Revista Brasileira de Entomologia
http://dx.doi.org/10.1590/S0085-56262014005000006

Preliminary study of insects associated to indoor body decay in Colombia[1]

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ABSTRACT. Preliminary study of insects associated to indoor body decay in Colombia. This is the first report studying insects associated to indoor body decay process of a white pig (*Sus scrofa*) (Artiodactyla, Suidae) in a controlled indoor environment in an urban area of Florencia city, Amazonia Piedmont, Colombia. For a period of 54 days, 9,220 individuals (immature and adults), distributed in 3 orders, 5 families, 10 genera, and 10 species were collected using entomological nets and tweezers. Five decaying stages are described (fresh, bloated, active decay, advanced decay and remains). During the fresh stage we recorded *Cochliomyia macellaria* (Fabricius, 1775), *Chrysomya albiceps* (Wiedemann, 1819), *Ophyra aenescens* (Wiedemann, 1830), *Oxysarcodexia* sp., *Lepidodexia* sp. and *Lasiophanes* sp.; during the bloating stage *C. macellaria*, *C. albiceps*, *Lucilia eximia* (Wiedemann, 1819), *Hemilucillia semidiaphana* (Rondani, 1850), *Musca domestica* Linnaeus, 1758, *O. aenescens*, *Oxysarcodexia* sp., *Lepidodexia* sp., *Dermestes maculatus* De Geer, 1774 and *Lasiphanes* sp.; during the active decay *C. macellaria*, *C. albiceps*, *L. eximia*, *M. domestica*, *O. aenescens*, *Lepidodexia* sp. *D. maculatus* and *Lasiophanes* sp.; during the advanced decay *C. macellaria*, *C. albiceps*, *M. domestica*, *Lepidodexia* sp. and *Lasiophanes* sp.; and during the remains stage *C. albiceps*, *D. maculatus* and *Lasiophanes* sp. The insects were sorted out in 3 ecological categories; necrophagous, predators and parasites and sarco-saprophagous. According to Chao and Jack estimators, total richness was observed on day 20, with 100% of the expected species.

KEYWORDS. Amazon Region; Forensic Entomology; Indoor Closed, Post-Mortem Interval.

Forensic Entomology is the application of the study of insects in cases of legal nature, in any of its three components: urban, stored products and medico-legal (Hall & Huntington 2010); these use of insects as a tool in legal situations, has been well documented since the thirteenth century and artistically presented by sculptors, painters and poets since Middle Ages (Benecke 2008). Analysis of the distribution, biology and behavior of the insects found in a crime scene yields valuable information about where, when, and sometimes how the facts being investigated took place (Hall *et al*. 2008). Factors such environmental conditions (temperature, rainfall), clothing, body depth and weight affect the rate of decomposition of the body, consequently insect colonization (Mann *et al*. 1990).

Studies on arthropods succession associated to outdoor animal remains decomposition are well documented in temperate regions (Anderson & VanLaerhoven 1996; Arnaldos *et al*. 2001; Grassberger & Frank 2004; Tabor *et al*. 2005; De Jong & Hoback 2006), as well as for the Neotropical region (Jirón *et al*. 1982; Moura *et al*. 1997; Cruz & Vasconcelos 2006; Carvalho *et al*. 2000, Carvalho & Linhares 2001; Iannacone 2003; Velásquez 2008; Souza *et al*. 2008; Vasconcelos & Araujo 2012). In Colombia, studies on forensic entomology started out in 2001, and have focused mainly on patterns of decomposition in outdoor environments and aquatics conditions (Wolff *et al*. 2001; Pérez *et al*. 2005; Camacho 2005; Martínez *et al*. 2007; Segura *et al*. 2009; Grisales *et al*. 2010; Segura *et al*. 2011; Ramos-Pastrana & Wolff 2011; Barrios & Wolff 2011).

