Original Article

A Modified Trap for Adult Sampling of Medically Important Flies (Insecta: Diptera)

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(Received 13 Dec 2011; accepted 7 May 2012)

Abstract

Background: Bait-trapping appears to be a generally useful method of studying fly populations. The aim of this study was to construct a new adult flytrap by some modifications in former versions and to evaluate its applicability in a subtropical zone in southern Iran.

Methods: The traps were constructed with modification by adding some equipment to a polyethylene container (18× 20× 33 cm) with lid. The fresh sheep meat was used as bait. Totally 27 adult modified traps were made and tested for their efficacies to attract adult flies. The experiment was carried out in a range of different topographic areas of Fars Province during June 2010.

Results: The traps were able to attract various groups of adult flies belonging to families of: Calliphoridae, Sarcophagidae, Muscidae, and Faniidae. The species of *Calliphora vicina* (Diptera: Calliphoridae), *Sarcophaga argyrostoma* (Diptera: Sarcophagidae) and *Musca domestica* (Diptera: Muscidae) include the majority of the flies collected by this sheep-meat baited trap.

Conclusion: This adult flytrap can be recommended for routine field sampling to study diversity and population dynamics of flies where conducting of daily collection is difficult.

Keywords: Trap, Diptera, Calliphoridae, Sarcophagidae, Iran

Introduction

The insect order of Diptera (the true flies) is one of the most species-rich, anatomically varied and ecologically innovative groups of organisms, contributing 10–15% of known animal species. An estimated 150,000 species of Diptera have been described (Groombridge 1992, Thompson 2005). Diptera outrank other insect orders in terms of medical and veterinary significance, being responsible for the transmission of a wide variety of pathogens such as viruses, bacteria, fungi, protozoan and metazoan parasites in humans and animal (Banjo et al. 2005, Forster et al. 2007, Forster et al. 2009).

The invasion of host tissues by fly larvae, called myiasis, is the most widespread form of host invasion by arthropods (Mullen and Durden 2002) and is commonly noted in veterinary medicine and can occur in humans even in the West's sanitized society (Byrd and Castner 2001).

Myiasis is the infestation of live human and

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vertebrate animals with dipterous larvae, which at least for a certain period on the host's dead or living tissue, liquid body substances, or ingested food (Zumpt 1965). Human myiasis is a rare condition in any part of the globe, but is more common in the regions with a warm and humid climate (Maturo et al. 2007). The first case was reported by Minar when he recovered *Oestrus ovis* larva from the eye of an Iranian woman in Tehran (Minar 1976). From that time, varieties of case reports and case series have been reported in Iran (Tirgari et al. 2003, Mohammadzadeh et al. 2008, Faramarzi et al. 2009, Soleimani Ahmadi et al. 2009, Salimi et al. 2010a,b). Some valuable surveys with topic of fauna of potentially myiasis producing flies has been done in Tehran (capital of Iran) which various species of blowflies, flesh flies (Khoobdel et al. 2008), Muscidae and Fanniidae (Khoobdel and Davari 2011) have reported. Despite of these scattered published data, status of human and animal myiasis in Iran is remained obscure. Study on various populations of medically important flies as causative agents of myiasis and vectors of various pathogens should be more emphasized.

The first step for a comprehensive study of fly population is conducting appropriate design using improved equipments. Bait trapping appears to be a generally useful method of studying fly populations (Suenaga and Kurahashi 1994, Hall 1995). Bait traps have no chemical reagents, do not harm the environment, and can be used both for short- and long-term control (Suenaga and Kurahashi 1994). They can be used also for studying population dynamics of flies.

Systematically confirmation of identification process needs the presence of adult and larvae of the same sample. Therefore, adult flies collected by traps should be reared for acquiring the larvae (Zumpt 1965).

Adult flytraps usually are using for trapping and studying of adults. This study has been conducted to design and to evaluate an adult flytrap to collect adult flies and to prepare a breeding place for egg laying, fixing, and storing larvae simultaneously.

