A COMPARISON OF THE ROLE OF *MUSCA DOMESTICA* (LINNAEUS) AND *CHRYSOMYA MEGACEPHALA* (FABRICIUS) AS MECHANICAL VECTORS OF HELMINTHIC PARASITES IN A TYPICAL SLUM AREA OF METROPOLITAN MANILA

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Abstract. A total of 1,016 flies (508 each for *Musca domestica* and *Chrysomya megacephala*) were collected from a typical urban slum area (Barangay 51, Pasay City, Metropolitan Manila) in the Philippines and examined for the presence of helminth ova attached to their external surfaces. A significantly greater proportion of *C. megacephala* (41.9%) was found positive compared to *M. domestica* (9.4%). *C. megacephala* also exhibited a significantly higher average egg load (11.9 eggs per positive fly) than *M. domestica* (2.6 eggs per positive fly). Male and female flies were equally contaminated for both species.

Only 29 out of the 2,651 eggs recovered (1.1%) were infective to man. *Ascaris* spp. and *Trichuris trichiura* ova occurred most frequently while eggs of hookworm. *Taenia* spp., *Toxocara* spp. and *Capillaria hepatica were infrequent or rare. Despite the low proportion of infective eggs recovered, the role of these* synanthropic flies in the transmission of certain helminthiases should not be discounted.

INTRODUCTION

The occurrence of flies is such a typical aspect of life in tropical countries that their role in disease transmission is often overlooked. The associations can sometimes be so subtle that attention is called to their presence and importance only when the epidemiological relationships have been clearly established.

The urban setting, inspite of rapid modernization and industrialization, is not exempt from the scourge of these pests which have adapted a domestic lifestyle in close coexistence with man. Two species of flies closely associated with man in the Philippines are the common house fly *M. domestica* and the common blow fly *C. megacephala.*

Literature on *M. domestica* is vast. Being a classical eusynanthropic, endophilous and markedly communicative species, it fulfills all the conditions required of a disease vector, namely: (1) eusynanthropy, ie, close existence with man, sharing his artificial biocoenosis (anthropobiocoenosis); (2) consumption of both contaminated and non-contaminated food; (3) great flight activity and dispersal and (4) constant alternation between feces and food (Greenberg, 1971).

In addition to various bacteria and viruses, *M. domestica* has been shown experimentally to carry the following helminth eggs externally: *Taenia solium* (Linnaeus), *T. pisiformis* (Bloch), *T. hydatigena* (Pallas), *Hymenolepis nana* (von Siebold), *Dipylidium caninum* (Linnaeus), *Diphyllobothrium latum* (Linnaeus), *Enterobius vermicularis* (Linnaeus), *T. trichiura* (Linnaeus), both internally and externally; *Necator americanus* (Stiles), *Ancylostoma caninum* (Ercolani), *Ascaris equorum* (Goeze), *Toxascaris leonina* (von Linstrow) and *Hymenolepis diminuta* (Rodolphi) (Nicoll, 1911). West (1951) also lists the eggs of *Ascaris lumbricoides* (Linnaeus), *Ancylostoma duodenale* (Dubini) and *Echinococcus granulosus* (Batsch). Protozoan cysts such as those of *Entamoeba histolytica* and *Giardia lamblia* can also be mechanically transported (Frye and Meleney, 1932).

In contrast, *C. megacephala* is a hemisynanthropic to eusynanthropic exophilous species which is a common household and bazaar pest in the Asian and Australasian regions. Adults

are strongly attracted to carrion and excrement for breeding purposes (Greenberg, 1971, 1973). Since adults have been reported as a nuisance in slaughterhouses and on meat, fish, sweets, fruits and other foodstuffs in market places (Greenberg, 1973), this species is regarded as an important food contaminator (Illingworth, 1926; Patton, 1930) and thus deserves the attention of hygienists and epidemiologists (Greenberg, 1971).

C. megacephala was reported as the most important fly breeding on garbage and visiting food in the Philippines (de la Paz, 1938a). In Manila, de la Paz (1938b) described the threat from *Musca, Chrysomya* and *Sarcophaga* species which carried 6 *Shigella* types in markets, groceries, restaurants and food stores; 9 *Salmonella* types were also found in the first two fly genera.