After temperature, access to carcasses by insects is the most important factor affecting the decaying rate (Mann *et al*. 1990). Studies of fauna in carrion in controlled indoor environments have been restricted around the world, and particularly the great majority has been made directly on human remains, like the one performed in Hawaii in which exclusive species for both open and closed habitats were determined (Goff 1991). That same year, in Gdansk Poland, Piatkowski (1991) analyzed the entomologic fauna of a remain found on the 11th floor of a building; later in Germany, Benecke (1998) and Schroeder *et al*. (2002) analyzed entomologic evidence of remains found inside apartments. In Argentina, Centeno *et al*. (2002) carried out the first study in controlled indoor environments using pigs carcass; in the United States, Gennard (2007) analyzed the development of blow flies in bodies found both indoors and outdoors; in Finland, Pohjoismäki *et al*. (2010) observed the colonization of insects in bodies inside rooms; in Germany, Frost *et al*. (2010) indicated that 81.9% of the 364 bodies infested with insects were found indoors; in Malaysia, Ahmad *et al*. (2011) compared the decaying bodies of monkeys indoors and outdoors.

There are no reports of this kind of studies in Colombia, so this research aims at determining the entomological succession, ecological categories and decaying rates of a body of a white pig (*Sus scrofa*) in a controlled indoor environment, in Florencia city, Caquetá-Colombia.

MATERIAL AND METHODS

The study was carried out in an area of 4 m^2, in an old bath located on the seventh floor of a building, 70 m from the ground. The bathroom has no windows, a door which remained closed, leaving only a space for the entrance of the insects of approximately 2 cm between the door and the bathroom floor. This building is located in the urban area of Florencia, (2º58' N and 0º40' S and between 71º30' and 76º15' W., at 270 m.) with an annual mean rainfall of 3,793 mm, average temperature of 25°C, mean annual relative humidity of 92%. The region is characterized by being the intersection zone between the piedmont and the Amazonia planes, featured by small hills and alluvial terraces which resulted from accumulation of materials, forming reliefs that go from plane to undulate and abrupt (IGAC 2010).

The study was carried out using a white pig (*Sus scrofa*) of approximately 14.5 kg, slaughtered at the study site (performed by a professional of "Cuerpo Técnico de Investigación", the Technical Body of Researches C.T.I. for the Spanish acronym, of the Nation General Prosecutors), by means of impact of a caliper 9 mm bullet in the frontal region of the skull, on July 20, 2010 at approximately 06:00 a.m. From the moment of death until the carcass was only bones and skin, photographs were taken and notes of the physical changes observed were recorded; samples of insects were taken four times every day (06:00, 10:00, 14:00 and 18:00 hours) all along the decaying process. Besides, factors such as body weight, room temperature (thermo-hygrometer digital Thermo) and rectal body temperature, (Elan digital thermometer) were recorded.

Sampling of adult flying insects was made using entomological nets of 20 cm in diameter; non-flying adults and immature individual found on, under, and around the body were collected using tweezers and fine tip brushes, following the methodology proposed by Haskell (1990). The individuals collected were taxonomically determined to species when possible, using the keys proposed by Mariluis & Peris (1984); Smith (1986); Queiroz & Carvalho (1987); Peris (1992); Ribeiro & Carvalho (1998); Carvalho & Ribeiro (2000); Palacio & Fernández (2003); Amat *et al*. (2008); Almeida & Mise (2009); Flórez & Wolff (2009); Brown *et al*. (2009); Brown *et al*. (2010); Carvalho *et al*. (2012).

Life cycles. Once the first masses of eggs were found, they were taken into rearing chambers, consisting of polythene containers with lids, filled with white sterile sand to facilitate pupation. Larvae where fed with ground cow meat, the chambers were kept in styrofoam containers to avoid contamination by other insects and the temperature was kept constant. Rearing chambers were taken into the Entomology lab at the Natural History Museum of *Universidad de la Amazonia*, where observations and sampling were made in periods of four hours each (06:00, 10:00, 14:00 y 18:00 hours). Five larvae were collected in each sampling period, and stored in vials with alcohol at 75% for their conservation, and date, hour, temperature, and relative humidity were recorded. Observations were made until adults emerged which were then used for taxonomic determination of the pioneer species.

