Research Note

Survey on flies of the genus *Musca* (Diptera, Muscidae) in the process of construction and development of human settlements in a tropical forest, Indonesia

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Abstract: Invasive phenomenon and incidence of the *Musca* species in the process of construction and development of human settlements in a tropical forest were observed with bait-traps in the dry season in Sulawesi and Seram, east Indonesia. Flies collected at 7 stations in the Toili district of Central Sulawesi numbered 2,215 comprising 3 families, viz., Muscidae, Calliphoridae and Sarcophagidae. Of them, 47 individuals of 3 species, *Musca domestica* Linnaeus, *M. ventrosa* Wiedemann, and *M. sorbens* Wiedemann, were collected. No *Musca* species was caught in the uninhabited forest. *M. domestica* and *M. ventrosa* were caught in the deforestation area and at the boundary between the natural forest and a new village. *M. sorbens*, together with *M. domestica* and *M. ventrosa*, was caught in a new village, an old village and the Toili town. The proportion of the *Musca* species in total flies increased with the lapse of time after construction of human settlements. In Manusela village isolated by a tropical forest in Seram, *M. sorbens* occupied 98.3% of the *Musca* species collected, while *M. domestica* were very few.

INTRODUCTION

The *Musca* species are the most familiar and medically the most important members of the flies. They are known to have high potential for transmitting enteric pathogens such as bacteria, protozoa and helminth eggs (West, 1951; Lindsay and Scudder, 1956; Greenberg, 1971, 1973). Many species of these flies enter the human environment and consequently co-exist with man as synanthropic flies. Various degrees of synanthropy exist among the *Musca* species, and even within the species (Harwood and James, 1979).

In the tropics and subtropics, the occurrence and synanthropy of the *Musca* species in relation to the density of human settlement or difference of habitats (urban, rural and forest) have been reported by Roy and Dasgupta (1980), Paul *et al.* (1989, 1990), and D'Almeida (1992). There has been, however, limited observation of the invasion and incidence of the *Musca* species in the process of construction and development of human settlements in tropical forests.

In the present paper, we report an invasive phenomenon and incidence of the *Musca* species in the process of deforestation and construction of transmigrant vil-

Fig. 1. Map showing 7 stations surveyed in Toili district, central Sulawesi, and Manusela in Seram.

lages in Sulawesi, and those in an isolated village in a tropical forest in Seram, East Indonesia.

MATERIALS AND METHODS

In Sulawesi, the survey was conducted

in the Toili district (Fig. 1) located in the central peninsular area. Seven stations with different conditions (natural forest, deforestation area, and transmigrant villages with different formative periods) were selected for the investigation (Fig. 1).

Station 1: Natural forest-1 (1.2 km from boundary of new village)

Station 2: Natural forest-2 (1.0 km from boundary of new village)

Station 3: Deforestation area (500 m inside of the forest)

Station 4: Boundary between natural forest and new village

Station 5: New transmigrant village (1–2 years old; several tens of houses with about 200 inhabitants)

Station 6: Old transmigrant village (12 years old; several tens of houses with about 150 inhabitants)

Station 7: Toili town (20 years old; several thousand inhabitants)

The natural forest (Sta. 1 and 2) was a densely wooded lowland forest in the Tropics. In the deforestation area (Sta. 3) most trees have been cut down, but there were many dead trees, fallen trees and stumps. In the cultivated field of Sta. 5–7, cassava was mainly planted and scattered cows were kept in the grassland. Collections of

flies by bait-trap using cow meat (500 g; 2–3 days old) were conducted for 30 minutes from 10 a.m to 2 p.m under clear weather (30–33°C) in each station during 26–29 August 1997 (dry season; average rainfall 4.9 mm in August). Flies attracted were collected by a sweeping net and classified into the *Musca* species and other flies (other Muscidae, Calliphoridae, and Sarcophagidae) and counted. Collection of flies by the same method was done in Manusela village (Fig. 1; 750 m above sea level, 70 houses with about 300 inhabitants) isolated by a remote and dense tropical forest (taking 3 days on foot from the base village) in the Murkele mountain range of Seram Island on 18 September (dry season), 1997.

