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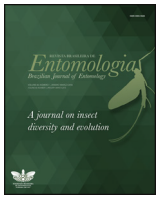

Ants of Ecuador: new species records for a megadiverse country in South America

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ABSTRACT

Despite its small territory Ecuador hosts a remarkable biological diversity. Paradoxically, its prominent insect richness has been poorly studied and is usually underestimated in biodiversity inventories. Ants are a major component of such richness. With the aim of promoting myrmecological research, we present 20 new ant records for the country belonging to nine genera and six subfamilies. The species *Tapinoma ramulorum inrectum* Forel is recorded for the first time in South America. We provide brief taxonomic diagnoses and general comments for all species. Our results expand on the records of Formicidae species previously informed for Ecuador and stress the importance of scientific reference collections as biodiversity repositories.

Introduction

Arguably, Ecuador is one of the most megadiverse countries in the world. In its small territory (256 370 Km^2) converges a tremendous amount of species diversity, only comparable to that of few other tropical regions in the planet. Located in the northwest coast of South America, on the equinoctial line, this country has many ecosystems spread across a complex topography where three of the global hotspots of biological diversity converge, namely the Tropical Andes, the Chocó Biogeographic Region, and the Galápagos Islands (Myers et al., 2000; Ridgely and Greenfield, 2001; Ministerio del Ambiente del Ecuador, 2013).

The comparatively high species diversity of Ecuador is perhaps explained by the array of Ecological and biogeographical units identified across its territory which encompass eight biogeographic divisions (Sierra, 1999; Ridgely and Greenfield, 2001; Freile and Santander, 2005), 10 biomes (Bioweb, 2020), and 91 ecosystems (Ministerio del Ambiente del Ecuador, 2013). Within this complex topographic matrix mostly filled by heterogeneous Andean and Amazonian habitats, which have boosted the diversification of a number of organisms (Hughes and Eastwood, 2006 Ribas et al., 2007; De-Silva et al., 2016), approximately 19 000 species of plants and 3 500 species of terrestrial vertebrates have been recorded (Bioweb, 2020). In regards to the terrestrial arthropod fauna, particularly insects, the information is less well-structured. Current knowledge on insect species richness is biased to few, though highly diverse groups, for example, Lepidoptera (diurnal butterflies) (Dangles et al., 2009), Diptera (horse flies, flower flies, mosquitoes) (Cárdenas et al., 2009, Marín-Armijos et al., 2017, Ponce et al., 2021) and Coleoptera (ground beetles, click beetles, dung beetles) (Dangles et al., 2009, Aguirre-Tapiero and Johnson, 2014, Chamorro et al., 2018, 2019). Unveiling species richness of another mega diverse insect order, as for example, the Hymenoptera, will require the efforts of many generations of zoologists.

Among the Hymenoptera, ants stand out as one of the most conspicuous and abundant groups in preserved forests as well as in agricultural and urban ecosystems (Wolters et al., 2006; Santos, 2016). Despite its dominance and ecological importance, historically the ant fauna of most Neotropical countries, including Ecuador, has been poorly studied (Fernández and Sendoya, 2004; Bezděčková et al., 2015). In the most recent literature review about ant species from Ecuador, Salazar et al. (2015) informed a total of 679 species, belonging to 92 genera. Since that publication we have discovered a number of novel species records in three of the most representative ant collections

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of the country. For each new species record we provide a concise morphological diagnosis, and for most species we show brief notes about their biology, ecology and distribution.

Materials and methods

The specimens identified by the authors via direct examination are deposited in the natural history collections of the below institutions:

MECN – Museo Ecuatoriano de Ciencias Naturales, Instituto Nacional de Biodiversidad, Quito, Ecuador.

MEPN – Museo de Historia Natural, "Gustavo Orcés V.", Escuela Politécnica Nacional, Quito, Ecuador.

QCAZ – Museo de Zoología, Pontificia Universidad Católica del Ecuador, Quito, Ecuador.

We used the following taxonomic treatments for species determination: Fernández & Guerrero (2019) for Ponerinae, Mackay & Mackay (2019) and W. Mackay (unpublished *Camponotus* revision) for *Camponotus* Mayr; Ortiz and Fernández (2011) for *Dolichoderus* Lund, Palacio (2019) for *Nomamyrmex* Borgmeier, Johnson (2015) for *Pogonomyrmex* Mayr, De Andrade & Baroni Urbani (1999) and Oliveira et al. (2021) for *Cephalotes* Latreille, and Ward (2019) for *Pseudomyrmex* Lund.

We compared the remaining non identified material, *i.e.* those which did not key out using the treatments above, to already identified specimens in the following ant collections: Coleção do Laboratório de Mirmecologia, Centro de Pesquisas do Cacau (CPDC), Instituto Alexander von Humboldt (IAvH), Museu de Zoologia da Universidade de São Paulo (MZSP), United States National Museum of Natural History (USNM), and the Ecuadorian repositories of the present material, listed above. We also supported our identifications on AntWeb (www.antweb.org) images of type material, when available. R. J. Guerrero (Universidad del Magdalena, Colombia) assisted with species confirmation of the Dolichoderinae. L. Souza-Barros and A. Troya, who are revising *Simopelta* Mann and *Neoponera* Emery, respectively, confirmed the species records for those genera. *Pseudomyrmex* species, except *P. penetrator*, were identified by University of California, Davis.

In order to verify the new record status of our determined material, we consulted two main sources: the checklist of Salazar et al. (2015), and the Global Ant Biodiversity Informatics – GABI - database (Guénard et al., 2017) visualized through Antmaps (Janicki et al., 2016) (referred further in text as "antmaps").

Collection information, e.g., site, coordinates, collector, associated with each specimen was directly digitized either from the accompanying labels and/or field catalogues. Geographic coordinates were verified with Google Maps and with The World Coordinate Converter (TWCC, 2020). We georeferenced sites for specimens with no available coordinates. We used SimpleMappr (Shorthouse, 2010) and Microsoft Power Point v. 2112 for making the distribution maps.

Geographic and collection information of our examined material is shown on each species treatment. The reader can also find the full record set, containing this information and additional collection details, including museum catalogue numbers (*aka.* unique specimen identifiers), in csv format (Supplementary Data 1 [online only]).

Images of the specimens were generated using a digital camera Nikon D 7500, adapted with a Leitz 3.2X lens. Final images were stacked in Helicon Focus v. 7.5.6 (Helicon Soft Ltd.) and posteriorly edited in Adobe Photoshop CS5®.

The following author abbreviations "APP" for Alex Pazmiño-Palomino and "AT" for Adrian Troya are used, where applicable, in the comments section of some species. The following symbols are used to refer to ant castes in the species accounts: ☿ = worker/soldier; ♀= queen.

Results

We identified 20 new ant species records for continental Ecuador, which are deposited in the three Ecuadorian natural history collections mentioned before (see also Supplementary Data 1 [online only]). The total number of new records is distributed in six subfamilies and nine genera: Myrmicinae (7 species), Formicinae (5), Ponerinae (3), Pseudomyrmecinae (2), Dolichoderinae (2), Dorylinae (1) (Table 1).

Table 1
Summary of new ant records in continental Ecuador. Provinces: ES=Esmeraldas, GU=Guayas, EO=El Oro, PI=Pichincha, LO=Loja, SU=Sucumbíos, NA=Napo, OR=Orellana, PA=Pastaza, ZC=Zamora Chinchipe. Abbreviations: G&B=Gotwald & Brown; M&M=Mackay & Mackay; O&F=Ortiz & Fernández.

