



Research Article

SUCCESSIONAL PATTERN OF NECROPHAGOUS DIPTERA ON A DEAD ASIATIC JACKAL'S (*Canis aureus* Linnaeus, 1758) BODY IN VEERANGANA DURGAWATI WILDLIFE SANCTUARY, MADHYA PRADESH, INDIA

¹Shyamkant S. Talmale, ²Oishik Kar, ¹Sachin R. Patil, ^{2*}Atanu Naskar, and ²Dhriti Banerjee

¹Zoological Survey of India, Western Regional Centre, Vidyanagar, Pune-411 044.

²Zoological Survey of India, 535, M-Block, New Alipore, Kolkata-700 053.

Article History: Received 24th May 2023; Accepted 26th June 2023; Available online 31th August 2023

ABSTRACT

The field of forensic entomology emphasizes the close relationship between insects and cadavers, as well as the utilization of insects in medicolegal investigations, and helps understand the reasons for death. In forensic science, the presence of necrophagous dipteran flies on a dead body is particularly important as well as they play a significant role in the decomposition of the carcass. In recent times, necrophagous fly data has been used to investigate the causes of mortality. The evidence is useful in the estimation of post-mortem interval (PMI) which is important in solving medico-legal cases in human beings, and also helpful in wildlife forensics. The present paper reports day-wise observations of the dipteran visitors on the decaying corpse of the Asiatic Jackal in the Veerangana Durgawati Wildlife Sanctuary, Damoh district, Madhya Pradesh. Adult dipteran flies consisting of five species fewer than four families namely Calliphoridae, Sarcophagidae, Muscidae, and Sepsidae were collected from the site. *Chrysomya megacephala* was the first visitor of the carcass and both *Chrysomya megacephala* and *Chrysomya rufifacies* were the most common species during the various stages of decay of the cadaver. The other necrophagous flies which visited the cadaver were: *Musca planiceps*, *Sarcophaga (Seniorwhitea) princeps*, and *Themira bifida*. This study is the first of its kind conducted in Central India. The findings might be used to supplement the information in forensic investigations for criminal cases and wildlife hunting from India.

Keywords: Carcass, Forensic entomology, Necrophagous flies, Wildlife crime.

INTRODUCTION

Wildlife in its natural environment involves both flora (plants) and fauna (animals), which is critical for the biodiversity and ecological balance of Earth (Dorst, 1991; Xue-Hong *et al.*, 2016). Poachers and illegal unauthorized hunters of wild creatures represent a significant danger to wildlife and ecosystems (Rana & Kumar, 2023). Crime involving wildlife is a global issue, and poacher activities like live trading, body part sale, or selling processed items immediately affect protected flora and fauna (Wilson-Wilde, 2010; Anagnostou and Doberstein, 2022). Wildlife and its products are the world's second-largest illicit trade, accounting for over \$25 billion USD (Singh *et al.*, 2012).

Forensic entomology is a broad branch of study that uses insect components as evidence in medical and legal cases. When there is entomological proof, the entomologist's task begins, which needs a specialized study of the species concerned, stages of development when the insect was found, its life cycle, and additional components of its biology (Rodríguez *et al.*, 2020). These insect colonizers may be utilized in calculating the postmortem interval (PMI), or the period between death and corpse discovery, as well as the movement of the carcass, the technique and reason for death, and the association of criminals at the location of the crime (Sukontason *et al.*, 2007; Amendt *et al.*, 2010; González Medina *et al.*, 2011; Nuñez, 2012).

*Corresponding Author: Dr. Atanu Naskar, Scientist-C Zoological Survey of India, 535, M-Block, New Alipore, Kolkata-700 053 Email: atanu.diptera@gmail.com.

The natural instinct of necrophagous flies is to colonize the body or cadaver for living and reproducing (Palavesam *et al.*, 2022). The common necrophagous flies are classified as follows: Diptera, which includes the Calliphoridae, Muscidae, Sarcophagidae, Phoridae, Stratiomyidae, Sepsidae etc. families, are well-known as forensically significant flies (Anderson and VanLaerhoven, 1996; Villet, 2010; Sharif and Qamar, 2021; Kar *et al.*, 2022; Palavesam *et al.*, 2022). In India, there are limited reports on the occurrence of insects of forensic interest (Singh and Bharti, 2000; Bharti *et al.*, 2001; Nandi, 2002; Bharti and Singh, 2003; Ramaraj *et al.*, 2014; Bharti and Singh, 2017; Chakraborty *et al.*, 2017; Hore *et al.*, 2017; Bhattacharjee *et al.*, 2021; Sharif and Qamar, 2021; Shinde *et al.*, 2021; Babu *et al.*, 2022; Kar *et al.*, 2022; Palavesam *et al.*, 2022).

