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Updated checklist and new records of Calyptratae carrion flies (Diptera, Schizophora) from Valle de Aburrá and other localities in Colombia

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Abstract

Ramírez-Mora MA, Buenaventura E, Gómez-P LM, Amat E. 2011. Updated checklist and new records of Calyptratae carrion flies (Diptera, Schizophora) from Valle de Aburrá and other localities in Colombia. Entomotropica 27(1): 27-35.

In recent years there have been an increasing number of studies on carrion flies due to the medical importance and development of forensic entomology. Knowledge of the species involved in a particular space and time is essential to apply forensic techniques. An updated checklist of carrion flies (Diptera, Calyptratae) from the Valle de Aburrá, Antioquia, Colombia is presented as a result of one year sampling using Van Someren Rydon traps. Ninety four species were identified (14 Calliphoridae, 12 Fanniidae, 20 Muscidae, 48 Sarcophagidae), fourteen of these are new records from Colombia, twenty five are new records for the province, one Fannid is a new species, and the first neotropical record of *Ravinia querula* is reported; finally species diversity of the community and faunistics aspects of some species are discussed.

Additional key words: Check list, Forensic Entomology, Decomposer flies, Van Someren Rydon.

Resumen

Ramírez-Mora MA, Buenaventura E, Gómez-P LM, Amat E. 2011. Lista actualizada y nuevos registros de moscas de cadaveres Calyptratae (Diptera, Schizophora) del Valle de Aburrá (Antioquia) y otras localidades en Colombia. Entomotropica 27(1): 27-35.

En los últimos años ha habido un creciente número de estudios sobre las moscas carroñeras debido a la importancia médica y el desarrollo de la entomología forense. El conocimiento de las especies involucradas en un determinado espacio y el tiempo es esencial para aplicar las técnicas forenses. Un listado actualizado de las moscas carroñeras (Diptera, Calyptratae) del Valle de Aburrá, Antioquia, Colombia se presenta como resultado de un año de muestreo utilizando trampas Van Someren Rydon. Noventa y cuatro especies fueron identificadas (14 Calliphoridae, 12 Fanniidae, 20 Muscidae, 48 Sarcophagidae), catorce de ellas son nuevos registros para Colombia, veinticinco son nuevos registros para la provincia, un Fannido es una nueva especie, y se registra por primera vez en el Neotropico *Ravinia querula*, y por último la diversidad de especies de la comunidad y los aspectos faunísticos de algunas especies se discuten.

Palabras clave adicionales: Lista, entomología forense, moscas descomponedoras, Van Someren Rydon.

Introduction

Diptera is one of the megadiverse orders of insects comprising approximately 152 000 described species worldwide (Courtney et al. 2009). In the Neotropical region nearly 24 000 species have been reported (Amorim et al. 2002).

Calyptratae flies are the most important insects involved in decomposition processes (Keh 1985, Smith 1986, Catts and Haskell 1991, Oliveira-Costa 2008). These flies breed on carrion to complete their life cycles (Souza and Linhares 1997), the behaviour as necrophagous insects is the baseline in forensic entomology, due to developmental larvae cycle is fundamental to calculate the post mortem interval (PMI) (Greenberg 1991, Oliveira-Costa and Mello-Patiu 2004). By their colonizer habits, is widely accepted that the most important insect families are Calliphoridae, Sarcophagidae, Muscidae, and Fanniidae (Keh 1985, Smith 1986, Catts and Haskell 1991, Greenberg 1991, Catts and Goff 1992, Carvalho et al. 2000, Oliveira-Costa 2008). To establish a reliable forensic entomological framework, it is necessary the basic knowledge of biological and ecological aspects of their species in a particular space and time (Rocha et al. 2009).

Despite the relevance of the carrion flies in terms of abundance and frequency in corpses, few long term studies (> 1 year) have been proposed in the Neotropical region to study species seasonality except those made by Linhares (1981), Mulieri et al. (2008), Pires et al. (2008) and Brundage et al.(2011). In the Valle de Aburrá (Colombia) where high occurrence of corpses have been reported (Fiscalía, Instituto Nacional de Medicina Legal y Ciencias Forenses 2009), none long term study has been performed, previous studies in this location had focused on the succession of cadaveric fauna in a specific date range (Wolff et al. 2001, Pérez et al. 2005).

