*Tropical Biomedicine* 25(1): 17–22 (2008)

# Fly artifact documentation of *Chrysomya megacephala* (Fabricius) (Diptera: Calliphoridae) - a forensically important blowfly species in Malaysia

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Received 31 October 2007; received in revised form 27 December 2007; accepted 28 December 2007.

**Abstract.** Analysis on fly artifacts produced by forensically important blowfly, *Chrysomya megacephala* (Fabricius) (Diptera:Calliphoridae), revealed several unique patterns. They can be divided into fecal spots, regurgitation spots and swiping stains. The characteristics of fecal spots are round with three distinct levels of pigmentation; creamy, brownish and darkly pigmented. Matrix of the spots appears cloudy. The round spots are symmetrical and non-symmetrical, delineated by irregular and darker perimeter which only visible in fairly colored fecal spots. Diameter of these artifacts ranged from 0.5 mm to 4 mm. Vomit or regurgitation spots are determined by the presence of craters due to sucking activity of blowflies and surrounded by thickly raised and darker colored perimeter. The size of these specks ranged from 1 mm to 2 mm. Matrix of the spots displays irregular surface and reflective under auxiliary microscope light. Swiping stains due to defecation by flies consists of two distinguishable segments, the body and tail. It can be seen as a tear drop-like, sperm-like, snake-like and irregular tadpole-like stain. The direction of body and tail is inconsistent and length ranged between 4.8 mm to 9.2 mm. A finding that should be highlighted in this observation is the presence of crater on tadpole-like swiping stain which is apparent by its raised border characteristic and reflective under auxiliary microscope light. The directionality of this darkly brown stain is random. This unique mix of regurgitation and swiping stain has never been reported before. Highlighting the features of artifacts produced by flies would hopefully add our understanding in differentiating them from blood spatters produced from victims at crime scenes.

## INTRODUCTION

Fly artifacts or flyspecks are minute, dark stains originating from vomit spots and fecal deposit of flies. These artifacts may appear as spatters, as a result of regurgitation, excretion and tracking by flies, and the presence of such artifacts are believed to be able to create erroneous analysis of bloodstain pattern at a crime scene, leading to misinterpretation of crime scene reconstruction (Bevel & Gardner, 2002).

The locations of fly artifacts was found to be inconsistent with blood spatters linked with injury sustained by the victim and have been reported to be discovered indirectly from the location of victims (Benecke & Barksdale, 2003). It was also apparent that fly artifacts could also be found on victim's body and clothing (James & Eckert, 1999).

Insects have been earlier associated with bloodstain pattern by the historical work of Lassaigne in 1856 (Bevel & Gardner, 2002) and it was believed to be his effort to divert the attention of bloodstain pattern analyst to differentiating such stains from normal stains by victims.

Greenberg & Kunich (2002) quoted Graham-Smith (1914) who wrote a description of flyspecks and distinguished three types of spots, i.e. the fecal deposits, vomit stains and proboscis marks

(Greenberg & Kunich, 2002). In the latest documentation of flyspecks, Benecke & Barksdale (2006) emphasized the importance of understanding the uniqueness and distinctive features of fly artifacts in bloodstain pattern analysis through description of real cases and simulation of laboratory work by using *Calliphora vicina* Robineau-Desvoidy (Diptera: Calliphoridae) which was later argued as erroneous and misleading (Ristenbatt *et al.*, 2005).

Documentation on the characteristics of fly artifacts is essential to interpret these bloodstains because the presumptive test for blood using Saugur and Luminol could not differentiate stains from flies or victims (Bevel & Gardner, 2002). Bloodstains of fly artifacts are also known rarely to yield DNA (Ristenbatt, *et al.*,2005).

An understanding and proper documentation on the aspect of flyspeck characteristics is therefore necessary and will be discussed further by using *Chrysomya megacephala*, the most forensically important blowfly species in Malaysia (Lee *et al.*, 2004).

