Multivariate Discrimination and Description of a New Species of *Tapinoma* From the Western United States

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ABSTRACT The ant *Tapinoma sessile* (Say) 1836 is one of the most widely distributed ants in North America; yet, it has received very little attention from biologists apart from its ability to infest houses. The original species description does not adequately account for the phenotypic variation present in this species of typically darkly concolored ant. In California, a bicolored morph was discovered that superficially resembles *T. sessile*; hence, its species status was questioned. Comparative morphometric analysis indicates that the bicolored ants are consistently distinguishable across a range of characters, and allometric techniques conclusively demonstrate that these two morphs are divergent. Based on the analysis of morphological data it was concluded that the bicolored ant is not *T. sessile* and is described as a new species, *Tapinoma schreiberi*. A neotype of *T. sessile* also is designated in this article, and measurement data are presented to assist taxonomists and delimit the morphological boundaries of *T. sessile*.

KEY WORDS Formicidae, *Tapinoma sessile*, *Tapinoma schreiberi*, morphometrics, multivariate allometry

Tapinoma sessile (Say) 1836 is typically a small, darkly concolored ant that occurs throughout the Nearctic region (Shattuck 1992). In California, a bicolored ant was discovered, with a red head, mesosoma, and a black gaster, but that was otherwise similar to the concolored *T. sessile* (R. R. Snelling, personal communication). The bicolored morph has been recently collected at two biological field stations, Sagehen Creek in Nevada County and Eagle Lake in Lassen County and is also known from other locations in museum records (San Diego County, CA; Clark County, NV). Initial reports indicated that colonies contained either all concolored or bicolored morphs, but no mixed colonies (R. Snelling, personal communication). Bicolored colonies were also reported as sympatric with concolorous colonies (P. S. Ward, personal communication).

Taxonomic Background

Subfamily Dolichoderinae Forel 1893. The Dolichoderinae form one of the larger subfamilies of ants, with ≈1,000 described species in 42 genera (Shattuck 1992). The greatest regions of diversity for this subfamily lie in the Neotropical, Ethiopian, and Australian bioregions; yet, the origin of this subfamily remains unknown (Hölldobler and Wilson 1990; E.O. Wilson, personal communication). The Dolichoderinae have traditionally received little attention from taxonomists due to the apparent lack of morphological diversity. As a result a high number of taxa were placed in poorly defined genera due to a reliance on a limited set of morphological characters (Shattuck 1992). The misconception that dolichoderines are morphologically similar has led many taxonomists to focus on the more dramatically diverse groups of ants, such as the Ponerinae or Myrmicinae.

Genus *Tapinoma* Föerster 1850. Generic limits within the Dolichoderinae were poorly defined until Shattuck (1992, 1995) revised the subfamily at the generic level. The genus *Tapinoma* was revised to hold 95 extant species that are globally distributed below 55° N. Three species of *Tapinoma* have been found in the United States: *T. sessile*, *T. melanocephalum* (F.) 1793, and *T. litorale* Wheeler 1905. Southern Florida seems to be the northernmost extreme of the range of *T. litorale*, and it seems that *T. melanocephalum* is introduced in Florida.

***Tapinoma sessile* (Say) 1836.** After being originally described as *Formica sessilis*, in the Boston Journal of Natural History by Thomas Say in 1836, there has been little taxonomic work on *T. sessile* apart from its status as a pest. The original description is one paragraph in length and does not adequately describe a taxon that is highly variable in both size and color. The original species description was based on workers and queens from Indiana and many of the specimens from his

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Table 1. Names of species now held in synonymy with *T. sessile*

Formica sessilis Say (1836), p. 287, queen and worker
Tapinoma sessilis Smith (1858), p. 57
Tapinoma sessile Mayr (1886a) Mayr (1886b), p. 434; Emery (1895), p. 332, female and male
Tapinoma boreale Roger (1863), p. 165, female and worker; Mayr (1866), p. 498, worker
Formica gracilis Buckley (1866), p. 158, worker and female
Formica parva Buckley (1866), p. 159, worker
Bothriomyrmex dimmocki Wheeler (1915), p. 417, worker and queen; Emery (1925), p. 19; Shattuck (1992), p. 153

Authority, date, and caste(s) examined follow the binomen (from Bolton et al. 2006).

collection have been lost, including the holotype (Say 1836; R. R. Snelling, personal communication).

Cytogenetic studies have revealed the chromosome number within *T. sessile* to be $n = 8$ (Crozier 1970) and $2n = 16$ (Taber and Cokendolpher 1988). Although the chromosome number is consistent within *T. sessile*, other researchers have found intraspecific ploidy to vary within *Tapinoma* (Imai et al. 1984). For example, the *T. indicum* ploidy number has been reported as $2n = 10$ (Imai et al. 1984) and also $n = 7$ (Crozier 1975). A likely explanation for why chromosome number varies within an organism is that the location of extracted cells plays a role in determining the ploidy number. Cells involved in secretory processes often have supernumary chromosomes to allow for increased secretion of protein product (Crozier 1975).

Several other species of ant have been described that were later determined to be *T. sessile* (Table 1). In 1928, M. R. Smith revisited the biology of *T. sessile.* He provided a more complete description of *T. sessile* and provided measurement data and descriptions of color variation to demonstrate the level of phenotypic variability present in this species. The focus of Smith's work was related to *T. sessile*'s ability to infest houses (hence its common name the odorous house ant); as such, his scope was limited. He did not mention any bicolored morphs (Smith 1928).

