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Research Article

Diptera Succession during Early Decomposition Stages in a Mediterranean Pinewood Umbrage

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Abstract

The succession of entomosarcosaprophagous fauna depends on multiple factors, being the environment one of the most important. Thus the study of sarcosaprophagous community in different microclimatic environments is relevant, even if the different locations are close to each other. Results concerning the early sarcosaprophagous community collected during a whole year in an umbrage area located at 980 MASL in Sierra Espuña Mountain (Murcia province, SE Spain) are presented. The study was carried out using a Schoenly trap baited with 5kg piglets. A daily sample was taken during all four seasons. More than 12700 specimens, belonging to 18 orders of Arthropoda, were collected. The most abundant in all seasons was Diptera, representing 97.66% of the captures in fall. Among Diptera, Calliphoridae was the most representative family during the first stages of decomposition, representing 94.37% of all Diptera in spring, 41.05% in summer, 61.03% in fall and 80% in winter. Muscidae and Fannidae were also abundant in summer and fall. The Calliphorid species collected were: *Calliphora vicina, Calliphora vomitoria, Chrysomya albiceps, Lucilia caesar, Lucilia sericata, Pollenia sp.* and *Stomorhina lunata*. The primary species was always *C. vicina*. The most abundant species in the whole study was *Chrysomya albiceps*, being the most representative species in summer and fall. *Calliphora vicina* was the most representative in spring and winter. These results are compared with previous studies conducted with a piglet and chicken carcasses in a near suburban area. Differences concerning community species composition and dynamics and succession, as well as decomposition process have been detected.

Keywords: Calliphoridae; Forensic entomology; Iberian Peninsula; Sarcosaprophagous fauna

Introduction

Studies on the entomosarcosaprophagous community and the successional patterns in carcasses represent the starting point of research in forensic entomology that mainly deals with death investigations. One of the methods to estimate the delay between death and corpse finding is based on the biological principle of succession, where the colonization of the corpse occurs in a sequence that, when known, is predictable. Successional stages are represented by the variety of arthropods present in the corpse at a particular time. This diversity is, then, compared to know successional patterns for that geographic area or habitat [1]. Unfortunately, most of the studies concerning the sarcosaprophagous community and its successional patterns have been conducted in restricted areas, mainly man influenced, and few comparisons with other close and different environments have been made. In particular, wild areas have been ignored, except for some locations [1-10].

In the Iberian Peninsula, except for some data [3,4,11-15], hardly any work has been devoted to natural environments related to the sarcosaprophagous community. With exception of the information on diversity of species and relative abundance of taxa obtained from succession studies [16] no other data exists about sarcosaprophagous succession in wild conditions in the Iberian Peninsula.

As it concerns the community, the most important component for forensic purposes is the necrophagous, mainly Diptera, some of which are known to be the first arthropods to arrive at the corpse. These insects arrive immediately after death, and their dynamics depend on several factors [17], such as the corpse placement, weather conditions, and season. In addition, the corpse itself is an important factor [18-20].

Given all of above, our study attempts to provide for the first time data, for the Iberian Peninsula and also Europe, on the early sarcosaprophagous community in a mountainous wild environment.

Materials and Methods

The present study was carried out in the Murcia region of Sierra Espuña, a mountainous area located in the southeast of the Iberian Peninsula (SE Spain). The selected location was an umbrage area named Peña Apartada, at 980 MASL (UTM 30TXG6274190).

The vegetation of the area is a mixed mediterranean forest composed of *Pinus halepensis, Pinus pinaster, Pinus nigra, Quercus rotundifolia, Quercus faginea, Quercus coccifera, Juniperus oxycedrus* and *Pistacia lentiscus*.

