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A SURVEY OF GROUND-DWELLING ANTS (HYMENOPTERA: FORMICIDAE) IN GEORGIA

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ABSTRACT

Ground-dwelling ants (Hymenoptera: Formicidae) were sampled at 29 sites in 26 counties in Georgia with pitfall traps, leaf litter extraction, visual searching, and bait stations. We found 96 ant taxa including nine species not previously reported from Georgia: *Myrmica americana* Weber, *M. pinetorum* Wheeler, *M. punctiventris* Roger, *M. spatulata* Smith, *Pyramica wrayi* (Brown), *Stenamma brevicorne* (Mayr), *S. diecki* Emery, *S. impar* Forel, and *S. schmitti* Wheeler, as well as three apparently undescribed species (*Myrmica* sp. and two *Stenamma* spp.). Combined with previous published records and museum records, we increased the total number of ground-dwelling ants known from Georgia to 144 taxa.

Key Words: ground-dwelling ants, Formicidae, survey, Georgia, species.

RESUMEN

Hormigas que habitan en el suelo (Hymenoptera: Formicidae) fueron recolectadas en 29 sitios en 26 condados del estado de Georgia con trampas de suelo, extración de hojarasca, busqueda visual, y trampas de cebo. Nosotros encontramos 96 taxa de hormigas incluyendo nueve especies no informadas anteriormente en Georgia: *Myrmica americana* Weber, *M. pinetorum* Wheeler, *M. punctiventris* Roger, *M. spatulata* Smith, *Pyramica wrayi* (Brown), *Stenamma brevicorne* (Mayr), *S. diecki* Emery, *S. impar* Forel, y *S. schmitti* Wheeler, además de tres especies aparentemente no descritas (*Myrmica* sp. y dos *Stenamma* spp.). Al juntar estos datos con las publicaciones y registros de museos, nosotros aumentamos el número de hormigas conocidas que habitan el suelo en Georgia a un total de 144 taxa.

The state of Georgia in the southeastern United States is characterized by a relatively wide range of soil, topographic and climatic conditions. The eight Major Land Resource Areas (MLRAs) identified in the state are (1) Atlantic Coast Flatwoods, (2) Southern Coastal Plains, (3) Carolina and Georgia Sand Hills, (4) Black Lands, (5) Southern Piedmont, (6) Southern Appalachian Ridges and Valleys, (7) Sand Mountains, and (8) Blue Ridge (USDA–SCS 1981). Each MLRA is characterized by a unique combination or pattern of soils, climate, water resources, and land use. These factors, in turn, affect the biotic communities and habitats as well as the floral and faunal characteristics of each.

The diversity and abundance of ants (Hymenoptera: Formicidae) in Georgia are relatively unknown. Wheeler (1913) published a list of 72 ant species collected in Georgia by J. C. Bradley and W. T. Davis; taxonomic revisions have since decreased this list to 62 species. Since that publication, museum records and collections have been the primary sources of occurrence and distribution of ant species in the state; these data are limited in scope. With the exception of Florida (Johnson 1986; Deyrup 2003) and South Carolina (Smith 1934), surveys for ant species are also limited from areas bordering Georgia.

The objective of the study reported herein was to collect, identify, and catalog ground-dwelling ant species from representative MLRAs in Georgia. Undisturbed habitats were purposely sampled to avoid high population levels of two invasive ant species—*Solenopsis invicta* Buren and *Linepithema humile* (Mayr)—that occur throughout the state and reportedly compete with and displace other ant species (Porter & Savignano 1990; Holway 1999).

MATERIALS AND METHODS

Sample Methods and Sites

Twenty-nine sites were sampled 1 to 4 times between June 2000 and September 2002 for ground-dwelling ants (Fig. 1). Most sites were located in state parks; others were on state-owned properties. The sites represented six of the eight MLRAs identified in Georgia. Information and characteristics of each collection site are listed in Table 1.