An updated checklist of necrophagous Calyptratae species of Calliphoridae, Sarcophagidae, Muscidae and Fanniidae from Valle de Aburrá based on one year of field work and literature is offered. Data and species checklist obtained from this survey will be part of the Andean carrion flies local database of necrophagous insects of forensic importance.

Materials and Methods

Monthly samplings were performed from February 2010 to January 2011 in four localities from Valle de Aburrá as follow: Copacabana (lat 06° 22' 07" N, long 75° 29' 22" W) at 1 417 m altitude, semi-rural area located outskirts of Medellin and surrounded by Medellin river and its sewages; Caldas (lat 06° 03' 06" N, long 75° 37' 19" W) at 1 840 m, located in a rural area near to a stream, dedicated to an agriculture use; Pajarito in Medellin municipality (lat 06° 17' 10" N, long 75° 36' 43" W) at 1 929 m, highly slope semi-urban area surrounded by pastures and some shrub relics, and La Cola del Zorro in Medellin municipality (lat 06° 12' 19" N, long 75° 32' 43" W) at 1 943 m a semi-urban area dominated by eucalyptus forest. In each locality a Van Someren Rydon trap baited with 250 g of chicken viscera and fish heads were settled at an altitude of 2 m**.** Traps operated five days monthly and bait was replaced by fresh at the third day. Specimens were sacrificed in Ethanol (70 %) and determined at the highest taxonomical level possible. Calliphorids were identified using the keys of Amat et al. (2008) and Withworth (2010). Additionally genitalia of some specimens were dissected to corroborate taxonomical identification. Sarcophagidae identification followed the studies of Lopes (1946), Lopes and Tibana (1987), Carvalho and Mello-Patiu (2008), Buenaventura et al. (2009), Buenaventura and Pape (In press) and originals descriptions not included in keys, male dissection followed the methodology of Giroux et al. (2010).

Muscids identification were done by using keys of Pamplona and Couri (1989), Carvalho and Couri (2002), Carvalho and Mello-Patiu (2008). Finally, Fanniids were identified by using the preliminary key of Grisales (2010).

Each dissected structure were kept in a microvial with glycerine or glued in a paper triangle of pinned specimen. Insect mounted and identified

were deposited at Colección Entomológica del Tecnológico de Antioquia (CETdeA).

Previous species records of the study area were obtained from Wolff et al. (2001), Wolff et al. (2004), Pérez et al. (2005), Buenaventura (2006), Amat (2009), Giraldo (2007), Vélez and Wolff (2008), Grisales (2010), Buenaventura and Pape (in press) and Salazar-Ortega et al. (2012).

Results and Discussion

A total of 94 species belonging to tha families Calliphoridae (14), Sarcophagidae (48), Muscidae (20) and Fanniidae (12), were identified. 14 records are new from Colombia and 25 new from Valle de Aburrá (Table 1). Prior studies of insect succession on dead pig in the study area have shown lower richness values of decomposer flies; 10 and 17 species were reported respectively by Wolff et al. (2001) and Perez et al. (2005). Richness and abundance values among these studies cannot been compared because of their differences in terms of assessed area, sampling effort (30 to 45 days) and seasonality (rainy and dry season). Classical short term studies of carrion flies fauna on pig carcasses or specific time studies do not provide enough data to understand fly seasonality or phenology, even more when different methodologies and baits for insect attraction were applied. However these differences in results allow us to foresee the importance of long term sampling collections to reach a comprehensive knowledge of community composition.

Within the calliphorid family, two new records for the area were found, it is remarkable the occurrence of the exotic genus *Chrysomya* particularly *C. putoria* (Wiedemann, 1818) previously recorded in the Colombian Andean south region by Salazar-Ortega (2008) and in the Amazon by Baumgartner and Greenberg (1984), this is the northernmost record of this species for South America. *Paralucilia pseudolyrcea* (Mello, 1969) is recorded for the first time in Antioquia from an altitude of 1 943 m.

