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Diversity of arthropods associated with sheep, cow, goat, and camel manure in the southeast of Algeria

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Abstract. Within the region of southeast Algeria, the Berlese method was utilized to conduct an inventory of the arthropods that were associated with four different types of manure: cow, sheep, goat, and camel. A total of 6,908 arthropods were collected, and they were categorized into four classes, 14 orders, and 37 families. The three families, *Histeridae, Sphaeroceridae,* and *Staphylinidae*, were found almost everywhere, with the relative abundance of each family varying according to the type of manure. The *Anthicidae* and *Scarabaeidae* families, which are the only two families remaining, were distributed selectively. The Shannon diversity index (H') for arthropod families obtained from the various types of manure reveals that sheep and goat manure display the highest level of diversity by (H' = 2.26 bits) and (H' = 2.23 bits), respectively. The frequency of the larval form (86.58%, NI = 5,981) compared to the adult form (13.42%, NI = 927) suggests that manure is an appropriate environment for incubating the immature stages of several arthropods. On occasion, members of certain families of pests were discovered. These families include *Bostrychidae, Dermestidae*, and *Gryllotalpidae.*

Keywords: Berlese, *Histeridae*, inventory, manure, *Scarabaeidae*

Introduction

Animal manure can increase soil fertility by providing N, P, K, and other mineral nutrients (Hoffmann *et al*., 2001; Lupwayi *et al*., 2000; Bayu *et al*., 2005). Livestock manure increases soil organic matter content and cation exchange capacity, as well as the pH of acid and calcareous soils. It also improves soil aggregate stability, infiltration, soil macrostructure, and erosion resistance (Bayu *et al*., 2005). The use of animal manure to increase crop yield and restore soil fertility is an age-old and important practice for nutrient recycling. Using livestock manure is an inexpensive way to fertilize crops (Radke *et al*., 1988).

Several studies (Bezanson and Floate, 2019; Buse *et al*., 2021; Heo *et al*., 2015; Mohr, 1943; Pecenka and Lundgren, 2019) have shown that animal dung is associated with a wide range of arthropod species. According to (Liu *et al*., 2019), animal manure can influence habitat selection for some insectivorous birds because it contains coleopteran adults and larvae, which serve as food indicators. The arthropod fauna associated with decaying animal manure has received significant attention in studies, with the majority of previous research focusing on Coleoptera and Diptera, which play critical roles in the dung decomposition process (Curry, 1979).

(Valiela, 1974) stated that the arthropod fauna of soil and vegetation invades fresh manure in an orderly pattern, with the number of taxa and complexity of the food web increasing as succession occurs. Fresh mammal manure is an important food source for many dung-breeding flies and beetles (Heo *et al*., 2015; Nichols *et al*., 2008). Coprophagous beetles play important ecological roles by feeding on animal manure both as adults and larvae (Nichols *et al*., 2008). Within this context, a comprehensive survey was undertaken to assess the arthropod population linked to diverse forms of organic fertilizer, which directly impacts agricultural practices in southeast Algeria. The manure originated from four different sources: cows, sheep, goats, and camels.

Materials and methods

Study area

The investigation was conducted in the Oued Righ region, located in the northeastern part of the Algerian Sahara. The longitude of the location is situated between 05°50’ and 05°75’ East, while its latitude ranges from 32°54’ to 39°9’ North. The geographical range spans from the southern to the northern regions (Lakhdari and Kherfi, 2010; Zahi *et al*., 2011). The Oued Righ region contains a number of oases. These oases are located along a 130 km canal that extends between the El Oued and Ouargla provinces (Lembarek and Remini, 2019). Oued

Righ exhibits a Saharan climate characterized by a hot summer and a temperate winter. The air is relatively dry, with an average annual humidity of approximately 48%. Precipitation is infrequent and irregular, seldom surpassing 17 mm in the most humid month, while maximum temperatures can reach 47 °C (Dehliz *et al.*, 2018; Lembarek and Remini, 2019). Furthermore, this area is distinguished by the existence of wetlands that support a limited variety of plant life but are well suited to the challenging ecological conditions caused by the prevailing climate (drought) and soil (high salinity) (Koull and Chehma, 2013) (Fig. 1).