## METHODOLOGY

Fifty males and fifty females of the first phenotype adult *C. megacephala* bred at insectarium of the Department of Biomedical Science, Faculty of Allied Health Sciences, Universiti Kebangsaan Malaysia laboratory were used and confined separately in 33 cm (length) × 33 cm (width) × 33 cm (height) breeding cages. These cages were kept at laboratory temperature ranging from 24°C to 26°C and humidity ranging from 48% to 53%, under 12 hours light and 12 hours dark condition.

A square 33 cm × 33 cm, 80 gram and clean grid paper was placed horizontally on each floor of the breeding cages. A dish half-filled with fresh chicken blood was introduced into each breeding cage as the only food and drink source in this test group. Neither additives nor preservatives were added to prevent blood from clotting.

The observations on the fly artifacts produced by *C. megacephala* adults were carried out for three consecutive days. The artifacts were analyzed under Leica EZ 4D microscope fitted with a digital camera.

## RESULTS AND DISCUSSION

A total of 1544 fly artifacts were found from the two cages (Table 1). Artifacts from these two groups displayed distinctive patterns of three types of fly artifacts; the fecal spots, regurgitation spots and swiping stains.

Table 1. Numbers of artifacts produced by adult *C. megacephala*

| Type of Fly Artifacts | Male | Female |
|---|---|---|
| Fecal Spot | 1011 | 885 |
| Vomit Spot | 59 | 655 |
| Swiping Stain | 1 | 4 |
| **Total** | **1071** | **1544** |

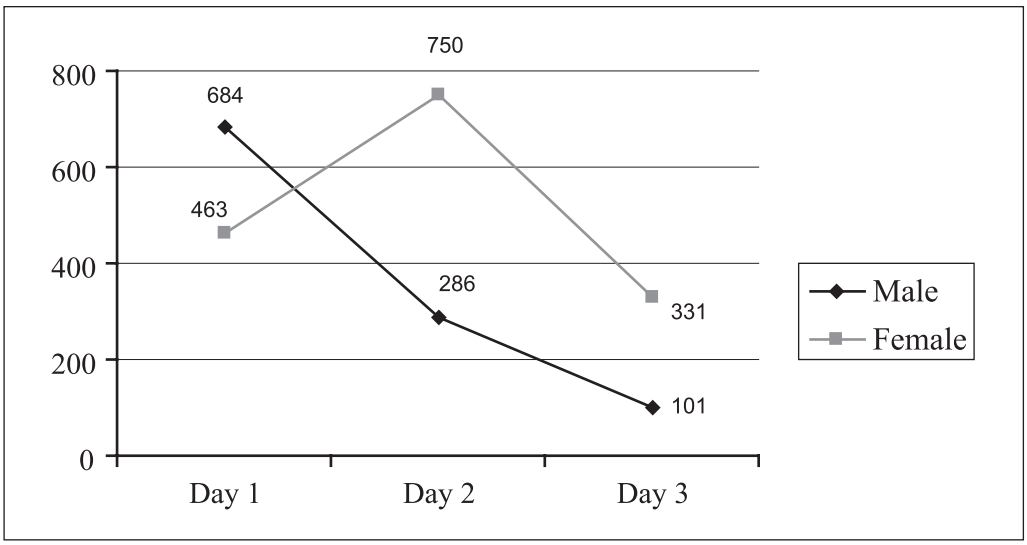
Numbers of artifacts produced by female adult *C. megacephala* are generally higher than male adult of its species. This is possibily due to females consuming more blood than the male during the period of confinement in the cage.

The highest number of artifacts was recorded on Day 2 caused by female flies and the numbers of artifacts decreased on the following day for both male and female (Table 2).

*1. Fecal Spot*

There are three features recognized from fecal spot (Figure 1A, 1B & 1C); creamy, brownish and darkly pigmented with matrix of the spots appears cloudy. The round spots are symmetrical and non-symmetrical, delineated by irregular and darker perimeter which only visible in fairly colored fecal spots. Diameter of these artifacts ranged from 0.5 mm to 4 mm. They are as similarly described by Graham-Smith (Greenberg & Kunich, 2002) that fecal spots are round, opaque often raised and yellowish, brownish or whitish in color.

