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Full Length Research Paper

The role of cockroaches and flies in mechanical transmission of medical important parasites

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Arthropods can be found on human or animals as ecto-parasites. Vectors can contaminate stored foods and transmit illness, or introduce diseases in new areas. Pet species facilitating infestations, and different risk factors related to infestation were identified. To determine the possible role of insects in dissemination of medically important parasites, study was carried out in residential areas of Khaldyia Village, El–Fayoum governorate, Egypt In 2009 - 2010. Parasites of medical importance were isolated and identified. The cockroaches collected from residential areas were 45 as the control group. A total of 178 cockroaches were collected, over a period of one year. Flies collected from human feces were also observed. Flies were abundant in defecation areas and around houses. This study aimed to isolating parasite objects from the exteriors of the bodies of flies, and Isolation and identification of parasites from internal and external surface of cockroaches, and to investigate parasite transmission rates among flies in an unsanitary community.

Key words: Mechanical transmission, flies, cockroaches.

INTRODUCTION

Arthropods are probably the most successful of all animals because of one or other reasons. They are found in every type of habitat and in all regions of the world. They feed on a wide variety of plant or animal material and have been known as major cause diseases for centuries.

Without the vector, the parasite life cycle would be broken and the pathogen cannot survive. Vectors can cause harm in different ways. They may cause illness, and this may happen through the consumption of food contain human entero pathogens, mechanically transmitted by flies or cockroaches. Muscoids dipterans have always been associated with human and domestic animals due to the abundance of food resources found in stables and domestic garbages. These flies are of major concern for veterinary medicine due to their capacity to act as vectors of several pathogenic organisms such as protozoa cysts, helminth parasites, enteropathogenic bacteria, and enterovirus (Graczyk et al., 2001).

Stored food products may be damaged or contaminated by live or dead insects, faeces from them, odours, webbing or cast skins. Furthermore, vectors such as mosquitoes maybe introduced, and established in areas in which they have not previously been found (Chandler and Read, 1962), and where vector borne diseases can spread. Closed living accommodation favour the spread of ecto-parasites. Overcrowding, bad hygiene and lack of ventilation made the place an ideal environment for infection.

Soil transmitted helminths (STH) are relatively common parasites in the slum and rural area of many countries (Che Ghani et al., 1993; Sornmani et al., 1983; 2004), this high prevalence is closely related to poor environmental hygiene, and impoverished health services (Montresor et al., 1998). The main source of transmission is defecation outside latrines by heavily infected persons (Mott, 1989). While contaminated water might be the major transmission mode, indirect transmission by non biting flies cannot be excluded (Chandler and Read, 1962; Getachew et al., 2007). Many authors have indicated that the primary school children are an ideal target group for (STH) (Bundy et al., 1992), as children frequently defecate indiscriminately around their houses, particularly in the courtyards, sitting room, drains, even houses

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has latrines (Lai and Ow Yang, 1993; Yu et al., 1993).

Over 50 species of synanthropic flies have been reported to be associated with unsanitary conditions and are involved in dissemination of human pathogens in the environment(Olsen, 1998).

In unsanitary communities, garbage, dead animal carcasses, and piles of feces, are often scattered around the houses. Flies are commonly found both indoor and outdoors. They persist on excrement, dead animal bodies, and contaminated areas where faecal matter, large amounts of organic waste, and piles of garbage are left exposed and unattended (Sualiman et al., 1989), theoretically, flies can transmit helminths through mechanical or biological means (Harwood and James, 1979). Human pathogens can also be transmitted as airborne particles for short distances from fly- electrocuting traps, as electrocuting traps do not alter the infectivity of pathogens transported by flies (Olsen, 1998). There are size limitations regarding the transmittal from the communicated sites. Bigger particles such as helminth eggs are transported by flies on their external surface, that is, exoskeletons, while small cystic stages of human infectious intestinal protozoa can be ingested as well as transported on the exoskeleton.

