

Mesic Elements in the Western Nearctic Ant Fauna: Taxonomic and Biological Notes on *Amblyopone*, *Proceratium*, and *Smithistruma* (Hymenoptera: Formicidae)

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ABSTRACT: *Amblyopone pallipes* Haldeman is recorded from California for the first time, and the specific distinctness of it and *A. oregonense* Wheeler is confirmed. The previously unknown worker castes of *Proceratium californicum* Cook and *Smithistruma californica* Brown are described. *Proceratium californicum* is compared with other members of the genus including a new species (*P. compitale*) from west Texas and Coahuila, Mexico. Three new species of *Smithistruma* are described: one (*S. reliquia*) from a remnant patch of riparian oak woodland in the Sacramento Valley of California, and two others (*S. chiri-cahua*, *S. arizonica*) from southeastern Arizona. Biological and distributional notes are given on these and other mesophilic ants whose presence in southwestern United States attests to an earlier period of more benign climate. The affinities of these ants appear to lie with taxa in the eastern United States and, less clearly, with those of temperate Asia.

The contemporary climate of California and other southwestern states does not favor the extensive development of lowland mesic forest (Barbour and Major, 1977). Not surprisingly, groups of cryptobiotic ants which thrive under mesic conditions in southeastern United States (e.g., *Smithistruma*, and various ponerine genera) are poorly represented in this region, yet are not altogether absent. Rather, they occur as localized, and seemingly relictual, populations in patches of warm, mesic habitat such as riparian woodland or moist foothill gullies.

In this paper I present taxonomic and biological observations on several genera of cryptobiotic ants which occur in California and other western states. Three genera are considered in detail—*Amblyopone*, *Proceratium*, and *Smithistruma*—and comments are given on similarly distributed species of *Myrmecina* and *Neivamyrmex*.

The findings are based in part on the results of recent intensive collecting of litter-inhabiting ants in northern California, using Winkler extractors (see Ward, 1987, for a description of the collecting method). I have also had access to useful material in several museums, particularly recent accessions of the Los Angeles County Museum (LACM).

Methods

Collections are referred to by the following abbreviations, which adhere to the codens of Arnett and Samuelson (1986) as closely as possible:

- CASC California Academy of Sciences, San Francisco, California
CDAE California Department of Food and Agriculture, Sacramento, California
LACM Los Angeles County Museum of Natural History, Los Angeles, California

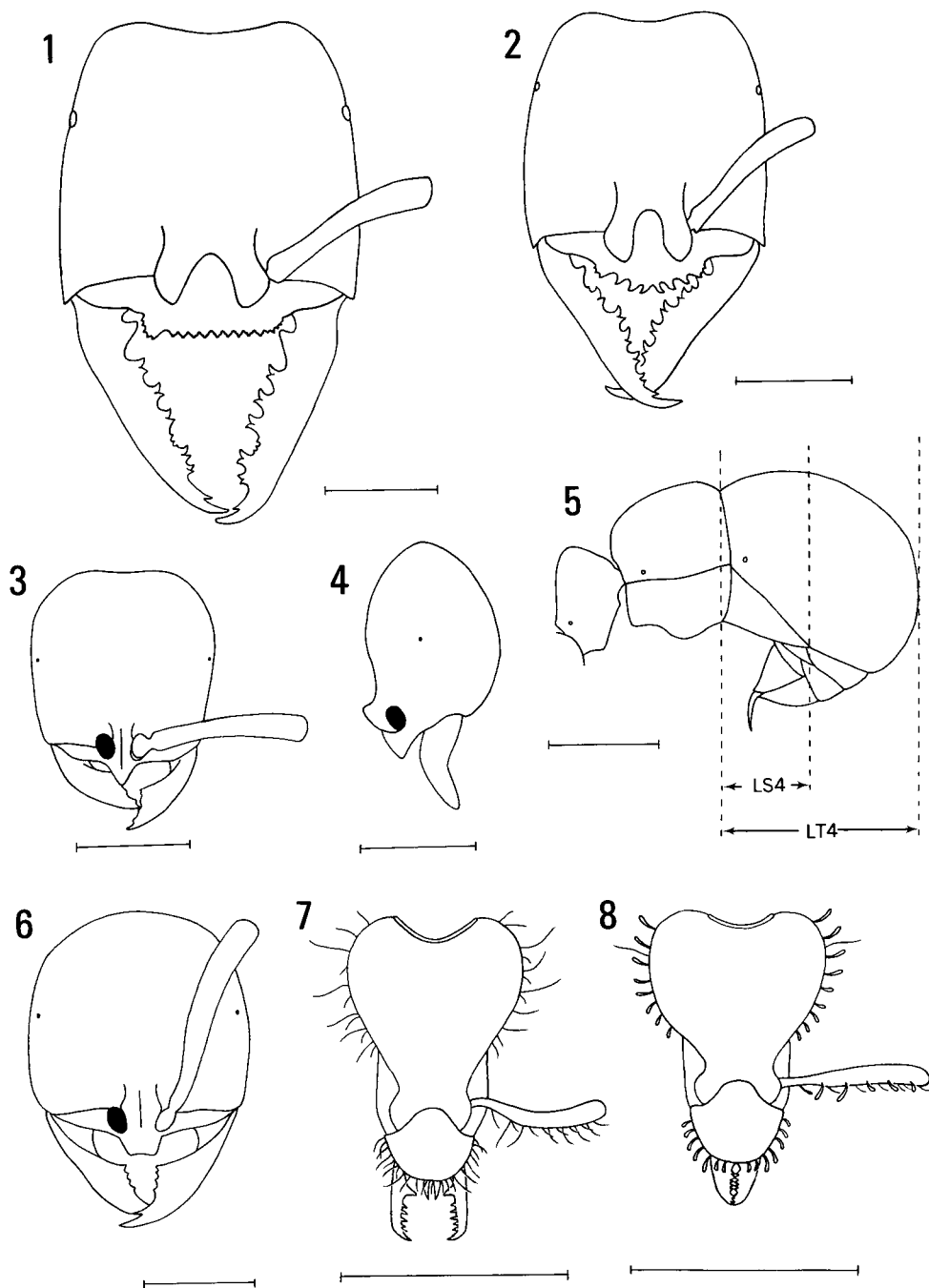
- MCZC Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts
- OSUO Oregon State University, Corvallis, Oregon
- PSWC P. S. Ward collection, University of California, Davis, California
- SOSC S. O. Shattuck collection, University of California, Davis, California
- UCDC Bohart Museum of Entomology, University of California, Davis, California
- USNM National Museum of Natural History, Washington, D.C.

The following metric measurements are used (the genera in which they are applied being given in parentheses):

- HW Head width: maximum width of head in full-face, dorsal view, excluding the eyes in workers and queens but including the eyes in males (*Amblyopone*, *Proceratium*, *Smithistruma*)
- HL Head length: maximum measurable length of head in full-face, dorsal view, from the anterior clypeal margin to the mid-point of a line drawn across the posterior margin of the head (*Amblyopone*, *Proceratium*, *Smithistruma*)
- ML Mandible length: length of mandibles in closed position, taken from the anterior clypeal margin to the anterior-most point of the mandible, and measured in the same plane and line of measurement as HL (*Smithistruma*)
- SL Scape length: maximum measurable length of the first antennal segment, excluding the radicle (*Amblyopone* males, *Proceratium*)
- LF11 Length of the penultimate funicular segment (*Amblyopone* males)
- WF11 Width of the penultimate funicular segment (*Amblyopone* males)
- WL Weber's length: diagonal length of the mesosoma (alitrunk) measured in lateral view from the anterior pronotal margin, excluding the collar, to the posterior extremity of the metapleural lobe (*Proceratium*, *Smithistruma*)
- LS4 Length of abdominal sternum IV: maximum longitudinal length of the fourth abdominal sternum, measured in lateral view from the anterior margin to the posterolateral extremity (note: good illumination is necessary to highlight the posterolateral border); this measurement is taken perpendicular to a line drawn through the anteroventral and anterodorsal margins of the fourth abdominal segment, excluding the acrosclerites (see Fig. 5) (*Proceratium*)
- LT4 Length of abdominal tergum IV: length of the fourth abdominal tergum, measured in lateral view along the same line of measurement as LS4, from the anterior margin (excluding the acrotergite) the posterior extremity (Fig. 5) (*Proceratium*)

Measurements were made at 50 \times power on a Wild microscope, using two Nikon stage micrometers, positioned at right angles to one another and wired to a digital readout. Measurements were made in millimeters to the nearest thousandth of a millimeter, and later rounded to two decimal places for presentation here.

