

## DISTRIBUTION OF PONEROMORPH ANTS (HYMENOPTERA: FORMICIDAE) IN THE MEXICAN STATE OF MORELOS

LUIS N. QUIROZ-ROBLEDO AND JORGE VALENZUELA-GONZÁLEZ

Instituto de Ecología, A. C. Departamento de Entomología. Km 2.5 Carretera Antigua a Coatepec No. 361.

Congregación El Haya. Código Postal 91070 Xalapa, Veracruz, Mexico

E-mail: quirozl@ecologia.edu.mx; valenjor@ecologia.edu.mx

### ABSTRACT

We surveyed poneromorph ants of Morelos state in south-central Mexico with pitfall traps and hand collecting. In total, we collected 16 poneromorph species representing 9 genera (*Anochetus*, *Ectatomma*, *Gnamptogenys*, *Hypoconera*, *Leptogenys*, *Odontomachus*, *Pachycondyla*, and *Platythyrea*). Although all 16 species are previously known from Mexico, our records increase the number of poneromorphs known from Morelos from 5 to 18. The most commonly collected species were *O. clarus*, *G. striatula*, *E. tuberculatum*, and *H. opaciceps*, all extremely widespread Neotropical species. Some information is provided on distribution, foraging strati, and nesting.

Key Words: ants, Poneromorphs, nesting, strati

### RESUMEN

Se hizo un inventario de las hormigas Poneromorfas del estado de Morelos, ubicado en la región centro-sur de la República Mexicana. Los muestreos se realizaron por medio de colectas directas y del uso de trampas. En total se encontraron 16 especies poneromorfas pertenecientes a nueve géneros (*Anochetus*, *Belonopelta*, *Ectatomma*, *Gnamptogenys*, *Hypoconera*, *Leptogenys*, *Odontomachus*, *Pachycondyla* y *Platythyrea*), ninguna de estas especies son informadas por vez primera para México, pero nuestros registros incrementan el número de poneromorfas conocidas para Morelos de 5 a 18. Las especies más comúnmente colectadas fueron *O. clarus*, *G. striatula*, *E. tuberculatum* y *H. opaciceps*, todas ellas especies neotropicales ampliamente dispersas. Se proporciona alguna información de su distribución, de sus estratos de forrajeo y de anidación.

Translation provided by the authors.

In general, poneromorph ants (Bolton 2003), previously part of the subfamily Ponerinae, have been considered "primitive" both in terms of their morphology and habits. These ants have a wide, mainly Pan-tropical distribution (Smith 1979; Hölldobler & Wilson 1990). Most species live in small colonies formed by a few dozen to a maximum of some hundred individuals, with workers that tend to be monomorphic. They are generally predators, although some also feed on sugary nectars, fruit, and the secretions of certain homopterans. Most species forage alone, although some exhibit recruiting behavior. Hölldobler & Wilson (1990) provide additional information on their biology and habits.

On the American continent, 25 genera of these ants are known, of which 17 have been recorded for Mexico (Bolton 1994; Brandão 1996; Lattke 2003). At present, 76 species of poneromorphs are recognized for the Mexican Republic, of which only 5 have been recorded for Morelos (Kempf 1972; Smith 1979; Rodríguez 1986; Brandão 1991, 1996; Cartas 1993; Bolton 1995; Lattke 1995; Quiroz & Valenzuela 1995, 2002; Castaño 1996; Rojas 1996; Longino 1998; Lachaud &

García-Ballinas 2001; Durou et al. 2002). Baroni-Urbani (1983), Hölldobler & Wilson (1990), and Bolton (1994) provide keys for the identification of Neotropical genera, and MacKay & MacKay (1989) for those found in Mexico.

The state of Morelos is situated in south central Mexico between 2 important geographic zones: the Transverse Neovolcanic Belt and the Rio Balsas Basin. The state's rugged topography favors several climatic domains and an important floristic diversity. In addition, Morelos is characterized by the presence of Neartic, Neotropical, and some autochthonous faunal components (Anonymous 1981; Aguilar 1990).

The present study provides an inventory of the poneromorph ant species that occur in the state. It also includes some information on the distribution, nesting, and foraging habits of these species.