When infected persons excrete in open areas, there is an increased risk of contact between flies and pathogen-positive faecal matter (Getachew et al., 2007). Several studies have shown that eggs of *Ascaris lumbericoides*, *Trichuris trichiura*, hook worm, *Entrobious vermicularis*, *Taenis* sp., *Hymenolips nana*, *Toxocara canis*, hook worm larvae, and *Strongyloides* larvae are carried by many species of house flies (Getachew et al., 2007; Sualiman et al., 1989).

Cockroaches are among the most notorious pests of premises, they frequently feed on human faeces, and therefore they can disseminate cysts of enteric protozoans in the environment if such faeces are contaminated (19). They can not only contaminate food by leaving droppings and bacteria that can cause food poisoning (Che Ghani et al., 1993) but also they can transmit bacteria, fungi, and other pathogenic microorganisms in infected areas (Czajka et al., 2003; Kopanic, 1994). Cockroaches feed on garbage and sewage and so have copious opportunities to disseminate human pathogen (Cotton et al., 2000; Pai et al., 2005). Also their nocturnal and filthy habits make them ideal carriers of various pathogenic microorganisms (Allen, 1987). Some parasites have been found in external surface or internal parts of body of cockroaches and some studies have shown that exposure to cockroach antigens may play an important role in asthma- related health problems (Montresor et al., 1998; Mott, 1989).

The study was carried out in an unsanitary community where parasitic infections and soil contamination with helminth ova were high and where flies were abundant in defecation areas and house hold environment.

This study aimed to isolate parasite objects from the exteriors of the bodies of flies, and Isolation and identification of parasites from internal and external surface of cockroaches, and to investigate parasite transmission rates among flies in an unsanitary community. The Ethics Committee for this study protocol has been approved by the governorate.

MATERIALS AND METHODS

Study area

The study area was Khalidiya village. It is located north of the Fayoum city. The village presents severe lack of hygiene services, although it occupies a unique tourist site that is far less than half a kilometer from Qarun lake.

This area was chosen because when we conducted a study of parasite infections in this area, we observed many piles of faecal matter in the nearby mangrove swamp.

Flies were seen everywhere in the area on food during meals, around children eating confectionery, flies were above sleeping children, dropped food, baby toys, and garbage. The abundance of flies around the house hold was attributable to the stock of rotten fish, and could also be caused because of the product of the cuttlefish harvest.

Fly collection

Flies were collected from the mangrove swamp and the nearby community, since many flies were seen on every pile of faecal matter in the swamp. The best method for collecting them was by stool bait trap.

Field-expedient bottle traps

Fly traps can be fashioned from disposable plastic water bottles. The simplest of these were constructed by cutting off the top and inverting it to form a cone leading into the body of the bottle, where bait is placed. Flies attracted to the bait are trapped inside the bottle and disposed of when the bottle becomes too full to be effective (Figure 1). Baits may consist of spoiling fruit or meat, food residue, and similar fragrant items. Once flies are attracted into the bottle, their natural pheromones increase attractiveness of the trap to other flies. These traps can be hung (no higher than 2.5 to 3 m) or placed on the ground out of traffic areas.

Under adverse environmental conditions, such as constant high wind, rain, or dust storms which cause fly baits less effectiveness, it may becomes necessary to employ alternatives for dispensing baits. One of it is to add poison in the bait of the trap which is illustrated earlier, or fashion a trap filled to a depth of 5 cm with poison fly bait and in which four 6 mm holes are cut near the top of the bottle to allow the flies access (Figure 2). The trap should be hung between 1 and 3 m above the ground. These traps also work well indoors. The contents must be shaken periodically so that dead flies do not accumulate on the surface of the bait, inhibiting contact between newly attracted flies and the poison. Another technique is to place the bait in a box to keep it from blowing away or becoming soaked or dust-coated. A simple example is to put granular fly bait in a flat box constructed from scrap wood, clearly labeled with the appropriate warning, and place the box on the ground where flies can access it. Such boxes should be checked periodically to dump dead flies and recharge them with bait. Dead flies should be disposed with waste material, ideally with medical waste when possible. An added advantage to this method is that it prevents troops from collecting and misusing the bait. These bait stations work well when placed near latrines, showers, and waste disposal sites

