An Analysis of the Ecological Succession Pattern of Diptera on the Carcass of Laboratory Bred Rats

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Abstract – Jaipur has a hot semi-arid steppe climate. Environmental conditions have a direct impact on the fauna of forensically important flies. So an effort was made to study and identify the fauna of flies of forensic significance. Flies were collected twice a day using insect nets from 2nd Nov. 2015 to 7th Nov. 2015. Laboratory bred rats, Rattus norvegicus Wistar, were used as bait for the flies. The captured flies were identified using taxonomic keys. During present study, a total number of 9 species of flies in four families, viz. Calliphoridae, Sarcophagidae, Muscidae and Phoridae were collected. Parasarcophaga (Liopygia) ruficornis (Sarcophagidae) was pioneer species to visit the carrion, followed by Calliphoridae, Muscidae and Phoridae. Phorid flies were observed to arrive at the carrion on the third day. However, the most abundant flies were of Calliphoridae (44.24%), followed by Muscidae (28.87%), Sarcophagidae (16.53%) and Phoridae (13.35%).

Keywords – Forensically Important, Calliphoridae, Muscidae, Sarcophagidae, Phoridae, Semi-arid.

I. INTRODUCTION

Forensic entomology is the application of the study of arthropod to legal issues. Its most important application is the estimation of Post-mortem interval (PMI) [1]. The successional pattern of arrival of necrophagous insects at a cadaver is a key feature in the estimation of the minimum post-mortem interval. The type and composition of taxa that are attracted to a carcass usually change in a predictable pattern as decomposition progresses through the different stages [2]-[4]. Insect colonization and period of colonization depend on many factors such as environmental conditions and conditions of the corpse (position, sunshine or shade, clothes, indoor or outdoor) [5]. Therefore, the pattern of succession of insects is specific to the location and environmental conditions in which a carcass occurs [6].

Because taxa can vary greatly with locale, the identification of the forensically important insects that are specific to an area is important for precise estimation of the PMI [7]. Hence, for use of insects in legal medicine, sufficient data should be collected in each geographical region, such as time of arrival of insects to the corpse, insect succession on cadavers and biology of insects [1].

Studies of carcass arthropods and their successional pattern on carcass have been comprehensively carried out in many regions of the world [8]. Studies on insects associated to carrion are well documented in different regions of India as well. However, such studies have not been documented so far in Rajasthan. So the objective of the present study is to determine insect fauna associated with carrion in Jaipur region of Rajasthan.

II. MATERIAL & METHODS

To study the successional pattern of Diptera on the carcass, laboratory bred rats, Rattus norvegicus Wistar weighing ~200 g, were used as experimental animal model, in the campus of University of Rajasthan, Jaipur. The study was conducted for 6 days. Physical environmental conditions, like temperature and humidity were recorded daily. The average of maximum and minimum temperature and relative humidity was recorded as 32.38°C, 19.5°C and 52% respectively.

The rats were placed in wooden cages in the campus (bushy area) (Fig.1). The cages had wider mesh to allow entrance of the insects. The experiment was carried out in five replicates. Observations and collection of flies were made thrice daily for six days (2.11.2015- 07.11.2015). Adult flies were collected using insect nets, which were killed using ethyl acetate and then pinned with entomological pins for further studies. Identification of the species was accomplished using taxonomic keys of [2], [9]-[12].

III. RESULTS

The present study revealed seven genera and eight species from four families of Diptera associated with the carcasses during the study (Fig.4). Decomposition of the rats lasted for six days, from 2nd November to 7th November, 2015. During this period, flies from four families, viz., Calliphoridae, Sarcopagidae, Muscidae and Phoridae, were collected. Sarcophagidae was the first one to visit the carrion followed by Calliphoridae (Fig.3). Parasarcophaga ruficornis visited the carrion after 13 minutes of exposure of the carrion (Fig.2). The most abundant family was found to be Calliphoridae followed by Muscidae, Sarcophagidae and Phoridae (Table I & Fig. 5). Musca domestica and Chrysomya megacephala were present throughout the study, whereas Megaselia sp. Belonging to Phoridae arrived at the carcass on third day (Table II).