Ratios which were calculated from the preceding measurements are as follows



Figs. 1-8. Views of the worker caste of various species of *Amblyopone*, *Proceratium*, and *Smithistruma*. Scale lines represent 0.5 mm. 1. *Amblyopone oregonense* (Tuolumne Co., California); full-face, frontal view of head; pilosity and antennae (except left scape) omitted. 2. *A. pallipes* (Napa Co., California), same view. 3. *Proceratium californicum* (Yolo Co., California), same view. 4. *P. californicum* (Yolo Co., California), lateral view of head. 5. *P. californicum* (Yolo Co., California), lateral view of petiole and gaster, illustrating the measurements LS4 and LT4. 6. *P. compitale*, holotype (Val Verde Co., Texas), frontal view of head; pilosity and antennae (except left scape) omitted. 7. *Smithistruma reliquia*, paratype (Yolo Co., California), frontal view of head, including pilosity in outline. 8. *S. chircahua* holotype (Cochise Co., Arizona), same view as in Fig. 7.

Table 1. Ranges of various metric measurements and indices in *Amblyopone oregonense* (from California and Oregon) and *A. pallipes*. Sample size is given in parentheses above each set of measurements.

	<i>A. oregonense</i>	<i>A. pallipes</i> (California)	<i>A. pallipes</i> (Texas, eastern U.S.)
Workers	(31)	(16)	(36)
HW	1.21–1.40	0.99–1.15	0.89–1.33
CI	0.94–1.01	0.86–0.90	0.87–0.97
Males	(6)	(18)	(15)
HW	1.14–1.20	0.94–1.26	0.92–1.15
CI	1.16–1.18	1.06–1.26	1.09–1.18
SI	0.21	0.23–0.28	0.19–0.21
FI	0.63–0.71	0.44–0.57 ^a	0.61–0.70

^a Sample size = 17, because one *A. pallipes* male from California lacked the funicular segments.

(the orthodox, but redundant, procedure of multiplying these ratios by 100 has not been followed):

- CI Cephalic index: HW/HL
 MI Mandibular index: ML/HL
 SI Scape index: SL/HW
 SI2 Scape index, using HL: SL/HL
 FI Funicular index: WF11/LF11
 IGR Index of gastric reflexion: LS4/LT4

Genus *Amblyopone*

TAXONOMY: This cosmopolitan genus of subterranean ponerine ants was long considered to be represented in California by a single species, *A. oregonense* Wheeler, occurring from northern California to southern British Columbia (Brown, 1960; Smith, 1979). *A. oregonense* was originally described as a subspecies of *A. pallipes* Haldeman, a common eastern species known to occur sporadically as far west as Arizona, but Brown (1960) raised *A. oregonense* to the rank of species. Recent fieldwork in California, coupled with a reexamination of material in existing collections, has revealed the occurrence of *Amblyopone* populations in California which represent western outliers of *A. pallipes*. Some of the specimens in collections were misidentified as *A. oregonense*, but there is no indication that these western populations of *A. pallipes* intergrade with those of *A. oregonense*. The differences between these two species, in the shapes of the mandibles and clypeus (Brown, 1960:192) continue to hold up. In workers and queens of *A. pallipes* the inner border of the mandibles and (usually) the anterior clypeal margin are convex in outline (ignoring irregularity due to dentition) while in *A. oregonense* these same margins are more or less straight. Similarly, the outer border of the mandibles is more distinctly concave in *A. pallipes* than in *A. oregonense* (Figs. 1, 2). In addition, California workers of *A. pallipes* have smaller, narrower heads than those of *A. oregonense*, although eastern *A. pallipes* workers overlap *A. oregonense* in this regard (Table 1), and the pilosity on the body dorsum is more conspicuously erect or suberect.

Size differences between males are less pronounced. In the samples available

for study, males of *A. pallipes* are smaller, on average, than those of *A. oregonense*, but there is broad overlap in size (Table 1). On the other hand, California males of *A. pallipes* differ conspicuously from those of *A. oregonense* and from those of eastern *A. pallipes*, by the possession of significantly longer antennal segments (see ranges of SI and FI in Table 1). The scape lengths of these males lie distinctly above the scape length/head width regression line shared by *A. oregonense* and eastern *A. pallipes* (Fig. 9). In addition the postpetiolar dorsum (third abdominal tergum) of western *A. pallipes* males is coriaceous-imbricate and opaque, while in males of *A. oregonense* and of eastern *A. pallipes* the same segment is smooth, shiny, and covered with fine, piligerous punctures. The extent and significance of this apparent divergence between eastern and western males of *A. pallipes* cannot be assessed without more collections, particularly from intermediate localities.

Based on genital dissections of three *A. oregonense* males (from California and Oregon) and four *A. pallipes* males (from California and Maryland), the male terminalia of these two species appear to be nearly identical. In the three males of *A. oregonense* the anterior margin of the hypopygium forms a less acute angle at the mesial apodeme than in the four *A. pallipes* males, but the difference is not striking, and there is sufficient variability in this character to suggest that it may not be diagnostic.

DISTRIBUTION AND BIOLOGY: The known distributions of *A. oregonense* and *A. pallipes* suggest that they may prove to be broadly parapatric in northern California (Fig. 11). *A. oregonense* occurs along the coast from southern British Columbia to the California–Oregon border, then jogs east and south down the Sierra Nevada at least as far as Tuolumne County. In California *A. pallipes* has been recorded from the Coast Ranges and, less frequently, the foothills of the Sierra Nevada, as far north as Placer, Lake and Mendocino Counties. There are a very few records of *A. pallipes* from Arizona, New Mexico, and southern Nevada (see Cole, 1953; Wheeler and Wheeler, 1986; and list of material examined, below).

In California the two species appear to occupy different habitats and nest sites. In northern California I have encountered *A. pallipes* in riparian woodland, foothill oak woodland, and mixed coastal forest (*Quercus*, *Pinus*, *Pseudotsuga*) at elevations ranging from 40 m to 690 m. Workers were collected in Winkler litter samples, and as scattered individuals under stones. A colony fragment (with workers and cocoons) was also located under a stone. Most museum records lack habitat data, but there are workers from “chaparral”, “berl. litter, oak-conif. forest” and “ex feces and soil in woodrat house”. Foraging habits of California *A. pallipes* workers are unknown, although they are likely to be similar to eastern *A. pallipes* which have been recorded feeding on centipedes and, less frequently, other soil arthropods (Wheeler, 1900; Brown, 1960; Traniello, 1982).

Males of California *A. pallipes* have been collected at light traps in August and September. The dates of male specimens in collections range from August 3 to September 18. On two nights in late August 1984 I collected a total of 10 males at u-v light in oak woodland at Cold Canyon, Solano Co., California (a locality where workers have also been collected), and I found that they flew for a very restricted period of time at dusk (8:25–8:40 P.M.). Crepuscular flight habits are also suggested by a collection of *A. pallipes* males from Mill Valley, Marin Co., California (14.ix.1963, E. S. Ross) “alighting on white auto, 7:30 P.M.”.

California records of *A. oregonense* come from regions of mixed coniferous

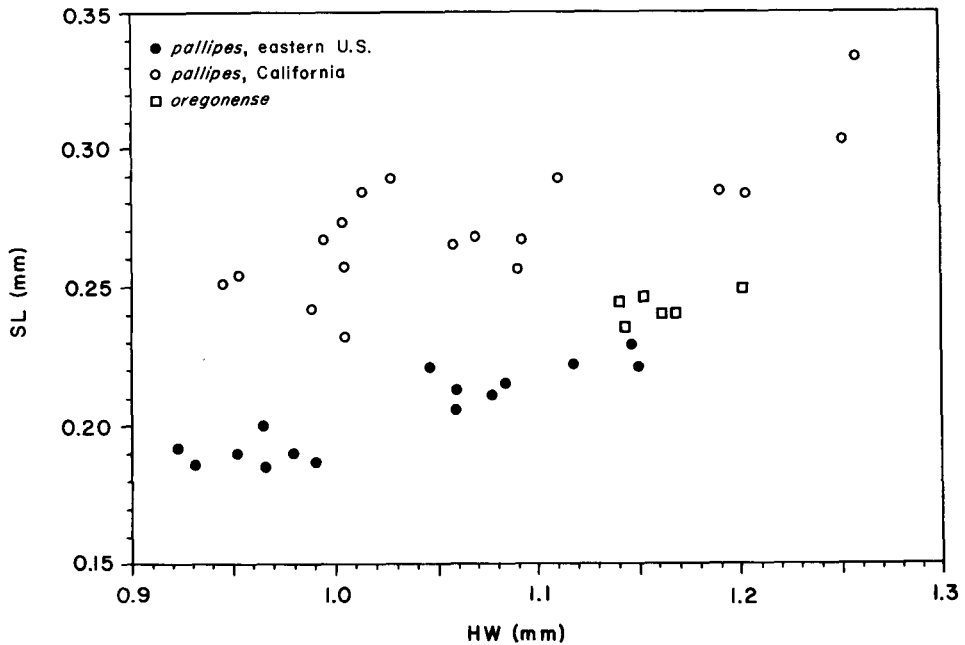


Fig. 9. Plot of scape length (SL) by head width (HW) in Nearctic *Amblyopone* males.

forest, mostly in the rich transition zone of the Sierra Nevada, dominated by conifers of the genera *Pseudotsuga*, *Pinus*, *Libocedrus* and *Abies*, together with maple (*Acer*) and oak (*Quercus*). Elevation records (where given) range from 580 m to 1740 m. At two localities (in Plumas and Tuolumne Counties) I discovered populous, multiple-queen colonies of *A. oregonense*, with abundant brood, under the bark of large, moist, rotten coniferous logs, in shaded forest. Remains of a geophilomorph centipede were seen in one cluster of larvae.

