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Forensic entomology and wildlife crime–the role of Blowfly larvae

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Abstract

The importance of forensic entomology in crime scenes investigation cannot be underestimated. Through analysis of the morphology of blowfly larvae in comparison with the ambient environment at a death scene, critical information regarding a crime can be acquired. Interpretations can then be made in identifying the average time since the death of the particular animal- Post Mortem Interval. In conservation, therefore, the application of forensic techniques combined with other methods such as DNA analysis could help in identifying probable offenders thereby solving criminal acts involving animals and enhancing the protection of critically endangered species.

Keywords: Blowfly larvae, conservation, CSI, forensic entomology, Post Mortem Interval (PMI), wildlife crime.

Introduction

Reported and employed first in the 13th century, forensic entomology has been used sporadically an as a crucial part in investigations involving murder[1]. This is because insects and larvae found on corpses in a crime scene can provide information useful to identifying suspects. Their colonization of carcasses/corpses however is dependent on different factors such as the ambient temperature, the habitat/location of the murder scene among others[2]. Several experiments involving observation of three different final instar blowfly larvae species' mouthparts and posterior spiracles in a microscope and their behavior in different soil textures were conducted. Their observations were recorded, the summary results recorded and inferences made.

Methodology

This study aimed at conducting an identification of fly maggot species, *C. Vomitoria, M. Domestica* and *L. sericata* (hereinafter referred to as maggot 1, 2 and 3 respectively) important in forensic investigations, and their burrowing habits in relation to wildlife crime. The larvae mouth and posterior sections were observed in a microscope and the images recorded for comparison. The larvae were also placed in jars bearing different soil forms (loose or compacted) and allowed to burrow. Their frequency at various soil depths (cm) was recorded along with the average time (secs) taken by the maggot species to burrow in the soil. The results were then presented in tables and graphs, and critical commentary and interpretations made in relation to wildlife crime forensic investigations.

Results and discussion

Through observations using a miscope, the maggots were identified. The results were as follows;

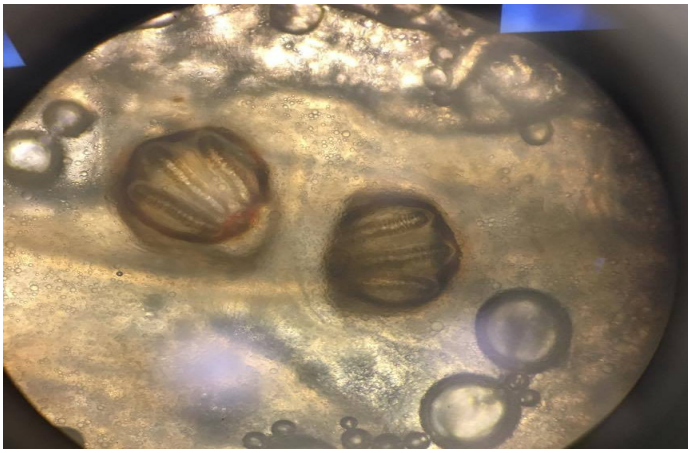

Figure-1: A microscopic image showing the posterior spiracles of maggot 1 - Calliphoridae larva sp., *Calliphora vomitoria* (Blue bottle fly).

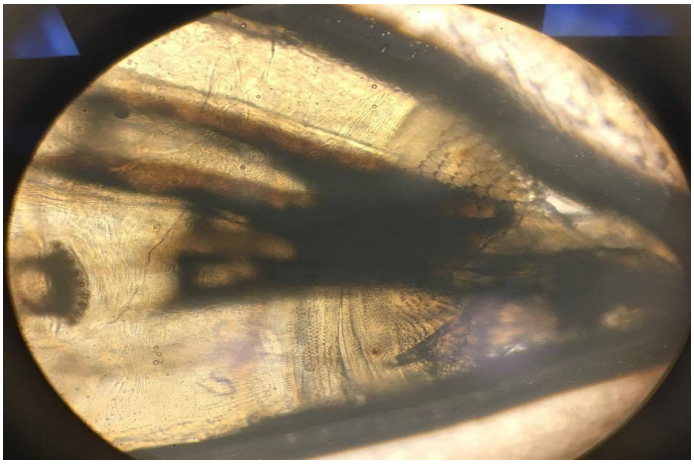

Figure-2: A microscopic image showing the mouthparts/spines of maggot 1-Calliphoridae larva sp., *Calliphora vomitoria* (Blue bottle fly).