Subfamily	No.	Species	Province
Dolichoderinae	1	*Dolichoderus utriensis* O&F	ES
	2	*Tapinoma ramolorum inrectum* Forel	PI
Dorylinae	3	*Nomamyrmex hartigii* (Westwood)	GU
Formicinae	4	*Camponotus banghaasi* Emery	OR
	5	*Camponotus heathi* Mann	OR
	6	*Camponotus rufipes* (Fabricius)	OR
	7	*Camponotus santschii* Forel	GU
	8	*Camponotus traili* Mayr	OR
Myrmicinae	9	*Cephalotes dentidorsum* De Andrade	SU
	10	*Cephalotes grandinosus* (Smith)	NA, OR
	11	*Cephalotes serraticeps* (Smith)	OR
	12	*Cephalotes simillimus* (Kempf)	NA, OR
	13	*Cephalotes solidus* (Kempf)	SU, NA, OR
	14	*Cephalotes trichophorus* De Andrade	OR
	15	*Pogonomyrmex naegelii* Emery	ZC
Ponerinae	16	*Neoponera antecurvata* (M&M)	OR
	17	*Neoponera moesta* (Mayr)	ES, OR, PA
	18	*Simopelta laticeps* G&B	EO
Pseudomyrmecinae	19	*Pseudomyrmex penetrator* (Smith)	OR
	20	*Pseudomyrmex peruvianus* (Wheeler)	NA

Species accounts

Dolichoderinae

***Dolichoderus utriensis* Ortiz & Fernández, 2011**

Figs. 1, 21A

Material examined. Ecuador. Esmeraldas: Reserva Ecológica Cotacachi Cayapas, 4 Km S Gualpi, Onzole river, 0.76111°N, 79.1542°W, 50m, 3☿, 2001-04-01, Araujo, P. et al., fogging, (MEPN).

Comments. This species can be separated from its congenerics by the carinated propodeal lateral margins bearing a weak spine from which four erect hairs emerge. The morphology of the specimen we examined matches the diagnostic characters of the original description. However, as expected for a representative from another population separated from that of the Colombian collection site by almost 600 Km, our specimen displays certain morphological variations in reference to the illustration of Ortiz and Fernández (2011): absence of a lobe on the anterodorsal margin of the pronotum, mesonotum not bulging, and yellow hairs on the body dorsum. In Ecuador this species was collected by canopy fogging in the Chocó Biogeographic region. Nothing is known about its natural history except that it is likely arboreal. *Dolichoderus utriensis* was previously known by a single specimen from the Chocó Department of Colombia (Ortiz and Fernández, 2011).

***Tapinoma ramulorum inrectum* Forel, 1908**

Figa. 2, 21A

Material examined. Ecuador. Pichincha: Bosque Protector Mashpi, 0.1666°N, 78.8869°W, 895m, 50☿, 1♀, 2020-01-03, Pazmiño, A., hand collected, (MECN).

Comments. This species shows very long antennal scapes, about one third of their length extends beyond the posterior head margin; in frontal view, margin of vertex evenly rounded, not medially emarginate. *T. ramulorum inrectum* nests in small carton structures beneath leaves. It is the only species of the genus that uses a living resource for nesting (Guerrero, unpublished data). In the Mashpi cloud forest reserve APP observed colonies on the underside of leaves of *Palicourea* sp. (Rubiaceae) and *Heliconia* sp. (Heliconiaceae) on tourist trails, but also on human-made, metallic-based constructions. Mashpi lies in a complex of foothill forests in northwestern Ecuador, where the Chocoan and Andean biota converge. This population is more than 900 Km away from the southernmost record known so far. The status of this taxon will possibly change to species in the coming future, as is the case with other subspecies within the genus (Escárraga et al., 2021; Guerrero, personal communication). *Tapinoma ramulorum inrectum* was previously known only in Central America (Janicki et al., 2016).

Dorylinae

***Nomamyrmex hartigii* (Westwood, 1842)**

Figs. 3, 21A

Material examined. Ecuador. Guayas: Bosque Protector Cerro Blanco, 2.14153°S, 80.0862°W, 260m, 1☿, 2016-11-16, Pazmiño, A., Winkler, (MEPN).

Comments. This species differs from its morphologically closest species, *N. esenbeckii* Westwood, by the absence of the postoccipital sulcus and the posterior face of the petiolar node without longitudinal rugae (Palacio, 2019). *Nomamyrmex hartigii* is a rarely collected species. In the Cerro Blanco reserve, a seasonal dry forest within the city of Guayaquil, APP found a single individual in a leaf litter sample. This species is widely distributed in Central and South America (Janicki et al., 2016).

Figure 1 *Dolichoderus utriensis* Ortiz & Fernández (worker, MEPN 4890): A) profile, B) frontal view, C) dorsal view. Images by Vladimir Carvajal. Scale bars = 1 mm.

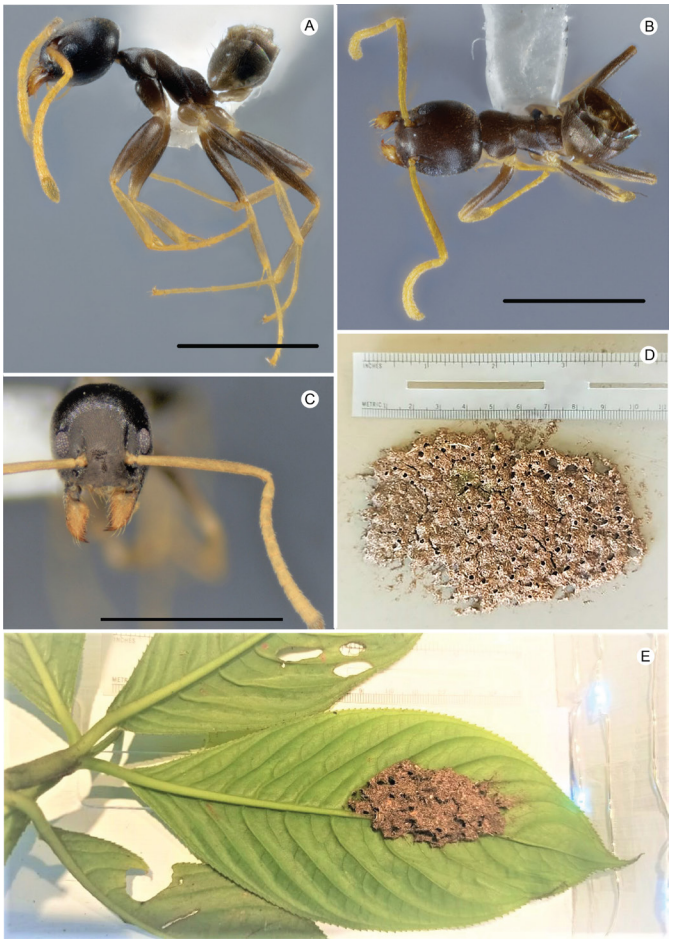

Figure 2 *Tapinoma ramulorum inrectum* Forel (worker, MECN-EN-HYM 4601): A) profile, B) dorsal view, C) frontal view, D) nest on a metallic structure, E) nest on leaves of Rubiaceae. Images by Alex Pazmiño. Scale bars = 1 mm.

Figure 3 *Nomamyrmex hartigii* (Westwood) (worker, MEPN 40184): A) profile, B) frontal view, C) dorsal view. Images by Vladimir Carvajal. Scale bars = 1 mm.