Table 2. Numbers of artifacts produced by adult *C. megacephala* according to days



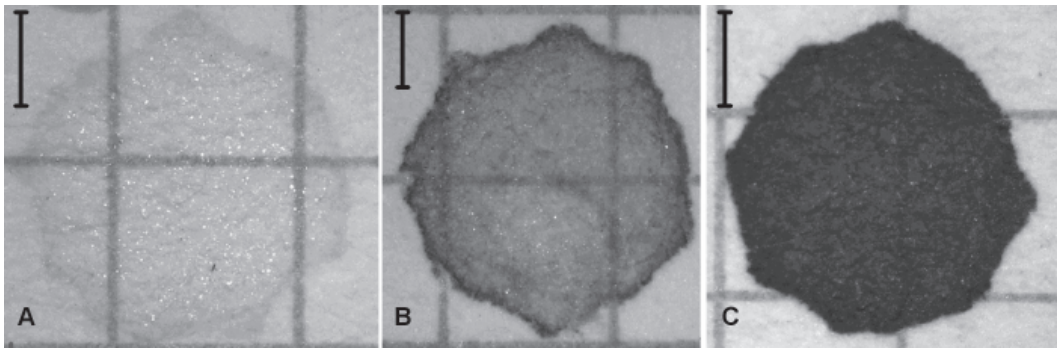




Figure 1. Fecal spot patterns of adult *C. megacephala*. A. Creamy fecal spot. B. Brownish fecal spot with visible darker perimeter and cloudy matrix. C. Dark and opaque fecal spot. Bar = 1 mm.

*2. Vomit Spots*

Vomit or regurgitation spots were determined by their distinctive features - the presence of craters due to sucking activity of blowflies and surrounded by thickly raised and darker colored perimeter (Figure 2A, 2B & 2C). Microscopic observation on these spots also revealed symmetrical feature as elaborated by Bevel & Gardner (2002). The size of these specks ranged from 1 mm to 2 mm. Matrix of the spots displayed irregular surface and reflective under auxiliary microscope light.

These artifacts can be explained by the feeding behavior and its mechanics. As described by James & Eckert (1999), the surface upon which these activities have taken place will contain small spots of blood material with no point of convergence or origin. These patterns are also most often reportedly found in resting areas, particularly warm areas including where the sun strikes (Bevel & Gardner, 2002).

*3. Swiping Stains*

Swiping stains can be considered as one of the most unique characteristics in flyspeck analysis which is due to defecation by flies (James & Eckert, 1999). By consisting of two distinguishable segments, the body and tail, swiping stains can be seen as tear drop-like, sperm-like, snake-like and irregular tadpole-

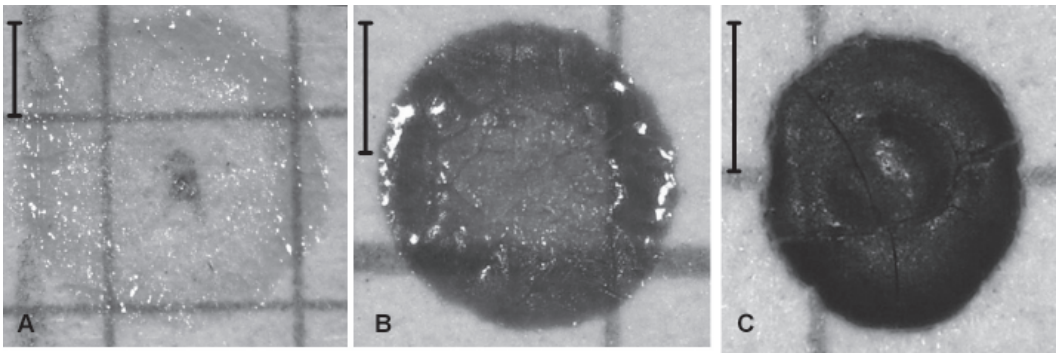



Figure 2. Symmetrical features of vomit spot of adult *C. megacephala.* A. Creamy and yellowish vomit spot. B. Brownish spot. C. Dark brown spot. Bar = 1 mm.