Asiatic Jackal (*Canis aureus* Linnaeus, 1758) lives in almost any environment, the greater number live in the lowlands, about towns, and villages and cultivation. They usually come out at dusk. Jackals are omnivores, feeds on fruits, berries, insects, crabs, birds, small mammals etc (Prater, 1965). This is the first attempt to study the *Necrophagous dipteran* flies collected from the corpse of Jackal from the Central India. Different species and life stages of flies were collected on daily basis from the corpse

of Jackal found in the Veerangana Durgawati Wildlife Sanctuary, District Damoh, Madhya Pradesh. Post-death changes in the body of Jackal attracted different Dipteran flies varying according to stages of decay. Variation in life stages of necrophagous flies is also noticed. The present paper reports a list of necrophagous Diptera on the corpse of Asiatic Jackal in the sanctuary and its forensic importance.

MATERIALS AND METHODS

Study Area

The study was done in the Veerangana Durgawati Wildlife Sanctuary (VDWLS) which was notified and came to existence in January, 1997 in Damoh district of Madhya Pradesh (Figure 1). It covers 24 sq. kms. of area under its jurisdiction. The sanctuary is located within 23° 30' and 23° 35' N latitudes and 79° 40' and 79° 50' E longitudes. There is hilly topography in the sanctuary with mosaic patches of all kinds of habitat (Dwivedi, 2003). Forests of this sanctuary are classified as tropical mixed dry deciduous forests of medium quality and density (Champion & Seth, 1968).

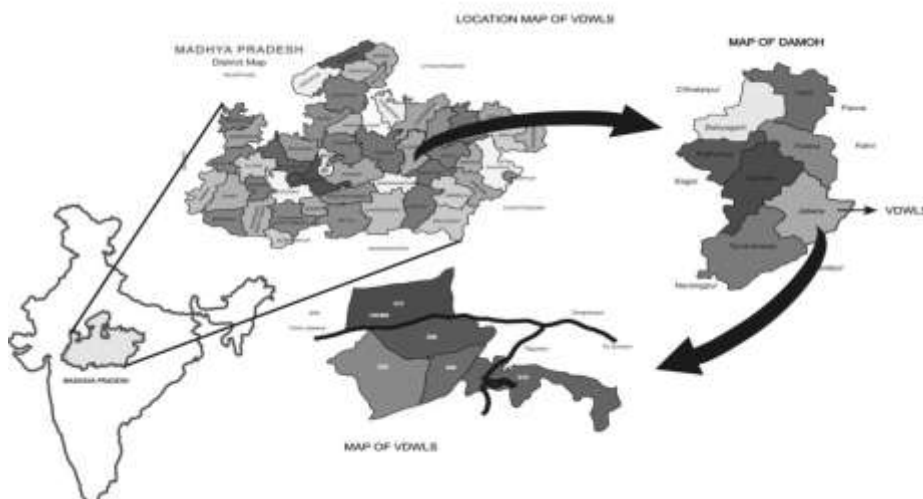


Figure 1. Location of Veerangana Durgawati Wildlife Sanctuary (Not to Scale).

Carrion

During the faunistic survey of the Veerangana Durgawati Wildlife Sanctuary, District Damoh, Madhya Pradesh a sub adult female of *Canis aureus* was sighted near Danital Lake (Lat. N 23°32.868' & Long. E 079°43.705', Altitude: 1277 ft.) in the evening (around 6 pm) of 19.02.2011 (Figure 2). It was walking in a dizzy way and behaving as in mutilate condition. Within five minutes she was doing the vomiting-like behavior and lied down for two minutes and was found writhing in pain. She stood up and again started to walk. Then she walked towards the Danital Lake and behaved the

same way that she has done 10 minutes before and found dead within few seconds. The death may be occurred possibly due to passive poisoning through the food prey used by any poacher. The observations of her dead body were taken from the day 1-7 before leaving the sanctuary.

