

# NON-CALLIPHORIDAE-NECROPHAGOUS-DIPTERA SUCCESSION ON PIG CARCASSES IN MANADO, INDONESIA

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**Abstrak.** Penelitian mengenai suksesi Diptera nekrofagus non-Calliphoridae dilakukan di Manado, Indonesia pada tahun 2012. Tiga ekor bangkai babi domestik (berat badan 21-23 kg) dimatikan dengan tiga cara yang berbeda (dosis letal potasium sianida per oral, pukulan benda tumpul pada area osipital, dan tikaman benda tajam). Penelitian dilakukan selama 15 hari. Suhu udara ambien dan kelembaban, serta data suhu dari Badan Meteorologi Klimatologi dan Geofisika (BMKG) Stasiun Klimatologi Kayuwatu. Babi yang dimatikan dengan potasium sianida memperlihatkan perlangsungan dekomposisi yang lebih panjang (10 hari) dibandingkan dengan lainnya (delapan hari). **Simpanan:** Terdapat empat famili dan dua spesies Diptera nekrofagus non-Calliphoridae yang mengunjungi bangkai hewan coba: Sarcophagidae, Piophilidae, Ophyra, Phoridae, *Musca domestica*, dan *Hermetia illucens*. Sarcophagidae dan Ophyra telah ditemukan sejak hari ke-1. Dari keenam jenis serangga non-Calliphoridae yang berkunjung, hanya empat jenis yang berkolonisasi pada bangkai hewan coba, yaitu: Ophyra, Phoridae, *Musca domestica*, and *Hermetia illucens*.

**Kata kunci:** nekrofagus non-Calliphoridae, babi domestik, suksesi, kolonisasi

**Abstract.** A study was conducted on Non-Calliphoridae-Necrophagous-Diptera succession on pig carcasses in Manado, Indonesia, in the year 2012. Three domestic pig carcasses (weighing 21-23 kg) were killed by using three different manners (a lethal oral dose of potassium cyanide, a blow with a blunt material, and a stabbing with a sharp material). This study was conducted for 15 days. Ambient air temperatures and humidity, and temperature data of the Climatology Station, Kayuwatu were recorded. The pig killed with potassium cyanide showed a longer decomposition duration (10 days) than the others (eight days). **Conclusion:** there were four families and two species of Non-Calliphoridae-Necrophagous Diptera visited the carcasses: Sarcophagidae, Piophilidae, Ophyra, Phoridae, *Musca domestica*, and *Hermetia illucens*. The first visitors (day 1) were Sarcophagidae and Ophyra. From the six visitors, there were only four that colonized on the carcasses: Ophyra, Phoridae, *Musca domestica*, and *Hermetia illucens*.

**Key words:** Non-Calliphoridae-Necrophagous-Diptera, domestic pigs, succession, colonization

Insects constitute the biggest group of organisms that has survived for more than 300 million years.<sup>1-4</sup> These fauna have a high capacity of adaptation to the environment and occupy nearly all habitats in this

world,<sup>3,5,6</sup> including crime scenes. The usage of insects in forensic fields and medicolegal investigations belongs to Forensic Entomology.<sup>1,3,7,8</sup>

Insects (adult and immature) have

been used in e.g. the estimation of post mortem interval (PMI), investigation of causes and manners of deaths,<sup>8</sup> and finding out whether a dead body or its remains have been removed or not.<sup>8,9</sup> In Indonesia, the insect identification technology, especially for the immature forms, has not been well developed. Moreover, no database of forensic insects has been reported so far.

Insects visiting corpses or carcasses are commonly described based on their ecological roles: necrophagous, predatory and parasitoid, omnivorous, adentive, and accidental insects.<sup>10-12</sup> These insects do not visit or leave the corpses abruptly, but in "waves",<sup>2,13</sup> called an insect succession pattern, which differs from area to area, and country to country.<sup>11,12,14-16</sup>

Diptera and Coleoptera are the most important orders visiting corpses. Calliphoridae is the most successive family reported in many cases. Moreover, Calliphoridae is the most published family as it is the first visitor to a dead body, but the other Non-Calliphoridae-Diptera families or species are usually found on the corpse and play some important roles, too.<sup>8,17-19</sup> Non-cosmopolitan insects are very important in considering that a dead body or its remains have been removed.<sup>20</sup> A continual database of forensic insects in every country is needed to obtain better results in medico-legal investigations.<sup>16</sup>

## MATERIAL AND METHODS

### Carcasses

Three domestic pigs, weighing 21-23 kg, were killed by using three different manners (simulation of death manners in autopsied cases in Manado) in January 27, 2012. The first pig was given a lethal oral dose of potassium cyanide; the second one was struck with a blunt instrument; and the third one was stabbed in its heart with a sharp instrument. The carcasses were put in cages, covered with poultry wire. The cages were placed at a distance of 20 m from each other.