Data Analysis. This study was designed to evaluate the succession pattern of insects during the decomposition of a cadaver indoors, and was not designed for a quantitative analysis. To determine the differences between decaying stages an analysis of variance was performed and Turkey test ($P<0.05$) was applied. To determine if the sampling effort was optimal, a cumulative curve of species was calculated using Chao1, Chao2, Jackknife1 and Jackknife2 estimators, which are based on the incidence (present-absent) (Jiménez-Valverde & Hortal 2003), using the software EstimateS version 8.0 for Windows (Colwell 2006). Each decomposition stage was correlated to a group of insects, environmental and physical factors such as room and body temperature, and weight loss. A succession table and an occurrence matrix of presence-absence were built. Graphics showing the physical and environmental conditions during the decaying process were plotted. Ecological categories of each species were used according to Smith (1986) and Magaña (2001).

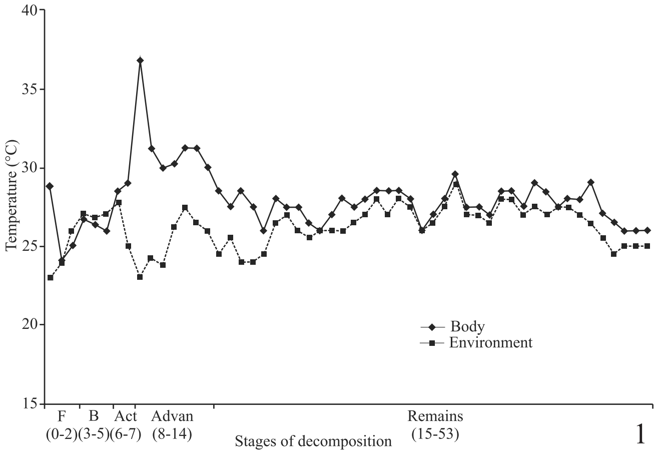
RESULTS

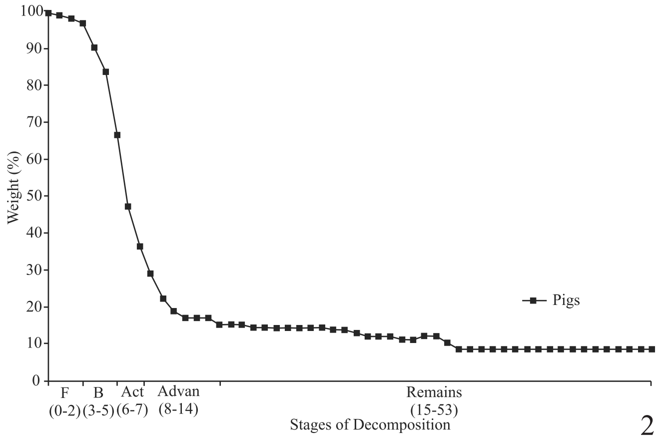
A total of 9,220 adults and immature insects were collected, distributed in 3 orders, 5 families, 10 genera and 10 species (Table I). The most abundant order was Diptera with 8,703 individuals (94%), of which Calliphoridae was the dominant family with 6,878 individuals (75%), followed by Muscidae 1,454 (16%), and Sarcophagidae with 371 (4%) (Tables II, III). Coleoptera was the second most abundant order, with Dermestidae 301 individuals (3%); followed by Formicidae (Hymenoptera) 216 (2%) (Tables II, III).

Decaying stages and associated insects. Total decay lasted 54 days, five decaying stages statistically different ($P < 0.05$) were identified: Fresh, Bloated, Active, Advanced and Remains.