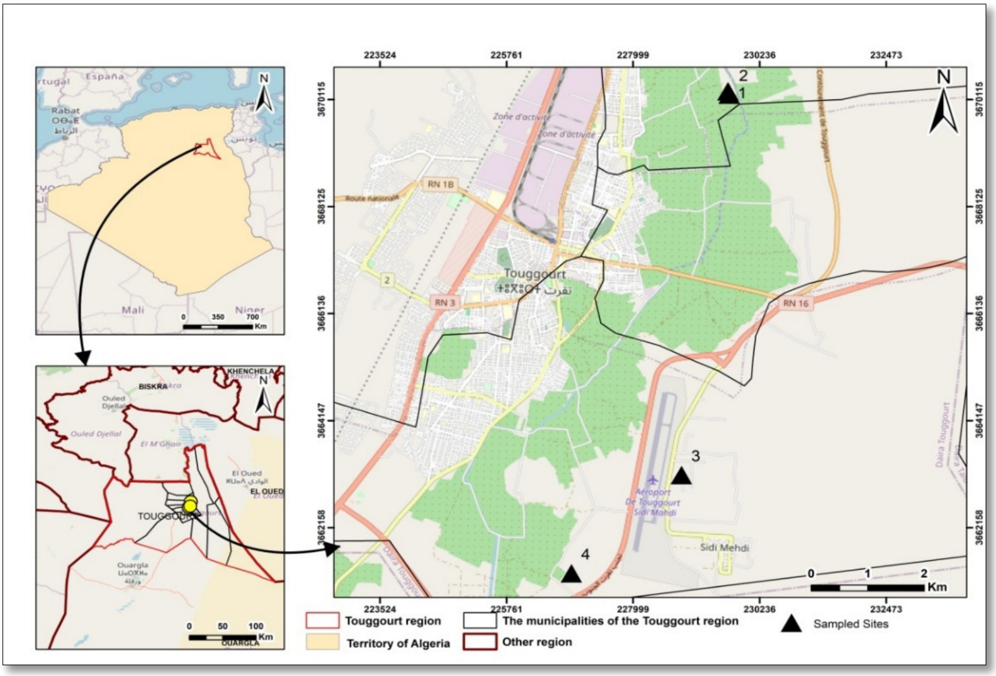

Figure 1. Study Area and Sampling Sites in Touggourt County, Algeria.

Experimental sites

The choice of investigation sites was determined by specific criteria, including the selection of well-structured farms with a significant number of animals and farms where only one livestock species was present to allow for the separate study of different manure types. Additionally, farms were chosen where the use of chemical products that could harm the manure fauna was avoided (Daam *et al.*, 2019; Lumaret *et al.*, 2012). Lastly, all selected farms had been operational for at least two years, guaranteeing the presence of a substantial number of arthropods that interact with the manure, either directly or indirectly. For this study, we chose four farms situated in the southeast of Oued Righ that engage in distinct breeding activities (Fig. 2). The average distance between the four sampling sites is around three kilometers.

Figure 2. Sampling sites for different types of manure: A: Camel farm, B: Sheep farm, C: Goat farm, D: Cow farm.

The camel farm covers an area of 200 m² and is surrounded by date palm cultivation in all four directions. The facility accommodates a total of 10 dromedaries, primarily consisting of young males who are specifically bred for meat production. Additionally, the facility is situated in an area that is directly exposed to sunlight. The cow and sheep farms are located in close proximity and are also encompassed by date palm cultivation on three sides, with the Oued Righ channel acting as their northern boundary. The cow farm spans a 2-ha plot and houses 80 dairy cows, the majority of which are exposed to direct sunlight. The sheep farm spans an area of 50 square meters and houses a population of 15 individuals, with half of the area being shaded. The goat farm is situated within the INRAA (National Institute of Agronomic Research of Algeria) station of Touggourt. It spans an area of 320 m² and accommodates 35 goats. The farm is surrounded by open space in all directions.

Animal feeding

Throughout our research, we recorded the feeds provided for each type of animal at the various study sites. Cow feed consists primarily of corn silage, [69]uzern, and other grasses, whereas sheep, camels, and goats eat wheat bran, dried dates, barley, and hay. Camel breeders, in particular, use spontaneous plants from the Tamaricaceae family when there is a feed shortage.