Sarcophagids have shown the greatest value of richness (48 species). Pape et al. (2004) reported 78 species from Colombia; we add 10 new records to the list. Most remarkably novelty is the occurrence of *Ravinia querula* (Walker, 1849) only known for the Nearctic region reaching Baja California and Sonora in Mexico (Pape 1996), this is the first record in Neotropical area. The genera *Oxysarcodexia* and *Peckia* were the richest of the family. It is significant the occurrence of *Peckia* (*Peckia*) *chrysostoma* (Wiedemann, 1830), *Peckia* (*Pattonella*) *intermutans* (Walker, 1861), *Blaesoxipha* (*Gigantotheca*) *plinthopyga* (Wiedemann, 1830) and *Sarcophaga* (*Liopygia*) *ruficornis* (Fabricius, 1794), they were reported associated to human environments (Jirón et al. 1983, Oliveira et al. 2002, Moura et al. 2005, Barros et al. 2008, Rocha et al. 2009, Vairo et al. 2011). The last three had been founded in advance state of decomposition corpses in the Valle de Aburrá (Antioquia); *P.* (*P.*) *intermutans* during the emphysematous stage (bloated) and *B.* (*G.*) *plinthopyga* and *S.* (*L.*) *ruficornis* during the emphysematous and colliquative stages (bloated-decay) (per. obs. by the second author). With these findings we highlight the potential of these species as forensic markers.

Muscids were the second richest family (20 spp). Four records are new from Colombia and had been collected and associated to pig and human corpse decomposition (Carvalho et al. 2000, Rocha et al. 2009) remaining species were reported as regular carrion and necrophagous breeders flies (Moura et al. 1997, 2005, Carvalho et al. 2000, Carvalho and Linhares 2001, Carvalho et al. 2004, Souza et al. 2008).

Fanniids shown a very high value of richness (8 spp) compared with previous studies, where only one single species was reported (Wolff et al. 2001, Perez et al. 2005), and the recently described species of *Euryomma* (Grisales et al. 2012).

Table 1. List of carrion flies species in the metropolitan area of Valle de Aburrá, Antioquia, Colombia. (*) new records for Colombia. (+) new records for Antioquia. (^) Informally described species by Grisales (2010). (CAL) Caldas; (COP) Copacabana; (CDZ) Cola del Zorro; (PAJ) Pajarito,

Species	Locality	Reference
Calliphoridae		
Chrysomya albiceps (Wiedemann, 1819)	CAL, CDZ, COP, PAJ	Wolff et al. (2001), Wolff et al. (2004), Pérez et al. (2005), Salazar-Ortega et al. (2012)
Chrysomya megacephala (Fabricius, 1794)	CAL, CDZ, COP, PAJ	Wolff et al. (2004), Pérez et al. (2005), Salazar-Ortega et al. (2012)
Chrysomya putoria (Wiedemann, 1818)+	CDZ, COP	
Cochliomyia macellaria (Fabricius, 1775)	CDZ, COP, PAJ	Wolff et al. (2001), Pérez et al. (2005)
Compsomyiops verena (Walker, 1849)	CAL, PAJ	Amat (2009)
Compsomyiops sp.		Pérez et al. (2005)
Hemilucilia segmentaria (Fabricius, 1805)+	CAL, COP	
Hemilucilia semidiaphana (Rondani, 1850)	CAL, CDZ, COP, PAJ	Salazar-Ortega et al. (2012)
Lucilia cuprina (Wiedemann, 1819)	CDZ, COP	Salazar-Ortega et al. (2012)
Lucilia eximia (Wiedemann, 1819)	CAL, CDZ, COP, PAJ	Giraldo (2007), Vélez and Wolff (2008)
Lucilia peruviana (Robineau-Descoidy, 1830)	CAL, CDZ, PAJ	Salazar-Ortega et al. (2012)
Lucilia sericata (Meigen, 1826)		Wolff et al. (2004), Pérez et al. (2005)
Lucilia sp.		Salazar-Ortega et al. (2012)
Paralucilia pseudolyrcea (Mello, 1969)+	CDZ	
Fanniidae		
Euryomma aburrae Grisales, Wolff & Carvalho, 2012	CAL, CDZ	Grisales et al. (2012)
Euryomma cornuatum Grisales, Wolff & Carvalho, 2012	CAL, PAJ	Grisales et al. (2012)
Euryomma tahami Grisales, Wolff & Carvalho, 2012	COP	Grisales et al. (2012)
Fannia canicularis (Linnaeus, 1761)		Pérez et al. (2005)
Fannia dodgei (Seago, 1954)		Grisales (2010)
Fannia pusio (Wiedemann, 1830)		Grisales (2010)
Fannia trimaculata (Stein, 1898)		Grisales (2010)
Fannia scalaris (Fabricius, 1794)		Wolff et al. (2004)
Fannia sp.		Wolff et al. (2001)
Fannia sp. 7^	CAL, CDZ, COP	Grisales (2010)
Fannia sp. 9^	CAL, CDZ, COP	Grisales (2010)
Fannia sp. n. 1	CDZ	
Muscidae		
Atherigona orientalis Schiner, 1868	CAL, CDZ, COP, PAJ	Salazar-Ortega et al. (2012)
Biopyrellia bipuncta (Wiedemann, 1830)+	CAL, CDZ, COP, PAJ	
Graphomya sp.	CAL, CDZ, COP, PAJ	
Hydrotaea nicholsoni Curran, 1939+	PAJ	
Morellia basalis (Walker, 1853)+	COP	
Morellia dendropanacis Pamplona y Couri, 1995 *	CDZ, COP, PAJ	
Morellia humeralis (Stein,1918) *	CAL, COP, PAJ	
Morellia violacea (Robineau-Desvoidy, 1830)+	PAJ	
Morellia sp.		Wolff et al. (2001)
Musca domestica Linnaeus, 1758	CAL, CDZ, COP, PAJ	Wolff et al. (2004), Pérez et al. (2005), Salazar-Ortega et al. (2012)