Each site was 600 m^2 and was located in wooded areas and at least 60 m from any paths, roads, or right-of-ways. Sampling methods employed were pitfall trapping, extraction from leaf litter collections, visual searching, and baiting as described by Agosti & Alonso (2000) and Bestle-

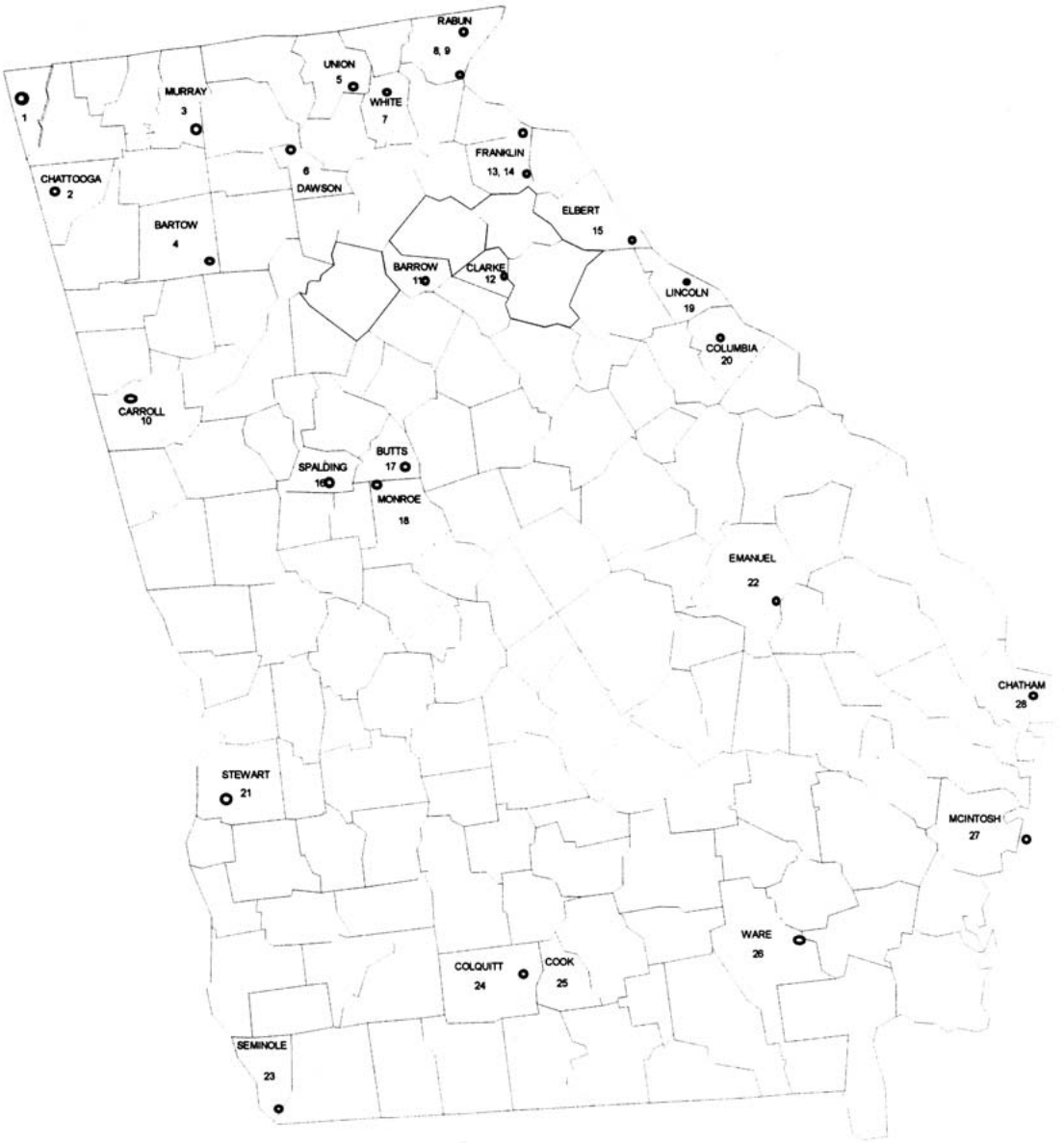

Fig. 1. Georgia sites sampled for ground-dwelling ants, 2000-2002.

