Short Article

A rapid ecological assessment for necrophagous flies (Diptera, Calyptratae) in a mosaic landscape of the Colombian Andes

Eduardo Amat[1,3] y Claudia A. Medina[2]

[1]Grupo de Investigación Bioforense, Facultad de Derecho y Ciencias Forenses, Tecnológico de Antioquia Institución Universitaria.

[2]Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, Calle 28A#15-09 Bogotá, Colombia

[3] Corresponding author: ecamat@gmail.com

Abstract

A necrophagous flies ensemble (Diptera, Calyptratae) was rapidly assessed in four coverages of an anthropogenic landscape in the east range of the Colombian Andes. Ninety-seven individuals belonging to eight species were collected in only two hours of sampling. The highest diversity values and the occurrence of asynanthropic flies in the forest under conservation management may indicate a positive effect of the natural restoration process in the area assessed. Grassland, rural and urban coverages were similarly low in diversity and composition. A brief discussion about the flies' bionomy and their environment association is offered. Necrophagous flies ensembles by coverage behave as an indicator of the anthropic impact on the landscape.

Keywords: Blow flies, Carrion-feeding, Decomposers, Diversity, Forensic Entomology

Resumen

Una evaluación ecológica rápida del ensamble de moscas necrófagas (Diptera, Calyptratae) se llevó a cabo en cuatro coberturas del paisaje antropizado del municipio de Viotá, Cundinamarca, Colombia. Noventa y siete individuos distribuidos en tres familias y ocho especies fueron recolectados en tan solo dos horas de muestreo. Los valores mas altos de diversidad y la presencia de moscas asinantrópicas típicas de áreas prístinas en la cobertura de bosque, podría indicar un efecto positivo en su proceso de restauración. El pastizal, el área rural y la región urbana resultaron similares en composición y valores de baja diversidad. Se ofrece una breve discusión acerca de la bionomía de las moscas y su ambiente asociado. Finalmente evidenciamos que los ensambles de moscas por cobertura se comportan como indicadores del impacto antropogénico en el paisaje.

Palabras clave: Calliphoridae, Carroñeras, Descomponedores, Diversidad, Entomología Forense.

Introduction

Necrophagous or carrion-feeding flies (Diptera, Calyptratae) are well known by their medico-legal, forensic and veterinary importance (Marshall 2012); additionally, they have been suggested as a practical bioindicator of the restoration process and conservation management of the forest (Majer 1987; de Sousa et al. 2014). Carrion-feeding flies have different tolerances to the habitat conditions, being affected by the degree of human impact on the natural environment (anthropization process) (Povolný 1971). The level of preference is commonly known in entomological studies as "Synanthropy" (Gregor and Povolný 1958). Thus, synanthropic, hemisynanthropic, and asynanthropic are the ecological categories for classifying flies according to their degree of attraction or repulsion for human settlements (Povolný 1971). In a rapid assessment (two hours), the ensemble and diversity of necrophagous flies (Diptera, Calyptratae) were assessed. Species are classified according to their associations to coverages in a heterogeneous landscape located in the east range of the Colombian Andes.

Materials and methods

The study was conducted in a mosaic landscape area of the Viotá Municipality, Cundinamarca province (4°26'19.73"N; 74°31'12.47"W) at 600m of elevation in the east range of the Andean cordillera. Flies collection took place beginning the dry season on the 7th of December of 2018, starting approximately at 10:00 am to 1:00 pm. The climate in Viotá is usually hot and humid; monthly temperature averages range from 21°C to 32°C. Four coverages of the landscape were surveyed (Forest 4°26'34.15"N, 74°30'47.41"W; Grassland 4°26'28.93"N, 74°31'0.48"O; Rural 4°26'27.28"N, 74°31'15.51"W and Urban 4°26'14.78"N, 74°31'15.78"O), one collection site was settled in each (Figure 1). The secondary forest coverage is located within the Camino Verde Natural Reserve (CVNR) (Figure 2). This natural sanctuary has an area of 10 ha.; it was traditionally used for cattle raising decades ago, but nowadays, it is under active restoration management, include sections restored from 9 to 24 years old. The grassland of *Cenchrus clandestinus* (Kikuyu grass), the rural vicinities of ranch houses, and the adjacent urbanized area of the Viotá municipality complete the set of coverages. In each collection site, an active manual collection for thirty minutes, using an entomological net, and as a bait a three days old fish head rotten, was performed. Flies gathered were preserved in OH 90% and taxonomically identified following the keys of Amat, Vélez, and Wolff (2008); Grella et al. (2015); Whitworth (2014); Whitworth and Yusseff-Vanegas (2019). Pinned and labeled specimens were deposited at Colección

