THE SOUTHWESTERN NATURALIST 44(4):457–461 DECEMBER 1999

THE MYRMECOFAUNA (HYMENOPTERA: FORMICIDAE) ALONG AN ALTITUDINAL GRADIENT IN THE SIERRA MADRE ORIENTAL OF NORTHEASTERN MEXICO

KARLA Y. FLORES-MALDONADO, SHERMAN A. PHILLIPS, JR., AND GERARDO SÁNCHEZ-RAMOS

Instituto de Ecología y Alimentos, Universidad Autonoma de Tamaulipas, Ciudad Victoria, Tamaulipas, C.P. 87040, Mexico (KYF-M, GS-R)
Department of Plant and Soil Science, Texas Tech University, Lubbock, TX 79409-2134 (SAP)

ABSTRACT—Necrophilic traps were used to collect ants from both disturbed and undisturbed sites within the Cañon del Novillo which is located in the Sierra Madre Oriental of northeastern Mexico. Of the 23 species of Formicidae collected, representing five subfamilies, one species is a new record for Mexico, and six species are new records for the state of Tamaulipas. Shannon-Wiener index of diversity showed that undisturbed pine and oak forest sites were more diverse than disturbed sites, but that the disturbed site was more diverse than the undisturbed site in the tropical forest.

RESUMEN—Se utilizaron trampas necrofílicas para colectar hormigas en áreas alteradas y no alteradas en el Cañón del Novillo, localizado en la Sierra Madre Oriental, al noreste de México. Se colectaron 23 especies de Formicidae representadas en cinco subfamilias, de las cuales una es un nuevo registro para México y seis son nuevos registros para el estado de Tamaulipas. El indice de diversidad de Shannon-Wiener mostró que las áreas no alteradas de los bosques de pino y encino fueron más diversas que las áreas alteradas, pero en el bosque tropical, las áreas alteradas fueron más diversas que las áreas no alteradas.

Ants are one of the most abundant groups of animals in terrestrial ecosystems and are present in nearly all habitats (MacKay, 1981). This family (Formicidae) is adapted to a wide range of conditions and food resources (Michener and Michener, 1951). Although most ants are omnivorous (Carroll and Janzen, 1973), many are strictly carnivorous. Others are phytophagous and feed on fungi and plant products such as leaves, seeds, and nectar (Holdobler and Wilson, 1990). Currently 8,804 species of ants are known worldwide, and of those, 580 are reported from the nearctic regions (Holdobler and Wilson, 1990).

Although Mexico contains a wide diversity of insect life, in part because it consists of both the Nearctic and Neotropical realms, its myrmecofauna is not well known (Rojas-Fernández, 1996). Continued habitat transformation in Mexico will destroy many species before they can be described and studied. However, investigators have begun to catalogue the ants of Mexico (Kempf, 1972; Watkins, 1982; MacKay et al., 1985; MacKay, 1987; Rojas-Fernández and Cartas, 1991, 1992; Rojas-Fernández and Fragoso, 1994; Escobar-Urrutia and Morales-Moreno, 1996), and some (MacKay and MacKay, 1989) have constructed keys to the genera. Within the state of Tamaulipas where the present study took place, 33 species within six subfamilies are known (Jusino-Atresino and Phillips, 1992).

The primary objective of this study was to sample the myrmecofauna from three relatively pristine areas along an altitudinal gradient in the Sierra Madre Oriental of the state of Tamaulipas in northeastern Mexico. Secondarily, we compared species found within these areas to those found in similar but disturbed habitats.

METHODS AND MATERIALS—The study site was located in the Cañon del Novillo in the mountains of the Sierra Madre Oriental of northeastern Mexico. Specifically, the site was in the municipio (county) of Ciudad Victoria, Tamaulipas, Mexico, from 23°41′09″ to 23°45′00″ N and 99°11′10″ to 99°18′20″

W, at an altitude between 450 and 1,700 m above sea level. The climate is semiarid with an average annual temperature between 18 and 22°C. Precipitation varies between 800 and 900 mm annually. Three different biomes can be found within this area (Gutiérrez-Nuñez et al., 1993). The woody vegetation of the lower tropical forest, between 450 and 600 m, includes *Esenbechia runyonii, Sapindy saponaria, Platanus mexicana, Salix humboldtiana,* and *Populus.* The dominant understory vegetation consists of *Piper amalago, Heimia salicifolia,* and *Baccharis.* The oak forest, located between 600 and 800 m, is composed of *Quercus glaucoides, Q. laurina, Q. polymorphay,* and *Q. sartorii,* and the dominant understory vegetation of this biome consists of *Randia* and *Pithecellobium pallens.* Pine forest can be found at 800 m and above and is composed of *Pinus teocote,* with an understory consisting mostly of *Acacia angustissima, Dioon endule* and *Brahea dulcis.*