meyer et al. (2000). For each sampling event, 20 pitfall traps were placed individually at 1-m intervals along a transect. Traps were 40-ml plastic vials filled to 60% of container volume with propylene glycol. The vials were placed in the ground with the upper opening level with the soil surface. The traps remained in the ground for 7 d when they were removed, capped, and transported to the laboratory for processing. Leaf litter was gathered by hand from several locations within the 600 m^2 site. These were combined and placed in a 50-L plastic bag, stored on ice, and transported to the laboratory. In the laboratory, litter samples were divided and placed in Berlese funnels (Agosti & Alonso 2000) for 24 h to separate ants. Bait stations used were those described by Brinkman et al. (2001). Tuna packaged in oil, was placed in a thin layer over the surface of a 2.5-cm diam filter paper disk (Whatman no. 1) in a plastic Petri dish (10 × 35 mm). Ten stations were placed individually at 2-m intervals along a transect. The stations remained uncovered on the ground for 2 h. They were then covered, placed on ice, and transported to the laboratory for processing. The ground, tree trunks, fallen trees, and other surfaces were visually searched for ants at

TABLE 1. LOCATIONS AND CHARACTERISTICS OF SITES SAMPLED FOR GROUND-DWELLING ANTS IN GEORGIA, 2000-2002. ALL STUDY SITES WERE IN STATE-OWNED PROPERTY (STATE PARKS OR UNIVERSITY OF GEORGIA).

Survey Site	Sites	County	N;W	Major Land Resource Areas	Elevation
1	Cloudland Canyon	Dade	34°50.4; 085°28.9	Sand Mountain	602 m
2	Sloppy Floyd	Chattooga	34°26.4; 085°20.2	Sand Mountain/Southern Appalachian	303 m
3	Fort Mountain	Murray	34°46.6; 084°42.5	Southern Appalachian/Blue Ridge	906 m
4	Red Top Mountain	Bartow	34°08.6; 084°42.2	Southern Appalachian/Blue Ridge	325 m
5	Vogel	Union	34°46.1; 083°54.9	Blue Ridge	236 m
6	Amicalola Falls	Dawson	34°34.2; 084°14.7	Blue Ridge	900 m
7	Unicoi	White	34°43.9; 083°43.6	Blue Ridge	887 m
8	Black Rock Mountain	Rabun	34°54.4; 083°24.3	Blue Ridge	1055 m
9	Tallulah Gorge	Rabun	34°44.4; 083°23.3	Blue Ridge	539 m
10	John Tanner	Carroll	33°36.1; 085°09.9	Southern Piedmont	332 m
11	Fort Yargo	Barrow	33°57.9; 083°43.4	Southern Piedmont	303 m
12	UGA Whitehall Forest	Clarke	33°53.7; 083°21.9	Southern Piedmont	887m
13	Victoria Bryant	Franklin	34°17.7; 083°09.7	Southern Piedmont	236 m
14	Tugaloo	Franklin	24°29.5; 083°04.4	Southern Piedmont	374 m
15	Richard B. Russell	Elbert	34°10.8; 082°45.9	Southern Piedmont	214m
16	Bobby Brown	Elbert	33°58.1; 082°34.6	Southern Piedmont	89 m
17	UGA Griffin Campus	Spalding	33°16.0; 084°17.2	Southern Piedmont	307 m
18	Indian Springs	Butts	33°14.9; 083°55.5	Southern Piedmont	193 m
19	High Falls	Monroe	33°10.3; 084°00.7	Southern Piedmont	178 m
20	Elijah Clark	Lincoln	33°51.3; 082°24.0	Southern Piedmont	154 m
21	Mistletoe	Columbia	33°39.9; 082°22.9	Southern Piedmont	163 m
22	Providence Canyon	Stewart	32°04.0; 084°54.3	Southern Coastal Plain	222 m
23	George L. Smith	Emanuel	32°32.7; 082°07.5	Southern Coastal Plain	123 m
24	Seminole	Seminole	30°48.2; 084°52.7	Southern Coastal Plain	35 m
25	Reed Bingham	Colquitt	31°09.6; 083°32.3	Southern Coastal Plain	78 m
26	Laura S. Walker	Ware	31°08.5; 083°12.9	Atlantic Coast Flatwoods	47 m
27	Sapelo Island Dunes	McIntosh	31°23.4; 081°15.9	Atlantic Coast Flatwoods	0 m
28	North Sapelo Island	McIntosh	31°23.4; 081°15.9	Atlantic Coast Flatwoods	19 m
29	UGA Bamboo Farm	Chatham	31°59.9; 081°16.2	Atlantic Coast Flatwoods	19 m