Smith's descriptions were based on specimens from Illinois, from which he reported all colonies as polygynous, with colony size varying from 100 to 10,000 workers. All colonies Smith examined were house infesting, and he did not report collecting ants from natural habitats. There may be a trend within the Dolichoderinae, species that are normally monogynous in their native habitat become polygynous and greatly increase the number of workers when the colony becomes invasive or pestiferous (Giraud et al. 2002, Ingram 2002). Smith also described that the length of workers varied from 2.39 to 3.19 mm, although it is unclear whether this size range is continuous or bimodal. This is of particular interest because *T. sessile* is considered a monomorphic ant and, if this is true, each colony should contain individuals of approximately the same size.

Of the 299 papers examined during a literature review (conducted in November 2008), the plurality of scientific publications (31%), specifically mentioning *T. sessile,* focus on its status as a pest and not on its biology or ecology in a natural setting. Despite the high number of papers referring to *T. sessile,* only 2% have addressed issues of taxonomy. The recent taxonomic papers referring to *T. sessile* were restricted to the higher level systematics of the Dolichoderinae and not on the species status of *T. sessile* (Shattuck 1992, 1995). Despite this lack of clear species delimitation, authors have hinted that *T. sessile* in North America may not be one species but rather a complex of morphologically similar species (Clark and Blom 2007, Fisher and Cover 2007).

The goal of this research was to investigate the taxonomic status of the bicolored ants using the morphological species concept. This species concept is the one most commonly used when dealing with museum specimens (Hölldobler and Wilson 1990). The null hypothesis tested was that the bicolored morphs and the concolored morphs are the same species, *T. sessile.* If the bicolored and concolored ants are the same species, then it is expected that the morphological variation found between the two morphs will not be significantly different ($\alpha = 0.05$). If the two morphs are different species, then the morphological variation found between them should be divergent. In the field, the bicolored ant has been observed in sympatry with *T. sessile* yet no mixed colonies or intergrades have been found; thus, they seem to remain distinct.

Materials and Methods

Several measurements were taken from both field-collected and museum specimens (Table 2) (Ward 1999, Wild 2004). Extensive field collections were conducted in California, focusing on sites in Nevada, Sierra, and Lassen counties, where the bicolored ant has been collected on multiple occasions (Fig. 1). Relevant material also was examined from the collections of the following repositories: Natural History Museum of Los Angeles (LACM), Bohart Museum of Entomology (UCDC), California Academy of Sciences (CASC), Essig Museum of Entomology (UCBC), Smith Museum of Natural History (CIDA), Albert J. Cook Arthropod Research Collection at Michigan State University (MSUC), and P. S. Ward (PSWC).

Head measurements were taken with the head in full-face view so the posterior border and the anterior clypeal margin were in the same focal plane. As ants are considered prognathous, the frontal area of the head is dorsal and the clypeus is anterior (Wild 2004). Morphometric analyses are used to directly infer species boundaries, as characters are likely to diverge in the absence of gene flow (Ward 1996, 2001). Morphometric measurements were made using a Wild Heerbrugg M5 dissecting scope, calibrated against a stage micrometer, at 50× magnification (except for wing length, which was taken at 25×). Measurements were taken to within 0.01 mm. These measurements were taken from 427 concolored workers from throughout the range of *T. sessile.* In addition, 148 bicolored workers were measured from sites in California (Nevada, Sierra, and San Diego counties) and one site in Nevada (Clark County). All materials col-

Table 2. List of morphometric measurements and indices

Head length (HL)	In full-face view, the midline distance from the level of the max posterior projection of the posterior margin of the head to the level of the most anterior projection of the anterior clypeal margin. In males, the posterior margin of the head was considered as the vertex between, and not including, the ocelli.
Head width (HW)	In full-face view, the max width of the head posterior to the compound eyes.
Minimum frontal carinal width (MFC)	In full-face view, the min. distance between the frontal carinae.
Antennal scape length (SL)	Measured from the apex of the first antennal segment to the base, exclusive of the radicle.
Profemur length (FL)	In posterior view, measured along the longitudinal axis from the apex to the junction with the trochanter.
Metatibial length (LHL)	In dorsal view, measured along the longitudinal axis from the apex to the level of the lateral condyles, excluding the medial proximal condyle.
Pronotal width (PW)	In dorsal view, the max width of the pronotum measured from the lateral margins.
Wing length (WGL)	In males and queens only, the max distance between the base of the sclerotized wing veins to the distal margin of the wing.
Weber's length (WL)	In lateral view, the distance between the anterior margin of the pronotum to the posterior margin of the metapleural bulla. For this study, Weber's length was measured only in queens because in workers there is a flexible articulation between the pronotum and mesonotum that can introduce error as an artifact of specimen preservation.
Eye length (EL)	In full-face view, the length of the compound eye along the longitudinal axis.
Eye width (EW)	With the eye held in the focal plane facing the viewer, the max transverse width of the compound eye.
Eye size (ES)	EL × EW × 100
Scape index (SI)	SL/HL × 100
Cephalic index (CI)	HW/HL × 100

All measurements taken from worker unless otherwise noted. From Wild (2004).

lected for this research were deposited in the entomology collection at California State University–Fresno unless otherwise stated.