The study was initiated in October 1994 and terminated in August 1995. Ants were collected using a modified necrophilic trap for collecting insects known as an NTP-80 (for description see Morón and Terrón, 1982, 1984). The traps we used, however, were 30 cm in height and 9 cm in diameter. Traps were baited with fish according to the methods of Morón and Terrón (1982, 1984), and ethylene glycol diluted 50% with water was used as the preservative within each container. Traps were placed in the ground, the top of each container flush with the soil surface. Two traps were used to sample each of the three altitudinal gradients (biomes). One trap within each of the three biomes was placed in a disturbed area, whereas the other traps were placed in undisturbed areas. Disturbance within the canyon was characterized by human impact such as grazing of cattle, sheep, horses, and goats, presence of pigs and dogs, and collection of vegetation for cooking fuel. In addition, a one-lane dirt road provided access through the canyon for other types of human activity such as recreation, with the subsequent accumulation of food remnants and trash. Traps in disturbed areas were placed within 30 m of this dirt road. Traps in the undisturbed portion were placed ca. 1 km away from these areas but within the same vegetation type. Ants were removed from traps every 3 months (December, March, and June) for the first three sampling periods. For the last collection, traps were left in the field for only 2 months because of the onset of the rainy season which begins in August. With each removal, fresh fish bait and clean ethylene glycol were reintroduced. Ants were preserved in 70% ethanol in the laboratory, and keys of MacKay and MacKay (1989) and Holdobler and Wilson (1990) were used for identification to genera. Subsequently, specimens were sent to W. P. MacKay, University of Texas at El Paso (UTEP), for verification and identification of species, and voucher specimens were placed there in the Department of Biology (UTEP).

Species diversity in each of the habitats was determined using the Shannon-Wiener index of diversity. In addition, Sorenson's similarity coefficient was used to determine the effect of disturbance within each of the biomes (Magurran, 1988).

RESULTS—A total of 23,505 specimens was collected representing five subfamilies and 23 species (Table 1). Of those, *Apterostygma pilosum* Mayr is a new species record for Mexico, although Kempf (1972) alluded to the possibility of its occurring in that country. In addition, the following are new records for the state of Tamaulipas: *Trachymyrmex turrifex* (Wheeler), *Leptothorax (Macromischa)* sp., *Pachycondyla villosa* (Fabricius), *Labidus praedator* (Smith), *Neivamyrmex opacithorax* (Emery), and *Camponotus abdominalis* (Fabricius).

Surprisingly, species heterogeneity was greatest in the disturbed site of the tropical forest compared to that of the undisturbed tropical forest site (Shannon-Wiener Index = 0.78 and 0.18 for disturbed and undisturbed sites, respectively). In addition, Sorensen's coefficient of similarity of 0.52 indicates that the two sites shared ca. 50% of the species in common. However, in oak habitat, the Shannon-Wiener Index was greater (0.88) for the undisturbed site than the disturbed site (0.37). Sorensen's similarity coefficient of 0.47 once again indicates that about half of the species were shared. The pine forest habitat also showed a higher value for Shannon-Wiener in the undisturbed site (0.78) compared to the disturbed site (0.19), and all species found in the undisturbed site also were found in the disturbed site (Sorensen = 1.0).

DISCUSSION—The pine forest habitat at the higher elevation of the canyon showed a greater richness of species in undisturbed sites compared to disturbed sites. In addition, all species of the undisturbed site of the pine habitat (highest elevation) were represented at the disturbed site. Midway down the canyon in the oak habitat, species richness was still greater in the undisturbed habitat, but only half the species were shared between disturbed and undisturbed sites. These findings might be expected and are in agreement with Rojas-Fernández and Cartas (1992) in which they found fewer

TABLE 1—Ants collected with necrophilic traps in the Sierra Madre Oriental (Cañon del Novillo) from the state of Tamaulipas in northeastern Mexico (October 1994–August 1995; U = undisturbed, D = disturbed).