Materials and Methods

Study area

Fars is one of the 31 provinces of Iran, located in the southern part of the country. Due to topographic characters, there are three distinct climatic regions in this province. The first part is hilly area in north and northwest of the province, with considerable vegetation covering. This part has a moderate temperature with 400–600 mm of precipitation annually. The second part is central part of the province with a relatively moderate temperature and hot and dry weather in summer. The average of annual precipitation in this part is around 200–400 mm. The third part is the lowland of south and southeast regions of the province with moderate temperature in winter and very hot wet weather in summer. The average rainfall of this part is below 200 mm annually. Three cities in each geographical region were selected for evaluation of the trap including Abadeh, Arsanjan and Sepidan Cities located in north part, Shiraz, Kazerun and Neyriz Cities located in central part and Darab, Jahrum and Lar Cities from southern part. Some meteorological information of three geographical parts of Fars Province in June 2011 has been shown in Table 1.

Observations on applicability of the trap were performed during June 2010. Three villages were randomly selected around each city and one trap hanged in each village. One modified trap was hanged in or around of sheep breeding place in each selected villages. Totally 27 adult modified traps were hanged in the selected cities of the province. The sampling sites have been pointed by GPS device (Garmin 76CSx®). All points have been shown in Fig. 1 using Google Earth Software.

Using of this kind of flytraps for fly mass

population control has been done in Abadeh City. One city was set one trap for hanging it in his yard, situated in the city. He brought back the trap with collected flies.

Trap Construction

The trap consists of a polyethylene container (18× 20× 33 cm) with lid (Fig. 2) with some modifications from Satl Arya Company®. Round openings with 8 cm diameter was prepared in each of four sides of the container. Each opening should be placed in first half of the height of container. Each opening was equipped with wiry funnel prepared on each side of the container (Fig. 3). The opening at the end of funnel has 1 cm diameter to prevent escaping of attracted flies. A rectangular vegetable plastic netted dish used as bait chamber. The dish had large mesh to permit falling down of any larval instars. Bait chamber placed in the inner of the container in front of funnels and fixed by means of hard cupper wires on the lowest screw of 3–4 screws, which has used for fixing the wiry funnels (Fig. 3 and 4). All four funnels ended toward the middle of bait chamber. Bottom of the trap filled with 2% formaldehyde and 0.02% chlorhexidine mixed solution (Fig. 5).

About 20–30 gr of sheep fresh meat were used as bait for the traps. The traps were hanged in suitable parts of the villages away from animal and children disturbing (Fig. 5). Flies attracted to odors of bait and entered the trap via one-way funnel. They laid egg after feeding on the bait. A few of the fully-grown larvae became pupa in the bait (meat) or around its chamber. Adults, which appeared from these pupae (as F1), were found alive in the trap or were fallen down in the solution in bottom of trap. Majority of fully-grown larvae fell down and fixed in the solution placed in bottom of the trap. Collecting of samples from the traps was carried out monthly. The collected samples transferred the laboratory of medical entomology. Adult flies in each batch of samples were washed with 70% ethanol and dried out on tissue paper for carful identification. Larvae were washed out with 70% ethanol and preserved in 70% ethanol.

Morphological identification

Identification of the collected adult and larval specimens was based on morphological identification keys (James 1947, Zumpt 1965, Ishijima 1967, Whitworth 2006, Amendt et al. 2010, Whitworth 2010).

Results

The traps collect various groups of adult flies and maintain their F1 larvae. Some species of Calliphoridae, Sarcophagidae, Muscidae, and Faniidae families were collected during the study period. Numbers of adult flies, which have been collected by these traps, have been shown in Table 2.

Most of the trapped flies were female and majority of them laid their eggs or larvae on the meat bait. Due to condition of the inner condition of the trap, none of the eggs hatched. It was shown that all of the first instar larvae of both from hatched eggs or from mother flies (in Sarcophagidae) were not able to complete their larval cycle. Therefore, various larval instar of different families would be found in bottom of the traps. The identification of first and second instar larvae of most of dipteral families is somehow difficult. The identified samples of larvae, which were conserved in the liquid of trap bottom, have been shown in Table 3.

From Table 2 and 3, it is concluded that *Calliphora vicina* (Diptera: Calliphoridae), *Sarcophaga argyrostoma* (Diptera: Sarcophagidae) and *Musca domestica* (Diptera: Muscidae) were the highest number of collected adults or larvae.