To determine whether concolored and bicolored ants differed in any of the measurements taken (Table 2), a series of two-tailed *t*-tests were conducted in SAS version 9.1 (SAS Institute, Cary, NC) for each of the measurements. Because the samples analyzed were of different size and had different variances, the Satterthwaite correction was applied to the *t*-test.

Results

The bicolored ants were significantly larger than the concolored ants over all measured features (two-tailed tests) (Table 3). When these characters were compared in bivariate plots, the slopes for each morph also seemed visibly different (Figs. 2 and 3). Despite these differences in characters between morphs, it was determined that additional tests were required because the size of ant workers studied was found to be highly correlated with the altitude at which they were collected (Fig. 4).

It could be argued that, due to the superficial morphological similarity exhibited between the bicolored and concolorous ants, that the bicolored ant is simply a larger variant of *T. sessile.* The bicolored ants were collected at altitudes of at least 800 m, whereas the concolored ants were generally collected at much lower altitudes (Fig. 4). Bergmann's rule holds body size increases with latitude or altitude. This size increase may be related to different temperatures experienced at higher latitudes and altitudes (Schreider 1950). This temperature effect, also known as the temperature size rule, has been demonstrated in >40 insect taxa and two species of Formicidae (Blanckenhorn and Demont 2004). The size of ant workers studied seemed highly correlated with the altitude at which they were collected and this correlation in size had to be corrected for (Fig. 4).

Techniques such as principle components analysis (PCA) have often been used to compare patterns of morphological covariation. Analyses of covariation in size and shape are often confounded by the inability to distinguish size effects from shape effects (Somers 1986). Size refers to the magnitude of a given character, whereas shape describes the relationship between two or more characters (Sprent 1972). In a PCA, the first principle component of morphometric data are an approximation of size. This component can be extracted and used to standardize the data set so that shapes are being compared without the confounding influence of size (Somers 1986, Tzeng and Yeh 2002, Shingleton et al. 2009).

I used PCA to remove the component of size from the data sets of the two morphs, and then I compared the allometric vector angles between the two data sets according to the method described by Shingleton et al. (2009). The angle between the two allometric vectors indicates their degree of similarity (Klingenberg 1996). The smaller the angle, the more similar the allometric coefficient and consequently the null hypothesis would be supported. For this analysis, the null hypothesis tested was that the bicolored ants and the concolored ants had the same multivariate allometric vector after correcting for size ($\alpha = 0.05$). After extracting size from the data set, the compared allometric coefficients of the bicolored and concolored ants were significantly different ($P = 0.002$).

Discussion

Based on the multiple comparisons of morphological characters of bicolored and concolored *Tapinoma*