Samples were collected daily for 15 days during the four seasons of the year defined as fall (15/09/06-29/09/06), winter (8/01/07-

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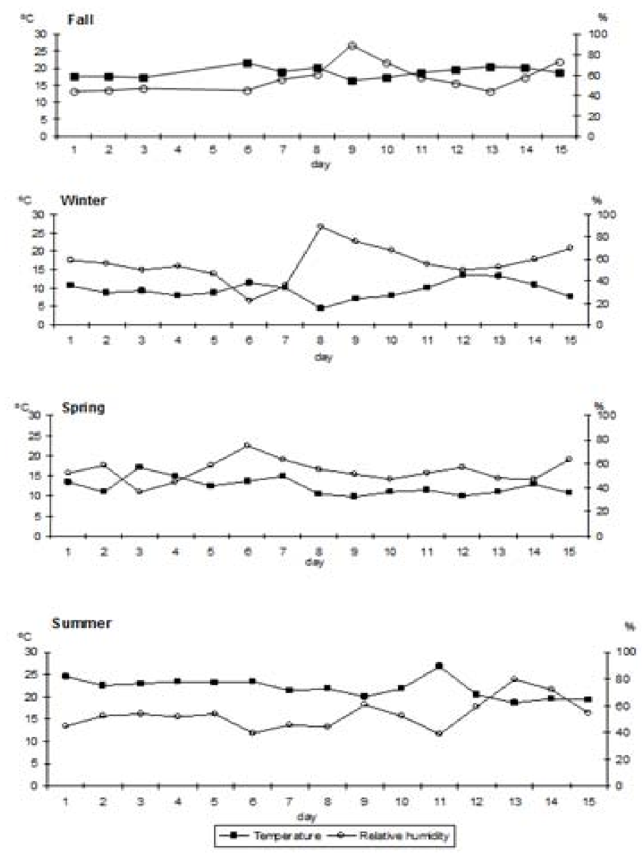

Figure 1: Mean temperature and mean relative humidity all along sampling period.

22/01/07), spring (4/04/07-18/04/07) and summer (15/06/07-29/06/07).

A modified version of the trap designed by Schoenly et al. [21] measuring 60 × 70 × 70 cm and Morril solution [22] as preservative solution were used to collect sarcosaprophagous fauna. This trap has been used previously for the study of sarcosaprophagous fauna [23-30], and has been shown to be as effective as other conventional methods by Ordóñez et al. [31].

Each season the trap was baited with a dead piglet (*Sus scrofa* L.) of 5kg weight. The piglet was euthanized using ketamine and saline solution, according to European Convention for the Protection of Vertebrate Animals used for Experimental and Other Scientific Purposes (86/609/CEE) D.O.C.E. 18.12.86. The piglets were provided by the University of Murcia Veterinary farm. As soon as the animals died, they were covered by a plastic bag to protect them during transportation to the trap.

The relative humidity and the temperature inside the trap were continuously recorded with HOBO U1O Data loggers placed in the trap.

Each sampling day, digital photographs of the bait were taken, and any other relevant data related to weather conditions, odours, etc. were also recorded.

Insect taxa were identified using different keys [32-35].

To estimate the diversity of Diptera community in our study, Margalef and Shannon indexes were calculated for each season, and for every decomposition stage. Margalef index was calculated following the equation MI=(S-1)/lnN, where S is the number of identified taxa and N is the total amount of individuals. Shannon's index was calculated from the equation: $H' = -\sum p_i \ln p_i$, where p_i is the proportion of individuals found in the ith species from the total pool of species. The importance, utility and characteristics of both indexes have been extensively discussed in Magurran [36] and in Prado e Castro (pers. comm.) regarding the sarcosaprophagous community. Although the value of the Shannon index usually falls between 1.5 and 3.5 [36], the special characteristics of the sarcosaprophagous community made this index to achieve lower values, as reported in other special communities.

Results and Discussion

Climatological data

During fall, mean temperatures were quite warm (17-22ºC); relative humidity varied between 43 and 89% (Figure 1). In winter, mean temperature decreased reaching a minimum of 4.5°C and a maximum of 13.5ºC. Relative humidity was close to 50% reaching 70% around the middle of the sampling period. Spring was characterized by low mean temperatures, close to 10ºC, and relative humidity close to 50% except for the first days. During summer, mean daily temperature was close to 23ºC; relative humidity reached values in the upper 50%, increasing towards the end of the sampling period.

Stages and rates of decomposition

Three decomposition stages were identified: fresh, bloated and active decay, according to the description of decomposition stages provided by Goff [37].

The rate of decomposition was quite different in each season (Table 1). The fresh stage had high variability being shorter in warm seasons than in cold seasons. The bloated stage was not visible in the winter and spring seasons, most likely as a result of cold weather. The active decomposition stage was reached at the same time during spring and summer periods. Although fall was warmer than spring and, obviously, than winter, active decomposition was reached later in this season.