### DESCRIPTION OF THE STUDY AREA

The state of Morelos is located between 18°22'06"N and 19°07'10"N, and 98°03'W and 98°30'08"W. Its region (covering a surface area of 4,958 km<sup>2</sup>) is divided into 33 municipalities, with

the state capital located in the city of Cuernavaca. The 2 highest points in Morelos, Chichinautzin Mountain and the Popocatepetl Volcano, are located in the northern region at altitudes of 3,450 m and 5,452 m above sea level, respectively. From these heights, the state's topography descends southward to 890 m in the Jojutla Valley and then climbs again to 1,500 m in the Sierra de San Gabriel in southern Morelos, near Guerrero (Vidal 1980).

The climate is hot and sub-humid in most parts of the state. Temperate and sub-humid conditions predominate on mountain slopes, whereas semi-cold to cold conditions characterize altitudes above 2,800 m (Anonymous 1981). Tropical deciduous forest (TDF) is the most widely distributed vegetation type in the state, ranging between 890 m and 1,800 m above sea level and covering more than 50% of the state's surface area. Some disturbed areas of TDF have been transformed into thorn forests ("huizacheras"), which are generally characterized by a great number and variety of *Acacia* species. Among the ravines and canyons of the mountainous zone, small patches of temperate cloud forest can be found. Stands of pine, oak, and fir occur from 1,800 m to 4,000 m. In the highest part of the state, bordering the slopes of Popocatepetl, mountain prairie is prevalent. The average frost line is located at approximately 5,000 m (Miranda & Hernández 1963; Rzedowski 1978; Anonymous 1981).

#### MATERIALS AND METHODS

We collected ants at 2-4 sites in each of the 33 municipalities of Morelos, in 7 vegetation types at elevations ranging from 890-3500 m (Fig. 1 and Table 1). Ants were collected from pitfall traps and also captured directly with entomological forceps and aspirators. Direct collection was conducted by following a 100 m transect at each sampling site, with ants captured from soil, under rocks, on fallen trunks, inside trunks, and on vegetation (grass, shrubs, and trees) to a height of approximately 2 meters. Two people carried out this procedure, which lasted 3 h at each of the 77 sites (Table 1).

For trapping, we placed 2 pitfall traps in each of the selected areas. They consisted of 1-L capacity plastic containers with a diameter of 13 cm. These were half-filled with commercial antifreeze diluted 30% with water as a preservative and buried so that their openings were at soil level. Finally, they were covered with a plastic plate to prevent desiccation and contamination by garbage and/or water if it rained. Traps were emptied every 48 h after placement.

We preserved specimens in 70% ethanol. We mounted vouchers and identified them using MacKay & MacKay (1989), MacKay & Vinson 1989, Bolton 1994, and Longino's (1998) web page. We deposited vouchers of all species at the Institute of Ecology, Xalapa, Veracruz (IEXA).

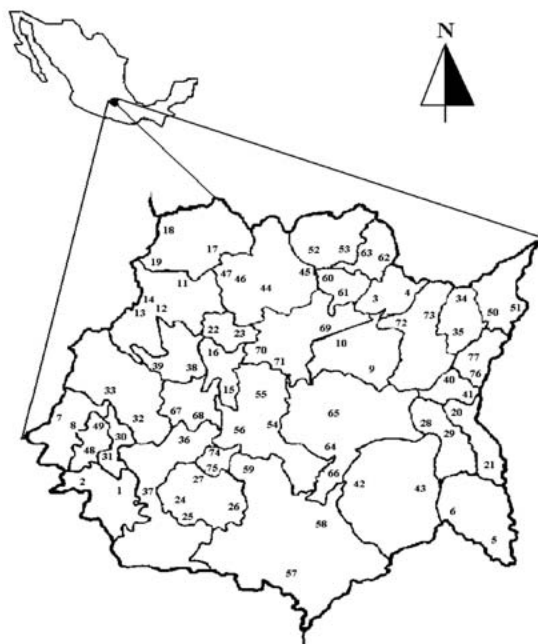


Fig. 1. Location of the study area. Collection sites (1 to 77) are identified on the map according to numbers, as indicated in Table 1.