Fresh (day 0 to 2). Fresh decaying stage started from the moment of decease until the first signs of body bloating were observed. No characteristic odors of decomposition were perceived, lowering of body temperature was evident from 28.75°C to 24°C, while room temperature ranged between 23°C and 26°C, relative humidity oscillated between 67% and 98% (Fig. 1). During this stage, body biomass loss was 1.12% (Fig. 2). Mainly adult individuals of Diptera, *Cochliomyia macellaria* and *Chrysomya albiceps* (Calliphoridae), *Ophyra aenescens* (Muscidae) and *Oxysarcodexia* sp. (Sarcophagidae) were found, while *Lepidodexia* sp. (Sarcophagidae) was found at an immature stage; *Lasiophanes* sp. (Formicidae) was also present (Tables II, III, IV).

Bloated (day 3 to 5). Bloated decaying stage started at the moment when carcass bloating was evident due to the gases originated by anaerobic bacteria. It was the easiest stage to differentiate due to the spherical shape taken by the body. Initially, the abdomen was bloated then the entire body; period in which characteristic odors of decaying ani-





Figs. 1–2. Daily variation of (1) temperature and (2) weight related with the stage of decomposition in a closed precinct of the Colombia Amazonia Piedmont.

Table I. Succession of immature (I) and adult (A) insects in different stages of cadaveric decomposition collected in a closed precinct of the Colombia Amazonia Piedmont. N = necrofagous, P = parasite, S = saprofagous.

Order	Family	Specie	Ecol. Cat.	Stage: Fresh (0–2)		Bloated (3–5)		Active (6–7)		Advanced (8–14)		Remains (15–53)	
				I	A	I	A	I	A	I	A	I	A
Diptera	Calliphoridae	*Chrysomya albiceps*	N, P		x	x	x	x	x	x	x	x	x
		Cochliomyia macellaria	N		x	x	x	x	x	x	x		
		Lucilia eximia	N			x	x	x					
		Hemilucilia semidiaphana	N				x						
	Muscidae	*Musca domestica*	S			x		x		x			
		Ophyra aenescens	S		x		x		x				
	Sarcophagidae	*Oxysarcodexia* sp.	N,S		x		x						
		Lepidodexia sp.	N,S	x		x		x		x			
Coleoptera	Dermestidae	*Dermestes maculatus*	N				x		x	x	x	x	x
Hymenoptera	Formicidae	*Lasiophanes* sp.	P		x		x		x		x		x

Table II. Percentage of adult individual insects associated to a cadaveric decomposition in a closed precinct of the Colombia Amazonia Piedmont.

Order	Family	Species	Fresh (0–2)	Bloated (3–5)	Active (6–7)	Advanced (8–14)	Remais (15–53)
Diptera	Calliphoridae	*Cochliomyia macellaria*	0.15 (n = 14)	2.79 (n = 257)	0.20 (n = 18)	0.03 (n = 3)	0 (n = 0)
		Chrysomya albiceps	0.02 (n = 2)	0.31 (n = 28)	0.10 (n = 9)	0.21 (n = 19)	1.21 (n = 112)
		Hemilucilia semidiaphana	0 (n = 0)	0.02 (n = 2)	0.01 (n = 1)	0 (n = 0)	0 (n = 0)
		Lucilia eximia	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)
	Muscidae	*Musca domestica*	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)
		Ophyra aenescens	0.17 (n = 16)	3.77 (n = 348)	2.22 (n = 205)	0.08 (n = 7)	0 (n = 0)
	Sarcophagidae	*Oxysarcodexia* sp.	0.11 (n = 10)	0.03 (n = 3)	0 (n = 0)	0 (n = 0)	0 (n = 0)
		Lepidodexia sp.	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)
Coleoptera	Dermestidae	*Dermestes maculatus*	0 (n = 0)	0.03 (n = 3)	0.03 (n = 3)	0.34 (n = 31)	0.34 (n = 31)
Hymenoptera	Formicidae	*Lasiophanes* sp.	0.36 (n = 33)	0.28 (n = 26)	0.15 (n = 14)	0.34 (n = 31)	1.21 (n = 112)

Table III. Percentage of immature individual insects associated to a cadaveric decomposition in a closed precinct of the Colombia Amazonia Piedmont.