Community composition and Diptera diversity

In this study more than 12700 adult specimens have been collected, belonging to 18 arthropod orders (Table 2). The predominant collected orders were Diptera, Acarida, Coleoptera, Collembola and Hymenoptera. Diptera was the most abundant order in the whole study, as well as in every season. They represented more than 90% of the total collected fauna in summer and fall.

Table 1: Decomposition stages identified in each season. Decomposition stages: ☐ fresh, ▒ bloated, ■ active decay.

season	day														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
FALL	fresh	fresh	fresh	fresh	fresh	fresh	bloated	bloated	bloated	bloated	active decay	active decay	active decay	active decay	active decay
WINTER	fresh	fresh	fresh	fresh	fresh	fresh	fresh	fresh	active decay	active decay	active decay	active decay	active decay	active decay	active decay
SPRING	fresh	fresh	fresh	fresh	fresh	fresh	active decay	active decay	active decay	active decay	active decay	active decay	active decay	active decay	active decay
SUMMER	fresh	fresh	bloated	bloated	bloated	bloated	active decay	active decay	active decay	active decay	active decay	active decay	active decay	active decay	active decay

Table 2: Frequency and capture percentage for each arthropod order in the four seasons, n: number, % percentage. The shaded cells show the most collected orders.

	SPRING		SUMMER		FALL		WINTER		ALL SEASONS	
ORDER	n	%	n	%	n	%	n	%	n	%
Diptera	284	75.53	5836	93.83	5474	97.66	329	55.57	11923	93.20
Acarida			107	1.72	7	0.12	182	30.74	296	2.31
Coleoptera	1	0.27	131	2.11	49	0.87	4	0.68	185	1.45
Collembola	26	6.91	56	0.90	6	0.11	58	9.80	146	1.14
Hymenoptera	8	2.13	55	0.88	37	0.66	3	0.51	103	0.81
Araneida	30	7.98	9	0.14	12	0.21	9	1.52	60	0.47
Thysanoptera	24	6.38	2	0.03			4	0.68	30	0.23
Diplopoda					13	0.23			13	0.10
Dictyoptera			12	0.19					12	0.09
Dermaptera			1	0.02	3	0.05	3	0.51	7	0.05
Psocoptera	1	0.27	2	0.03	4	0.07			7	0.05
Homoptera	1	0.27	2	0.03					3	0.02
Lepidoptera			3	0.05					3	0.02
Microcoryphia	1	0.27							1	0.01
Neuroptera			1	0.02					1	0.01
Orthoptera			1	0.02					1	0.01
Pseudoscorpionida			1	0.02					1	0.01
Siphonaptera			1	0.02					1	0.01
	376	100	6220	100	5605	100	592	100	12793	100

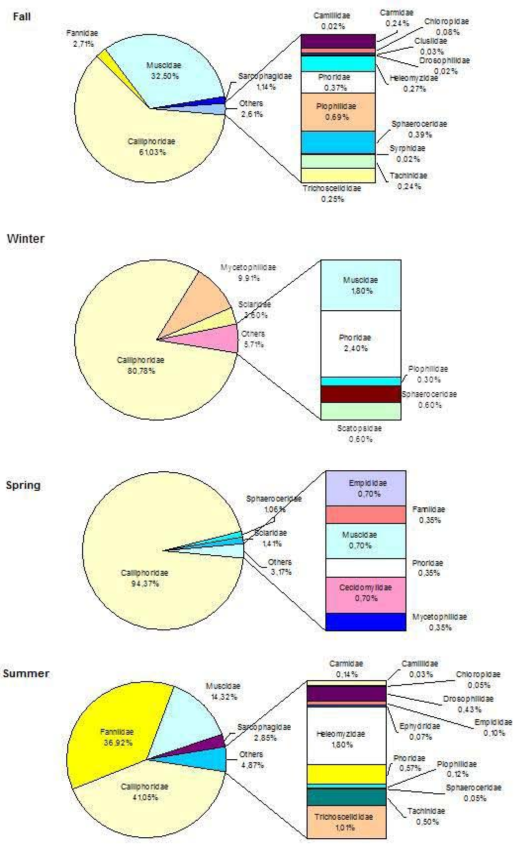

Figure 2: Capture percentage of Diptera collected in each seasons.