At a population of *A. oregonense* near Quincy, Plumas Co. I performed the following crude test of prey preference. I exposed a brood chamber containing numerous workers and larvae of *A. oregonense* by removing a small portion of the bark cover on a fallen, douglas-fir (*Pseudotsuga menziesii*) log; I then placed the following items into the disturbed nest chamber: a geophilomorph centipede, a lithobiomorph centipede (probably Henicopidae), and a freshly swatted adult mosquito. The centipedes were attacked and stung almost immediately, while the mosquito received similar treatment after 2–3 minutes. Within 15 minutes the *A. oregonense* workers had dragged the paralyzed geophilomorph under the adjacent bark cover along with their larvae, while the lithobiomorph centipede and mosquito had been abandoned.

Laboratory colonies of *A. oregonense*, maintained in small plaster-of-Paris nests and established from polygynous colony fragments collected in the field, also readily accepted geophilomorph centipedes. The centipedes were captured, stung, dragged into adjacent brood chambers, and, in some instances, cut into several pieces which were fed upon by larvae. Lithobiomorph centipedes did not elicit such a strong reaction and were not dragged over to the brood pile. Workers and queens were observed to assiduously lick the surface and exposed cuts of geo-

philomorphs. On one occasion three freshly laid eggs appeared on a geophilomorph, 24 hours after capture. Nevertheless, I was unable to sustain healthy brood production in these laboratory colonies of *A. oregonense*. All such colonies experienced considerable larval mortality and declined in size, although several adults (one queen, four workers) were kept alive on a diet of small arthropods (mostly *Drosophila*) for 16 months.

One of the laboratory colonies of *A. oregonense* was started from a field collection of workers and cocoons in late July 1984. Alate queens and males eclosed in this colony between August 6 and 14, 1984. Dates of field-collected *A. oregonense* alates from California and Oregon span the period August 22 to September 18. An alate queen from Forest Grove, Washington Co., Oregon bears the annotation "4 p.m., swarm before rain", suggesting that *A. oregonense* alates may fly earlier in the day than those of *A. pallipes*. Alternatively, queens of both species might simply be released before males.

When I removed a sample of alates from the aforementioned laboratory colony of *A. oregonense*, in mid-August 1984, two of the four males remaining in the nest began making attempts to copulate with callow workers. Although the attempts did not appear to be successful, they point to the possibility of intranidal (and worker-male?) mating in this species.

MATERIAL EXAMINED: *A. oregonense* Wheeler: BRITISH COLUMBIA: Elk Falls Park (R. King) (LACM); Duncan, Vancouver Island (Darlington) (LACM); Royal Oak, Vancouver Island (J.D.T.) (MCZC); Victoria, Vancouver Island (K. F. Auden) (USNM).

WASHINGTON: *King Co.*: Bothell (T. Kincaid; N. Fuhr) (OSUO); Seattle (C. H. Bowen) (USNM); Seattle, Univ. Washington campus (T. Kincaid) (OSUO, LACM); *Thurston Co.*: Olympia (T. Kincaid) (MCZC, syntypes); Olympia (OSUO).

OREGON: *Benton Co.*: Alsea (H. A. Scullen; E. A. Dickason) (LACM, MCZC, OSUO, SOSC, USNM); Blodgett (Darlington) (MCZC, USNM); Corvallis (K. Gray & J. Schuh; H. A. Scullen; V. T. Shattuck) (OSUO, MCZC, USNM); McDonald Forest, Oak Creek (G. L. Parsons) (OSUO, SOSC); *Lane Co.*: Blue R., H. J. Andrews Exp. Forest (W. Nagel) (OSUO, PSWC); *Marion Co.*: 2 mi W Mehama (E. M. Fisher) (LACM); 2.5 mi W Mehama (E. M. Fisher) (LACM); no specific locality (P. J. Schmitt) (MCZC); *Washington Co.*: Forest Grove (A. C. Burill; G. Ferguson; M. C. Lane; J. Schuh) (LACM, MCZC, OSUO, USNM); ? *Co.*: Benton-Lane Park, 250 ft (H. A. Scullen) (MCZC, OSUO, USNM).

CALIFORNIA: *Amador Co.*: Bear River Res. (S. R. Sims) (UCDC); *Butte Co.*: 3 km N Feather Falls (town), 580 m (P. S. Ward) (UCDC); Forest Ranch (D. H. Kistner) (LACM); *El Dorado Co.*: Blodgett Forest (D. S. Chandler) (LACM, UCDC); Blodgett Forest, 15 mi E Georgetown (T. C. Paine) (UCDC); Sand Flat Cpgrd., El Dorado Natl. For. (M. B. DuBois) (LACM); *Placer Co.*: 2 km SSW Emigrant Gap, 1470 m (P. S. Ward) (UCDC); *Plumas Co.*: 8 km NW Quincy, 1030 m (L. D. French; P. Timper; P. S. Ward) (PSWC, SOSC, UCDC); Belden (H. S. Barber) (MCZC, USNM); *Shasta Co.*: Shingletown (T. F. Leigh & T. O. Thatcher) (USNM); *Siskiyou Co.*: Ash Crk. Rgr. Sta., 9 mi E McCloud, 3500 ft (J. Powell) (LACM); *Tuolumne Co.*: Calaveras Big Trees South Grove, 1430 m (P. S. Ward) (PSWC, UCDC).

A. pallipes Haldeman (western U.S. records only): CALIFORNIA: *Calaveras Co.*: 3 mi NE Glencoe, 2000 ft (A. Newton & M. Thayer) (MCZC); *Lake Co.*:

Soda Bay (R. E. Dolphin) (UCDC); *Marin Co.*: Fairfax (H. L. Mathis) (LACM, UCDC); Mill Valley (T. W. Davies; R. Leech; E. S. Ross) (CASC, LACM); *Mendocino Co.*: U. C. Hopland Field Station (J. R. Anderson et al.) (CASC); *Monterey Co.*: 9.5 mi SW jct. Hwy. 101 and Jolon Rd. (F. C. Raney & R. O. Schuster) (LACM); FS Hastings Nat. H. Res. (J. M. Linsdale) (USNM); Hastings Res. (V. E. Shelford) (USNM); *Napa Co.*: R. L. Stevenson State Park, 690 m (P. S. Ward) (PSWC, UCDC); *Placer Co.*: Auburn (J. Mavey) (CDAE); Weimar (M. D. Norman) (CDAE, LACM); *Riverside Co.*: Mt. San Jacinto, James Res., 5300 ft ("JAM") (LACM); *San Luis Obispo Co.*: 28 mi W Paso Robles (F. C. Raney & R. O. Schuster) (LACM); *Solano Co.*: Cold Canyon, 19 km NNW Vacaville, 120 m, 300 m, 600 m (P. S. Ward) (PSWC, UCDC); Lake Solano Park, 40 m (P. S. Ward) (UCDC); 2 km NW Rockville, 85 m (P. S. Ward) (UCDC); *Tulare Co.*: Ash Mtn., Three Rivers (R. D. Haines) (CDAE); *Yolo Co.*: Rumsey (E. A. Kurtz) (LACM, UCDC).

ARIZONA: *Cochise Co.*: Rustlers Park, Chiricahua Mtns. (L. M. Smith & R. O. Schuster) (LACM); *Pima Co.* (?): Leatherwood, Catalina Mtns. (MCZC); Leatherwood Trail, Catalina Mtns. (USNM); Soldiers Camp, Sta. Catalina Mtns. (L. F. Byars) (USNM).

NEW MEXICO: *Colfax Co.*: Cimarron Canyon, Cimarron (A. C. Cole) (LACM); *San Miguel Co.* (?): Sapello Canyon, Beulah, 8000 ft (A. C. Cole) (LACM).

TEXAS: *Brewster Co.*: Boot Springs, Chisos Mtns., 2040 m (P. S. Ward) (PSWC, UCDC).

Genus *Proceratium*

Like *Amblyopone*, this genus of cryptobiotic ants has a worldwide distribution. There are three species reported from eastern North America (Brown, 1980), but only one in the West: *P. californicum* Cook, described on the basis of a single male (Cook, 1953), and heretofore known only from the holotype male and several alate queens collected at scattered locations in California (Snelling, 1967). I recently collected several *Proceratium* workers in northern California which, for reasons outlined below, are believed to represent *P. californicum*. A description of these workers is given next, followed by a comparison of *P. californicum* to related taxa including a new species from west Texas and adjacent northern Mexico.

Proceratium californicum Cook

(Figs. 3–5)

WORKER: *Measurements* ($n = 3$): HW 0.80–0.84, WL 1.08–1.12, CI 0.87–0.91, SI 0.85–0.88, SI2 0.76–0.79, IGR 0.37–0.42.