Order	Family	Species	Fresh (0–2)	Bloated (3–5)	Active (6–7)	Advanced (8–14)	Remains (15–53)
Diptera	Calliphoridae	*C. macellaria*	0 (n = 0)	0.78 (n = 72)	16.87 (n = 1555)	4.52 (n = 417)	0.03 (n = 3)
		Ch. albiceps	0 (n = 0)	0.31 (n = 29)	17.82 (n = 1653)	8.80 (n = 811)	7.38 (n = 680)
		H. semidiaphana	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)
		L. eximia	0 (n = 0)	0.03 (n = 3)	0.03 (n = 3)	0 (n = 0)	0 (n = 0)
	Muscidae	*M. domestica*	0 (n = 0)	0.01 (n = 1)	5.01 (n = 462)	4.65 (n = 429)	0 (n = 0)
		O. aenescens	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)
	Sarcophagidae	*Oxysarcodexia* sp.	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)
		Lepidodexia sp.	0.52 (n = 48)	0.10 (n = 9)	1.18 (n = 109)	2.07 (n = 196)	0 (n = 0)
Coleoptera	Dermestidae	*D. maculatus*	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)	2.53 (n = 233)
Hymenoptera	Formicidae	*Lasiophanes* sp.	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)	0 (n = 0)

mal matter were perceived, and rigidity of legs and hardiness of the great muscles became evident. Body temperature was homogeneous, fluctuating between 26°C and 26.75°C, room temperature ranged between 26.75°C and 27°C and relative humidity oscillated between 75% and 94% (Fig. 1). During this stage biomass loss was 7.16% (Fig. 2). Adult and immature individuals of *C. macellaria*, *C. albiceps* and *Lucilia eximia* were observed, while *Hemilucillia semidiaphana* (Calliphoridae), *O. aenescens*, *Oxysarcodexia* sp., *Lasiophanes* sp. and *Dermestes maculatus* (Coleoptera: Dermestidae) were found only in adult stage; *Musca domestica* (Muscidae) and *Lepidodexia* sp. in immature stage (Tables II, III, IV). The first laying of Diptera was observed in natural orifices of the body such as eyes, ears, nose, mouth and anus, and in the wound. A follow up of the life cycle of these eggs led to determine the adult form of *C. macellaria* (Fig. 3).

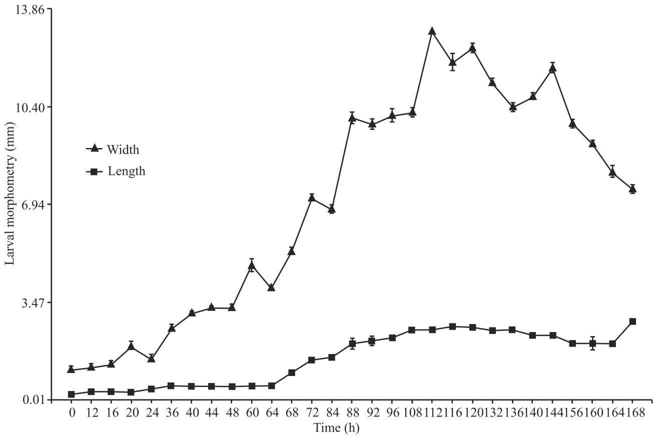


Fig. 3. Average length and width (in mm) of larvae of *Cochliomyia macellaria* during growth in the Colombia Amazonia Piedmont.

