# Synanthropy and ecological aspects of Muscidae (Diptera) in a tropical dry forest ecosystem in Colombia

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ABSTRACT. Synanthropy and ecological aspects of Muscidae (Diptera) in a tropical dry forest ecosystem in Colombia. The synanthropic index and other ecological aspects of the Muscidae family were evaluated through simultaneous monthly sampling in three different environments (urban, rural and forest) using van Someren-Rydon traps baited with human faeces, chicken viscera and decomposing fish and onion. Four traps were set up in each environment (one per bait item) for 48 hours per month, with samples taken every 12 hours. A total of 5726 specimens were collected, belonging to 19 species and 13 genera. *Brontaea normata* (+99,9), *Brontaea quadristigma* (+96,9), *Synthesiomyia nudiseta* (+96,5), *Ophyra aenescens* (+96,2), *Musca domestica* (+95,7) and *Atherigona orientalis* (+93,8) had the highest synanthropic indices, showing a marked preference for human environments. The most abundant species were *B. normata* (24,31%), *Biopyrellia bipuncta* (20,60%) and *Pseudoptilolepis nigripoda* (15,82%), the latter two showed a preference for uninhabited areas. A total of 11 new records for Colombia were found: *Ophyra aenescens*, *Cyrtoneuropsis pararescita*, *Morellia basalis*, *Neomuscina dorsipuncta*, *Biopyrellia bipuncta*, *Pseudoptilolepis nigripoda*, *Neomuscina instabilis, Neomuscina currani*, *Polietina orbitalis*, *Neomuscina pictipennis* and *Cyrtoneuropsis maculipennis*. Except for the first four species, the remainder presented negative synantrophy indexes (from minor to major), which would allow to use them as ecological indicators of the disturbance degree of dry forests in Colombia.

KEYWORDS. Ecology; flies; human environments; La Pintada.

RESUMEN. Sinantropía y algunos aspectos de la ecología de Muscidae (Diptera) en un ecosistema de bosque seco tropical en Colombia. Se evaluó el índice de sinantropía al igual que otros aspectos ecológicos de la familia Muscidae, mediante muestreos mensuales simultáneos en tres ambientes (urbano, rural y bosque), para lo cual se utilizaron trampas van Someren Rydon cebadas con excremento humano, vísceras de pollo, pescado y cebolla en descomposición. En cada zona se instalaron cuatro trampas (una por atrayente), durante 48 horas cada mes, realizando colectas cada 12 horas. Se colectaron 5726 ejemplares pertenecientes a 19 especies y 13 géneros. *Brontaea normata* (+99,9), *Brontaea quadristigma* (+96,9), *Synthesiomyia nudiseta* (+96,5), *Ophyra aenescens* (+96,2), *Musca domestica* (+95,7) y *Atherigona orientalis* (+93,8), presentaron los índices de sinantropía mas altos, mostrando una marcada preferencia por los ambientes humanos. Las especies más abundante fueron *B. normata* (24,31%), *Biopyrellia bipuncta* (20,60%) y *Pseudoptilolepis nigripoda* (15,82%), las dos últimas con preferencia por áreas deshabitadas. Se encontraron un total de 11 reportes nuevos para Colombia: *Ophyra aenescens*, *Cyrtoneuropsis pararescita*, *Morellia basalis*, *Neomuscina dorsipuncta*, *Biopyrellia bipuncta*, *Pseudoptilolepis nigripoda*, *Neomuscina instabilis, Neomuscina currani*, *Polietina orbitalis*, *Neomuscina pictipennis* y *Cyrtoneuropsis maculipennis*. Exceptuando las primeras cuatro especies, las restantes presentaron índices de sinantropía bajos (de menor a mayor), lo que permitiría usarlas como indicadores ecológicos del grado de perturbación de los bosques secos en Colombia.

PALABRAS-CLAVE. Ambiente humano; ecología; La Pintada; moscas.

Muscidae are a large family belonging to the order Diptera. Almost 4500 species have been described, covering all biogeographic regions, 846 of which are present in the Neotropics (de Carvalho *et al.* 2005). Adults can be predatory, hematophagous, saprophagous or necrophagous, living in varied habitats, such as dung, decomposing organic vegetable or animal matter, wood, fungi, nests and dens, among others (Couri & de Carvalho 2005; Espindola 2006). Some species are considered to be of medical and veterinary importance, given that they act as mechanical vectors for a large variety of pathogens (Greenberg & Klowden 1972; Manrique-Saide & Delfín-González 1997; Thyssen *et al.* 2004; Graczyk *et al.* 2005; Sukontason *et al.* 2006; Reilly *et al.* 2007), others cause obligate or facultative myiasis (Greenberg 1971; Guimarães & Papavero 1999).

Some species have developed a close relationship with human settlements given the available resources at these dwellings (Linhares 1981a). The degree and nature of this relationship depends on the species, geographic and climatic variation, as well as the characteristics of each human group who modify their surroundings according to their way of life. This type of behaviour is known as synanthropy (Nuorteva 1963). Gregor and Povolny (1958) classified this behaviour in three categories according to the abundance of each species in a determined ecological area: eusynanthropic (endophilic and exophilic; communicative and non communicative), hemisynanthropic and asynanthropic. Eusynanthropic species are typically urban and can be found within housing; hemisynanthropic species inhabit semi-rural areas; and asynanthropic species are mainly found in well-conserved environments. The former two categories are of the highest medical and sanitary importance.