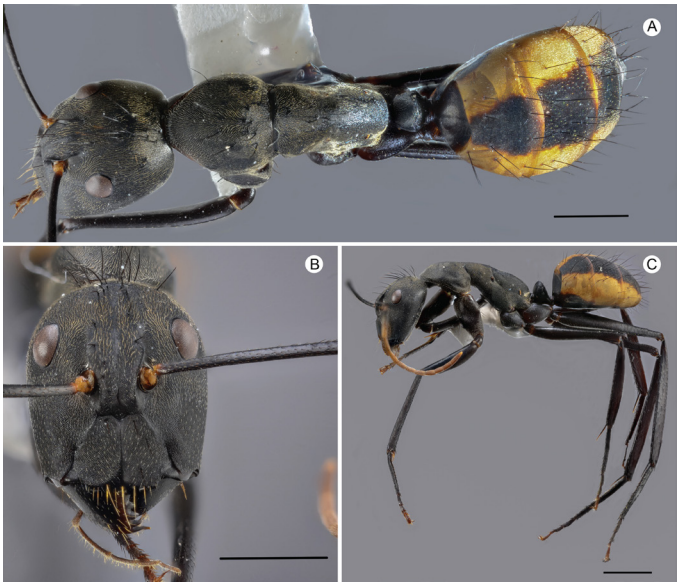

Figure 4 *Camponotus banghaasi* Emery (worker, MEPN 34287): A) dorsal view, B) frontal view, C) lateral view. Images by Vladimir Carvajal. Scale bars = 1 mm.

Figure 5 *Camponotus heathi* Mann (worker, MEPN 34258): A) profile, B) frontal view, C) dorsal view. Images by Vladimir Carvajal and Alex Pazmiño. Scale bars= 1 mm.

Formicinae

***Camponotus (Myrmoplatypus) banghaasi* Emery, 1903**

Figs. 4, 21A

Material examined. Ecuador. Orellana: Parque Nacional Yasuní, 32 Km SSE Limoncocha, Km 39 Pompeya sur, 0.65713°S, 76.453°W. 216m, 2☿, 1994-01-22. Erwin, T. et al., fogging, (MEPN); same information, except: 7☿, 1995-02-08, (MEPN).

Comments. The main distinguishing feature of this species is a whitish-yellow area partially covering the gaster, leaving a black subtriangular, longitudinal band dorsally; majors and minor workers lack erect hairs on the antennal scapes; pronotum lacking spines; hind tibiae strongly flattened (as in for example, *C. sericeiventris* Guérin-Méneville) with anterior concave surface. Although *C. banghaasi* is an uncommonly collected species, possibly because of its arboreal habits and presumably small colonies as compared to other *Camponotus* species, it may be easily noticed due to its large size (ca. 10-12 mm) in understorey Amazonian rainforest trails. It was previously reported only from Peru (Mackay, 2004).

***Camponotus (Myrmobrachys) heathi* Mann, 1916**

Figs. 5, 21B

Material examined. Ecuador. Orellana: Parque Nacional Yasuní, 32 Km SSE Limoncocha, Km 39 Pompeya sur, 1.29444°S, 76.0608°W, 216m, 2☿, 1995-10-07, Erwin, T. et al., fogging, (MEPN); Parque Nacional Yasuní, -1.2944, -76.0608, 216m, 1☿, 2014-02-01, Troya, A., (MEPN).

Comments. This uncommonly collected species is easily recognizable from other Neotropical *Camponotus* since it bears two ubiquitous propodeal spines: the first located anteriorly just next to the vestigial metanotal suture, and the other, usually bifurcated apically, located at the dorsal propodeal slope. The petiolar node shows three horizontally equidistant spines, smaller than those on the propodeum. Virtually nothing is known on the biology of *C. heathi*, except that it is arboreal. P.S. Ward collected one specimen in a fallen *Hymenaea* (Fabaceae) tree in Santa Cruz, Bolivia (AntWeb, 2021). The presently examined specimens were collected through canopy fogging in Amazonian lowland rain forests. Wheeler (1923) reported a specimen from an unidentified termite nest in the Brazilian Amazonia. The undescribed *Camponotus* JTL055 (INB0003605921) (AntWeb, 2021) from Heredia, Costa Rica, may be potentially close to *C. heathi*. It was previously known from Colombia, Guyana, Peru, Bolivia, and Brazil (Amazonas, Rondônia, Mato Grosso), (Mackay and Mackay, 2019; AntWeb, 2021).

***Camponotus (Myrmothrix) rufipes* (Fabricius, 1775)**

Figs. 6, 21B

Material examined. Ecuador. Orellana: Parque Nacional Yasuní, 32 Km SSE Limoncocha, Km 39 Pompeya sur, 0.65713°S, 76.453°W, 216m, 5☿, 1995-02-08, Erwin, T. et al., fogging, (MEPN); same information, except: 1☿, 1994-01-22, (MEPN).

Comments. This species is easily recognizable due to its blackish body with brown or orange legs making a strong contrast; abundant erect hairs on the antennal scapes and tibiae; antennal scapes flattened near the base; anterior margin of clypeus concave and angled laterally. *C. rufipes* is widely distributed in South America (Mackay and Mackay, 2019). Colonies make their nests in rotten wood or under tree bark. Oliveira et al., (2015) found colonies of *C. rufipes* nesting in *Cecropia* trees, while Fagundes et al., (2010) found nests in bamboo in Brazil. The workers can be very aggressive and may be found foraging inside the vegetation (litter leaf) or on ground trails. It may inhabit in anthropized areas, as for example, cities and crops, but also in natural grasslands, shrubby areas, and tropical rain forests (Mackay and Mackay, 2019).

***Camponotus (Myrmobrachys) santschii* Forel, 1899**

Figs. 7, 21B

Material examined. Ecuador. Guayas: Guayaquil, Bosque Protector Cerro Blanco, 2.17268°S, 80.0221°W, 160m, 1☿, 2016-11-16, Pazmiño, A., pitfall (MEPN); same information, except: 1☿, 2017-04-21, hand collected, (MEPN).

Comments. The workers of this species are distinguished from other similar taxa by showing a pair of spines on the propodeum and a long medial spine on the petiole; the propodeum is convex anteriorly and concave posteriorly; the metanotal groove is strongly depressed. The biology and behavior of *C. santschii* is unknown. The examined specimens were collected through pitfall traps and by hand in a seasonal dry forest in western Ecuador. It was formerly known from Central America and northern Colombia (Magdalena) (Mackay and Mackay, 2019). This is the southernmost record of this species in the continent.

***Camponotus (Dendromyrmex) traili* Mayr, 1878**

Figs. 8, 21B

Material examined. Ecuador. Orellana: Loreto, 0.733333°S, 77.5167°W, 870m, 1☿, 1991-08-08, Ward, P. S. (MECN); Parque Nacional Yasuní, 32 Km SSE Limoncocha, Km 39 Pompeya sur, 0.65713°S, 76.453°W, 216m, 2☿, 1994-01-22, Erwin, T. et al., fogging, (MEPN); same information, except: 3☿, 1994-10-06, (MEPN).

Comments. Within the subgenus *Dendromyrmex* this species is distinguished by having a sculpted pronotum with transverse, wrinkled striae dorsally, and similar striae arranged vertically on its side; antennal scapes with abundant hairs; dorsum of gaster mostly smooth and shiny (Mackay, 2004). We examined specimens from canopy fogging and hand-collected samples from lowland Amazonian forests. Antmaps shows a record of *C. traili* for Ecuador, without reference though, only a non-traceable collection number is indicated. *Camponotus traili* was previously known from the Amazon region of Colombia, Venezuela, Bolivia, and Brazil, (Janicki et al., 2016).