RESULTS

The total number of flies collected at 7 stations in the Toili district numbered 2,215 comprising 3 families, viz., Muscidae, Calliphoridae and Sarcophagidae (Table 1). In the present study, only the *Musca* species and *Hydrotaea chalcogaster* (Wiedemann) were identified into species; the identification and a faunistic analysis of Calliphoridae will be published in an-

Table 1. Species and number of flies collected and % of *Musca* species at 7 stations in Toili district, Central Sulawesi, 1997.

Family species	Stations							Total
	1	2	3	4	5	6	7	
Muscidae								
<i>Musca domestica</i>	0	0	1	2	2	9	13	27
<i>Musca ventrosa</i>	0	0	1	2	1	2	1	7
<i>Musca sorbens</i>	0	0	0	0	3	4	6	13
<i>Atherigona</i> spp.	22	52	72	162	17	68	59	452
<i>Hydrotaea chalcogaster</i>	15	12	6	21	3	29	18	104
<i>Myospila</i> spp.	0	2	0	0	0	0	0	2
Calliphoridae								
<i>Chrysomya</i> spp.	314	192	364	152	228	114	127	1,491
<i>Phumosia</i> spp.	69	2	0	0	0	0	0	71
Sarcophagidae spp.	0	2	7	5	9	14	11	48
Total	420	262	451	344	263	240	235	2,215
% of <i>Musca</i> species	0a	0a	0.4a	1.2a	2.3b	6.3c	8.5c	2.1

Figures followed by a different letter are significantly different at $P < 0.05$ by χ^2 test.

Table 2. Species and number of flies collected in Manusela village, Seram I., on 18 Sept. of 1997.

Species	Number (%)
Muscidae	
<i>Musca domestica</i>	3 (0.5)
<i>Musca sorbens</i>	177 (28.9)
<i>Atherigona</i> spp.	188 (30.7)
<i>Hydrotaea chalcogaster</i>	13 (2.1)
Calliphoridae	
<i>Chrysomya</i> spp.	231 (37.7)
Total	612

other work by one (H. Kurahashi) of us. At two stations in the natural forest (Sta. 1 and 2), no *Musca* species was caught. In the deforestation area (Sta. 3) and at the boundary area (Sta. 4) between a natural forest and a new village, *M. domestica* Linnaeus and *M. ventrosa* Wiedemann were collected. *M. sorbens* Wiedemann was collected at Sta. 5 to 7. Three species, *M. domestica*, *M. ventrosa* and *M. sorbens*, were caught together in a new village (Sta. 5), an old village (Sta. 6) and the Toili town (Sta. 7). The proportion of *Musca* species in total flies was higher in the new transmigrant village (Sta. 5) than in Sta. 1–4 and further increased in the old transmigrant village (Sta. 6) and Toili Town (Sta. 7). The number of *M. domestica* and *M. ventrosa* collected was much less than that of *Atherigona* spp. or *Chrysomya* spp., although these two *Musca* species were abundantly seen in villages. This may be due to existence of much attractive substances at bazaars near the surveyed points in the villages.

The species and the number of flies collected by bait-trap on 18 September 1997 in Manusela village of Seram are shown in Table 2. *M. sorbens* occupied 98.3% of the *Musca* species, and was 28.9% of all flies. *M. domestica* was only 1.7% of the *Musca* species.

DISCUSSION

No specific conclusions can be drawn

from the present data because of shortage of data, but it may be possible to speculate some invasive phenomena of the *Musca* species in the tropics. *M. domestica* is distributed worldwide, adapting to human habitations. It is well known that this species does not enter uninhabited forests in the tropics (Roy and Dasgupta, 1980; Paul *et al.*, 1990; D'Almeida; 1992). However, the present study suggested that *M. domestica* is one of the first flies to invade the deforestation area together with man.