Sampling method

Manure samples were collected monthly, three times per month, over six months, from January 2021 to June 2021. The manure sampling was conducted randomly, selecting samples from both the central and peripheral areas of each farm. All samples contained a mixture of fresh, moist, and dried manure. The sampling depth varied between 5 and 10 cm. Furthermore, samples were collected consistently between 9:30 AM and 2:00 PM on identical days.

Extraction of arthropods from manure

To remove arthropods that are linked to various forms of manure, we employed the Berlese funnel, a method that has been endorsed and utilized by multiple authors for the purpose of removing arthropods from different substrates (Anderson *et al*., 2013; Bousquet and Laplante, 2006). Prior to introducing the substrate into the funnels, arthropods of greater dimensions were collected. Two nets were employed: the initial one consisted of a rubber material with a pore size of 1.5 mm^2, reinforced by a rigid plastic net with a pore size of 2 mm^2. To ensure that manure samples were of the same volume, we used funnels of the same volume, 1400 cm^{3,} for all manure types. The collection container was filled with a solution of ethanol with a concentration of 70%. The samples were then kept in a controlled environment for five days.

Techniques for specimen conservation

The majority of the specimens collected using the Berlese funnel are diminutive and susceptible to harm. Hence, they are placed within tubes containing a 70% ethanol solution. Specimens of considerable size were affixed to entomological pins and stored in a desiccated state.

Identification of collected arthropods

The specimens were counted and classified under a stereomicroscope utilizing multiple taxonomic identification guides. We employed (Bertone's, 2019) key for Dipteran identification and Coleoptera. We consulted the keys provided by (Arnett Jr and Thomas, 2001), (Hagstrum, 2016), and (Jameson, 2002). Furthermore, we employed the overarching principles outlined by (Borror *et al*., 1970). The unidentified samples were transported to the Zoology Laboratory at the National Veterinary School of El Alia. There, they were identified and verified in the Arthropod collection of the Forest and Agricultural Zoology Department (ENSA).

Data analysis

To assess the findings, we used the ecological composition indices of total richness (S) (Blondel, 1975), relative abundance (RA%) (Dajoz, 1971), and Shannon's ecological structure indices, which measure species diversity and relative abundance in a given sample. It accounts for both the number of species and their relative distribution. The diversity index indicates how diverse the sample is. The H' diversity index, 'H' = -∑ Pi log2 Pi (Blondel *et al*., 1973), ranges from 0 to H' max, where H' max represents the maximum theoretical value. H' max equals Log2 S. And Pielou's evenness index I E = H' / H' max measures the consistency with which species are distributed in the sample (Blondel, 1975). It accounts for both the number of species and their relative abundance. An equity index of 1 indicates a completely even distribution of species, whereas an index less than 1 indicates an uneven distribution. Correspondence factor analyses (CFA) were conducted on the number of families identified using PAST version 1.37 (Hammer and Harper, 2001) to investigate the distribution of families in the various types of manure examined. Additionally, variance analyses (ANOVA) and chi-square tests were performed using version 19 of Minitab software.

Results

By extracting arthropods from various forms of manure, we were able to classify them into four distinct categories: Entognatha, Arachnida, Crustacea, and Insecta. The latter is the most prevalent in all four types of manure (cow, goat, sheep, and camel), with relative abundances of 99.97%, 99.54%, 99.73%, and 93.53%, respectively. Additionally, it is the only class present in all manure types examined.

Larval and imaginal forms

Out of the collected Arthropods, 13.42% (NI = 927) were in their adult stage, while the larval stage was the most prevalent, accounting for 86.58% (NI = 5981). The second group consists of two orders, Diptera and Coleoptera, with abundances of 93.04% (NI = 5565) and 6.96% (NI = 416), respectively. The number of Diptera larvae was highest in cow manure (NI = 3567), followed by sheep manure (NI = 1350), and lowest in camel manure (NI = 241). The abundance of Coleoptera larvae in all the types of manure studied was low, ranging from 54 to 197 individuals (54 ≤ NI ≤ 197) (Fig. 3).