### Site description

The study area was located in an open field with a few medium-sized trees and bushes at Winangun in Manado, the capital city of North Sulawesi, Indonesia. According to the climate classification of Köppen-Geiger, Indonesia is identified as a tropical rainforest country (Af).<sup>21</sup>

### Procedures

Observation of insects visiting the carcasses and measurement of ambient air temperatures and relative humidity with a thermo-hygrometer Meter were done twice daily (09.00 AM and 03.00 PM). Collected insects, adult and immature, were morphologically identified. Besides that, immature insects were reared in the Laboratory of the Agriculture Faculty, University of Sam Ratulangi, Manado. Temperatures and humidities of the site area were obtained from Badan Meteorologi Klimatologi dan Geofisika (BMKG) Climatology Station, Kayuwatu, Manado during January 2012. The whole study was conducted during 15 days.

## RESULTS

### Temperature

During this study, ambient air temperatures at the site were 26.6 - 29<sup>0</sup>C. According to the Climatology Station, Kayuwatu, temperatures at Winangun, Manado were 23.4 - 26.6<sup>0</sup>C and the humidities were 49-70 %. Temperatures in the laboratory were 28 - 29<sup>0</sup>C and the humidities were 62-66%.

### Decomposition

There were five observable stages of decomposition: fresh, bloated, active decay, post decay, and skeletonization. The duration of stages were the same on the second and the third pigs, but most of them (active, post decay, and skeletonization) were longer on the first pig.

### Collected and reared Non-Calliphoridae-Necrophagous Diptera

Collected adults of Non-Calliphoridae-Necrophagous Diptera were Sarcophagidae (flesh fly, Figure 1), Piophilidae (skipper fly, Figure 2), Ophyra (Hydrotea, dump fly, Figure 3), Phoridae (scuttle fly, Figure 4), *Musca domestica* (house fly, Figure 5), and *Hermetia illucens* (black soldier fly, Figure 6).

Immature insects found were the larvae of Ophyra (until day 15 at the study site) and pupae of Phoridae (during rearing). Adults of *Musca domestica* and *Hermetia illucens* were found during rearing, using the soil surrounding the carcasses.

### DISCUSSION

Sarcophagidae species are spread world-wide, especially in tropical and temperate areas.<sup>3</sup> Adult flies feed on sugar containing materials such as honey, plant sap, and honeydew. They are also found feeding on carrions and decaying plants.<sup>3,22</sup> Larvae feed on decomposed organic matter, and most of them are necrophagous and saprophagous.<sup>3,5,22,23</sup> Sarcophagidae species are attracted to carcasses in a variety of conditions: sunlit or shade, dry or wet, and indoor or outdoor. Larviposition can occur in early and late stages. They usually come at the same time or not long after Calliphoridae species.<sup>3,5</sup> According to Villet (2011), Calliphoridae and Sarcophagidae dominated the carcasses' ecosystem in Africa.<sup>24</sup> According to Byrd and Castner (2010), Sarcophagidae species flew well, even in a bad weather, so they had the chance to come first to a corpse or carcass.<sup>3</sup> In this study, adults of Sarcophagidae visited the carcasses on the first day post mortem and then during the whole study, but no larvae were found until the end of the study. It means that the colonization of Sarcophagidae did not occur in the carcasses.

Adult Piophilidae species are found on garbage, carrions, corpses, bones, skin and leather, and naturally dried high-protein

materials.<sup>3,25</sup> They are mostly found in the late active decay and early dry stages.<sup>3,5,26</sup> Larvae and adult flies feed on carcasses and decomposed materials.<sup>3,22</sup> In this study, adults were found in day 7 (post decay stage) but immature insects were not found during the whole study. It means that the colonization of Piophilidae did not occur in the carcasses.