Table 1. (cont.) List of carrion flies species in the metropolitan area of Valle de Aburrá, Antioquia, Colombia. (*) new records for Colombia. (+) new records for Antioquia. (^) Informally described species by Grisales (2010). (CAL) Caldas; (COP) Copacabana; (CDZ) Cola del Zorro; (PAJ) Pajarito,

Muscidae		
Ophyra aenescens (Wiedemann, 1830)	CAL, CDZ, COP, PAJ	Salazar-Ortega et al. (2012)
Ophyra albuquerquei Lopes, 1985 *	COP	
Ophyra capensis (Wiedemann, 1818)		Pérez et al. (2005)
Ophyra chalcogaster (Wiedemann, 1824) *	PAJ	
Ophyra sp.		Wolff et al. (2001)
Phaonia sp.		
Polietina sp. 1	CAL, CDZ, COP	
Polietina sp. 2	CAL, CDZ	
Synthesiomyia sp.		Pérez et al. (2005)
Stomoxys calcitrans (Linnaeus, 1758)+	COP	
Sarcophagidae		
Blaesoxipha plinthopyga (Wiedemann, 1830)		Salazar-Ortega et al. (2012)
Boettcheria sp. 1	CAL, PAJ	
Chrysagria sp. 1	PAJ	
Helicobia sp. 1	PAJ	
Lepidodexia sp.		Buenaventura (2006)
Nephochaetopteryx sp. 1	PAJ	
Oxysarcodexia amorosa (Schiner, 1868)+	COP, PAJ	
Oxysarcodexia angrensis (Lopes, 1933) *	CAL, COP, PAJ	
Oxysarcodexia avuncula (Lopes, 1933)+	CAL, PAJ	
Oxysarcodexia bakeri (Aldrich, 1916)+	COP	
Oxysarcodexia conclausa (Walker, 1861)+	CAL, CDZ, COP, PAJ	
Oxysarcodexia diana (Lopes, 1933)*	PAJ	
Oxysarcodexia fluminensis Lopes, 1946 *	COP, PAJ	
Oxysarcodexia grandis Lopes, 1946+	CAL, CDZ	
Oxysarcodexia major Lopes, 1946+	CAL, CDZ, PAJ	
Oxysarcodexia mitifica Lopes, 1953*	COP	
Oxysarcodexia peruviana Lopes, 1975*	CDZ, PAJ	
Oxysarcodexia plebeja Lopes, 1946*	PAJ	
Oxysarcodexia sarcinata Lopes, 1953+	CAL, COP, PAJ	
Oxysarcodexia taitensis (Schiner, 1868)+	COP	
Oxysarcodexia thornax (Walker, 1849)+	COP	
Oxysarcodexia timida (Aldrich, 1916) *	CAL, COP	
Oxysarcodexia sp.		Wolff et al. (2001), Pérez et al. (2005), Salazar-Ortega et al. (2012)
Oxysarcodexia sp. 1	CAL, CDZ, COP	
Oxysarcodexia sp. 2	CDZ	
Oxysarcodexia sp. 3	CDZ	
Oxysarcodexia sp. 4	CDZ	
Oxysarcodexia sp. 5	CDZ, PAJ	
Oxysarcodexia sp. 6	PAJ	