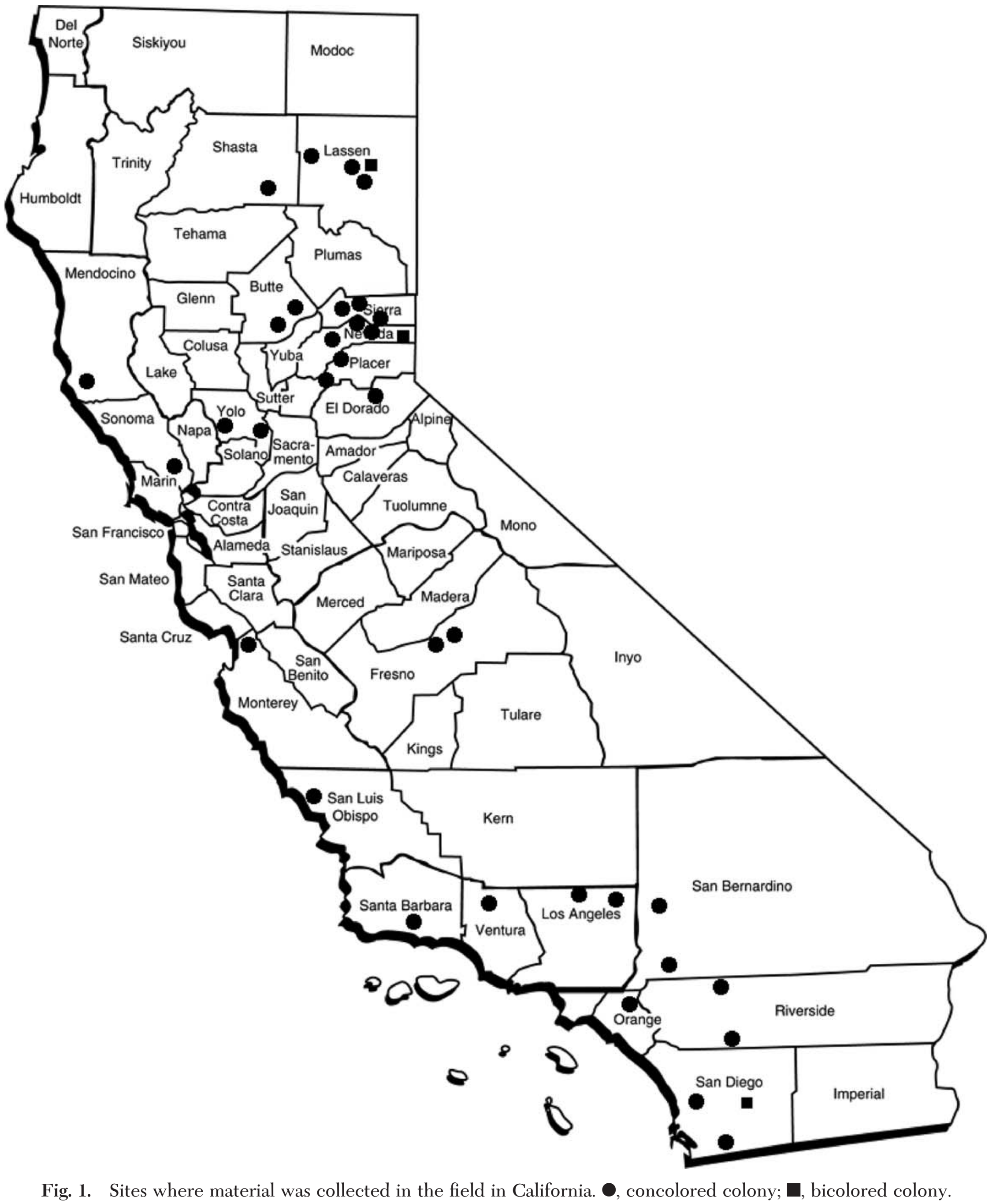


Fig. 1. Sites where material was collected in the field in California. ●, concolored colony; ■, bicolored colony.

specimens, it was concluded that the bicolored ant is a species new to science. Despite extensive surveys, the bicolored ant was only found at Lassen and Sierra counties by me. The bicolored ant was found to be sympatric with concolored *T. sessile*, although never in the same nest. Bicolored workers reacted with aggression to concolored workers, and vice versa, when placed in foraging columns or near the nest entrance (C.A.H., personal observation). This contrasts with a conspicuous lack of aggression toward conspecifics that has been reported for *T. sessile* (Smith 1965).

Other researchers investigating *Tapinoma sessile* have discovered that there are probably multiple species present in the Nearctic region (Clark and Blom 2007; Fisher and Cover 2007; S. P. Cover, unpublished data). Further research on this system is highly warranted and preliminary results from molecular data support the conclusions of the multivariate analysis

Table 3. Comparisons of morphometric measurements and indices for workers of concolored *T. sessile* (*n* = 427) worker ants and bicolored worker ants that seemed similar to *T. sessile* (*n* = 148)

Character[a]	Mean ± SD		*t* value	*P* value
HL (mm)	0.77 ± 0.06	0.68 ± 0.06	−6.46	<0.0001
HW (mm)	0.75 ± 0.07	0.63 ± 0.08	−5.46	<0.0001
SL (mm)	0.77 ± 0.08	0.64 ± 0.07	−7.19	<0.0001
EL (mm)	0.19 ± 0.02	0.17 ± 0.02	−3.96	0.0003
MFC (mm)	0.29 ± 0.03	0.22 ± 0.03	−9.37	<0.0001
EW (mm)	0.15 ± 0.01	0.14 ± 0.02	−3.76	0.0005
FL (mm)	0.69 ± 0.05	0.53 ± 0.09	−10.61	<0.0001
LHL (mm)	0.63 ± 0.05	0.46 ± 0.08	−13.03	<0.0001
PW (mm)	0.54 ± 0.06	0.43 ± 0.05	−6.89	<0.0001
ES	2.75 ± 0.41	2.33 ± 0.47	−4.13	0.0002
SI	99.50 ± 7.02	93 ± 3.58	−4.08	0.0005
CI	95.80 ± 7.29	91.5 ± 4.39	−2.57	0.016

Statistical results are from two-tailed *t*-tests with all probabilities reported using Satterthwaite's correction for unequal variances.
[a] See Table 2 for full character definitions.

conducted here (C.A.H. and P. Crosbie, unpublished data).

In conclusion, the bicolored and concolored forms, both initially treated as *T. sessile*, are actually two species based on classical morphometric and multivariate allometry techniques. An exploratory pairwise comparison of morphometric characters indicated significant differences between morphs. After the confounding variable of size was removed using a PCA, and the slopes of the multivariate allometries were compared, morphometric differences between the morphs were still present and highly significant. The only remaining explanation is that the bicolorous and concolorous ants are distinct species. The bicolored ant is new to science and its formal description follows in this text. Given that the types of *T. sessile* are lost, the following neotype is designated to stabilize the taxonomic identity of *T. sessile* (Say 1836).

Neotype Designation

Tapinoma sessile (Say 1836)

Neotype. Worker, with the following measurements (see Table 2 for full character definitions): HL, 0.68 mm; HW, 0.60 mm; SL, 0.60 mm; EL, 0.18 mm; MFC, 0.18 mm; EW, 0.14 mm; FL, 0.50 mm; LHL, 0.40 mm; PW, 0.42 mm; ES, 2.52 mm; SI, 88.2; and CI, 88.20. The neotype resides in the collection of the Museum of Comparative Zoology (MCZ) at Harvard University and bears the following labels:

USA Posey Co.
New Harmony, IN
21-VI-09, 110 m
38.130° N, 87.935° W
Coll by: C. A. Hamm

Nest in soil next to house
5 m from grave of T. Say

This concolored black specimen does not differ in any significant way from the descriptions of Say (1836) and Shattuck (1992, 1995). This specimen will carry a label designating it as the neotype. Additional material collected from this series has been deposited at the UCDC, MCZ, MSUC, and LACM.