Entomológica Tecnológico de Antioquia, Institución Universitaria (CETdeA) located in Medellín, Colombia and also in the Colección Entomológica del Instituto Alexander Von Humboldt (IAvH) in Villa de Leiva, Colombia. The diversity data gathered by coverage was analyzed and compared based on diversity profiles and the effective number of species (Hills numbers) (Chao and Jost 2015). Three values of diversity according the order of coefficient *q* were plotted (the parameter *q* determines the measure of sensitivity to the species abundance); where *q*=0 for absolute number of species (richness), *q*=1 for the exponential of Shannon entropy and *q*=2 for the inverse of Simpson dominance. Additional Gini-Simpson equitability (*Eq*) was calculated. The category of synanthropy was deduced based on the value of the Sinanthropy Index (S.I) proposed by Nuorteva (1963) excluding those individuals from grassland. The S.I ranges from -100 (avoidance for human settlements) to 100 (affinity for human settlements). Finally, synanthropic data is contrasted with previous information reported in the literature; a brief discussion about the flies' synanthropy and their landscape associated (Figure 2) is offered.

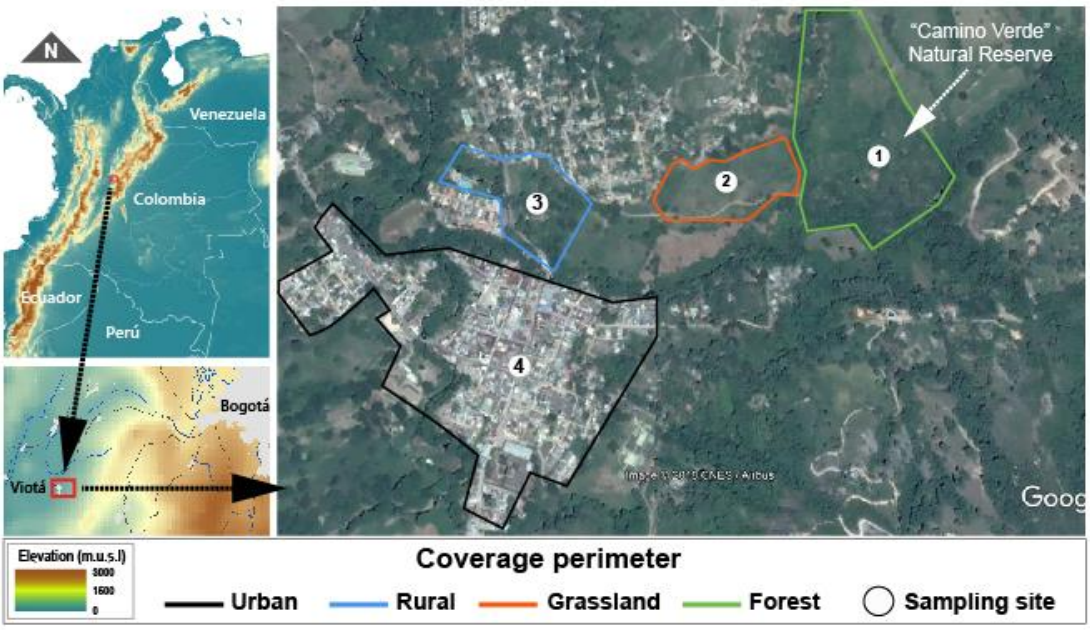

Figure 1. The geographical location of the study area, coverages assessed, and collection sites in Viotá Municipality, Colombia.