TABLE 2. LIST OF GROUND-DWELLING ANTS COLLECTED IN GEORGIA 2000-2002 SURVEY WITH COLLECTION SITE (S) NOTED.

Species	Survey sites[1]
Acanthomyops interjectus (Mayr)	5
Amblyopone pallipes (Haldeman)	6,8,21,9
Aphaenogaster ashmeadi (Emery)	10,28
Aphaenogaster fulva Roger	6,10,11,18,19
Aphaenogaster lamellidens Mayr	11,16,18,19
Aphaenogaster miamiana Wheeler	27
Aphaenogaster picea/rudis/texana complex[2]	1,2,3,4,5,6,7,8,9,10,11,12,13,14,16,18,19,20,21,23,29
Aphaenogaster tennesseensis (Mayr)	23
Brachymyrmex depilis Emery	18,19,22,23,24,25,26,29
Brachymyrmex musculus Forel	23,29
Camponotus americanus Mayr	1,2,4,10,11,14,18,19
Camponotus castaneus (Latreille)	10,14,29
Camponotus floridanus (Buckley)	19,24,29
Camponotus nearcticus Emery	10,21,26
Camponotus pennsylvanicus (De Geer)	1,2,4,8,9,10,11,18,19,23
Camponotus subbarbatus Emery	1,19
Crematogaster ashmeadi Mayr	2,4,9,10,11,12,14,16,18,19,20,21,23,26,28,29
Crematogaster cerasi (Fitch)	29
Crematogaster lineolata (Say)	1,2,7,9,11,12,14,18,19,20
Crematogaster minutissima Mayr	10,18,19
Cyphomyrmex rimosus (Spinola)	22,24,25,26
Dorymyrmex bureni Trager	22,25,26,27,29,26
Dorymyrmex insanus (Buckley)	25,29
Forelius analis (Andre)	10,14,18,19,29
Forelius pruinosus (Roger)	25
Formica archboldi Smith	10
Formica exsectoides Forel	1
Formica pallidefulva Latreille	6,10,14,17,19,20,21,23,29
Formica rubicunda Emery	1
Formica schaufussi Mayr	10,19
Formica subintegra Wheeler	10
Formica subsericea Say	1,5,6,7,9,10,11,18,20
Hypoponera opaciceps (Mayr)	5,7,18,20,23,29
Hypoponera opacior (Forel)	10,17,18,19,20,21,23,29
Lasius alienus	5,6,8,18,19,25,29
Lasius neoniger Emery	10
Leptothorax curvispinosus Mayr	2,3,4,9,10,11,29
Leptothorax pergandei Emery	9,16,24,28,29
Leptothorax schaumii Roger	14,19
Leptothorax smithi Baroni Urbani	16
Linepithema humile (Mayr)	10,17,21,25
Monomorium minimum (Buckley)	1,10,18,19,21
Monomorium viride Brown	27
Myrmecina americana Emery	1,3,4,5,8,9,10,11,13,14,16,20,21
Myrmica americana Weber	6,18,23
Myrmica pinetorum Wheeler	19
Myrmica punctiventris Roger	5,7,8,9,10,18,19
Myrmica spatulata Smith	5,9
Myrmica sp. (undescribed)[3]	6
Odontomachus brunneus (Patton)	29

[1]Sites and site information are provided in Table 1.

[2]*Aphaenogaster picea/rudis/texana* complex includes *A. picea* (Wheeler), *A. picea rudis* Enzmann, *A. texana* Wheeler, and *A. texana carolinensis* Wheeler species (S. Cover, personal communication).

[3]Previously undescribed species (S. Cover, personal communication).