Material Examined. (LACM, UCDC, CSUF, CASC, UCBC, CIDA, MSUC, PSWC). Arizona: Oak Creek Canyon, Coconino County. California: Quincy, Butte County; South Lake Tahoe, El Dorado County; McKenzie Table Mountain Preserve, Miller Preserve at Black Mountain Fresno County; Wyman Canyon, Inyo County; Eagle Lake Field Station, Lassen County; Agoura, Westwood Hills, Tan Bark Flat Los Angeles County; Coarsegold, Madera County; Ukiah, Mendocino County; Sagehen Creek, NV County; Lake Forest, Orange County; Millard Canyon, Riverside County; Temecula Canyon, Riverside County; Woodcrest, Riverside County; Woodside, Riverside County; Big Bear, Arrowhead San Bernardino County; Los Peñasquitos Creek, Sweetwater River San Diego County; San Simeon, San Luis Obispo County; Los Olivos, Santa Barbara County; Redding, Shasta County; Russian River, Sonoma County; Sequoia National Park, Tulare County; Columbia, Tuolumne County; Moss Landing Marine Laboratories, Monterey County; Big Creek Reserve, Monterey County; Ojai, Ventura County; Stebbins Cold Canyon Reserve, Yolo County; Davis, Yolo County. Colorado: Fort Collins, Larimer County; Vail, Eagle County. Illinois: Champaign, Champaign County. Indiana: Cedar Lake, La Grange County; New Harmony, Posey County. Louisiana: Alexandria, Rapids Parish. Nevada: Mt. Wheeler, Verdi, Washoe County; Lehman Caves, White Pine County. New Jersey: Camp Louemma, Sussex County. North Dakota: Montrose Township, Cavalier County; Golden Township, Walsh County; Roosevelt National Memorial Park, Billings County; Grand Forks, Grand Forks County. Michigan: Wakelee Fen, Cass County; MacCready Preserve, Jackson County. Oregon: South Cottage Grove, Lane County. UTAH: Bassets Spring, Uinta County. Montana: Browning, Glacier County. Washington: San Juan Island, San Juan County. Wisconsin: Madison, Dane County.

To further aid in the delimitation of *T. sessile*, the following means (± SD) are provided (*n* = number specimens examined) (see Table 2 for full character definitions).

Worker. (*n* = 427). HL, 0.68 ± 0.06 mm; HW, 0.63 ± 0.08 mm; SL, 0.64 ± 0.07 mm; EL, 0.17 ± 0.02 mm; MFC, 0.22 ± 0.03 mm; EW, 0.14 ± 0.02 mm; FL, 0.53 ± 0.09 mm; LHL, 0.46 ± 0.08 mm; PW, 0.43 ± 0.05 mm; ES, 2.33 ± 0.47 mm; SI, 93 ± 3.58; and CI, 91.5 ± 4.39.

Male. (*n* = 59). HL, 0.71 ± 0.05 mm; HW, 0.73 ± 0.06 mm; SL, 0.69 ± 0.06 mm; EL, 0.29 ± 0.02 mm; MFC, 0.22 ± 0.02 mm; EW, 0.34 ± 0.02 mm; FL, 0.76 ± 0.07 mm; LHL, 0.65 ± 0.06 mm; PW, 0.75 ± 0.07 mm; MML, 1.09 ± 0.10 mm; WGL, 3.35 ± 0.31 mm; ES, 6.98 ± 1.04 mm; SI, 96.4 ± 4.81; and CI, 103 ± 2.62.

Queen. (*n* = 64). HL, 0.80 ± 0.05 mm; HW, 0.85 ± 0.05 mm; SL, 0.73 ± 0.06 mm; EL, 0.26 ± 0.02 mm; MFC, 0.28 ± 0.04 mm; EW, 0.21 ± 0.02 mm; FL, 0.72 ± 0.08 mm; LHL, 0.61 ± 0.08 mm; PW, 0.83 ± 0.06 mm;

