

A preliminary study of insect succession on a pig carcass in a palm oil plantation in Malaysia

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Abstract. This preliminary study was carried out in a palm oil plantation in Tanjung Sepat, Selangor in 17 May 2007 by using pig (*Sus scrofa*) as a carcass model in forensic entomological research. A 3 month old pig (8.5 kg) that died of pneumonio was placed in the field to observe the decomposition stages and the fauna succession of forensically important flies. Observation was made for two weeks; two visits per day and all climatological data were recorded. The first visitor to the pig carcass was a muscid fly, seen within a minute, and followed by ants and spiders. Within half an hour, calliphorid flies came over. On the second day (fresh), few calliphorid and sarcophagid flies were found on the carcass. Two different species of moths were trapped in the hanging net. The first larva mass occurred on the third day (bloated) around the mouthpart, with some L1 and L2 found in the eyes. Reduviid bugs and Staphylinidae beetles were recovered on the fourth day (active decay), and new maggot masses occurred in the eyes and anus. L3 larvae could be found beneath the pig carcass on the fourth day. On the fifth day (active decay), new maggot masses were found on neck, thorax, and hind legs. Advance decay occurred on the sixth day with abundant maggots covering all over the body. The main adult fly population was *Chrysomya megacephala* (day 2 to day 6), but the larvae population was mainly those of *Chrysomya rufifacies* (day 4 to day 14). The dry stage began on the eighth day. *Hermetia illucens* adult was caught on day-13, and a larvae mass of *Chrysomya rufifacies* was seen burrowing under the soil. This forensic entomological research using pig carcass model was the first record in this country.

INTRODUCTION

Entomology is the study of insects while forensic is the application of medical knowledge in legal uses (Haskell & Catts, 1990). Forensic entomology plays a main role in determination of Post-Mortem Interval (PMI) (Erzinclioglu, 1986). Despite historical anecdotes and based upon sound scientific entomological principles, the application of forensic entomology in death investigation is relatively young. Rodriguez & Bass (1983) were among the first to look at insects on human remains from a study conducted at a unique research facility at the University of

Tennessee's Anthropological Research Facility at Knoxville, Tennessee. This facility is the first and currently the only facility of its kind in the world where research studies can be conducted on freshly dead human remains placed under various simulating dead scenes. This research facility has led to establishing the domesticated pig as a model which will duplicate the human remains when studying the progression of decomposition and the insect fauna which will colonize human remains over a period of time. This positive correlation between the human and pig carcasses has proven essential in determining time of death based upon

insect occurrence, growth, and development in several high profile trials in both the United State and Canada (Haskell, 2003).

Insects' colonization of decomposing remains can appear minutes after death and can persist long after a body is skeletonized. The most common insects found in frequency and numbers of species are from the order Diptera (flies) and Coleoptera (beetles) (Haskell *et al.* 1997).

Lee & Marzuki (1993) in Malaysia obtained dipteran flies of Calliphoridae, Sarcophagidae, Muscidae and Stratiomyiidae as well as Coleopteran larvae using monkey carcasses. The present study was carried out to observe the process of faunal succession and stages of decomposition using pig carcass.

MATERIALS AND METHODS

A 3 month old pig (*Sus scrofa*), weighing around 8.5 kg, from the pig rearing farm in Tanjung Sepat, Selangor (approximately 85 km from Kuala Lumpur) that died of pneumonia was immediately placed in a palm oil plantation near the pig farm. The pig carcass was put on top of grass and fencing was provided to protect the carcass from animals (such as dogs and civet-cats). The study was conducted in the afternoon of 17 May 2007, which was taken as the first day.

Observations were made for 14 days (2 weeks), with two visits per day. First visit was in the morning (10 a.m.) and second visit was in the afternoon (4 p.m.). Climatological data such as ambient temperature and humidity were recorded for 14 days by using mercury thermometer and hygrometer. Ground temperature, body surface temperature, internal temperature and maggot mass temperature were taken for each visit. Adult flies were caught by using sweep net and hanging net (Figure 1). Some of the fly larvae (10-20 larvae) were collected using forceps for rearing and put into ethyl alcohol 70% for preservation. This procedure is based on that of Haskell & Catts (1990). The

specimens were processed for species identification and kept as a record in the Department of Parasitology & Medical Entomology, Faculty of Medicine, Universiti Kebangsaan Malaysia.

RESULTS

The ambient temperature in the palm oil plantation for the two weeks period ranged from 29°C to 34°C (mean 31.1°C, $\pm 1.54^\circ\text{C}$), air humidity ranged from 69% to 100% (mean 82.2%, $\pm 8.52\%$) (Figure 2). Ground surface temperature ranged from 28°C to 31°C (mean 30.4°C, $\pm 0.79^\circ\text{C}$). Five stages of decomposition were identified; they were fresh, bloated, active decay, advanced-decay, and dry/remains (Table 1).