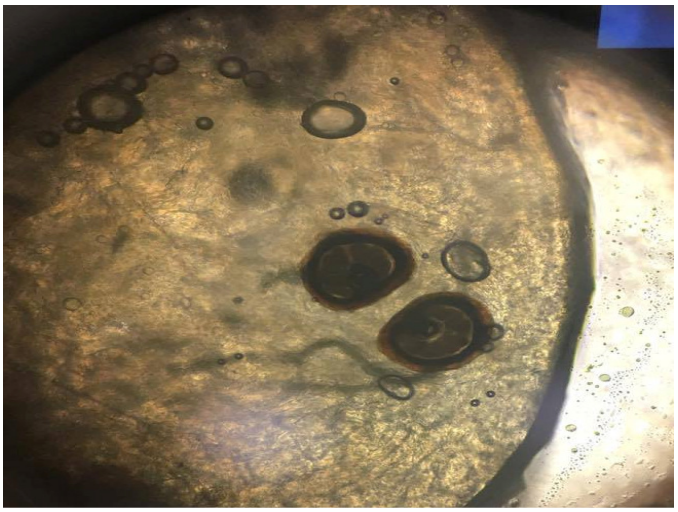

Figure-3: A microscopic image showing the posterior spiracles of maggot 2-Muscidae larva sp., *Musca domestica.*

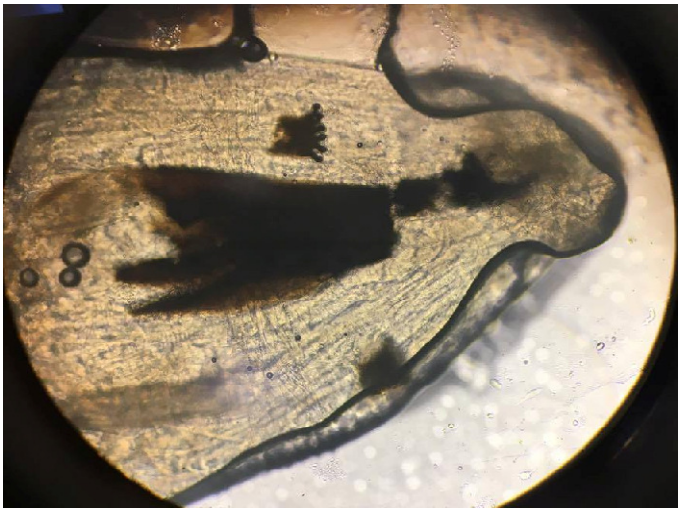

Figure-4: A microscopic image showing the mouthparts/spines of maggot 2-Muscidae larva sp., *Musca domestica* (house fly).

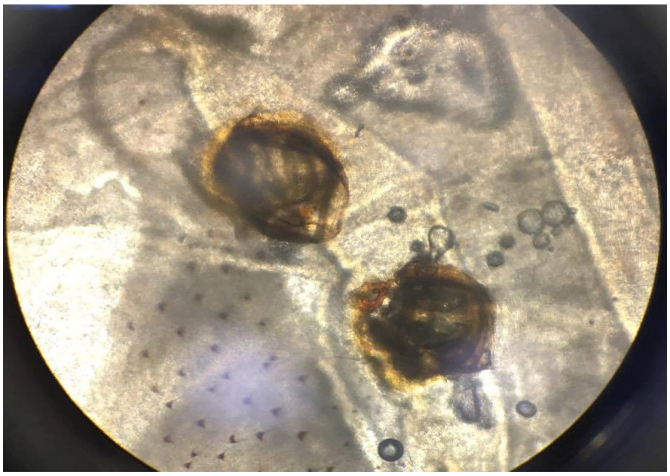

Figure-5: A microscopic image showing the posterior spiracles of maggot 3-Calliphoridae larva sp., *Lucilia sericata* (Common green bottle fly).