Although the amounts of Acarida during winter were low (only 182 specimens), they represent the 30.74% of the collected fauna during this season. In summer, similar amounts (107 specimens) were collected, although they only represented 1.72% of the total. The similar amount of specimens could be explained because of the extreme weather conditions of both seasons that could make the corpse a refuge for this fauna. Therefore, it is worth to consider that Acarida has a relative importance for this kind of studies.

Among Diptera, Calliphoridae was the most representative family during the sampling period (Figure 2). In spring it represented the 94.37% of all Diptera; in summer only 41.05%, in fall 61.03% and in winter 80.78%. Two other families were relevant in some seasons: Muscidae in summer (14.32%) and fall (32.50%), and Fannidae in summer (36.92%).

Comparison of our study conducted in a wild area (henceforth WA) with other studies using similar methodology with chicken carcasses (henceforth SAC) [23,24] and piglets (henceforth SAP) [38] as baits in a suburban area of the same region revealed very different results. In the wild area, 22 Diptera families have been collected while in the suburban environment only 13 families were collected. These results were independent of the bait used since piglet and chicken carcasses gave similar results.

The results obtained in the three independent studies (Table 3) indicate that Calliphoridae was the predominantly collected family in fall and winter. In spring, a different pattern appears depending on the bait and environment; thus, in WA and SAC, Calliphoridae was the most collected family while in SAP, it was Muscidae. In addition, in summer, the results appear to be different and only related to the

Table 3: Capture percentage of Diptera families in wild and suburban areas using different baits. WA: Wild area. SA: suburban area. B: Brachycera. N. Nematocera. The shaded cells show the most collected families in each environment and bait.

			WA	SA	
Season		Families	Piglet	Piglet	Chicken
Fall	B	Anthomyiidae			0.45
		Calliphoridae	61.03	35.14	58.36
		Camillidae	0.02		
		Carnidae	0.24		
		Chloropidae	0.08		
		Clusiidae	0.03		
		Drosophilidae	0.02		
		Fannidae	2.71		15.60
		Heleomyidae	0.27		
		Muscidae	32.50	16.22	15.60
		Phoridae	0.37	16.22	1.51
		Piophilidae	0.69		
		Sarcophagidae	1.40		5.06
		Scatophagidae			0.06
		Sphaeroceridae	0.39		
		Syrphidae	0.02		
		Tachinidae	0.24		
		Trichoscelididae	0.25		
		Cecidomyiidae			2.35
	N	Chironomidae		2.70	
		Psychodidae		13.51	0.73
		Sciaridae		16.22	0.28
Winter	B	Anthomyiidae			6.79
		Calliphoridae	80.78	85.59	48.83
		Fannidae			7.05
		Milichiidae		0.90	
		Muscidae	1.80		22.72
		Mycetophilidae	9.91		
		Phoridae	2.40	9.01	7.57
		Piophilidae	0.30		
		Sarcophagidae			0.26
		Scatopsidae	0.60		
		Sphaeroceridae	0.60		0.52
	N	Cecidomyiidae			1.04
		Psychodidae		0.90	1.04
		Sciaridae	3.60	3.60	4.18

Table 3 cont: Capture percentage of Diptera families in wild and suburban areas using different baits. WA: Wild area. SA: suburban area. B: Brachycera. N. Nematocera. The shaded cells show the most collected families in each environment and bait.