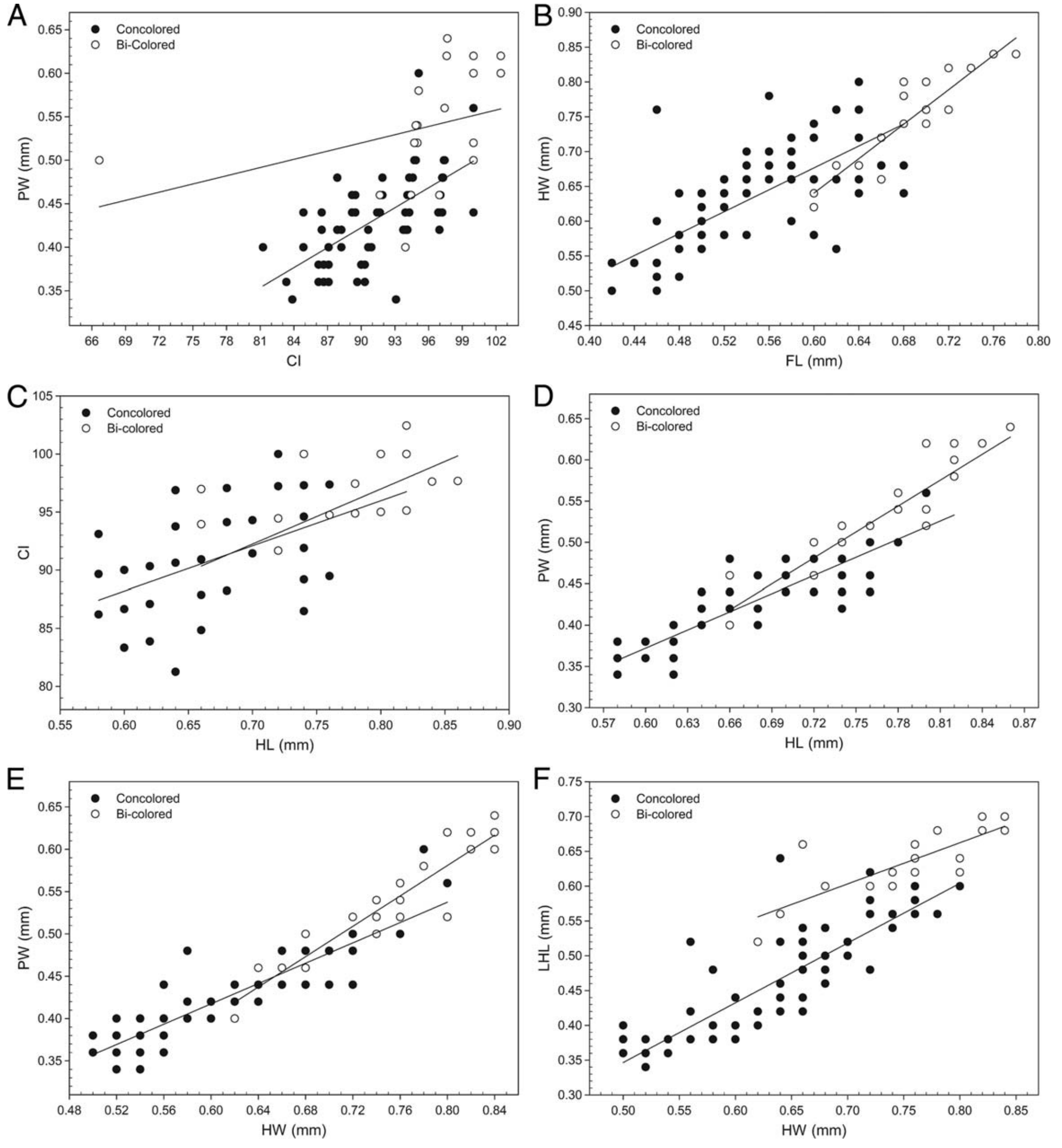


Fig. 2. Bivariate plots of various measurements and indices in workers of concolorous *T. sessile* and the bicolored ants that seemed similar to *T. sessile.*

WL, 1.17 ± 0.09 mm; WGL, 3.52 ± 0.52 mm; ES, 5.54 ± 1.04 mm; SI, 91.8 ± 5.56; CI, 106 ± 3.18.

New Species Description

Tapinoma schreiberi n. sp.

(Figs. 5–8)

Holotype. Worker, with the following measurements: HL, 0.82 mm; HW, 0.84 mm; SL, 0.82 mm; EL, 0.20 mm; MFC, 0.32 mm; EW, 0.16 mm; FL, 0.76 mm; LHL, 0.70 mm; PW, 0.60 mm; ES, 3.2 mm; SI, 100; and CI, 102.44.

Description. (Figs. 5 and 7). Appearance is superficially similar to *T. sessile,* although generally larger. The following mean values (± SD) of measurements were the made from 148 workers: HL, 0.77 ± 0.06 mm; HW, 0.75 ± 0.07 mm; SL, 0.77 ± 0.08 mm; EL, 0.19 ± 0.02 mm; MFC, 0.29 ± 0.03 mm; EW, 0.15 ± 0.01 mm; FL, 0.69 ± 0.05 mm; LHL, 0.63 ± 0.05 mm; PW, 0.54 ± 0.06 mm; ES, 2.75 ± 0.41 mm; SI, 99.50 ± 7.02; and CI, 95.80 ± 7.29. The worker is bicolored with the head and mesosoma rufous in color; the gaster is black to brown, although in older workers this color fades to gray. The head is concave

