; Rustler's Park, Chiricahua Mtns.; 1 ♂; Chiricahua Nat. Mon.; 1 ♂; Sierra Vista, 2 ♂. New Mexico: Rodeo, 16 ♀; Lordsburg, 1 ♀.

Eremobates suspectus Muma
(Fig. 48-58)

Eremobates suspectus Muma, 1951: 19; Muma, 1970: 25 (♂ and ♀).

Types: Male holotype and female allotype from White Mountains, 10 miles northeast of White River, Arizona, 8-11-VII-1940, Gertsch and Hook, in the American Museum of Natural History, New York, N. Y.
Fig. 37-47. *Eremobates durangonus* Roewer. 37-46, ♂. 37. Right chelicera ectal view. 38. Right chelicer fixed finger, mesal view. 39. Right cheliceral fixed finger, dorsal view. 40. Propeltidium, dorsal view. 41. First post-stigmatic abdominal sternite. 42. Palpus, anterolateral view. 43. Leg 1, anterolateral view. 44. Leg 2, anterolateral view. 45. Leg 3, anterolateral view. 46. Leg 4, anterolateral view. 47. Female genital opercula, ventral view.
Fig. 48-58. *Eremobates suspectus* Muma. 48-57, ♂. 48. Right chelicera, ectal view. 49. Right cheliceral fixed finger, mesal view. 50. Right cheliceral fixed finger, dorsal view. 51. Propeltidium, dorsal view. 52. First post-stigmatic abdominal sternite. 53. Palpus, anterolateral view. 54. Leg 1, anterolateral view. 55. Leg 2, anterolateral view. 56. Leg 3, anterolateral view. 57. Leg 4, anterolateral view. 58. Female genital opercula, ventral view.
Diagnosis: Males and females are pale yellow to amber in coloration with propeltidium slightly dusky to dusky throughout, but somewhat darker anteriorly and paler centrally; palpi slightly dusky to dusky throughout and slightly darker on the metatarsus and tarsus; legs slightly dusky throughout (Fig. 51, 53-57). Malleoli white. Male mesoventral groove narrow and deep (Fig. 49, 50), ventral hollow deep and rotated mesially. Mesal tooth large and distinct. A/CP 6.00±0.26. Fondoal notch (Fig. 48). L/W 1/1.2. No palpal papillae. No ctenidia (Fig. 52). Female genital opercula with interior margins forming a narrow "V" anteriorly and a distinct moderate-sized notch at the posterior edge (Fig. 58). Posterior edge otherwise straight. A/CP 5.11±0.15.

Remarks: This species apparently is endemic to the White River Basin. It is closely related to E. durangoanus and can best be separated in the male by the lack of palpal papillae and the large mesal tooth. The female opercula are distinctive. Muma's (1970) Colorado record is in error.

Study Specimens: Arizona: 9 mi. SW White River, 2 ♀, 2 ♂; 4 mi. SW White River, 1 ♂; Shoe Low, 1 ♂; Bisbee, 1 ♂ (This ♂ is either mislabeled or is found in spring or fall. There are no seasonal data on the locality label).

Eremobates simoni Muma
(Fig. 59-71)

Eremobates californicus (Simon), Muma 1951: 76 (in part, not Datames californicus Simon) (♂ and ♀).


Types: Male holotype from Gillespie County, Texas, 14-V1-1954, J. N. Knoll, in American Museum of Natural History, New York, N. Y. A female allotype from Wichita County, Texas, V-1976, (Bob Lifsey) is hereby designated and deposited in the same museum.

Diagnosis: Males and females yellow to dark amber in coloration with propeltidium dark marginally and variably dusky throughout except for a narrow pale median stripe; palpi dusky from apical ends of femora through the tibia and dark on the apical two thirds to all of metatarsi and tarsi; legs faintly dusky especially on the femora and tibia (Fig. 62, 63, 65-69); mesoventral groove deep and distinct; ventral hollow rotated mesially. Mesal tooth medium. Fixed finger of the male recurved. A/CP 5.60±0.38; fondoal notch (Fig. 59), L/W 1/1.5. Palpal papillae 65.85±23.2; ctenidia variable in our small sample; generally none, (Fig. 64), but one male with 2 small hair-like ctenidia. Female genital opercula similar to that of E. durangoanus and E. suspectus but with interior margins forming a "V"-like wide deep posterior notch that is much deeper and wider than that of E. suspectus, (Fig. 70, 71). A/CP 4.78±0.66.

Remarks: This species is found in central Texas. It is known from limited specimens and is somewhat variable in the female. It matures earlier than any other species of the pallipes group, reaching sexual maturity in June.