*Hermetia illucens* was first reported in the United States and has spread to the other continents<sup>25</sup> in tropical and temperate countries.<sup>3,27</sup> Adults are not strong fliers, and are found around bushes and flowers, seeking honey.<sup>4,25</sup> They are also found in garbage, manure, and decaying plants.<sup>28</sup> Larvae feed on decomposed materials of fruits, animals, and manure,<sup>3,4,25,27,29</sup> human feces, and dung.<sup>4</sup> Besides that, they are predators of other Diptera larvae.<sup>4</sup> In tropical areas, *H. illucens* can be found all year.<sup>30</sup> This species is not usually found in corpses and it colonizes in the later decomposition stages, 20-30 days post mortem.<sup>5,12,30</sup> In this study, *Hermetia illucens* visited the carcasses at day 5 and 6 post mortem (active decay stage). Gunn (2009), Goff (2011), and Tomberlin *et al* (2005) reported that adult females did oviposition in the advanced /putrid decay.<sup>5,12,30</sup> The second generation of *Hermetia illucens* was found during rearing (day 35-39), using the soil surrounding the carcasses. It means that the colonization of this species occurred in the carcasses which was appropriate to their larvae' nature as being necrophagous and predatory to the other Diptera larvae.<sup>3,4,25,27,29</sup>

Adults of Ophyra are attracted to carrion and excrement. Although larvae develop primarily in feces, second and third instars are predacious, and they attack larvae of *Musca domestica* and other Muscidae species if they are at the same place.<sup>3,25,31</sup> In this study, adults visited the carcasses from day 1 until day 8, and larvae were found from day 6 until day 14 (fresh stage until skeletonization). It means that the colonization of this species occurred in the carcasses.



**Figure 1.** Sarcophagidae: dorsal view.



**Figure 4.** Phoridae: lateral view.



**Figure 2.** Piophilidae: lateral view.



**Figure 5.** *Musca domestica*: dorsal view.



**Figure 3.** *Ophyra*: dorsal view.



**Figure 6.** *Hermetia illucens*: ventral view.

*Musca domestica* is the most frequently found species of Muscidae.<sup>3,5,25</sup> They are attracted to carrion due to feces or exposed gut contents, body exudate, sweet food, meat, and decomposed plants.<sup>3,5,25,26</sup> Larvae are saprophagous and they feed on feces, decomposed plants, and tissues of corpses/carcasses.<sup>3,5</sup> Besides that, they are predators of eggs and larvae of other Diptera.<sup>3</sup> Adults of *Musca domestica* mostly visit corpses shortly after Calliphoridae and Sarcophagidae in active and post decay stages. They rarely visit fresh corpses, unless there is feces or exposed gut contents.<sup>3,5,25</sup> In this study, *Musca domestica* visited the carrion from day 2 (bloated stage) until day 5 (active decay stage), earlier than the stages suggested by Byrd and Castner (2010), Gunn (2009), and Smith (1986).<sup>3,5,25</sup> The early arrivals of adult insects were beneficial to larvae development since they were predators of eggs and larvae of other Diptera, in this case *Chrysomya* species. Adult flies were found during larva rearing in the laboratory after seven days. This species needs a relatively high temperature to complete its life cycle in an optimum condition, which are 6-8 days.<sup>5</sup>

The Phoridae family is spread worldwide, especially in tropical countries.<sup>32</sup> Adults of Phoridae are found on decaying plants and organic matter.<sup>3,22,25,32</sup> Larvae feed on a variety of materials, and as detritivores they are found in decomposed plants, animals, corpses (on the ground or buried), fungi, as internal parasites in a variety of insects, commensal in ant or termite nests,<sup>3,5,22,32</sup> parasitoid, and as predators of other larvae.<sup>3,5,25,32</sup> According to Gunn (2009), Phoridae species visited carcasses in later stages when the remains began to dry.<sup>5</sup> In this study, adult Phoridae species were found in day 5 (active decay stage), which favored these flies since their larvae were predators of other Diptera larvae. Pupae and adult flies were found during rearing using soil surrounding the carcasses. It means that Phoridae species had colonized successfully on the car-

casses.

## CONCLUSION

There were five observable decomposition stages (fresh, bloated, active decay, post decay, and skeletonization) of domestic pig carcasses in Manado, Indonesia. Non-Calliphoridae-Adult-Necrophagous Diptera visiting the carcasses were Ophyra, Piophilidae, Phoridae, Sarcophagidae, *Musca domestica*, and *Hermetia illucens*. Ophyra, Phoridae, *Musca domestica*, and *Hermetia illucens* colonized successfully in the carcasses.

## Suggestion

It is suggested that database and successions of Non-Calliphoridae-Necrophagous Diptera and other forensic insects can be applied optimally in the medicolegal investigation.

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