

Biological Diversity and the Synanthropy Behaviour of Calliphoridae Flies in Abadan County, 2015

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Abstract

Background: Some members of family Calliphoridae are myiasis agents and mechanical vectors of some pathogens. The aim of this study was to measure the biodiversity and synanthropy behaviour of Calliphoridae flies in Abadan, Khuzestan province.

Methods: Data were collected based on a monthly schedule during March to December 2014 in urban, semi-urban and rural ecosystems of Abadan County. Bottle trap was equipped with 30 g of chicken liver and installed 3 days in each collection site where net collection was done for about 30 minutes. Synanthropy Index (SI) of flies and biodiversity indices including Simpson, Shannon-Wiener and Margalef were calculated.

Results: As many as 1479 samples of Calliphoridae were collected including 18, 1212 and 249 specimens of *Chrysomya megacephala*, *C. bezziana* and *C. albiceps* respectively. *C. bezziana* showed a moderate SI in some collecting times. In spite of more collection of *C. megacephala* in all three ecosystems, its SI had the highest range in comparisons with the others. The biodiversity of Calliphoridae community was high in spring ($H' = 0.67$) while the highest diversity of dominant species was in autumn ($1-D = 0.74$). Margalef Index showed equal estimation of species richness in spring and autumn ($Mg = 0.3$) but it was reduced in summer.

Conclusion: *C. megacephala* was the common species of Calliphoridae in Abadan. Abadan is an old international county in Iran which is the host of many domestic and international engineers, workers and visitors. Knowing the fauna and behaviour of medically important flies would be a major fact for the conditions of the health status of this city.

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Introduction

The Calliphoridae (Diptera: Cyclorrhapha) have about 1000 species and are distributed in all tropic and sub-tropic

areas of the world. As one of the biggest families of Cyclorrhaphan Diptera, Calliphoridae follow the main feeding strategy of higher Diptera and breed in filthy habitats (1). They

are cleaners of the nature and can live on all human and animal wastes as well as among the common flies which are necrophagous (2). Anthropogenic ecosystems are suitable places for these necrophagous blowflies as members of a globally distributed family, Calliphoridae. Therefore, they have potentiality to transmit some pathogens mechanically to humans and animals (3). Considering them as mechanical vectors, they feed on infected wastes and move to food and open wounds of humans and animals.

Increased number of food-borne diarrhea patients is in positive relationship with increase in population of filth flies in some seasons (4).

Despite their potential as mechanical vectors, this behaviour is mostly studied on house flies, *Musca domestica* (Ditera: Muscidae), in Iran (5).

As they are the first visitors of human and animal cadavers, they are important in forensic entomology especially for the estimation of PMI (Post Mortem Interval) (6). Some of them are main agents for various kinds of myiasis (7, 8). Myiasis is defined as the larvae of higher flies (Cyclorrhapha) enter the human and animal body tissues and consume the digested food or mucus of the body at least in a period of time (9). Larvae of some members of Calliphoridae are responsible for huge economic losses around the world due to their attack to livestock as agents of obligatory myiasis. *Cochliomyia huminivorax* in new world and *C. bezziana* in old world are responsible for such economic damages. Obligatory myiasis agents attack live tissues and can move to open wounds of humans and animals after a small damage on the skin. Recent studies have shown that the main myiasis agent of cattle wounds is not *C. bezziaia* but it has its role in producing obligatory myiasis in Iran which needs special attention (10).

Nevertheless, most members of this family are agents of facultative myiasis. Larvae of facultative myiasis such as *C. albiceps* grow on dead and necrotic tissues. This feeding behavior of some species of Calliphoridae family such as *Lucilia sericata* is used in maggot therapy of chronic ulcers on humans and animals.

Members of Calliphoridae family have various behaviours in human occupied environment. Some of them are very close which are named synanthropic or eusynanthropic flies (11). New ecological niches may be made due to human activities which make possibilities for living of some flies. In this condition, synanthropic flies can remain easily and an increase of the related diseases can be expected (12).

The species of synanthropic flies seem to be more than 50 around the world (13).

The potential of Calliphoridae flies in accompanying human in the cities can be estimated by Synanthropy Index (SI). This index is related to various biological and ecological conditions. This index can be varied from -100 to 100. Species with higher numbers in this range may be mentioned as eusynanthropic flies (12, 14).

Iran has various geographical conditions. Based on biogeographical points of view, Iran is placed in Palaearctic zone and has influences of Afrotropical from southwest and Oriental from southeast. Investigations on fauna and biodiversity of flies have been conducted in some parts of Iran such as fauna of Sistan and Baluchestan province (15), North Khorassan and Kerman (16), Fars province (17), Iranian triple islands in Persian Gulf (18) and so on. These studies did not focus on calliphoridae family. There is not a study on the diversity of flies in southwest where Abadan County is located.