Table 1. (cont.) List of carrion flies species in the metropolitan area of Valle de Aburrá, Antioquia, Colombia. (*) new records for Colombia. (+) new records for Antioquia. (^) Informally described species by Grisales (2010). (CAL) Caldas; (COP) Copacabana; (CDZ) Cola del Zorro; (PAJ) Pajarito,

Sarcophagidae		
Peckia (*Euboettcheria*) *aequata* (Wulp, 1895)+	CDZ, PAJ	
Peckia (*Euboettcheria*) *anguilla* (Wulp, 1895)		Buenaventura and Pape (in press)
Peckia (*Euboettcheria*) *asinoma* (Hall, 1938) *	CAL, CDZ, PAJ	
Peckia (*Euboettcheria*) *collusor* (Curran y Walley, 1934) *	CDZ, PAJ	Buenaventura and Pape (in press)
Peckia (*Patonella*) *intermutans* (Walker, 1861)	CAL, CDZ	Buenaventura and Pape (in press)
Peckia (*Peckia*) *chrysostoma* (Wiedemann, 1830)	COP	Buenaventura and Pape (in press)
Peckia (*Squamatodes*) *ingens* (Walker, 1849)	CAL, CDZ	Buenaventura and Pape (in press)
Peckia sp.		Salazar-Ortega et al. (2012)
Peckia sp. 4		Salazar-Ortega et al. (2012)
Peckia sp. 5		Pérez et al. (2005)
Ravinia effrenata (Walker, 1861)+	COP, PAJ	
Ravinia querula (Walker, 1849) *	CAL, PAJ	
Ravinia sp.		Pérez et al. (2005)
Ravinia sp. 1	PAJ	
Sarcodexia lambens (Wiedemann, 1830)+	CAL, COP, PAJ	
Sarcofahrtiopsis cuneata (Townsend, 1935)+	COP	
Sarcophaga sp.		Pérez et al. (2005)
Sarcophaga ruficornis (Fabricius, 1794)		Salazar-Ortega et al. (2012)
Tricharaea sp. 1	COP	

Classic studies on carrion flies communities suggest their composition is dominated by few abundant species (Hanski 1987). These communities in Neotropical region are expected to be composed of a great number of species.

This study shows us that previous studies underestimated the fly fauna of Medellin and surrounding areas. Even though ninety-four species is the highest richness reported for a single carrion fly community, we believe that the real number of fly species occurring in the area assessed is still incomplete, if different stages of decomposition are considered. Our estimation is a reflection of the high richness of insects in tropical environments (Godfray et al 1999).

The present checklist and records reported will provide a taxonomic and faunistics tools for future studies focuses on competency, dispersion, bait selection, resource partitioning of ephemeral flies communities, as well become part of the insect of forensic importance database.

Most of the species collected in this study had been reported as carrion breeders with potential as forensic markers in Colombia and other neotropical countries (Carvalho et al. 2000, Wolff et al. 2001, Barreto et al. 2002, Iannacone 2003, Camacho 2005, Pérez et al. 2005, Martínez et al. 2007, Moretti et al. 2008, Segura et al. 2009, Oliveira and Vasconcelos 2010). According to Salazar-Ortega et al. (2012) 27 species compose the fauna of carrion flies of Medellin city (381 km^2), this is around 28 % of species founded in the Valle de Aburrá (876 km^2 covered by this study). Spatial scale and size of study area may explain this richness pattern; beside we consider the strong influence on species richness of long-term studies, these kind of faunal approach probably will reveal species not found in

short term studies. A comprehensive faunistic study might consider phenological dynamics and population seasonality, key factors in the entomological inference to clarify forensic cases.