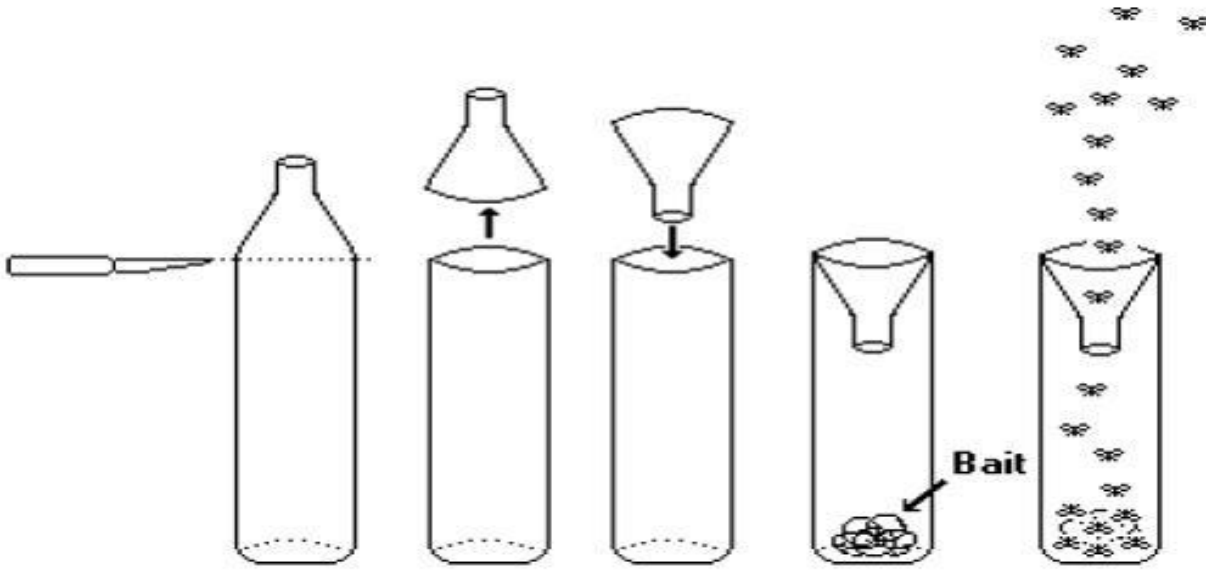

Figure 1. Plastic water bottle fly trap (inverted cone model).