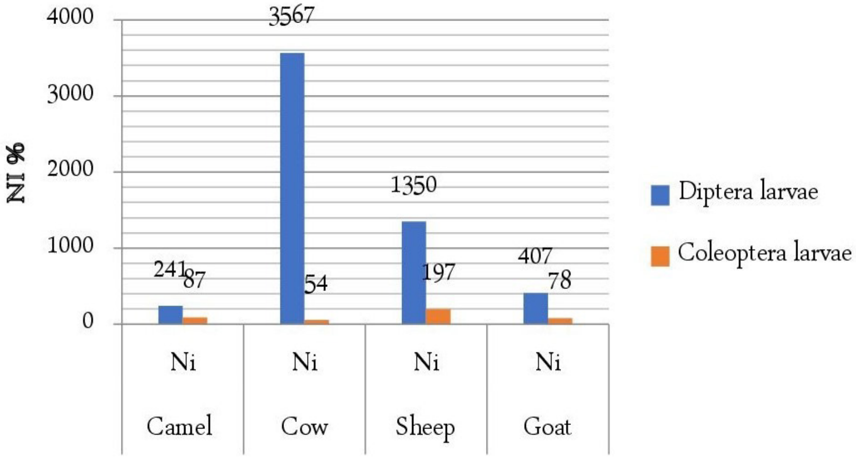

Figure 3. The number of individuals (NI) of Coleoptera and Diptera larvae counted in the four types of camel, cattle, sheep and goat manure.

The chi-square test was used to determine the distribution of Coleoptera and Diptera larvae in four different types of manure. The results revealed a highly significant (d =1, χ^2=4432.74, $p < 0.0001$) difference between the Diptera and Coleoptera orders, with the high dominance of Diptera larvae. Furthermore, the distribution of larvae by manure type was found to be highly significant (df=3, χ^2=503.4, $p < 0.0001$), indicating a heterogeneous distribution of larvae from both orders across the different types of manure.

After extracting various types of manure, 6,908 arthropods from 14 orders were recovered (Tab. 1). Diptera (25.76 ≤ RA%≤ 51.45), Coleoptera (25.76 ≤ RA% 52.20), and Hymenoptera (1.52 ≤ RA% ≤ 17.13) were the three most common orders among the four manure types (cow, goat, sheep, and camel). Five orders have a selective presence (recorded in a single type of manure): Collembola RA=38.64%, Thysanoptera RA=38.64% (camel manure), Isopoda RA=0.61%, Orthoptera RA=0.31% (goat manure), and Lepidoptera RA=0.34%. Six orders, Araneae, Hemiptera, Psocodea, Homoptera, Ombioptera and Pseudoscorpiones, share two to three types of manure and have low relative abundance (0.31 ≤ RA% ≤ 6.06).

Table 1. Results of a study on the distribution of arthropod orders in four different types of manure: camel, cow, sheep and goat.

Nr crt	Order	Camel		Cow		Sheep		Goat	
		Ni	AR %	Ni	AR %	Ni	AR %	Ni	AR %
1	Araneae	-	-	1	0.34	-	-	1	0.58
2	Pseudoscorpiones	-	-	-	-	3	0.92	2	1.16
3	Isopoda	-	-	-	-	2	0.61	-	-
4	Collembola	51	38.64	-	-	-	-	-	-
5	Diptera	34	25.76	111	37.63	122	37.31	89	51.45
6	Psocodea	8	6.06	1	0.34	-	-	-	-
7	Hymenoptera	2	1.52	17	5.76	56	17.13	3	1.73
8	Thysanoptera	2	1.52	-	-	-	-	-	-
9	Homoptera	1	0.76	2	0.68	-	-	-	-
10	Coleoptera	34	25.76	154	52.20	141	43.12	69	39.88
11	Lepidoptera	-	-	1	0.34	-	-	-	-
12	Hemiptera	-	-	7	2.37	1	0.31	9	5.20
13	Ombioptera	-	-	1	0.34	1	0.31	-	-
14	Orthoptera	-	-	-	-	1	0.31	-	-
	Total	132	100	295	100	327	100	173	100

The chi-square test was used to determine the most abundant orders in four types of manure. Results revealed highly significant differences between orders (χ^2 =444.51 *df*=15 p < 0.0001), with Coleoptera representing the most dominant order (43%), followed by Diptera (39%). The other four orders (Collembola, Hemiptera, Psocodea and Hymenoptera) had percentages below 10%. The distribution of arthropods on the four types of manure also proved highly significant (χ^2 =1032.88, df=5, p < 0.0001). Tab. 2 shows that the four manure types account for a total of 37 arthropod families. The findings show that their diversity, frequencies, and spatial distribution vary depending on habitat type but follow a relatively similar pattern. Goat and sheep manure have higher RA% values for some arthropod families compared to other manure types.