Myrmicinae

***Cephalotes dentidorsum* De Andrade, 1999**

Figs. 9, 21C

Material examined. Ecuador. Sucumbíos: Puchuchoa ravine forest, 0.08094°N, 77.27877°W, 411 m, 3☿, 2003-01-23, Araujo, P. & Enríquez, S., fogging, (MEPN).

Figure 6 *Camponotus rufipes* (Fabricius) (worker, MEPN 34036): A) profile, B) frontal view, C) dorsal view. Images by Vladimir Carvajal. Scale bars= 1 mm.

Figure 7 *Camponotus santschii* Forel (worker, MEPN 40194): A) profile, B) frontal view, C) dorsal view. Images by Vladimir Carvajal. Scale bars = 1 mm.

Comments. This rare species is phylogenetically placed in the *C. angustus* clade *sensu* De Andrade and Baroni Urbani (1999) and confirmed in Oliveira et al. (2021). Workers of *C. dentidorsum* are highly similar to those of the also rare *C. adolphi* Emery. They differ only in the sculpture of the first gastral segment being opaque and with slight punctae in *C. adolphi*, and smooth and shining in *C. dentidorsum*. Based on their morphological features these two species should be very closely related, which is confirmed through analysis of COI gene sequences (< 2% interspecific divergence) (Troya & Donoso, unpublished data). Nothing is known about the biology of *C. dentidorsum*, which has only been previously recorded in western Amazonia (Peru), while *C. adolphi* has been recorded in Brazil (Mato Grosso, Minas Gerais and Distrito Federal) (De Andrade & Baroni Urbani, 1999; Oliveira et al., 2021).

Figure 8 *Camponotus traili* Mayr (worker, MEPN 34297): A) profile, B) frontal view, C) dorsal view. Images: A, C, Vladimir Carvajal; B, Alex Pazmiño. Scale bars= 1 mm.

Figure 9 *Cephalotes dentidorsum* De Andrade (worker, MEPN 28208): A) dorsal view, B) frontal view, C) profile. Images by Adrian Troya. Scale bars = 1 mm.

***Cephalotes grandinosus* (Smith, 1860)**

Figs. 10, 21C

Material examined. Ecuador. Napo: Carlos Julio Arosemena Tola, 1.165046°S, 77.855307°W, 490 m, 2☿, 2003-12, Wild, A., (QCAZ); Orellana: Parque Nacional YasunÍ, 0.66667°S, 76.3833°W, 120 m, 1☿, 1996-12, Baus, E., (QCAZ).

Comments. This species is placed in the *C. grandinosus* clade in the De Andrade and Baroni Urbani (1999) phylogeny and confirmed in Oliveira et al. (2021). *Cephalotes grandinosus* is morphologically very similar to *C. persimilis* De Andrade and *C. persimplex* De Andrade but differs from them in showing strongly impressed foveae mainly on the head dorsum; also, the propodeal lamellae of *C. grandinosus* are less broadened than in those species. Homoplasies are prevalent in *Cephalotes*, and in this specific case the degree of character conservatism is evident with *C. persimilis* and *C. persimplex* diverging from *C. grandinosus* (of Miocene origin) approximately during the late Paleocene (Price et al, 2014). This species is broadly distributed in the Americas, inhabiting tropical deciduous and rain forests from Central America, mainly at the Pacific side, to northwestern South American tropical flooded savannas, Amazonian tropical lowland forests, and deciduous and xeric shrublands and savannas of the Brazilian Caatinga and Cerrado. *Cephalotes grandinosus* was previously reported in Costa Rica, Panama, Colombia, Trinidad & Tobago, Venezuela, Guyana, French Guiana, Bolivia, and Brazil (Amazonas, Bahia, Ceará, Espírito Santo, Goiás, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Paraná, Rondônia, São Paulo, Sergipe, Tocantins) (De Andrade and Baroni Urbani, 1999; Oliveira et al. 2021).

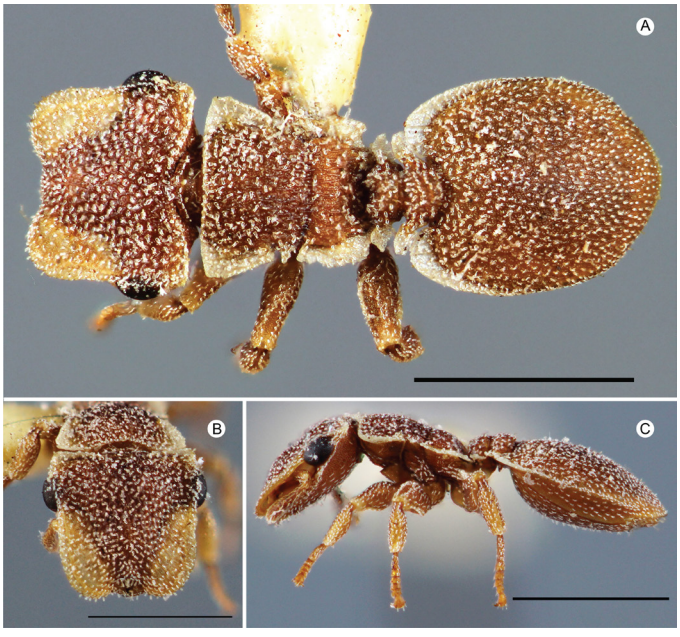

Figure 10 *Cephalotes grandinosus* (Smith) (worker, QCAZ 56564): A) dorsal view, B) frontal view, C) profile. Images by Adrian Troya. Scale bars = 1 mm.

***Cephalotes serraticeps* (Smith, 1858)**

Figs. 11, 21C

Material examined. Ecuador. Orellana: Parque Nacional Yasuní, 27 Km SSE Limoncocha, 0.625226°S, 76.4967°W, 207m, 7☿, 2008-05-21, Troya, A., fogging, (MEPN).

Comments. This species is a member of the *C. atratus* clade, *sensu* De Andrade & Baroni Urbani (1999), and confirmed in Oliveira et al. (2021), and is characterized mainly by the bispinose cephalic corners; presence of dorsal stout spines both on the pronotum and propodeum; usually entirely jet-black body lacking scales and dense pubescence; and flattened meso- and metabasitarsi which are distally narrowed. Although the soldiers and queens of *C. serraticeps* are easily separated from those in its sister species *C. alfaroi* Emery by the strongly crenulate frontal lobes (absent in *C. alfaroi*), the workers of both species are not so easily distinguished. A longitudinal, well-impressed, dorsal pronotal carina present only in workers of *C. serraticeps*, can be of aid. Virtually nothing is known about the natural history of this species. The workers from Ecuador were collected through canopy fogging in a temporarily flooded Amazonian forest in the beginning of the rainy season. Previous records of this species include regions of the Colombian Amazonia and Orinoquia (Sandoval-Gómez and Sánchez-Restrepo, 2019), and Amazonian lowland forests in southern Peru and Brazil (Acre, Amapá, Amazonas, Maranhão, Rondônia, Pará) (De Andrade and Baroni Urbani, 1999; Oliveira et al. 2021). A soldier (CASENT0922509) collected by P. Ward at Corcovado National Park, Costa Rica, has been recently uploaded to AntWeb (AntWeb, 2021).

***Cephalotes simillimus* (Kempf, 1951)**

Figs. 12, 21C

Material examined. Ecuador. Napo: Jatun Sacha Biological Reserve, 1.06667°S, 77.6167°W, 450m, 1☿, 2008-12-05, Troya, A. & Vizuete, J., fogging (MEPN); Orellana: Parque Nacional Yasuní, 27 Km SSE Limoncocha, 0.625226°S, 76.4967°W, 207m, 2☿, 2007-10-21, Troya, A., fogging (MEPN); same information, except: 1☿, 2007-06-15, Troya, A., (MEPN); Parque Nacional Yasuní, 28 Km SSE Limoncocha, 0.62389°S, 76.4806°W, 209m, 1☿, 2008-05-18, Troya, A., fogging (MEPN); Parque Nacional Yasuní, 58 km SEE Limoncocha, 0.631944°S, 76.1442°W, 250m, 1☿, 1☿ (soldier), 2002-07-21, Erwin, T. et al., fogging (MEPN).

