Altitudinal Diversity of Forensic Blowflies (Diptera: Calliphoridae) of Western Ghats (Maharashtra)

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Abstract

Western Ghats is one of the 18 hot spots of the world for biodiversity conservation and protection. Increasing human activities and tourism in forestry and changing life style of humans lead more difficult to solve criminal cases. Blow flies (Diptera: Calliphoridae) are important components of decomposition process of wild and human bodies in forest ecosystems. Biotic and abiotic factors of environment have direct impact on population dynamics of flora and fauna of forensic importance. The blow fly diversity decreased with increase of altitudes and qualitative faunal diversity of blow flies were different at different study spots. The outcome of faunal turn over analysis clearly indicated that assemblage at 545 m and 585 m share almost 71.42% of their fauna in common. Also elevation of 900 m shares 70.70% of its assemblage with 585 m. Similarly, assemblage at 42 m and 22 m share about 40% of their fauna in common. The life cycle under laboratory (27 ± 1ºC, 70-80%, 12 hours photo period) ranged from 9-11 days in the species, C. erythrocephala and L. sericata.

Keywords: Altitudinal diversity; forensic blowflies; Developmental time; Western Ghats Maharashtra; India

Introduction

Blow flies (Diptera: Calliphoridae) are commonly called green bottles and blue bottles. The blue bottles Calliphora occur commonly around houses in search of breeding material and food and attracted to meat, carrion, feacal matter and dead animals for egg laying and to cheese for food. The genus Chrysomya includes green bottles of large size and metallic green colour and cause myiasis in human and other animals in India. This genus is reported from India, Africa, Philippines, Celebes and New Guinea. Lucilia species are also known as green bottles and are metallic, shining green but smaller and less bristly than Calliphora. The larvae of Lucilia infect wounds and body cavities in man and some attacks sheep in India. Western Ghats is one of 18 hot spots of the world for conservation and protection of biodiversity. Biotic and abiotic factor have direct impact on population dynamics of flora and fauna. Extension tourism in forestry and changing life style of humans lead criminal cases. Therefore, altitudinal diversity of blow flies in Western Ghats will add great relevance in protecting wild and human life and the data will be helpful to forensic science. Review of literature indicates that forensic insects have been studied with respect to diversity, biology, development and utility in forensic science by Senior-white [1], James [2], Smith [3], Greenberg [4], Kurahashi and Thapa [5], Smith and Wall [6], Anderson [7], Dadour et al. [8], Kurahashi[9], Tachibana and Numata [10], Bharti and Singh [11], Grassberger et al. [12], Pitts and Wall [13], Clark et al. [14] Bharti [15,16] Bharti and Kurahashi [17], Higley and Haskel [18], Shiravi et al. [19], Sathe and Jadhav [20,21], Sathe et al., [22] Vasconcelos et al.[23], Ghodake et al. [24] etc.

Materials and Methods

Collection of blow flies were made during the years 2012-13 from Kolhapur city, Radhanagari, Gaganbawada, Vaibhawwadi, Kankawali and Sindhudurg covering most of the altitudal and road side spots. The blow flies were collected with the help of sweeping net from the carcasses. The carcasses of dogs, cats and cows were used...
Lucilia and Calliphora with 5, 6 and 2 species respectively (Table 1). The results indicated that the blow flies population was increased during the monsoon season than the winter and summer season and diversity of blow flies was found decreased with increase in altitude in the Western Ghats. It was noted that in almost every spot blowflies gathered on meat piece within half an hour expect Chrysomya which appeared 3 hours. The number of attracted blowflies was decreased with increase of altitude (Table 2). The blowflies were also found increased in number on goat meat after 30 minutes of exposure. In general, qualitative and quantitative diversity of blowflies were more in monsoon than winter and summer. The outcome of faunal turn over analysis clearly indicated that assemblage at 545 m and 585 m share almost 71.42% of their fauna in common. Also elevation of 900 m shares 70.70% of its assemblage with 585 m. Similarly, assemblage at 42 m and 22 m share about 40% of their fauna in common.