Goat manure

Goat manure exhibits the highest level of diversity, encompassing 24 distinct families. The *Sphaeroceridae* family has the highest abundance, accounting for 42.66% of the total. The families *Nitidulidae*, *Staphylinidae*, and *Scarabaeidae*, comprising 6.99% to 11.89% of the total, rank second in terms of abundance.

Camel manure

Camel manure exhibited the lowest diversity, with a recorded count of 15 families. Collombola was the most prevalent, accounting for 44.74% of the total. *Aphodiidae* followed with a prevalence of 12.28%. Psocodea, *Histeridae*, *Scarabaeidae*, and *Sphaeroceridae* were evenly distributed, with relative percentages ranging from 7.02% to 8.77%.

Sheep manure

Sheep manure contained 21 families, with the most common ones being *Staphylinidae* (accounting for 29.30% of the total) and *Histeridae* (accounting for 14.42% of the total). The next most frequent families were *Formicidae*, *Sphaeroceridae*, *Carabidae*, and *Tenebrionidae*, with relative abundances ranging from 7.44% to 11.63%.

Cow manure

Out of the 18 families collected, four families have a notable average presence: *Histeridae*, *Sphaeroceridae*, *Staphylinidae*, and *Anthicidae*, with relative abundances of 26.86%, 26.03%, 20.66%, and 10.33%, respectively. The results of the analysis of variance (ANOVA) (Tab. 2) indicate that the variations in the relative abundance of the families studied are not significantly influenced by the period and family parameters, nor by their interactions.

We performed a multivariate statistical analysis on the arthropod population data collected at four distinct stations throughout our investigation to gain a thorough picture of the distribution of the different families among the four types of manure. The findings are displayed in the Axis 1 and Axis 2 factorial design of the Correspondence Factorial Analysis (CFA) (Fig. 4), which encompasses 83.8% of the data.

Table 2. Analysis of variance: impact of manure, months, and families on variations in arthropod relative abundance.

Source	*df*	Sum of squares	Mean square	F-Values	P-Values
Manure	3	0.000084	0.000028	0.94	0.423
Months	5	0.000117	0.000023	0.78	0.563
Families	37	0.000885	0.000024	0.8	0.798
Manure* months	15	0.000627	0.000042	1.4	0.144
Manure* families	111	0.003368	0.00003	1.01	0.453
Months * families	185	0.00517	0.000028	0.93	0.709
Error	531	0.015907	0.00003		
Total	887	0.026187			

df: degree of freedom

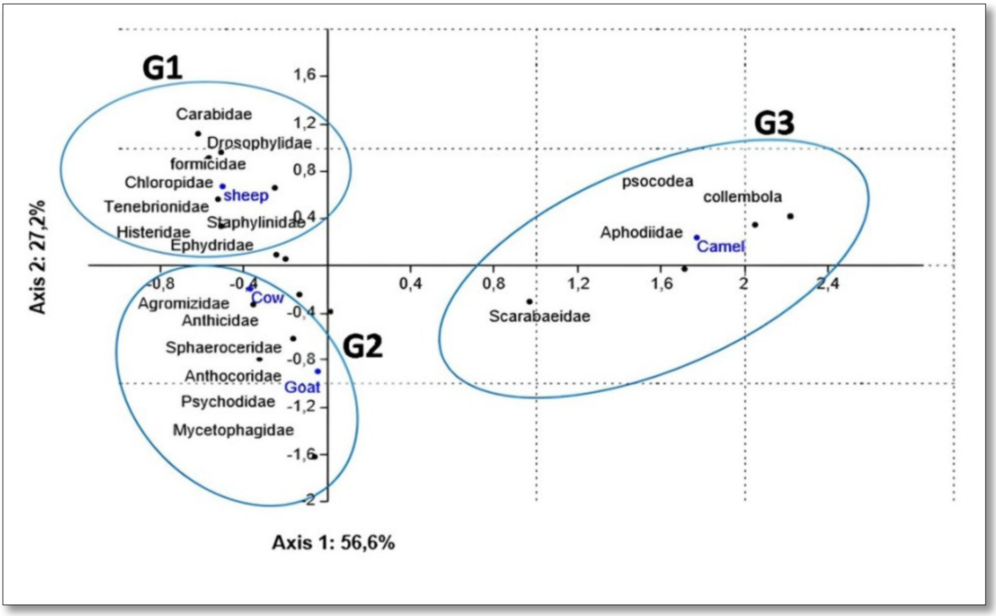

Figure 4. Factorial Correspondence Analysis (FCA) showing the association between arthropod families and four types of manure in the factorial plane (Axis 1 explains the largest portion of variance at 56.6%, and Axis 2 explains the second largest portion at 27.2%).