M. ventrosa is distributed in the Old World Tropics, and gathers on the human body, cattle and horses, and its breeding sources are usually cattle and water buffalo dung (Emden, 1965; Shinonaga and Kano, 1971). Roy and Dasgupta (1980) reported that *M. ventrosa* was not found in dense settlements (city), although a few occurred in a thinly populated village and an uninhabited forest where a rest house stands in India. Collection of *M. ventrosa* at Sta. 3 indicated that this species also has an invasive tendency to the deforestation area in the tropics as well as *M. domestica*. However, it may not thrive in new villages and dense settlements where there are few or no cattle or other domestic animals.

M. sorbens is widespread in the Old World Tropics; the adult is attracted to the human body, and it is aptly referred to as the bazaar fly and eye fly (Harwood and James, 1979). Roy and Dasgupta (1980) observed that *M. sorbens* could not enter an uninhabited forest. The collection of *M. sorbens* at Sta. 5 suggests that this species thrives after construction of human settlement.

It is considered that two species of *M. domestica* and *M. sorbens* increase with the lapse of time after human settlement, but their densities vary with the places. Sucharit *et al.* (1976) and Sucharit and Tumrasvin (1981) surveyed the synanthropic flies at markets and garbage places in Thailand and reported that *M. domestica* occupied 99% and 97% of the *Musca* species, respectively. Khan *et al.* (1965) in-

vestigated the flies at bazaars in various parts of India and noted that *M. domestica* was predominant at most places surveyed in Bengal, while *M. sorbens* occupied 78% of the fly population in Chandigar, Punjab. It was also noted that *M. sorbens* replaces *M. domestica* over much of the Old Tropics (Harwood and James, 1979). However, it appears that the factors affecting the densities of both species have not been discussed anywhere. Human excrement is known to be the major breeding source for *M. sorbens* (Buxton and Hopkings, 1927; Hafez and Attia, 1958), while horse and cow manure is the most important medium for the larvae of *M. domestica* (Harwood and James, 1979). In Manusela village, there are no cattle or other domestic animals except for some chickens and dogs, and human excrement is available everywhere in the village. The predominance of *M. sorbens* (98.7% of the *Musca* species) in Manusela village indicates that this species prevails in human settlements out of livestock and domestic animals in the tropics. Taking into account the flight ability of *M. domestica* (usually 1 to 3 km by Harwood and James (1979)), we assume it does not fly across remote and dense forests, but probably breeds within the village. And it might be suggested that *M. domestica* poorly thrives due to competition with *M. sorbens* in such traditional human settlements isolated by a tropical forest.

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摘 要

インドネシアのスラウェシおよびセラムにおける
森林伐採と村落形成過程におけるイエバエ属
(双翅目, イエバエ科) ハエ類の調査

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インドネシアのスラウェシとセラムの乾季の熱帯林において、森林伐採と村落形成・人の定着過程におけるイエバエ属 (Genus *Musca*) の侵入と発生の様相を腐肉トラップを用いて観察した。中央スラウェシの Toili 地区の7地点で採集されたハエ類は計3科(イエバエ科, クロバエ科, ニクバエ科), 2,215個体で, そのうちイエバエ属はイエバエ *Musca domestica*, ハラアカイエバエ *Musca ventrosa*, フタスジイエバエ *Musca sorbens* の計3種47個体であった。人が住んでいない自然林ではイエバエ属ハエ類は採集されなかった。イエバエとハラアカイエバエは, 調査地点5-7の村・町に加えて, 伐採地域および自然林と新しい村(形成後1-2年)との境界(林縁部)でも採集された。フタスジイエバエは, 新しい村, 形成後12年の村, 形成後20年の町 (Toili Town) で採集された。ハエ類全体に占めるイエバエ属の割合は, 村落形成後の経過に伴って増加した。セラムのムルケレ山系において熱帯林によって隔絶・孤立されたマヌセラ村では, 採集された180個体のイエバエ属のうち, フタスジイエバエが98.3% (177個体) を占め, イエバエは3個体のみであった。