Abadan County is one of the most important cities in Iran due to economic and political issues. This city is the host of many domestic and international engineers and workers concerning oil and gas industries. In addition, on account of its rebuild after war, we decided to undertake this study in Abadan. Our study highlights the presence and activity of medically important flies in Abadan. Abadan is also a corridor for importing and exporting goods from Persian Gulf. This study was conducted with the aim of determining the biodiversity and synanthropy behaviour of Calliphoridae flies in Abadan, Khuzestan province.

Materials and Methods

This cross-sectional study was undertaken on calliphoridae fly community. Three sites in each of the three ecosystems of the city in the centre, semi-urban area and villages around Abadan have selected for sampling of flies. Sampling was conducted based on a monthly schedule during March to December 2014. Due to winter time, collection did not continue in Jan and Feb 2015. Two sampling methods were used for this study including net collection and bottle trap collection. Traps were installed in a suitable height and we put 30 grams of chicken liver as bait inside. Each trap was installed just for three days in each month. Trapped flies were collected three days after installing. Net collection was done in some places near the traps for half an hour at the day of installing of traps. The collected flies were pinned after anesthetizing and were identified using new published keys for Calliphoridae of Eastern Mediterranean Region (19).

SI calculation was done with the formula, $SI = (2a + b - 2c) / 2$, which was introduced by Nuorteva 1963 (14, 20). In this equation a, b and c are representative for percentage of fly

species in condensed human area, city, percentage of fly species in moderate condensed area, semi-urban, and percentage of fly species in rural area respectively (20)

Shannon-Wiener and Simpson (1-D) indices were calculated to estimate the overall biodiversity and diversity of dominant species in the fly community. For species richness, the Margalef index was calculated. Evenness index was calculated to show how even the distribution of species in the area was.

The equation for Shannon-Wiener Index was:

$$H' = \sum_{i=1}^s (P_i)(\ln P_i)$$

Characters S and P_i are representative for number of species in the community and proportion of the number of individuals of each species per all number of individuals in the community.

The equation for Simpson Index (1-D) was:

$$1 - D = \sum_{i=1}^s \left[\frac{ni(ni - 1)}{N(N - 1)} \right]$$

Characters N, S and n_i are representative for all number of individuals in the community, number of species in the community and number of individuals of each species in the community.

The equation for Evenness Index was:

$$J' = \frac{H'}{\ln SP}$$

Character SP means the number of species in the community.

Results

As many as 1479 individuals of Calliphoridae family were collected. They included 18, 1212 and 249 specimens of

Chrysomya megacephala, *C. bezziana* and *C. albiceps* respectively. *C. bezziana* was collected in April and October. *C. megacephala* was collected in April, May and October. *C.*

albiceps was collected in May, September and October. All three species were collected more in villages than urban and semi-urban areas (Table 1).

Table 1. Abundance of three species of Calliphoridae based on monthly collection in 2015

Months	Number of <i>C. bezziana</i>			Number of <i>C. megacephala</i>			Number of <i>C. albiceps</i>		
	Urban	Semi-Urban	Rural	Urban	Semi-Urban	Rural	Urban	Semi-Urban	Rural
Mar	0	0	0	27	31	46	0	5	15
Apr	0	0	6	54	34	121	0	5	15
May	0	2	0	29	42	104	0	6	37
June	0	0	0	10	23	58	0	9	26
July	0	0	0	-	-	-	0	0	0
Aug	0	0	0	11	10	26	0	0	0
Sept	0	0	0	43	19	71	25	13	23
Oct	0	4	6	38	64	108	0	10	35
Nov	0	0	0	29	48	76	3	0	18
Dec	0	0	0	11	32	47	0	0	4
Total	0	6	12	252	303	657	28	48	173

SI calculation of *C. bezziana* in most of collecting times was negative. However, in May it was about 16. This index for *C. megacephala* in most of the collection dates was

between 7–9. SI for *C. albiceps* had great variations during the year from negative scores to 91 in September (Table 2).

Table 2. Synanthropy Index of three Calliphoridae species in Abadan County

Months	SI of <i>C. bezziana</i>	SI of <i>C. megacephala</i>	SI of <i>C. albiceps</i>
Mar	0	8.83	-2.62
Apr	-50	8.62	-11.79
May	16.7	2.61	-13.37
June	0	-1.06	-4.2
July	0	0	0
Aug	0	2.06	0
Sept	0	9.39	91.05
Oct	-16.7	9.2	7.95
Nov	0	7.86	1.04
Dec	0	2.49	2.15

Our findings showed that biodiversity and species richness of the fly communities seem to be low in Abadan County (Table 3).

Table 3. Overall biodiversity of Calliphoridae fly community in three ecosystems based on Shannon-Wiener Index in Abadan County at

2015	
Shannon-Wiener	0.53
Simpson	0.69
Evenness	0.49
Margalef	0.28

Results of calculations concerning biodiversity indices in Abadan County are shown in table 4. The highest biodiversity of Calliphoridae fly community was in spring ($H' = 0.67$) (table 4). The highest diversity of dominant species in this community was in autumn ($1-D = 0.74$) and its highest evenness was in summer ($J' = 0.82$) (table 4). Species richness of this community did not change in spring and autumn ($Mg = 0.3$) but in summer it was lower than the other studied seasons ($Mg = 0.18$) (Table 4).