Tropical dry forest is considered one of the most threatened ecosystems in the Neotropics given the intense changes in land use due to human activities (Janzen 1983). In Colombia, this ecosystem is placed among the three most degraded and fragmented ecosystems, as well as being one of the least well known (Álvarez *et al.* 1997). Only about 1.5% of the original ecosystem coverage of 80,000 km$^2$ is estimated to remain (Etter 1993). Dry forest was originally located on the Caribbean plains and inter-Andean valleys of the rivers Magdalena and Cauca between an altitude of 0 and 1000 m, in the provinces of Valle del Cauca, Tolima, Huila, Cundinamarca, Antioquia, Sucre, Bolívar, Cesar, Magdalena, Atlántico and south Guajira (Álvarez *et al*. 1997). Knowledge of this habitat type in Colombia is poor (Álvarez *et al.* 1997) and represents a serious obstacle to its conservation and sustainable management. Entomological knowledge of this ecosystem is even more deficient, estimates of insect diversity are lacking and their roles in ecosystem functioning are largely unknown (Escobar 1997). Monitoring of insects in natural areas is one of the simplest ways to observe and provide early warning of changes to biodiversity and habitat structure. This is possible for insects' utility as biological and ecological indicators of local, regional and national diversity as well as degree of disturbance.

Muscidae is an important component of South America's synanthropic fauna, however the species of the family had only been studied from this perspective in Cuba (Gregor 1975); Campinas (Linhares 1981b), Curitiba (de Carvalho *et al*. 1984), Rio de Janeiro (d'Almeida 1992), Pelotas (Costa *et al.* 2000) and Paracambi (Espindola 2006) in Brazil; and Valdívia (Figueroa & Linhares 2004) in Chile. In Colombia, studies on Muscidae are scarce. The present study aims to evaluate ecological and synanthropic aspects of the species of Muscidae in three areas differing in their degree of human intervention, thus contributing to knowledge of this group within a tropical dry forest ecosystem.

## MATERIAL AND METHODS

### Study Area

The municipality of La Pintada is located in the southeast of the province of Antioquia at a latitude of 5º 44' north, a longitude of 75º 36' west and an altitude of 600 m. The area is of great regional importance given that it is located at a strategic intersection of interprovincial highways within the province. The municipality has an area of 55 km$^2$ with a population of 10,450 inhabitants and an urban area of 6.5 km$^2$. Average annual temperature is 27ºC and relative humidity is 76%. Average annual rainfall is 1000 mm, with a bimodal pattern consisting of two wet seasons (April-May and September-November) and two drier periods (December-March and June-August) (Velásquez *et al.* 2006).

Sampling was carried out simultaneously in three areas with different ecological characteristics. 1) Urban Zone: located in the municipal capital (5º44'48"N; 75º36'34"W) at an altitude of 610 m. This area has piped drinking water, sewers and periodic rubbish collection. 2) Rural Zone: sampling was carried out in fields (5º43'25"N; 75º37'26"W) at 5 km from the urban zone and at an altitude of 770 m. Drinking water in this area is collected from a spring, there is also a sceptic tank, and rubbish is buried. The site provides ecotourism services with approximately 150 visitors per month, there are four permanent inhabitants as well as cattle and horses. 3) Forest Zone: this area is characterised by low human disturbance and is located at the base of a rocky outcrop, known as the Farallón de la Paz, at 5.5 km from the Urban Zone and at an altitude of 850 m (5º43'24"N; 75º37'15"W).

### Sampling

Flies were captured with Van Someren-Rydon traps, placed 1 m above the ground and separated by 50 m between each trap. Four types of bait were used: chicken viscera, decomposing fish, human faeces (Nourteva 1963) and decomposing onion (*Allium cepa* L.) (de Carvalho *et al*. 1984). Care was taken to place approximately the same quantity of bait (100g) per trap. Four traps (one per type of bait) were placed in each of the three zones of the study area for a period of 48 hours each month for six months. Samples were taken every 12 hours, wetting the bait if necessary. Samples were separated by trap and by time of collection (day 6:00-18:00 and night 18:00-6:00).

The study was carried out from February to July 2007: 15-16 February, 15-16 March, 19-20 April, 24-25 May, 21-22 June and 25-26 July. Weather data during the sampling period were provided by the Colombian Meteorological Institute (Instituto de Hidrología, Meteorología y Estudios Ambientales de Colombia -IDEAM).

### Preservation

Specimens were separated, quantified, mounted and identified using taxonomic keys the de Carvalho (2002), Marques and Couri (2007) and Nihei and de Carvalho (2007). A reference collection was deposited at the Entomological Collection of the Universidad de Antioquia (CEUA - National Collection No. 036).

### Synanthropic index

The synanthropic index (SI) was calculated according to Nuorteva (1963) using the formula:

$$IS = (2a+b-2c)/2$$

a = percentage of individuals of each species collected in the urban zone

b= percentage of the same species collected in the rural zone

c = percentage of the same species collected in the forest zone

The index ranges from +100 to -100, where a value of +100 indicates a strong preference of the species for densely populated urban areas and -100 indicates a complete avoidance of human settlements. Intermediate values indicate differential degrees of synanthropy. This analysis was carried out for those species with more than 10 individuals collected.