Results

Ninety-seven individuals (80 females, 82,4% and 17 males, 17.5%) belonging to eight species (Figure 2) encompassing three families (Calliphoridae, Mesembrinellidae, and

Muscidae) of Calyptratae flies were collected. The most common species was *Chrysomya albiceps* (Wiedemann, 1819), followed by *Musca domestica* Linnaeus, 1758, and *Cocliomyia macellaria* (Fabricius,1775). Only one individual of *Chloroprocta idioidea* (Robineau-Desvoidy, 1830), *Lucilia eximia* (Wiedemann, 1830), and *Mesembrinella bicolor* Fabricius, 1893 was recorded (Table 1).

Necrophagous flies were most abundant in the urban area (48 individuals), while in the grassland, only 16 individuals were collected. The forest coverage displayed the highest value of diversity when *q*=0 (7 species), while in the grassland, rural and urban coverages, it was collected three species respectively. In general the forest area was the most diverse showing the highest values of diversity orders and equitability (*q*=0:7; *q*=1:4; *q*=2:2.7 – Eq:73.2%) , followed by the rural (*q*=0:3; *q*=1:2.6; *q*=2:2.3 – *Eq*:85.6%), urban (*q*=0:3; *q*=1:2.5; *q*=2:2.7 – *Eq*:80%) and finally the grassland coverage (*q*=0:3; *q*=1:2.2; *q*=2:1.9 – *Eq*:69%) (Figure 3).

Table 1. Necrophagous flies of Viotá municipality collected in two hours sampling; abundance tendencies; Synanthropy index (S.I) and their synanthropic categorization. (a) asynanthropic; (eu) eusynanthropic; (hem) hemisynanthropic.

Family	Species	Complete abundance	Relative abundance (%)	Abundance by coverage				S.I	Synanthropic category
				Forest	Grassland	Rural	Urban		
Calliphoridae	*Chloroprocta idioidea* (Robineau-Desvoidy, 1830)	1	1,0	1	-	-	-	-100	a
	Chrysomya albiceps (Wiedemann, 1819)	39	40,2	15	11	7	6	-20	hem
	Cochliomyia macellaria (Fabricius, 1775)	15	15,5	2	4	3	6	50	eu
	Hemilucilia segmentaria (Fabricius, 1805)	2	2,1	2	-	-	-	-100	a
	Hemilucilia semidiaphana (Rondani,1850)	4	4,1	4	-	-	-	-100	a
	Lucilia eximia (Wiedemann, 1819)	1	1,0	1	-	-	-	-100	a
Mesembrinellidae	*Mesembrinella bicolor* Fabricius, 1893	1	1,0	1	-	-	-	-100	a
Muscidae	*Musca domestica* Linnaeus, 1758	34	35,1	-	1	13	20	80	eu