The CFA's factorial design yielded three distinct groups (G1, G2, G3) consisting of families linked to a specific type of manure, namely cow, sheep, camel, or goat. Group G1 features the eight families with the highest abundance in sheep manure, such as *Carabidae*, *Staphylinidae*, *Tenebrionidae* and *Histeridae*. In comparison, group G2 contains six families with the highest numbers in cow and goat manure, including *Sphaeroceridae*, *Anthocoridae* and *Anthicidae*. Group G3 features the most abundant families in camel manure, including *Aphodiidae*, *Scarabaeidae* and Collembola. The distance between families and manure type on the factorial plane decreases with the increasing workforce of individuals and vice versa. Regarding the arthropod population, it is evident that cow manure has the highest number of individuals (242) while camel manure has the lowest number (114) (Tab. 3). On the contrary, the total richness of goat manure is the highest at 24 species, while the other types of manure - sheep, cattle and camel have a total richness of 21, 18 and 15 species, respectively.

Table 3. Number of samples (NS), number of individuals (NI), and total richness (S) of arthropod families collected from four types of manure.

Parameter	Camel	Cow	Sheep	Goat
NS	90	90	90	90
NI	114	242	215	143
S	15	18	21	24

Table 4. Results of a study on the distribution of arthropod families in four different types of manure: camel, cow, sheep and goat.

No crt.	Family	Camel		Cow		Sheep		Goat	
		Ni	RA %	Ni	RA %	Ni	RA %	Ni	RA %
1	*Porcellionidae*	-	-	-	-	1	0.47	-	-
2	*Neobisiidae*	-	-	-	-	1	0.47	-	-
3	*Cheliferidae*	-	-	-	-	1	0.47	1	0.70
4	*Chernetidae*	-	-	-	-	-	-	1	0.70
5	*Sphaeroceridae*	9	7.89	63	26.033	20	9.30	61	42.66
6	*Psychodidae*	2	1.75	6	2.479	2	0.93	4	2.80
7	*Chloropidae*	2	1.75	2	0.826	13	6.05	2	1.40
8	*Agromizidae*	1	0.88	6	2.479	1	0.47	1	0.70
9	*Scatopsidae*	-	-	-	-	-	-	1	0.70

No crt.	**Family**	**Camel**		**Cow**		**Sheep**		**Goat**	
		Ni	RA %	Ni	RA %	Ni	RA %	Ni	RA %
10	*Sciaridae*	-	-	-	-	1	0.47	1	0.70
11	Collembola	51	44.74	-	-	-	-	-	-
12	*Drosophylidae*	-	-	-	-	9	4.19	1	0.70
13	*Phoridae*	1	0.88	-	-	-	-	-	-
14	*Ephydridae*	1	0.88	4	1.653	4	1.86	2	1.40
15	*Aphididae*	1	0.88	1	0.413	-	-	-	-
16	*Anthicidae*	1	0.88	25	10.331	1	0.47	1	0.70
17	*Aphodiidae*	14	12.28	-	-	-	-	4	2.80
18	*Scarabaeidae*	10	8.77	1	0.413	4	1.86	17	11.89
19	*Laemophloeidae*	2	1.75	-	-	-	-	3	2.10
20	*Histeridae*	10	8.77	65	26.860	31	14.42	5	3.50
21	*Corylophidae*	-	-	1	0.413	1	0.47	1	0.70
22	*Staphylinidae*	-	-	50	20.661	63	29.30	10	6.99
23	*Tenebrionidae*	-	-	4	1.653	16	7.44	3	2.10
24	*Carabidae*	-	-	1	0.413	18	8.37	-	-
25	*Bostrychidae*	-	-	1	0.413	-	-	-	-
26	*Dermestidae*	-	-	1	0.413	-	-	-	-
27	*Hybosoridae*	-	-	-	-	1	0.47	-	-
28	*Monotomidae*	-	-	-	-	1	0.47	2	1.40
29	*Cryptophagidae*	-	-	-	-	-	-	2	1.40
30	*Nitidulidae*	-	-	-	-	-	-	6	4.20
31	*Mycetophagidae*	-	-	-	-	-	-	10	6.99
32	*Ptiliidae*	-	-	-	-	-	-	1	0.70
33	Psocodea	8	7.02	-	-	-	-	-	-
34	*Formicidae*	1	0.88	4	1.653	25	11.63	-	-
35	*Anthocoridae*	-	-	6	2.479	-	-	3	2.10
36	*Liposcelididae*	-	-	1	0.413	-	-	-	-
37	*Gryllotalpidae*	-	-	-	-	1	0.47	-	-
	Total	114	100	242	100	215	100	143	100