## RESULTS

A total of 5726 specimens of Muscidae were collected, belonging to 13 genera and 19 species, 11 of which are new reports for Colombia (Table I). *Brontaea normata* (Bigot, 1885), *Biopyrellia bipuncta* (Wiedemann, 1830) and *Pseudoptilolepis nigripoda* (Snyder, 1949) were the most abundant species, representing 61.16% of the total number of individuals. Monthly abundance of Muscidae species is shown in Table III. In general terms, abundance increased in months with most rainfall (Fig. 1). With regard to nycthemeral (daily) behaviour, 68.39% of individuals showed diurnal activity between 6:00 and 18:00 (Table II). A greater number of females was collected, representing 67.05% of the total (Table II).

*Brontaea normata* has a Neotropical distribution, present in Mexico, Venezuela, Colombia, Peru, Bolivia, Brazil and Paraguay (de Carvalho & Pont 1997). This species showed the highest number of captures (Table I), corresponding to 24.31% of the Muscidae studied. The majority of individuals were collected in May in the urban study area (97.43%), showing a notable increase in abundance during this month (Table III). This species also showed a strong attraction for faeces, with a preference of 99.29%. Its synanthropic index was +99.89, showing a strong preference for human settlements. It was not recorded in the forest zone (Table V). In total, 62.86% of specimens were collected at night.

*Biopyrellia bipuncta* was the second highest in abundance (Table I). The species is found in Mexico, Costa Rica, Panama, Venezuela, Trinidad and Tobago, Bolivia, Brazil, Paraguay and Argentina (de Carvalho *et al.* 2005). This study represents the first record of the species for Colombia. The species showed an increase in abundance in months with less rainfall, with a peak in June, when 59.13% of the total number of individuals were collected. The species showed a strong preference for human faeces (Table IV) and its synanthropic index was -20.86, implying a strong avoidance of human settlements.

*Pseudoptilolepis nigripoda* has been recorded from Nicaragua, Panama, Brazil (Schuehli & de Carvalho 2005), Costa Rica, Venezuela (de Carvalho *et al.* 2005), USA (Lopes & de Carvalho 1985). This study represents the first record from Colombia. It showed greatest abundance in the wettest months, especially April (Table III). It was strongly attracted to decomposing animal bait (Table IV), especially chicken viscera, representing 57.94% of captures. Its synanthropic index was -35.43, showing a strong avoidance of human settlements.

*Morellia basalis* (Walker, 1853) has been reported in Mexico, El Salvador, Costa Rica, Jamaica, Cuba, Haiti, Puerto Rico, US Virgin Islands, Venezuela and the Neartic region (de Carvalho *et al.* 2005), with this study representing the first record for Colombia. The greatest number of captures was made in the months of May and June (Table III). The greatest number of individuals was collected on human faeces (Table IV). Its synanthropic index was +74.53, showing a strong preference for human settlements, with 57.7% collected in the urban area.

*Cyrtoneuropsis gemina* (Wiedemann, 1830) is found in Mexico, Guatemala, Belize, El Salvador, Costa Rica, Panama, Colombia, Peru, Venezuela, Brazil and Paraguay (de Carvalho *et al.* 2005). Capture of this species was directly related to rainfall, increasing in those months with greatest rainfall (Table III). A total of 92.19% of individuals were collected on human faeces, showing a strong preference for this type of bait. The synanthropic index of this species was +69.53,

Table I. Absolute and relative frequencies of species of Muscidae (n≥10) in three localities areas in La Pintada, Colombia from February to July 2007. * New report from Colombia.

| Species | Urban | | Rural | | Forest | | Total |
|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | |
| *Atherigona orientalis* | 236 | 94,8 | 7 | 2,8 | 6 | 2,4 | 249 |
| *Biopyrelllia bipuncta** | 10 | 0,8 | 614 | 51,6 | 565 | 47,5 | 1189 |
| *Brontaea quadristigma* | 136 | 93,8 | 9 | 6,2 | 0 | 0,0 | 145 |
| *Brontaea normata* | 1400 | 99,8 | 3 | 0,2 | 0 | 0,0 | 1403 |
| *Cyrtoneurina geminata* | 1 | 2,3 | 23 | 52,3 | 20 | 45,5 | 44 |
| *Cyrtoneuropsis gemina* | 179 | 55,8 | 123 | 38,6 | 18 | 5,6 | 320 |
| *Cyrtoneuropsis maculipennis** | 0 | 0,0 | 0 | 0,0 | 25 | 100,0 | 25 |
| *Cyrtoneuropsis pararescita** | 9 | 56,3 | 7 | 43,8 | 0 | 0,0 | 16 |
| *Graphomya* sp. | 3 | 12,0 | 21 | 84,0 | 1 | 4,0 | 25 |
| *Morellia basalis** | 401 | 57,7 | 274 | 39,5 | 20 | 2,9 | 695 |
| *Musca domestica* | 279 | 93,3 | 18 | 6,0 | 2 | 0,7 | 299 |
| *Neomuscina currani** | 0 | 0,0 | 10 | 32,3 | 21 | 67,7 | 31 |
| *Neomuscina dorsipuncta** | 3 | 4,5 | 45 | 68,2 | 18 | 27,3 | 66 |
| *Neomuscina instabilis** | 4 | 9,5 | 11 | 26,2 | 27 | 64,3 | 42 |
| *Neomuscina pictipennis** | 0 | 0,0 | 1 | 1,1 | 93 | 98,9 | 94 |
| *Ophyra aenescens** | 12 | 92,3 | 1 | 7,7 | 0 | 0,0 | 13 |
| *Polietina orbitalis** | 0 | 0,0 | 8 | 22,2 | 36 | 77,8 | 44 |
| *Pseudoptilolepis nigripoda** | 27 | 3,0 | 357 | 39,1 | 529 | 57,9 | 913 |
| *Synthesiomyia nudiseta* | 105 | 92,9 | 8 | 7,1 | 0 | 0,0 | 113 |
| Total | 2805 | | 1540 | | 1381 | | 5726 |