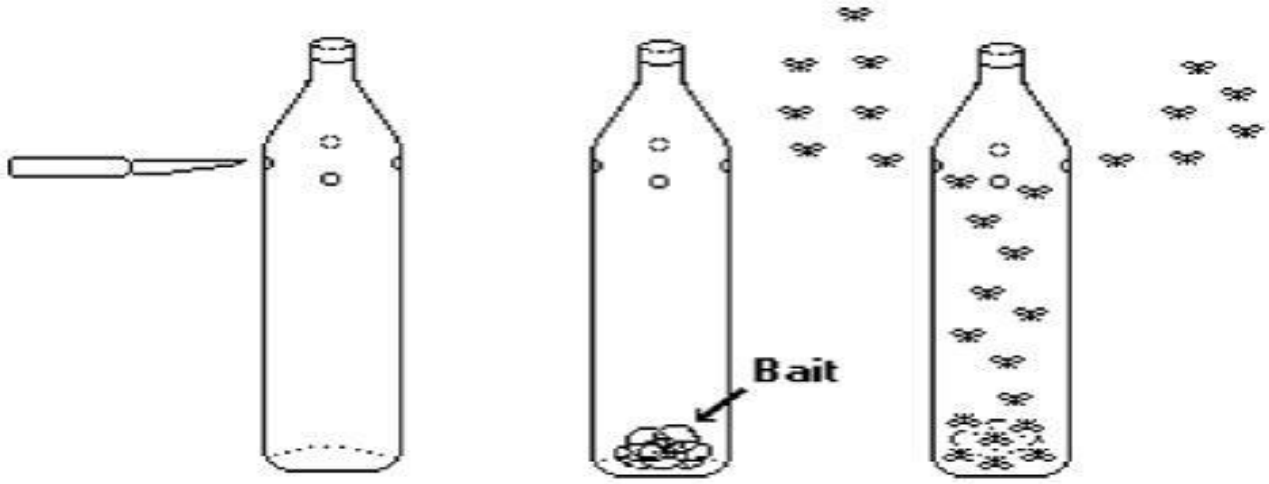

Figure 2. Plastic water bottle fly trap (multi-hole model).

(burn locations, dump sites, etc.

A stool sample with a mass of flies on its surface was chosen as the bait was placed in a fly trap left in the area and left for 1 h. To attract the attention of the flies, other piles of faecal matter were covered with sand, soil, leaves, or a wood during fly collection. Due to the strong sunlight and high temperatures during the day time summer (July), most of the flies become somnolent and were easily collected in the collecting chamber and transferred to collecting tubes. In the community rotten fish was used to lure and trap the flies.

Fly examination

The flies were divided into 2 groups, as follow:

1. Flies, from mangrove swamp, represented a homogeneous contamination of the fly population since they were exposed to the same source of infection and community group.

2. Helminths ova on the body surfaces were examined using manual shaking technique. 10flies were pooled and stored in a test tube with formalin detergent solution (FDS), while 200 flies were processed per test.

Specimens were brought to the laboratory for processing.

Laboratory processing

The collected flies were washed by manual shaking for 1 min. The flies were removed by clean forceps and kept for identification.

The remaining preparation was centrifuged at 2000 rpmfor2min. All sediments were examined under a light microscope for parasite objects.

Cockroach collection

One hundred and seventy-eight cockroaches were collected, over a period of one year, 133 from different wards of houses of the village as the test group and 45 from residential areas, situated within 2 km premises from the study areas as the control group.

The test group of insects captured (mostly at night time or early morning) from the floor of wards and kitchens, basements or bathrooms of residential areas.

Each cockroach was collected in a sterile test tube transported to the laboratory and anaesthetised by outing at 0°C for 5 min examined under the dissecting microscope and identified using standard taxonomic keys. For comparing control and test group, Chi –square test was applied.

Isolation and identification of parasite from external surface

After identification, 2 ml of sterile normal saline (0.9%) was added to the test tube and the cockroaches were thoroughly shaken for 2 min.

Isolation of parasitic cyst was carried out by using 1 ml of the washing result which was centrifuged at 2000 rpm for 5 min. The deposit was then examined after staining with 1% lugols iodine under light microscopy and identified (Beaver et al., 1984).

Isolation and identification of parasites from internal surfaces

After external washings, cockroaches were placed in flasks rinsed with 70% alcohol for 5 min. (to decontaminate external surfaces as 70% alcohol is bactericidal). They were transferred to other flasks and allowed to dry at room temperature. Cockroaches were then washed with normal saline for 2t o 3 min to remove traces of alcohol. Only whole and live captured cockroaches were utilised for the study. After being immobilised at 0°C the gut of the cockroach was dissected out and macerated in 2 ml of normal saline. The resulting macerate was then processed in a similar way as described previously and the results recorded. For parasites ova/cysts, about 1 ml of the washing result was centrifuged at 2000 rpm for 5 min. and the resulting deposit examined after staining with 10% Lugol iodine under light microscope and identified (Beaver et al., 1984).

RESULTS

Flies with helminthic objects on the body surface

A total of 576 house flies (195 male and 381 female) were studied, all were identified as *Musca domestica*, and *Chrysomya megacephala*.

108 flies from the swamp area and 68 house flies in the community were studied. The results are shown in Table 1 and 2.