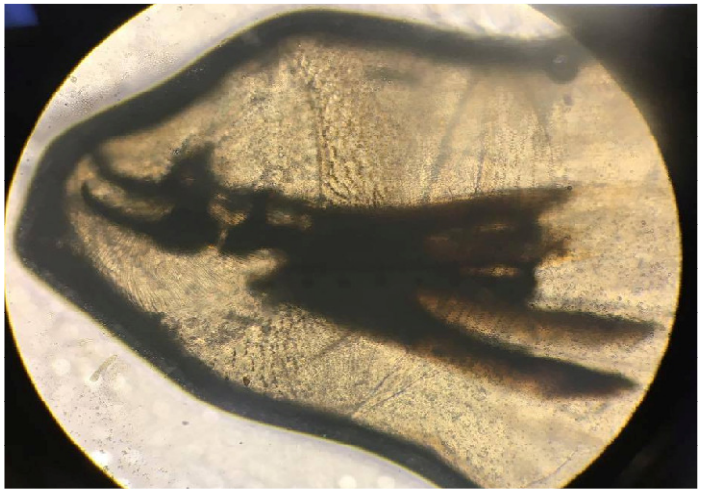

Figure-6: A micscopic image showing the of mouthparts/spines maggot 3-Calliphoridae larva sp., *Lucilia sericata* (Common green bottle fly).

Interpretation of the microscopic images above: In identifying the maggots, the shape and appearance of both the spiracles and mouthparts was used. Posterior spiracles of the larvae species are differentiated by the shape of the slits especially for the *M. domestica* species whose slits are spiral-shaped as seen from the above diagrams. *C. vomitoria* has a thick peristreme while *L. sericata* has a thinner peristreme. Mouthparts of the three species are also differentiated mainly by their physical appearance. For instance, from the diagrams above, it can be observed that *C. calliphora* has a more conspicuous hooked mouthpart. *M. domestica* on the other hand has a more pointed mouthpart.

The results of the burying behaviour of the final instar blowfly larvae species are presented in the following tables.

Table-1: A table showing burrowing frequency (%) of Blowfly larvae species in various normal (loose) soil depths (cm).

Frequency	*C. vomitoria*	*L. sericata*	*M. domestica*
Surface	0	0	0
0-2	3	55	11
2-4	17	27	9
4-6	20	5	5
6-8	17	7	7
8-10	8	1	7
10-12	9	3	11
12-14	9	3	8
14-16	5	0	12
16-18	7	0	13
18-20	4	0	9
20-22	0	0	5
22-24	0	0	3

Table-2: A table showing burrowing frequency (%) of Blowfly larvae species (pre-buried at 20cm) in various normal (loose) soil depths (cm).

	C. vomitoria	*L. sericata*	*M. domestica*
Surface	0	0	0
0-2	1	15	3
2-4	15	25	9
4-6	15	16	12
6-8	17	4	11
8-10	15	8	11
10-12	9	7	13
12-14	5	5	5
14-16	11	7	25
16-18	4	7	3
18-20	4	4	5
20-22	4	3	3
22-24	0	0	0

Table-3: A table showing burrowing frequency (%) of Blowfly larvae species in various compacted soil depths (cm).

	C. vomitoria	*L. sericata*	*M. domestica*
Surface	0	0	0
0-2	36	73	24
2-4	39	16	49
4-6	25	11	16
6-8	0	0	11
8-10	0	0	0
10-12	0	0	0
12-14	0	0	0
14-16	0	0	0
16-18	0	0	0
18-20	0	0	0
20-22	0	0	0
22-24	0	0	0

Table-4: A table showing burrowing frequency (%) of Blowfly larvae species (high density) in various normal (loose) soil depths (cm) in various loose soil depths.