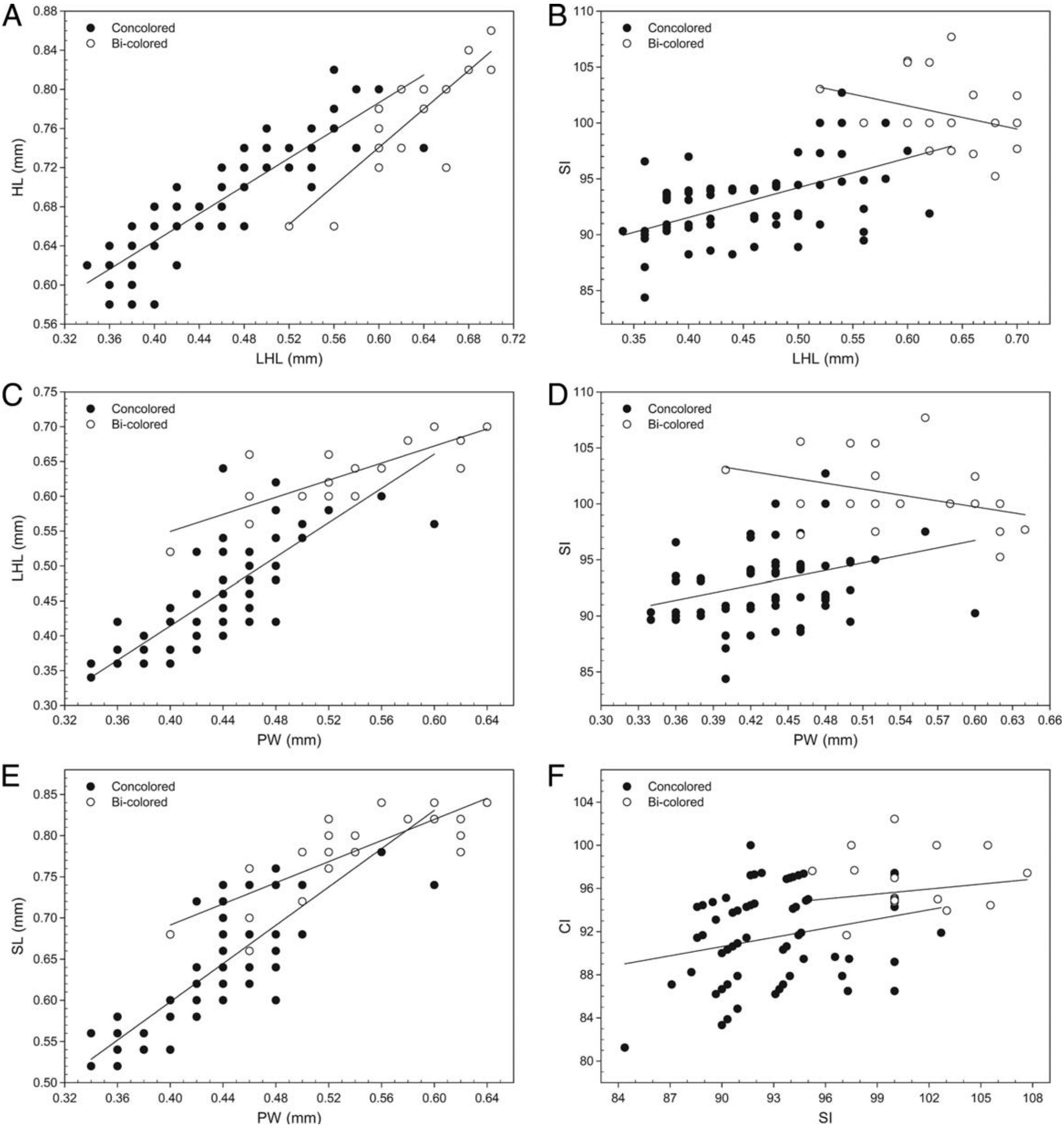


Fig. 3. Bivariate plots of various measurements and indices in workers of concolorous *T. sessile* and the bicolored ants that seemed similar to *T. sessile*.

at the vertex and ocelli are absent. The antennal scape surpasses the vertex by approximately one third its total length; the flagellum possesses 12 segments. The anteroclypeal margin has a shallow concavity that does not surpass the antennal sockets. The mandibles with four teeth and seven denticles with the apical tooth the longest, slightly larger than the subapical tooth, the basal angle is not distinct and the curve between the masticatory and basal margin is smooth and not interrupted. In total, six anterior clypeal setae overhang the mandibles. Erect hairs are absent on the dorsum of the mesosoma though are present on propleuron, coxae and gastral sternites, and posterior tergites.

Material Examined. (LACM, PSWC, CSUF). California: Mt. Laguna, San Diego County (W. S. Creighton); Sagehen Creek, Nevada County (P. S. Ward); Eagle Lake, Lassen County (P. S. Ward). Nevada: Kyle Canyon, Clark County (A. C. Cole, S. Cover).

Holotype. Worker, collected by P. S. Ward and deposited in the MCZ at Harvard University, bearing the following labels:

CA Nevada Co.
Sagehen Creek
39° 26′N, 120° 14′W
1,920 m, 27-VI-1994
PS Ward # 12585