#### RESULTS AND DISCUSSION

A total of 139 poneromorph ant samples were obtained, with 56.3% collected directly and 46.3% from traps. From all samples, 576 specimens were obtained. Compared with the capture of other ant subfamilies, relatively few poneromorph specimens were obtained; for example, over 5000 Ectoninae ants were collected under similar conditions (Quiroz & Valenzuela 2006). Poneromorphs tend to form low-population colonies, and individuals generally forage alone. They can, however, represent a substantial percentage of ant biomass in tropical regions due to the abundance of certain species and to the relatively large size of some (e.g., Cartas 1993).

Preliminary data show that in the state of Morelos the subfamily Myrmicinae has the greatest richness in terms of genera (41.5%), followed by poneromorphs (19.5%), Formicinae (17.1%), Dolichoderinae (12.2%), Ectoninae (7.2%), and Pseudomyrmecinae (2.5%).

Table 2 lists the species collected. The genus with the greatest species richness is *Gnamptogenys* (4 species), followed by *Hypoponera*, *Pachycondyla*, *Odontomachus*, and *Ectatomma* (2 species each); and *Anochetus*, *Belonopelta*, *Leptogenys*, and *Platythyrea* (1 each).

A total of 16 species of poneromorph ants were found in Morelos. Two other species, *Hypoponera foeda* and *Leptogenys wheeleri*, were not collected

TABLE 1. COLLECTIONS SITES (CS) FOR PONEROMORPH ANTS IN THE STATE OF MORELOS, MEXICO, LISTED BY MUNICIPALITY. THE COORDINATES AND ALTITUDE OF EACH SITE ARE LISTED.

Municipality	CS	Altitude	Longitude W	Latitude N
Amacuzac	1. Amacuzac	900	99°22'10"	18°35'55"
	2. Huajintlán	920	99°25'30"	18°36'35"
Atlatlaucan	3. Atlatlaucan	1620	98°53'52"	18°56'05"
	4. San Juan	1600	98°55'40"	18°56'09"
Axochiapan	5. Axochiapan	1030	98°45'10"	18°30'08"
	6. Quebrantadero	1060	98°47'23"	18°31'31"
Coatlán del Río	7. Cocoyotla	1060	99°26'57"	18°45'15"
	8. Coatlán	1010	99°26'00"	18°44'43"
Cuautla	9. Libramiento	1382	98°53'46"	18°47'27"
	10. Calderón	1317	98°58'42"	18°51'41"
Cuernavaca	11. Chamilpa	1850	99°14'03"	18°58'05"
	12. Reforma	1530	99°13'00"	18°56'06"
	13. Flores Magón	1520	99°11'05"	18°55'05"
	14. Cuernavaca	1510	99°14'03"	18°55'07"
Emiliano Zapata	15. Tetecalita	1150	99°10'46"	18°46'05"
	16. Calera Chica	1205	99°46'05"	18°49'53"
Huitzilac	17. Coajomulco	1650	99°12'16"	19°02'01"
	18. Cempoala	3500	99°21'03"	19°06'00"
	19. Huitzilac	2550	99°16'02"	19°01'42"
Jantetelco	20. Carr. a Cuautla	1400	98°47'06"	18°42'07"
	21. Carr. a Izucar	1440	98°47'55"	18°43'24"
Jiutepec	22. Tlahuapan	1350	99°10'04"	18°53'07"
	23. Progreso	1350	99°09'12"	18°52'48"
Jojutla	24. Carr. Jojutla-Ttla	900	99°16'05"	18°34'05"
	25. Tehuixtla	870	99°16'15"	18°33'34"
	26. Higerón	900	99°10'50"	18°34'39"
	27. Jicarero	940	99°13'20"	18°36'50"
Jonacatepec	28. Jonacatepec	1290	98°48'09"	18°40'58"
	29. Tlaica	1300	98°50'57"	18°42'15"
Mazatepec	30. Justo Sierra	980	99°21'43"	18°43'37"
	31. Cuauchichinola	910	99°22'27"	18°39'49"
Miacatlán	32. Coatetelco	980	99°19'32"	18°43'46"
	33. Miacatlán	1000	99°21'34"	18°46'07"
Ocuituco	34. Huecahuasco	2100	98°47'08"	18°56'13"
	35. Ocuituco	1900	98°46'24"	18°52'22"
Puente de Ixtla	36. Carr. a Alpuyecá-Xoxocotla	1030	99°14'38"	18°41'06"
	37. Pte. De Ixtla	900	99°19'11"	18°37'00"
Temixco	38. Acatlipa	1170	99°13'07"	18°48'06"
	39. Xochicalco	1170	99°17'52"	18°47'21"
Temoac	40. Temoac	1580	98°46'32"	18°46'23"
	41. Amilcingo	1500	98°46'10"	18°44'33"
Tepalcingo	42. Agua Fría	1100	98°58'01"	18°35'02"
	43. Tepalcingo	1160	98°50'37"	18°35'47"
Tepoztlán	44. Tepoztlán	1710	99°05'59"	18°59'07"
	45. Amatlán	1620	99°02'09"	18°58'41"
	46. Tescal	1700	99°09'02"	18°58'02"
	47. Cartuchos	1940	99°11'35"	18°58'46"
	48. Actopan	980	99°24'30"	18°43'53"
Tetecala	49. Tetecala	960	99°23'55"	18°43'45"
	50. Tetela del V	2200	98°43'46"	18°53'31"
Tetela del Volcán	51. Hueyapan	2340	98°41'29"	18°53'02"
	52. Felipe Neri	2050	98°59'49"	19°00'24"
Tlalnepantla	53. El Vigía	2140	98°57'34"	19°00'35"
	54. Temilpa	960	99°06'28"	18°42'41"
Tlaltizapan	55. Ticuman	990	99°10'44"	18°41'54"
	56. Acamilpa	1000	99°09'25"	18°42'59"
Tlaquiltenango	57. Huautla	945	99°01'18"	18°26'29"
	58. Quilamula	1070	99°01'10"	18°30'35"
Tlayacapan	59. Tlaquiltenango	920	99°09'37"	18°37'44"
	60. S. José de L	1880	99°00'06"	18°58'54"
	61. El bebedero	1310	98°59'40"	18°55'27"