The inventory yields two biodiversity indices, namely Shannon's diversity index (H') and Pielou's evenness index (E), as presented in (Tab. 5). Shannon's diversity index (H') was used to assess the diversity of arthropod families in various types of manure in southeastern Algeria. The results indicate that the H' values for the different types of manure range from 1.89 to 2.26 bits, suggesting a slight variation in arthropod diversity among the different types of manure. However, the H max values for the different samples suggest that the diversity has not been fully explored, and there may be other families present. Pielou's evenness index (E) for the various manure types varied between 0.67 and 0.74, indicating that the distribution of arthropods is relatively uniform within each manure type. However, the variations between the different manure types are not significant. The findings suggest a minor difference in arthropod diversity among the various types of manure but a consistent pattern in their distribution.

Table 5. Shannon index (H') and Pielou's evenness index (E) applied to arthropod families obtained from four types of manure.

Diversity	Camel	Cow	Sheep	Goat
H'	1.89	1.94	2.26	2.23
Hmax	2.71	2.89	3.04	3.18
E	0.70	0.67	0.74	0.70

Discussion

This study allowed the identification of the arthropods found in four different types of manure (cow, sheep, goat, and camel) in southeastern Algeria. Four classes of arthropods were identified: Entognatha, Arachnida, Crustacea, and Insecta. The latter, referring to a specific type, is the most prevalent, constituting over 90% of all analyzed manure samples. (Floate, 2011) stated that coprophagous insects exhibit a tendency towards being generalists and are drawn to the feces of various animal species, albeit with certain preferences.

Larval and imaginal forms

The preponderance of larval rather than adult forms can be attributed to the nature of manure, which provides a favorable developmental environment for the immature stages of certain species, particularly Diptera and Coleoptera associated with various types of manure. According to (Hammer, 1941; Legner and Olton, 1970), the components and arrangements of domestic animal manure attract females of specific Diptera groups, who lay their eggs within the manure, where the larvae feed and develop. Furthermore, the technique used to extract arthropods is ineffective for capturing flying insects such as Diptera and Hymenoptera. As a result, all adult Diptera collected were submerged during the extraction period. Diptera larvae density varied according to manure type, with the highest abundance found in cow manure and the lowest in camel manure. This variation could be attributed to humidity, which is essential for Diptera larvae development.

According to (Fatchurochim *et al*., 1989), the amount of moisture in manure plays an important role in determining fly abundance. According to (Akbassova *et al*., 2016), of all manure types (cow, sheep, and camel), camel manure has the lowest odor, light structure, and moisture content (5-8%). According to Ali (Khan *et al*., 2012), cow manure has a very high moisture content of 75.9%. This moisture content is required for the incubation of *Musca domestica* (Linnaeus, 1758) larvae. Cow manure had the highest number of arthropod individuals (NI = 242), most likely due to the abundance of decomposer larvae (Diptera and Coleoptera) that attract other types of arthropods, including predators, as suggested by (Sladecek *et al*., 2021). Insects colonizing manure at the start of the succession encourage the establishment of other insects at the end, such as coprophagous beetles and coprophagous insect larvae, as demonstrated by (Sladecek *et al*., 2021).