Table II. Sexual proportion and nycthemeral of the collected species in La Pintada from February to July 2007.

| Species | Female | % | Male | % | Diurnal | % | Nocturnal | % |
|---|---|---|---|---|---|---|---|---|
| *Atherigona orientalis* | 248 | 99,60 | 1 | 0,40 | 233 | 93,57 | 16 | 6,43 |
| *Biopyrellia bipuncta* | 640 | 53,83 | 549 | 46,17 | 1133 | 95,29 | 56 | 4,71 |
| *Brontaea quadristigma* | 90 | 61, | 55 | 37,93 | 46 | 31,03 | 99 | 68,28 |
| *Brontaea normata* | 932 | 66,36 | 471 | 33,64 | 523 | 37,14 | 880 | 62,86 |
| *Cyrtoneurina geminata* | 25 | 50,00 | 19 | 50,00 | 44 | 100,00 | 0 | 0,00 |
| *Cyrtoneuropsis gemina* | 267 | 83,39 | 53 | 16,61 | 263 | 82,13 | 57 | 17,87 |
| *Cyrtoneuropsis maculipennis* | 16 | 62,50 | 9 | 37,50 | 21 | 87,50 | 4 | 12,50 |
| *Cyrtoneuropsis pararescita* | 8 | 50,00 | 8 | 50,00 | 16 | 100,00 | 0 | 0,00 |
| *Graphomya* sp. | 25 | 100,00 | 0 | 0,00 | 23 | 92,00 | 2 | 8,00 |
| *Morellia basalis* | 462 | 66,47 | 233 | 33,53 | 600 | 86,33 | 95 | 13,67 |
| *Musca domestica* | 250 | 83,61 | 49 | 16,39 | 282 | 94,31 | 17 | 5,69 |
| *Neomuscina currani* | 18 | 58,06 | 13 | 41,94 | 23 | 74,19 | 8 | 25,81 |
| *Neomuscina dorsipuncta* | 30 | 45,45 | 36 | 54,55 | 33 | 50,00 | 33 | 50,00 |
| *Neomuscina instabilis* | 17 | 43,33 | 25 | 56,67 | 27 | 63,33 | 15 | 36,67 |
| *Neomuscina pictipennis* | 53 | 56,38 | 41 | 43,62 | 71 | 75,53 | 23 | 24,47 |
| *Ophyra aenescens* | 9 | 69,23 | 4 | 30,77 | 13 | 100,00 | 0 | 0,00 |
| *Polietina orbitalis* | 40 | 90,91 | 4 | 9,09 | 16 | 36,36 | 28 | 63,64 |
| *Pseudoptilolepis nigripoda* | 616 | 67,47 | 297 | 32,53 | 460 | 50,38 | 453 | 49,62 |
| *Synthesiomyia nudiseta* | 105 | 92,92 | 8 | 7,08 | 100 | 88,50 | 13 | 11,50 |
| Total | 3851 | 67,19 | 1875 | 32,81 | 3927 | 68,53 | 1799 | 31,47 |

showing a preference for human environments (Table V).

*Musca domestica* (Linnaeus, 1758) is a cosmopolitan species (de Carvalho *et al.* 2005). Slightly less than half the specimens (47.49%) were collected in April (Table III). The species showed a strong preference for animal bait (fish and chicken viscera) on which 98.32% of individuals were collected. Its synanthropic index was +95.65, showing eusynanthropic behaviour (Table V).

*Atherigona orientalis* (Schiner, 1868) is distributed throughout the tropics (de Carvalho *et al.* 2005). Its abundance was related to relative humidity, with captures increasing as humidity increased. It showed a strong preference for decaying bait on which 94.78% of individuals were collected (Table IV). The synanthropic index was +93.78, showing a strong preference for densely populated human settlements (Table V).

*Brontaea quadristigma* (Thomson, 1869) is found in Mexico, Honduras, Cuba, Puerto Rico, Guadalupe Is., Grenada, Haiti, Dominican Republic, Jamaica, St. Lucia, St. Vincent, St. Martin, Trinidad & Tobago, Peru, Colombia, Bolivia, Ecuador, Brazil, Argentina, Chile; Nearctic Region (de Carvalho et al. 2005). It was collected mainly in May (88.28%), exclusively on human faeces (Table IV). Its synanthropic index was +96.90, indicating a strong preference for human settlements, with 93.8% of individuals collected in the urban area. It was not recorded in forest.

*Synthesiomyia nudiseta* (Wulp, 1883) is found in the Neotropics (de Carvalho *et al.* 2005). It was collected throughout the study period, but with greater incidence in wetter months (Table III). It showed a greater attraction to decomposing animal bait (fish and chicken, without preference) on which 86.73% of individuals were collected (Table IV). Its synanthropic index was +96.46, showing a strong preference for urban areas, without records in the forest (Table I). Of all specimens collected, 92.92% were females (Table II).