TABLE 1. (CONTINUED) COLLECTIONS SITES (CS) FOR PONEROMORPH ANTS IN THE STATE OF MORELOS, MEXICO, LISTED BY MUNICIPALITY. THE COORDINATES AND ALTITUDE OF EACH SITE ARE LISTED.

Municipality	CS	Altitude	Longitude W	Latitude N
Totolapan	62. Tepetlixpita	1870	98°55'40"	18°58'38"
	63. Nepopualco	2040	98°56'34"	18°59'54"
Villa de Ayala	64. Rafael Merino	1133	98°59'04"	18°44'37"
	65. Moyotepec	1100	98°59'35"	18°43'12"
Xochitepec	66. Chinameca	1050	98°59'46"	18°37'14"
	67. Alpuyecá	1050	99°15'29"	18°44'37"
Yautepec	68. Alcanfores	1060	99°16'13"	18°42'27"
	69. Cocoyoc	1320	98°58'55"	18°53'03"
Yecapixtla	70. Cañon de L.	1240	99°06'32"	18°51'27"
	71. San Isidro	1105	99°05'35"	18°49'17"
Zacatepec	72. Yecapixtla	1500	98°51'07"	18°52'52"
	73. Xochitlán	1740	98°48'45"	18°53'13"
Zacualpan	74. Chiverias	945	99°13'14"	18°39'14"
	75. Galeana	930	99°12'35"	18°38'28"
Zacualpan	76. Zacualpan	1640	98°45'57"	18°47'02"
	77. Tlacotepec	1740	98°45'00"	18°48'54"

by us but have been reported for the state (Brandão 1996). With the new recordings, the number of poneromorph ant species reaches 18 for Morelos. None is endemic to the state: *O. clarus* is distributed in the United States and Mexico; *L. mexicana* and *L. wheeleri* have been recorded only from Mexico; *H. foeda* is known for Mexico, Central America, and some Caribbean Islands; *H. opaciceps*, *P. stigma*, *P. villosa*, and *E. tubercu-*

*latum* are distributed from South America to the United States; *G. striatula* and *G. regularis* are known from Mexico to Argentina; *A. mayri*, *G. strigata*, *G. sulcata*, *O. laticeps*, and *E. ruidum* are distributed in Mexico, Central America and northern South America; *B. deletrix* is distributed from Mexico to Costa Rica. One species, *Pl. punctata*, is known from the United States, Mexico, Central America, and some Caribbean Islands.