			WA	SA	
Season		Families	Piglet	Piglet	Chicken
Spring	B	Anthomyiidae			1.46
		Calliphoridae	94.37	14.64	48.10
		Empididae	0.70		
		Fannidae	0.35	1.37	1.07
		Muscidae	0.70	82.96	13.44
		Mycetophilidae	0.35		
		Phoridae	0.35	0.23	8.76
		Sarcophagidae		0.69	4.97
		Scatophagidae			0.58
		Sphaeroceridae	1.06		5.55
		Tachinidae		0.01	
	N	Cecidomyiidae	0.70		1.95
		Psychodidae		0.04	2.43
		Sciaridae	1.41	0.06	11.59
		Tipulidae			0.10
Summer	B	Anthomyiidae			0.15
		Calliphoridae	41.07	41.42	25.30
		Camillidae	0.03		
		Carnidae	0.14		
		Chloropidae	0.05		
		Drosophilidae	0.43		
		Empididae	0.10		
		Ephydridae	0.07		
		Fannidae	36.92	2.40	2.26
		Heleomyzidae	1.80		
		Muscidae	14.32	51.14	44.58
		Odiniidae		0.05	
		Phoridae	0.57	0.36	6.63
		Piophilidae	0.12		
		Sarcophagidae	2.85	4.55	17.32
		Scatophagidae			0.30
		Sphaeroceridae	0.05		0.30
		Tachinidae	0.50		
		Trichoscelididae	1.01		
		Ulidiidae		0.05	
	N	Cecidomyiidae			1.81
		Chironomidae		0.03	
		Culicidae			0.15
		Psychodidae			0.75
		Sciaridae			0.45

environment; thus, in wild area, Calliphoridae was the most collected family while, in suburban area, it was Muscidae, independently of the bait used. On the other hand, during fall and summer, the wild environment was associated with more families (16) than SAC (10 and 12) or SAP (6 and 8). However, during winter and spring, SAC provided more families (10 and 12), than WA (8 and 9), and SAP (5 and 8).

Table 4: Diversity indexes in wild and suburban environments using different baits. AcD: Active decomposition, AdD: Advanced decomposition, All: whole season, B: Bloated stage, C: Chicken, Env.: Environment, F: Fall, Fr: Fresh stage, P: Piglet, S: Season, Sk: Skeletonization, SP: Spring, SU: Summer, Sub: Suburban, W: Winter. The shaded cells show the upper index value.

			Margalef Index						Shannon Index					
Env.	**Bait**	**S**	Fr	B	AcD	AdD	Sk	All	F	B	AcD	AdD	Sk	All
Wild	P	F	1.04	1.13	1.90	--	--	1.72	0.51	0.85	1.09	--	--	0.96
		W	1.37	--	1.08	--	--	1.20	1.20	--	0.53	--	--	0.76
		SP	1.24	--	1.42	--	--	1.41	0.95	--	0.30	--	--	0.32
		SU	0.39	1.11	1.75	--	--	1.73	0.27	1.21	1.35	--	--	1.35
Sub	C	F	1.27	--	1.50	--	--	1.47	1.20	--	1.34	--	--	1.33
		W	1.38	--	1.87	--	--	1.84	1.09	--	1.65	--	--	1.63
		SP	1.68	--	2.03	1.94	--	1.85	0.94	--	2.10	1.94	--	1.87
		SU	1.65	--	1.51	1.67	2.08	1.20	1.38	--	1.31	1.60	1.64	1.49
	P	F	1.24	--	1.44	--	--	1.38	1.05	--	1.62	--	--	1.62
		WI	0.78	--	0.87	--	--	0.84	0.69	--	0.53	--	--	0.55
		SP	0	0.74	0.69	0.97	--	0.78	0	0.54	0.48	0.60	--	0.55
		SU	1.24	1.00	0.79	0.60	--	0.85	0.95	0.99	0.88	0.99	--	0.96

Although Sarcophagidae has traditionally been considered a compulsory part of the sarcosaprophagous Diptera community, it does not behave like that, at least in some seasons or baits, as reported by Matuszewski et al. [5]. For instance, in the three studied areas (WA, SAP and SAC), it appeared only during summer.

Diptera community (defined as families composing it) appears to be different dependent of the bait used. When using chicken, nine families were present (Anthomyiidae, Calliphoridae, Cecidomyiidae, Fannidae, Muscidae, Phoridae, Psychodidae, Sarcophagidae and Sciaridae) during all seasons, while, when using piglets, only two families (Calliphoridae and Phoridae) were present in all seasons in suburban area, and three families (Calliphoridae, Muscidae and Sphaeroceridae) in wild area. Calliphoridae is the only family present during all seasons in the three studies.

In our study, the richest and most diverse season was summer; the less rich was winter, and the less diverse spring, using the Margalef and Shannon indexes (Table 4). Nevertheless, in suburban habitats, the richest and most diverse season was spring when using chicken carcasses, but the fall when using piglets.

