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Diversity of forensic insects in a rodent carcass

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Abstract
The ecological succession pattern represents an important tool in legal investigations. Forensic entomology is the application and study of insects and other arthropod biology to criminal matters. It involves the interaction of arthropods (mainly insects) with legal activity. Forensic entomology is the study of insects associated with a dead body and has been used and accepted in courts around the world. It is primarily concerned to determine time of death. In the present study a total of 123 insects belonging to seven Families of 3 Orders namely Diptera (Calliphoridae, Muscidae, Sarcophagidae), Hymenoptera (Formicidae), and Coleoptera (Dermestidae, Histeridae and Staphylinidae) was observed from rodent carcass at the time intervals. The major species was the house fly, *Musca domestica* (26.02 %), followed by *Hypoponera Sp* (16.26 %), Blue fly (8.94 %) and other insects was observed in least number. The order Diptera was dominant in rodent carcasses when compared with other Orders. Total decomposition period was 11 days. The diversity indices such as, Dominance_D (123), Shannon_H (2.199), Simpson_1-D (0.8648) and Evenness_e^H/S (0.8198) were also analyzed.

Keywords: forensic entomology, decomposition, arthropods, diversity indices

Introduction
The decomposition of a dead body starts initially through the action of microorganisms such as fungi and bacteria, followed by the action of a series of arthropods, with the predominance of the sarcosaprophagous insects [1]. Notable differences were noted in the decomposition process, basically related to time of disintegration, being faster in the presence than in the absence ofinsects [2]. After death, the body undergoes natural changes, going through different stages of decomposition that are attractive to necrophagous insects. According to Bornemissza3the decomposer community of a carcass goes through a process of ecological succession. Therefore, the insects arrive in a determined sequence, producing an addition and/or substitution of species. Knowing these sequences as well as their preference for the different stages of decomposition, and the meteorological data, it is possible to determine the Post Mortem Interval (PMI) [2].

The decomposers of carcasses can be divided into two groups, those that consume the soft tissues of fresh carcasses i.e. Diptera and those that utilize the skin and hair material of carcasses i.e. Coleoptera [4]. They complete every stage of their life cycle on the carcasses but mostly in initial stages of decomposition and not in decay. The members of Coleoptera are the second decomposers, become the most important forensic indicators during later stages of decomposition, as they feed upon the skin and hairs [5].The pattern of arthropod colonization follows a reasonably predictable sequence; the limits of each stage of decomposition will not necessarily coincide with a major change in the faunal community. Therefore, the stages of decomposition were defined by the observable physical changes to the state of the carcass. A pattern of insect succession results as different carrion insects are attracted to the varying biological, chemical and physical changes that occur in a carcass undergoes throughout the process of decay. The identification of insects associated with a corpse and their specific biology in the context of a crime scene can provide use full data for the best estimation of death criteria, i.e. PMI estimation, when studying decomposition from an entomological point of view and for the purpose of applying data to human death investigations [6]. Hence, the present study has been carried out to analyse the presence of insect community in the rodent carcasses during the decaying period.

Materials and Methods
In the present study insect fauna were observed in the carcass of an experimental animalrodent at Ayya Nadar Janaki Ammal college campus. The dead Rodent was reshly collected from the Rajapalayam vegetable Market. The carcass was kept under the iron cage in the ground of college campus under natural environmental conditions. Insect faunaof different species were collected every morning, noon and evening. All adult insects were killed with ethyl acetate and preserved dry by entomological mounting or in 70%alcohol.Collected insects have been identified byappropriate literature [7, 8, 9, 10, 11]. The diversity indices were also calculated by Software packages (Past software)

Results and Discussion
In the present study a total of 123 insects belonging to seven