TABLE 2. COLLECTION FREQUENCY ( $n = 139$ ) OF SPECIES OF PONEROMORPH ANTS COLLECTED IN THE STATE OF MORELOS, MEXICO WITH ALTITUDINAL RANGES AND VEGETATION TYPES WHERE THEY WERE FOUND (A: TROPICAL DECIDUOUS FOREST; B: THORN FOREST; C: PASTURELAND; D: MANGO ORCHARDS; E: AVOCADO ORCHARDS; F: ECOTONE BETWEEN TDF AND PINE-OAK FOREST; AND G: URBAN VEGETATION).

Species	N	Altitude (m)	Vegetation
<i>Anochetus mayri</i>	2	945-990	a, c
<i>Belonopelta deletrix</i>	1	1229	a
<i>Ectatomma ruidum</i>	8	950-1510	a, c, d, g
<i>Ectatomma tuberculatum</i>	10	990-1480	a, d
<i>Gnamptogenys regularis</i>	1	1010	a, d
<i>Gnamptogenys striatula</i>	17	1010-1510	a, b, d
<i>Gnamptogenys strigata</i>	7	945-1540	a, g
<i>Gnamptogenys sulcata</i>	4	1010-1160	a
<i>Hypoponera foeda</i>	—	—	—
<i>Hypoponera punctatissima</i>	1	1130	a
<i>Hypoponera opaciceps</i>	10	1010-1850	a, d, f
<i>Leptogenys mexicana</i>	4	990-1190	a, b
<i>Leptogenys wheeleri</i>	—	—	—
<i>Odontomachus clarus</i>	52	890-1890	a, c, f, b, g, d, e
<i>Odontomachus laticeps</i>	7	1054-1480	a, g, d
<i>Pachycondyla stigma</i>	8	950-1850	a, f
<i>Pachycondyla villosa</i>	1	950	a
<i>Platythyrea punctata</i>	6	950-1850	a, f

Finally, *H. punctatissima* is a pantropical tramp species, probably of African origin (Wilson & Taylor 1967; Kempf 1972; Brandão 1991, 1996; Bolton 1995; Lattke 1995, 2003; Longino 1998).

Of the 16 species collected during this study, 13 are new records from the state of Morelos: *A. mayri*, *B. deletrix*, *E. ruidum*, *E. tuberculatum*, *G. strigata*, *G. sulcata*, *G. regularis*, *H. punctatissima*, *L. mexicana*, *O. laticeps*, *P. stigma*, *P. villosa* and *Pl. punctata*.

Poneromorphs are widely distributed throughout Morelos. Only four of the 33 municipalities in Morelos (Huitzilac, Tlalnepantla, Ocuituco, and Tétela del Volcán) failed to produce samples of these ants. Failure to yield samples could occur because these municipalities are located in the mountainous northern part of the state.

The most abundant and widely distributed species were *O. clarus* (37.4% of the total number of samples obtained), *G. striatula* (12.2%), *E. tuberculatum* and *H. opaciceps* (7.1%), and *E. ruidum* and *P. stigma* (6%). These 6 species represent 75.8% of the samples collected (Tables 2 and 3). Next in frequency were *G. strigata* and *O. laticeps* (5%), *Pl. punctata* (4.3%) *G. sulcata* and *L. mexicana* (3%), and *A. mayri* (1.4%). The remaining 4 species (*B. deletrix*, *G. regularis*, *H. punctatissima*, and *P. villosa*) were collected only once each, suggesting that they are uncommon in Morelos or that our sampling methods were ineffective in detecting them. Due to the methods used, we could be underestimating the species abundance of tree inhabitants, subterranean habits, and ants that nest and forage in litter.