Muma's (1951) female records of this species from Arizona are not this species but are presently unplaced. Muma's (1951) male record of this species from California cannot be located. His Montana record may be docolora n. sp.
Fig. 59-71. *Eremobates simoni* Muma. 59-69, ♂. 59. Right chelicera, ectal view. 60. Right cheliceral fixed finger, mesal view. 61. Right cheliceral fixed finger, dorsal view. 62. Propeltidium, dark, dorsal view. 63. Propeltidium, pale, dorsal view. 64. First post-stigmatic abdominal sternite. 65. Palpus, anterolateral view. 66. Leg 1, anterolateral view. 67. Leg 2, anterolateral view. 68. Leg 3, anterolateral view. 69. Leg 4, anterolateral view. 70. Female genital opercula, ventral view. 71. Variation of ♀ genital opercula.
Eremobates barberi (Muma), New Combination

Eremothera barberi Muma, 1951: 83; Muma, 1970: 29 (♀).
Eremobates californicus Simon, Muma: 1951: 76 (in part, some ♂) (not Datames californicus (Simon)).

Types: Female holotype from Brownsville, Texas in the United States National Museum, Washington, D.C. A male allotype and female paratype from Sanderson, Texas, 7-VII-1974, J.O. Brookhart are designated and deposited in the American Museum of Natural History, New York, N.Y.

Diagnosis: Males and females yellow to amber in coloration with propeltidium dark to nearly black anteriorly and laterally; palpi and legs dusky to dark from apical half of femora through tarsi (Fig. 75, 77-81). Malleoli white. Male fixed finger with from 3 to 5 aborted, saw-like teeth on the ventral margin (Fig. 78). Basal cup of the mesoventral groove rounded and distinct (Fig. 73, 74); ventral hollow shallow and rounded. Mesal tooth small. Supernumerary teeth in the middle of the fond. A/CP 6.20±0.40. Fondal notch (Fig. 72), L/W 1.7/1. Palpal papillae 65.8±0.23. Two short broad ctenidia (Fig. 76). Female genital opercula diverging widely posteriorly, but with no distinct posterior notch (Fig. 82). Posterior edge slightly recurved. A/CP 5.16±0.06.

Remarks: This apparently is a Chihuahuan species whose range extends into southwestern Texas from Brownsville to Van Horn, Texas. It probably will be found in adjoining Mexican states.

Muma's (1951, 1962) records of E. angustus Muma from Texas were obviously females of this species. His Texas records of E. durangonius are also probably this species.

Study Specimens: Texas: Sonata, 1 ♂, 1 ♀; Alpine, 1 ♂, 1 ♀ Chisos Mtns., 1 ♂; Van Horn, 2 ♂; Sanderson, 1 ♂, 1 ♀; Limpia Creek Canyon, Davis Mtns., 1 ♀.

Eremobates woodruff Brookhart and Muma, New Species
(Fig. 83-92)

Types: Male holotype from Pulligum Mountain, 1829.27 m, at light, Big Bend National Park, Texas, 16-VIII-1970, R.E. Woodruff in American Museum of Natural History, New York, N.Y.

Diagnosis: Male holotype yellow to amber in coloration with propeltidium, palpi, and legs strikingly dark as shown in (Fig. 86, 88-92). Malleoli white. Mesoventral groove deep; basal cup wide (Fig. 84, 85); ventral hollow wide and rotated mesially. Mesal tooth medium. A/CP 6.37. Fondal notch (Fig. 83) L/W 1/1.3. Two distinct abdominal ctenidia (Fig. 87). No palpal papillae. Females unknown.

Remarks: This probably is another Chihuahuan species that reaches the northern-most extension of its range in Big Bend National Park. We also have 3 immatures from the state of Tamaulipas, 3 mi. south of Reynosa that appear to be this species.

Study Specimens: Only the male holotype is known.

Eremobates dilatatus (Putnam)
(Fig. 98-94)

Datames dilatata Putnam, 1883: 259 (♀)
Fig. 72-82. *Eremobates barberi* (Muma). 72-81, ♀. 72. Right chelicera, ectal view. 73. Right cheliceral fixed finger, mesal view. 74. Right cheliceral fixed finger, dorsal view. 75. Propeltidium, dorsal view. 76. First post-stigmatic abdominal sternite. 77. Palpus, anterolateral view. 78. Leg 1, anterolateral view. 79. Leg 2, anterolateral view. 80. Leg 3, anterolateral view. 81. Leg 4, anterolateral view. 82. Female genital opercula, ventral view.

**Type:** Female type with no data in the Academy of Natural Sciences of Philadelphia, Pennsylvania. There are 2 labels in the vial with the specimen: the smallest contains the number 1403, the largest reads “Sulpugidae examined by Putnam”, and the last is the type label “Datames dilatatus Putnam, Type 11240”. It is possible that the label 1403 refers to a collector’s journal which would cite the type locality, but no one presently at the Academy has any knowledge of such a journal.

**Diagnosis:** The female type is badly discolored by age and preservative so no coloration or color patterns can be cited. The specimen also is shriveled by drying 1 or more times in the past and the abdomen is overgrown with fungus. No complete leg or palpus is available on the specimen or in the vial for study or measurement.