*Neomuscina pictipennis* (Bigot, 1878) is found in Mexico, Guatemala, El Salvador, Costa Rica, Panama, Venezuela, Guyana, Peru, Brazil and Paraguay (de Carvalho *et al.* 2005). This is the first record in Colombia. It was only collected between April and July (Table III), with an increase in abundance during wetter months. Most individuals were collected on fish bait (68.09%). Its synanthropic index was -98.40, indicating a complete avoidance of human settlements. It was not collected in the urban area and 98.93% of individuals were captured in the forest area.

*Neomuscina dorsipuncta* (Stein, 1918) is found in Mexico, Costa Rica, Panama, Venezuela and Brazil (de Carvalho *et al.* 2005), with this study representing the first record for Colombia. It showed a preference for the wetter months, being absent in February when the least rainfall and the highest temperature were recorded (Fig. 1). A preference was shown for chicken viscera, with 96.97% of individuals collected on animal remains (Table IV). No specimens were taken on human faeces. Its synanthropic index was +11.36, with captures being more frequent in the rural zone (68.18%).

Less than 50 individuals of the following species were collected, therefore the index only provides an approximate indication of synanthropic trends (Nuorteva 1963).

*Polietina orbitalis* (Couri & Lopes, 1987) has only been recorded from Brazil (de Carvalho *et al.* 2005), with this study representing the first record for Colombia. It was present throughout the whole of the study period without abundance being linked to any environmental factor in particular. Although it was collected on all bait types, it showed the greatest attraction for human faeces (Table IV). Its synanthropic index was -72.73, showing an avoidance of human environments. No captures of this species were made in the urban area.

*Cyrtoneurina geminata* (Stein, 1904) is found in Mexico,

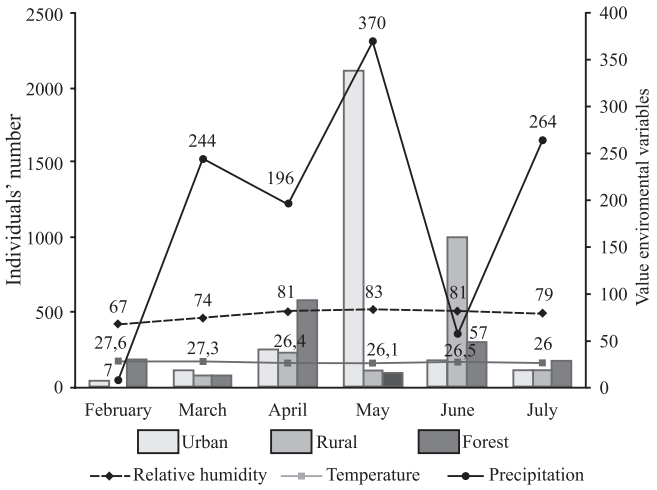


Fig. 1. The individuals' of Muscidae monthly frequency collected in each one of the sampling areas and the environmental factors among the months of February to July 2007 in La Pintada, Colombia.

Guatemala, Honduras, El Salvador, Costa Rica, Panama, Colombia, Venezuela, Peru, Brazil and Paraguay (de Carvalho *et al.* 2005). The species was collected from May through July, with greatest abundance in June. This species was only collected on human faeces and its synanthropic index was -27.63, with only 2.6% collected in urban areas, showing an avoidance of human settlements (Table V).

*Neomuscina currani* (Snyder, 1949) has been recorded in Panama and Brazil (de Carvalho *et al.* 2005). This study represents a new species record for Colombia. Specimens were collected from April through June, with greatest abundance in April (Table III), the species showed a preference for animal bait (fish and chicken) without a preference for either type. The synanthropic index for this species was -51.61, not being collected in urban areas, and therefore showing an avoidance of these environments.

*Neomuscina instabilis* (Snyder, 1949) has been recorded in Trinidad and Tobago, Panama and Brazil (de Carvalho *et al.* 2005), with this study representing a new record for Colombia. The species was present throughout the study period with the exception of February, with greatest abundance in April. It was only captured with decomposing animal bait, without preference for any type (Table IV). The synanthropic index for this species was -41.67. It was captured in all three study areas, showing a preference for forested zones (Table I).

*Graphomya* sp. was only collected in relatively wetter months (April - June), showing a greater attraction for fish bait (Table IV). Its synanthropic index was +50.00, with 84.00% of individuals collected in rural areas, showing a preference for human environments.

*Cyrtoneuropsis maculipennis* (Macquart, 1843) is found in Costa Rica, Panama, French Guiana, Brazil and Bolivia (de Carvalho *et al.* 2005), with this study representing the first record for Colombia. It was collected from April through June, with just one individual captured in February. The species was captured in all types of bait, especially fish and human faeces. The synanthropic index for this species was -100, showing a total avoidance of human settlements (Table V).

*Cyrtoneuropsis pararescita* (Couri, 1995) had only been reported for Brazil (de Carvalho *et al.* 2005) prior to this study, representing the first record for Colombia. It was only collected from May through June, showing a preference for human faeces (87.50%). Its synanthropic index was +78.13, without captures being recorded in forest areas, showing a preference for inhabited environments.