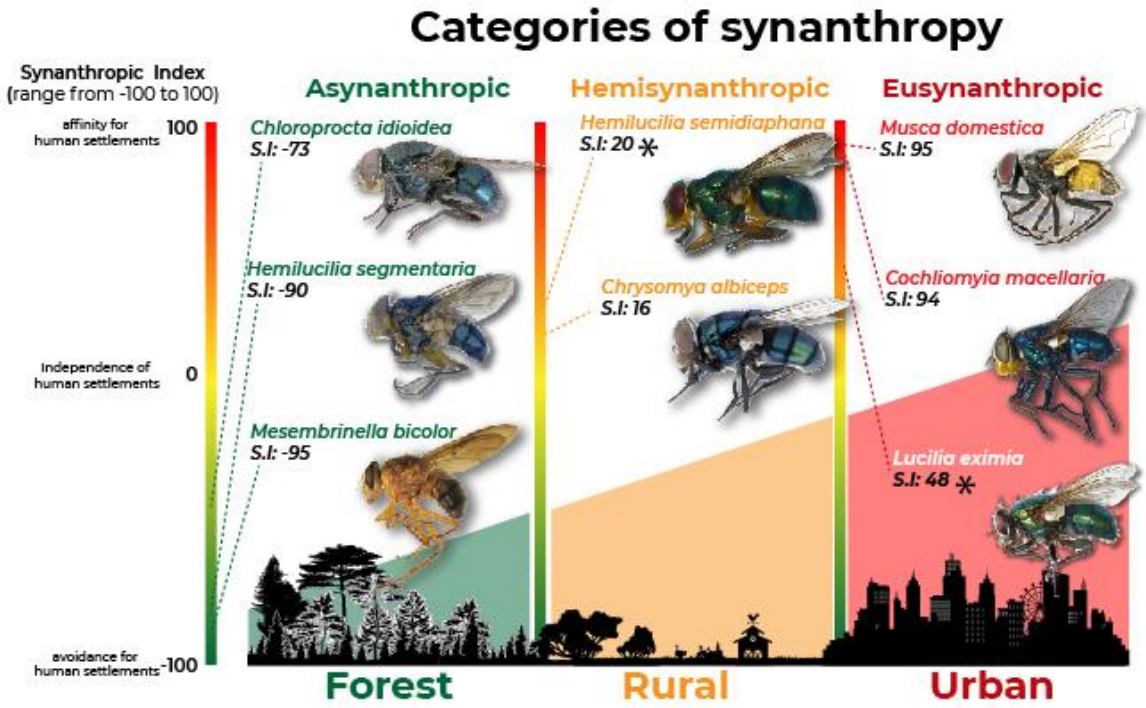

Figure 2. Synanthropic tendencies and categorization of necrophagous flies in the Viotá Municipality. The values of the Synanthropy Index (S.I) was based in literature. *asynanthropic in this study.

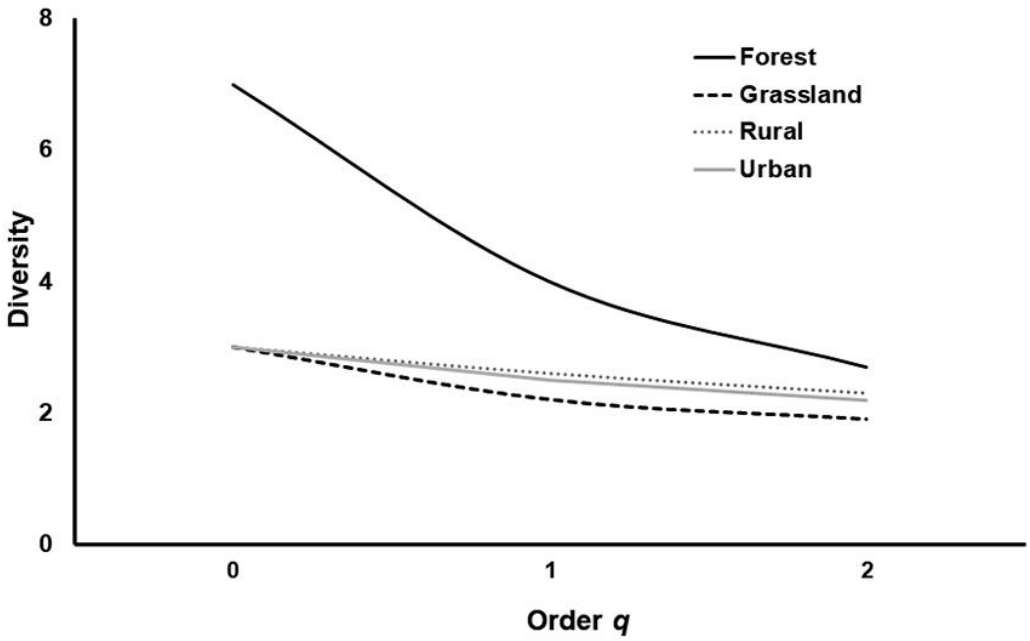

Figure 3. The diversity profile of the necrophagous flies based on the effective number of species (q=0,1 and 2) by coverage assessed in the Viotá municipality.