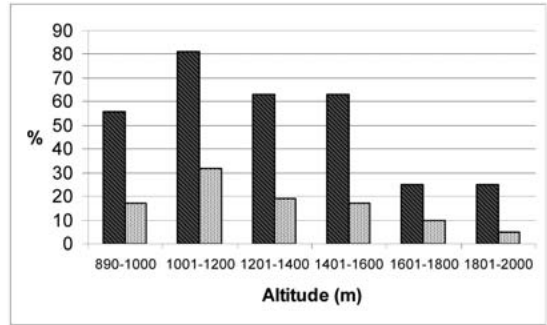


Fig. 2. Species richness (dark bars) and collection frequency (light bars) of poneromorph ants at different altitudes in the state of Morelos.

The greatest abundance and diversity were found between 890 and 1600 m; 86.1% of samples and all species were found in this altitudinal range. Only 4 species (*H. opaciceps*, *O. clarus*, *Pl. punctata*, and *P. stigma*) were obtained above 1600 m. The highest collection altitude recorded (1,890 m) corresponds to *O. clarus*, which was found in Nepopualco, in the municipality of Totolapan (Fig. 2 and Table 2).

Poneromorphs were encountered in a great diversity of vegetational associations (Table 2) including tropical deciduous forest (TDF), ecotonal areas between TDF and pine-oak forests, thorn forests, pastureland, urban and suburban vegetation, and a variety of agroecosystems (including mango, avocado, and guava orchards).

TABLE 3. DISTRIBUTION OF PONEROMORPH SPECIES FOUND IN THE STATE OF MORELOS. TABLE 1 SHOWS THE SITE THAT CORRESPONDS TO EACH NUMBER.

Species	Locality
<i>Anochetus mayri</i>	49, 56
<i>Belonopelta deletrix</i>	57
<i>Ectatomma ruidum</i>	7, 13, 32, 44, 55, 64
<i>Ectatomma tuberculatum</i>	7, 21, 32, 43, 44, 48, 65, 68
<i>Gnamptogenys regularis</i>	7
<i>Gnamptogenys striatula</i>	5, 6, 7, 21, 32, 44, 45, 46, 47, 70, 71
<i>Gnamptogenys strigata</i>	12, 29, 33, 46, 56, 70
<i>Gnamptogenys sulcata</i>	7, 8, 20
<i>Hypoponera foeda</i>	—
<i>Hypoponera punctatissima</i>	23
<i>Hypoponera opaciceps</i>	7, 10, 11, 15, 16, 22, 26, 74
<i>Leptogenys mexicana</i>	49, 64, 66
<i>Leptogenys wheeleri</i>	—
<i>Odontomachus clarus</i>	1, 3, 4, 6, 7, 10, 11, 12, 13, 14, 15, 16, 20, 21, 22, 25, 28, 29, 30, 32, 33, 37, 38, 39, 41, 43, 44, 45, 46, 47, 48, 54, 55, 56, 57, 58, 59, 61, 62, 64, 65, 66, 67, 68, 69, 70, 71, 72
<i>Odontomachus laticeps</i>	7, 32, 44, 65, 70
<i>Pachycondyla stigma</i>	6, 11, 55
<i>Pachycondyla villosa</i>	58
<i>Platythyrea punctata</i>	11, 20, 46, 58

Most species were found in TDF, the most extensive vegetational association in Morelos and one that is especially common in the central and southern portions of the state. Other landscape elements, including pastureland, cultivated fields, and thorn forest (mainly *Acacia* spp.), are often interspersed with the more abundant TDF. Pine-oak forests are encountered in the mountainous, northern part of the state, and a transitional ecotone is a common occurrence between TDF and the pine-oak forest. This transitional zone appears to establish the distributional limit for poneromorphs within the state of Morelos.

We found that most species are epigeal foragers (except for *G. regularis* and *P. villosa*). However, some can forage underground (*L. mexicana*, *G. strigata*), in litter (*G. strigata*, *G. sulcata*, and *B. deletrix*), and others on trees (*E. tuberculatum*, *G. regularis*, *P. stigma*, *P. villosa*, and *Pl. punctata*).