Slum areas still abound in the city of Manila. There is usually a high prevalence of soil-transmitted helminthiases among the inhabitants of these impoverished communities. These foci are characterized by low socio-economic status of the people, overcrowding and poor personal and environmental sanitation. In such areas, the role of flies in disease transmission is probably greater and thus merits deeper investigation.

MATERIALS AND METHODS

The study area was Barangay 51, Pasay City, Metro Manila. It was chosen because of its accessibility from the College of Public Health, UP Manila and since it represented a typical urban slum area in Manila. Environmental sanitation was poor as evidenced by its location near a polluted sewer, the presence of uncollected garbage, the crowded condition of the houses, lack of latrines and the generally low socio-economic status of the community's inhabitants. A recent parasitological survey (1982-1986) revealed that the area was endemic for soil-transmitted helminthiases, particularly ascariasis (53.9%), trichuriasis (63.0%) and hookworm infection (3.0%) (Cabrera, personal communication, 1986).

Flies were collected randomly along the surroundings of the houses during the early morning hours of weekends from August to October, 1986. Afternoon collections were not done due to the frequent rainfall at that time of the year. Flies were also observed to be sluggish and scarce in the afternoons.

Four conical nets made of semi-transparent nylon mosquito net material were used. Flies were caught individually and transferred immediately into covered vials containing 4 ml of 20% glycerine solution (West, 1951). In cases where two or more flies were caught at the same time, the net was held in such a way that individual flies were separated from each other. After collection, specimens were brought to the laboratory for processing.

Flies were sorted out according to species and sex. The covered vials were shaken vigorously for 1-2 minutes and the washings were transferred to centrifuge tubes. The vials were then washed with one ml of the glycerine solution and the second washing added to the centrifuge tube. Centrifugation was carried out at 1500-2300 rpm for one minute according to the procedure described by Changco (1969). After centrifugation, the supernatant was siphoned out and discarded. The remaining sediment was poured out on clean glass slides, covered with a coverslip and examined thoroughly under the microscope. For every specimen examined, the identity, number and stage or state of viability of the helminth ova found were recorded.

RESULTS

A total of 1,016 flies, 508 specimens for each species, were collected and examined. For *M. domestica*, 14 out of 161 males (8.7%) and 34 out of 347 females (9.8%) were found positive for helminth ova. A higher proportion of *C. megacephala* specimens were positive: 67 out of 146 males (45.9%) and 146 out of 326 females (40.3%). The proportions of male and female flies positive for helminth ova were not significantly different ($p > 0.05$) for both species. However, there was a significantly higher proportion of positive *C. megacephala* (41.9%) compared to positive *M. domestica* (9.4%) specimens ($p < 0.01$) (Table 1).

Ova from 6 types of helminths were recovered, namely: *Ascaris* spp., *T. trichiura,* hookworm, *Taenia* spp., *Toxocara* spp. and *Capillaria hepatica* (Table 2). *Ascaris* spp. and *T. trichiura* occurred most frequently. Each type of helminth ova was

Table 1

Distribution of flies collected randomly from Barangay 51, Pasay City, Metropolitan Manila, according to species, sex and presence of helminth ova.

Species	*Musca domestica*			*Chrysomya megacephala*		
	Male	Female	Total	Male	Female	Total
Positive	14 (8.7%)	34 (9.8%)	48 (9.4%)	67 (45.9%)	146 (40.3%)	213 (41.9%)
Negative	147 (91.3%)	313 (90.2%)	460 (90.6%)	79 (54.1%)	216 (59.7%)	295 (58.1%)
Total	161 (100.0%)	347 (100.0%)	508 (100.0%)	146 (100.0%)	362 (100.0%)	508 (100.0%)

Table 2

Distribution of positive flies according to type of helminth ova recovered.