Active (day 6 to 7). This stage is characterized by a humid carcass and rupture of the skin, which allows gases to escape, so the body begins to deflate gradually. Natural orifices become less defined and the body starts to lose its original shape still preserving its muscular end epithelial tissues. Rectal body temperature fluctuated between 28.5°C and 29°C, while room temperature between 25°C and 27.75°C; relative humidity oscillated between 79% and 82% (Fig. 1), and biomass reduction was 27.54% (Fig. 2). Adults and immature *C. macellaria* and *C. albiceps* were observed, while *O. aenescens*, *Lasiophanes* sp. and *D. maculatus* were found only as adults; *L. eximia*, *M. domestica* and *Lepidodexia* sp. were found in larval stage. It is important to notice that this stage was dominated by larvae of Calliphoridae (Tables II, III and IV).

Advanced (day 8 to 14). The carcass was characterized by reduction of flesh, preserving only the skin, cartilage, bones and remains of other tissues like intestines. Rectal body temperature varied between 30°C and 36.75°C, while room temperature ranged between 23°C and 27.5°C; relative humidity was 85% (Fig. 1). Due to the consumption of tissue mainly by larvae and dehydration, biomass loss was the highest 39.84% (Fig. 2). Immature and adults of *C. macellaria*, *C. albiceps*, *Lepidodexia* sp. dominated; *M. domestica* was found as larvae; *D. maculatus* and *Lasiophanes* sp. were also found in adult stage. The first pupae of *C. macellaria* were observed, as well as pupae and puparies of *C. albiceps* (Tables II, III and IV).

Remains (day 15 to 53). The carcass was reduced to skin, hairs and bones; its original form was not identifiable because the remains were dispersed due to degradation. Temperature oscillated between 26°C and 29.5°C; relative humidity was more variable between 44% and 85% (Fig. 1), registering the lowest percentage, and biomass loss was 13.06% (Fig. 2). Larvae of *D. maculatus* were the markers of this decomposition stage, although adults of this species were also present, as well as of *Lasiophanes* sp., and closed and open puparies of *C. albiceps* (Tables II, III and IV).

Succession Matrix (Present-Absent). Due to the low diversity and high abundance of insects associated to the process, a matrix of ecological succession was built with the total number of species collected; Diptera: *C. albiceps* (larvae, pre-pupae, pupae, adult), *C. macellaria* (larvae, pupae, adult), *L. eximia* (larvae, adult), *H. semidiaphana* (adult), *M. domestica* (larvae), *O. aenencens* (adult), *Oxysarcodexia* sp. (adult), *Lepidodexia* sp. (larvae), Coleoptera: *D. maculatus* (larvae, adult) and Hymenoptera: *Lasiophanes* sp. (adult) (Table IV).

Species Accumulation Curve. Species increase during the first six days, time in which six out of the 10 species found appeared, reflected on the graphic by the steep slope; thereafter, species increase slowed down until day 20^{th} when total richness reached its maximum. The observed species corresponded to 100% of the expected species by Chao and Jack estimators, indicating that the sampling time was enough to find the maximum number of species associated to indoor body decay (Fig. 4).

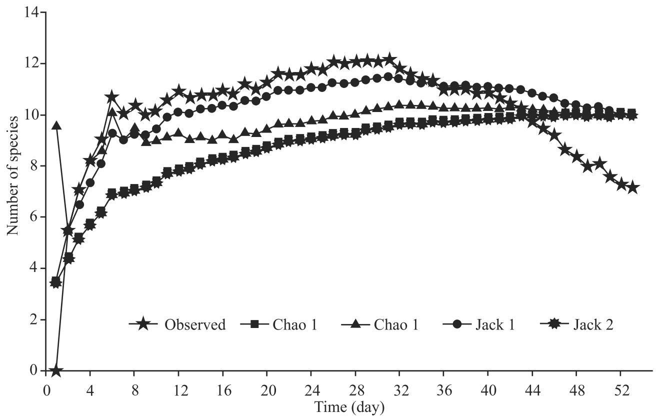


Fig. 4. Accumulation curve of species associated to indoor cadaveric decomposition in the Colombia Amazonia Piedmont.