[4]*Solenopsis molesta* complex includes *S. carolinensis* Forel, *S. molesta* (Say), *S. pergandei* Forel, *S. texana* Emery, *S. truncorum* Forel species (S. Cover, personal communication).

[5]Two previously undescribed species and first records from Georgia (S. Cover, personal communication).

TABLE 2. (CONTINUED) LIST OF GROUND-DWELLING ANTS COLLECTED IN GEORGIA 2000-2002 SURVEY WITH COLLECTION SITE (S) NOTED.

Species	Survey sites[1]
Pachycondyla chinensis (Emery)	11,14,15,16,18
Paratrechina arenivaga Wheeler	6,10,12,19,22
Paratrechina faisonensis (Forel)	1,7,10,11,14,17,19,21,28,29
Paratrechina parvula (Mayr)	19
Paratrechina vividula (Nylander)	2,4,7,9,10,11,19,20,28,29
Pheidole adrianoi Naves	29
Pheidole bicarinata Mayr	10,21,26,29
Pheidole bicarinata vinelandica Forel	10,14
Pheidole crassicornis Emery	18,19,22,23,25,26
Pheidole dentata Mayr	1,10,14,16,19,21,23,24,29
Pheidole dentigula Smith	10,18,19,23,24,28,29
Pheidole littoralis Cole	23
Pheidole metallescens	23
Pheidole morrisii Forel	29
Pheidole tysoni Forel	10,18,19,21,23
Pogonomyrmex badius (Latreille)	27,29
Polyergus lucidus Mayr	29
Ponera pennsylvanica	1,2,5,6,7,8,9,10,11,14,18,19
Prenolepis imparis (Say)	1,2,3,5,6,7,8,9,10,11,12,14,16,18,19,20,23
Proceratium croceum (Roger)	7
Proceratium pergandei (Emery)	19
Pseudomyrmex ejectus (Smith)	21
Pyramica bunki (Brown)	11
Pyramica carolinensis (Brown)	3
Pyramica ornata (Mayr)	10,18,19,21
Pyramica rostrata (Emery)	18,19
Pyramica wrayi (Brown)	29
Solenopsis geminata (Fabricius)	27
Solenopsis invicta Buren	10,18,19,21,22,24,25,26,28,29
Solenopsis molesta complex[4]	2,4,7,9,10,11,12,14,17,18,19,21,22,23,24,26,29
Stenamma brevicorne (Mayr)	18
Stenamma diecki Emery	1,4,5,6,7,8,9,23
Stenamma impar Forel	18,19
Stenamma schmitti Wheeler	5,6,8,18,19
Stenamma spp. (2 undescribed species)[5]	6
Strumigenys louisianae Roger	18,19,21,23,29
Tapinoma sessile (Say)	3,6,8,9,18,19,21
Trachymyrmex septentrionalis (McCook)	13,14,19,22,23,25

[1]Sites and site information are provided in Table 1.
[2]*Aphaenogaster picea/rudis/texana* complex includes *A. picea* (Wheeler), *A. picea rudis* Enzmann, *A. texana* Wheeler, and *A. texana carolinensis* Wheeler species (S. Cover, personal communication).
[3]Previously undescribed species (S. Cover, personal communication).
[4]*Solenopsis molesta* complex includes *S. carolinensis* Forel, *S. molesta* (Say), *S. pergandei* Forel, *S. texana* Emery, *S. truncorum* Forel species (S. Cover, personal communication).
[5]Two previously undescribed species and first records from Georgia (S. Cover, personal communication).

each sampling time. The total amount of time spent on visual searching was 1.5 h, but varied based on the number of individuals involved in the search. Ants discovered in the visual searches were collected, placed in 70% ethyl alcohol, and transported to the laboratory for processing.