Body temperature of the pig's carcass was taken by placing the mercury thermometer onto the body surface (Figure 3). The temperature was recorded from the fresh stage until active decay stage only. Internal temperature was taken by placing the thermometer inside the anus while the maggot mass temperature was taken by inserting the thermometer into the center of larva mass. Each reading of temperature was recorded after placing the thermometer for 3 minutes.

On the first day, muscid fly was the first comer (within a minute) attracted to the pig carcass, followed by ants (Formicidae) and spiders (Arachnidae). Within half an hour, blow flies



Figure 1. Hanging net and fencing around the pig carcass.

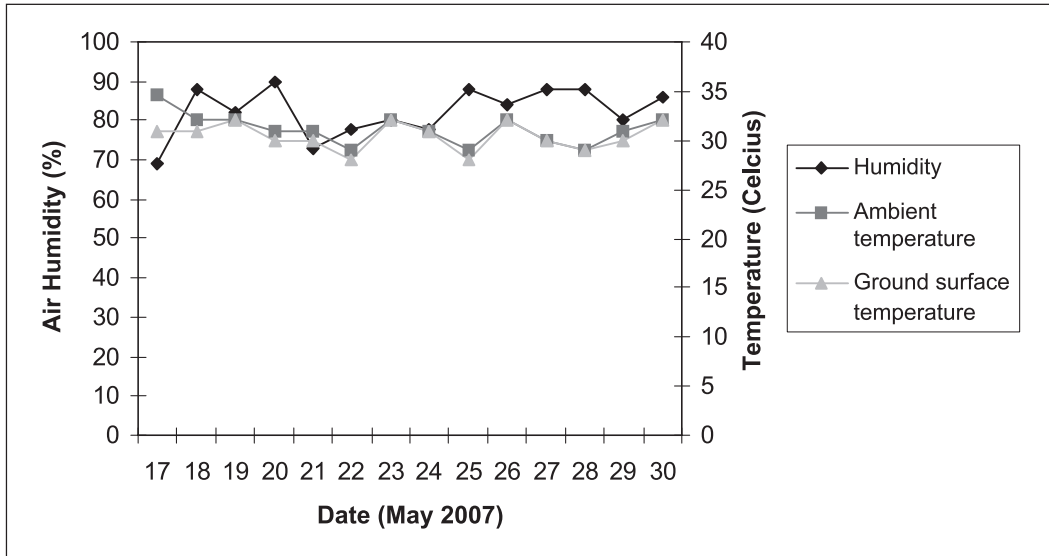


Figure 2. Ambient temperature, air humidity and ground surface temperature of the study site inside the palm oil plantation in Tanjung Sepat, Selangor.

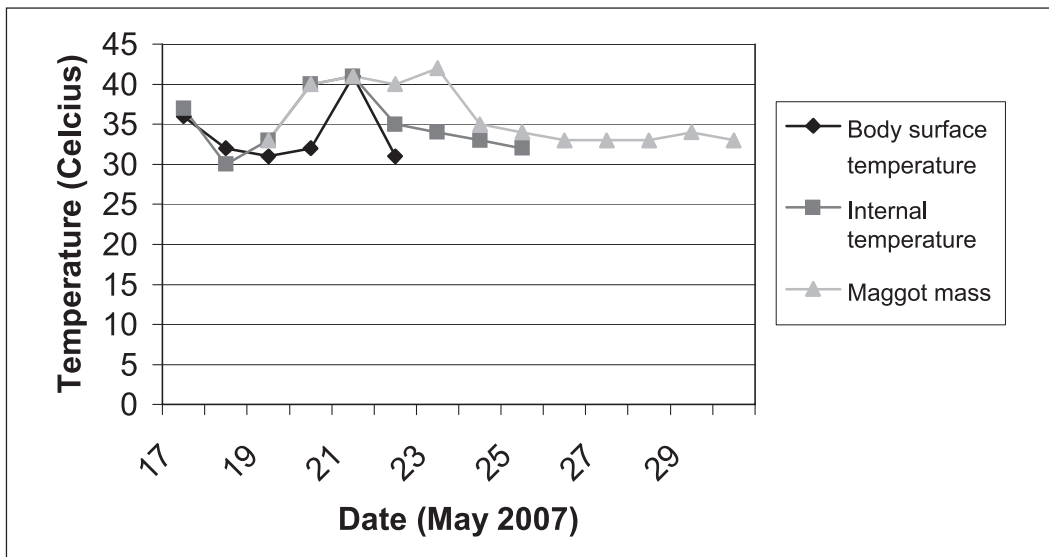


Figure 3. Body surface temperature, internal temperature and maggot mass temperature.

