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Diversity and Abundance of Medically-Important Flies in the Iranian Triple Islands; the Greater Tunb, Lesser Tunb and Abu-Musa

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Abstract

Aims: The flies are medically important insects for military forces especially in tropical climate. The aim of this study was to determine the diversity and abundance of medically important flies in the Iranian Triple Islands in the Persian Gulf.

Methods: Flies trapping was done using EAG Sintuz fly trap and plastic water bottle fly trap from March 2010 to March 2011. The captured flies were identified using valid systematic keys and species descriptions. The fly relative frequency was estimated by the mean number of flies trapped in each trap.

Results: In this study, 10 species of medically important flies including Lucilia sericata, Chrsomyia megacephala, Chrysomia albiceps, Calliphora vicina, Sarcophaga aegyptica, Sarcophega africa, Wohlfartia magnifica, Passeromyia species, Muscina stabulans and Musca domestica were captured and identified. The relative abundance of flies in the three mentioned islands was estimated at 6.8 (SE= ± 1.2).There were two peaks of activity in a year; from March to May and from September to October.

Conclusion: The fly diversity and abundance in the studied islands is high especially in early spring and autumn when effective steps need to be taken to control fly population.

Keywords: Flies, Dipteral, Insects of Medical Importance, Persian Gulf Islands

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Introduction

Flies are among the largest groups of insects. They fall into dipteral category and Muscomorpha Cyclorrhapha subcategory [1]. They have a wide variety. Almost 150,000 species in 158 families have been identified and described. Out of this number, 285 species come from fanniidae family, 5,000 from Muscidae family, 1,500 from Caliphoridae family, and 2,500 species from Sarcophaga family [2,3]. Medically important flies, also called filth flies, are comprised of four species; Muscidae, Fanniidae, Caliphoridae, and Sarcophigidae and some similar flies [4].

Flies are daylight active insects that live in human-living environment. They are very fast and can mechanically and non-mechanically transmit numerous pathogens to human's food and living environment especially in warm seasons [1,4]. Through their legs, bristle, and excreting and vomiting on foods, flies can transmit more than 100 bacterial, virus, or protozoan pathogens such as polio, trachoma, hepatitis, coxiella burnetii, shigellosis, colora, salmonella, listeria, streptococci, staphylococci, entamoeba and giardia, nematodes, and cestode larva [4,5]. In addition, its larva can contaminate human and animal tissues and organs and cause myiasis [1,5].

Some species of flies can bite or drink blood as in the case of Tsetse fly which can transmit sleeping disease (African Trypanosomiasis) to human. Other biting flies such as stable flies (Stomoxys), Hippoboscidae flies and some others, play a role in the transmission of animal diseases such as Trypanosoma or the transmission of Haemoproteus to birds [5].

The studies carried out in developed countries show that there is a significant relationship between fly control and a decrease in diarrheic diseases and some other eye infections such as trachoma [6,7]. By controlling the number of flies in rural areas in Pakistan, diarrheic diseases considerably decreased [8]. Another study showed that human contamination with shigellosis has a strong relationship with the number of contaminated flies in a region. Studies show that by controlling and decreasing the fly population in military environments, the number of soldiers' visits to military clinics due to diarrheic and gastroenteritis diseases decreases [9]. Other studies have shown that in some areas in England, the outbreak of gastroenteritis diseases caused by Campylobacters has a strong relationship with fly population. Moreover, the outbreak of diarrheic diseases is often in summer which matches with the seasonality of flies [10].

Research shows that after natural disasters, due to the right conditions for the nourishment and breeding of flies and the rupture of sanitary control system, fly population increases rapidly. In 2004 tsunami in South Asia, the fly population had a sharp increase in camps and rural areas [11,12].

Military forces are always faced with high fly population problem and the dangers flies cause in their living environment. US military forces in the Persian Gulf war and Somalia faced with the problem of fly population, especially Musca flies, in their camps mostly due to the hygienic problems in the villages and cities [13]. Moreover, after natural disasters, the military forces usually enter the area for help. That's why controlling fly population in such a situation is one of the most important responsibilities of the military hygiene units especially in tropical regions or in warm seasons in non-tropical regions [13].

In Iran-Iraq war too, one of the problems for Iranian military forces especially in the south

was the number of flies. The profusion of flies had caused the outbreak of diarrheic diseases in the forces [14,15].