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References

Amat E. 2009. Contribución al conocimiento de las Chrysomyinae y Toxotarsinae (Diptera: Calliphoridae) de Colombia. *Revista Mexicana de Biodiversidad* 80: 693-708.

Amat E. 2010. Notes on necrophagous flies (Diptera: Calyptratae) associated to fish carrion in Colombian Amazon. *Acta Amazonica* 40(2): 397-400.

Amat E, Vélez MC, Wolff M. 2008. Clave ilustrada para la identificación de los géneros y las especies de Califóridos (Diptera: Calliphoridae) de Colombia. *Caldasia* 30(1): 231-244.

Amorim DS, Silva VC, Balbi MIPA. 2002. *Estado do conhecimento dos dípteros neotropicais*. In: Proyecto de Red Iberoamericana de Biogeografía y Entomología Sistemática PrIBES, Monografias Tercer Milenio Vol 2. Edited by Costa C, Vanin SA, Lobo JM, Melic A. Zaragoza, Spain. SEA 29-36.

Barros RM, Mello-Patiu CA, Pujol-Luz JR. 2008. Sarcophagidae (Insecta, Diptera) associados à decomposição de carcaças de *Sus scrofa* Linnaeus (Suidae) em área de cerrado do Distrito Federal, Brasil. *Revista Brasileira de Entomologia* 52: 606-609.

Barreto M, Burbano ME, Barreto P. 2002. Flies (Calliphoridae, Muscidae) and Beetles (Silphidae) from Human Cadavers in Cali, Colombia. *Memórias do Instituto Oswaldo Cruz* 97(1): 137-138.

Baumgartner DL, Greenberg B. 1984. The genus *Chrysomya* (Diptera: Calliphoridae) in the New World. *Journal of Medical Entomology* 21: 105-113.

Biavati GM, Assis FH, Pujol-Luz JR. 2010. A checklist of Calliphoridae blowflies (Insecta, Diptera) associated with a pig carrion in central Brazil. *Journal of Forensic Sciences* 55(6): 1603-1606.

Buenaventura E. 2006. L*os Sarcofágidos (Diptera, Sarcophagidae) de importancia forense en Colombia* [Undergraduate thesis]. Bogotá D.C.: Universidad Distrital Francisco José de Caldas, Facultad de Ciencias y Educación. 192 p.

Buenaventura E, Camacho G, García G, Wolff M. 2009. Sarcophagidae (Diptera) de importancia forense en Colombia: claves taxonómicas, notas sobre su biología y distribución. *Revista Colombiana de Entomología* 35(2): 189-196.

Buenaventura E, Pape T. In preparation. Revision of the genus *Peckia* Robineau-Desvoidy (Diptera: Sarcophagidae). *Zootaxa*.

Camacho G. 2005. Sucesión de la entomofauna cadavérica y ciclo vital de *Calliphora vicina* (Diptera, Calliphoridae) como primera especie colonizadora, utilizando cerdo blanco (*Sus scrofa*) en Bogotá. *Revista Colombiana de Entomología* 31(2): 189-197.

Carvalho CJB, Couri MS. 2002. Part I. Basal groups. In: Muscidae (Diptera) of the Neotropical Region: taxonomy. Edited by CJB Carvalho. Curitiba, Editora Universidade Federal do Paraná 17-259.

Carvalho CJB, Mello-Patiu CA. 2008. Key to the adults of the most common forensic species of Diptera in South America. *Revista Brasileira de Entomologia* 52: 390-406.

Carvalho LML, Linhares AX. 2001. Seasonality of insect succession and pig carcass decomposition in a natural forest area in southeastern Brazil. *Journal of Forensic Sciences* 46: 604–608.

Carvalho LML, Thyssen PJ, Linhares AX, Palhares FAB. 2000. A checklist of Arthropods associated with pig carrion and human corpses in southeastern Brazil. *Memórias do Instituto Oswaldo Cruz* 95(1): 135-138.

Carvalho LML, Thyssen PJ, Goff ML, Linhares AX. 2004. Observations on the succession patterns of necrophagous insects on a pig carcass in an urban area of Southeastern Brazil. *Forensic Medicine and Toxicology* 5: 33-39.

Catts EP, Goff ML. 1992. Forensic entomology in criminal investigations. *Annual Review of Entomology* 37: 253-272.