Species	*Musca domestica*			*Chrysomya megacephala*		
	Male (n = 14)	Female (n = 34)	Total (n = 48)	Male (n = 67)	Female (n = 146)	Total (n = 213)
Helminths recovered						
Ascaris spp.	12 (85.7%)	28 (82.4%)	40 (83.3%)	48 (71.6%)	107 (73.3%)	155 (72.8%)
Trichuris trichiura	1 (7.1%)	8 (23.5%)	9 (18.8%)	46 (68.7%)	82 (56.2%)	128 (60.1%)
Hookworm	0 (0.0%)	1 (2.9%)	1 (0.02%)	10 (14.9%)	18 (12.3%)	28 (13.1%)
Taenia spp.	0 (0.0%)	1 (2.9%)	1 (0.02%)	1 (0.01%)	0 (0.0%)	1 (0.005%)
Toxocara spp.	2 (14.3%)	0 (0.0%)	2 (0.04%)	0 (0.0%)	1 (0.007%)	1 (0.005%)
Capillaria hepatica	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.007%)	1 (0.005%)

found to occur more or less equally among positive male and female flies of both species ($p > 0.05$). However, a significantly greater percentage of *C. megacephala* harbored *T. trichiura* and hookworm eggs ($p < 0.05$). The stage or state of viability of the eggs was noted (Table 3) and only 29 out of the total 2,651 eggs recovered (1.1%) were potentially infective to man upon ingestion.

Table 4 presents the mean number of eggs per positive fly classified according to species and sex. Statistical analysis revealed that a positive *C. megacephala* harbored a significantly greater number of helminth eggs than a positive *M.*

domestica ($p < 0.05$). Sex differences were also noted with female *M. domestica* carrying significantly more eggs than males ($p < 0.05$) and male *C. megacephala* carrying significantly more eggs than females ($p < 0.05$).

DISCUSSION

Grassi (1883) is believed to be the first modern investigator to link flies with the dissemination of helminths of other animals. He was able to prove this in the laboratory for *T. trichiura* and oxyurid eggs. Similar results were derived from the works of Grassi and Rovelli (1889) and Galli-Valerio (1905) who demonstrated the role of flies in the spread of *Choanotaenia infundibulum* (a fowl tapeworm) and *Ancylostoma duodenale,* respectively.

It is clear from this study that synanthropic fly species such as *M. domestica* and *C. megacephala* have considerable potential in the dissemination of helminth ova. *C. megacephala* seems to play a more important role since a greater proportion of this species is naturally contaminated with a

Table 3

Stages or states of viability of helminth ova recovered from positive flies in Barangay 51, Pasay City, Metro Manila (August-October, 1986).

Helminth	Stages or States of Viability Found
Ascaris spp.	- unfertilized - fertilized: single or multicellular stage - embryonated
Trichuris trichiura	- fertilized
Hookworm	- fertilized: multicellular stage - with unhatched rhabditiform larva
Taenia spp.	- fertilized
Toxocara spp.	- fertilized: single or multicellular stage
Capillaria hepatica	- fertilized

Table 4

Total and mean number of helminth ova recovered from positive flies, classified according to species and sex.

Species	*Musca domestica*			*Chrysomya megacephala*		
	Male (n = 14)	Female (n = 34)	Total (n = 48)	Male (n = 67)	Female (n = 146)	Total (n = 213)
Total number of eggs recovered	20	105	125	1200	1326	2526
Mean number of eggs recovered per positive fly	1.4	3.1	2.6	17.9	9.1	11.9
S.D.	0.9	3.3	2.9	35.3	18.1	25.2

significantly greater number of helminth eggs (Tables 1 and 4).

This finding may be attributed to the greater size (exposed body surface area) and more promiscuous feeding habits of *C. megacephala.* As members of Calliphoridae, they are basically carrion feeders (Oldroyd, 1964) which also feed on garbage and excrement (Klots and Klots, 1967). Their predilection for human feces, especially when accumulated in large masses, has been documented by Bohart and Gressitt (1951), Thomas (1951) and Liu *et al* (1957) who found large numbers of adults and larvae infesting latrines, pit privies, cesspools and night soil tanks. In contrast, *M. domestica* has a wider range and diversity in food preference; in Manila, it was found that garbage is the principal breeding material (de la Paz, 1938a).

No significant difference was found in both species with respect to proportions of male and female flies found positive for helminth ova. This implies that both sexes are equally attracted to fecal matter which is the main source of contamination.

The sex ratio in both species significantly deviated from 1:1 ($p < 0.05$) with females outnumbering males. Food availability has been proven to be one of the factors affecting larval survival rates as well as the final sex ratio of adults that attain maturity. Larval females require more nourishment than males for their development and perish in greater number when subjected to a starvation diet. Underfed larval stages yield a preponderance of males while females predominate when food is abundant (Herms, 1928). This theory is substantiated by the observable presence of large amounts of uncollected garbage and human excreta scattered around this slum community. Males are also more susceptible to various species of bacteria; among them, *Staphylococcus muscae,* which causes a fatal infection (West, 1951).