*Ophyra aenescens* (Wiedmann, 1830) is found throughout the Neotropical, Neartic and western Paleartic region, as well as the eastern Pacific (de Carvalho *et al.* 2005). It

Table III. Monthly distribution of the species of Muscidae (10≥) in La Pintada, Colombia from February to July 2007.

| Species | February | March | April | May | June | July |
|---|---|---|---|---|---|---|
| *Atherigona orientalis* | 5 | 27 | 36 | 72 | 53 | 56 |
| *Biopyrellia bipuncta* | 127 | 42 | 258 | 11 | 703 | 48 |
| *Brontaea normata* | 12 | 1 | 4 | 1367 | 16 | 0 |
| *Brontaea quadristigma* | 0 | 5 | 1 | 128 | 9 | 2 |
| *Cyrtoneurina geminata* | 0 | 0 | 0 | 2 | 39 | 3 |
| *Cyrtoneuropsis gemina* | 3 | 88 | 56 | 107 | 57 | 9 |
| *Cyrtoneuropsis maculipennis* | 1 | 0 | 15 | 6 | 3 | 0 |
| *Cyrtoneuropsis pararescita* | 0 | 0 | 0 | 5 | 11 | 0 |
| *Graphomya* sp. | 0 | 0 | 4 | 16 | 5 | 0 |
| *Morellia basalis* | 27 | 25 | 27 | 331 | 274 | 11 |
| *Musca domestica* | 8 | 58 | 142 | 40 | 27 | 24 |
| *Neomuscina currani* | 0 | 0 | 25 | 3 | 3 | 0 |
| *Neomuscina dorsipuncta* | 0 | 2 | 23 | 27 | 2 | 12 |
| *Neomuscina instabilis* | 0 | 4 | 16 | 5 | 3 | 2 |
| *Neomuscina pictipennis* | 0 | 0 | 17 | 41 | 32 | 4 |
| *Ophyra aenescens* | 0 | 0 | 1 | 8 | 3 | 1 |
| *Polietina orbitalis* | 13 | 4 | 1 | 11 | 13 | 2 |
| *Pseudoptilolepis nigripoda* | 18 | 5 | 412 | 83 | 193 | 202 |
| *Synthesiomyia nudiseta* | 8 | 1 | 16 | 54 | 20 | 14 |
| Total | 222 | 262 | 1054 | 2317 | 1466 | 390 |

Table IV. Absolute and relative frequency of the species but abundant of muscids collected in different attractive in La Pintada, in the period of February to July 2007.

| Species | Fish | % | Chicken viscera | % | Human faeces | % | Onion | % |
|---|---|---|---|---|---|---|---|---|
| *Atherigona orientalis* | 132 | 53,01 | 104 | 41,77 | 4 | 1,61 | 9 | 3,61 |
| *Biopyrellia bipuncta* | 192 | 16,15 | 28 | 2,35 | 969 | 81,50 | 0 | 0,00 |
| *Brontaea quadristigma* | 0 | 0,00 | 0 | 0,00 | 145 | 100,00 | 0 | 0,00 |
| *Brontaea normata* | 5 | 0,36 | 1 | 0,07 | 1393 | 99,29 | 4 | 0,29 |
| *Cyrtoneurina geminata* | 0 | 0,00 | 0 | 0,00 | 44 | 100,00 | 0 | 0,00 |
| *Cyrtoneuropsis gemina* | 21 | 6,56 | 3 | 0,94 | 295 | 92,19 | 1 | 0,31 |
| *Cyrtoneuropsis maculipennis* | 13 | 52,00 | 1 | 4,00 | 10 | 40,00 | 1 | 4,00 |
| *Cyrtoneuropsis pararescita* | 1 | 6,25 | 1 | 6,25 | 14 | 87,50 | 0 | 0,00 |
| *Graphomya* sp. | 17 | 68,00 | 7 | 28,00 | 1 | 4,00 | 0 | 0,00 |
| *Morellia basalis* | 27 | 3,88 | 8 | 1,15 | 652 | 93,81 | 8 | 1,15 |
| *Musca domestica* | 118 | 39,46 | 176 | 58,86 | 4 | 1,34 | 1 | 0,33 |
| *Neomuscina currani* | 16 | 51,61 | 15 | 48,39 | 0 | 0,00 | 0 | 0,00 |
| *Neomuscina dorsipuncta* | 25 | 37,88 | 39 | 59,09 | 0 | 0,00 | 2 | 3,03 |
| *Neomuscina instabilis* | 19 | 45,24 | 18 | 42,86 | 0 | 0,00 | 5 | 11,90 |
| *Neomuscina pictipennis* | 64 | 68,09 | 28 | 29,79 | 1 | 1,06 | 1 | 1,06 |
| *Ophyra aenenecens* | 9 | 69,23 | 4 | 30,77 | 0 | 0,00 | 0 | 0,00 |
| *Polietina orbitalis* | 5 | 11,36 | 9 | 20,45 | 24 | 54,55 | 6 | 13,64 |
| *Pseudoptilolepis nigripoda* | 345 | 37,79 | 529 | 57,94 | 38 | 4,16 | 1 | 0,11 |
| *Synthesiomyia nudiseta* | 52 | 46,02 | 46 | 40,71 | 13 | 11,50 | 2 | 1,77 |
| Total | 1061 | | 1017 | | 3607 | | 41 | |

was collected from April through July, with an increase in May. It was only attracted by decomposing animal matter, with a preference for fish. The synanthropic index for this species was +96.15, being captured with greater frequency in urban zones (92.30%), showing a preference for human environments (Table V).