Table IV. Matrix of occurrence. 0: Absent 1: Present. L: Larva. P: Pupa. Pp: Pre-pupa. A: Adult. Grayed squares indicate the first appearance of the species.

	Fresh			Bloated			Active		Avanced						
Days	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Specie	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A
Lasiophanes sp.	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 0	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1
C. macellaria	0 0 0 0	0 0 0 1	0 0 0 1	1 0 0 1	1 0 0 1	1 0 0 1	1 0 0 1	1 0 0 0	1 0 0 0	1 0 0 1	0 1 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
Lepidodexia sp.	0 0 0 0	0 0 0 0	1 0 0 0	1 0 0 0	1 0 0 0	1 0 0 0	1 0 0 0	1 0 0 0	0 0 0 0	1 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
Oxysarcodexia sp.	0 0 0 0	0 0 0 0	0 0 0 1	0 0 0 0	0 0 0 1	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
C. albiceps	0 0 0 0	0 0 0 0	0 0 0 1	0 0 0 1	0 0 0 1	1 0 0 1	1 0 0 1	1 0 0 0	1 0 0 0	1 0 0 0	1 1 0 1	1 1 0 0	1 1 0 0	1 1 0 0	1 1 1 0
O. aenescens	0 0 0 0	0 0 0 0	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
D. maculatus	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 1	0 0 0 0	0 0 0 1	0 0 0 1	0 0 0 0	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1
H. semidiaphana	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 1	0 0 0 1	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
L. eximia	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	1 0 0 0	1 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
M. domestica	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	1 0 0 0	1 0 0 0	1 0 0 0	1 0 0 0	1 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0

	Remains												
Days	15	16	17	18	19	20	21	22	23	24	25	26	27
Specie	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A
Lasiophanes sp.	0 0 0 0	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1
C. macellaria	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
Lepidodexia sp.	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
Oxysarcodexia sp.	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
C. albiceps	1 1 1 1	1 1 1 1	1 1 1 0	0 1 1 1	0 1 1 1	0 1 1 1	0 1 1 1	0 1 1 1	0 1 1 0	0 1 1 1	0 1 1 0	0 1 1 0	0 1 1 0
O. aenescens	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
D. maculatus	0 0 0 0	0 0 0 0	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 0	0 0 0 1	0 0 0 0	0 0 0 1	0 0 0 0	0 0 0 0	0 0 0 1
H. semidiaphana	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
L. eximia	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
M. domestica	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0

	Remains												
Days	28	29	30	31	32	33	34	35	36	37	38	39	40
Specie	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P P A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A
Lasiophanes sp.	0 0 0 1	0 0 0 1	0 0 0 0	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 0	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 0	0 0 0 1	0 0 0 1
C. macellaria	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
Lepidodexia sp.	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
Oxysarcodexia sp.	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
C. albiceps	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 1	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 0
O. aenescens	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
D. maculatus	0 0 0 1	0 0 0 0	0 0 0 0	0 0 0 1	1 0 0 0	1 0 0 0	1 0 0 1	1 0 0 1	1 0 0 0	1 0 0 0	1 0 0 0	1 0 0 1	1 0 0 0
H. semidiaphana	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
L. eximia	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
M. domestica	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0

	Remains												
Days	41	42	43	44	45	46	47	48	49	50	51	52	53
Specie	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A	I P Pp A
Lasiophanes sp.	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 1	0 0 0 0	0 0 0 1	0 0 0 1
C. macellaria	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
Lepidodexia sp.	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
Oxysarcodexia sp.	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
C. albiceps	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 0	0 1 1 0	0 0 0 0	0 1 1 0	0 1 1 0
O. aenescens	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
D. maculatus	1 0 0 0	1 0 0 1	1 0 0 0	1 0 0 1	1 0 0 1	1 0 0 0	1 0 0 1	1 0 0 0	1 0 0 0	1 0 0 0	1 0 0 0	1 0 0 1	1 0 0 1
H. semidiaphana	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
L. eximia	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0
M. domestica	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0