Among the helminth ova reported in this study, human infection was potentially possible only upon ingestion of embryonated *Ascaris* spp. and fertilized *Taenia* spp. eggs. The *Ascaris* eggs could be either *A. lumbricoides* or *A. suum* since infected pigs are commonly raised beside the homes of the more affluent members of the community. Ingestion of these infective embryonated *Ascaris* spp. eggs could lead to the usual intestinal infection for *A. lumbricoides* or to transient symptoms associated with the migration of juvenile ascarids in the case of *A. suum* (Beaver *et al,* 1984).

The *Taenia* spp. eggs can not be identified to the species but the possibility of cysticercosis exists if they are ingested and are in fact those of *T. solium.* Ova of *T. trichiura,* hookworm, *Toxocara* spp. and *Capillaria hepatica* were not infective. However a longer period of incubation in the soil could have allowed some of these to develop into the infective stage. The presence of *Toxocara* spp. is attributable to the usual presence of domestic dogs and cats which defecate around indiscriminately. As for *Capillaria hepatica* which is known to be endemic among rats in the Philippines (Tubangui, 1947), eggs can be found in the feces of cats that have eaten infected rats or they may also be transferred to flies that have arisen from the decaying carcasses of infected rats in the vicinity.

It is controversial as to how important flies are in the transmission of helminthic diseases. Greenberg (1973) states that eggs adhering to the surface of the fly are removed as the fly cleans itself; this usually occurs shortly after the fly leaves the surface on which it has been feeding. Pipkin (1943) confirmed this by contaminating *M. domestica* with eggs of various nematodes. Flies remained externally contaminated for an average maximum period of only 3.47 hours.

Although external phoresy may be of short generation, it would be rash to conclude that it is therefore unimportant. In crowded environments such as the slums, a few hours are enough for contaminated flies to transfer these ova from their sources to the food and personal effects of people living nearby.

Documented cases of external phoretic relationships between flies and helminth eggs are abundant. Zmeev (1936) trapped 100 *M. domestica vicina* in toilets and found 2 out of 4 positive flies contaminated with eggs, probably of *Taenia saginata,* strongly attached to their legs. Pokrovski and Zima (1938) found that among 18 positive flies, 12 harbored several species of helminths on their legs, 1 on the wing and 5 in the gut. Harada (1954) showed experimentally that larvae of *A. caninum* can be carried on the bristles and pulvilli of *Calliphora sp.* and *M. domestica.*

Since this study involved the investigation of helminth eggs transported externally on the surface of the fly's body, it must be pointed out that the role of flies in the dissemination of parasitic diseases increases in magnitude when we consider those viable helminth eggs which are ingested internally by the fly and pass through its gut to be expelled unharmed through the feces. The size of the eggs was found to be a limiting factor since only those with a diameter less than 0.05 mm were capable of being ingested (Nicoll, 1911). Chang (1940) assessed the importance of synanthropic flies as carriers of human intestinal parasites in Chengdu, China; he discovered *Entamoeba histolytica* and *Giardia lamblia* in the digestive tract but the frequency of helminth eggs (hookworm, *Trichuris trichiura* and *Ascaris lumbricoides*) was even greater. In his experience, examination by homogenization was less effective than dissection of individual flies.

In conclusion, although this study did not present direct evidence relating the prevalence of human infection in a slum community with the presence of contaminated flies, the data suggest that mechanical transmission of helminth eggs by synanthropic species of flies may be vital in the epidemiology of certain helminthic diseases in typical urban slums of Metro Manila.

A substantial percentage of flies (9.4% for *M. domestica* and 41% for *C. megacephala*) harbored helminth ova, the majority of which were not infective to man. Nevertheless, the potential for transmission of the infective stage exists. Greenberg (1973) states "the presence of contaminated flies in poverty areas where sanitation is low, food is unduly exposed and human infection rates are high provide us with compelling though still non-conclusive evidence of fly transmission".

Further studies investigating the frequency and state of viability of helminth eggs transported by flies via internal phoresy would be enlightening.

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