Comments. This is a member of the *C. pusillus* group *sensu* Oliveira et al. (2021). *Cephalotes simillimus* is highly similar to its sister species *C. minutus* Fabricius, however, the latter shows more laterally salient and defined pronotal teeth (more like denticle- and lamella-shaped in *C. simillimus*); also, the posterior propodeal spines in *C. minutus* usually do not expand ventrally in a lamella (these spines do expand into a lamella in all our *C. simillimus*). This species has been recorded only in South America, showing more records in lowland rain forests of central and southern Amazonia, though reaching also forest remnants in the Brazilian Atlantic Forest (De Andrade and Baroni Urbani, 1999), and xeric shrublands of the Cerrado in Brazil (Oliveira et al. 2021). Virtually nothing is known about the biology of *C. simillimus* except that it may nest in dead twigs and live branches (C. Moreau in AntWeb, 2021). Current examined specimens were all collected through canopy fogging, mostly in primary Amazonian rain forests. *Cephalotes simillimus* has been previously recorded in Colombia, Guyana, French Guiana, Bolivia, Peru, and Brazil (Acre, Amazonas, Bahia, Mato Grosso, Minas Gerais, Goiás, Rondônia, Roraima, Pará, Sergipe) (De Andrade and Baroni Urbani, 1999; Sandoval-Gómez and Sánchez-Restrepo, 2019; Oliveira et al. 2021).

***Cephalotes solidus* (Kempf, 1974)**

Figs. 13, 21D

Material examined. Ecuador. Napo: Jatun Sacha Biological Reserve, 1.06667°S, 77.6167°W, 450m, 1☿, 2008-12-03, Troya, A. & Vizuete, J., fogging (MEPN); same information, except: 3☿, 2008-12-04, (MEPN); Orellana: Parque Nacional Yasuní, 27 Km SSE Limoncocha, 0.625226°S, 76.4967°W, 207m, 1☿, 2008-05-19, Troya, A., fogging (MEPN); Parque Nacional Yasuní, 38 km SE Limoncocha, 0.66667°S, 76.3833°W, 120m, 1☿, 2005-07-05, Argoti, A., fogging (MEPN); Sucumbíos: Nuevo Sucumbíos, 0.229222°S, 77.3263°W, 655m, 1☿, 2005-12-27, Troya, A., fogging (MEPN).

Comments. The morphological features of *C. solidus* are unique in the genus, thus reflecting its "isolated" position in the *Cephalotes* phylogeny *sensu* De Andrade and Baroni Urbani (1999) where it is

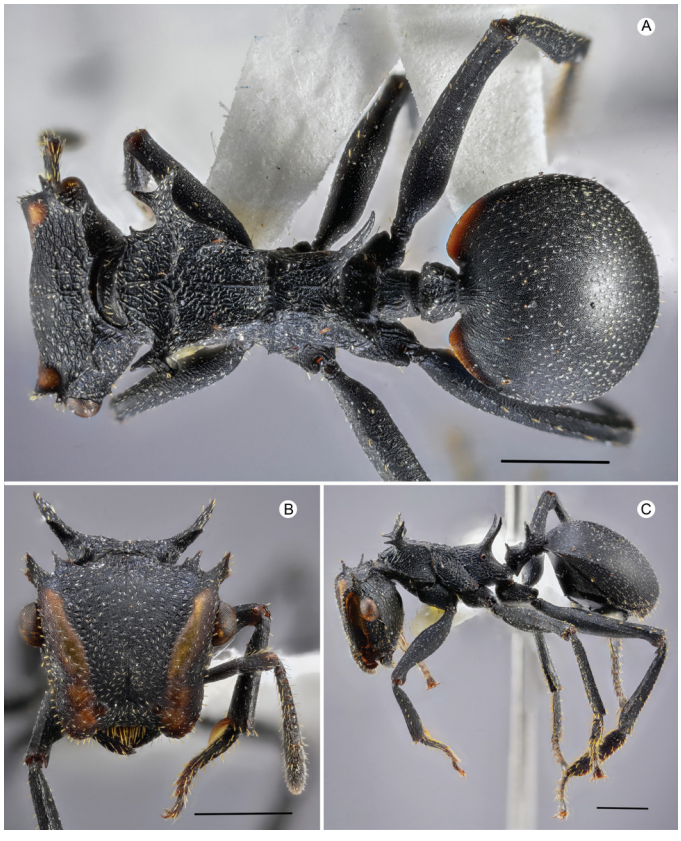

Figure 11 *Cephalotes serraticeps* (Smith) (worker, MEPN 28224): A) dorsal view, B) frontal view, C) profile. Images by Vladimir Carvajal. Scale bars = 1 mm.

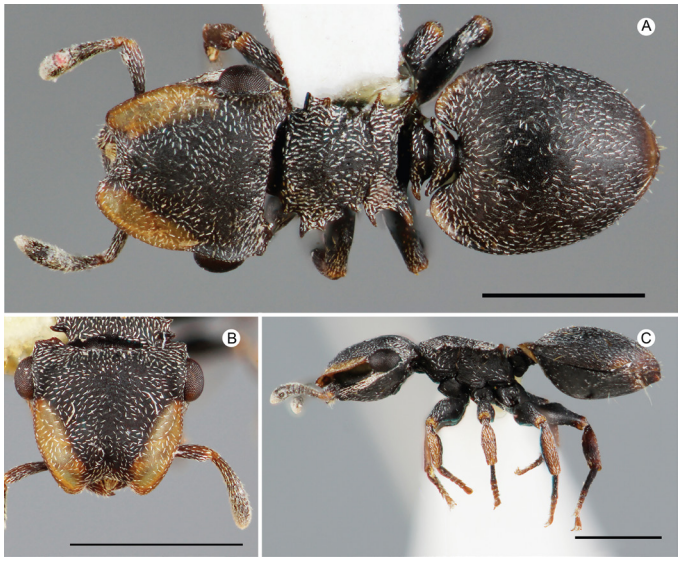

Figure 12 *Cephalotes simillimus* (Kempf) (worker, MEPN 4740): A) dorsal view, B) frontal view, C) profile. Images by Adrian Troya. Scale bars = 1 mm.

the sole member of its homonym clade. *Cephalotes solidus* is easily distinguished from other *Cephalotes* mainly by the almost complete absence of spinescence and lamellae on the head and mesosoma. The humeral dorsum is the only exception which shows a slightly developed, acute denticle; the petiolar and postpetiolar nodes are usually devoid of spines as well. According to Kempf's (1974) description, the petiolar node shows [a pair] of "prominent, stout denticle" (p. 74). No information is known about the natural history of this morphologically singular species. The specimens examined in our study were collected through canopy fogging in well-preserved, lowland Amazonian rain forests, so we assume it is arboreal. This species was previously recorded only in Brazil (Acre, Amazonas) (Janicki et al., 2016; Oliveira et al. 2021).

***Cephalotes trichophorus* De Andrade, 1999**

Figs. 14, 21D

Material examined. Ecuador. Orellana: Parque Nacional Yasuní, 38 km SE Limoncocha, 0.66667°S, 76.3833°W, 120m, 2☿, 2005-07-05, Argoti, A., fogging (MEPN).

