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Source: Southwestern Entomologist, 46(1) : 75-82

Published By: Society of Southwestern Entomologists

URL: https://doi.org/10.3958/059.046.0107

A New Ant Species of the Genus *Pheidole* Westwood, 1839[1] from Miocene Mexican Amber

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Abstract. A fossil species of *Pheidole* Westwood, 1839 (Formicidae, Myrmicinae) was described based on an amber inclusion found in the Miocene strata at Chiapas, southwestern Mexico. It was named *Pheidole pauchil* sp. nov., which is the first described species of the genus in Mexican amber. This broadens our understanding of the diversity of *Pheidole* in the Miocene in the southernmost part of North America.

Resumen. Se describe una especie fósil de *Pheidole* Westwood, 1839 (Formicidae, Myrmicinae) proveniente de una inclusión de ámbar encontrada en el estrato del Mioceno de Chiapas, Sureste de México. El espécimen se nombró *Pheidole pauchil* sp. nov., el cual representa la primera especie del género en ámbar de México. Esto amplía nuestro conocimiento sobre la diversidad de *Pheidole* en la parte más austral de Norteamérica en el Mioceno.

Introduction

The ant genus *Pheidole* (Fomicidae, Myrmicinae), with 1, 047 extant species according to Bolton (2020) and continuously increasing description of new members (Longino 2009, 2019), is widely distributed throughout the world. This hyperdiverse and cosmopolitan taxon is not well represented and has few specimens in the fossil record. The genus *Pheidole* currently is known in the Cenozoic strata of North and Central America. The fossil species *Pheidole tertiaria* Carpenter, 1930, is known from Eocene rocks of Colorado **(**Perkovsky 2016, Casadei-Ferreira et al. 2019). Other fossil species described from Miocene amber of the Dominican Republic include *Pheidole tethepa* Wilson, 1985; *Pheidole primigenia* Baroni Urbani, 1995; and *Pheidole anticua* Casadei-Ferreira, Chaul & Feitosa, 2019. *Pheidole* also was preliminarily recorded in Miocene amber of southern Mexico (Solórzano-Kraemer 2007), but no species were described.

Pheidole cordata Holl, 1829*,* is another specimen described in Eocene Baltic amber, but provenance of the specimen was questioned by Wilson (2003) who suggested *P. cordata* probably was a specimen embedded in copal (recent plant resin) or fake amber. A second specimen known as *Pheidole rasnitsyni* Dubovikoff, 2011 also was originally interpreted as amber inclusion from Eocene Baltic sediments (Dubovikoff 2011), but recently was considered a copal inclusion (Perkovsky 2016,

[1]Formicidae, Myrmicinae

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Cassadei-Ferreira et al. 2019: Table 1, p. 123). We describe a fossil ant from Miocene Mexican amber that best matches the genus *Pheidole* Westwood, 1839. It was erected as *Pheidole pauchil* sp. nov. Diagnosis and illustration are presented.

Amber-bearing beds of Simojovel are widely accepted as part of Mazantic shale and Balumtum sandstone strata dated as early to the middle Miocene (Poinar 1992, Perrilliat et al. 2010, Durán-Ruiz et al. 2013, Riquelme et al. 2013). The botanical source of Chiapas amber is attributed to an extinct legume tree species of the genus *Hymenaea* Linné (sensu Langenheim 1966). Chiapas amber has chemical signatures in common with plant resins of living *Hymenaea courbaril* Linné and *Hymenaea verrucosa* Gaertner that now are distributed in the tropics (Langenheim 2003, Riquelme et al. 2014a). The sedimentary record and associated paleobiota suggest resin-producing trees of *Hymenaea* were distributed in a lowland-fluvial environment close to a coastal plain (Graham 1999, Langenheim 2003, Durán-Ruiz et al. 2013, Riquelme et al. 2014b).

Materials and Methods

The fossil specimen treated in this study is embedded in golden amber with translucent to cloudy glossiness. It comes from the La Pimienta site at the town of Simojovel, Chiapas, southwestern México. It was designated Holotype CPAL.401 and deposited in the Colección de Paleontología, Universidad Autonoma del Estado de Morelos, Mexico (CPAL-UAEM).

Anatomical data were collected using high-resolution microscopy and multiple-image stacking for three-dimensional focus expansion as presented by Riquelme et al. (2014b) (Fig. 1). Schematic drawings were hand traced by electronic pen using a stereomicroscope and photomicrographs, and Corel Draw X7® was used for graphic editing (Fig. 2). Anatomical measurements are in millimeters, which were collected using an Olympus AZ binocular dissecting microscope and a U-OCM10/100 1 mm micrometer with 0.1- mm intervals. To help identify the fossil, the free version of Lucid software v.3.3 was used for the New World *Pheidole* data. Abbreviations and indices follow Longino (2019).