	C. vomitoria	*L. sericata*	*M. domestica*
Surface	0	0	0
0-2	3	53	8
2-4	17	32	13
4-6	28	8	15
6-8	21	3	14
8-10	16	2	15
10-12	6	1	14
12-14	4	1	11
14-16	3	1	6
16-18	2	0	2
18-20	0	0	2
20-22	0	0	1
22-24	0	0	0

From the tables above, it can be deduced that *C. Vomitoria* larvae pupates at a deeper depth than *L. sericata* larvae. *M. domestica* larvae pupates deepest. Graphical representation of experiments are given in Figure-7,8,9,10.

Discussion: The rate of decomposition of a corpse is directly proportion to the rate of colonization by insects[2]. The presence of insects is on the other hand affected by several factors among them soil texture (how loose or compacted soil is) and depth (Tables1-4 and Figures 7-10).

Different soil textures affect the rate of burrowing for the three blowfly species (Table-5). This also applies to the pupating where it's much deeper in loose soil as compared to compacted soil (*M. domestica* larvae pupates deepest, followed by *C. Vomitoria* larvae and *L. sericata* larvae in that order) (Figures 7 – 10). In the same note, different species of blowflies depict a different burrowing behavior where *M. Domestica* larvae tend to burrow deeper than *C. Vomitoria* and *L. sericata* larvae.