Most species nest in soil (except for *A. mayri*, *G. sulcata*, *H. punctatissima*, *P. stigma*, and *P. villosa*), in some cases preferentially under rocks (*O. clarus*). Others nest in hollow branches (*A. mayri*, *B. deletrix*, *G. regularis*, *H. punctatissima*, *H. opaciceps*, *G. strigata*, and *P. stigma*), in litter (*B. deletrix*), in pre-existing cavities in dead and living trees (*G. sulcata*, *P. villosa*), and at the base of epiphytic plants (*P. villosa*). Our observations regarding foraging and nesting sites coincide with those of Lachaud (1990), Lattke (1995), Longino (1998), and Durou et al. (2002). Data for *B. deletrix* and *L. wheeleri* were taken from Longino (1998), Wilson (1955), and Durou et al. (2002).

Of the 76 species of poneromorphs reported from Mexico, 18 (23.7%) are known for Morelos, even though this state is relatively small (4,958 km<sup>2</sup>; 0.25% of the entire area of the country).

Poneromorphs are Pantropical, although in America they have made some degree of penetration into the Nearctic region (Brown 1976). Of the 18 species of poneromorphs found in Morelos, 7 are recorded from the United States. The remaining 11 species are distributed only in the Neotropics. This composition of poneromorph ants may result from the location of the state at the juncture of these 2 biogeographic zones (Brown 1976; Anonymous 1981; Aguilar 1990).

#### ACKNOWLEDGMENTS

The assistance of Patricia Galindo, Adriana Trejo and Teresa Suarez is gratefully acknowledged, especially for their help in the collection and mounting of ants. Thanks also to Ingrid Marquez for help with the translation of this paper.

#### REFERENCES CITED

AGUILAR, B. S. 1990. Dimensiones Ecológicas del Estado de Morelos. Centro Regional de Investigaciones Multidisciplinarias, UNAM. México D. F. 221 pp.

- ANONYMOUS, 1981. Síntesis Geográfica del Estado de Morelos. Secretaría de Programación y Presupuesto. Coordinación general de los servicios Nacionales de Estadística, Geografía e Informática. 110 pp.
- BARONI-URBANI, C. 1983. Clave para la determinación de los géneros de hormigas neotropicales. Graellsia 39: 73-82.
- BOLTON, B. 1994. Identification Guide to the Ant Genera of the World. Harvard University Press, Cambridge, MA. 222 pp.
- BOLTON, B. 1995. A New General Catalogue of the Ants of the World. Harvard University Press, Cambridge, MA. 504 pp.
- BOLTON, B. 2003. Synopsis and Classification of Formicidae. Mem Am Entomol Inst. 71: 1-370.
- BRANDÃO, C. R. F. 1991. Adensos ao catálogo abreviado das formigas da região Neotropical. Rev. Brasileira Entomol. 35: 319-412.
- BRANDÃO, C. R. F. 1996. Catalogue of the Neotropical Ponerinae (Hymenoptera: Formicidae) [http://research.amnh.org/entomology/social\\_insects/ponesam.html](http://research.amnh.org/entomology/social_insects/ponesam.html)
- BROWN, W. L., JR. 1975. Contribution toward a reclassification of the Formicidae. V. Ponerinae, Tribes Platythyreini, Cerapachyini, Cyldromyecini, Acanthostichini and Aenictogitini. Search 5: 1-116.
- CARTAS, C. A. 1993. Aspectos ecológicos de la formico-fauna (Hymenoptera: Formicidae) del Volcán San Martín Pajapan, Veracruz. Tesis de Licenciatura. Fac. de Biol., Univ. Veracruzana. 78 pp.
- CASTAÑO-MENESES, G. 1996. Características ecológicas de las hormigas en la selva baja caducifolia de Chamela, Jal. Tesis de Maestría en Ciencias, Facultad de Ciencias, Universidad Autónoma de México, 92 pp.
- DUROU, S., A. DEJEAN, I. OLMSTED, AND R. R. SNELLING. 2002. Ant diversity in coastal zones of Quintana Roo, Mexico, with special reference to Army ants. Sociobiology 40:385-401.
- HÖLDOBLER, B., AND E. O. WILSON. 1990. The Ants. Belknap Press of Harvard University Press, Cambridge, MA. 732 pp.
- KEMPF, W. W. 1972. Catálogo abreviado das formigas da Região Neotropical. Studia Entomol. 15: 3-344.
- LACHAUD, J. P. 1990. Foraging activity and diet in some Neotropical ponerine ants I. Ectatomma ruidum Roger (Hymenoptera: Formicidae). Folia Entomol. Mexicana (78): 241-256.
- LACHAUD, J. P., AND J. A. GARCÍA-BALLINAS. 2001. Diversité de la myrmécofaune (Ponerinae et Cerapachyinae) dans les agroécosystèmes de café et cacao au Mexique. Actes des Colloques Insectes Soc. 14: 95-99.
- LATTKE, J. E. 1995. Revision of the ant genus *Gnampotogenys* in the New World (Hymenoptera: Formicidae). J. Hym. Res. 4: 137-193.
- LATTKE, J. E. 2003. Capítulo 16 Subfamilia Ponerinae, pp. 261-276 In F. Fernández (ed) Introducción a las Hormigas de la Región Neotropical Instituto Humboldt, Bogotá D.C., xxvi + 398 pp.
- LONGINO, J. T. 1998. Ants of Costa Rica. <http://www.evergreen.edu/ants/AntsofCostaRica.html>
- MACKAY, W. P., AND S. B. VINSON. 1989. A guide to species identification of New World ants (Hymenoptera: Formicidae). Sociobiology 16: 3-47.
- MACKAY, W. P., AND E. MACKAY. 1989. Clave de los Géneros de Hormigas en México (Hymenoptera: Formicidae). Memorias del II Simposio Nacional de Insectos Sociales. Oaxtepec, Mor. México. Sociedad Mexicana de Entomol. pp. 1-82.