Among 28 flies from the swamp area, 17 Hook worm eggs, 17 *T. trichura* and 1 *Ascaris* were detected (25.9%). The average egg count per positive fly was 1:3. Most flies carried only one egg on the body surface, while 17.9 and 7.1 % had 2 and 3 eggs respectively.

In the community 8 house flies (11.8%) were contaminated with Hook worm and *T. trichura* eggs, the average egg count per positive fly was 1.0.

Faecal dots attached to the inner surface of the collection chamber were washed with FD solution and examined for helminth objects, this contamination occurred when the flies were trapped in the chamber. In the laboratory, the washing was processed by sedimentation method.

0.5 ml of sediment was obtained containing 27 *T. trichura* and 27 hook worms; the total number of eggs carried by the 508 flies in the mangrove swamp was derived from the pooled eggs from the sediment, egg in the two trials. The average number of eggs on the body surface of a fly was 0.4. Mites, the ectoparasite of the flies were also isolated from the body surfaces of the house flies, the number of mites per fly ranged 1 to 40.

This study revealed that cockroaches trapped from different sites (toilets, parlours, kitchens and bedrooms) in the houses with pit latrines and water system shared the same parasites. The parasites included: cysts of *Entomoeba hystolitica*, oocysts of *C. parvum, C. cayetenensis* and *Isospora belli,* cysts of *Balantidium coli*, ova of *A. lumbricoides, Anchylostoma deodunale, Enterobius. vermicularis,* ovae *Trichuris. trichura* and larvae of *Strongyloides stercoralis.* (Table 3)

Cockroaches trapped in the toilets of houses with pit latrines had a mean parasites count of 98 parasites/ml while those trapped in the houses with water system had a mean parasitic count of 31 parasites/ml. On the other hand a mean parasitic count of 19 parasites/ml were recorded from kitchens of houses with water system (Table 4).

Medically important parasites were isolated from external and internal surface of 98% of test cockroach and 8.9% of control cockroach.

Human parasites isolated from test group of cockroaches showed adult *E. vermicularis* and 8 *Ascaris* egg in two cockroaches but observation of control group did not show any parasites.

DISCUSSION

In the village, people did not consider parasites infection a serious problem, most did not submit stool for examination. Some infected cases refused to take antiparasitic drugs.

House flies, bush flies, and blow flies were common around the house holds, in garbage and in human and animal excreta (Getachew et al., 2007: 30; Sualiman et al., 1989; Monzon et al., 1991)

House flies are a proven mechanical transmitter of pathogens to human food (Sulaiman S,Sohadi AR, Yunus H, Iberahim R, 1988). Ten intestinal helminth eggs and larvae has been isolated from flies collected around house hold, in un urban slum area, on an open defecation area, garbage heap, a small open air market, larvae has been isolated from flies collected around household,

Table 1. Percentage of contaminated flies in study area.

Area	No. examined	Positive flies [No. (%)]	Helminths eggs and larvae			
			Hook worm	*T. trichura*	Ascaris	*H. nana*
Swamp	108	28 (25.9)	17	17	1	4
Community	68	8(11.8)	5	5	0	1

Table 2. Number of parasite eggs on the body surfaces of flies in the swamp area.

Trails	Number of flies	Helminths eggs and larvae				Total
		Hook worm	*T. trichura*	*Ascaris*	*H. nana*	
Manual	400		86	34	-	121
Contamination rate	108	17	17	1	-	35
Washed sediment	-	27	27	-	-	54
Total	508	130	78	2	-	210

Table 3. Distribution of medical important parasites by sites and toilet facilities.

Source	No. of cockroaches studied	
	Pit toilet	Water system
Toilets	35	22
Kitchens	27	22
Living-rooms	16	10
Bed-rooms	14	8

Parasites identified—Cysts of *E. histolytica,* cysts of *Balantidium coli,* ova of *Ascaris lumbricoides*, *Anchylostoma deodunalae*, *Enterobius vermicularis*, ova of *Trichuris trichura* and larvae of *Strongyloides stercoralis*.