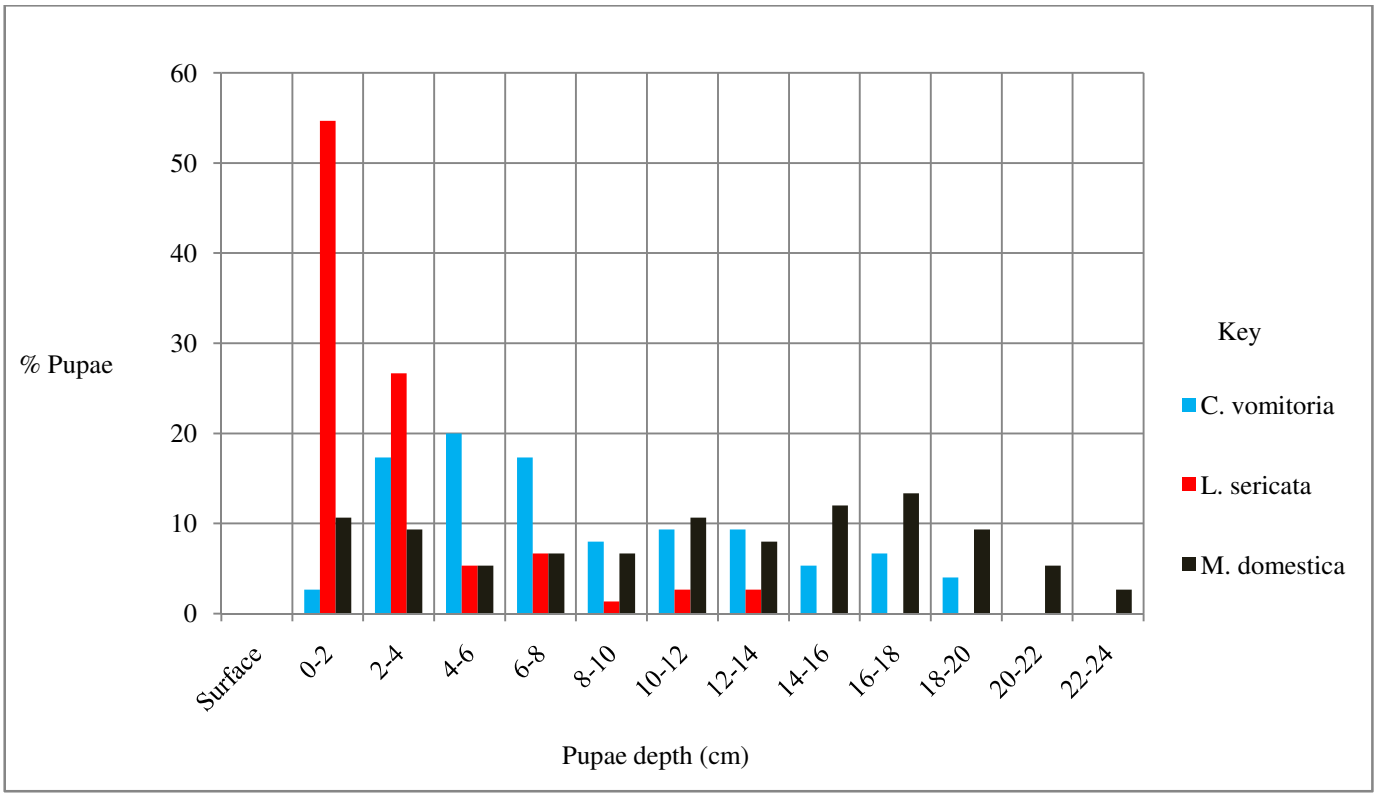

Figure-7: A graph showing pupating frequency (%) of Blowfly larvae species in various depths (cm) of normal (loose) soil.