Occipital margin broadly convex, weakly depressed or flattened medially, in full-face (dorsal) view; sides of head weakly convex, their lower halves becoming straight and converging slightly. Mandibles with 5 or 6 teeth on the masticatory margin. Clypeus with a conspicuous, median clypeal lobe, in the form of a blunt triangular tooth (Fig. 3), which projects beyond the anterior margin of the antennal fossae to a distance greater than the minimum distance between the frontal carinae. Frontal lobes raised and antennal insertions exposed; frontal carinae rather closely contiguous, diverging somewhat posteriorly, and strongly so anterolaterally where they fuse with the carinae which surround the antennal fossae; frontal carinae

strongly produced posterodorsally this being particularly evident in lateral view which reveals a marked posterodorsal angle (Fig. 4). Distance between frontal carinae at apex of this angle is less than the distal scape width. Antennae 12-segmented; scape failing to reach the occipital (posterior) margin of the head by an amount approximately equal to the length of the first funicular segment; first funicular segment 1.2 to 1.5 times as long as wide; second funicular segment about as wide as long. Eyes virtually absent, represented by a fleck of dark pigment at about the middle of the head on either side, no facet visibly breaking the continuity of the integument.

Mesosoma robust, ankylosed, convex in lateral view; metanotal groove marked by a darkened transverse suture which is scarcely impressed; declivitous face of propodeum concave in dorsal view, its angular junction with the basal face of the propodeum marked by a slightly raised median point and, posteroventral to this, a pair of weak, lateral projections (poorly developed propodeal teeth).

Petiole nodiform, higher than long, and a little broader than long in dorsal view; anterior and posterior faces of petiole distinct, converging to a well rounded summit, at an acute angle of about 60°; subpetiolar process consisting of little more than a thin, median lamella, not ventrally projecting as a tooth; postpetiole large, robust; second gastric (fourth abdominal) segment strongly inflated and produced caudad, but remaining gastric segments protruding from the middle (rather than the anterior half) of the venter, so that compared to most *Proceratium* with a nodiform petiole the second gastric (fourth abdominal) sternum is relatively long, its maximum measurable longitudinal length being about 0.4 times the length of the corresponding tergum (Fig. 5). Legs rather long and slender (hind tibia about 0.70 mm long); each leg with a pectinate tibial spur, a pair of simple tarsal claws, and an arolium.

Mandibles rugulose-punctate, opaque; dorsum of head and mesosoma finely and obscurely reticulate-punctulate, opaque, becoming sublucid and more distinctly punctulate on the side of the head, side of the mesosoma, and the posterior half of the mesosoma dorsum. Petiole densely punctulate, opaque, with a distinct, longitudinal median carinula on the posterior face. Postpetiole and second gastric (fourth abdominal) tergum smooth and shiny, the lustre dulled by numerous fine piligerous punctures.

Body densely covered with fine, short, appressed and decumbent pubescence, but virtually no erect hairs except around the mouthparts and gastric apex.

Castaneous brown in color.

COMMENTS: The above description is based on three workers from two adjacent localities in Yolo County, California. Three dealate *Proceratium queens* were also collected at one of these localities, in the same litter sample as one of the workers. An examination of the three newly collected queens and of previously collected alate queens of *Proceratium* from various California localities shows that they are similar to the workers in most respects, except for obvious caste-specific differences. In particular, all of these queens show (i) the distinctive configuration of the median clypeal lobe and the frontal carinae, described above, (ii) a slight longitudinal carinula on the petiole, (iii) the anterior and posterior faces of the petiole converging, at an acute angle, toward a rounded summit, (iv) a relatively long fourth abdominal sternum and (v) the presence of pretarsal arolia. Standing hairs are more common on the body than in workers, but they are mostly suberect

or subdecumbent, and they are lacking on the antennae and legs, as in the workers. The holotype male of *P. californicum* agrees with the preceding females in several important respects: (i) erect pilosity is sparse, and lacking on the appendages; (ii) there is a weak longitudinal carinula on the posterior face of the petiole; (iii) the anterior and posterior faces of the petiole converge at an acute angle; and (iv) the fourth abdominal sternum is relatively long. In this combination of characters the *P. californicum* male differs from known males of related New World *Proceratium* (*P. pergandei* Emery, *P. micrommatum* complex). Moreover the *P. californicum* male is comparable to the females in size and gastric sculpture. It seems reasonable to conclude that all of these California collections of *Proceratium* represent a single species, *P. californicum*.

Accepting this conclusion, then, females of *P. californicum* can be distinguished from all other New World *Proceratium* with a nodiform petiole by the more posterior position of the apical gastric segments and the associated greater length of the second gastric (fourth abdominal) sternum. There has been some misrepresentation of this character difference in the literature, however. In Brown's (1980) key to New World species of *Proceratium*, the second gastric (fourth abdominal) sternum of *P. californicum* is said to be subequal in length to that of the preceding segment, as seen from the side. In fact, the midline length of this sternum, taken in a lateral or ventral view from its anterior margin to the point at which it meets the remaining gastric segments, is about one-half the length of the preceding segment, in both workers and queens. Snelling's (1967) illustration of a *P. californicum* queen is inaccurate in this regard since it gives the misimpression that the midline lengths of the two sterna are equal.

The maximum measurable length of abdominal sternum IV, taken in lateral view from its anterior margin, excluding the (usually concealed) acrosternite, to its posterolateral extremity, is indeed subequal to the length of the preceding segment, but so it is also in some specimens of *P. pergandei*. No matter which interpretation of length is adopted, the existing literature introduces some ambiguity into the discrimination of *P. californicum* females from those of other species.

An alternative measure, which more effectively summarizes the differences in the shape of the gaster, is to take the maximum longitudinal length of abdominal sternum IV (LS4) and divide it by the total length of the same segment, which is in effect the length of the corresponding tergum (LT4) (see "Methods" section and Fig. 5). This quotient can be termed the index of gastric reflexion (IGR) for, although it actually measures the relative length of abdominal sternum IV, reduction of the latter appears to be closely associated with increased curvature and inflation of the tergum. IGR permits discrimination of *P. californicum* females from those of *P. pergandei* and other New World species (Table 2 and Fig. 10). Based on the limited material available for study, it appears that this index may be partly diagnostic for the male caste of *P. californicum* (Table 2), at least among the "Sysphincta-like" New World species, i.e., excluding the otherwise dissimilar *P. croceum* Roger and *P. silaceum* Roger.

P. californicum females show a gastric configuration similar to that of certain Old World species of *Proceratium* such as *P. melinum* Roger (IGR = 0.42), *P. algericum* Forel (IGR = 0.35–0.38), *P. itoi* Forel (IGR = 0.36), and *P. watasei* Wheeler (IGR = 0.35) (sample sizes of 1, 4, 1, and 1 workers, respectively). *P.*