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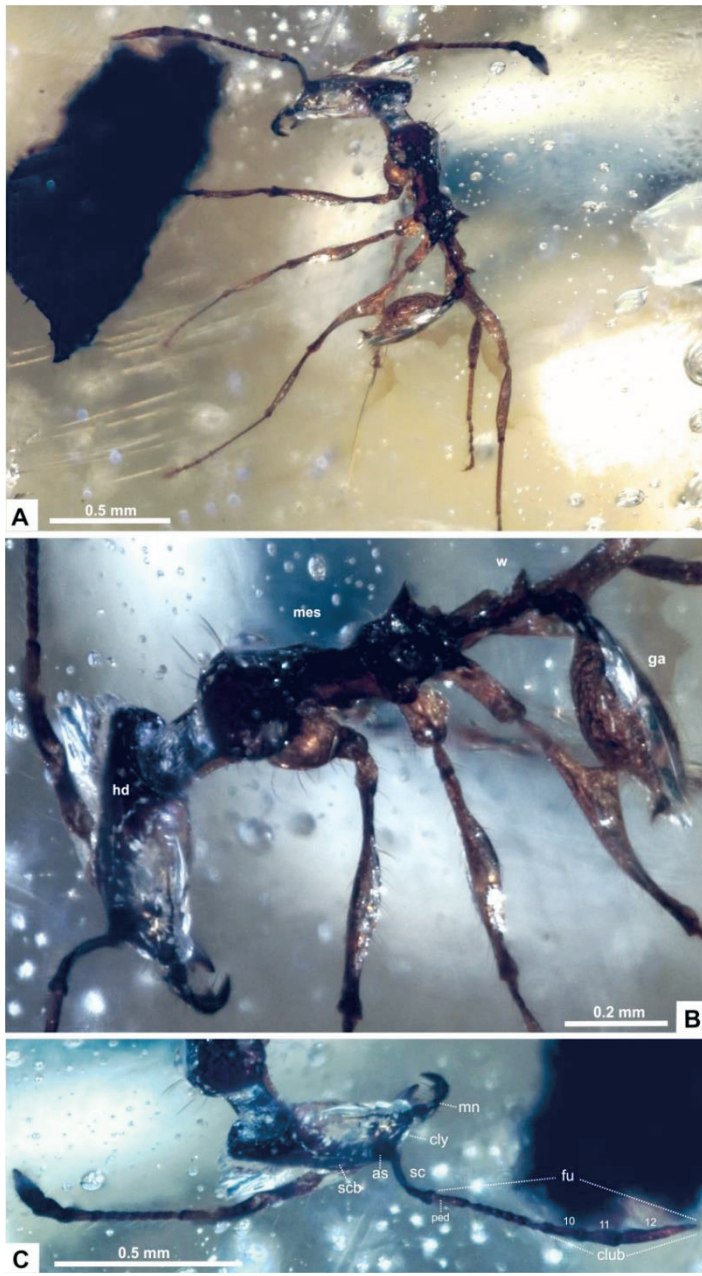

Fig. 1. *Pheidole pauchil* sp. nov. A. Holotype CPAL.401, amber inclusion, worker. B. Lateral view of the head (hd), mesosoma (mes), waist (w), and gaster (ga). C. Closer view of antenna. Abbreviations: (as) antennal socket, (cly) clypeus, (fu) funiculus, (mn) mandible, (ped) pedicel, (sc) scape, (scb) antennal scrobe.