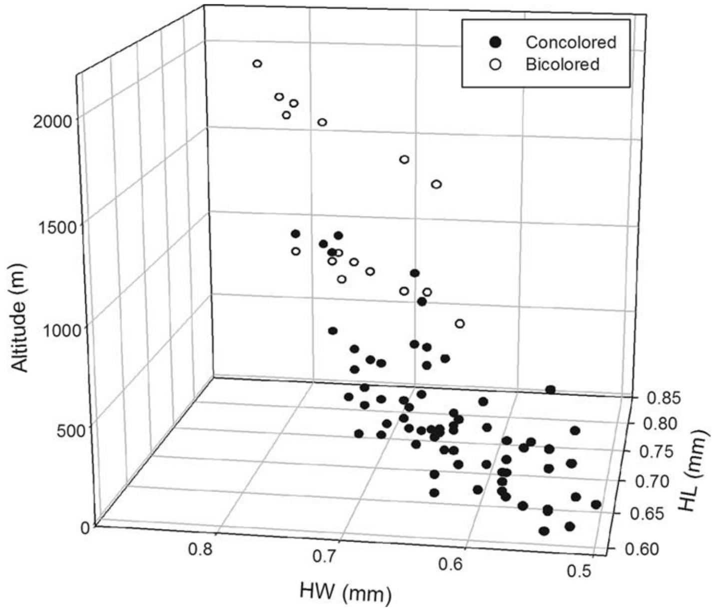


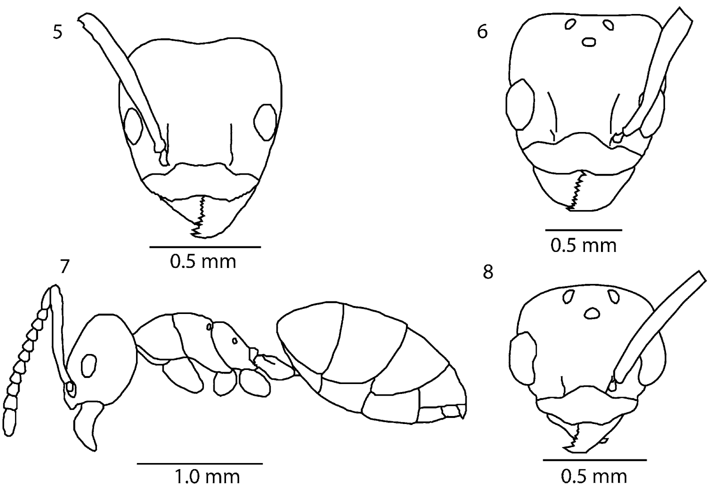
Fig. 4. Multivariate plot of head width × head length × altitude between concolorous *T. sessile* and the bicolored ant that seemed similar to *T. sessile*. Note that all measured characters followed this altitudinal cline and that only one set is presented here.

grd. forager(s)
pine-fir forest

This specimen also will carry a label designating it as the holotype. Additional material from this series of collected workers resides at the UCDC and LACM.

Male. (Fig. 8). The following mean values (± SD) of measurements were the made from two males in the collection of the LACM: HL, 0.68 ± 0.06 mm; HW, 0.68 ± 0.01 mm; SL, 0.73 ± 0.01 mm; EL, 0.26 ± 0.01 mm; MFC, 0.20 ± 0.03 mm; EW, 0.21 ± 0.01 mm; FL, 0.75 ± 0.01 mm; LHL, 0.64 ± 0.01 mm; PW, 0.76 ± 0.01 mm; MML, 1.08 ± 0.03 mm; WGL, 3.1 ± 0.31 mm; ES, 5.46 ± 0.37 mm; SI, 107 ± 2.39; and CI, 100 ± 4.16. The vertex of the head is flat to slightly convex, three ocelli at the vertex. Antennae with 13 segments, the scape surpasses the vertex of the head by one half its length. Apical tooth longest, masticatory margin of mandible with a series of small denticles. The male is concolorous and rufous or piceous brown, and is thus very similar to *T. sessile,* though generally smaller.

Queen. (Fig. 6). The following mean values (± SD) of measurements were the made from four alate queens in the collection of the LACM: HL, 0.93 ± 0.03 mm; HW, 1.03 ± 0.02 mm; SL, 0.87 ± 0.02 mm; EL,



Figs. 5–8. Drawings of *T. schreiberi*, full-face view of worker (5), queen (6), and male (8). Lateral view of *T. schreiberi* worker (7).

0.26 ± 0.01 mm; MFC, 0.41 ± 0.02 mm; EW, 0.2 ± 0.02 mm; FL, 0.84 ± 0.02 mm; LHL, 0.74 ± 0.04 mm; PW, 1.04 ± 0.0.03 mm; WL, 1.23 ± 0.04 mm; WGL, 4.08 ± 0.22 mm; ES, 5.20 ± 0.42 mm; SI, 93.60 ± 1.63; and CI, 110 ± 1.28. The queen is bicolored with the head and mesosoma rufous in color; the gaster is black to brown, although in older workers this color fades to gray. The head is slightly concave at the vertex and three ocelli are present. The antennal scape surpasses the vertex by approximately one third its total length; the flagellum possesses 12 segments. The anteroclypeal margin has a shallow concavity that does not surpass the antennal sockets. The mandibles with seven teeth and seven denticles with the apical and subapical teeth the longest, the basal angle is not distinct and the curve between the masticatory and basal margins is smooth and not interrupted. A total of six anterior clypeal setae overhang the mandibles. Erect hairs are absent on the mesosoma and gaster. The queens of this species seem slightly larger than *T. sessile* queens.

Etymology. The species is named in honor of Dr. Fred Schreiber, a professor for >35 yr at California State University–Fresno and mentor to countless students.

Remarks. This species is superficially similar to *T. sessile,* but this bicolored ant can be distinguished from the latter by its head and mesosoma (which are rufous) and its gaster (which is black). The workers and queens are, on average, larger than *T. sessile,* although males seem smaller and are concolorous. The comparisons in size between the sexual castes of *T. sessile* and *T. schreiberi* are made using very low numbers of individuals; caution should be exercised when using these data. I do not believe that this species is the *T. dimmocki* of Fisher and Cover (2007) because workers of both species are aggressive toward one another and were never found in the same nest.

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