M. domestica was the most frequent species in human settlement coverages; on the other hand, *C. albiceps* was the most frequent in forest and grassland (Table 1). The forest coverage houses all the rarest, asynanthropic, and hemisynanthropic species. Synanthropic index here deduced allows to categorized five species as asynanthropic (*Chl. Idioidea*; *H. segmentaria*, *H. semidiaphana*, *L. eximia*, and *M. bicolor*); one as hemisynanthropic (*Ch. albiceps*) and finally two as eusynanthropic (*Co. macellaria*, *M. domestica*) (Table 1).

Discussion

Despite the short time and fast sampling effort, the richness here reported (8 species) obtained in only two hours sampling is similar with comparable Andean forensic entomological studies of flies associated with decomposed corpses during six days in the fresh and bloated stage (9 species) (Grisales, Ruiz, and Villegas 2010). Coverage diversity data here obtained are in agreement with the study of de Sousa et al. (2020) in Amazonia, where they report the highest values of diversity estimated in the preserved environments; they also pointed that necrophagous flies respond differentially to the anthropic activity especially to cattle ranching. In other words, more preserve environment displays higher values of diversity, and inversely the more urbanized or disturbed environments exhibits the lowest values. The ensemble here assessed is dominated by *C. albiceps*, a highly competitive introduced species (Rosa et al. 2006). The high abundance values of introduced species (*Chrysomya* spp.) is a common tendency in tropical flies communities composition. Nevertheless, the ecological effects regarding biomass removal and competition are still unknown. Flies' synanthropy previously pointed by previous authors and the diversity tendencies, according to the coverage, are in agreement with the landscape of Viotá (Figure 3). This means that synanthropic species were most abundant in urbanized or highly perturbed environments but scarce in the forest or better-preserved habitats and vice-versa.

All fly species in Viotá kept the ecological category previously reported in the literature; *C. albiceps* , *Co macellaria*, and *Chl. Idioidea* by Baumgartner and Greenberg (1985); *M. bicolor* by D'almeida and Lopes (1983) and *M. domestica* by Uribe-M, Wolff, and Carvalho (2010) (Figure 3), except *H. semidiaphana* and *Lucilia eximia* here considered as asynanthropic. Conversely, *H. semidiaphana* was reported as hemisynanthropic in several environments of Northern South America and *L. eximia* as eusynanthropic in the same study (Amat 2017). The short time sampling noticeably affects the values of abundance entered to

calculate the synanthropic index. Nevertheless, for the rest of the species values here offered agrees in terms of ecological classification. *H. semidiaphana* and *L. eximia* are highly polymorphic species widespread in the neotropical region (Whitwhorth 2014, Amat 2017). Therefore, there is a high probability that species complexes morphologically identical with different bionomic attributes exist, here lies the importance of local and regional ecological surveys.

The occurrence of *M. bicolor* and the others highly asynanthropic species (Figure 3) in the forest coverage suggests that it is capable of supporting their natural populations, which are particularly feasible in highly preserved and forested environments (Gadelha 2009). However, the abundance is still low comparing to pristine environments and obviously by the sampling effort. The diversity data here obtained may foresee a preliminary positive effect of the natural process of restoration in the CVRN, indicating an adequate management, and right decisions doing livestock reconversion recovering the ecosystem services of the patch forest, in this area dominated by urbanization and cattle ranching. Although the data on adequate sampling for this ensemble may require more effort; this approach in only two hours of fieldwork, with a minimum budget and yielding this type of quality data, is undoubtedly a remarkable option to include these organisms in rapid ecological assessments (REA). The necrophagous flies here assessed meets the criteria to be an optimal bioindicator of anthropic effects during processes of environmental management. Flies are abundant, easy to sample, and respond rapidly to a change in environment (synanthropy); additionally, they are relatively well taxonomic and ecological understood as here evidenced. Additional surveys conducted in other neotropical environments with different degrees of anthropic effects would corroborate the efficiency of flies as indicator taxa. Faunistic data here offered serves as a preliminary tool to forensic entomology in the region.

Acknowledgments

We thank Ricardo Morales and Miguel Reyes for supporting the logistics of this survey in Reserva Natural Camino Verde at Viotá, Cundinamarca. Thanks to the staff of the research group Bioforense at Tecnológico de Antioquia, Institución Universitaria. The authors declare that they have no conflict of interest. This study was funding by the coauthors.