Table 1. Meteorological information of three geographical parts of Fars Province in June 2011

Part of province	Min temp	Max temp	Mean temp	Min humidity	Max humidity	Mean humidity	precipitation
Northern	20.74	35.13	27.94	10%	33%	18%	0
Central	22.58	39.42	31	10	33	21%	0
Southern	25.28	43.32	40.3	12	44	28%	0

Table 2. Number of adult flies, trapped by the modified adult fly trap, in each geographical regions of Fars Province, Iran, June 2010

Region	Calliphoridae species	n	n per trap	Sarcophagidae species	n	n per trap	Muscidae species	n	n per trap	Faniidae species	n	n per trap
Northern Part	*Calliphora vicina*	90	3.3	*Sarcophaga* sp	25	0.9	*Musca domestica*	83	3			
	Lucilia sericata	16	0.6	*Sarcophaga argyrostom*	34	1.3	*Muscina stabulans*	39	1.4			
				Sarcophaga variegata	2	0.07	*Hydrotea* sp	70	2.6			
				Wohlfahrtia sp	1	0.04						
	subtotal	106	3.9	subtotal	64	2.37	subtotal	192	7.1			
Central Part	*Calliphora vicina*	10	0.37	*Sarcophaga* sp	104		*Musca domestica*	30	1.1	*Fania canicularis*	3	0.11
	Lucilia sericata	2	0.07	*Sarcophaga argyrostom*	39		*Musca autumnalis*	2	0.07			
				Sarcophaga aegyptica	5							
				Wohlfahrtia sp	2							
	subtotal	12	0.44	subtotal	150	5.5	subtotal	32	1.18	subtotal	3	0.11
Southern Part	*Calliphora vicina*	3	0.11	*Sarcophaga* sp	63	2.3	*Musca domestica*	48	1.8			
	Lucilia sericata	2	0.07	*Sarcophaga argyrostom*	11	0.41	*Muscina stabulans*	2	0.07			
	Chrysomyia albiceps	8	0.3	*Sarcophaga aegyptica*	7	0.26						
	Chrysomyia rufifacies	1	0.04	*Wohlfahrtia* sp	8	0.3						
				Wohlfahrtia nuba	2	0.07						
	Subtotal	14	0.52	subtotal	91	3.37	subtotal	50	1.85			

Number of fly per trap was 4.86, 11.24, 10.13, and 0.11 for members of Calliphoridae, Sarcophagidae, Muscidae and Fanniidae respectively (Table 2). Regionally Muscidae has the greatest number of flies per trap in northern part of the province that was 7.1, however, in central and southern parts of the province the highest number of fly per trap was 5.5 and 3.37 respectively as for Sarcophagidae.

Due to unknown medically importance of some of the collected samples such as Anthomyiidae and Hypoboscidae, specimen identification to genus and species were not performed. These flies might be entered the traps accidentally or wind oriented.

For finding the applicability of this kind of traps for collecting synanthropic flies, only one trap was hanged in a house in city center of Abadeh City. This trap equipped with fresh sheep meat as well. Results of the identification of the collected flies in this trap have shown in Table 4.

Table 3. Number of fly larvae, collected by modified adult fly trap, in any geographical regions of Fars Province, Iran, June 2010

Region	Calliphoridae species	n	Sarcophagidae species	n	Muscidae species	n
Noerthern Part	*Calliphora vicina*	235	*Sarcophaga* sp	96	*Musca domestica*	212
	Lucilia sericata	85	*Sarcophaga argyrostom*	155	*Unknown*	21
	Unknown	8	Unknown	32		
			Wohlfahrtia sp	5		
Central Part	*Calliphora vicina*	88	*Sarcophaga* sp	338	*Musca domestica*	178
	Lucilia sericata	24	*Sarcophaga argyrostom*	198	*Unknown*	22
	Unknown	5	*Sarcophaga aegyptica*	28		
			Unknown	12		
Southern Part	*Calliphora vicina*	30	*Sarcophaga* sp	112	*Musca domestica*	136
	Lucilia sericata	10	*Sarcophaga argyrostom*	46	*Unknown*	11
	Unknown	11	*Sarcophaga aegyptica*	34		
			Wohlfahrtia sp	28		
			Unknown	8		
Total		496		1092		580

Table 4. Number of adult flies was trapped by a single modified trap in Abadeh City, Fars Province, Iran, June 2010

Region	Calliphoridae	n	Sarcophagidae	n	Muscidae	n
Northern Part	*Calliphora vicina*	68	*Sarophaga* sp	11	*Musca domestica*	471
	Lucilia sericata	15	*Sarcophaga argyrostoma*	5	*Muscina stabulans*	103