Comments. This scantly collected species is placed in the diverse *coffeae* clade *sensu* De Andrade and Baroni Urbani (1999) and confirmed in Oliveira et al. (2021). Most of its members are extinct. Workers of *C. trichophorus* are morphologically very similar to those of *C. setulifer* Emery. The easiest way to distinguish the workers of *C. trichophorus* from *C. setulifer* is through the lateral pronotal margins: forming slight, non-spiny lamellae in *C. trichophorus*, while *C. setulifer* bears two pairs of small, feebly developed denticles anteriorly. According to the phylogeny of De Andrade and Baroni Urbani (1999), *C. trichophorus* is sister to *C. coffeae* Kempf (morphological analysis), while in Price et al. (2014) *C. trichophorus* is sometimes placed as sister to *C. setulifer* (molecular analysis), and more usually as sister to *C. peruviensis* De Andrade (combined morphology and molecular data) which is another related species in this clade. Although Price et al. (2014) did not include *C. coffeae* in their analyses is clear that morphology alone is relatively limited for clarifying relationships in these taxa which show certain degree of morphological plasticity. Nothing is known about the biology of *C. trichophorus* except that it has been collected in Amazonian rainforests of Brazil (Acre) using arboreal pitfall traps (Oliveira et al., 2021). Currently examined specimens were collected through fogging in a well-preserved Amazonian rain forest. This species was previously reported only in Peru and Brazil (Acre, Amazonas) (Andrade and Baroni Urbani, 1999; Oliveira et al., 2021).

***Pogonomyrmex naegelii* Emery, 1878**

Figs. 15, 21D

Material examined. Ecuador. Zamora Chinchipe: Road to Zumba-La Balsa, Pucapamba, 4.9771°S, 79.1155°W, 680m, 1☿, 2017-08-10, Pazmiño, A., hand collected, (MEPN).

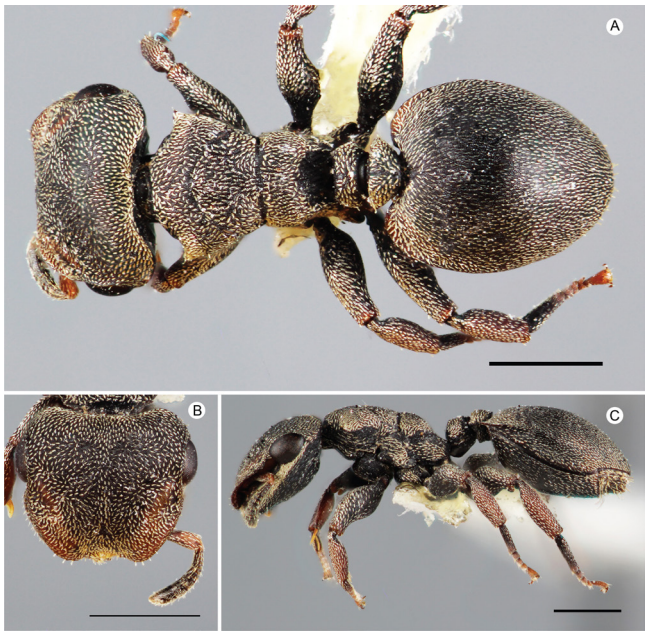

Figure 13 *Cephalotes solidus* (Kempf) (worker, MEPN 28447): A) dorsal view, B) frontal view, C) profile. Images by Adrian Troya. Scale bars = 1 mm.

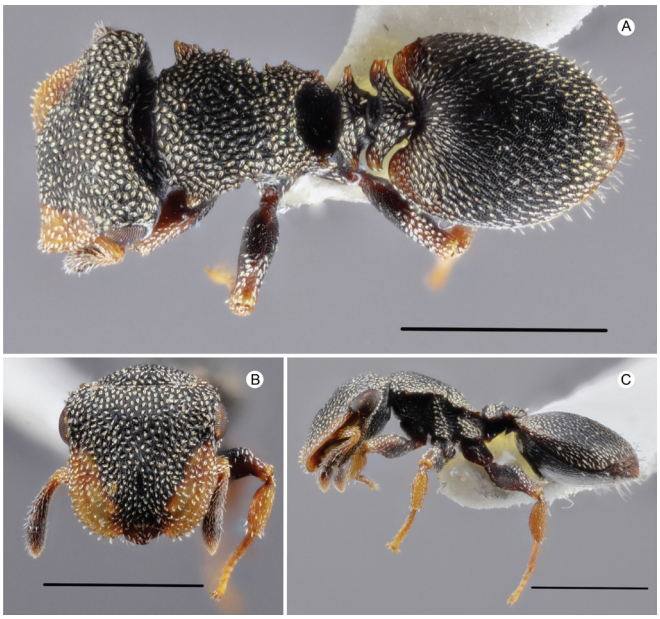

Figure 14 *Cephalotes trichophorus* De Andrade (worker, MEPN 28351): A) dorsal view, B) frontal view, C) profile. Images by Vladimir Carvajal. Scale bars = 1 mm.

Figure 15 *Pogonomyrmex naegelii* Emery (worker, MEPN 40046): A) profile, B) frontal view, C) dorsal view. Images by Vladimir Carvajal. Scale bars = 1 mm.

Comments. This species has been assigned to the *P. naegelii* group sensu Johnson (2015) and among some of the morphological traits characterizing this taxon, we may cite the following for the worker caste (based on said author, in part): frontal lobes bearing between 8-10 strong rugae; concavity on anterior clypeal margin feebly to well-developed, and usually lacking well-developed acute lobes, in frontal view; peduncle of petiole and anterior region of petiolar node meeting at an obtuse angle, in lateral view. This is the most commonly collected taxon in the genus and is distributed only in South America from northern Venezuela to central-northern Argentina and can be found in a variety of biomes and ecosystems but appears to be absent from deserts and high elevation zones (Johnson, 2015). APP collected a single specimen in a xerophytic disturbed area close to the southeastern border between Ecuador and Peru.

Ponerinae

***Neoponera antecurvata* (Mackay & Mackay, 2010)**

Figs. 16, 21E

Material examined. Ecuador. Orellana: Parque Nacional Yasuní, 27 Km SSE Limoncocha, 0.62583°S, 76.4953°W, 207m, 1☿, 2008-05-21, Troya, A., fogging (MEPN); Parque Nacional Yasuní, 28 Km SSE Limoncocha, 0.608279°S, 76.4567°W, 186m, 1☿, 2008-05-24, Troya, A., fogging (MEPN); Parque Nacional Yasuní, 32 Km SSE Limoncocha, Km 39 Pompeya sur, 0.65713°S, 76.453°W, 216m, 1♀, 1995-02-12, Erwin, T. et al., fogging (MEPN).

Comments. This uncommonly collected species belongs to the *N. crenata* group *sensu* Mackay and Mackay (2010). This species is very similar to *N. unidentata* Mayr and *N. donosoi* Mackay & Mackay, but mainly differs from them in the form of the petiolar node in profile, with its posterior face slightly domed (evenly convex in both *N. unidentata* and *N. donosoi*); in addition, *N. antecurvata* usually bears few (ca. four) coarse horizontal striae ventrally on the subpetiolar process (clearly more and less coarse in *N. unidentata*, and few feeble striations in *N. donosoi*). *Neoponera antecurvata* is likely arboreal and apparently prefers well-preserved habitats (see also Longino, 2002). Current records were collected with canopy fogging in mature Amazonian lowland wet forests. This species has been previously recorded in Guatemala, Honduras, Panama, Costa Rica, Peru, and Brazil (Amazonas) (Mackay and Mackay, 2010).