In our study, both indexes reveal the same results except for spring where, according to Margalef index, the richest stage is active decomposition, but according to Shannon index the most diverse is fresh stage.

In SAC the results of both indexes were the same in all cases, and they seem to indicate that the most advanced stages of decomposition were the most diverse and richest. On the other hand, in SAP, the diversity and taxa richness were coincidental in fall and spring, but clearly different in winter and summer. In general, SAP displayed some heterogeneity regarding the two indexes.

Calliphoridae succession

In our study, the calliphorid species collected during the whole period were: *Calliphora vicina* Robineau-Desvoidy, 1830, *Calliphora vomitoria* Linnaeus, 1758, *Chrysomya albiceps* (Wiedemann 1819), *Lucilia caesar* Linnaeus, 1758, *Lucilia sericata* Meigen, 1826, *Pollenia sp.* and *Stomorhina lunata* (Fabricius 1805) (Table 5). The most abundant species in the whole study was *Ch. albiceps*, representing more than 60%. The second most abundant species was *C. vicina*, in contrast to data from other Iberian mountain system [3] where the most abundant species were *C. vomitoria*, followed by *Ch. albiceps*.

Regarding the *Calliphora* species, both *C. vicina* and *C. vomitoria* have been collected together in wild environment, being *C. vicina* the dominant species. This result agrees that reported by Prado e Castro

Table 5: Number and capture percentage of Calliphoridae collected in all seasons. n: number, % percentage. The shaded cells show the most collected species.

	SPRING		SUMMER		FALL		WINTER		ALL SEASONS	
SPECIES	n	%	n	%	n	%	n	%	n	%
Chrysomya albiceps			1404	58.21	2737	75.6			4141	63.07
Calliphora vicina	163	60.82	693	28.73	792	21.90	260	96.65	1908	29.06
Calliphora vomitoria	105	39.18	243	10.07	11	0.30	9	3.35	368	5.60
Pollenia sp.			19	0.79	57	1.58			76	1.16
Lucilia sericata			52	2.16	12	0.33			64	0.97
Lucilia Caesar					8	0.22			8	0.12
Stomorhina lunata			1	0.04					1	0.02
	268	100	2412	100	3617	100	269	100	6566	100

Table 6: Calliphoridae succession in wild and suburban environment in Spring. AcD: Active decomposition, AdD: Advanced decomposition, Fr: Fresh stage, SAC: Suburban area using chicken carcasses SAP: Suburban area using chicken carcasses, WA: Wild area.

SPECIES	PLACE/BAIT	DAY 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Calliphoravicina	WA	•	•		•	•						•	•	□	■	■
		Fr						AcD								
	SAP		•	•	•	•	•		•							
		Fr	Bloated		AcD				AdD							
	SAC	•	•		•	•	•									
		Fr		AcD										AdD		
Calliphora vomitoria	WA														■	■
		Fr						AcD								
	SAP								•							
		Fr	Bloated		AcD				AdD							
	SAC	Notcollected														
		Fr		AcD										AdD		
Chrysomyaalbiceps	WA	Notcollected														
		Fr						AcD								
	SAP			□	□	□	♦	♦	♦	■	•					
		Fr	Bloated		AcD				AdD							
	SAC		•		•	•	•	•								
		Fr		AcD										AdD		
Luciliasericata	WA	Notcollected														
		Fr						AcD								
	SAP		□	♦	■	□	■	□	□	•						
		Fr	Bloated		AcD				AdD							
	SAC	♦	♦		■	□	□	□	•							
		Fr		AcD										AdD		
Polleniasp.	WA	Notcollected														
		Fr						Active decomposition								
	SAP	Notcollected														
		Fr	Bloated		AcD				AdD							
	SAC		•		•								•			
		Fr		AcD										AdD		
Luciliacaesar	WA	Notcollected														
		Fr						AcD								
	SAP				•											
		Fr	Bloated		AcD				AdD							
	SAC	Notcollected														
		Fr		AcD										AdD		

Symbols:• 1-10, □11-50, ■51-100,♦101-200, ▲> 201

et al. [30] for Western Iberian Peninsula confirming in Southern Europe the data reported by Greenberg [39] and Smith [40] for Northern Europe.