Families of 3 Orders such as, Diptera (Calliphoridae, Muscidae, Sarcophagidae), Hymenoptera (Formicidae), and Coleoptera (Dermestidae, Histeridae and Staphylinidae) was collected from rodent carcass. The major species was the house fly, *Musca domestica* (26.02 %), followed by *Hypoponera Sp* (16.26 %), Blue fly (8.94 %) and other insects are observed in least number. The order Diptera was dominant in rodent carcasses when compared with other orders (Table 1). Okiwelu [12] reported that the highest insect population was 414, recorded from the carcass of the Forest Genet, *Genetta poensis;* it consisted of 5 Families in 3 orders: Diptera (Muscidae, Bombyliidae, Syrphidae), Coleoptera (Cleridae) and Hemiptera (Reduviidae). The Order Diptera was dominant on all carcasses and the most prominent dipteran *M. domestica* was collected continuously, while the appearance of the other species was sporadic. Similar results were also observed by Anton [13] more than 57 species of Diptera belonging to 17 families and 48 species of Coleoptera belonging to 14 families were identified in pig carcasses. Dominant species belonged to the families of Calliphoridae (*n* = 11 spp.), Sarcophagidae (*n* = 8), Muscidae (*n* = 9), Piophilidae (*n* = 3), Silphidae (*n* = 6), Dermestidae (*n* = 3), Nitidulidae (*n* = 4), Cleridae (*n* = 3) and Histeridae (*n* = 2). During the study period to record the density pattern of insects in rodent carcass, the Diptera insects showed (52.03%), Hymenoptera (30.89%) and Coleoptera (17.08%) (Table 2). Okiwelu [12] reported that a total of 281 insects in four families of 2 orders: Diptera (Muscidae, Syrphidae, Calliphoridae) and Hymenoptera (Adidae), and 2 ixodids were collected from the mona monkey, *Cercipithecus mona.* The major species was the house fly, *Musca domestica* (72%).

With regard to the various indices were worked out the insects sampled. The Fisher_alpha index showed maximum (2.923) followed by Shannon_H (2.199), Margalef (2.078), Brillouin (2.043) and other indices are showed minimum (Table 3).Species richness and abundance were highest in the carcass of the forest genet; this was probably related to the longer period (25 days) of decomposition, compared to 11 and 14 days for the Greater Cane rat and Mona monkey respectively. The arthropod fauna on all carcasses were dominated by necrophages, specifically dipterans (syrphids, muscids) and coleopterans (clerids); The Calliphorid *Chrysomyia chloropyga* was only recorded on the primate, Mona monkey, the closest relative to humans, *Homo sapiens,* among the three experimental animals [14].

In the present study, different decomposed stages such as, Fresh (12 Hrs), Bloated (36 Hrs) Active (3-4 days) Advanced (5-6 days) Dry (7-11days) were observed. In the fresh stage *Lucilia sericata, Musca domestica, Camponotus* Sp. and Clown beetle were observed. In the Blotted stage*Lucilia sericata, Muscomorpha Schizophora, Musca domestica, Lucilia richardsi, Calliphora vomitoria,* Clown beetle, *Camponotus* Sp., *Aphaneogaster* Sp., *Hypoponera Sp*insects were observed. During active stage*Lucilia sericata, Muscomorpha Schizophora, Musca domestica, Calliphora vomitoria, Dermestes maculates,* Clown beetle, *Camponotus* Sp., *Aphaneogaster* Sp., *Hypoponera Sp. Lucilia richardsi*insects were observed. In Advance stage *Muscomorpha Schizophora, Musca domestica, Lucilia richardsi, Calliphora vomitoria, Dermestes maculates, Ocypus olens, Hypoponera Sp.* anddry stage *Musca domestica, Dermestes maculates, Ocypus olens*were observed. The maximum number of insects was observed in the active and advanced stages, when compared with other decaying stages. *Musca domestica*was observed of all decaying stages and the total decomposition period was 11 days (Table 4). The decomposition process of the carrions took sixteen days in the four phases - fresh, bloated, active and dry decay stages. Six orders of insects- Diptera, Coleoptera, Hymenoptera, Hemiptera, Orthoptera and Dictyoptera were collected on the carrions. The sarcophagids and calliphorids were the first to arrive on the carrions and deposited their first instar larvae and eggs respectively, few hours after death, during the fresh stage. The dermestids and clerids arrived on the carrions few days after death during the bloated stage. The insect species composition on the carrions peaked during the active decay stage. The larvae of these insects fed voraciously on the carrions, which led to faster decomposition of the carrions [15].