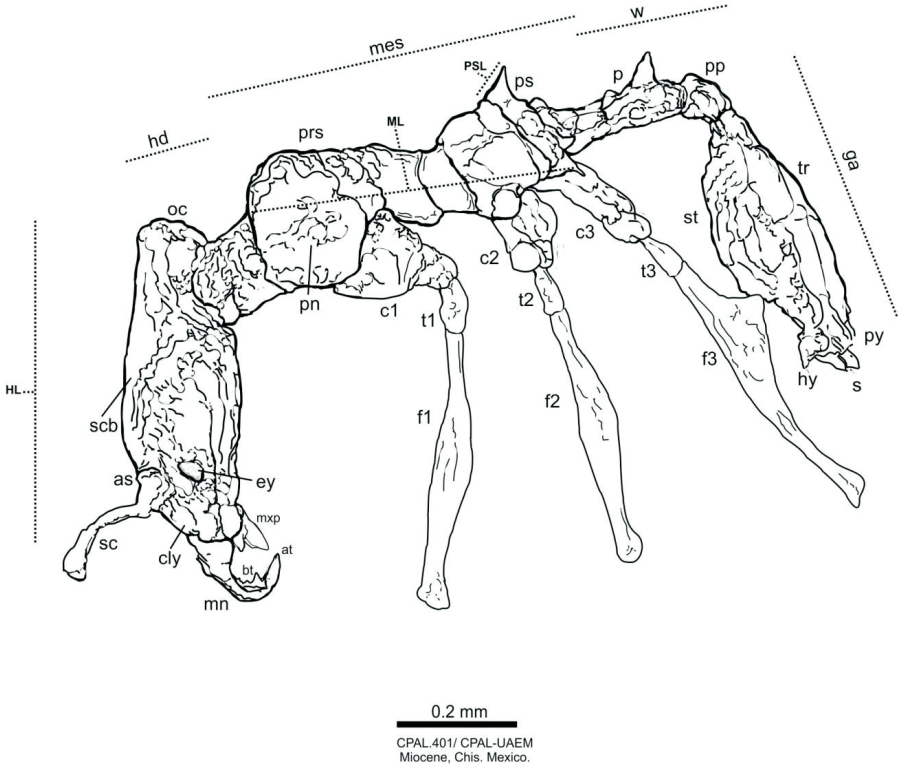

Fig. 2. *Pheidole pauchil* sp. nov. Holotype CPAL.401, line drawing of the head, mesosoma, petiole, and gaster in lateral view, based on photomicrographs and stereomicroscope observations. Abbreviations: (as) antennal socket, (at) apical tooth of mandible, (bt) basal tooth of mandible, (cly) clypeus, (c) coxa, (f) femur, (ga) gaster, (hd) head, (HL) head length, (hy) hypopygium, (mn) mandible, (mes) mesosoma, (ML) mesosoma length, (oc) occipital region, (p) petiole, (pp) post-petiole, (pn) pronotum, (prs) promesonotum, (ps) propodeal spine, (PSL) propodeal spine length, (py) pygidium, (sc) scape, (scb) antennal scrobe, (s) sting, (st) sternites, (t) trochanter, (tr) tergites, (w) waist.

HL: head length; in full-face view, maximum length of head, from line tangent to anterior-most projection of head capsule or clypeus to line tangent to posterior-most projection of vertex margin.
HW: head width; in full-face view, maximum width of head capsule not including eyes, if eyes protrude beyond margins of head, measured above or below eyes, depending on which is widest.
CI: cephalic index: 100*HW/HL.
SL: scape length; length of scape shaft from apex to basal flange, not including basal condyle and neck.
SI: scape index: 100*SL/HW.
ML: mesosoma length; in lateral view, distance from base of anterior face of pronotum, at inflection point between downward-sloping anterior face and flange-like

anteriormost projection of pronotum, to posteriormost extension of metapleural or propodeal lobes.
PSL: propodeal spine length; viewed laterally such that side of spine is roughly perpendicular to viewing angle, distance from inflection point between dorsal face of propodeum and base of spine to tip of spine.
SPLI: propodeal spine index: 100*PSL/HL.

Results

Systematic Paleontology.

Class Insecta Linnaeus, 1758
Order Hymenoptera Linnaeus, 1758
Family Formicidae Latreille, 1809
Subfamily Myrmicinae Lepeletier de Saint-Fargeau, 1835
Genus *Pheidole* Westwood, 1839
Pheidole pauchil sp. nov. Varela-Hernández & Riquelme. Type species by original designation.
ZooBank LSID: urn:lsid:zoobank.org:author:656B353A-952C-447A-A26D-0455E742C0AA

Diagnosis. With traits of the genus *Pheidole* and the following combination of diagnostic characters: tiny ant, 42 mm total length from head to posterior end of the abdomen. HL and HW equal in size, scape proportionally long. Antennal club 3-segmented, first funicular segment as long as the next three. Propodeal spines long and triangular, broad at the bases and pointed at the apex. Hind femur with a conspicuous lateral flange at about one third the distance to the apical end. Readily distinguished from *P. anticua* by the presence of long scapes, surpassing posterior end of the head; petiolar node sharp at the apex, with anterior and posterior sides meeting in an acute angle; extensor surface of posterior femur flattened and forming an acute angle approximately one third the distance to the apical end, while *P. anticua* has scapes short, not surpassing posterior end of the head; dorsal margin of the node meeting in a more or less sub-squared form; extensor surface of posterior femur not flattened and forming an acute angle.