Insect specimen collection and identification

The adult flies attracted to the corpse we recollected using entomological net from 19.02.2011-26.02.2011 and labeled day wise. In 90% high-grade ethanol, the adult fly specimens were collected (Table 1). The specimens were

maintained in the drying chamber for relaxation before being pinned and stored in the repository. The morphological identifications of adult flies were done with the aid of taxonomic keys (White *et al.*, 1940; Zimin and Elberg, 1988; Pape, 1996; Nandi, 2002b; Carvalho and Mello-Patiu, 2008; Sawaby *et al.*, 2018) under stereomicroscope. Identified specimens were preserved and registered at National Zoological Collection (NZC) of

Zoological Survey of India, Central Zone Regional Centre, Jabalpur, Madhya Pradesh. Meanwhile, the immature stages i.e., larva were collected from the carcass and sacrificed in boiled water (Table 1). Finally they were preserved in 70% high-grade ethanol and taxonomically identified using taxonomic keys (Sukontason *et al.*, 2004; Silva *et al.*, 2012; Jordaens *et al.*, 2013; Ren *et al.*, 2018; Sawaby *et al.*, 2018; Shinde *et al.*, 2021).



Figure 2. Asiatic Jackal (*Canis aureus*) sighted near Danital of Sanctuary area on 19.02.2011 at 6.00PM.



Figure 3. Photographs on day wise observations taken on carcass of *Canis aureus* Linnaeus (Asiatic Jackal).

RESULTS AND DISCUSSION

A total of 529 adult fly specimens were collected. Adult specimens collected contained 5 species under 4 genera and 4 families were identified. Calliphoridae and Muscidae families were the most abundant families found from the corpse. *Chrysomya megacephala* was the first visitor on the corpse of Jackal followed by *Chrysomya rufifacies*, *Musca planiceps*, *Sarcophaga (Seniorwhitea) princeps*, and *Themira bifida*. *Chrysomya rufifacies* and *Musca planiceps* were dominant at the later stages of decay also. This study

is first of its kind from the Central India. The variation in occurrence of different species and life stages of flies on the corpse of Jackal is the indicator of the post-death changes (Figure 3). Table 2 shows that the first visitor of dipteran fly on the corpse is *Chrysomya megacephala* (Fabricus) of family Calliphoridae and the subsequent visitors of the families are Muscidae, Sarcophagidae and Sepsidae. Larva collected from the later stages of decaying corpse were of *Chrysomya megacephala*, and *Chrysomya rufifacies*. Larva was in their 2nd instar stage.

Table 1. Showing observations of dead Jackal and attracting Dipteran flies.

Observation	Status of Jackal corpse	Collection of Dipteran Flies	Temperature	Relative Humidity (%)
Day 1 (19.02.2011)	No changes were observed and no Dipteran flies were present.	Nil	19 ^o C-16 ^o C (6:00PM-12AM)	43
Day 2 (20.02.2011)	Mouth of the corpse was open. Body was straightened and stiffer. No flies were observed.	Nil	18 ^o C-14 ^o C (6:00AM-12PM)	56
Day 3 (21.02.2011)	Body going to dry state along with emitting of some unpleasant smell.	Specimens of the Calliphorid dipteran flies taken for identification which arrived first at the spot.	25 ^o C-24 ^o C (12:00PM-6:00PM)	30
Day 4 (22.02.2011)	Loss of body hair from the corpse. Increased emission of unpleasant smell.	Group of flies wandering on dead body. Collected specimens of flies were taken for identification.	23 ^o C-14 ^o C (6:00AM-12:00PM)	60
Day 5 (23.02.2011)	More loss of body hair and muscle degradation was observed.	Two types of flies i.e., small to big size were collected for identification.	25 ^o C-18 ^o C (6:00AM-12:00PM)	50
Day 6 (24.02.2011)	Most of hair of the body were lost and dipteran maggots appeared in three places of the corpse namely inside mouth, around thoracic ribs, and on femur of right limb.	Only one type of fly was wandering around the corpse. Collected one specimen of dipteran fly.	29 ^o C-17 ^o C (12:00PM-6:00PM)	32
Day 7 (25.02.2011)	The whole body from inside was full of maggots. No hair seen on the body. Muscles thoroughly degraded and bones appeared.	Collected few specimens of the live maggots for rearing in the laboratory.	23 ^o C-16 ^o C (6:00AM-12:00PM) Thunderstorm and rainfall	74
Day 8 (26.02.2011)	Corpse totally degraded and only few portions of the bones were left.	Few maggots were observed.	26 ^o C-16 ^o C (6:00AM-12:00PM)	66