***Neoponera moesta* (Mayr, 1870)**

Figs. 17, 21E

Material examined. Ecuador. Esmeraldas: Reserva Ecológica Cotacachi Cayapas, 0.69611°N, 78.9108°W, 37m, 1♀, 2☿, 2001-04-01, Araujo, P. et al., fogging (MEPN); same information, except: 0.845264°N, 78.7447°W, 120m, 1♀, 2☿, (MEPN); Orellana: Parque Nacional Yasuní, 32 Km SSE Limoncocha, Km 39 Pompeya sur, 0.65713°S, 76.453°W, 216m, 3♀, 5☿, 1995-02-08, Erwin, T. et al., fogging (MEPN); same information, except: 4☿, 1995-02-11, (MEPN); 3☿, 1995-02-10, (MEPN); Pastaza: Parque Nacional Yasuní, 151 Km SE Limoncocha, 1.61°S, 75.9692°W, 172m, 1☿, 2014-01-13, Chasiliquín, N. & Villacrés, E., Winkler, (MEPN).

Comments. According to Mackay and Mackay (2010) this species belongs to the *N. crenata* group. This is a hard-to-identify species due to its strong morphological resemblance to its closest lineages *N. crenata* Roger and *N. globularia* Mackay & Mackay. Even the types (images available on AntWeb) require further revision. The workers and queens of *N. moesta* mainly differ from those of *N. crenata* in the distance from the anterior margin of eye to the anterolateral head corner (at the mandibular articulation) which is greater than half eye maximum length (shorter in *N. crenata*). *Neoponera moesta* is distinguishable from *N. globularia* mainly by its petiolar node, which is sub-triangular dorsally, while that of *N. globularia* is mostly rounded dorsally. This arboreal species is fairly common in well preserved to semi-disturbed habitats of lowland and pre-mountainous wet habitats of Amazonia and the Brazilian Atlantic Forest, though it has been collected also in deciduous habitats of Central America. Despite being relatively common in field samples virtually nothing is known about its natural history, but see Mackay and Mackay (2010), and Longino (2002). This species is widely distributed throughout Central and South America (Mackay & Mackay 2010).

Figure 16 *Neoponera antecurvata* (MacKay & MacKay) (worker, MEPN5053): A) profile, B) frontal view, C) dorsal view. Images by Adrian Troya. Scale bars = 1 mm.

Figure 17 *Neoponera moesta* (Mayr) (worker, MEPN 34660): A) profile, B) frontal view, C) dorsal view. Images by Adrian Troya. Scale bars = 1 mm.

***Simopelta laticeps* Gotwald & Brown, 1967**

Figs. 18, 21E

Material examined. Ecuador. El Oro: Santa Rosa, Birón Alto, 3.564°S, 79.774°W, 1472m, 8☿, 21-Nov-2018, Pazmiño, A. & Suárez-Torres, A., hand collected, (MECN).

Comments. This species can be distinguished by its posterior head margin being clearly concave medially; eyes present; mandible with four similarly sized teeth; and external mid tibial surface without thick and short hairs (Fernández and Guerrero, 2019). This species is rarely collected, and nothing is known about its biology (L. Souza-Barros, pers. comm., Dec-2021). APP found some workers in a foothill forest off the pacific coast in southern Ecuador. *Simopelta laticeps* was previously reported for Colombia, Peru, and French Guiana (Guénard et al., 2017).

Pseudomyrmecinae

***Pseudomyrmex penetrator* (Smith, 1877)**

Figs. 19, 21F

Material examined. Ecuador. Orellana: Parque Nacional Yasuní, 32 Km SSE Limoncocha, Km 39 Pompeya sur, 0.65713°S, 76.453°W, 216m, 1☿, 1994-01-23, Erwin, T. et al., fogging, (MEPN), same information, except: 1☿, 1994-01-12, (MEPN).

Comments. This species is very similar to *P. concolor* Smith, differing primarily in overall body color; gaster, and usually mesosoma, petiole and postpetiole, dark brown; head brown or orange-brown; antennae, tarsi and tibiae lighter yellow-brown; petiole relatively lower, with a smaller subpetiolar process; and postpetiole relatively broader (Ward, 1999). *Pseudomyrmex penetrator* is mutually associated with *Tachigali* spp. (Fabaceae), and exclusively depends on its food sources (Ward, 1999). It is widely distributed in the east-central Amazon basin and the adjacent Guyanas.

***Pseudomyrmex peruvianus* (Wheeler, 1925)**

Figs. 20, 21F

Material examined. Ecuador. Napo: Tena, Jatun Sacha Biological Reserve, 1.06667°S, 77.6167°W, 400m, 1☿, 1991-08-04, Ward, P. S., (MECN).

Comments. This species can be distinguished from its congeners by its yellowish-brown or orange-brown head and pronotum, which contrast with a dark-brown rest of the body; middorsal margin of petiolar node slightly shifted anteriorly, in lateral view; metanotal groove conspicuously incised. *Pseudomyrmex peruvianus* may nest in dead twigs. It has been previously collected in Colombia, Peru, French Guiana and Brazil (Acre, Mato Grosso) (Ward, 2019).

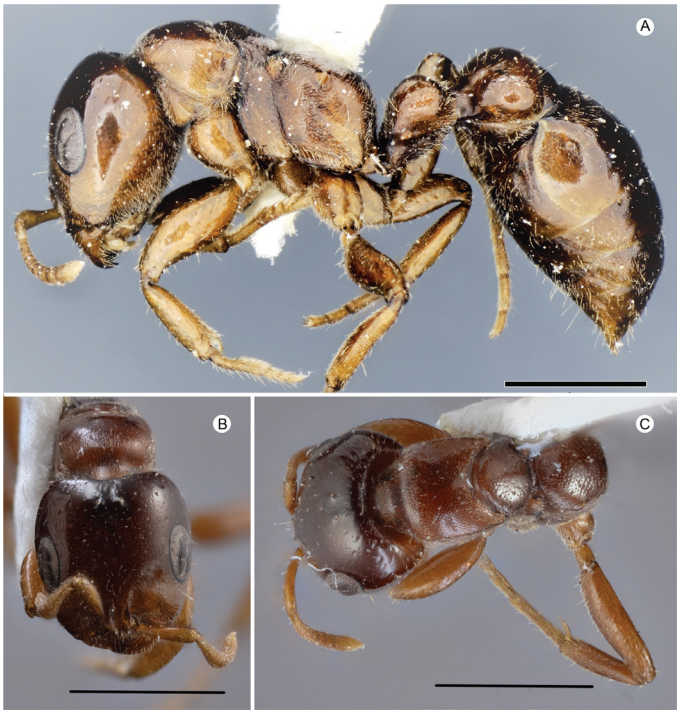

Figure 19 *Pseudomyrmex penetrator* (Smith) (worker, MEPN 31858): A) profile, B) frontal view, C) dorsal view. Images by Vladimir Carvajal and Alex Pazmiño. Scale bars = 1 mm.

Figure 18 *Simopelta laticeps* Gotwald & Brown (worker, MECN-EN-HYM 4602): A) profile, B) frontal view, C) dorsal view. Images by Alex Pazmiño. Scale bars = 1 mm.

Figure 20 *Pseudomyrmex peruvianus* (Wheeler) (worker, MECN-EN-HYM 4612): A) profile, B) frontal view, C) dorsal view. Images by Vladimir Carvajal. Scale bars = 1 mm.