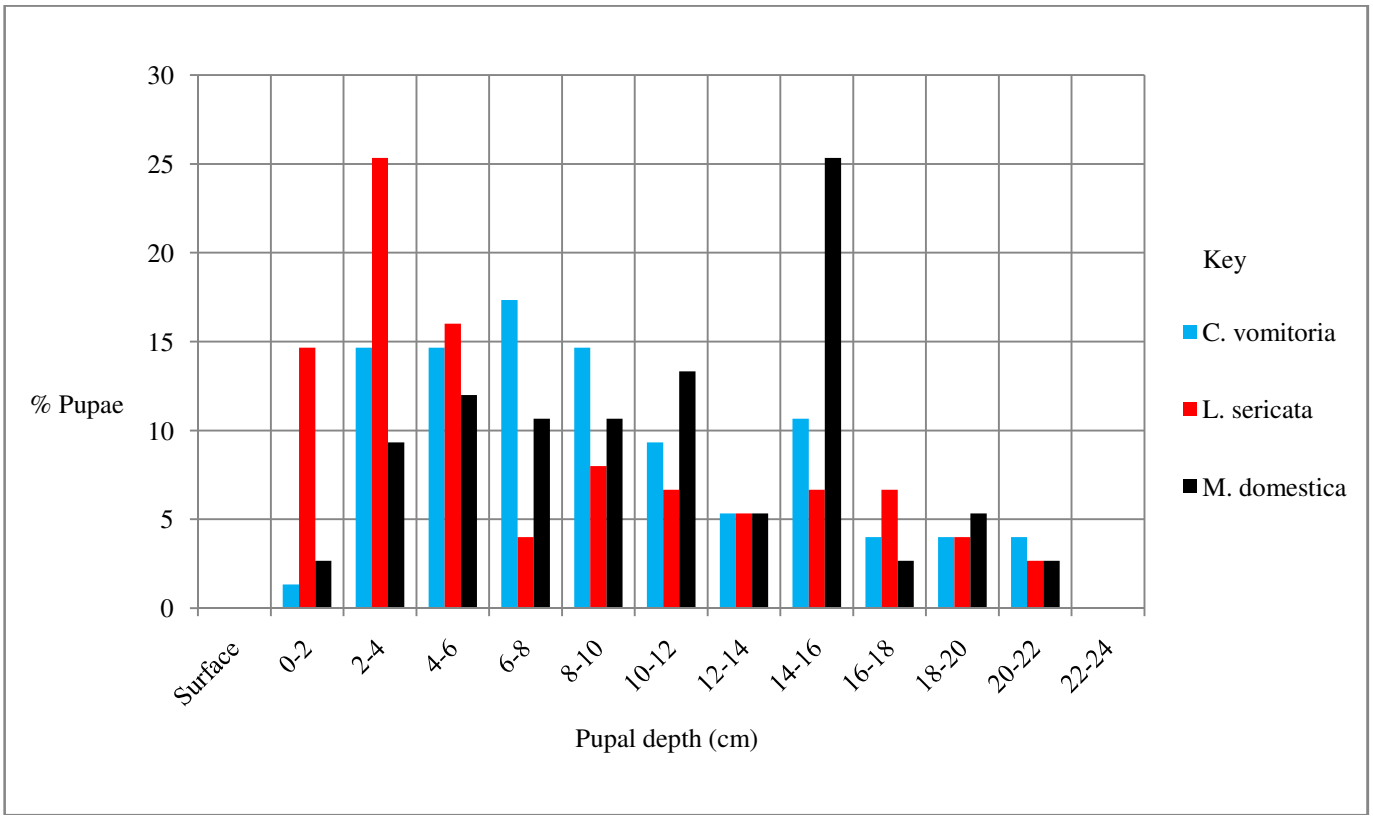

Figure-8: A graph showing pupating frequency (%) of Blowfly larvae species (pre-buried at 20cm) in various depths (cm) of normal (loose) soil.

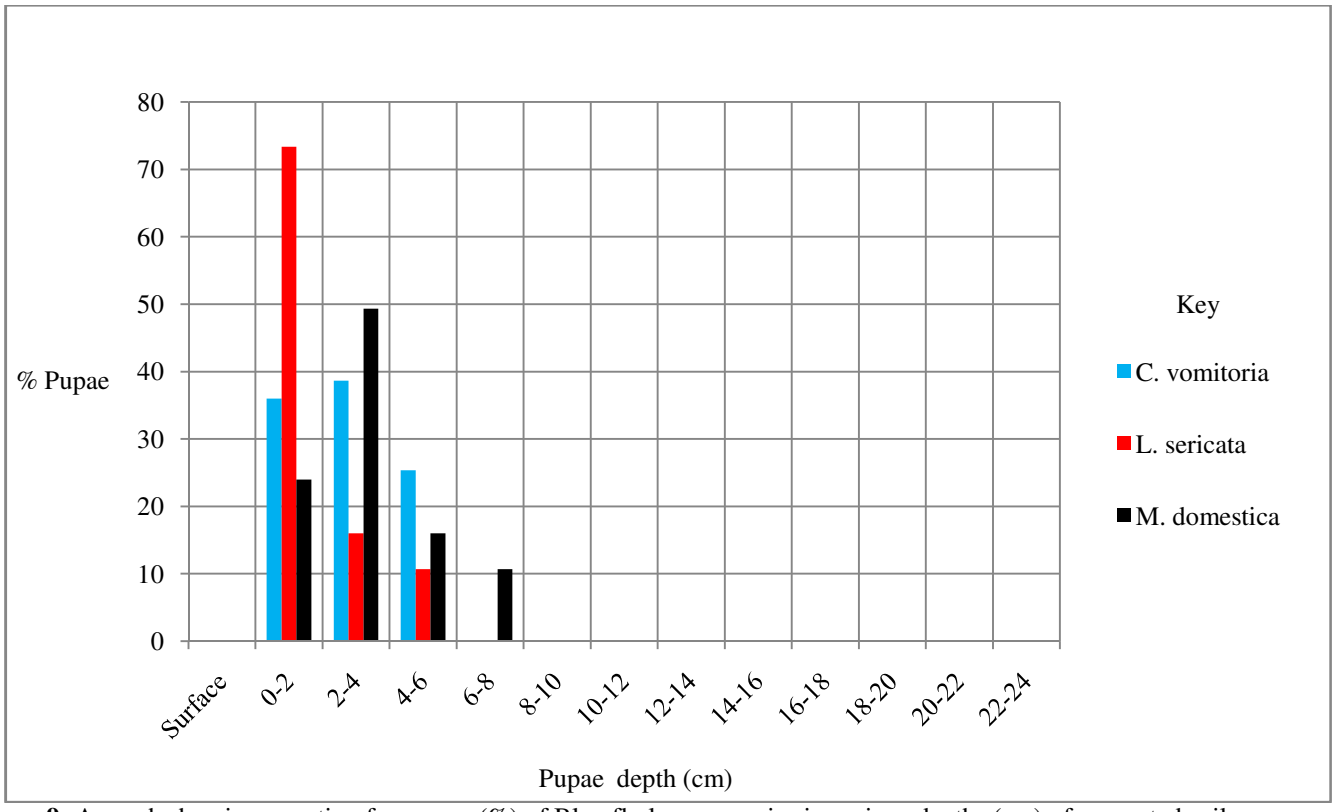

Figure-9: A graph showing pupating frequency (%) of Blowfly larvae species in various depths (cm) of compated soil.