Calliphoridae is the taxa with the highest evidence in forensic entomology amongst dipterans of medico-legal value and wildlife crimes (Radhakrishnan *et al.*, 2012; Singh *et al.*, 2012; Chakraborty *et al.*, 2016; Hore *et al.*, 2017; Babu *et al.*, 2022; Palavesam *et al.*, 2022). In addition, even in cases of myiasis, several other species have been documented as principal colonizers of human bodies and other animals (Singh *et al.*, 2004; Bhagat, 2016; Sharif & Qamar, 2021). The connection is useful since it lets us figure out the time from the body's

colonization until its discovery by tracking minimal gaps in death information. The dipteran species visited on the corpse play very important role in the forensic investigation, as they visited and lay their eggs in early decomposition and or later decomposition of the dead body (Goyal, 2012). Muscidae, and Sarcophagidae have been frequent in the later decay stages of the corpse. Also, for the first time Sepsidae family is being reported for the first time in India as a forensic indicator.

Table 2. Day wise details of adult flies observed on dead Jackal.

Sr. No.	Name of the Species	Family	Day of collection
1	<i>Chrysomya megacephala</i> Fabricius, 1794	Calliphoridae	Day 3
2	<i>Chrysomya rufifacies</i> Macquart, 1844	Calliphoridae	Day 4
3	<i>Musca planiceps</i> Wiedemann, 1824	Muscidae	Day 4
4	<i>Sarcophaga (Seniorwhitea) princeps</i> Wiedemann, 1830	Sarcophagidae	Day 4
5	<i>Themira (Themira) bifida</i> Zuska, 1974	Sepsidae	Day 5
6	<i>Musca planiceps</i> Wiedemann, 1824	Muscidae	Day 5
7	<i>Chrysomya rufifacies</i> Macquart, 1844	Calliphoridae	Day 6

CONCLUSION

This study is the first of its kind conducted in Central India. The findings might be used to supplement the information in forensic investigations for criminal cases and wildlife hunting from India. The data will be a useful source in Indian wildlife crime and helping out protect our fauna.

ACKNOWLEDGMENTS

The authors are highly grateful to the Director, Zoological Survey of India, Kolkata for providing facilities and encouragement. Sincere thanks are due to Dr. S. Sambath, Scientist-C & Officer-in-Charge, Zoological Survey of India, CZRC, Jabalpur for guidance and encouragement, the Principal Chief Conservator of Forests, Bhopal for permission to collection and survey the areas, and to the DFO, Obedullaganj to provide facilities and accommodation during the surveys. Thanks, are also due to Shri. Ramdayal Patel, for assistance during the faunistic surveys.

REFERENCES

- Amendt, J., Goff, M. L., Campobasso, C. P., & Grassberger, M. (2010). *Current concepts in forensic entomology*. Springer.
- Anagnostou, M., & Doberstein, B. (2022). Illegal wildlife trade and other organised crime: A scoping review. *Ambio*, 51(7), 1615-1631.
- Anderson, G. S., & VanLaerhoven, S. L. (1996). Initial studies on insect succession on carrion in southwestern British Columbia. *Journal of Forensic Science*, 41(4), 617-625.
- Babu, B. S., Kumar, R., El-Sharnouby, M., Salah, M., Sayed, S., Alhazmi, A., Hemeg, H. A., Asdaq, S. M. B., & Bala, M. (2022). Calliphorids as forensic indicator to facilitate PMI estimation: A case study from Chhattisgarh, India. *Journal of King Saud University-Science*, 34(1), 101709.
- Bhagat, R. C. (2016). Biodiversity of dipterous flies (Insecta) of myiasis-causing importance in animals and human of Jammu, Kashmir and Ladakh Himalayas (India). *Journal of Global Biosciences*, 5(7), 4341-4349.
- Bharti, M., & Singh, B. (2017). DNA-based identification of forensically important blow flies (Diptera: Calliphoridae) from India. *Journal of Medical Entomology*, 54(5), 1151-1156.
- Bharti, M., & Singh, D. (2003). Insect faunal succession on decaying rabbit carcasses in Punjab, India. *Journal of Forensic Sciences*, 48(5), 1133-1143.
- Bharti, M., Singh, D., & Sidhu, I. S. (2001). First record of some carrion flies (Diptera: Cyclorrhapha) from India. *Uttar Pradesh Journal of Zoology*, 267-268.
- Bhattacharjee, R., Banerjee, D., & Ghosh, S. (2021). *Chronology of appearance pattern and colonization of nutrient recycling forensic flies on house rat carcasses (rattus rattus) in urban and semi-urban habitats of southern part of west Bengal*.
- Carvalho, C. J. B. de, & Mello-Patiu, C. A. de. (2008). Key to the adults of the most common forensic species of Diptera in South America. *Revista Brasileira de Entomologia*, 52, 390-406.
- Chakraborty, A., Banerjee, D., & Saha, G. (2017). Biosystematic Approach: to inventorization of ubiquitous myiasis causing flies of veterinary importance in India. *Research in: Agricultural & Veterinary Sciences*, 1, 116-134.
- Chakraborty, A., Saha, G. K., & Banerjee, D. (2016). Developmental variation of two different variety of Indian blow flies: *Chrysomya megacephala* (Fabricius, 1794) and *Lucilia cuprina* (Wiedemann, 1830)(Diptera: Calliphoridae) on dead *Gallus gallus* (Linnaeus, 1758). *Journal of Entomological and Zoological Studies*, 4(5), 881-889.
- Champion, H. G., & Seth, S. K. (1968). *A revised survey of the forest types of India*. Manager of publications.
- Devinder, S., & Meenakshi, B. (2000). Forensically important blow flies (Diptera: Calliphoridae) of Punjab (India). *Uttar Pradesh Journal of Zoology*, 20(3), 249-251.
- Dorst, J. (1991). Impact of wildlife on the environment. *Revue Scientifique et Technique (International Office of Epizootics)*, 10(3), 557-593.