Table 4. Seasonal biodiversity of Calliphoridae fly community in three ecosystems based on Shannon-Wiener Index in Abadan County

Spring	Shannon-Wiener	0.67
	Simpson	0.67
	Evenness	0.50
	Margalef	0.21
Summer	Shannon-Wiener	0.62
	Simpson	0.56
	Evenness	0.82
	Margalef	0.18
Autumn	Shannon-Wiener	0.74
	Simpson	0.48
	Evenness	0.44
	Margalef	0.32

Discussion

Results of this study, as the first comprehensive study on medically important flies in Abadan, show the presence of various kinds of myiasis diseases in Abadan County. Lack of data on background of myiasis in Abadan (21), may be due to poor knowledge about the presence of dangerous fly species in that area such as *C. bezziana*.

C. bezziana is the most important species among the community of blow flies, Calliphoridae, in this study. This species is also the most important species of Calliphoridae family in old world (19). This species was not found in urban areas but it was collected in semi-urban and rural areas of Abadan. Similar to the results of this study, there is no evidence about the presence of *C. bezziana* in urban ecosystems of Iran (22, 23). There are some case reports about human myiasis in Iran due to the activities of this species such as head scalp myiasis in Hormozgan province (24) and auricular myiasis in Isfahan (25). This species has also been reported as the main agent of traumatic animal myiasis in Iran but evidence shows that *Wohlfahrtia magnifica* (Diptera: Sarcophagidae) is the main agent for traumatic animal myiasis in Iran (18). Both of *W. magnifica* and *C. bezziana* are obligate myiasis agents which can invade live tissues of the hosts such as human, animals or other vertebrates. Reporting of this species in rural and semi-urban areas of Abadan County can be an alarm for cattle keepers and public health managers to prevent its potential damage to human and animal health. The epizootic increase of *C. bezziana* population in Karkhe protected area near Abadan County killed about 60 yellow Iranian dears in 2014 (unpublished information). This is a great damage on the population of yellow Iranian dears which are endangered species.

C. bezziana showed low synanthropic index in urban areas in our study which proves less desire of this species for human environment. Low SI of this species seems to be good for human which is not a suitable host for myiasis. This low amount of SI can reduce the mechanical transmission of pathogens to humans as well. However, it should be under inspection for future because the behaviour of flies can change due to lack of their animal hosts. Huge urbanization and reducing domestic hosts can be worthy for humans.

Results of this study can confirm the presence and activity of *C. albiceps* for the first time for fauna of Abadan County. This species has also showed a higher abundance in comparisons with other species in this report. This species has been reported in various cities of Iran such as Tehran (26, 27) Fars province (28), Hormozgan province (29) and Iranian Triple Islands in Persian Gulf (30). This species has also reported as the main forensically important fly in Iran (22, 23). Therefore, the presence of this species should be investigated in human cadavers in autopsy halls to find and confirm its activity and its usefulness in forensic investigations in Abadan.

C. albiceps has been reported to be the agent for traumatic animal myiasis in Fars province (21). There have not been many reports of human myiasis due to *C. albiceps*. It seems that conditions of this species in Calliphoridae community is unstable due to huge variations in data of SI along with low biodiversity indices of Calliphoridae community in Abadan County. Such varied behaviour may be dangerous for human health in the area.

In an overall view, *C. megacephala* can be mentioned as a common species for Calliphoridae family in Abadan County. This species has been reported in southern parts of Iran (28, 29). Fortunately, there is no report about the diseases which can be transmitted by this species in Iran (21). But this species has some similar morphological characters like dangerous

species of Calliphoridae family, *C. bezziana*. This species may be mistaken with *C. bezziana*. *C. bezziana* is the agent of obligatory myiasis but *C. megacephala* is the agent of facultative myiasis. Any mistake for differentiation between these two species make drastically wrong results especially in crime scene investigations. However, showing the presence and activity of *C. megacephala* in Abadan County can help biologists to pay attention and concentrate on the identification of these species to prevent wrong reports.

Literature review showed that there are fewer studies on SI concerning Calliphoridae family in Palearctic biogeographical zone (31) in which Iran is located. There is one study of SI concerning Calliphoridae flies in Italy but the fauna of that place differs with Abadan County. There are many studies in Nearctic zones of the world such as Bogota, Colombia and Argentina (20, 32), but comparing the behaviour of flies in these two biogeographical zones is not logical.

Abadan is an old international county in Iran which is placed in the temperate area of southwest Iran. This county is the host of many engineers, workers and visitors from various continents of the world. Due to some difficulties in the identification and study of medically important flies, this branch of science has been neglected in many parts of the country as well as for Abadan. Our findings can be considered as a baseline to emphasize on flies and their impact on human health in the area.

Geographical situation of Abadan and the presence of many important flies of Calliphoridae family give enough evidence to search for other important synanthropic flies such as Sarcophagidae, Muscidae and Fanniidae in the area. Searching for these flies which are potential myiasis agents can be recommended for future works.

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