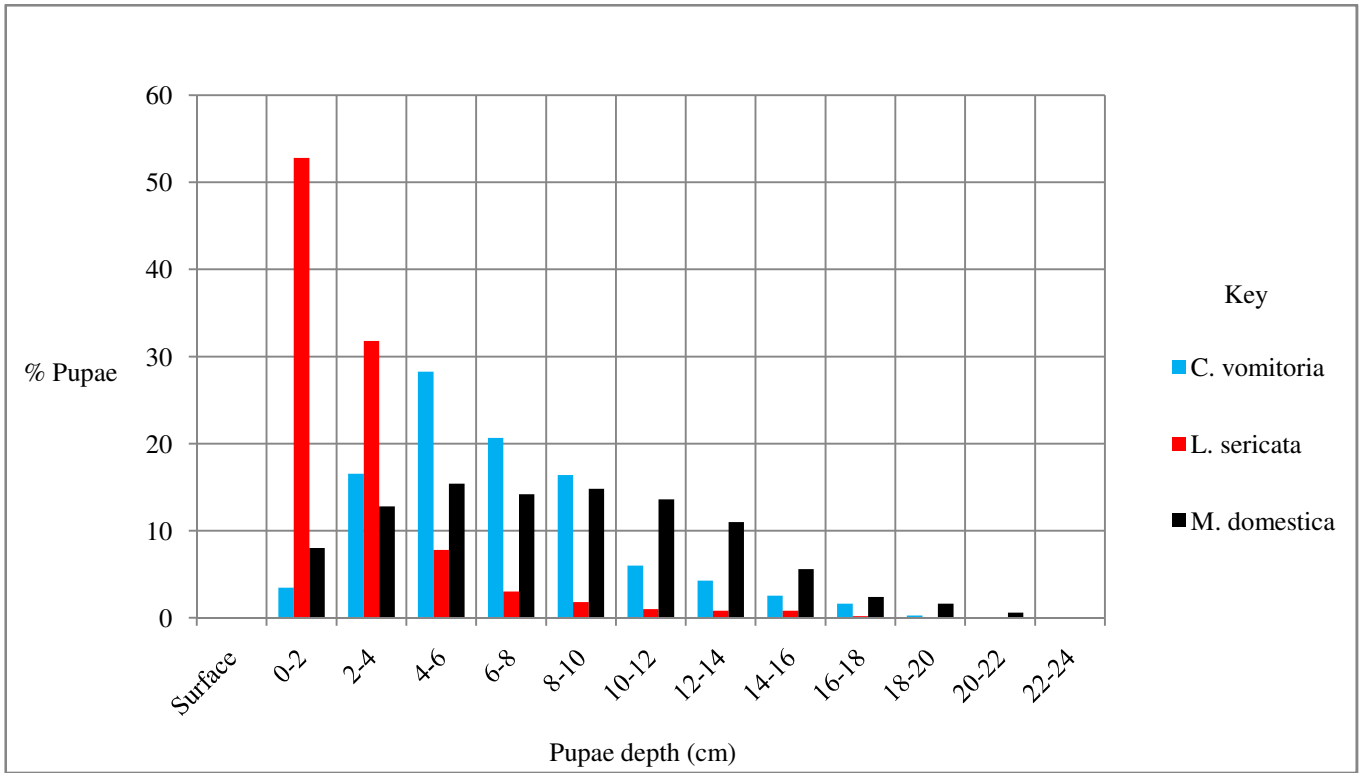

Figure-10: A graph showing pupating frequency (%) of Blowfly larvae species (high density) in various depths of normal (loose) soil.

Table-5: A table showing the average time (secs) taken by blowfly maggot species to burrow in soil.