There have been a few faunic studies in Tehran on the fauna of Muscidae, Fanniidae, Caliphoridae, and Sarcophigidae flies [16,17]. In addition, in the studies carried out in Hormozgan, Iran, and the Iranian triple islands, some species of the Caliphorda flies were reported [19].

The very important, strategic, and geopolitical islands in the Persian Gulf have a hot weather which is very suitable for breeding and spread of insects in general and flies in particular. The carried out studies have pointed to the high number of insect species in these islands [19-21]. A lot of military forces are settled in these islands in order to protect and guard the Iranian sea borders. As such, the study of different species of medically important insects in these areas for the purpose of their population control is of utmost importance. The present study was an attempt for the identification of the medically important flies in the Iranian triple islands.

Methods

The present study was a cross-sectional descriptive study. It was done over a year in the Iranian triple islands in Persian Gulf in the southernmost tip of Iran (see Figure1).

Abu Musa Island, being 12 km^2 wide, has a longitude and latitude of 54° 26-55° 19 and 25° 51-26° 19 respectively. The Greater Tunb, 10.3 km^2 wide, has a longitude and latitude of 55° 28-55° 34 and 26° 34-26° 30 respectively. Finally, the Lesser Tunb, 2.1 km^2 wide, has a longitude and latitude of 54° 26-55° 8 and 25° 51-26° 14 respectively [21,23].

Trapping only mature flies was intended for the purpose of the study. To do so, EAG Sintuz fly traps were used with protein and blood powder prey. The traps were hung 1.5 to 2 meters above ground level near restaurants, in garbage dumps, and near residential areas (Figure 2). Another type of trap used was plastic water bottle fly trap in reversed cone model. This simple trap is made from mineral water plastic bottles. The upper part is cut and is put inside the bottle in the reversed form. In order not to let trapped flies escape, one needs to narrow the top using tubular plastic or net. In order to attract the flies, one needs to use some prey such as food remains, blood powder, or meat prey (Figure 3). Flies enter the trap to get to the prey but cannot find the way out. The odor of pheromone coming from the trapped flies attracts other flies. In order for other insects not to be trapped, the traps should be installed in an appropriate height (1-3 meters from ground level) [11].

The monthly trappings were done in each island for a year in sunny days with no wind. There were 4 traps in Abu Musa Island and the other two islands had 3 traps each. Due to the limited island width, the traps were installed in almost every fly-prone place.

The traps were installed after sunrise and were controlled twice; once at noon and then in the evening. The trapped flies were collected at each control. The traps were then collected at sunset. However, there were times when, due to the distance, the traps were collected 2 or 3 days later. The mean day temperature and humidity is presented based on the months of the year in Table 1.

Table 1. The Mean Temperature & Humidity in the Triple Island

Variables Months	April	May	June	July	August	September	October	November	December	January	February	March
Temperature	26	31	34	34	35	36	30	25	20	18	20	25
Humidity(٪)	62	60	65	70	68	72	70	45	38	66	78	71

The trapped flies, after being killed, were mounted in cyanide (cyanide potassium) bottles using entomology needles. Then the sample information including the time and place of trapping were attached to it, and samples were sent to laboratory.

It is worth mentioning that some of the traps, due to the attack by cats, weasels, or ants, were out of order. In order to avoid such problems, the next traps were installed in a better position out of other animals' reach.

In order to identify the species of the trapped mature flies, identification keys and the available descriptions and explanations were used [24-31]. The samples were also checked and confirmed by the Fly Systematic Identification Center in Nicolas University, Copernicus, Austria. It must be noted that the identification of Sarcophigidae flies was done using only the male flies because the available identification keys for this group of flies belong to the males and species are recognized mainly based on the male genitals. Practically, there is no identification key for the females [3,13,24,25,31]. As such, in fresh male samples, the genitals were taken out under stereomicroscope. For dried samples, the samples were kept in discator or a sealed bottle with a humid tissue for 24 hours. After the samples became soft, the genitals were removed.