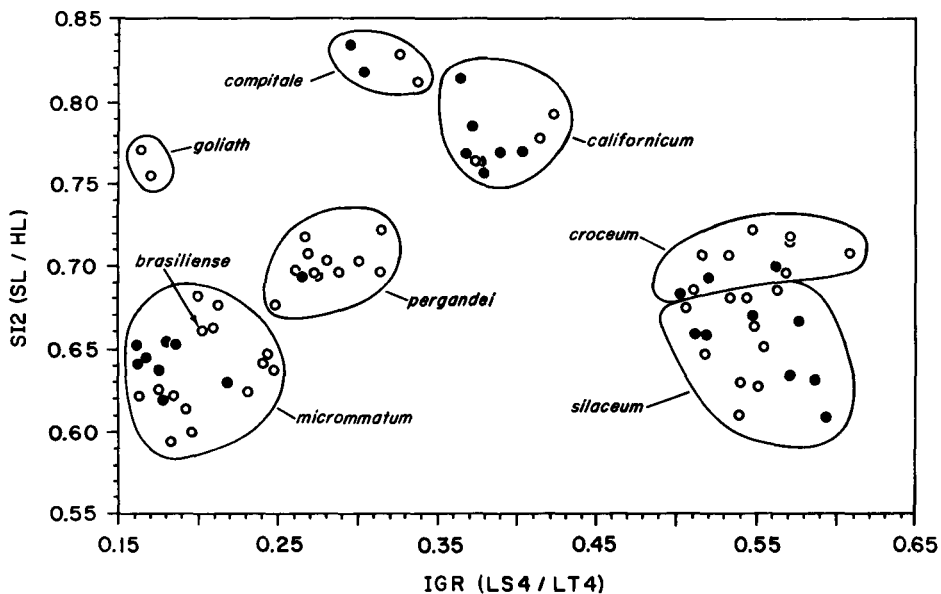


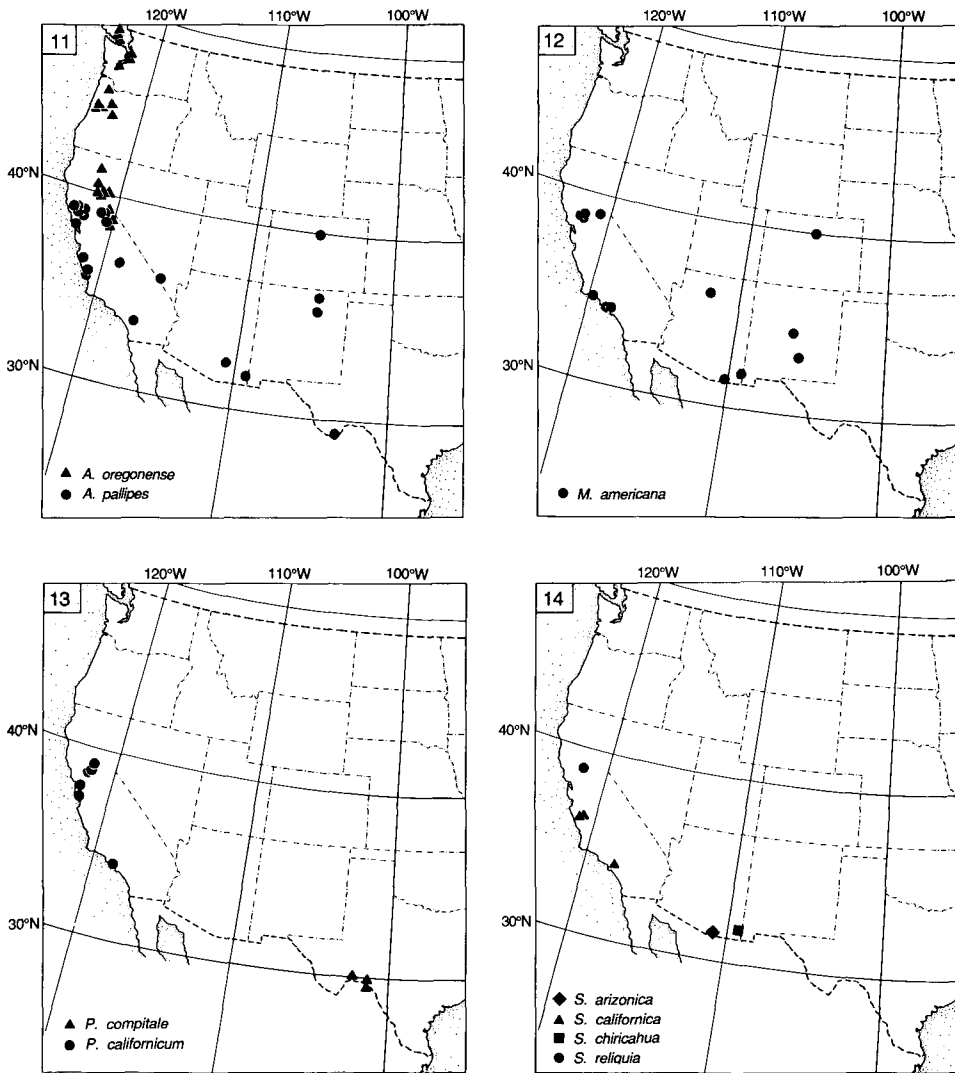
Fig. 10. Plot of scape index ($SI_2 = SL/HL$) by index of gastric reflexion ($IGR = LS_4/LT_4$) in workers and queens of New World *Proceratium*. Open circles: workers; closed circles: queens.

californicum differs from these and other Old World species by the combination of sparse pilosity, posterodorsally produced frontal carinae (Fig. 4), and the strongly projecting, triangular median clypeal lobe. Moreover, most *Proceratium* workers lack the pretarsal arolia seen in *P. californicum*, although they are partly developed in the Japanese species, *P. itoi*, and to some degree in the southern Palearctic species, *P. algericum*.

DISTRIBUTION AND BIOLOGY: The recently collected workers and queens of *P. californicum* are from adjacent localities in northern California and all were extracted from sifted litter in Winkler sacks. Two workers and three dealate queens come from a small patch of remnant valley oak (*Quercus lobata*) woodland (the type locality of the new species of *Smithistruma* described below), while one worker is from a roadside border of oak trees, adjacent to a golf course. The current known distribution of *P. californicum* is shown in Fig. 13.

Nothing is known about the biology of *P. californicum*. It may be presumed, by analogy with other species (Brown, 1980), that the workers are specialist, subterranean predators on spider eggs. Collection dates for the alates range from April 19 to May 27. This stands in contrast to the predominantly late summer flights of *Proceratium* species in eastern United States, and is all the more remarkable given the increasingly dry weather conditions in California in late spring and early summer.

MATERIAL EXAMINED: CALIFORNIA: *Alameda Co.*: Valle Vista, Oakland, 21 April, 1918, 1 alate queen (MCZC); *Los Angeles Co.*: Santa Monica Mtns., 19 April, 1959, 2 alate queens (Bimantoro) (LACM); *Santa Cruz Co.*: Glenwood, 27 May, 1908, holotype male (LACM); *Sutter Co.*: Yuba City, 27 April, 1965 (W. Wiard) (CDAE); *Yolo Co.*: 4 km E Yolo, 15 m, 23 February, 1985, 1 worker (P.



Figs. 11–14. Distributions of some mesophilic, cryptobiotic ants in western North America. *Amblyopone pallipes* and *Myrmecina americana* range widely in eastern United States; the remaining species are endemic to the west. 11. *Amblyopone oregonense*, *A. pallipes*. 12. *Myrmecina americana*. 13. *Proceratium californicum*, *P. compitale*. 14. *Smithistruma reliquia*, *S. chiricahua*, *S. californica*, *S. arizonica*.

S. Ward #7267-4 (LACM); same locality, 8 April, 1987, 1 worker, 3 dealate queens (P. S. Ward #8804-1 and #8805-1) (PSWC, UCDC); 8 km W Woodland, 30 m, 4 April, 1986, 1 worker (P. S. Ward #8265-2) (UCDC).

Proceratium compitale, new species
(Fig. 6)

HOLOTYPE WORKER: Texas, Val Verde Co.: Emerald Sink, 30 Nov. 1984 (J. Reddell & M. Reyes) (LACM).

Table 2. Range of values for IGR (index of gastric reflexion) in New World species of *Proceratium*. Sample size is given in parentheses.

Taxon	Workers	Queens	Males
<i>P. croceum</i> Roger	0.51–0.61 (8)	0.50–0.56 (3)	0.56 (1)
<i>P. silaceum</i> Roger	0.51–0.56 (10)	0.51–0.59 (7)	0.58–0.64 (8)
<i>P. californicum</i> Cook	0.37–0.42 (3)	0.36–0.40 (7)	0.62 (1)
<i>P. compitale</i> , n. sp.	0.33–0.34 (2)	0.29–0.30 (2)	—
<i>P. pergandei</i> Emery	0.25–0.31 (11)	0.27 (1)	0.55–0.60 (6)
<i>P. micrommatum</i> Roger (s.l.)	0.16–0.25 (13)	0.16–0.22 (8)	0.29–0.32 (5)
<i>P. brasiliense</i> Borgmeier	0.20 (1)	—	—
<i>P. goliath</i> Kempf and Brown	0.16–0.17 (2)	—	0.29 (1)

PARATYPES: One worker, same data as holotype (MCZC); 1 dealate queen, Texas, Terrell Co.: Blackstone Cave, 5 Feb. 1967 (D. McKenzie & D. Erickson (MCZC); 1 dealate queen, Mexico, Coahuila: 15 mi NW Cd. Acuña, Cueva de los Lagos, 27.I.1966 (J. H. Reddell) (LACM).

MEASUREMENTS: *Holotype*: HW 0.94, WL 1.38, CI 0.88, SI 0.94, SI2 0.83, IGR 0.33.

Paratype worker: HW 0.85, WL 1.27, CI 0.83, SI 0.97, SI2 0.81, IGR 0.34.

Paratype queens ($n = 2$): HW 0.99–1.00, CI 0.90–0.91, SI 0.91, SI2 0.82–0.83, IGR 0.29–0.30.

WORKER DIAGNOSIS: Similar to *P. pergandei* in general habitus but larger in size. Occipital margin convex, not medially flattened; sides of head weakly convex, lower halves becoming straight. Mandibles with (5 or) 6 teeth on the masticatory margin, the first (3 or) 4 teeth occurring on the proximal half of the margin and rather close to one another. Median clypeal lobe relatively broad, emarginate apically, projecting beyond the anterior margin of the antennal fossae a distance which is subequal to or a little greater than the minimum distance between the frontal carinae. Frontal lobes obliquely raised, largely exposing the antennal insertions, but not to the same degree as in *P. californicum*; frontal carinae correspondingly less closely contiguous, the maximum distance between them being greater than the distal scape width; frontal carinae subparallel to weakly converging posteriorly, conspicuously converging anteriorly and then fusing anterolaterally with the carina around each antennal fossa. Antennae 12-segmented; scape long and slender, reaching the occipital (posterior) margin of the head (see scape indices); first funicular segment about twice as long as wide; second funicular segment about 1.2 times longer than wide. Eye very small, a fleck of dark pigment in the middle of the side of head.