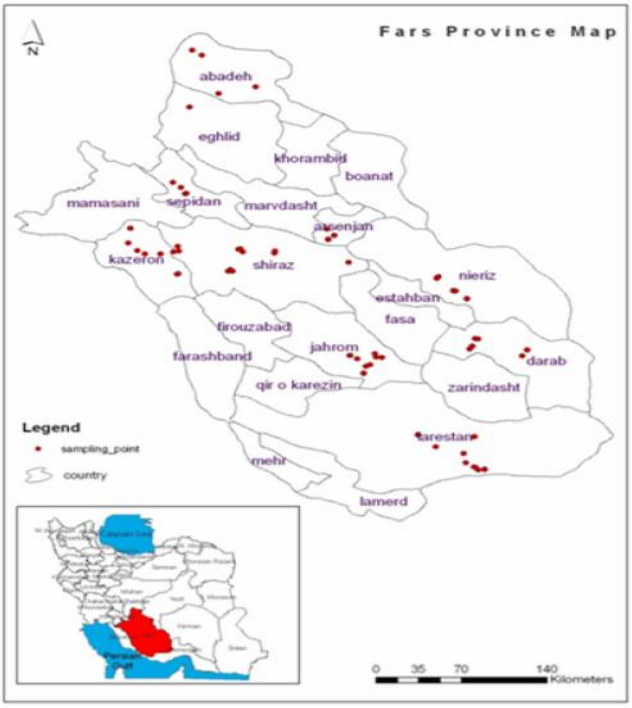

Fig. 1. Study area showing distribution of sample sites for evaluating of the modified adult flytrap. Data imported from GPS Garmin 76CSx® to GIS Software 9, Fars Province, Iran, 2010

Fig. 2. A Modified adult fly trap, evaluated as an applicable trap for collecting various families of Diptera, Fars Province, Iran 2010 (original)

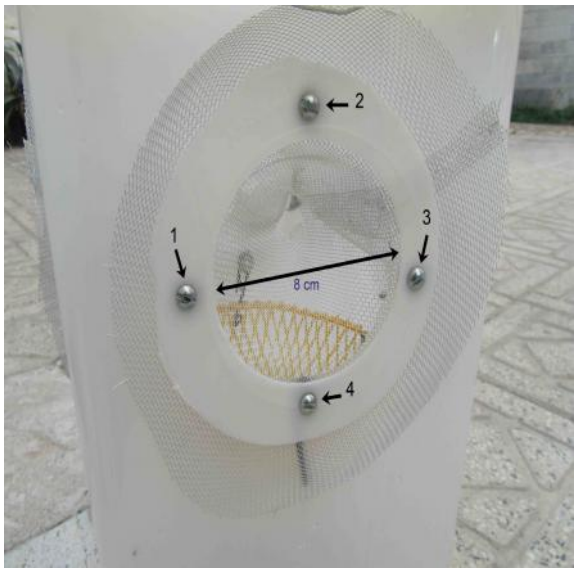

Fig. 3. Round openings of the modified adult flytrap with 8cm in diameter, provided for one-way entering flies, Tehran University of Medical Sciences, 2010 (original)

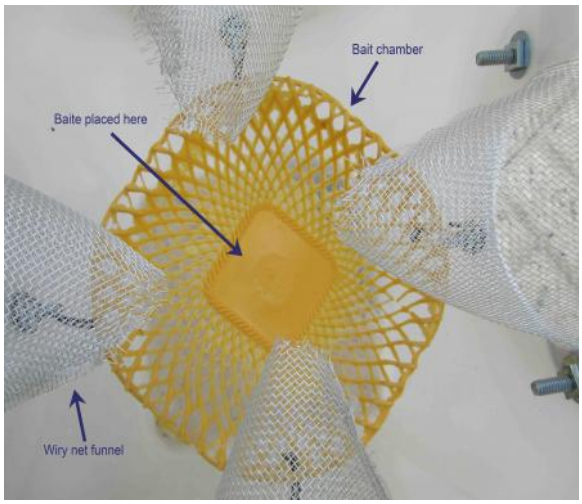

Fig. 4. Bait chamber of the modified adult flytrap, placed in lower level in front of round openings, Tehran University of Medical Sciences, 2010 (original)