The number of Calliphorid species was higher in WA than in SAC and SAP. Moreover, in WA, some taxa, such as *S. lunata*, appears for the first time, and *C. vomitoria*, *L. caesar* and *Pollenia* sp. are represented, while being minimal or not appearing in SAC and SAP. On the other hand, one of the most representative species in SAP and SAC (L. *sericata*) was very scarce in WA. *C. vicina*, the second most collected species in WA (29.06%), was also represented in lower amounts in SAP and SAC (4.22 and 11.52%, respectively). Nevertheless, the most important species in all three study areas was *Ch. albiceps*.

Seasonally, our study (Table 5) illustrates that *Ch. albiceps* was only captured in summer and fall, where it was the most representative species. In SAP, *Ch. albiceps* was collected in spring and summer and, during all seasons in SAC. It was clearly the dominating species during fall as it occurred in Lisbon in a small patchy woodland park [30].

Calliphora vicina was collected throughout the sampling period, being the most representative species in spring and winter. It was the only Calliphorid present in SAP, and had an appreciable presence in winter. It was also the most representative during winter in SAC.

Calliphora vomitoria was collected all along the sampling period, displaying preference for spring and summer. In SAP and SAC, it was present in very low number, and it can be considered irrelevant.

Lucilia sericata and *Pollenia* sp. were only collected in WA in the

Table 7: Calliphoridae succession in wild and suburban environment in Summer. AcD: Active decomposition, AdD: Advanced decomposition, Fr: Fresh stage, SAC: Suburban area using chicken carcasses SAP: Suburban area using chicken carcasses, WA: Wild area.

		DAY														
SPECIES	**PLACE/BAIT**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Calliphoravicina	**WA**	•	•	□	□	□	□	□	♦	□	□	□	□	♦	♦	□
		Fr		Bloated				AcD								
	SAP	Notcollected														
		Fr	Bloated			AcD			AdD							
	SAC	•	•													
		Fr		AcD					AdD						Sk	
Calliphora vomitoria	**WA**				•	•	•	□	■	□	□	•		□	□	•
		Fr		Bloated				AcD								
	SAP	Notcollected														
		Fr	Bloated			AcD			AdD							
	SAC	Notcollected														
		Fr		AcD					AdD						Sk	
Chrysomyaalbiceps	**WA**		•	•	•	■	■	■	■	■	▲	▲	□	□	□	□
		Fr		Bloated				AcD								
	SAP		□	♦	▲	♦	♦	▲	▲	♦	□	•	•	•		
		Fr	Bloated			AcD			AdD							
	SAC	•	•□	■	□	•										
		Fr		AcD					AdD						Sk	
Luciliasericata	**WA**				•	•	•	□	•	•	•			•		
		Fr		Bloated				AcD								
	SAP	•	□	□	□	•	•	•	•	•						
		Fr	Bloated			AcD			AdD							
	SAC	□	□	•	•	•										
		Fr		AcD					AdD						Sk	
Polleniasp.	**WA**							•	•		•		•	•	•	•
		Fr		Bloated				AcD								
	SAP	Notcollected														
		F	Bloated			AcD			AdD							
	SAC												•			
		Fr		AcD					AdD						Sk	
Stomorhinalunata	**WA**															•
		Fr		Bloated				AcD								
	SAP	Notcollected														
		F	Bloated			AcD			AdD							
	SAC	Notcollected														
		Fr		AcD					AdD						Sk	

Symbols:• 1-10, □11-50, ■51-100,♦101-200, ▲> 201

Table 8: Calliphoridae succession in wild and suburban environment in Fall. AcD: Active decomposition, AdD: Advanced decomposition, Fr: Fresh stage, SAC: Suburban area using chicken carcasses SAP: Suburban area using chicken carcasses, WA: Wild area.