Type Material. Holotype CPAL.401, amber inclusion, worker, and only specimen known (Fig. 1). Housed in the Colección de Paleontología, Universidad Autónoma del Estado de Morelos, Mexico (CPAL-UAEM).

Locality. La Pimienta site: 17°09´11´´N, 92°46´08´´W, Simojovel, Chiapas, México.

Horizon. Mazantic shale and Balumtum sandstone strata, Miocene, ca. 23 Ma (Poinar 1992, Perrilliat et al. 2010, Durán-Ruiz et al. 2013, Riquelme et al. 2013).

Etymology. The epithet "*pauchil*" means "*amber*" in the Tzeltal language, a modern version of Mayan language currently spoken at Simojovel, Chiapas, Mexico.

Description. Holotype CPAL.401, major worker; tiny sized ant, body length 42 mm, general measurements (mm): HL 0.35; HW 0.35, SL 0.4, CI 100; SI 114.28; ML 0.6, PSL 0.075; PSLI 21.42.

Head: in full face view, with lateral margins parallel; head compressed dorsoventrally, numerous erect hairs on dorsum of the head. Mandibles notably curved inward, two conspicuous apical and subapical teeth and four intercalary teeth in the masticatory margin. Hypostomal teeth not visible. Antenna 12-segmented, club 3-segmented. Club longer than rest of funiculus. Scapes long, surpassing vertex of head, abundant erect hairs all along the scape. First funicular segment very long, as much as the next three segments. Funiculus with numerous suberect hairs.

Mesosoma: in dorsal view, promesonotum with a well-developed neck, slightly longer than wide; pronotum longer than wide, wider anteriorly, lateral margins in dorsal view parallel from anterior side to half the length of pronotum, then stretching gradually and meeting posteriorly; long erect hairs on dorsum of pronotum. Mesonotum about as long as wide, triangular in dorsal view. Metanotum slender in dorsal view, depressed laterally between mesonotum and propodeum; mesonotal groove deep. Propodeum in lateral view, with long spine projections, sharp at the posterior edge, very wide at their base giving the impression of a well-defined triangle. Hind legs greatly expanded at the extensor surface of the femur about one third the distance to the apical end, forming a more or less right angle at the point of intersection of the sides that form the angle.

Petiole and Gaster: in profile view, petiolar peduncle long and slender; dorsal margin meeting anterior side of the node in a defined angle. Petiolar node in profile sharp, with anterior and posterior sides converging gradually at the apex of the node. In dorsal view, node markedly narrow, much broader than long. Gaster tergites, in profile view, relatively flattened with long fine erect hairs.

Remarks. Holotype CPAL.401 shows diagnostic characters that include the antennal club 3-segmented, which is not exclusive to all members of the genus, some species show antennal club 4-segmented or 5-segmented, but at least antennal club must be 3-segmented; propodeal spines also are present in CPAL.401, spines are variable in form and size in *Pheidole* but at least tiny denticles in the propodeum must be present. However, CPAL.401 is distinct from other congeners in having different specific proportions of the head, such as HL, HW, and SL, which are uncommon among the group. In extant species of *Pheidole*, the length of the head is typically longer than wide, whereas in CPAL.401, HL and HW are the same size, and the scape is also proportionally longer. Additionally, the size and shape of the head in CPAL.401 resembles a major worker.

Discussion

Pheidole is a successful group in evolutionary terms, with most taxa correlated to different biomes (Wilson 2003, Economo et al. 2015). Molecular phylogenetic analysis by Moreau (2008) suggests *Pheidole* emerged about 58.4-61.2 Ma. However, the oldest record of an undisputed fossil of *Pheidole* is *P. tertiaria* that dates from the late Eocene of North America, ca. 34 Ma (Carpenter 1930, Wilson 2003). However, a stem age of 59.8 Ma and crown age of 37.3 Ma were suggested for *Pheidole* (Economo et al. 2015). This radiation estimated in the Paleogene is consistent with the occurrence of *P. tertiaria.* New World origin and tropical distribution of *Pheidole* was discussed in Wilson (2003). Accordingly, the genus *Pheidole* was able to diversify widely in the Miocene tropics of North America, extending to the south of the continent, in response to intrinsic adaptability to a great range of environmental conditions, which is consistent with the occurrence of *Pheidole pauchil* sp. nov. in Miocene strata of southern Mexico, with an estimated age of 23 million years.