Life cycle duration of C. erythrocephala and L. sericata from egg to adult indicated that they completed their life cycle on different carcasses (dog, cat, cow) within the range of 9 days to 11 days at 27 ± 1°C, 70-80% and 12 hr photoperiod in the laboratory. There was not much difference in developmental life stages duration in both the species even on different carcasses (Table 4).
were dominated by all 3 species of elevation, the fresh and bloating stages of decomposition of carcass. These species were found feeding and egg laying on the carcass. At this stage, Chrysomya megacephala, C. rufifacies, C. nigripes, Lucilia illustris were most abundant. Additional species occurred at this elevation were Calliphora albiceps, C. pinguis, C. villeneuvi, L. sericata and Calliphora vicina. However, at an elevation of 2511 m only 3 species namely, C. villeneuvi and Calliphora vicina and Calliphora vomitoria were present. With increase in altitude there was a marked decrease in faunal diversity. In the present study, in Western Ghats (Maharashtra), maximum 13 species of blow flies were recorded from attitudinally lowest spot, Sindhudurg while, only six species have been reported from attitudinally highest spot, Gaganbawda. However, qualitative faunal diversity was different at different spots. The reason for maximum diversity of blow flies at Sindhudurg may be due to availability of more diverse host carcasses since it is a sea coastal spot.

Table 3: Geographical and climatic conditions of study spots.

| Sr No | Place           | Altitude (m) | Latitude (°N) | Longitude (°E) | Temperature (°C) | Humidity (%) | Rainfall (mm) |
|-------|----------------|--------------|---------------|----------------|------------------|--------------|---------------|
| 1     | Kolhapur       | 545.6        | 16.42         |                | 74.16            | 65-87        | 1000-1025     |
| 2     | Radhanagari    | 585.0        | 16.41         |                | 73.99            | 67-90        | 2500          |
| 3     | Gaganbawda     | 900          | 16.545        |                | 73.83            | 64-94        | 5000-6000     |
| 4     | Vaibhavwadi    | 80           | 16.496        |                | 73.745           | 64-97        | 3240          |
| 5     | Kankawali      | 42           | 16.285        |                | 73.684           | 59-92        | 3200          |
| 6     | Sindhudurg     | 22           | 16.04         |                | 73.48            | 65-95        | 3300          |

Discussion

According to Stevens and Walls [7,25-27] different species of Calliphorids have adapted to different feeding habits over the years for their survival and broadly divided as saprophages, facultative parasites like Chrysomya megacephala and Lucilia sericata and obligate parasites causing myiasis in man and other animals like Chrysomya bezziana. They were also adapted to various ecological niches. Bharati [4] studied altitudinal diversity of forensic important blow flies from Himalaya on decaying carcasses. A total of 14 species belonging to the genera Calliphora, Chrysomya and Lucilia have been reported. Out of 14 species, 6 were from the genus Chrysomya, 2 from the genus Calliphora while 6 were from the genus Lucilia. Bharati [4] further reported that at an elevation of 350 m (Shivalik range of Himalaya), a total of five species namely Chrysomya megacephala, Chrysomya rufifacies, Chrysomya porphyrina, Lucilia papuensis and Lucilia ampla acetabulae were present on the carcass. C. megacephala and L. papuensis were the most abundant species at this elevation. At 970 m also 5 species have been recorded (C. megacephala, C. rufifacies, C. nigripes, L. illustris and L. ampla acetabulae). These species were found feeding and egg laying on the carcass. At this elevation, the fresh and bloating stages of decomposition of carcass were dominated by all 3 species of Chrysomya while, during the decay stage C. nigripes was most abundant. She reported maximum diversity of blow flies at an elevation of 2057 m. A total of 8 species of blow flies were collected from cow carcass. Here C. megacephala and L. sericata were most abundant. Additional species occurred at this elevation were C. albiceps, C. pinguis, C. villeneuvi, L. sericata and L. cuprina and also Calliphora vicina. However, at an elevation of 2511 m only 3 species namely, C. villeneuvi and Calliphora vicina and Calliphora vomitoria were present. With increase in altitude there was a marked decrease in faunal diversity. In the present study, in Western Ghats (Maharashtra), maximum 13 species of blow flies were recorded from attitudinally lowest spot, Sindhudurg while, only six species have been reported from attitudinally highest spot, Gaganbawda. However, qualitative faunal diversity was different at different spots. The reason for maximum diversity of blow flies at Sindhudurg may be due to availability of more diverse host carcasses since it is a sea coastal spot.