The gender identification was done using the distance between the two eyes in Caliphoridae. Being dicoptic or the existence of some distance between the eyes distinguishes females from males which are holoptic (having eyes attached together). In Muscida family, though the eyes are not attached to each other in males, they are much closer to each other in comparison with females [1]. In Sarcophigidae family, though the distance between eyes in females is a little more than that of

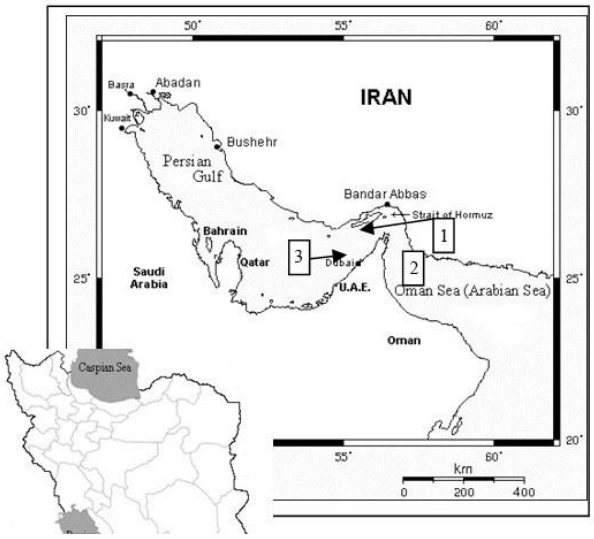

Figure 1. Geographical Location of Great Tunb Lesser Tunb and Abu Musa Islands in the Persioan Gulf Area 1- Great Tunb 2- Lesser Tunb 3-3 Abu Musu

males, checking male flies' genitals is a better identification technique [1]. In the present study, checking male genitals was used for the identification of Sarcophigidae flies. The samples are being kept in laboratory in Hygiene Research Center at Baqiyatallah University of Medical Sciences.

For data analysis, alpha level was set at 0.05. In order to compare the relative frequency of the trapped flies among different months of the year as well as the three islands, the two-way ANOVA test was used. Since the Leven's test was significant, the second root of the means was calculated and then the data were analyzed. For a two-by-two comparison, the Duncan's posthoc test was used.

Figure 2. AEG Sintuz fly trap

Figure 3. Plastic water bottle as fly trap

Results

On the whole, 120 traps were installed in the three islands. However, 6 (5%) were destroyed by animal attack and for other reasons. 1,025 insects were trapped in fly traps, but 250 (24.4%) of the trapped insects were bees or medically unimportant flies. The rest (775) were medically important flies from 3 families: Caliphoridae, Sarcophigidae, and Muscidae.

The mean ratio of fly number to the number of traps (not considering the fly species) was 6.8 flies in each trap (SD = 1.2). There was no significant difference between Abu Musa and the Greater Tunb for this number. However, the relative frequency of flies in the Lesser Tunb was significantly lower than the other two islands (See Table 2).

No significant difference observed in the number of flies trapped in the two trap types, but there was a significant difference in the number of trapped flies among the seasons and among the months of the year. Flies had two peaks in their activities in accordance with heat level; one in early spring, and one in early autumn (See Figure 5). Though the frequency of flies in Mehr (almost November 23rd to October 22nd) was less than that in first two months in spring (almost March 20th to May 20th), it was significantly more than other months of the year. As such, the highest number of flies was seen in Farvardin (almost March 20th to April 20th), Ordibehesht (almost April 21st to May 20th), and Mehr (almost November 23rd to October 22nd) respectively, with Tir (almost June 22nd to July 22nd), Mordad (almost July 23rd to August 22nd), and Bahman (almost January 21st to February 20th) having the lowest number of flies (See Figure 5). The highest number of trapped flies was in spring and autumn, and the lowest number of flies was in summer and winter.

Regarding the fly type, the majority of the trapped flies were Sarcophigidae (41.6%). In addition, 85% of the trapped flies were female. On the whole, 10 medically important species were observed in the 3 families; 4 in Caliphoridae, 3 in Sarcophigidae, and 3 in

Muscidae. The variety of species in Abu Musa was better than the other two islands.
A total number of 318 Sarcophigidae flies were trapped including 188 (59.1%) Sarcophaga flies, and 130 (40.8%) Wohlfatria flies. Wohlfatria magnifica was trapped in all three islands while Sarcophaga aegyptica was trapped only in Abu Musa and Sarcophaga africa was trapped in Abu Musa and the Greater Tunb but not the other island (See Table 4).