Table 1. Stages of decomposition with the duration and the presence of maggots

State	Day	Maggots present at
Fresh	1-2	Nil
Bloated	3	Yes (Mouthpart)
Active decay	4-5	Yes (Several parts)
Advance decay	6-8	Yes (Whole body)
Dry/Remains	9-14	Yes (Under the soil)

(Calliphoridae) were observed visiting the pig carcass. On the second day, there were about 8-10 adult blow flies, probably *Chrysomya megacephala* resting on the body. Two adult *Sarcophaga* sp. were attracted to the carcass. The hanging net also caught two different species of moth flies after the first night. Adult moths (Lepidoptera) are frequently attracted to decaying remains and feed on

decomposition fluids (Haskell & Catts, 1990). The first larva mass occurred on the third day, which could be seen at the pig's mouthpart. The adult fly species were *C. megacephala*, *Chrysomya rufifacies*, *Musca* sp., and ants. A few L1 and L2 larvae were found in the eyes. L3 were formed under the carcass on the fourth day, indicating that flies had laid eggs earlier. New maggot masses formed around eyes, mouthpart and anus. Reduviid bugs and beetles (Staphylinidae) were discovered on the carcass. On the fifth day, maggot masses were found near the neck, thorax, and hind legs. Estimated numbers of adult flies was 55 and consisted of *C. megacephala*, *C. rufifacies*, *Lucilia* sp., *Sarcophaga* sp., *Musca* sp., and moths. On the sixth day and onwards, the pig's carcass was highly decomposed, with skull and ribs exposed, and showed the stage of advance-decay. Estimate of adult flies was 60-100. The main adult fly population at this stage was *C. megacephala*, but the dominant larva was *C. rufifacies*. Maggots were seen all over the body. On the eighth day, the pig carcass was fully skeletonized, with very few adult flies sighted. Pupae were formed slightly away from the carcass. On day-13, only one adult *Hermetia illucens* (Stratiomyidae) was caught, generally indicating a high degree of body decomposition. Some *C. rufifacies* larvae mass was still found under the soil. A lot of ants (more than 3 different species) were attracted to the dry remains. Spider, millipede and grasshopper were also found around the skeletons. The vegetation surrounding the pig carcass was dead and became yellowish in color.

DISCUSSION

Decomposition is a natural process to return organic material back into the ecosystem (Richards & Goff, 1997). Corpses are the suitable microhabitat for certain organisms because of its food source and shelter (Tullis & Goff, 1987). Process of decomposition can be affected by several factors such as temperature,

humidity, total rainfall and the presence of arthropods (Mann *et al.*, 1990). There are five stages of decomposition: fresh, bloated, decaying, dry and remains (Anderson & VanLaerhoven, 1996; Early & Goff, 1986; Omar *et al.*, 1994; Richards & Goff, 1997; Tullis & Goff, 1986).

In the natural environment, insects will come and colonize the carrion according to specific sequences, which is called fauna succession. Adults of calliphorid and sarcophagid are the main species to reach at the fresh stage of decomposition. The most dominant species is *C. megacephala* (Tullis & Goff, 1986; Richards & Goff, 1997; Omar *et al.* 1994). Beside that, ants are also attracted to fresh carcasses (Omar *et al.*, 1994; Anderson & VanLaerhoven, 1996). During the bloated stage, peak activity of calliphorid adults occurred and its larvae are also seen (Omar *et al.*, 1992). Pupae of *C. megacephala*, *Chrysomya chani*, *C. rufifacies*, *Chrysomya nigripes*, *Chrysomya villeneuvei* and *Chrysomya pinguis* can be found in the dry stage of decomposition (Omar *et al.*, 1992). In the beginning of remains-stage, pupae of *Ophyra spinigera* and larvae (L3) of *H. illucens* are the only dipteran seen (Omar *et al.* 1992). In Malaysia, Lee *et al.* (1984) identified maggots of *C. megacephala* and *C. rufifacies* in 63% of murdered human corpses. Although several fly species belonging to different genera were found on human cadavers, the predominant species were still those of *Chrysomya* (Lee *et al.*, 2004).

This study showed that carcass decomposition rate was faster in Malaysia compared to the study carried out overseas. For example in Hawaii, the dry stage was reached on day 25 (Payne, 1965). In a study conducted in Western Australia, the dry stage was reached on day 40 (Bornemissza, 1957).

More studies should be conducted in different locations and different manner of death to obtain more accurate data in determining post-mortem intervals (PMI). This preliminary study provides information on forensic entomology using pig carcass for the first time in Peninsular Malaysia.

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