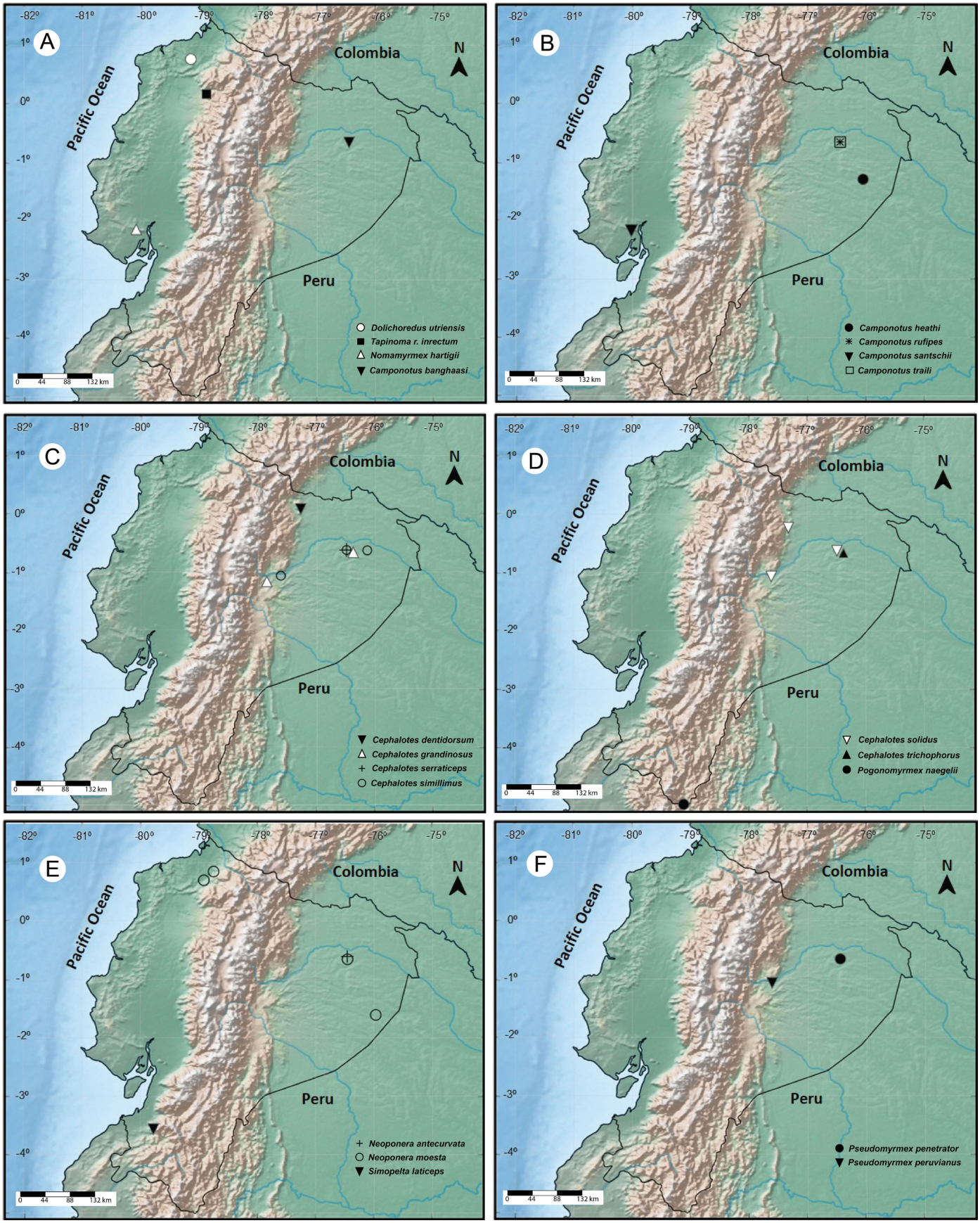

Figure 21 Geographic distribution of the species examined in the present study.

Discussion

In recent years, progress has been made towards knowing the biodiversity of insects in Ecuador (Marín-Armijos et al., 2017; Ponce et al., 2021; Kleemann et al., 2022), it is still notorious, though, how little is known the ant fauna in this small but megadiverse territory. Before Salazar et al. (2015), an updated species list for this country's continental area was inexistent. This first checklist was an important first contribution. However, a plethora of ant specimens contained in unexamined bottles and boxes which are deposited in various Ecuadorian institutions, still await proper study. The new records presented in our contribution reflect just a small proportion of the material that needs revision.

The new count of 803 species registered in Ecuador which is obtained by summing the current 783 valid records reported in GABI 1.0 release, January, 2022 (Guénard et al., 2017) plus our additions, represents approximately 23% of the species richness of the Neotropics. This richness is concentrated in one of the smallest territories of South America, and is remarkably high if we compare it to other megadiverse, though much larger countries in the region, for example, Brazil (30 X the size of Ecuador) for which approximately 1530 species are reported (R.M. Feitosa, pers. comm., Aug-2020), Mexico (7 X) with 890 species (Dáttilo et al., 2020), and Colombia (4 X) with approximately 1200 species (García et al., 2020).

By contrast, in Costa Rica (5 X smaller than Ecuador) 989 species have been registered so far (Guénard et al. 2017). In terms of species richness Costa Rica may be amongst the most intensively studied country of the American continent. Bearing in mind that many habitats in Ecuador are poorly inventoried, especially with respect to the Formicidae (Salazar et al., 2015), and that a significant proportion of already collected specimens remain unidentified in some Ecuadorian reference collections, we certainly expect a series of new discoveries for the Ecuadorian ant fauna be unveiled in future contributions.

The complex and rich habitat heterogeneity found in Ecuador possibly boosted such concentration of species richness in a comparatively small region (see Pitman et al., 2002; Dangles et al., 2009; Bass et al., 2010). Environmental heterogeneity coupled with a variety of climates, landscapes and vegetation types are considered among the potential drivers explaining current species richness, particularly in mountainous regions of tropical South America (Luebert and Weigend, 2014, Cuesta et al., 2017, Boschman and Condamine, 2022).

This high species richness hosted by a heterogenous matrix where Chocoan, Andean, and Amazonian habitats converge (Dangles et al., 2009; Bass et al., 2010; Santillán et al., 2020) is constantly threatened by deforestation due to extractivism, changes in land use and human settlements (Kleemann et al., 2022). Researchers must act fast in collaborative initiatives while encouraging next generations of the society to further scientific discovery.

Our results strengthen the importance of scientific collections as biodiversity repositories. Local institutions responsible for their maintenance, in particular those with public-dependent (state) budget, from where most of the present new records are deposited, have to be supported with financial, technological and human resources. This is just part of the debt earned by our society as a consequence of development.

Conclusion

The ant fauna dwelling in this small, but megadiverse Latin American country is still poorly comprehended, both taxonomically and biologically. The current 803 ant species known for Ecuador makes it one of the richest regions of the Americas, especially considering the size of its territory. The new records presented here contribute to the knowledge of the Formicidae of this country and of the Neotropical realm with highlights on some species for which their distribution may be less understood than previously thought. Our study also illustrates the importance of scientific collections as biodiversity repositories, which harbor historical information that can be used to promote the conservation of nature in the long term.

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Conflicts of interest

The authors declare no conflicts of interest.

Author contribution statement

APP and AT: identified most of the specimens; designed, built-up and refined the database; defined the manuscript structure and wrote the first draft; and took some of the images. APP made the distribution maps. AT obtained financial support for the publishing process. The authors revised and approved the final version of the manuscript.

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Supplementary material

Data 1 - (online only) Museum details and specimen collection information of the complete set of ant species records reported in this study in Darwin Core format. Includes voucher material at MECN, MEPN, and QCAZ repository collections.