Catts EP, Haskell NH. 1991. *Entomology and death: a procedural guide*. Clemson: Forensic Entomology Partners. 182 p.

Courtney GW, Pape T, Skevington JH, Sinclair BI. 2009. *Biodiversity of Diptera*. In: Insect Biodiversity Science and society. Edited by Foottit RG, Adlher PH. Wiley-Blackwell. p 185–222.

Giraldo A. 2007. Variabilidad Molecular de *Phaenicia cluvia* (Diptera: Calliphoridae) a partir de Secuencias de ADN Mitocondrial [Undergraduate thesis]. Medellín: Universidad de Antioquia, Instituto de Biología, Facultad de Ciencias Naturales. 96 p.

Giroux M, Pape T, Wheeler TA. 2010. Towards a phylogeny of the flesh flies (Diptera: Sarcophagidae): morphology and phylogenetic implications of the acrophallus in the subfamily Sarcophaginae. *Zoological Journal of the Linnean Society* 158: 740–778.

Godfray HCT, Lewis OT, Memmott J. 1999. Studying insect diversity in the tropics. *Philosophical Transactions of the Royal Society of London B*. 354 1811-1824

Greenberg B. 1991. Flies as forensic indicators. *Journal of Medical Entomology* 28: 565–577.

Grisales D. 2010.Taxonomia de Fanniidae (Diptera) da Colômbia [M.Sc. thesis]. Paraná: Universidad Federal do Paraná, Programa de Pós-Graduação em Ciências Biológicas, Área de Concentração em Entomologia. 151 p.

Grisales D, Wolff M, Carvalho CJB. 2012. Neotropical Fanniidae (Insecta: Diptera): new species of *Euryomma* Stein from Colombia. *Journal of Natural History* 46(13-14): 803-829.

Hanski I. 1987. Carrion fly community dynamics: patchiness, seasonality and coexistence. *Ecological Entomology* 12: 257–266.

Iannacone J. 2003. Artropofauna de importancia forense en un cadaver de cerdo en la Callo, Peru. *Revista Brasileira de Zoologia* 20: 85–90.

Jirón LF, Vargas LG, Vargas-Alvarado E. 1983. Four muscoid flies (Sarcophagidae and Muscidae) associated with human cadavers in Costa Rica. *Brenesia* 21: 3–5.

Keh B. 1985. Forensic entomology in criminal investigations. *Annual Review of Entomology* 30: 137-151.

Linhares AX. 1981. Synanthropy of Calliphoridae and Sarcophagidae (Diptera) in the city of Campinas, Sao Paulo, Brazil. *Revista Brasileira de Entomologia* 25(3): 189-215.

Lopes HS. 1946. Contribuição ao conhecimento das espécies do gênero *Oxysarcodexia* Townsend, 1917. *Boletin da Escola Nacional de Veterinaria* 1: 62-134.

Lopes HS, Tibana R. 1987. On *Oxysarcodexia*, with descriptions of five new species, key, list and geographic distribution of the species. *Revista Brasileira de Biologia* 47, 329-347.

Martínez E, Duque P, Wolff M. 2007. Succession pattern of carrion-feeding insects in Paramo, Colombia. *Forensic Science International* 166: 182-189.

Moretti TC, Ribeiro OB, Thyssen PJ, Solis DR. 2008. Insects on decomposing carcasses of small rodents in a secondary forest in Southeastern Brazil. *European Journal of Entomology* 105: 291-296.

Moura MO, Carvalho CJB, Monteiro-Filho ELA. 1997. A preliminary analysis of insects of medico-legal importance in Curitiba, State of Paraná. *Memórias do Instituto Oswaldo Cruz* 92: 269-274.

Moura MO, Carvalho CJB, Monteiro-Filho ELA. 2005. Estrutura de comunidades necrófagas: efeito da partilha de recursos na diversidade. *Revista Brasileira de Biologia* 22(4): 1134-1140.

Moura MO, Monteiro-Filho ELA, Carvalho CJB. 2005. Heterotrophic succession in carrion arthropod assemblages. *Brazilian Archives of Biology and Technology* 48: 473-482.

Mulieri PR, Schnack JA, Mariluis JC, Torretta JP. 2008. Flesh flies species (Diptera: Sarcophagidae) from a grassland and a woodland in a Nature Reserve of Buenos Aires, Argentina. *Revista de Biologia Tropical* 56(3): 1287-1294.