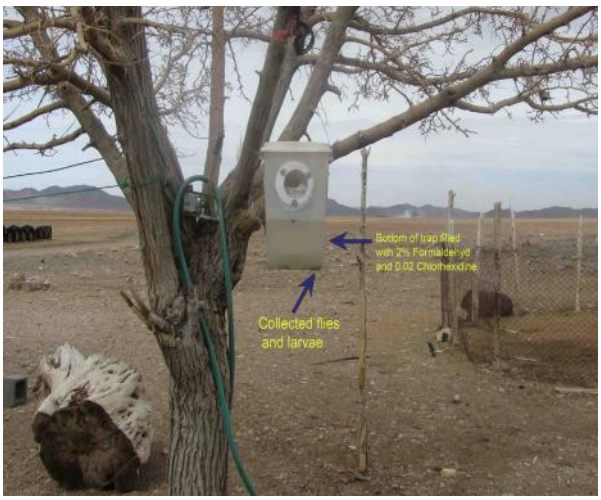

Fig. 5. A hanged meat baited modified adult flytrap with collected adult flies in Kazerun Station of Research, School of Public Health, Tehran University of Medical Sciences (original)

Discussion

Trapping systems can be used for research monitoring (Hwang and Turner 2005) and control of fly populations (Hall 1995, Baz et al. 2007, Gerry et al. 2007). Rearing of larvae is the way (Zumpt 1965, Amendt et al. 2010) to have adult and larvae of the same sample,

which is difficult, need more time and sometimes not successful.

Adult trapping process is the way to find medically important flies (Hall 1995) somewhere the larval population reduced by chemical controls. It has been observed that the modified adult flytraps are useful for collecting adults and larvae of flies simultaneously. Systematic observation needed to connect the adults and larvae after collecting them in the traps. Due to difficulties in systematic of the flies, their identification and completing the systematic relationship between larvae and adults should be done with experts.

Idea of the modified flytrap derived from the original trap introduced by Suenaga and Kurahashi (1994) which has bottom filled with soil in most of the volume. Presence of soil in their trap prepares suitable conditions for completing the F1 progeny from the entering flies. Their flytrap is suitable for studying of population dynamic of flies. The modified flytrap which has been evaluated in this study has bottom filled with solution of 2% formaldehyde and 0.02% chlorhexidine which comprising about one third of all volume. The surveyed modified flytrap is suitable for faunestic and diversities phenomenon.

The first problem in working with flies is correct identification. Morphological identification of some flies such as female and larvae of Sarcophagidae (Guo et al. 2010) and immature stage of Muscidae (Amendt et al. 2010) are very difficult. Therefore, in the case of female samples of family Sarcophagidae (*Sarcophaga* sp and *Whohlfahrtia* sp) their genus has reported merely. Due to the same reason some of larval samples have left as unidentified.

In field studying and routinely use of the modified adult flytrap, comparing of the results of adults and larval samples will lead to a precise identification. With any sampling process, there will be adults beside of their larvae, which very desired for systematically identifications. Presence of identified or semi-identified adults beside unknown larval samples will help for identification by limiting the range of searching. For example, it can be postulated that unknown larvae in central part of Fars province (Table 2), could be *Calliphora vicina* or *Lucilia sericata* with high probability. New techniques such as molecular identifications can be employed for identification of adults and larvae.

The tabled data were the only one sampling process for presenting the applicability of this kind of traps for collecting adults and relevant larvae simultaneously. The *Calliphora vicina* (Diptera: Calliphoridae), *Sarcophaga argyrostoma* (Diptera: Sarcophagidae) and *Musca domestica* (Diptera: Muscidae) formed the majority of the flies collected by this sheep-meat baited trap. By changing the baits, some desired flies can be collected (Boonchu et al. 2003). It has been observed that by changing the place of traps the number of trapped flies as well as their species will be changed (Table 1 and 3).

Temperature is probably the most influential environmental factor in the life history of populations, particularly in organisms with short life cycles such as insects (Levine and Levine 1991, Oshaghi et al. 2009, Shiravi et al. 2011). The highest number of fly per trap was as for Sarcophagidae (11.24%). Regional analysis revealed that Sarcophagid flies also had the greatest number of fly per trap in central and southern parts. These relatively higher rates may be due to of the higher temperature in these two regions in comparison with traps hanged in northern part. To find significant difference more sampling and comparing various temperatures in any seasons nis required.