The basic reason for using insects in criminal investigations, a science denominated as forensic entomology, resides in the fact that insects are the first ones to detect and to find a cadaver and are present in all stages of decomposition and, furthermore, some species are specific for certain areas and seasons. Another important point to be considered is that oviposition cans occur few minutes after death [16]. It is interesting to point out that insects of forensic importance are those that do not just visit the corpse or carcass in the adult form, but also breed in these substrates because, by knowing the developmental time of their larvae, it is possible to estimate the time of death. The insects can be useful tools in investigations on causes and circumstances of death. However, the usefulness of this method depends on how the corpse has been handled before the arrival of the entomologist at the death scene [2]. The insect diversity is differing from one region to other region. The appearance of forensic insects or visiting is different from animal to animal and environmental conditions. This study is very useful to correlate the occurrence at different forensic insects in the college campus and to develop an understanding of forensic entomology and increase critical thinking application for student to further their interest in future career goals in entomology.

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Conflict of interest

Author confirmed no any Conflict of interest

Table 1: Diversity of insects recorded in the rodent carcasses

S. No.	Order	Common Name	Family	Zoological Name	No. of insects	Percentage
1	Diptera	Blow fly	Calliphordiae	*Lucilia sericata*	07	5.69
2	”	Flesh fly	Sarcophagidae	*Muscomorpha Schizophora*	09	7.32
3	”	House fly	Muscidae	*Musca domestica*	32	26.02
4	”	Holarctic blow fly	Calliphoridae	*Lucilia richardsi*	05	4.07
5	”	Blue fly	Calliphoridae	*Calliphora vomitoria*	11	8.94
6	Coleoptera	Skin beetles	Dermestidae	*Dermestes maculatus*	04	3.25
7	”	Rove beetles	Staphylinidae	*Ocypus olens*	10	8.13
8	”	Clown beetle	Histeridae	-	07	5.69
9	Hymenoptera	Carpenter ant	Formicidae	*Camponotus* Sp.	06	4.87
10	”	Ant	Formicidae	*Aphaneogaster* Sp.	12	9.76
11	”	Ant	Formicidae	*Hypoponera Sp.*	20	16.26
Total Average SD					123	100
					11.18	9.09
					± 8.18	± 6.65

Table 2: Total number of species, percentage and density of insects recorded in the rodent carcass

S. No	Order	Number of Species	Percentage	Density
1	Diptera	5	45.46	52.03
2	Coleoptera	3	27.27	17.08
3	Hymenoptera	3	27.27	30.89
Total Number of species		11		

Table 3: Diversity indices for insects observed by rodent carcass

S. No	Diversity indices	Species richness
1	Dominance_D	123
2	Individuals	0.1352
3	Simpson_1-D	0.8648
4	Shannon_H	2.199
5	Evenness_e^H/S	0.8198
6	Menhinick	0.9918
7	Margalef	2.078
8	Equitability_J	0.9171
9	Brillouin	2.043
10	Fisher_alpha	2.923
11	Berger-Parker	0.2602

Table 4: The insect species associated with rodent carcass observed during different decomposed stages

S. No.	Order	Name of the insect	Family	Scientific name	Stages of decaying				
					Fresh (12 hrs)	Bloated (36 hrs)	Active (3-4 days)	Advanced (5-6 days)	Dry (7-11days)
1	Diptera	Blow fly	Calliphordiae	*Lucilia sericata*	P	P	P	A	A
2	“	Flesh fly	Sarcophagidae	*Muscomorpha Schizophora*	A	P	P	P	A
3	”	House fly	Muscidae	*Musca domestica*	P	P	P	P	P
4	”	Holarctic blow fly	Calliphoridae	*Lucilia richardsi*	A	P	P	P	A
5	”	Blue fly	Calliphoridae	*Calliphora vomitoria*	A	P	P	P	A
6	Coleoptera	skin beetles	Dermestidae	*Dermestes maculatus*	A	A	P	P	P
7	”	Rove beetles	Staphylinidae	*Ocypus olens*	A	A	A	P	P
8	”	Clown beetle w	Histeridae		P	P	P	A	A
9	Hymenoptera	Carpenter ant	Formicidae	*Camponotus* Sp.	P	P	P	A	A
10	”	Ant	Formicidae	*Aphaneogaster* Sp.	A	P	P	A	A
11	”	Ant	Formicidae	*Hypoponera Sp.*	A	P	P	P	A

P – Present; A- A

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