Oliveira VC, D'Almeida JM, Paes MJ, Sanavria A. 2002. Population dynamics of calyptrate Diptera (Muscidae and Sarcophagidae) at the Rio-Zoo foundation, Rio de Janeiro, Brazil. *Brazilian Journal of Biology* 62(2): 191-196.

Oliveira-Costa J. 2008. *Entomologia forense: quando os insetos são vestígios*. Campinas: Millenium. 420 p.

Oliveira-Costa J, Mello-Patiu CA. 2004. Application of forensic entomology to estimate of the postmortem interval (PMI) in homicide investigations by the Rio de Janeiro Police Department in Brazil. *Forensic Medicine and Toxicology* 5: 40-44.

Oliveira TC, Vasconcelos SD. 2010. Insects (Diptera) associated with cadavers at the Institute of Legal Medicine in Pernambuco, Brazil: Implications for forensic entomology. *Forensic Science International* 198: 97–102.

Pamplona D, Couri MS. 1989. Revisão das espécies neotropicais de *Ophyra* Robineau-Desvoidy, 1830 (Diptera, Muscidae, Azelinae). *Memórias do Instituto Oswaldo Cruz* 84 supl. IV: 419-429.

Pape T. 1996. Catalogue of the Sarcophagidae of the world (Insecta: Diptera). *Memoirs on Entomology International* 8: 558 pp.

Pape T, Wolff M, Amat E. 2004. Los califóridos, éstridos, rinofóridos y sarcofágidos (Diptera: Calliphoridae, Oestridae, Rhinophoridae y Sarcophagidae) de Colombia. *Biota Colombiana* 5(2): 201-208.

Pérez S, Duque P, Wolff M. 2005. Successional behaviour and occurrence matrix of carrion-associated arthropods in the urban area of Medellín, Colombia. *Journal of Forensic Sciences* 50(2): 1-7.

Rocha RR, Mello-Patiu CA, Mello RP, Carvalho MM. 2009. New records of calyptratae dipterans (Fanniidae, Muscidae and Sarcophagidae) associated with the decomposition of domestic pigs in Brazil. *Memórias do Instituto Oswaldo Cruz* 104(6): 923-926.

Salazar-Ortega J, Amat E, Gómez-Piñerez L. 2012. A checklist of necrophagous flies (Diptera, Calyptratae) from urban area in Medellín, Colombia. *Revista Mexicana de Biodiversidad* 83: 562-56.

Segura NA, Usaquen W, Sánchez MC, Chuaire L, Bello F. 2009. Succession pattern of cadaverous entomofauna in a semi-rural area of Bogotá, Colombia. *Forensic Science International* 187: 66–72.

Smith K. 1986. *A manual of forensic entomology*. New York: British Museum (Natural History) London and Cornell University Press. 205 p.

Souza AM, Linhares AX. 1997. Diptera and Coleoptera of potential forensic importance in Southeastern Brazil: relative abundance and seasonality. *Medical and Veterinary Entomology* 11: 8-12.

Souza ASB, Kirst FD, Krüger RF. 2008. Insects of forensic importance from Rio Grande do Sul state in Southern Brazil. *Revista Brasileira de Entomologia* 52: 641-646.

Velez MC, Wolff M. 2008. Rearing five species of Diptera (Calliphoridae) of forensic importance in Colombia in Semicontrolled field conditions. *Papeis Avulsos de Zoologia* 48: 41- 47.

Whitworth T. 2010. Keys to the genera and species of blow flies (Diptera: Calliphoridae) of the West Indies and description of a new species of *Lucilia* Robineau-Desvoidy. *Zootaxa* 2663:1-35.

Wolff M, Uribe A, Ortiz A, Duque P. 2001. A preliminary study of forensic entomology in Medellín, Colombia. *Forensic Science International* 120: 53-59.

Wolff M, Builes A, Zapata G, Morales G, Benecke M. 2004. Detection of Parathion (O, O diethyl O (4-nitrophenyl) Phosphorothioate) by HPLC in insect of Forensic importance in Medellin Colombia. *Annual Aggrawal's Internet Journal of Forensic Medicine and Toxicology* 5: 6-11.