Mesosoma robust, ankylosed, somewhat flattened dorsally; metanotal groove unmarked; declivitous face of propodeum concave in dorsal view, meeting the basal face of the propodeum abruptly, at almost a right angle (lateral view); the declivity flanked laterally by a lamella which does not form a propodeal tooth or denticle but is expanded posteroventrally as a rounded "metapleural" lobe (probably part of the propodeum).

Petiole low and nodiform, about as long as high (excluding the subpetiolar process) and slightly broader than long; anterior and posterior faces converging, at an obtuse angle, to a very broadly rounded summit; subpetiolar process con-

sisting of a well-developed, triangular tooth, recurved backward; postpetiole large, robust; second gastric (fourth abdominal) segment strongly inflated and recurved forward, the maximum longitudinal length of the sternum being about one-third the total length of the segment. Each leg with a pectinate tibial spur and pair of simple, slender claws; pretarsal arolia absent.

Mandibles striato-punctate, subopaque; head, mesosoma, petiole and postpetiole punctulate to obscurely rugulose and opaque, becoming sublucid on the side of the mesosoma; propodeal declivity mostly smooth and shiny; second gastric (fourth abdominal) tergum sublucid, with numerous fine piligerous punctures.

Appressed and standing hairs common on most parts of body, including dorsum, scapes, and legs.

Rather uniformly ferruginous brown (the paratype worker a lighter castaneous brown, perhaps callow).

COMMENTS: The truncate median clypeal lobe, low nodiform petiole (with anteroventral tooth), punctulate-rugulose body sculpture, and abundant standing hairs indicate that this species is more closely related to *P. pergandei* than to any other known *Proceratium*. Initially I felt some reluctance in describing *P. compitale* as a different species, particularly in view of its similarity, and allopatry, to *P. pergandei*. However when plotting the differences in scape index and gastric configuration between *P. californicum* and other New World *Proceratium*, the *pergandei*-like specimens from west Texas and adjacent northern Mexico stood out distinctly (see Fig. 10).

To summarize the differences: *P. compitale* females are larger, on average, than those of *P. pergandei*, with disproportionately longer scapes (SI 0.91–0.97, SI2 0.81–0.83 in *P. compitale*; SI 0.76–0.83, SI2 0.68–0.72, in a sample of 11 *P. pergandei* workers and one queen). The scapes of *P. compitale* attain the occipital margin when held back against the head whereas in *P. pergandei* they fail to reach the margin by about the length of the first funicular segment. Not surprisingly, the funicular segments of *P. compitale* are also relatively longer, e.g., the second funicular segment is about 1.2 times longer than wide in *P. compitale* whereas it is about as wide as long, or wider than long, in *P. pergandei*. The median clypeal lobe is broader apically in *P. compitale*, and (at least in the two workers) the gaster appears to be less strongly reflexed (compare IGR values in Table 2).

P. compitale differs from *P. californicum* in the configuration of the fronto-clypeal region, relative scape length, shape of the propodeal declivity, shape of the node, relative length of the fourth abdominal sternum, absence of pretarsal arolia, and in details of pilosity and sculpture. It is interesting that in regard to gastric reflexion *P. compitale* approaches *P. californicum* more closely than any other species (Fig. 10).

DISTRIBUTION AND BIOLOGY: *P. compitale* is known only from the type specimens, collected in Val Verde and Terrell Counties, Texas and at an adjacent locality in the Mexican state of Coahuila. The nearest known population of *P. pergandei* is from Bandera County, Texas (Lost Maples State Natural Area, P. W. Kovarik leg.) (LACM), about 180 km east of the *P. compitale* localities.

Proceratium micrommatum Roger

A single male collected at u-v light in Hidalgo County, Texas (Bentsen-Rio Grande State Park, 13.xii.1984, P. S. Ward #7152) (PSWC) represents the first

record of this species (or species complex) from the United States. The male is relatively small (HW 0.66) with a strongly reflexed gaster, for this sex (IGR 0.32); and the mid-tibia lacks an apical spur (a pectinate spur is present on the fore- and hind-tibiae). This clearly excludes the possibility of it being one of the five other known Nearctic species or the large Central American species, *P. goliath* Kempf and Brown.

P. micrommatum itself is a somewhat variable entity (Brown, 1974, 1980; see also Fig. 10 in this paper), and the possibility exists that it comprises more than one species. The members of this complex (*P. micrommatum* and *P. brasiliense* Borgmeier) can be recognized by the absence of a pectinate spur on the mid-tibia, in addition to distinctive fronto-clypeal characters. *P. brasiliense* is only weakly differentiated from *P. micrommatum* and may well prove to be a junior synonym of the latter.

Key to New World *Proceratium* (Workers and Queens)

The following is based on Brown's (1980) key, modified to incorporate *P. compitale* and new information on the other species.

- 1(a). Petiolar node in the form of a thick erect scale, with anterior and posterior faces subparallel and apex more or less truncate, in lateral view; fourth abdominal (second gastric) sternum relatively long, its maximum longitudinal length, taken in lateral view from the anterior margin to the posterolateral extremity, one-half or more the length of the corresponding tergum ($IGR \geq 0.50$), the latter not strongly inflated 2
- (b). Petiolar node low and "bun-shaped", broad at the base, with anterior and posterior faces converging to a rounded summit; fourth abdominal (second gastric) sternum less than half the length of the corresponding tergum ($IGR \leq 0.44$), the latter strongly inflated and recurved caudad 3
- 2(a). Larger species, worker HW > 0.80, queen HW > 0.90 (SE United States) *croceum* Roger
- (b). Smaller species, worker HW < 0.80, queen HW < 0.90 (eastern North America, south to Colombia) *silaceum* Roger
- 3(a). Scape and legs with standing pilosity; fourth abdominal (second gastric) sternum short, its maximum longitudinal length, one-third or less the length of the corresponding tergum ($IGR 0.16-0.34$) 4
- (b). Standing pilosity lacking on scape and legs; fourth abdominal (second gastric) sternum more than one-third the length of the tergum ($IGR 0.37-0.42$) (California) *californicum* Cook
- 4(a). Mid-tibia with a pectinate apical spur; anterior clypeal border produced as a median lobe that is emarginate apically 5
- (b). Mid-tibial spur lacking; anterior median lobe of clypeus absent or reduced to a small, rounded or single-pointed tooth 7
- 5(a). Very large species (HW > 1.20); petiole longer than high and slightly longer than broad in worker; fourth abdominal (second gastric) segment strongly recurved ($IGR 0.16-0.17$) (Central America) *goliath* Kempf and Brown
- (b). Medium to large species (HW < 1.05); petiole about as high as long,

- and broader than long; fourth abdominal segment less strongly re-curved (IGR 0.25–0.34) 6
- 6(a). Larger species (worker HW > 0.84, worker HL > 1.00); scapes long and slender, reaching or exceeding the occipital margin when held back against the head (SI2 0.81–0.83) (Texas, northern Mexico) *compitale*, new species
- (b). Smaller species (worker HW < 0.88, worker HL < 1.00); scapes shorter, failing to reach the occipital margin by an amount subequal to the length of the first funicular segment (SI2 0.68–0.72) (eastern United States) *pergandei* Roger
- 7(a). Worker mesosoma in side view with dorsal outline evenly convex from pronotum to top of propodeal declivity (Antilles, Texas to Ecuador) *micrommatum* Roger
- (b). Worker mesosoma in side view with propodeal dorsum feebly concave in outline, then raised as a rounded angle or boss where it meets the declivity (SE Brasil) *brasiliense* Borgmeier

Genus *Smithistruma*

This genus of specialist collembolan predators is richly represented in eastern United States, where about 24 species are found (Smith, 1979). In the western half of the country there is a single described species, *S. californica* Brown, which for a long time was known only from the type locality (Claremont, California) and had been considered possibly adventive (Brown, 1950, 1953). Hunt and Snelling (1975) listed an unidentified *Smithistruma* sp. in their checklist of Arizona ants.

Recent collections in California and Arizona have yielded three new species of this genus, which are described below and compared with *S. californica* and with congeners from eastern United States.

Smithistruma reliquia, new species (Fig. 7)

HOLOTYPE WORKER: California, Yolo Co.: 4 km E Yolo, 15 m, 4.iv.1986, ex sifted litter (leaf mold, rotten wood), riparian woodland (P. S. Ward #8266-5) (MCZC).

PARATYPE WORKERS: Two workers, same data as holotype (PSWC, UCDC); 3 workers, same locality as holotype, 8.v.1986 (S. Shattuck #715) (LACM, SOSC, USNM).

MEASUREMENTS: *Holotype*: HL 0.60, HW 0.40, WL 0.60, CI 0.66, MI 0.17.

Paratypes ($n = 5$): HL 0.58–0.62, HW 0.38–0.40, WL 0.58–0.61, CI 0.65–0.66, MI 0.16–0.18.