Acknowledgment

We thank Susana Guzmán at the IB-UNAM for assistance with photomicrography and Derek Hennen at Virginia Tech for English editing. We also thank Antonio Hernández-Romero for the first drawing sketches. We thank the

Academic editor and anonymous reviewers whose feedback has improved the final published version.

References Cited

Bolton, B. 2020. An online catalog of the ants of the world https://antcat.org. Accessed on 06.05.2020.

Carpenter, F. M. 1930. The fossil ants of North America. Bulletin of the Museum of Comparative Zoology 70: 1-66.

Casadei-Ferreira, A. J., C. M. Chaul, and R. M. Feitosa. 2019. A new species of *Pheidole* (Formicidae, Myrmicinae) from Dominican amber with a review of the fossil records for the genus. ZooKeys 866: 117-125.

Dubovikoff, D. A. 2011. The first record of the genus *Pheidole* Westwood, 1839 (Hymenoptera: Formicidae) from the Baltic amber. Russian Entomological Journal 20: 255-257.

Durán-Ruíz, C., F. Riquelme, M. Coutiño-José, G. Carbot-Chanona, G. Castaño-Meneses, and M. Ramos-Arias. 2013. Ants from the Miocene Totolapa amber (Chiapas, Mexico), with the first record of the genus *Forelius* (Hymenoptera: Formicidae). Canadian Journal of Earth Sciences 50: 495-502.

Economo, E. P., P. Klimov, E. M. Sarnat, B. Guénard, M. D. Weiser, B. Lecroq, and L. L. Knowles. 2015. Global phylogenetic structure of the hyperdiverse ant genus *Pheidole* reveals the repeated evolution of macroecological patterns. Proceedings of the Royal Society B 282: 20141416.

Graham, A. 1999. Studies in Neotropical Paleobotany. XIII. An OligoMiocene palynoflora from Simojovel (Chiapas, Mexico). American Journal of Botany 86: 17-31.

Langenheim, J. H. 1966. Botanical source of amber from Chiapas, Mexico. Ciencia 24: 201-211.

Langenheim, J. H. 2003. Plant Resins: Chemistry, Evolution, Ecology and Ethnobotany. Timber Press, Oregon.

Longino, J. T. 2009. Additions to the taxonomy of New World *Pheidole* (Hymenoptera: Formicidae). Zootaxa 2181: 1-90.

Longino, J. T. 2019. *Pheidole* (Hymenoptera: Formicidae) of Middle American wet forest. Zootaxa 4599: 1-126.

Moreau, C. S. 2008. Unraveling the evolutionary history of the hyperdiverse ant genus *Pheidole* (Hymenoptera: Formicidae). Molecular Phylogenetics and Evolution 48: 224-239.

Perkovsky, E. E. 2016. Tropical and Holarctic ants in Late Eocene ambers. Vestnik Zoologii 50: 111-122.

Perrilliat, M. C., F. J. Vega, and M. A. Coutiño. 2010. Miocene mollusks from the Simojovel area in Chiapas, Southwestern Mexico. Journal of South American Earth Sciences 30: 111-119.

Poinar, G. O. 1992. Life in Amber. Stanford University Press, CA.

Riquelme, F., J. Alvarado-Ortega, M. Ramos-Arias, M. Hernández, I. Le Dez, T. A. Lee-Whiting, and J. L. Ruvalcaba-Sil. 2013. A fossil stemmiulid millipede (Diplopoda: Stemmiulida) from the Miocene amber of Simojovel, Chiapas, México. Historical Biology 26: 415-427.

Riquelme, F., P. Northrup, J. L. Ruvalcaba-Sil, V. Stojanoff, D. P. Siddons, and J. Alvarado-Ortega. 2014a. Insights into molecular chemistry of Chiapas amber

using infrared-light microscopy, PIXE/RBS, and sulfur K-edge XANES spectroscopy. Applied Physics A 116: 97-109.
Riquelme, F., M. Hernández-Patricio, A. Martínez-Dávalos, M. Rodríguez-Villafuerte, M. Montejo-Cruz, J. Alvarado-Ortega, J. L. Ruvalcaba-Sil and L. Zúñiga-Mijangos. 2014b. Two flat-backed polydesmidan illipedes from the Miocene Chiapas-amber Lagerstätte, Mexico. PLoS ONE 9: e105877.
Solórzano-Kraemer, M. M. 2007. Systematic, palaeontology and palaeobiogeography of the insect fauna from Mexican amber. Palaeontographica, Albteilung A 282: 1-133.
Wilson, E. O. 2003. *Pheidole* in the New World. A Dominant, Hyperdiverse Ant Genus. Harvard University Press, Cambridge, MA.