DISCUSSION

Five decaying stages were observed just like in other indoor studies (Centeno *et al*. 2002; Ahmad *et al*. 2011), the same number of stages observed in outdoor conditions (Mégnin 1894; Wolff *et al*. 2001; Vitta *et al*. 2007; Martínez *et al*. 2007; Ramos-Pastrana & Wolff 2011).

In studies of decaying bodies outdoors, Smith (1986) affirmed that ovoposition may occur a few minutes after death; Fiedler *et al*. (2008) in study in western Germany about the diversity of Diptera on decomposition piglets on the edge forest and inside forest, reported the first eggs were deposited after a few minutes in the first and 30 minutes on the second situation during fresh decomposition; in Colombia, Wolff *et al*. (2001) observed the arrival of Diptera 30 minutes after slaughter and ovoposition during the bloated stage; Ramos-Pastrana & Wolff (2011) reported the arrival of *C. macellaria* and *C. albiceps* under sunny conditions and of *L. eximia* and *H. segmentaria* under shadow conditions, respectively (4 and 7 minutes after death). In the present indoors study, the arrival of *C. macellaria* was registered on day 1, similarly to the data obtained by Centeno *et al*. (2002), in which its arrival was registered on day 1 in the autumn, spring and summer, while on day 2 in winter; Ahmad *et al*. (2011) reported a 3-day delay in the arrival of colonizing species; other studies have also demonstrated such a delay (Goff 1991; Amendt *et al*. 2004).

In relation to total timing of the study, it was observed that in Colombian Amazon the time of decomposition from fresh to remains takes 54 days; while in Buenos Aires-Argentina in spring and summer 22 days, in winter and autumn 74 and 129 days respectively (Centeno *et al*. 2002).

From the bloated to the advanced stage, *C. macellaria*, *L. eximia*, *C. albiceps*, *M. domestica* and *Lepidodexia* sp. dominated tissue consumption. The Muscidae *O. aenescens* was present in greater abundance during all the decomposition process, in concordance with data obtained by Centeno *et al*. (2002), but contrasting with those of Ahmad *et al*. (2011), where the species of *Chrysomya* were dominant in these stages. Concerning the advanced decaying stage, larvae of *D. maculatus* were present, species reported also by Centeno *et al*. (2002), but without specifying its decaying stage. During the remains stage, high abundance of pupae of *C. albiceps* was found next to carcass.

Diptera was the prevalent order with more than 90% of the species, starting its activity from the fresh stage and reaching the highest number during the active stage, given by larval activity. Coleoptera and Hymenoptera were only 6%; however, they were important components carrying out functions as necrophagous and predators, generating great dynamism throughout body decay. Studies of the succession of insects associated to decaying bodies in special microenvironments in Colombia are very significant for their contribution to the development of forensic science in the country, as well as a potential forensic tool in cases of human corpses found indoors.

ACKNOWLEDGMENTS

Thanks to the entomology seed research of University of the Amazonia; to Colciencias Project 601-2009 (YR); to *Universidad de Antioquia*; To Dr. César A. Estrada González (*in memorian*), research Vice Dean at the University of Amazonia; to Jhoha E. Cárdenas García, Jesús Matiz Caicedo, Yenny Rojas Grande, Cindy K. Andrade, Cesar Valverde and Yesion J. Penagos García; MSc. Sandra Pérez; to biology student Carlos Andrés Londoño.

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Received 30 May 2014; accepted 9 September 2014
Associate Editor: Rodrigo F. Krüger