WORKER DIAGNOSIS: Dacetine ant with typical *Smithistruma* habitus, i.e., relatively short, subtriangular mandibles; 6-segmented antennae; and ventrolaterally placed eyes.

Basal lamella of mandibles acutely tipped, followed by a distinct diastema, longer than the length of the basal lamella; mandible with 5 principal teeth in the apical series; the first principal tooth variable in size and possibly adventitious but present in all known (6) workers, not exceeding the length of the fourth tooth,

which is shorter than teeth 2, 3, and 5; principal teeth followed by 2 small intermediate teeth, 4 preapical denticles, and a modest apical tooth.

Clypeal disc slightly wider than long; anterior clypeal margin broadly rounded; preocular laminae subparallel on their posterior half, converging anteriorly, the overall effect being that the head is more pyriform than cuneiform in full-face, dorsal view.

Dorsum of pronotum planar in lateral view, and meeting the mesonotum at an angle; remainder of mesosoma dorsum more or less flat, the metanotal groove weakly (and variably) impressed. Propodeal teeth acute, directed more backward than upward; infradental lamellae broadened ventrally, variably so; spongiform appendages conspicuously developed ventral to, and posterodorsal to, the petiole and postpetiole.

Head, including clypeus, densely punctulate and opaque, except the smooth, shiny frontal triangle. Promesonotum punctulate with a median longitudinal carinula, the sculpture becoming partly effaced on the pronotum which is correspondingly smooth and shiny, with faint obsolete striae. Similarly, the basal face of propodeum and petiolar dorsum are partly smooth and shiny, due to effacement of punctulae. Side of mesosoma predominantly smooth and shiny, as are postpetiole and gaster. Basal costulae of first gastric (fourth true abdominal) tergum rather short, about one-fourth the length of the tergum.

Pilosity characteristic: hairs filiform and slender, not notably enlarged distally. Clypeal disc densely covered with filiform, sublinear hairs which are directed outward and upward, away from the midline (this includes the hairs on the sides of the clypeus). Anterior surface of antennal scape with filiform hairs, curving mostly towards the apex; 2 or 3 longer flagelliform hairs on basal third of scape. Upper half of head with numerous, slender hairs, curving predominantly toward the midline (in contrast to those of the clypeal disc). Remainder of body dorsum with scattered, long, flagelliform hairs, the pair of hairs on the pronotal shoulders subequal in length to the terminal funicular segment.

Ferruginous brown, head slightly darker in color.

COMMENTS: The diastemate mandibles, pyriform head shape, relatively wide clypeus with rounded anterior margin, abundant clypeal pilosity, and promesonotal carinula place this species in the *S. talpa* group. This group contains four described species, all from eastern United States (*S. creightoni* Smith, *S. filitalpa* Brown, *S. talpa* Weber, and *S. wrayi* Brown). *S. reliquia* differs from these species by having five principal teeth on the mandibles, although the first tooth is shorter than most of the others. All of the eastern species have four principal teeth. *S. reliquia* appears to be most closely similar to *S. filitalpa* (known from Arkansas and Indiana) insofar as it possesses filiform clypeal hairs and a smooth, shiny integument on the petiolar dorsum and parts of the pronotum. The three other eastern species have spoon-shaped or otherwise distally enlarged clypeal hairs and punctate sculpture on the body dorsum. Besides mandibular dentition, *S. reliquia* differs from *S. filitalpa* in the longer and finer pilosity which covers the entire head. In addition, the filiform clypeal hairs of *S. reliquia* are directed antero- and dorso-laterally, away from the midline, whereas in *S. filitalpa* they are curved anteromedially. Differences between *S. reliquia* and *S. chiricahua*, a newly described species in the *S. talpa* group from Arizona, are given below.

DISTRIBUTION AND BIOLOGY: This species is known only from the type locality

where six workers were extracted from sifted litter, using the Winkler apparatus. The collections were made in a small (2 hectare) remnant patch of valley oak (*Quercus lobata*) riparian woodland, located near the junction of Hwy. 113 and Yolo County Rd. 17, in the Sacramento Valley.

Litter sifting at this location has uncovered a relatively rich (for California) cryptobiotic ant fauna which includes *Smithistruma reliquia*, *Proceratium californicum*, three species of *Hypoponera* and four species of *Stenammina*. One species in each of the last two genera appears to be undescribed (or at least not currently identifiable), but the species-level taxonomy of these genera needs major revisionary work, and it does not seem useful to contribute isolated species descriptions at this time.

Riparian woodland was once more widespread in the Sacramento Valley: historical reports refer to forests several miles wide fringing the Sacramento River and its tributaries (Thompson, 1961). About 95% of this has been destroyed, and the remaining patches are threatened with habitat degradation (Roberts et al., 1980; Katibah, 1984).

Smithistruma chiricahua, new species
(Fig. 8)

HOLOTYPE WORKER: Arizona, Cochise Co.: SW Research Sta., Chiricahua Mtns., 4.viii.1958 (L. M. Smith & R. O. Schuster No. 175) (LACM).

MEASUREMENTS: HL 0.55, HW 0.39, WL 0.56, CI 0.70, MI 0.18. /

WORKER DIAGNOSIS: A member of the *S. talpa* group, and agreeing in general habitus with *S. talpa* Weber (for description see Brown, 1953:76) and *S. reliquia*, described above. Differing from *S. reliquia* as follows: head broader (compare CI values); preocular laminae more nearly parallel, less convergent anteriorly; pronotum rounding more evenly into mesonotum, in lateral view; pilosity differing sharply: most hairs conspicuously clavate or spatulate; clypeal disc with a conspicuous cover of short, spatulate hairs, those on the side of the clypeus curved anteromedially; anterior margin of scape with about 6, more or less anteriorly directed, spatulate hairs, set against a background of shorter hairs which are curved towards the apex of the scape; upper half of head covered predominantly with spatulate hairs, curving towards the midline, but with at least 1 pair of filiform hairs on the sides of the head; a few inclinate spatulate hairs on the promesonotal dorsum. Light castaneous brown, the head and gaster a little darker.

COMMENTS: This species shares some characteristics of *S. reliquia* (five principal mandibular teeth; partly smooth and shiny dorsum) but has distinctly different pilosity, even more spatulate than that of *S. talpa*.

DISTRIBUTION AND BIOLOGY: *S. chiricahua* is known only from the holotype worker collected at the Southwestern Research Station, in Cochise County, Arizona. According to R. O. Schuster (pers. comm.) the collection number (175) refers to a Berlesate sample derived from 2 cu. ft of leaf litter, concentrated by sifting; the sample was taken in oak woodland at the station proper.

Smithistruma californica Brown

Described on the basis of two partially dealate females from Claremont, Los Angeles Co., California (Brown, 1950) *S. californica* has been considered something of an enigma. It is a member of the *S. rostrata* group, of which there are

two species in eastern United States and two in temperate east Asia (Brown, 1949, 1953). Brown (1953) surmised that *S. californica* might be an Asian species introduced into California. There are now several recent collections of *Smithistruma rostrata* group workers, from California and Arizona. The California workers are here considered to be conspecific with the *S. californica* queens, while those from Arizona are believed to represent a closely related, undescribed species (*S. arizonica*, described below). A description of the *S. californica* workers follows.

WORKER: *Measurements* ($n = 2$, unless otherwise indicated): HL 0.60–0.62, HW 0.38, WL 0.61 ($n = 1$), CI 0.62, MI 0.16.

Mandibles adiaestemate, the acutely tipped basal lamella (BL) being followed by 5 principal teeth (P1–P5) and 2 intermediate teeth (I1, I2), of the following relative lengths (in order of decreasing size, with teeth of comparable length separated by commas): BL; P1, P2, P3; P5; P4; I1, I2; intermediate teeth followed by several minute preapical denticles and a short apical tooth.

Head rather elongate, mandibles relatively short (see measurements above); clypeal disc about 1.1 times broader than long, the sides converging anteriorly; anterior clypeal margin more or less straight mesially; preocular laminae parallel.

Dorsum of pronotum flat in lateral view, meeting the mesonotum at a distinct angle; remainder of mesosoma dorsum slightly concave (in lateral view), metanotal groove very weakly developed. Infradental lamellae convexly expanded below the short, triangular propodeal teeth.

Head densely punctulate and opaque, except the smooth, shiny clypeal tumulus and frontal triangle; promesonotum and petiole punctulate and opaque, the former with a conspicuous median carinula; punctulate sculpture of mesosoma dorsum becoming effaced on the basal face of the propodeum which is correspondingly smooth and shiny; propleuron weakly punctulate, sublucid; mesopleuron, side of propodeum, postpetiole, and gaster smooth and shining; basal costulae of fourth abdominal (first gastric) tergum about one-quarter the total length of the tergum. Posterior margin of the fourth abdominal tergum with very fine, reticulate and longitudinally striolate sculpture, the striolae about 0.06 to 0.10 mm long; similar sculpture present on the posterior margins of the fourth abdominal sternum and the 2 succeeding terga and sterna; such sculpture renders the integument sub-opaque.