		DAY														
SPECIES	**PLACE/BAIT**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Calliphoravicina	**WA**			•	•	□	♦	♦	♦	♦	■	□	□	•	•	•
		Fr						Bloated				AcD				
	SAP		•		•		•	•	•							
		Fr					AcD									
	SAC	•	•	•	•	•	•	•			•	•				•
		Fr			AcD											
Calliphora vomitoria	**WA**							•		•	•					
		Fr						Bloated				AcD				
	SAP	Notcollected														
		Fr					AcD									
	SAC	Notcollected														
		Fr			AcD											
Chrysomyaalbiceps	**WA**						♦	▲	▲	♦	▲	▲	▲	▲	♦	■
		Fr						Bloated				AcD				
	SAP	Notcollected														
		Fr					AcD									
	SAC			♦	♦	▲	♦	♦	□	□	□	□	□	•	•	•
		Fr			AcD											
Luciliacaesar	**WA**						•	•	•	•						
		Fr						Bloated				AcD				
	SAP	Notcollected														
		Fr					AcD									
	SAC															
		Fr			AcD											
Luciliasericata	**WA**						•	•	•	•	•					•
		Fr						Bloated				AcD				
	SAP										•					
		Fr					AcD									
	SAC	•	•	□	□	□	•	•	•	•	•					
		Fr			AcD											
Polleniasp.	**WA**							•		□	□	□	•		•	
		Fr						Bloated				AcD				
	SAP	Notcollected														
		Fr					AcD									
	SAC	Notcollected														
		Fr			AcD											

Symbols:• 1-10, □11-50, ■51-100,♦101-200, ▲> 201

warmer seasons of summer and fall, and the same pattern occurs in SAP and SAC. We would like to mention that *L. sericata*, the most representative in SAC during spring, is not present during this season in WA. This could be due, among other reasons, to the shaded character of the selected place.

In our study, the primary species was always *C. vicina* (Tables 6-9), although it was well represented all along the decomposition process, contrasting with SAC where it was present in all stages only in winter. *C. vomitoria* acted as secondary species in this environment, as well as *Ch. albiceps*, *L. sericata* and *Pollenia* sp. *C. vomitoria* was present in most of decomposition stages only in WA, and in summer. *Ch. albiceps*, when present, showed preference in WA

Table 9: Calliphoridae succession in wild and suburban environment in Winter. AcD: Active decomposition, AdD: Advanced decomposition, Fr: Fresh stage, SAC: Suburban area using chicken carcasses SAP: Suburban area using chicken carcasses, WA: Wild area.

SPECIES	PLACE/BAIT	DAY														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Calliphoravicina	WA		•	•		•	•	□	□	□	□	□	□	□	□	■
		Fr								AcD						
	SAP		•		•	•	•	□	•	•	■	•	•	•	•	•
		Fr					AcD									
	SAC		□	•	□	□	□	•	□	•	□	□	□	•	•	•
		Fr			AcD											
Calliphora vomitoria	WA												•	•	•	•
		Fr								AcD						
	SAP	Notcollected														
		Fr					AcD									
	SAC						•		•				•			
		Fr			AcD											
Chrysomyaalbiceps	WA	Notcollected														
		Fr								AcD						
	SAP	Notcollected														
		Fr					AcD									
	SAC			•			•									
		Fr			AcD											
Luciliasericata	WA	Notcollected														
		Fr								AcD						
	SAP	Notcollected														
		Fr					AcD									
	SAC					•	•		•				•	•		
		Fr			AcD											
Polleniasp.	WA	Notcollected														
		Fr								AcD						
	SAP	Notcollected														
		Fr					AcD									
	SAC											•		•	•	•
		Fr			AcD											

Symbols:• 1-10, □11-50, ■51-100,♦101-200, ▲> 201

for bloated and active decomposition stages but in SAP was collected in all decomposition stages registered, and in SAC in fresh and active decomposition. *L. sericata* although secondary in WA, is typically a primary species appearing like that in SAC in spring (Table 6), summer (Table 7) and fall (Table 8).

Conclusion

The early sarcosaprophagous fauna of the wild habitat in the Murcia mountain umbrage is richer and more diverse than that of a suburban area of the same region, and these differences were not attributed to the type of animal carcass.

Some of the species present in the umbrage could be used as habitat indicators. Concerning Calliphoridae, *L. caesar*, *S. lineata* and *C. vomitoria* were almost absent in the suburban area, thus allowing a characterization of the wild environment community.

It is well known that detection of the length of decomposition stages and Calliphorid succession in different environments especially in wild areas provides information about the structure and dynamics of sarcosaprophagus community which is very essential for forensic application. Therefore, there is a need for such entomological studies concerning the whole decomposition process instead of only faunistic studies, and this work is one of the few attempts to gain insights, mainly in Spain.

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