- Dwivedi, A. P. (2003). Protected Areas of Madhya Pradesh. *Forest Department of Madhya Pradesh, Bhopal, India*.
- González Medina, A., González Herrera, L., Martínez Téllez, I., Archilla Peña, F., Higuera Hidalgo, J., & Jiménez Ríos, G. (2011). Estimación del intervalo post-emersión de un cadáver hallado en un embalse en Granada (España). *Cuadernos de Medicina Forense*, 17(3), 137-144.
- Goyal, P. K. (2012). An entomological study to determine the time since death in cases of decomposed bodies. *Journal of Indian Academy of Forensic Medicine*, 34(1), 10-12.
- Hore, G., Parui, P., Saha, G. K., & Banerjee, D. (2017). Variations in colonization and succession pattern of dipteran flies of forensic importance on Indian mole-rat carcasses in urban and suburban localities of Kolkata, West Bengal: Implications in corpse relocation studies. *Malaysian Journal of Medical Research*, 1(3), 52-62.
- Jordaens, K., Sonet, G., Richet, R., Dupont, E., Braet, Y., & Desmyter, S. (2013). Identification of forensically important Sarcophaga species (Diptera: Sarcophagidae) using the mitochondrial COI gene. *International Journal of Legal Medicine*, 127, 491-504.
- Kar, O., Naskar, A., Pramanik, D., Mukherjee, K., Sarkar, S., Mukherjee, A., Ghosh, D., Sengupta, J., & Banerjee, D. (2022). An inventory of necrophagous flies from India. *Uttar Pradesh Journal of Zoology*, 79-108. <https://doi.org/10.56557/upjoz/2022/v43i233262>
- Nandi, B. C. (2002a). Blow flies (Diptera: Calliphoridae) of West Bengal, India with a note on their biodiversity. *Records of the Zoological Survey of India*, 100(1-2), 117-129.
- Nandi, B. C. (2002b). The fauna of India and the adjacent countries. Diptera: Volume X, Sarcophagidae. *The Fauna of India and the Adjacent Countries. Diptera: Volume X, Sarcophagidae*.
- Núñez, J. (2012). Entomología forense en Venezuela. *Editorial Livrosca*.
- Palavesam, A., Selvakumar, R., Latha, B. R., Soundararajan, C., Jyothimol, G., & Harikrishnan, T. J. (2022). Occurrence of necrophagous flies of forensic importance in medico-legal cases in Tamil Nadu State, India. *Egyptian Journal of Forensic Sciences*, 12(1), 1-12.
- Pape, T. (1996). *Catalogue of the Sarcophagidae of the world (Insecta: Diptera)*. Associated Publishers.
- Prater, S. H. (1965). *The book of Indian animals* (Vol. 2). Bombay natural history society.
- Radhakrishnan, S., Gopalan, A. K. K., Ravindran, R., Rajagopal, K., Sooryadas, S., & Promod, K. (2012). First record of *Chrysomya albiceps* Wiedemann, 1819 (Diptera: Calliphoridae) maggots from a sambar deer (*Rusa unicolor*) in Kerala, South India. *Journal of Parasitic Diseases*, 36(2), 280-282.
- Ramaraj, P., Selvakumar, C., Ganesh, A., & Janarthanan, S. (2014). Report on the occurrence of synanthropic derived form of *Chrysomya megacephala* (Diptera: Calliphoridae) from Royapuram fishing harbour, Chennai, Tamil Nadu, India. *Biodiversity Data Journal*, 2, e1111. <https://doi.org/10.3897/BDJ.2.e1111>
- Rana, A. K., & Kumar, N. (2023). Current wildlife crime (Indian scenario): Major challenges and prevention approaches. *Biodiversity and Conservation*, 1-19.
- Ren, L., Shang, Y., Chen, W., Meng, F., Cai, J., Zhu, G., Chen, L., Wang, Y., Deng, J., & Guo, Y. (2018). A brief review of forensically important flesh flies (Diptera: Sarcophagidae). *Forensic Sciences Research*, 3(1), 16-26.
- Rodríguez, J. N., Villarreal, M. B., & Liria, J. (2020). A checklist of Diptera collected in the Caña de Azúcar morgue of Aragua, Venezuela.
- Sawaby, R. F., Hamouly, H. E., & Abo-El Ela, R. H. (2018). Diagnosis and keys of the main dipterous families and species collected from rabbit and guinea pig carcasses in Cairo, Egypt. *The Journal of Basic and Applied Zoology*, 79, 1-14.
- Sharif, S., & Qamar, A. (2021). Insect faunal succession on buried goat carcass in Aligarh Region of Uttar Pradesh, India, with implications in forensic entomology. *Egyptian Journal of Forensic Sciences*, 11(1), 1-8.
- Shinde, A. M., Mahakalkar, A. L., Sapkal, H. P., Abd Al GALil, F. M., Al-Mekhlafi, F. A., & Wadaan, M. A. (2021). Molecular identification of a forensically relevant blowfly species (Diptera: Calliphoridae) from the Nagpur region of Maharashtra, India. *Entomological Research*, 51(6), 315-320.
- Silva, J. O., Carvalho-Filho, F. da S., Esposito, M. C., & Reis, G. A. (2012). First record of *Chrysomya rufifacies* (Macquart)(Diptera, Calliphoridae) from Brazil. *Revista Brasileira de Entomologia*, 56, 115-118.
- Singh, M., Kulshrestha, P., & Satpathy, D. K. (2004). Synchronous use of maggots and diatoms in decomposed bodies. *Journal of Indian Academy of Forensic Medicine*, 26(3), 121-124.
- Singh, R., Sharma, P., & Mehta, R. K. (2012). Wildlife forensic entomology: A study on national level highlighted cases of tigers death in Ranthambour and Sariska national parks (Rajasthan) *Journal of Applied Biosciences*, 38(2), 127-131.
- Sukontason, K., Narongchai, P., Kanchai, C., Vichairat, K., Sribanditmongkol, P., Bhoopat, T., Kurahashi, H., Chockjamsai, M., Piangjai, S., & Bunchu, N. (2007).