IV. DISCUSSION

In the present study, Sarcophagidae family was observed as the first fly species that visited the carcass, however, its abundance was less than C. megacephala and M. domestica. This is in agreement with the studies which
suggest that flesh flies are primary invaders of carrion in warm temperature and tropical region, whereas secondary species in cooler regions [2], [13], [14]. However, results are contradictory to the results given by [15] who studied forensically important diptera associated with dog carcass in Pakistan and observed C. rufifacies as the first colonizer on the carcass followed by P. ruficornis. Other important flies in their study were M. domestica and Piophila casei. Unlike the results of the present study, [16] observed order of succession of Dipteron flies on decomposing dog (Canis lupus familiaris L.) carcass at Ankara province as Calliphoridae, followed by Sarcophagidae and Muscidae. They observed C. albiceps, C. vomitoria and C. vicinia from Calliphoridae family; Sarcophaga sp. from Sarcophagidae family and Musca sp. and Hydrotaea ignava from Muscidae family. Similarly, [17] also reported that adults of Calliphoridae were amongst the initial colonizers of the corpse, arriving shortly after exposure of the carrion and laying eggs into the natural orifices. Ref. [18], [19] also reported C. nigripes and C. megacephala to visit the carcass first in their respective studies. Likewise, [20] in Bhagdad collected five families of Diptera from the carcass and also reported Calliphoridae and Muscidae as the initial colonizers of the carcass.

In the present study, although P. ruficornis was the initial colonizer but C. megacephala and M. domestica were dominant species which is in accordance with [21] who also reported M. domestica as the most prominent diptera in their study. However, [22], [23] revealed in their study that C. megacephala and C. rufifacies were dominant species in forests area. Similarly, M. domestica and C. rufifacies were reported to be present in the fresh, bloat and active decay studies in Pakistan by [24].

Among families, Calliphoridae predominated in the carrion during the present study of fresh, bloat and active decay stages of decomposition. This is in consonance with the study of [25] who identified 229 individuals belonging to 11 species from six families of Diptera from two mangrove areas of Peninsular Malaysia and recorded C. megacephala, C. rufifacies and Hydrotaea sp. as the most abundant species in their study. However, [26] registered Phoridae, Anthomidae and Fanniidae as important forensic families besides Calliphoridae and Sarcophagidae. The dominant species among colonizers, in their study, were Hemilucilia segmentaria Fabricius (Diptera: Calliphoridae), H. semidiaphana (Rondani) and Ophyra chalagaster (Wiedmann) (Muscidae). They observed Megaselia scalaris Loew (Phoridae) was the most abundant species at the period immediately after death. On the contrary, in the present study, Megaselia sp. was seen on the third day of experimentation.

**V. CONCLUSION**

The present study concludes that dipteran species of the families Calliphoridae and Sarcophagidae are able to reach cadavers within a few hours of death and are the first colonizers of a corpse which is in accordance with [6], [8], [27], [28]. Similarly, [29] have also concluded in their study that potentially important diptera are C. albiceps, C. megacephala, C. putoria, Phaenicia eximia and H. segmentaria, Pattonella intermutans, Liopygia ruficornis and Adiscochaeta ingens. These were able to breed in carrion exposed to natural environmental conditions. This ability has led to the more frequent use of sarcophagids and calliphorids as evidence in medico-criminal investigations [3].

**V. ACKNOWLEDGMENT**

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REFERENCES


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Nirupama Singh (nirupamasingh@gmail.com) (D.O.B.-12/06/1984), Jaipur, is presently pursuing Ph.D. She has done M.Sc. (2009) in Zoology with specialization in Entomology and M.J.M.C. (2011) from University of Rajasthan, Jaipur. Her field of interest is forensically important dipteran flies. She is CSIR-UGC-NET qualified. She has attended 15 Conferences and presented her work in 7 International and National Conferences. She is a life member of Association of Entomologists and fellow member of Academy of Environment and Life Sciences.

Dr. Vinod Kumar (vinos.khangarot@yahoo.com) (D.O.B.-10th Nov, 1975), Jaipur, has done M.Sc (1998) and Ph. D (2002) in Zoology with specialisation in entomology from University of Rajasthan, Jaipur. Her field of study is biological control of pests, biodiversity, and forensically important dipteran flies.

She is an Assistant Professor in Government College, Chimanpura, Jaipur from 2002 and has teaching and research experience of 13 yrs and 16 yrs. She has been selected as Research Awardee under Post Doctoral Research Awardee Scheme by UGC for two years. She has 20 publications- six in International Journals, six National Journals, two in proceedings of International Conferences and six chapters in Books. She has attended 46 conferences and presented her research work in 30 National and International conferences.

Dr. Vinod Kumar fellow member of Academy of Environment and Life Sciences and Society of Education. She is also a life member of Association of Entomologists, Indian Science Congress Association, Indian Society Of Arachnology, International Society of Arachnology, Hind Institute of Science and Technology, Journal of Biopesticides and Indian Journal of Entomology. She has received one Young Scientist Award, four Best oral presentations in conferences.

Prof. N. P. Singh (singhnpa@yahoo.com) born on 2nd June 1954, Aligarh, did his M. Sc (1975) and Ph. D (1981) in Zoology with specialisation in entomology from Aligarh Muslim University, Aligarh. His field of interest is Insect Pest Management, biodiversity and forensically important flies.