Four species were trapped from the Caliphoridae family in all the three islands: Lucilia sericata, Chrysomya megacephala, Calliphora vicina, and Ch. Albiceps.

Musina stabulans, Musca domestica or house fly and a kind of Passeromyia from Muscidae family were also trapped in all the studied islands.
According to the researchers' observations, there were no livestock in the Greater and Lesser Tunb Islands. As such, searching for myiasis was not logical. In Abu Musa Island, there was one traditional husbandry with keeping Pakistani goats. There were also a few camels in the island, but in the examinations, no sign of myiasis was observed. In addition, there was no recorded case with human myiasis in the islands' health centers. The authorities also stated that no case of myiasis had been reported in the past few years in the triple islands

Table 2. Frequency of Files & Traps in the Triple Islands

Island	No. of installed traps in a year	No. of undamaged Traps	No. of Trapped Flies	Frequency Trap(±SE)
Greater Tunb	36	35	257	7/3±1/1
Lesser Tunb	36	36	171	4/8±0/8
Abu Musa	48	43	347	8/1±1/6
Total	120	114	775	6/8±1/2

Table 3. Frequency of Male & Female Medically Important Files

Family	Gender		Total	Percentage
	Male	Female		
Caliphoridae	17(50%)	242(83%)	292	38/2%
Sarcophigidae	24(8%)	294(92%)	318	41/6%
Muscidae	38(25%)	116(75%)	154	20/2%
Total	112(14/7%)	652(85/3%)	764	%100

Table 4. The Identified Fly Species in the Triple Islands

Species	Island			Total(٪)
	Greater Tunb	Lesser Tunb	Abu Musa	
Lucilia sericata	19	3	11	33(%7)
Chrysomya megacephala	13	8	39	60 (12/8)
Ch.albiceps	31	20	104	155 (%33)
Calliphora vicinia	14	4	26	44 (9/4%)

Species	Island			Total(٪)
	Greater Tunb	Lesser Tunb	Abu Musa	
Sarcophaga aegyptica	-	-	1	1 (0/2%)
Sarcophaga africa	1	-	1	2 (0/4%)
Wohlfatria magnifia	8	2	11	21 (4/5%)
Passeromia*	3	1	2	6 (1/3%)
Musina stabulans	12	10	36	58(12/3%)
Musca domestica	25	36	29	90 (19/1%)
Total	126	84	260	470 (%100)

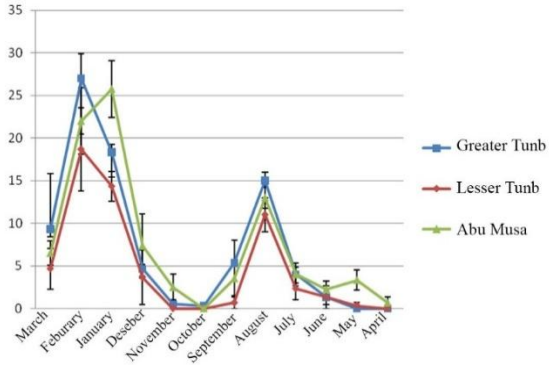

Figure 4. Relative Frequency of Files in each Month

Discussion

On the whole, 10 medically important fly species were identified in the three islands, including: Lucilia sericata, Chrysomya megacephala, Calliphora vicina, Chrysomia albiceps, Sarcophaga Aegyptica, Sarcophaga africa, Wohlfatria magnifica, Musina stabulans, Musca domestica, and a species from Passeromyia. The trapped species were important due to their ability to mechanically transmit virus, bacterial, and parasitic diseases such as diarrheic diseases and myiasis [1,4]. In the other studies done on flies in the triple islands, only four species (Musca domestica, Lucilia sericata, Wohlfatria magnifica, and Chrysomya albiceps) were reported [19], but in the present study, more medically important species were observed: 5 in Lesser Tunb, 6 in the Greater Tunb, and 7 in Abu Musa. It is worth mentioning that Chrysomya megacephala and Ch. albiceps were already reported in Bandar-e-Abbas, Hormozgan Province, Iran [18].