Marginal clypeal pilosity consisting of dense, short, curved, spatulate hairs, directed anteriorly; clypeal disc with small, squamous hairs; anterior margin of scape with 7 or 8 short, spatulate hairs (against a backdrop of finer, shorter, laterally directed setae), the first such spatulate hair directed laterally, the next 4 (on the proximal half of scape) rather broadly spatulate and directed anteriorly, the last 2 or 3 hairs (on the distal half of scape) directed laterally; upper half of head covered with short spatulate hairs, directed towards the midline, no flagelliform or linear hairs visible. Promesonotum with scattered short, spatulate hairs; humeral angles with a single thin, flagelliform hair, such hairs also present on the petiole, postpetiole, and gaster.

COMMENTS: The two newly collected workers from California agree well with the original and expanded descriptions of *S. californica* (Brown, 1950, 1953) and with a type-compared *S. californica* female ("Claremont/Cal Baker") (LACM) which is probably part of the same series as the type specimens. The major differences are that the workers have more elongate heads (CI 0.62, compared

with 0.66–0.67 in the Claremont females) and less dense pilosity on the gaster. Points of agreement include the small size, short mandibles, spatulate clypeal hairs (less strongly spatulate on the upper third of the head in the queens), smooth shiny basal face of the propodeum, convexly expanded infradental lamellae, and the presence of fine reticulate-striolate sculpture on the posterior margins of the gastric terga and sterna.

DISTRIBUTION AND BIOLOGY: The two workers from Monterey County, California are labeled as “ex [or “on”] *Eriogonum*”.

MATERIAL EXAMINED: CALIFORNIA: *Los Angeles Co.*: Claremont (Baker), 1 alate queen (LACM); *Monterey Co.*: San Lucas, 22 Sept. 1966 (T. R. Haig), 1 worker (CDAE); 15 mi E San Lucas along Hwy. 198, 22 Sept. 1966 (Keifer), 1 worker (MCZC).

Smithistruma arizonica, new species

HOLOTYPE WORKER: Arizona, Santa Cruz Co.: Madera Canyon, ~5600 ft, 2 August, 1975 (A. Mintzer) (MCZC).

PARATYPE WORKERS, MALE: One worker, same data as holotype (MCZC); 3 workers, 1 male, same data as holotype (LACM).

MEASUREMENTS: *Holotype:* HL 0.64, HW 0.38, WL 0.62, CI 0.60, MI 0.15.

Paratype workers ($n = 4$): HL 0.59–0.63, HW 0.37–0.39, WL 0.59–0.62, CI 0.61–0.64, MI 0.15–0.16.

WORKER DIAGNOSIS: A member of the *S. rostrata* group and similar to the worker of *S. californica*, described above, except as follows: mesonotum and basal face of propodeum straight, not concave, in lateral profile; entire mesosoma dorsum, including basal face of propodeum, densely punctulate and opaque; promesonotal carinula almost entirely effaced; smooth, shiny surface on the side of the mesosoma less extensive than in *S. californica*, punctulae encroaching marginally; posterior margins of the sterna and terga of the fourth, fifth, and sixth abdominal (first, second, and third gastric) segments entirely smooth and shining, without the reticulate-striolate sculpture characteristic of *S. californica*.

MALE: *Paratype male:* HL 0.53, HW 0.43, WL 0.80. Compound eyes large, convex, their greatest diameter 0.19 mm; mandibles slender, edentate; notauli well developed anterolaterally, between them a pair of short anteromedial furrows which fuse posteriorly; parapsidal furrows distinctly impressed, about 0.24 mm long; propodeal teeth lacking; petiole slender with rounded node and long anterior peduncle; spongiform appendages lacking on petiole and postpetiole, except for a thin, ventral petiolar lamella. Head and mesosoma dorsum, including basal face of propodeum, punctate and opaque; meso- and metapleura predominantly smooth and shining, as are the petiolar and postpetiolar nodes; gaster smooth and shining except for very short, basal striae on the fourth abdominal (first gastric) tergum. Pilosity scattered, inconspicuous, most hairs appressed or decumbent. Dark brown, the head contrastingly darker (brownish-black); scapes and legs sordid brownish-yellow.

COMMENTS: *S. arizonica* is evidently very closely related to *S. californica*, but the worker differences outlined above seem substantial enough to warrant specific status. The current records, although very limited, suggest that both *S. californica* and *S. arizonica* are indigenous Nearctic species.

DISTRIBUTION AND BIOLOGY: Known only from the type locality. The type

specimens were taken under a stone shared with a *Trachymyrmex* colony on a steep hillside in pinyon pine woodland (A. Mintzer, pers. comm.).¹

Five species of ants in the tribe Dacetini are now known to occur in western North America: the four species of *Smithistruma* discussed here (distributions given in Fig. 14), and *Trichoscapa membranifera* Emery, a widespread tramp species possibly of African origin. *T. membranifera* has been recorded from Stockton, California (Smith, 1979) and was recently collected in Davis, California (alate queens emerging from freshly watered lawn, 27.vii.1982, P. S. Ward #5524). The workers and queens of these species may be identified by means of the following key.

Key to Western Nearctic Dacetine Ants (Workers and Queens)

- 1(a). Standing pilosity very sparse, absent on the dorsum of the head except for 1 pair of setae on the vertex; dorsal surface of mandible with a conspicuous transverse basal margin *Trichoscapa membranifera* Emery
- (b). Standing pilosity abundant, numerous spatulate or filiform hairs on the dorsum of head; dorsal surface of mandible without a transverse basal margin (*Smithistruma*) 2
- 2(a). Mandible with a conspicuous diastema (gap) between the basal lamella and first principal tooth (e.g., Fig. 7); first principal tooth (of 5) shorter than the next 2; worker head relatively broad, with moderately long mandibles (CI 0.65–0.70, MI 0.16–0.18) 3
- (b). Mandible without a conspicuous gap between the basal lamella and first principal tooth; first 3 principal teeth (of 5) subequal in length; worker head rather narrow, with shorter mandibles (CI 0.60–0.66, MI 0.15–0.16) 4
- 3(a). Pilosity of entire body, including head, consisting entirely of long, filiform hairs not notably enlarged distally (Fig. 7); worker head narrower (CI 0.65–0.66) *S. reliquia*, new species
- (b). Most hairs, especially those of head, shorter and conspicuously clavate or spatulate (Fig. 8); worker head broader (CI = 0.70 in the unique type) *S. chiricahua*, new species
- 4(a). Basal face of propodeum densely punctulate and opaque; posterior margins of the gastric terga and sterna smooth and shining *S. arizonica*, new species
- (b). Basal face of propodeum predominantly smooth and shining; posterior margins of the gastric terga and sterna finely reticulate-striolate and subopaque *S. californica* Brown

Discussion

The preceding results demonstrate the existence of a significant, albeit depauperate, cryptobiotic ant fauna associated with mesic habitats in the southwestern Nearctic region. Besides species of *Amblyopone*, *Proceratium* and *Smithistruma*,

¹ Since the above was written, I received a second sample of *S. arizonica* worker^s collected by Stefan Cover in a *Trachymyrmex* nest at Southwestern Research Station, near Portal, Arizona.

other taxa which arguably belong in this category include *Myrmecina americana* (distribution given in Fig. 12), various species of *Hypoponera* and *Stenammina*, and possibly *Neivamyrmex opacithorax*, whose Nearctic distribution is similar to that of *Amblyopone pallipes* and *M. americana* (see Watkins, 1976, Map 39).

For most of these ants, affinities appear to lie with congeners in eastern United States. Indeed in the case of *Amblyopone pallipes* and *Myrmecina americana* the eastern and western populations are considered conspecific. It is worth noting, however, that *A. pallipes* populations from the two regions are somewhat differentiated (see previous comments, especially regarding scape length in males); and the western populations of *M. americana* are sufficiently divergent morphologically that they were once considered to represent a distinct species (*M. californica* Smith). The rarer taxa, *Smithistruma* and *Proceratium*, have produced distinct species, endemic to the western Nearctic region, although they belong to species groups which are also found in eastern United States. Two of the western *Smithistruma* belong to a species group which also contains two eastern Palearctic species. Similarly, *Proceratium californicum* possesses some features in common with temperate Old World *Proceratium* (including the Japanese species, *P. itoi*) which it does not share with other New World species, but the characters involved (shapes of the node and gaster, presence of arolia) may represent shared ancestral conditions and hence not reflect close relationship. More rigorous phylogenetic analysis would be needed to underpin any additional biogeographic statements.

In summary, there is a range of differentiation between eastern and western pairs of closely related, mesophilic Nearctic ants; and some evidence of affinities between western Nearctic species and eastern Palearctic congeners. The western fauna is clearly depauperate relative to that of other regions. This pattern is concordant with the vegetation history of the area, the contemporary mesic vegetation being an impoverished representative of a richer ancestral flora, some of whose relatives now occur only in eastern United States or temperate Asia (Axelrod, 1977; Robichaux, 1980).

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