He has worked as Lecturer in Zoology, D.S. College, Aligarh (Affiliated to Agra University, Agra) from March 1979 to August 1979, as Asstt. Professor in Zoology, University of Rajasthan, Jaipur from 16th August 1979 to 15th August 1992, as Associate Professor in Zoology, University of Rajasthan, Jaipur from 16th August 1992 to May 2001 and as Professor since May 19, 2001 and Head Department of Zoology, University of Rajasthan, Jaipur – 302004. He has guided twenty two students leading to Ph.D degree. In all, he has an experience of 35 years of teaching and research. He has published more than 64 research papers and has attended more than 50 conferences. He has also chaired the sessions in more than 15 Conferences.

Prof. N. P. Singh is a member of selection committee – Chhattisgarh Public Service commission, Raipur, Forest Research Institute (FRI) Dehradun, Rajasthan Public Service Commission (RPSC), Affiliated colleges of University of Rajasthan Jaipur, The Kashmir University, Srinagar (J&K), Sarguja University Ambikapur, Chhattisgarh and Panjab University, Chandigarh. He has been an active member of Board of Studies- University of Rajasthan, Jaipur, M.D.S. university, Ajmer, Maharaja Ganga Singh University, Bikaner, Dr. B.R. Ambedkar University, Agra, M. L. S University, Udaipur and J N V University, Jodhpur.

### Table I: Identified dipteran species and their absolute and relative abundance

<table>
<thead>
<tr>
<th>Family</th>
<th>Generic name</th>
<th>Common name</th>
<th>Absolute abundance (n)</th>
<th>Relative abundance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calliphoridae</td>
<td>Calliphora vicina Robineau Desvoldy,1830</td>
<td>Urban Blue bottle fly</td>
<td>12.2</td>
<td>10.1836%</td>
</tr>
<tr>
<td></td>
<td>Lucilia sericata (Meigen,1826)</td>
<td>English sheep blow fly/ Green bottle fly</td>
<td>10.2</td>
<td>8.5141%</td>
</tr>
<tr>
<td></td>
<td>Chrysomya albiceps (Wiedemann,1819)</td>
<td>Hairy maggot blue fly</td>
<td>9.8</td>
<td>8.1803%</td>
</tr>
<tr>
<td></td>
<td>Chrysomya megacephala</td>
<td>Oriental latrine fly</td>
<td>20.8</td>
<td>17.362%</td>
</tr>
<tr>
<td>Sarcophagidae</td>
<td>Parasarcophaga (Liopygia) ruficornis (Fabricius,1794)</td>
<td>Flesh fly</td>
<td>13.8</td>
<td>11.519%</td>
</tr>
<tr>
<td>Muscidae</td>
<td>Sarcophaga sp.</td>
<td></td>
<td>6</td>
<td>5.001%</td>
</tr>
<tr>
<td></td>
<td>Musca domestica</td>
<td>House fly</td>
<td>25.2</td>
<td>21.035%</td>
</tr>
<tr>
<td></td>
<td>Ophyra sp.</td>
<td></td>
<td>5.8</td>
<td>4.841%</td>
</tr>
<tr>
<td>Phoridae</td>
<td>Megaselis sp.</td>
<td>Hump-backed fly</td>
<td>16</td>
<td>13.355%</td>
</tr>
</tbody>
</table>

### Table II: Successional patterns of dipteran flies associated with decomposing rat carcasses at different time intervals after death

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>3 hr</th>
<th>24 hr</th>
<th>48 hr</th>
<th>72 hr</th>
<th>96 h</th>
<th>120 h</th>
<th>144 hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calliphoridae</td>
<td>Calliphora vicina</td>
<td>*</td>
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<td>*</td>
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<td></td>
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<tr>
<td></td>
<td>Lucilia sericata</td>
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<tr>
<td></td>
<td>Chrysomya albiceps</td>
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<td></td>
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<tr>
<td></td>
<td>Chrysomya megacephala</td>
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<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sarcophagidae</td>
<td>Parasarcophaga (Liopygia) ruficornis</td>
<td>*</td>
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<td>*</td>
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<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muscidae</td>
<td>Sarcophaga sp.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Musca domestica</td>
<td>*</td>
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<td>*</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ophyra sp.</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phoridae</td>
<td>Megaselis sp.</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Fig. 5. Relative abundance (%) of forensically important Dipteran flies in Jaipur region.

- Calliphora vicina: 21.04%
- Lucilia sericata: 10.18%
- Chrysomya albiceps: 13.36%
- Chrysomya megacephala: 11.52%
- Parasarcophaga (Liopygia) ruficornis: 17.36%
- Sarcophaga sp.: 5.00%
- Musca domestica: 8.51%
- Megaselia sp.: 8.18%
- Ophyra sp.: 4.84%