In the laboratory, ant specimens were separated and placed in 95% ethyl alcohol. Identifications were made with keys by Bolton (1994, 2000); Buren (1968); Creighton (1950); Cuezzo (2000); Deyrup et al. (1985); DuBois (1986); Gregg (1958); Holldobler & Wilson (1990); Johnson (1988); MacKay (2000); Smith (1957); Snelling (1973, 1988); Snelling & Longino (1992); Taylor (1967); Trager (1984, 1988); Ward (1985, 1988); Wilson (1955); and Wing (1968), and by comparison with specimens housed in the University of Georgia Natural History Museum (Athens, GA). Stefan Cover (The Museum of Comparative Zoology, Harvard Univ., Cambridge, MA) and Mark Deyrup

TABLE 3. SPECIES OF GROUND-DWELLING ANTS PREVIOUSLY REPORTED TO OCCUR IN GEORGIA BUT NOT COLLECTED IN THE 2000-2002 STATE SURVEY.

Species	Record
Acanthomyops claviger (Roger)	UGANHM[1]
Acanthomyops murphyi (Forel)	UGANHM[1]
Aphaenogaster ashmeadi (Emery)	Wheeler 1913
Aphaenogaster treatae Forel	Wheeler 1913
Camponotus caryae (Fitch)	UGANHM[1]
Camponotus decipiens Emery	Wheeler 1913
Camponotus discolor (Buckley)	Wheeler 1913
Camponotus impressus (Roger)	ABS[2]
Camponotus socius Roger	Wheeler 1913
Crematogaster missuriensis Emery	ABS[2]
Crematogaster pilosa Emery	Wheeler 1913
Crematogaster sp. (undescribed)	ABS[2]
Cryptopone gilva (Roger)	UGANHM[1]
Discothyrea testacea Roger	ABS[2]
Dolichoderus mariae Forel	Wheeler 1913
Dolichoderus pustulatus Mayr	Wheeler 1913
Dorymyrmex grandulus (Forel)	UGA NHM[1]
Formica difficilis Emery	Wheeler 1913
Formica integra Nylander	Wheeler 1913
Formica nitidiventris Emery	Wheeler 1913
Formica obscuriventris Mayr	Wheeler 1913
Leptothorax bradleyi Wheeler	Wheeler 1913
Leptothorax texanus Wheeler	ABS[2]
Monomorium pharaonis (L.)	Wheeler 1913
Myrmica latifrons Starcke	Wheeler 1913
Nievamyrmex carolinensis (Emery)	UGANHM[1]
Nievamyrmex nigrescens (Cresson)	UGANHM[1]
Neivamyrmex opacithorax (Emery)	Wheeler 1913
Paratrechina longicornis (Latreille)	Wheeler 1913
Pheidole pilifera (Roger)	UGANHM[1]
Ponera exotica Smith	ABS[2]
Proceratium creek De Andrade	ABS[2]
Proceratium crassicorne Emery	ABS[2]
Pseudomyrmex pallidus (Smith)	Wheeler 1913
Pyramica abdita (Wesson)	ABS[2]
Pyramica angulata (Smith)	ABS[2]
Pyramica clypeata (Roger)	UGANHM[1]
Pyramica dietrichi (Smith)	UGANHM[1]
Pyramica laevinasis (Smith)	ABS[2]
Pyramica ohioensis (Kennedy & Schramm)	ABS[2]
Pyramica pergandei (Emery)	ABS[2]
Pyramica pilinasis (Forel)	ABS[2]
Pyramica pulchella (Emery)	ABS[2]
Pyramica reflexa (Wesson)	ABS[2]
Solenopsis picta Emery	UGANHM[1]
Solenopsis tennesseensis Smith	ABS[2]
Solenopsis xyloni McCook	Jouvenaz et al. 1977
Tetramorium bicarinatum (Nylander)	UGA NHM[1]

[1]University of Georgia Natural History Museum.
[2]Archbold Biological Station.

(Archbold Biological Station, Lake Placid, FL) confirmed species identifications. Voucher specimens have been deposited in the University of Georgia Natural History Museum and the Museum of Comparative Zoology at Harvard University.

RESULTS AND DISCUSSION

Ninety-six species of ground-dwelling ants representing 33 genera were collected and identified in this 2-year survey (Table 2). Of those collected,

9 species have not been previously reported from Georgia. These are *Myrmica americana* Weber, *M. pinetorum* Wheeler, *M. punctiventris* Roger, *M. spatulata* Smith, *Pyramica wrayi* (Brown), *Stenamma brevicorne* (Mayr), *S. diecki* Emery, *S. impar* Forel, and *S. schmitti* Wheeler.