Wind direction and visual cues are also important to attract more flies (Boonchu et al. 2003). By considering the bionomics of any species and its behavior, the trap can be focused for collecting specific species. Pheromones or

pheromone based baits (Geden et al. 2009) can be used for collecting exactly the target species.

The modified trap used for this study was enough big and able to collect high number of adult flies. This character can be used for control of fly population when large number of traps can be hanged up around the specific places. It can be recommended as an environmental friendly fly control. For this purpose, education, finding suitable baits as well as appropriate places for local use in various geographical conditions is needed. The highest number of *M. domestica* in sheep breeding places was 83, but this was 479 for the single trap. These results also showed the synanthropic behavior of this fly as it confirmed by Figueroa-Roa and Linhaes (2004). It is so cleared that finding of one trap is not enough for showing scientifically the synanthropic behavior of *M. domestica* and need more research in this province.

In conclusion, this kind of adult fly trap can be recommended for routine field sampling for studying the diversity of flies as well as study of population dynamics where conducting of daily collection is difficult. This kind of flytrap can be applied also for long-term faunestic study of flies.

Acknowledgements

The authors wish to thanks all local technicians and people who helped us in accomplishing this work. This work was part of project number 10478-27-01-89, which was financially supported by Tehran University of Medical Sciences. The authors declare that there is no conflict of interest.

References

Amendt J, Lee Goff M, Campobasso CP, Grassberger M (2010) Current Concepts in Forensic Entomology. Springer, Dordrecht.

Banjo AD, Lawal OA, Adeduji OO (2005) Bacteria and fungi isolated from housefly (*Musca domestica* L.) larvae. Afr J Biotechnol. 4: 780–784.

Baz A, Cifrian B, Diaz-Aranda LM, Martin-Vega D (2007) The distribution of adult blow-flies (Diptera: Calliphoridae) along an altitudinal gradient in Central Spain. Ann Soc Entomol Fr. 43(3): 289–296.

Boonchu N, Piangjai S, Sukontason KL, Sukontason K (2003) Comparison of the effectiveness of baits used in traps for adult fly collection. Southeast Asian J Trop Med Public Health. 34(3): 630–633.

Byrd JH, Castner JL (2001) Forensic Entomology: The Utility of Arthropods in Legal Investigations. CRC Press, Boca Raton, FL.

Faramarzi A, Rasekhi AR, Kalantari M, Hatam GR (2009) *Chrysomya bezziana* as a Causative Agent of Human Myiasis in Fars Province, Southern Iran. Iran J Arthropod-Borne Dis. 3(1): 60–63.

Figueroa-Roa L, Linhaes AX (2004) Synanthropy of Muscidae (Diptera) in the City of Valdivia, Chile. Neotrop Entomol. 33(5): 647–651.

Forster M, Klimpel S, Mehlhorn H, Sievert K, Messler S, Pfeffer K (2007) Pilot study on synanthropic flies (e.g. *Musca*, *Sarcophaga*, *Calliphora*, *Fannia*, *Lucilia*, *Stomoxys*) as vectors of pathogenic microorganisms. Parasitol Res. 101: 243–246.

Forster M, Klimpel S, Sievert K (2009) The house fly (*Musca domestica*) as a potential vector of metazoan parasites caught in a pig-pen in Germany. Vet Parasitol. 160: 163–167.

Geden CJ, Szumlas DE, Walker TW (2009) Evaluation of commercial and field-expedient baited traps for house flies, *Musca domestica* L. (Diptera: Muscidae). J Vector Ecol. 34(1): 99–103.

Gerry AC, Peterson NG, Mullens BA (2007) Predicting and controlling stable flies on California Dairies. ANR Publication No 8258, Oakland, California.

Groombridge B (Ed) (1992) Global biodiversity: Status of the Earth's Living Resources. Chapman and Hall, London.

Guo YD, Cai JF, Li X, Xiong F, Su RN, Chen FL, Liu QL, Wang XH, Chang YF, Zhong M, Wang X, Wen JF (2010) Identification of the forensically important sarcophagid flies *Boerttcherisca peregrina*, *Parasarcophaga albiceps* and *Parasarcophaga dux* (Diptera: Sarcophagidae) based on COII gene in China. Trop Biomed. 27(3): 451–460.

Hall MJ (1995) Trapping the flies that cause myiasis: their responses to host-stimuli. Ann Trop Ned Parasitol. 89(4): 333–357.