Table 4. Mean parasite count of cockroaches by site and toilet facilities.

Source	Pit toilet	Water system
	Mean parasitic count (parasite/ml)	Mean parasitic count (parasite/ml)
Toilets	98	31
Kitchens	50	19
Living-rooms	47	11
Bed-rooms	38	11

Parasites identified—Cysts of *E. histolytica*, cysts of *Balantidium coli*, ova of *Ascaris lumbricoides, Anchylostoma deodunalae, Enterobius vermicularis,* ova of *Trichuris trichura* and larvae of *Strongyloides stercoralis*.

in un urban slum area, on an open defecation area, garbage heap, a small open air market,and meat butchers near human dwellings (Getachew et al., 2007;30; Sualiman et al., 1989; Beaver et al., 1984). Because the mangrove swamp was the post- tsunami defecated area for the villagers, piles of faecal matter attracted flies. After feeding and resting, the flies travelled into the community, about 100 m from the feeding site. Flies that had direct contact with parasite positive faeces were efficient carriers, because at least 25.9% were contaminated with pathogens. In the defecation area every 2 to 3 flies carried at least 1 parasite objects on the body surface. After feeding, they rested in the area and contaminated the environment with the pathogens on their footpads, hairs, bristles, and external mouth parts.

An almost invisible dot of faeces in the environment might contain eggs or larvae that develop further and then transmit to humans.

In this community 11.8% of flies had eggs on their body surface and could transmit them to human food, and household surroundings. 25.9% of infected flies had 2 to 3 eggs adhering to their body surface. The study found that 508 flies could leave 0.5 ml of faecal sediment in the collection chamber. This was considered to be the

amount of pathogenic faecal matter distributed into the environment by 508 flies, thus, a fly carried 0.001 g faecal mass on the body surface after feeding on human waste.

We did not investigate the presence of parasite objects in flies' guts. Nevertheless many researchers have reported higher parasite detection rates in the gastrointestinal lumen than on body surface (Getachew et al., 2007; Monzon et al., 1991; Khan and Huq, 1978).

Sulaiman et al. (1989) found hook worm eggs and larvae in the gut of lies, but found more on external surfaces. From this investigation it may be concluded that only one person with a light soil transmitted infection can contaminate both defecation areas and disease vectors. Over 25.9% of the fly population was contaminated. After resting and contaminating the environment with infective matter carried on the body surface, they transmitted the infection to the community, at the rate of 11.8%. The discovery of *A. lumbercoides* eggs on the flies supported the supposition that housefly was a potential STH transmitter, which could carry and spread pathogens to other places, since they are able to travel up to 20 miles to unsanitary sites (Umeche and Mandah, 1989).

The current study showed that the house fly is a potential mechanical vector for parasite infection, and therefore its role in disease transmission should be not being underrated. In high risk areas, health education targeting the elderly should emphasize personal and environmental hygiene. In areas where open air defection is common, food must be strictly protected from house flies, since in this study are in every 11 flies around the house was found positive for helminth eggs. Other micro-organisms causing bacterial infection have been reported (Getachew et al., 2007).

The control or eradication of house flies should be attempted, to stop intestinal parasite transmission in the community, in addition to drug administration.

The results of the present study revealed contamination of almost all cockroaches collected from homes with different parasites which are significantly higher in comparison to control group. The importance of cockroaches as carrier of parasitic worm, cysts, or eggs, is because there are some reports about the presence of parasitic forms on or in cockroaches (Greenberg, 1973). The finding of the present study showed the parasitic contamination in high numbers. The presence of *E. vermicularis* infestation indicates that the cockroaches had opportunity to get in touch with infested patients or contaminated clothes which emphasises their vectorial potential for parasitic diseases (Chan et al., 2004).

Conclusions

Synanthropic insects such as flies and cockroaches can significantly contribute to the spread of food- borne parasites diseases in both developing and developed countries.

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