Taxa	Number of ants					
	Tropical		Oak		Pine	
	U	D	U	D	U	D
Subfamily: Myrmicinae						
Tribe Pheidolini						
Pheidole sp. 1	1	2	7	242	0	0
Pheidole sp. 2	0	0	2,719	0	4	64
Pheidole sp. 3	0	0	3	65	1	1
Pheidole sp. 4	0	2	0	0	1	0
Pheidole sp. 5	0	0	0	36	0	0
Pheidole sp. 6	1	0	169	0	0	0
Aphaenogaster sp.	5	2	1	0	40	0
Tribe Attini						
Apterostygma pilosum Mayr[a]	0	11	0	0	0	1
Trachymyrmex turrifex (Wheeler)[b]	0	6	0	0	1	1
Atta mexicana (F. Smith)	11	22	14	0	0	3
Cyphomyrmex sp.	0	0	2	0	0	1
Tribe Solenopsidini						
Monomorium marjoriae Dubois	0	0	9	0	0	6
Solenopsis geminata (Fabricius)	0	10	34	4,331	792	9,610
Tribe Crematogastrini						
Crematogaster sp.	17	8	2	46	15	1
Tribe Leptothoracini						
Leptothorax (Macromischa) sp.[b]	0	4	2	0	0	0
Subfamily Ponerinae						
Tribe Ponerini						
Pachycondyla villosa (Fabricius)[b]	1	0	5	0	0	0
Leptogenys sp.	0	0	1	0	1	2
Tribe Ectatommini						
Ectatomma tuberculatum (Olivier)	2	0	0	0	0	0
Subfamily Ecitoninae						
Tribe Ecitonini						
Eciton mexicanum (Roger)	0	1	0	0	2,051	10
Labidus praedator (Smith)[b]	1,125	334	1,313	5	24	261
Neivamyrmex opacithorax (Emery)[b]	0	0	1	0	1	0
Subfamily Formicinae						
Tribe Camponotini						
Camponotus abdominalis (Fabricius)[b]	0	0	0	0	0	19
Subfamily Dolichoderinae						
Tribe Tapinomini						
Forelius pruinosus (Roger)	0	0	0	0	21	1
Total number of specimens	1,163	402	4,282	4,725	2,952	9,981
Total number of species	8	11	15	6	12	14

[a] New record for Mexico.
[b] New record for Tamaulipas.

ant species in disturbed habitats in the state of Veracruz, Mexico, which borders the state of Tamaulipas. In addition, MacKay et al. (1991) found only 32 of an original 71 species at their study site in the state of Chiapas, Mexico, 1 month after a slash and burn policy had been implemented, again confirming the deleterious impact that habitat perturbation has on diversity of ant species (Rojas-Fernández, 1996). Within the lowest section of the canyon, typified by tropical forest, and that portion of the canyon most impacted by human activity, once again about half the species were shared between disturbed and undisturbed sites, as observed in oak habitat. However, in this instance, the greatest diversity was observed at the disturbed compared to undisturbed site. This last finding is in agreement with Jusino-Atresino and Phillips (1992) who also found ant diversity to be highest in tropical forest habitats of the biosphere reserve "El Cielo" that had been altered by human activity compared to that which had not been altered.

This study may raise the question as to whether ants are useful as indicators of ecological disturbance. Granted, indices of diversity were inversely related to disturbance in the higher elevations, but that disturbance was minimal compared to the tropical forest perturbation in the lower, more accessible areas of the canyon. Perhaps ants are so successful and adaptable that they are only minimally affected by environmental change. If this is found to be true, then their use as key bioindicators of environmental pertubation may be limited. Obviously, disturbance affects ants. But the question as to how much disturbance is required to produce a measurable effect remains elusive.

We thank W. P. MacKay, University of Texas at El Paso, for verification and identification of species and J. Delgado Cabañas for assistance in the field and in the laboratory. We also are indebted to personnel of the Institute of Food and Ecology, Autonomous University of Tamaulipas, for logistical and financial support of this project.

Literature Cited

Carroll, C. R., and D. H. Janzen. 1973. Ecology of foraging by ants. Annual Review of Ecology and Systematics 4:231–257.

Escobar-Urrutia, D. C., and A. Morales-Moreno. 1996. Mirmecofauna atraída a las necrotrampas NTP-80. in Sta. Martha, Los Tuxtlas, Veracruz, México. In: Deloya-Lopez, C., editor. Memorias del VI Latinamericano Congreso de Entomología Sociedad Mexicana de Entomología, A. C. Pp. 37–38.