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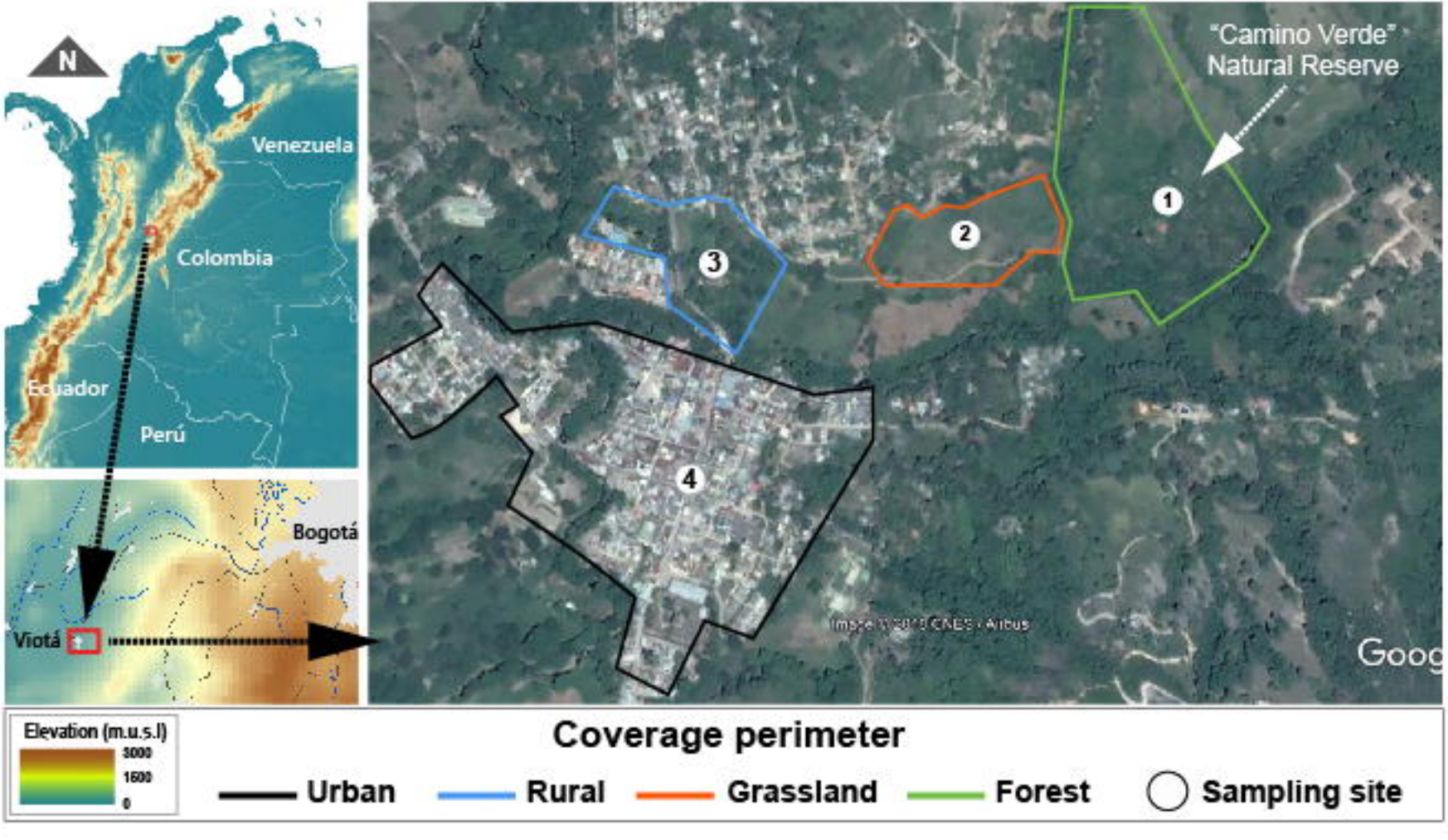
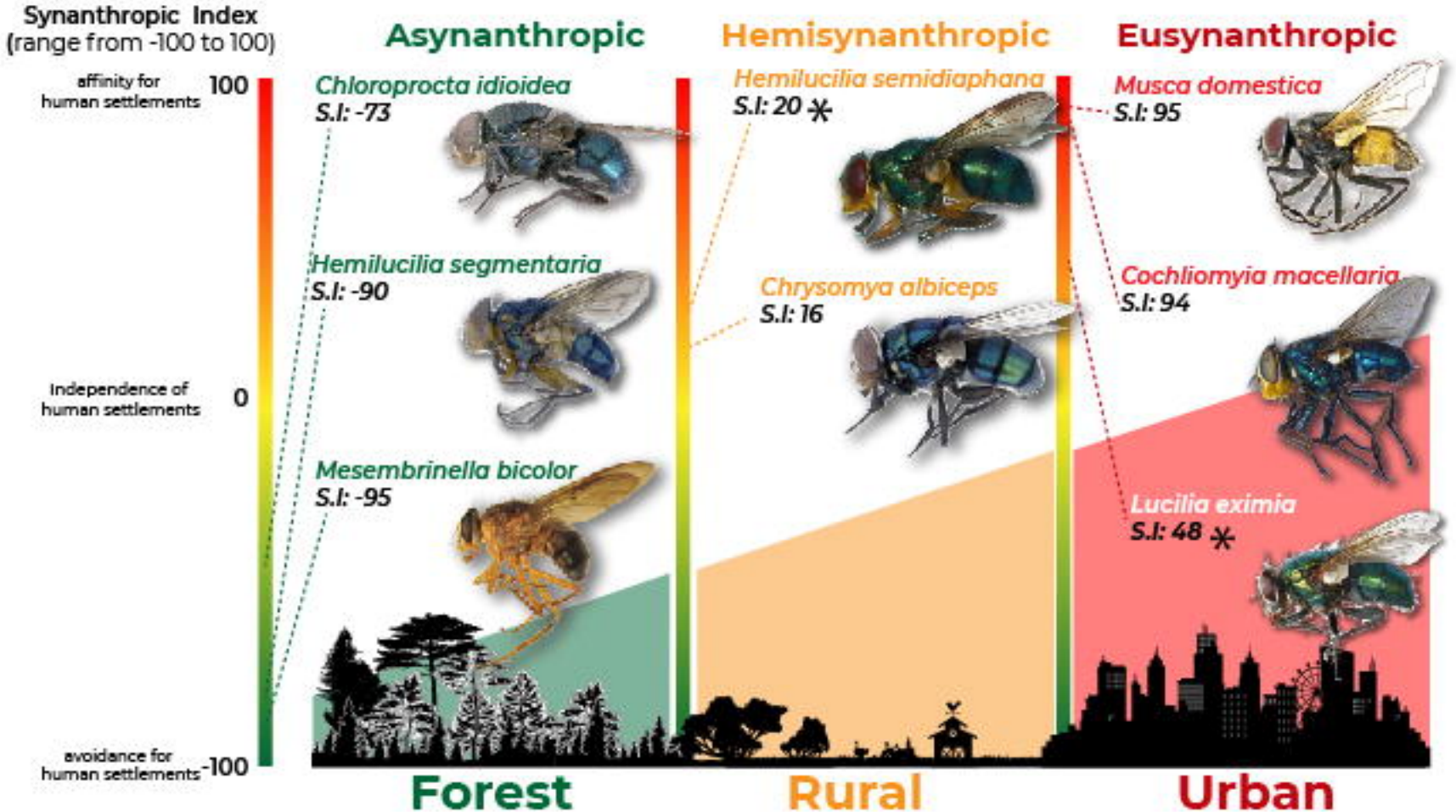