Hwang C, Turner BD (2005) Spatial and temporal variability of necrophagous Diptera from urban to rural areas. Med Vet Entomol. 19: 379–391.

Ishijima H (1967) Revision of the third stage larvae of synanthropic flies of Japan (Diptera: Anthomyiidae, Muscidae, Calliphoridae and Sarcophagidae). Sanit Zool. 18(2.3): 47–100.

James MT (1947) The Flies that Cause Myiasis. USDA Miscellaneous Publication No. 631, Washington, D.C.

Khoobdel M, Jonaidi N, Seiedi Rashti M (2008) Blowfly and flesh (Diptera: Cyclorrhpha) fauna in Tehran, Iran**.** J Entomol. 5(3): 185–192.

Khoobdel M, Davari B (2011) Fauna and abundance of medically important flies of Muscidae and Fanniidae (Diptera) in Tehran, Iran. Asian Pac J Trop Med. 4(3): 220–223.

Levine OS, Levine MM (1991) Houseflies (*Musca domestica*) as mechanical vectors of Shigellosis. Infect Immun. 31: 445–452.

Maturo S, Michaelson PG, Brennan J (2007) Auricular myiasis. Otolaryngol Head Neck Surg. 136: 668–669.

Minar J (1976) A case of eye myiasis in man caused by first instar larvae of *Oestrus ovis* L. (Diptera Oestridae) in Iran. Folia Parasitol. (23): 283.

Mohammadzadeh T, Hadadzadeh R, Esfandiari F, Sadjjadi SM (2008) A Case of Gingival Myiasis Caused by *Wohlfahrtia magnifica*. Iran J Arthropod-Borne Dis. 2(1): 53–56.

Mullen G, Durden L (2002) Medical and Veterinary Entomology. Academic Press, San Diego.

Oshaghi MA, Ravasan NM, Javadian E, Rassi Y, Sadraei J, Enayati AA, Vatandoost H, Zare Z, Emami SN (2009) Application of predictive degree day model for field development of sandfly vectors of visceral leishmaniasis in northwest of Iran. J Vector Borne Dis. 46(4): 247–255.

Salimi M, Edalat H, Jourabchi A, Oshaghi MA (2010a) First Report of Human Nasal Myiasis Caused by *Eristalis tenax* in Iran (Diptera: Syrphidae). Iran J Arthropod- Borne Dis. 4(1): 77–80.

Salimi M, Goodarzi D, Karimfar MH, Edalat H (2010b) Human Urogenital Myiasis Caused by *Lucilia sericata* (Diptera: Calliphoridae) and *Wohlfahrtia magnifica* (Diptera: Sarcophagidae) in Markazi Province of Iran. Iran J Arthropod-Borne Dis. 4(1): 72–76.

Shiravi AH, Mostafavi R, Akbarzadeh K, Oshaghi MA (2011) Temperature Requirements of Some Common Forensically Important Blow and Flesh Flies (Diptera) under Laboratory Conditions. Iran J Arthropod-Borne Dis. 5(1): 54–62.

Soleimani Ahmadi M, Nasirian H, Nazemi Gheshmi AM, Yaghoobi Ershadi MR (2009) Human Extensive Head Skin Myiasis. Iranian J Publ Health. 38(1): 134–138.

Suenaga O, Kurahashi H (1994) Improved Types of the Horse Meat Baited Fly Trap and the Fly Emergence Trap. Trop Med. 36(2): 65–70.

Tirgari S, Nateghpour M, Jahanian AH, Akbarzadeh K (2003) Case report: First Record of Human Myiasis caused by Chrysomia bezziana (Villeneuve) in Iran (Diptera, Calliphoridae). Iranian J Publ Health. 32(3): 68–70.

Thompson FC (2005) Biosystematic Database of World Diptera. Version 7.5, http://www.diptera.org/biosys.htm.

Whitworth T (2006) Keys to the genera nad species of blow flies (Diptera: Calliphoridae) of America North of Mexico. Proc Entomol Soc Wash. 108(3): 689–725.

Whitworth T (2010) Keys to the genera and species of blow flies (Diptera: Calliphoridae) of the West Indies and description of a new species of *Lucilia* Robineau-Desvoidy. Zootaxa. 2663: 1–35.

Zumpt F (1965) Myiasis in Man and Animals in the Old World, a textbook for physicians, veterinarians and zoologist. Butterwort, London.