- MIRANDA, F., AND E. HERNÁNDEZ X. 1963. Los tipos de vegetación de México y su clasificación. *Boletín de la Sociedad Botánica de México* 27: 67-114.
- QUIROZ-ROBLEDO, L., AND J. VALENZUELA-GONZÁLEZ. 1995. A comparison of ground ant communities in a tropical rainforest and adjacent grasslands in Los Tuxtlas, Veracruz, Mexico. *Southwest. Entomol.* 20: 203-213.
- QUIROZ-ROBLEDO, L., J. VALENZUELA-GONZÁLEZ, AND L. T. SUÁREZ. 2002. Las hormigas ecitoninas (Formicidae: Ecitoninae) de la Estación de Biología Tropical "Los Tuxtlas", Veracruz, México. *Folia Entomol. Mexicana* 41: 261-281.
- QUIROZ-ROBLEDO, LUIS N., AND J. E. VALENZUELA-GONZÁLEZ. 2006. Las hormigas Ecitoninae (Hymenoptera: Formicidae) de Morelos, México. *Rev. Biol. Trop.* 54(2): 531-552.
- RODRÍGUEZ, G. J. A. 1986. Hormigas (Hymenoptera: Formicidae) de Nuevo León. Tesis de Maestría en Ciencias, Colegio de Postgraduados, 107 pp.
- ROJAS-FERNÁNDEZ, P. 1996. Formicidae (Hymenoptera), pp 483-500 *In* J. Llorente Bousquets, A. N. García-Aldrete, and E. González-Soriano (eds.), *Biodiversidad Taxonomía y Biogeografía de Artrópodos de México: Hacia una Síntesis de su Conocimiento*. UNAM: México.
- RZEDOWSKI, J. 1978. *La Vegetación de México*. Primera edición. Ed. Limusa. México. DF. 432 pp.
- SMITH, D. R. 1979. Superfamily Formicoidea, Family Formicidae, pp. 1323-1467 (Vol. 2) *In* K. V. Krombein, P. D. Hurd, D. R. Smith, and B. D. Burks (eds), *Catalog of Hymenoptera in America North of Mexico*. Smithsonian Institution Press. Washington D.C.
- VIDAL, C. R. 1980. *Algunas Relaciones Clima-cultivos en el Estado de Morelos*. Primera edición. Instituto de Geografía, UNAM. México D.F. 95 pp.
- WILSON, E. O. 1955. Ecology and behavior of the ant *Belonopelta deletrix* Mann (Hymenoptera: Formicidae). *Psyche* 62: 82-87.
- WILSON, E. O., AND R. W. TAYLOR. 1967. The Ants of Polynesia (Hymenoptera: Formicidae). *Pac. Insects Monogr.* 14: 1-109.