Of those previously unreported species, *M. americana* was collected from 3 sites, *M. pinetorum* was collected from 1 site, *M. punctiventris* was collected from 7 sites, and *M. spatulata* was collected from 2 sites. Ants of this genus nest in soil and in rotting wood and are primarily carnivorous, but they will feed on plant exudates such as nectar (Creighton 1950). In addition, *P. wrayi* and *S. brevicorne* were each collected from 1 site, *S. diecki* was collected from 8 sites, *S. schmitti* was collected from 5 sites, and *S. impar* was collected from 2 sites. All *Stenamma* species are carnivorous, and *Pyramica* are specialized predators of collembolans (Holldobler & Wilson 1990).

Eleven individuals of *Myrmica* and 3 individuals of *Stenamma*, possibly representing two species, were collected from Amicalola State Park in Dawson Co. (site 6) and represent as yet undescribed species (S. Cover, pers. comm.). Those specimens were collected on 2-V-2000, primarily by pitfall trapping and leaf litter collection.

A review of ant specimens deposited in the Archbold Biological Station (ABS), the University of Georgia Natural History Museum (UGANHM), the lists of ants published by Wheeler (1913), and a survey conducted by Jouvenaz et al. (1977) reveal that 48 species of ground-dwelling ants representing 21 genera have been reported from Georgia but were not collected in the survey reported herein (Table 3). To date, these two lists (Tables 2 and 3) comprise the ground-dwelling ant species reported from Georgia. Species collected within the *Aphaenogaster picea/rudis/texana* complex and the *Solenopsis molesta* complex are footnoted in Table 2.

In terms of occurrence and distribution, *Prenolepis imparis* (Say) was collected from 17 of the 29 sites sampled, the *Aphaenogaster picea/rudis/texana* complex from 21 sites; the *Solenopsis molesta* complex from 17 sites, and *Crematogaster ashmeadi* Mayr from 16 sites in this survey. All other species were collected from less than one-half of the sites. Members of the genus *Pheidole* were most numerous with 2,765 individuals representing 10 species collected at 14 sites. *Dorymyrmex burnei* (Trager), *D. insanus* (Buckley), and *Cyphomyrmex rimosus* (Spinola) were collected only at southern sites, while *Amblyopone pallipes* (Haldeman), *Ponera pennsylvanica* Buckley, and *Tapinoma sessile* (Say) were collected from sites in northern Georgia. *Pseudomyrmex ejectus* (Smith) was collected from pitfall traps at one site. *Pseudomyrmex* spp. are characteristically arboreal in their habits. These specimens most likely dropped to the forest floor, and thus were collected as ground-dwellers. Three species - the seed harvester *Pogonomyrmex badius* (Latreille), the obligate slave raider *Polyergus lucidus* Mayr, and the generalist *Aphaenogaster miamiana* Wheeler—were recovered only on Sapelo Island, a barrier island on Georgia's coast.

The survey reported herein provides a basis for various ecological studies and assessments. Ant assemblages, species composition, and community structure are important in terms of community ecology. For example, in Australia, ants are one of the most functionally important faunal groups (Matthews & Kitching 1984; Anderson 1992) and are model organisms for studies in community ecology (Anderson 1983, 1988, 1991; Greenslade & Halliday 1983). Ants also have been used as bio-indicators in mine site rehabilitation (Majer 1983, 1985).

Schultz & McGlynn (2000) noted the many interactions that occur between ants and other organisms within habitats. They further postulated that if these interactions are understood, one could predict ecological conditions within a given habitat based upon the presence or absence of specific ants. Furthermore, one could correlate the presence of a specific ant species with specific ecological conditions, and these correlations could be used as predictors of ant biodiversity and interactions among ant species (Alonso 2000).

This survey is the first published listing of ground-dwelling ants in Georgia since Wheeler (1913). This compilation will serve to support biodiversity, systematics, and ecological studies for Georgia and surrounding environs.

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