Muma (1951) cited the total length of the specimen as 31.0 mm, and the propeltidium as 6.4 mm long and 8.2 mm wide. The right chelicera is 9.9 mm long and 4.5 mm wide. Fig. 93 is of the right chelicera; Putnam (1883) figured the left chelicera on plate 2, Fig. 15. The female genital opercula are shown in Fig. 94. Since the opercular setae have been rubbed off, the opercular setal pattern cannot be shown.

**Remarks:** We have not seen or collected additional specimens of this species, so we presume that it is Mexican.

**Distribution**

Explanation of the present known distribution of solpugids in general and the *pallipes* group in particular poses several problems.

First, the only fossil solpugid available is *Protosolpuga carbonaria* Petrunkevitch from the Pennsylvanian of Illinois (Petrunkevitch 1913: 74-6).

Second, they are generally regarded as part of the fauna of arid and semiarid regions, but little is known of the limiting factors impinging on these arachnids. Schmoller (1970) considered them indicators of desert biomes. From collections made by both authors (Muma 1963, 1974, and unpublished, Brookhart 1972 and unpublished), specimens are found in both hot and cold deserts and arid grasslands, less commonly in pinyon-juniper associations, and very rarely in ponderosa pine or spruce-fir communities. Analysis of known collection records correlates their distribution with the 50 cm or less isohyet in the western United States. Therefore we can assume that at least for the present and probably in the past, the amount of moisture and associated biotic and abiotic factors have played an important role in their speciation patterns.

Third, their mating process involves no discernible “lock and key” mechanism as is found in many other arachnids, but the genital opercula of the female and the fixed cheliceral finger and fondal notch of the male are involved in the insemination process and are also of diagnostic value at the species level. So far, we have been unable to determine how these morphological differences could become isolating mechanisms.

The mating patterns for *E. pallipes*, *E. arizonica*, and *E. durangomensis* have been observed (Muma 1966 and Muma and Brookhart unpublished), but few differences could be seen among the 3.

The presumed distributions of the *pullipes* species-group based on collection records, or where records are scanty, on the suitability of the area for solpugid habitation are shown in Fig. 1. From the morphology of the female
genital opercula and the chelicerae of the male, we can see 3 divisions. The first is a northern lineage consisting of *E. pallipes*, *E. docolora*, *E. arizonica* and possibly *E. dentilis*; a southern, probably Mexican lineage, consisting of *E. durangensis*, *E. suspectus*, and *E. simoni*; and a third, also of Mexican lineage, consisting of *E. barberi* and *E. woodruffi*.

The northern group seems to be separated largely by the Rocky Mountains with *E. pallipes* in the Great Plains, *E. docolora* in the Laramie Basin and Colorado Plateau, and *E. arizonica* west of the Front Range of the Rocky Mountains in western New Mexico and Arizona. *Eremobates pallipes* and *E. docolora* may be sympatric in south central Montana. Brookhart (1972) found no *pallipes* in the San Luis Valley of Colorado which is west of the Front Range in Colorado indicating separation from *arizonica*. It is possible that *E. pallipes* is also sympatric with *E. simoni* in the Texas panhandle and *E. arizonica* in eastern New Mexico, but morphological differences and time of sexual maturity make hybridization unlikely.

*Eremobates simoni* may be partially separated from *E. barberi* by a boundary roughly corresponding to the Balcone Escarpment, and it also may be separated by temporal maturity. *Eremobates simoni* occupies the region Blair (1950) called the Kansan, while *E. barberi* has a range extending from the Trans-Pecos to Brownsville and probably into adjoining Mexican states. *Eremobates woodruffi* is known from only 1 male specimen, but the type locality probably is the northern extension of its range. The same also may be true for *E. dentilis*.

*Eremobates suspectus* is endemic to the White River basin in Arizona and closely related to *E. durangensis* whose range it abuts in southeastern Arizona. Burger (1974) suggested that insect species from the White River are Mexican in origin, and Martin's (1963) work indicated that isolation in this region could have occurred recently. It is the opinion of the authors that the present separation could be maintained by the playas which are often wet and muddy during the period of sexual activity of most species. We have, in fact, collected an isolated specimen of each species in territory ordinarily occupied by the other species but only in the spring time when sexual activity is not known.

*Eremobates dilatatus* is known from a single female with no locality label. It undoubtedly will prove to be a Mexican species.

Additional species are to be expected in Mexico. Baja California was listed as the type locality of *E. putnami* (Banks) (Banks 1898; Muma 1951, 1970) and Warren Savary (in ms.) has described 2 new species of what may eventually prove to be a *putnami* group from this peninsula. Examination of a limited number of museum collections in the process of this work has revealed several new species of the *pallipes* group from both the Chihuahuan and Sonoran desert regions of Mexico. More specimens are needed to substantiate the preliminary diagnoses and to delineate the pattern of their distribution.

**LITERATURE CITED**


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