## DISCUSSION

The most abundant species was *B. normata*, with increased abundance shown in months with greatest rainfall. This species was collected with greatest frequency in urban zones, obtaining the highest synanthropic index (+99.89). This trait, as well as its strong attraction to human faeces could make it a potential vector for the transport of pathogens to humans. This species is associated with human environments in Brazil (de Carvalho *et al.* 2002). *B. normata* and *B. quadristigma* have been reported to visit bovine faeces, suggesting the use of this substrate by its larvae (de Carvalho & Pont 1997; Marchiori & Linhares 1999; Marchiori *et al.* 2001).

Another species showing a strong attraction to faeces was *B. bipuncta,* although contrary to *B. normata*, it showed a weak relationship with human environments. In the municipality of La Pintada it was the second most important species in terms of abundance. These characteristics coincide with those observed in Paracambi (Brazil) where it showed a strong preference for human faeces, an avoidance of human environments (SI = -87.01), as well as being the most abundant species (Espindola 2006). de Carvalho & Couri (1991) and Koller *et al.* (2004) reported this species in areas of low human intervention, although de Carvalho *et al.* (2002) indicated the species as associated with human environments. Mendes & Linhares (2002) collected it in bovine faeces, showing that this substrate was used for larval development. Therefore the species is most frequently found in rural and forest areas.

*Pseudoptilolepis nigripoda* was the third most abundant species in this study, showing strong necrophagous behaviour, mainly in areas of forest, thus this species could be employed as a forensic entomological indicator in tropical dry forest. It showed a negative synanthropic index, coinciding with that found in Campinas (Brazil), where it was shown to be highly asynanthropic (Table VI). Pombal & Morellato (2002) reported *P. nigripoda* for semi-deciduous forest in Brazil, as the principal pollinator of *Metrodorea nigra* (Rutaceae).

The next most abundant species were *M. basalis, C. gemina, M. domestica, A. orientalis, B. quadristigma* and *S. nudiseta*, all of which showed a strong preference for human environments, especially the latter four, similar to that reported in de Carvalho *et al.* (2002) for Brazil. *Musca domestica* was the only common species in all studies, providing evidence for its previously known eusynanthropic behaviour (Ferrar *et al.* 1975; Linhares 1981b; de Carvalho *et al*. 1984; d'Almeida 1992; Figueroa-Roa & Linhares 2004; Espindola 2006; Costamagna *et al.* 2007). *Morellia basalis* was reported for the first time as a synanthropic species, and given its preference for faeces could be considered important in the transmission of pathogens to humans. *Cyrtoneuropsis gemina* also showed a strong preference for this substrate, a behaviour which was previously reported in Paracambi (Espindola 2006) and on Isla del Governador, Rio de Janeiro (Leandro & d'Almeida 2005). However, in these studies, it was shown to have a low preference for human environments and a low number of individuals, contrary to that found in La Pintada.

Despite *A. orientalis, S. nudiseta* and *M. domestica* being collected on all types of bait, they showed a marked necrophagous behaviour, confirming their importance in forensic entomology (Salazar 2006; Calderón- Arguedas *et al.*

Table V. Index of Synanthropy and meaning of the value of the index according to Nuorteva (1963) for the species of Muscidae (>30) collected in La Pintada, Colombia from February to July 2007.

| Species | SI | Significance of the value of the index | Value limit | |
|---|---|---|---|---|
| *Brontaea normata* | 99,89 | Strong preference for dense human settlements | 100 | 90 |
| *Brontaea quadristigma* | 96,90 | Strong preference for dense human settlements | 100 | 90 |
| *Synthesiomyia nudiseta* | 96,46 | Strong preference for dense human settlements | 100 | 90 |
| *Ophyra aenenecens* | 96,15 | Strong preference for dense human settlements | 100 | 90 |
| *Musca domestica* | 95,65 | Strong preference for dense human settlements | 100 | 90 |
| *Atherigona orientalis* | 93,78 | Strong preference for dense human settlements | 100 | 90 |
| *Cyrtoneuropsis pararescita* | 78,13 | Strong preference for human settlements | 90 | 65 |
| *Morellia basalis* | 74,54 | Strong preference for human settlements | 90 | 65 |
| *Cyrtoneuropsis gemina* | 69,53 | Strong preference for human settlements | 90 | 65 |
| *Graphomya* sp. | 50,00 | Preference for human settlements | 65 | 20 |
| *Neomuscina dorsipuncta* | 11,36 | Independence of human settlements | 20 | 0 |
| *Cyrtoneurina geminata* | -17,05 | Preference for uninhabited areas | 0 | -40 |
| *Biopyrellia bipuncta* | -20,86 | Preference for uninhabited areas | 0 | -40 |
| *Pseudoptilolepis nigripoda* | -35,43 | Preference for uninhabited areas | 0 | -40 |
| *Neomuscina instabilis* | -41,67 | Preference for uninhabited areas | -40 | -100 |
| *Neomuscina currani* | -51,61 | Complete avoidance for human senttlements | -40 | -100 |
| *Polietina orbitalis* | -72,73 | Complete avoidance for human senttlements | -40 | -100 |
| *Neomuscina pictipennis* | -98,40 | Complete avoidance for human senttlements | -40 | -100 |
| *Cyrtoneuropsis maculipennis* | -100,0 | Complete avoidance for human senttlements | -40 | -100 |

2005; Horenstein *et al.* 2005; Krüger *et al*. 2002; d'Almeida *et al.* 1997). d'Almeida & Almeida (1998) and Oliveira *et al.* (2002a) reported the above species for Rio de Janeiro, with the latter being the most abundant at the zoo operated by Fundación Rio Zoo as well as having the second highest number of helminths eggs on its body surface and intestinal contents (Oliveira *et al.* 2002b; Oliveira *et al.* 2006).