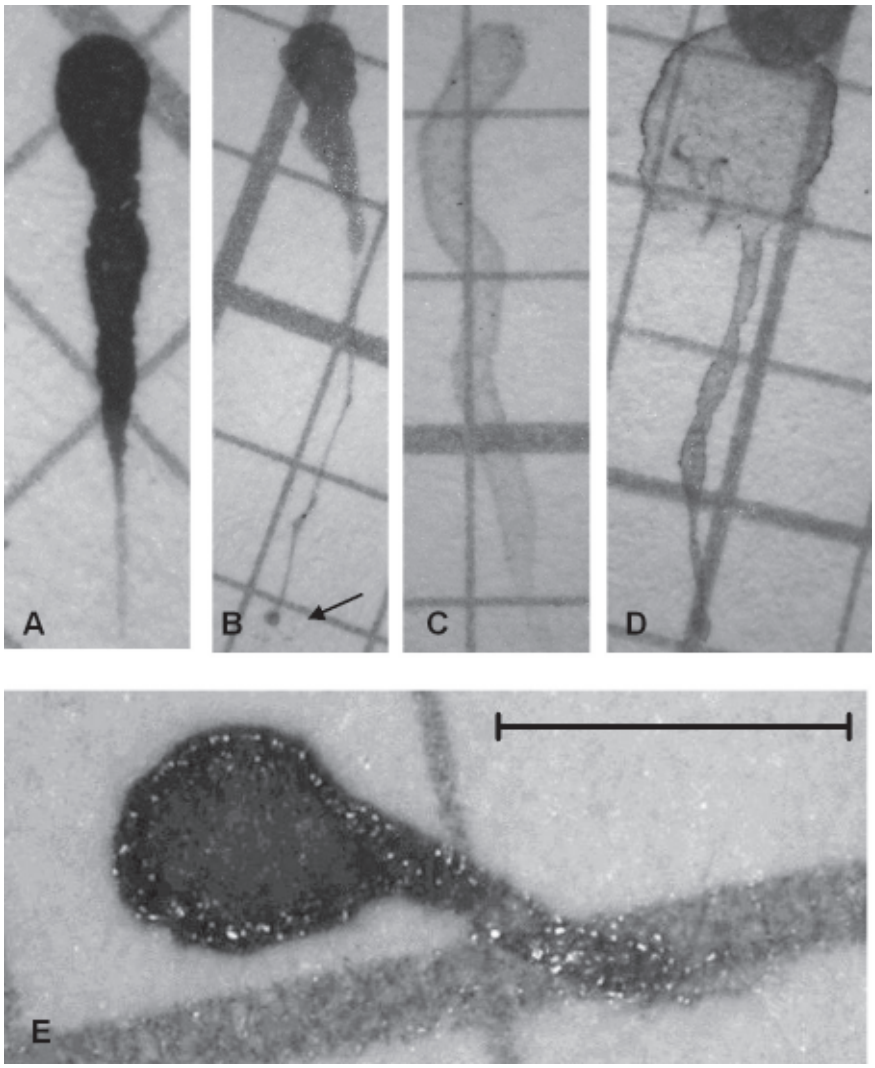



**Figure 3.** Swiping stains of adult *C. megacephala.* A. Tear drop-like stain. B. Sperm-like stain with small dot at tail-end (arrow). C. Snake-like stain. D. Irregular tadpole-like stain. E. Tadpole-like stain with raised border and ridges within crater (arrow). Bar = 1mm.