Regarding the Sarcophigidae family, two species, Sarcophaga aegyptica and Sarcophaga africa, were trapped in Abu Musa and the Greater Tunb, which were the first time report of them in the Persian Gulf. The presence of Sarcophaga aegyptica in Iran was already reported by Sugiyama in 1989 and that of Sarcophaga africa was first reported by Pape in 1996 [31,32]. Sarcophaga africa species lives in human living environments and is a medically important species because its larva can cause myiasis in human and livestock, and it is used in forensic medicine for determining death time [33, 34]. Sarcophaga aegyptica species, which is sinantropic and likes warm weather, is found in pole arctic and Afro-tropical areas [37].

Wohlfatria magnifica from Sarcophigidae family is a dangerous species. It can cause myiasis. Its larva can cause eye, ear, and nose traumatic myiasis in human and animals

[1,36]. This species was trapped in all the three islands.

Figure 5. Wohlfahrtia Magnifia Trapped in Genitalia

The Passeromyia trapped from Muscidae family was only checked for gender. The identification of the type needs more investigation. Their identification needs Muscidae specialists' opinion. Some of the Passeromyia species at larva stage are bird parasite [38]. The mature Passeromyia flies are relatively bigger and stronger with 9 mm in length. They are characterized by a white powder-like cover on their body. There is some distance between eyes in both genders, but it is more in the females [28].

The relative frequency of Sarcophigidae was higher than the others, with Caliphoridae being second and Muscidae having the lowest frequency. In fact, this indicates the number of flies attracted to the traps, and it cannot be a precise measure of their frequency. It seems that Muscidae flies are less attracted to these traps especially if the traps are collected in day light and less time is available for fly pheromone oders to spread. Such a smell can attract other flies.

The mean relative frequency of flies in triple islands was 6.8 per each trap, but this number was different during different seasons and months. The relative frequency and activity of flies has a direct relationship with food as well as optimum temperature and humidity. They rest in very hot and very cold weather [1]. As such, and based on the peak of their activity, which is in early spring and autumn, the military health and hygiene units need to attempt to control fly population.

The abundance and variety of flies in the Lesser Tunb was less than other two islands, which could be due to the fact that this island is only about 2 km2 wide. More than 85% of the trapped flies were female. In fact, female flies are more sensitive to the odor of protein and meat preys, and searching for an appropriate place for feeding and breeding, they enter the traps [11,39]. This does not make a problem in the case of Caliphoridae, and Muscidae because using the available identification keys, it is possible to identify both genders. However, regarding the Sarcophigidae flies which are identified based on males, the identification is more difficult. It is worth mentioning that 92% of the Sarcophigidae trapped flies were female. The female Sarcophigidae flies usually search for a place for their lava. As such, the larva present in traps can be used for culturing and having mature male flies to be used for identification.

In addition to transmitting myiasis, flies have an important role in the mechanical transmission of diseases in tropical areas. Flies are among insects which are very important to military forces because they can transmit diarrheic diseases and result in a fall in soldiers' combat power or even result in their mortality. That's why all over the world the presence and control of flies in military environments is of utmost importance [11]. It is suggested that future research examine the identification of bacterial pathogens in diarrheic diseases and the fly parasites in the triple islands. Due to the variety in fly species, it is suggested that faunal identification of medically important flies in other islands
in the Persian Gulf be studied.
The abundance of flies in these islands is high in the majority of months. This can be due to appropriate weather and environment for their reproduction and breeding. According to the reports and observations, garbage

dumping has been the most critical problem in these islands. The accumulation of the wastes helps the proliferation of flies and the transmission of diseases. Waste management in islands is an effective strategy in decreasing fly population because improving environmental sanitation is the best way for fly control [1, 39]. At the same time as the sanitation systems are being improved, using more physical protective devices such as metal nets for windows can be helpful. Saturating such nets with insecticides can also help decrease the number of flies in public places [40,41].

Although most repellents are not as efficient for flies as they are for mosquitoes, the use of non-chemical repellents with mint, citronella, and eucalyptus essence and chemical repellents can help keep flies away [42,43]. Due to the repelling nature of pyrethroid insecticides, saturating military forces' uniforms in permethrin can repel flies [44,45].

Conclusion

The importance of the abundance and relative frequency of medically important flies in the triple islands, which are very important and strategic islands with military significance, is high. Most of the year time, especially in early spring and autumn, the weather condition is so appropriate for flies' reproduction. The accumulation of wastes in the islands also helps that. Therefore, effective steps need to be taken to control fly population in these seasons.

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The present study is dedicated to all military forces and the natives living in the studied islands.

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