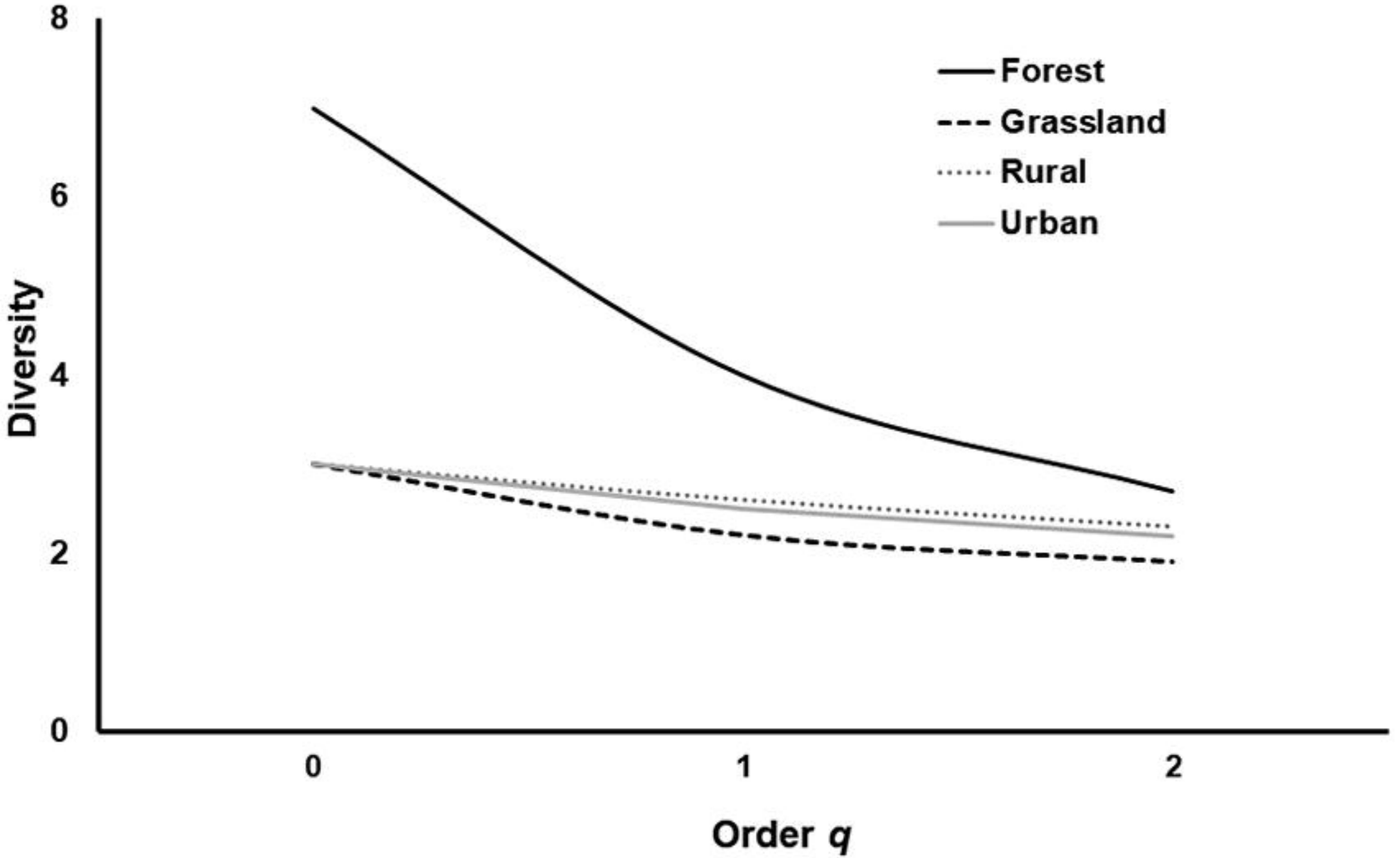

N
Venezuela
Colombia
Ecuador
Perú
Bogotá
Viotá
"Camino Verde"
Natural Reserve
1
2
3
4
Elevation (m.u.s.l)
3000
1600
0
Coverage perimeter
Urban
Rural
Grassland
Forest
Sampling site

Categories of synanthropy




8
6
4
2
0
Diversity
0
1
2
Order q
Forest
Grassland
Rural
Urban