	C. vomitoria	*L. sericata*	*M. domestica*
Average time (Secs)	Loose soil		
1st larva to burrow	15	10	21
Last larva to burrow	120	83	120
	Compacted soil		
1st larva to burrow	70	112	29
Last larva to burrow	781	1156	333
	High density in loose soil		
1st larva to burrow	10	24	18
Last larva to burrow	230	326	240

This is important because from related forensically relevant experiments investigating postburial interval estimates on buried pig carcasses, it was evident that soil depth was an crucial factor in the rate of colonization[2,3]. Diversity of insect larvae also varied with soil depth with Hydrotaea sp. and *Megaselia scalaris* colonizing pig carcasses at 60cm. Time was also an important factor where the longer the carcass was buried, the greater the diversity of arthropod species recovered.

This has the implication that physical soil surfaces (texture) can often influence insect colonization and thus affect decomposition of a corpse[2]. This is supported by the experiments where blowfly larvae burrow averagely much faster and deeper in loose soil than in compacted soil, possibly due to the fact that compacted soil is much harder to penetrate.

Normally, suspects bury a carcass in an attempt to dispose of it and conceal evidence. However, based on studies, buried bodies decompose at a much slower rate than those exposed to the air due to lack of exposure to climatic conditions such as temperature, water and air[2,3]. Insects also tend to colonize carcasses faster on the surface than while buried. However, bodies are still approachable by insects as they are normally buried at shallow depths[2].

The importance of knowing the correct length of a blowfly maggot in a wildlife crime scene investigation: Insects are usually the first to arrive at a death scene[4-6]. Due to the varied ways in which death takes place, victims may not be discovered for days, weeks, or even months. This is when forensic entomology helps provide a rather accurate method of determining time since death (Post Mortem Interval). Forensic entomologists use development-based age estimates which, among other considerations include morphological features such as larval size/length (a measure of size of maggots in a carcass).

Determining time since death is of paramount importance in a death investigation[7,8]. Knowing time since death directs the investigators into determining the right time frame. The presence/absence of maggots, and knowledge of their rate of development (length in this case) and ecology, combined with information about the scene can be used to determine the stage of decomposition of the body and make estimates of when the individual was actually murdered (time since death)[5]. Typically, the first and second instar larval stages are brief with little length variations while the third instar larvae are much longer[10].

The larvae present on the dead body can provide evidence for the estimation of PMI up to one month[5]. The first step is identification of the correct species as species differ in their growth rates and maturation. By measuring the length of the oldest larvae and comparing it with reference data, age of the larvae can be estimated, thereby providing an indicated how long the corpse has been dead[5,6,8]. The rate of development of the larvae is, however, dependent on the environmental/ surrounding temperatures. Each stage of development has its temperature requirement hence each species has its own defined number of accumulated degree days or hours to complete its development[5,11]. Once the thermal history of the larvae is obtained, it can be compared with temperatures at the death scene and PMI can be estimated[8].

Maggot age and development is used in the first few weeks after death and can be accurate to a few days. Determination of the position at which larvae have been feeding on a body is also a crucial observation at a crime scene and in PMI estimation[9]. Temperature is especially important since insects are cold-blooded - their metabolic rate increases (and the duration of development decreases) as the temperature rises, and *vice-versa.*

Looking at the oldest stage of insect, a forensic entomologist can then estimate the day or range of days in which the first insects laid eggs and provide an estimate of time of death[6]. This method applies until the first adults emerge. After this, it is impossible to determine which generation is present and time since death must be estimated from insect succession.

Conclusion

Blow flies are probably the most insects important to forensic entomology and have much to offer, right from the early stages when the insects get attracted to a body and lay eggs in it. By identifying and analyzing their developmental stages, forensic entomologists are able to get vital information to help in unraveling the mysteries behind a murder investigation. This process requires some prior knowledge including the behavior and morphology of insects/larvae, their distribution in the specific location and the weather conditions of the scene. This helps make some basic considerations in making estimates of minimum time of death.

The knowledge of the burial (and reemerging) habits of larvae species is especially important because different species depict different burial characteristics. Forensic investigators may also use this understanding to estimate how long a body may have been left above the ground before being buried. This could be through determining an approximation of when insects found the corpse based on the blow flies' stage of development, their distribution patterns and the size of the maggots.

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