*Atherigona orientalis* was the most abundant species found at Campinas (Linhares 1981b) and Rio de Janeiro (d'Almeida 1992) and the second most abundant at Paracambi (Espindola 2006), always exhibiting eusynanthropic behaviour (Table VI).

d'Almeida & Almeida (1998) reported a larger trophic niche for this species in the urban area of Rio de Janeiro, with a preference for vegetable substrate for reproduction, coinciding with Ogbalu *et al*. (2005). *A. orientalis* differs to behaviour shown in La Pintada in this study, where it was found with most frequency on decomposing animal bait. Given that all specimens collected were female, it is feasible that they were looking for substrate to lay their eggs in (Couri & Araújo 1992).

The genus with the greatest number of species collected was *Neomuscina* (11 spp.), showing a strong preference for rural and forest areas. *Neomuscina pictipennis* was the most abundant as well as showing the highest avoidance of human environments, coinciding with that observed by d'Almeida (1992) in Rio de Janeiro. All species showed strong necrophagous behaviour, differing from that reported by Snyder (1949), who suggested that these species were of minor economic and sanitary importance.

*Cyrtoneuropsis maculipennis* was collected exclusively in forest areas, contrary to that found by de Carvalho *et al.* (2002) and Moura *et al.* (1997) who found an association between these species and inhabited areas. *P. orbitalis* and *C. geminata* also showed a strong preference for uninhabited areas, with the latter being exclusively collected on faeces, coinciding with that observed by Snyder (1954) and Mendes & Linhares (2002).

The species with the highest proportion of individuals collected in the rural study area was *Graphomya* sp., whereas *C. pararescita* and *O. aenescens* showed a greater preference for inhabited areas, and absent from forest areas. *C. pararescita* showed a stronger attraction for faeces, in agreement with that shown by Snyder (1954), Couri (1995) and Marchiori *et al.* (2001). Despite the low number of individuals collected of *O. aenescens*, a strong preference was observed for inhabited areas, coinciding with that observed in Campinas (Linhares 1981b) where was found to have the highest synanthropic index. The same was found in Paracambi (Espindola 2006), differing from a study in Pelotas (Costa *et al.* 2000) where it was shown to have no preference for inhabited areas (SI = +18.65). In Rio de Janeiro (d'Almeida, 1992), the species showed a preference for uninhabited areas as well as strong necrophagous behaviour, similar to that shown in studies by Linhares (1981b) and Espindola (2006). Given its synanthropic trait and the facultative capacity of its larvae to predate the species of sanitary importance, the species has been employed in the biological control of *M. domestica* (Turner *et al.* 1992; Axtell 1999; Ribeiro *et al.* 2000a; Ribeiro *et at.* 2000b).

The increasing knowledge of biological and meteorological factors that affect synanthropic arthropods in dry ecosystems in the Neotropical region, would allow to predict the species dynamics and their effects on these ecosystems. In fact the occurrence of forest species in those anthropic habitats, suggests the high vulnerability of them to changes caused by forest transformations.

Table VI. Comparison of the Index of Synanthropy of the main species of Muscidae captured in La Pintada and the established ones for the cities of Campinas, Curitiba, Rio de Janeiro, Pelotas, Valdivia y Paracambi.

| Species | Index of Synanthropy | | | | | | |
|---|---|---|---|---|---|---|---|
| | La Pintada | Campinas[1] | Curitiba[2] | Rio de Janeiro[3] | Pelotas[4] | Valdivia[5] | Paracambi[6] |
| *Atherigona orientalis* | 93,78 | 65,0 | …. | 59,43 | | | 14,5 |
| *Biopyrellia bipuncta* | -20,86 | | | | | | -87,01 |
| *Brontaea quadristigma* | 99,89 | | | | | | |
| *Brontaea normata* | 96,90 | | | | | | |
| *Cyrtoneurina geminata* | -17,05 | | | | | | |
| *Cyrtoneuropsis gemina* | 69,53 | | | | | | -35,71 |
| *Cyrtoneuropsis maculipennis* | -100,0 | | | | | | |
| *Cyrtoneuropsis pararescita* | 78,13 | | | | | | |
| *Graphomya* sp. | 50,00 | | | | | | |
| *Morellia basalis* | 74,54 | | | | | | |
| *Musca domestica* | 95,65 | 89,16 | 33,28 | 58,64 | | 62,8 | 93,69 |
| *Neomuscina currani* | -51,61 | | | | | | |
| *Neomuscina dorsipuncta* | 11,36 | | | | | | |
| *Neomuscina instabilis* | -41,67 | | | | | | |
| *Neomuscina pictipennis* | -98,40 | | | -100 | | | |
| *Ophyra aenenecens* | 96,15 | 67,2 | | -10,46 | 18,65 | | 30,49 |
| *Polietina orbitalis* | -72,73 | | | | | | |
| *Pseudoptilolepis nigripoda* | -35,43 | -92,1 | | | | | |
| *Synthesiomyia nudiseta* | 96,46 | 59,4 | …. | 70,22 | | | 81,37 |

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