Gutiérrez-Nuñez, C., J. Treviño, A. Mora, and A. Cardona. 1993. Evaluación ambiental y bases para un programa de manejo sostenido del Cañon del Novillo, Cd. Victoria, Tam. Sociotam III 1: 21–56.

Holdobler, B., and E. O. Wilson. 1990. The ants. Belknap Press of Harvard University Press, Cambridge, Massachusetts.

Jusino-Atresino, R., and S. A. Phillips, Jr. 1992. Myrmecofauna en la reserva ecológica de la biosfera "El Cielo", Tamaulipas, México. Biotam 4: 41–54.

Kempf, W. W. 1972. Catalógo abreviado das formigas da regiao neotropical (Hym. Formicidae). Studia Entomólgica 15:3–344.

MacKay, W. P. 1981. A comparison of the nest phenologies of three species of *Pogonomyrmex* harvester ants (Hymenoptera: Formicidae). Psyche 88:25–75.

MacKay, W. P. 1987. El género *Pogonomyrmex* en Mexico (Hymenoptera: Formicidae). Resúmenes del XXII Congreso Nacional de Entomología, Pp. 193–194.

MacKay, W. P., and E. E. MacKay. 1989. Clave de los géneros de hormigas en México (Hymenoptera: Formicidae). Memorias II, Simposio Nacional de Insectos Sociales, Oaxtepec, Morelos, Pp. 1–82.

MacKay, W. P., E. E. MacKay, J. F. Perez-Dominquez, L. I. Valdez-Sánchez, and P. Vielma-Orozco. 1985. Las hormigas del Estado de Chihuahua Mexico: el género *Pogonomyrmex* (Hymenoptera: Formicidae). Sociobiology 11:39–54.

MacKay, W. P., M. A. Rebeles, H. C. Arredondo, A. D. Rodríguez, D. A. González, and S. B. Vinson. 1991. Impact of the slashing and burning of a tropical rain forest on the native ant fauna (Hymenoptera: Formicidae). Sociobiology 18:257–268.

Magurran, A. E. 1988. Ecological diversity and its measurement. Princeton University Press, Princton, New Jersey.

Michener, C. D., and M. H. Michener. 1951. American social insects: a book about bees, ants, wasps and termites. Van Nostrand, New York.

Morón, M. A., and R. Terrón. 1982. Análisis de la entomofauna necrófila de la Cañada de Otongo, Hidalgo. Folia Entomológica Mexicana 53:38–39.

Morón, M. A., and R. Terrón. 1984. Distribución altitudinal y estacional de los insectos en la Sierra Norte de Hidalgo, México. Acta Zoológica Mexicana 3:1–47.

Rojas-Fernández, P. 1996. Formicidae (Hymenop-

tera). In: Llorente-Bousquets, J., A. N. García-Aldrete, and E. González-Soriano, editors. Biodiversidad, taxonomía y biogeografía de arthrópodos de México: hacia una síntesis de su conocimiento. Universidad Nacional Autónoma de Mexico, Ciudad de México. Pp. 483-500.

ROJAS-FERNÁNDEZ, P., AND A. CARTAS. 1991. La formicofauna de ladera SW del Volcán San Martin Pajapan, Veracruz, en relación a sus tipos de vegetación. In: Sociedad Mexicana de Entomología, editors. Memorias del XXXVI Congreso Nacional de Entomología, Veracruz. Pp. 403.

ROJAS-FERNÁNDEZ, P., AND A. CARTAS. 1992. Estudio faunístico de las hormigas (Hymenoptera: Formicidae) del estado de Veracruz; los géneros y su distribución. In: Sociedad Mexicana de Entomología, editors. Memorias del XXXVII Congreso Nacional de Entomología, San Luis Potosí. Pp. 174.

ROJAS-FERNÁNDEZ, P., AND C. FRAGOSO. 1994. The ant fauna (Hymenoptera: Formicidae) of the Mapimi Biosphere Reserve, Durango, Mexico. Sociobiology 24:47–75.

WATKINS, J. F., II. 1982. The army ants of Mexico (Hymenoptera: Formicidae: Ecitoninae). Journal of the Kansas Entomological Society 55:197–247.

Submitted 22 September 1997. Accepted 14 December 1998. Associate Editor was Steven Goldsmith.