- Forensic entomology cases in Thailand: A review of cases from 2000 to 2006. *Parasitology Research*, 101(5), 1417–1423.
- Sukontason, K., Sukontason, K. L., Ngern-Klun, R., Sripakdee, D., & Piangjai, S. (2004). Differentiation of the third instar of forensically important fly species in Thailand. *Annals of the Entomological Society of America*, 97(6), 1069–1075.
- Villet, M. H. (2010). Forensic Entomology: The Utility of Arthropods in Legal Investigations. JH Byrd & JL Castner (Eds.): book review. *African Entomology*, 18(2), 387.
- White, R. S., Aubertin, D., & Smart, J. (1940). Fauna of British India, Diptera. Vol. VI. Family Calliphoridae. *Fauna of British India, Diptera. Vol. VI. Family Calliphoridae.*, 6.
- Wilson-Wilde, L. (2010). Wildlife crime: A global problem. *Forensic Science, Medicine, and Pathology*, 6(3), 221–222.
- Xue-Hong, Z., Xiao-Tong, W. A. N., Yu-Hui, J. I. N., & Zhang, W. (2016). Concept of scientific wildlife conservation and its dissemination. *Zoological Research*, 37(5), 270.
- Zimin, L. S., & Elberg, K. Y. (1988). Family Muscidae. *Keys to the Insects of the European Part of the USSR*, 5, 839–974.