Order dominance

The two predominant orders of arthropods, Diptera and Coleoptera, were the most frequently detected among the four types of manure examined. The prevalence of these two orders fluctuates, depending on the developmental stage of the individuals. Diptera exhibit greater dominance during their immature stage, whereas Coleoptera exhibit greater dominance during their adult stage. The variation in dominance observed may be attributed to the extraction method employed. Various researchers have documented the prevalence of Diptera and Coleoptera in various forms of manure (Blume, 1970; Fatchurochim *et al*., 1989; Lee and Wall, 2006; Legner and Olton, 1970; Sladecek *et al*., 2021).

Family distribution

Only three of the 37 arthropod families identified were present in the majority of the manure types examined. The *Sphaeroceridae* are associated with decomposing plant and animal organic matter such as dung, leaf litter, manure, and vertebrate corpses, according to a study by (Papp *et al*., 2021). These various types of organic matter create an ideal environment for larval development. This information supports the findings, with the *Sphaeroceridae* family being the most extracted in the Berlese apparatus due to the high density of larvae in the various types of manure studied. The accumulation of eggs and larvae from this and other families makes the environment appealing to certain predators, who come second. (Arnett Jr and Thomas, 2001) and (Legner and Olton, 1970) considered *Histeridae* and *Staphylinidae* to be predators. (Arnett Jr and Thomas, 2001) discovered that *Histeridae* prefer large mammals' excrements, which are high in larvae, particularly those of certain dipteran families.

Other recorded species are from families such as *Tenebrionidae*, *Bostrychidae*, *Dermestidae* and Psocodea, which are primarily associated with animal feedstuffs like barley and wheat bran, which are commonly infested by stored-product insect pests. According to (Subramanyam, 1995), all important insect species that harm stored products belong to one of seven families: *Tenebrionidae*, *Silvanidae*, *Dermestidae*, *Curculionidae*, *Bostrichidae*, *Bruchidae* or *Cucujidae*. Some insects have a selective distribution, and their presence in certain types of manure may be related to the needs of their next generation or their feeding preferences. The *Scarabaeidae* and *Aphodiidae* families, for example, are found exclusively in camel and goat manure. *Scarabaeoidea* beetles in a semi-arid climate have mouthparts adapted to consume dry vertebrate pellets, according to a study by (Verdú and Galante, 2004).

Other families, like the *Anthicidae*, prefer cow manure because it contains more moisture than other types of manure. Adults in this family are omnivorous (Werner and Chandler, 1995), eating fungal hyphae, spores, and plant exudates, but they can also be opportunistic predators of small arthropods. The *Anthicidae* family includes predatory species as well as saprophagous ones. The *Nitidulidae* family has also been identified in this type of manure. Species in this family are predominantly mycetophagous (Jameson, 2002) and saprophagous. It should be noted that the *Anthicidae* and *Nitidulidae* families' use of cow manure is related to their trophic requirements for predatory species and their hyphae richness for mycetophagous species (Dickinson and Underhay, 1977). Of the 37 arthropod families recorded, 11 were only observed once. The families are *Aphididae*, *Dermestidae*, *Chernetidae*, *Neobisiidae*, *Liposcelididae*, and *Gryllotalpidae*. According to (Floate, 2011), some arthropod species may be present in manure despite having no direct relationship with it. Springtails, millipedes, spiders, ground beetles, and ants, for example, may pay them a passing visit.

Conclusions

The objective of this study was to enhance our comprehension of the arthropod fauna linked to various types of manure that are not well-documented in the Oued Righ region of southeastern Algeria. This endeavor has facilitated our comprehension of the various categories of arthropods, whether they are adversaries or allies in oasis agriculture, and has enhanced our approach to utilizing this prevalent organic material in agriculture in southeast Algeria. Four classes of arthropods were identified: Entognatha, Arachnida, Crustacea, and Insecta. Among the four types of manure examined, Insecta was found to be the most prevalent. While cow manure is highly fertile for coprophagous Diptera larvae, its abundance of larvae creates an appealing environment for specific predatory families, particularly *Histeridae* and *Staphylinidae*. The succession of different families highlights the impact of trophic requirements on the distribution of families. Conversely, specific families that are regarded as nuisances, such as *Gryllotalpidae*, *Bostrychidae*, and *Dermestidae*, are not linked to beneficial manure but can be introduced through contaminated cattle feed. Therefore, the farmer must exercise all essential measures prior to utilizing this particular organic matter.

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