Vasconcellos et al. [23] provided first check-list of forensically important dipteran species in a rainforest environment in North eastern Brazil, a region exposed to high rates of homicides. They used a decomposing pig, Sus scrofa L. (Artiodactyla : Suidae), carcass as a model and adult flies were collected immediately after death and in the early stages of carcass decomposition. To confirm actual colonization of the carcass, insects that completed their larval development on the resource were also collected and reared until adult stage. They noted 28 species of seven families of order Diptera with necrophagus habits within few minutes after death. Out of 28 species, 11 have completed their larval development on carcass. The majority of individuals emerged from larvae collected at the dry stage of decomposition. Hemilucilia segmentaria Fab. (Calliphoridae), H. semidiaphana (Rondani) and Ophyra chalcogaster (Wied.) (Muscidae) were the dominant species among the colonizers. In the present study, carcasses of dog, cat and cow and goat meat were used. The dominant species found in the western Ghats was Chrysomya megacephala. However, the genus Lucilia represented maximum 6 species in the region with altitudinal specificity. At an elevation of 22 m Sindhudurg represented 6 species of Lucilia and 5 species of Chrysomya.

Vasconcellos et al. [23] reported in total, 153 insects from 14 families in the first 3 hours after the death. This included species of Phoridae 24.2%, Sarophagidae 18.3%, Piophilidae 10.5%, Calliphoridae 10.5%, Fanniidae 8.5%, Chloropidae 6.5%, Muscidae 4.6% and Dixidae 4.6% while other families were in smaller proportions. The present study was pinpointed for the single family Calliphoridae. However, reporting other families from this region will be of great interest in future.

Determination of post mortem interval (PMI) or the time between death and the discovery of the corpse is the most important application of forensic entomology. Flies belong to the families Calliphoridae (blow flies) and Sarcoptagidae (flesh flies) are often the first insects to arrive on a corpse where their larvae feed and breed effectively [2,18]. Developmental rates of flies are frequently used to estimate PMI in homicide investigations in the first few weeks after death. The development of immature insects is climate or temperature dependent. Therefore, PMI is normally calculated by the accumulated degree day/ hour model.
According to Shiravi et al. [19] the developmental rates in C. albiceps and L. sericata were highly different in terms of accumulation of degree days required than that of the flesh fly Sarcophaga sp. They reported that the speed of development in the flesh fly was slower than blowflies. At 28°C the total developmental time from egg to adult was 13–19 days in Sarcophaga sp. While, in the present study the development was completed within the range of 9 to 11 days in both the species C. erythrocephala and L. sericata.

According to Hall and Doisy [26] the amount of time after death affected the structure of the assemblage of insects attracted to a carcass; a feature that will have direct implications on the accuracy of the biological information available to the forensic entomologist. Forest ecosystems are characterized by predator prey relations, parasitism, mutualism, symbiotism, etc. Therefore, forensic insects are supposed to be the indicators of ecologically varying regions and types of forests. The present work will add great relevance.

The speed of development in the flesh fly was also reported slower than blow flies [22]. Therefore, temperature requirements of some common forensically important blow and flesh flies (Diptera) under laboratory conditions have been studied by several workers [1,12,19,23]. They reported that rates of development decreased step by step as the flies grew from egg to larvae and then to adult stage. However, this rate was bigger for blow flies C. albiceps and L. sericata in comparison with the flesh fly Sarcophaga sp. According to Gallagher et al. [27] the development of fly larvae is temperature dependant and in higher temperature, the rate of development increases and duration of development becomes shortened. The variation of developmental times between different populations emphasizes on specific characterization of regional developmental times and survival in the region. The present work was carried out at various altitude and climatic conditions. Therefore, the present data will be very useful for ecologists, environmentalist and in forensic science.

The development of blow flies is related with natural and synthetic diet, humidity and competition between larvae [14]. It has been noted that beef liver that are often used in laboratory rearing of flies produce offensive odours and contamination. The presence of toxins noted that beef liver that are often used in laboratory rearing of flies in decomposing tissues from natural diets has also been demonstrated to produce offensive odours and contamination. The presence of toxins in decomposing tissues from natural diets has also been demonstrated to affect the development rate of blow flies [14]. On the liver of pigs and cows, the larvae of flies develop very fastly with larger adult size than tissues. An artificial diet, powdered milk caused a lower duration of larval stages in comparison with the animal liver [10]. Similarly, overcrowding of larvae also decreased the growth rate of blow flies leading to wrong conclusions [6]. Therefore, biology fecundity, intrinsic rate of increase of blow flies plays an important role in forensic cases. The present work will add great relevance in forensic science and environmental science for wild life protection and conservation.

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