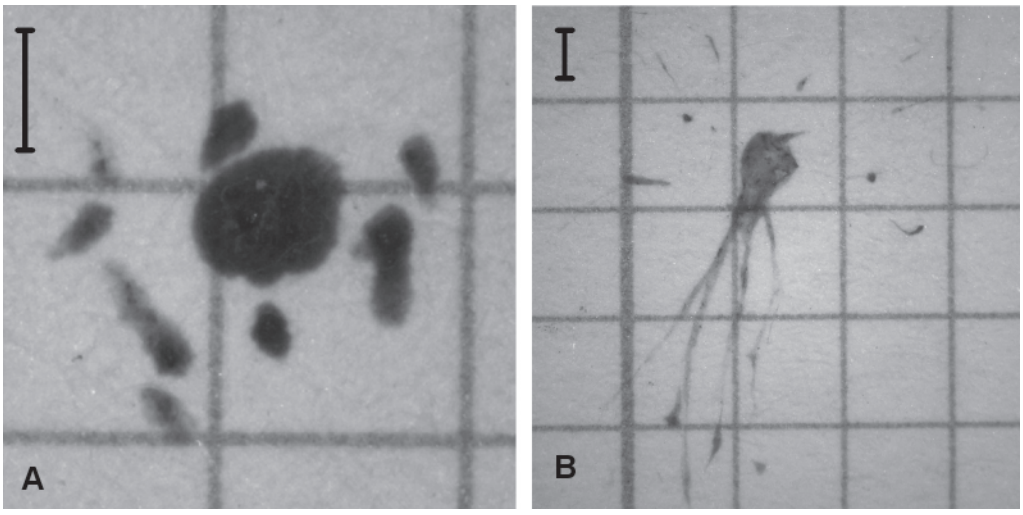



Figure 4. Different features of fly artifacts. A. A speck surrounded by satellites of minute and dark stain. B. Fly artifact resembles a bloodstain. Bar = 1 mm.

like stain. The direction of body and tail were inconsistent and length ranged between 4.8 mm to 9.2 mm.

Tear drop-like stain (Figure 3A) displayed features of almost symmetrical with tail-end obviously thin and narrowing. Body and tail are perfectly aligned. The segment between body and tail is bordered by irregular lining and dark brown opaque. The sperm-like swiping stain (Figure 3B) can be distinguished by its body-tail structure. Tail is longer than body with irregular curve and ends with a small dot (arrow). The snake-like stain (Figure 3C) was fairly brown colored and showed indistinguishable body and tail segment with noticeable darker perimeter surrounding the stain. The directionality of this type of stain is irregular and curve at many random angles. The irregular tadpole-like stain (Figure 3D) was found to be conspicuously larger and bordered by uneven darker perimeter with cloudy matrix.

Some components of these findings have been previously documented by the work of Benecke & Barksdale (2003) and reference of tail/body length ratio (Ltl/Lb) greater than 1 was used to distinguish fly artifact. Even though all swiping stains present Ltl/Lb greater than 1, it is inconclusive due to small numbers of stains recorded.

Another finding that should be highlighted in this observation is the presence of crater on tadpole-like swiping stain (Figure 3E) which was apparent by its raised border characteristic and reflective under auxiliary microscope light. The directionality of this stain is random and darkly brown stained with inner ridges (arrow). This unique mixed regurgitation and swiping stain has never been acknowledged and the mechanical cause of this stain is unknown.

It should be noted that these three main types of fly artifacts as described above should not be finally concluded as the only kind of artifacts produced by flies. Other stains such as in Figure 4A showed opaque, non-symmetrical stain surrounded by its minute satellites, including an abnormal and obviously large pattern of flyspeck resembling a blood spatter (Figure 4B) proved the documentation of fly artifacts need not to be limited to certain characteristics.

This paper has highlighted the important features of fecal spots, vomit spots and swiping stains produced by *C. megacephala*. This information could be useful for forensic scientist in differentiating blood spatters produced from the victims and those formed by flies, especially in the process of crime event reconstruction.

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