

Host-feeding patterns of *Culex pipiens* (Diptera - Culicidae) in El-Abtal village, Ismailia Governorate, Egypt.

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ABSTRACT

Host selection patterns of *Culex pipiens* were determined over the mosquito's seasonal activity period (May to November) during the year 1999 at El-Abtal village, representing new settlements in Ismailia Governorate. A total of 224 blood meals were analyzed by an enzyme-linked immunosorbing assay. Almost half of the indoor tested mosquitoes were found to feed on human 50.7% (n=142). The outdoor collected samples had fed predominately on mammals other than humans 65.8% (n=82). Mixed meals were recognized 14.1% (n=142) and 9.8% (n=82) from total engorged female *Cx. pipiens* from both indoor and outdoor respectively. The occurrence of mixed meals of the blood of humans and other mammals were calculated in order to evaluate the potentials of this species as a vector of human and zoonotic diseases in new settlements.

KEYWORDS: *Culex pipiens*, feeding, ELISA.

INTRODUCTION

Mosquito host-feeding patterns are important in the epidemiology of mosquito-borne pathogens. Diseases of public health significance in Egypt are commonly caused by mosquito-borne pathogens, such as RVF viruses (Kenawy *et al.* 1987; Gad *et al.* 1987, 1995) and filariasis (Soliman 1990, 1995)

A series of studies on mosquito feeding in Egypt was carried out on mosquitoes from Gharbiya Governorate by Zimmerman *et al.* (1985), West Desert Oases (Kenawy *et al.* 1986), Aswan Governorate (Kenawy *et al.* 1987; Gad *et al.* 1999) and Sharqia Governorate (Gad *et al.* 1995).

The present study was conducted in El-Abtal village, an area representing new settlements in Ismailia Governorate. The objective of this study is to estimate the potential of *Culex pipiens* in the transmission of mosquito-borne diseases by the determination of host feeding preferences.

MATERIALS AND METHODS

The study site: El-Abtal village is located at the East of lakes area at Ismailia Governorate, which represents a new settlement surrounded by newly reclaimed lands. It is inhabited with immigrants mostly from the Nile valley. The surrounding lands are irrigated during the whole year round by El-Salam canal, where crops of alfalfa, wheat and rice are rotated in the fields. Citrus, mango, grapes, pomegranate, apricot, fig and banana orchards are presents in some areas. Wild vegetation is scattered near the canals.

Mosquito sampling: Engorged mosquitoes were collected from outdoor areas and inside houses over the mosquito activity period (May to November) through the year 1999. A battery-powered aspirator (D.vac) (Nasci 1981) was used to collect engorged mosquitoes, which were resting outdoors. Mosquito were sampled in a series of 5-min collections in vegetation surrounding houses, along irrigation canals and in the fields within 250 metres of houses during late afternoon. Samples inside houses were done by spraying pyrethroids

insecticides with a hand pump and collecting mosquito as they fell onto a 1-m² index cloth with two handles. The cloth was moved around the walls and also under furniture and other objects. Collected specimens were identified according to the key of Gad (1963) and Harbach (1985). Blood samples were sorted according to species and location, each group was placed in a labeled vial and stored at -70°C until tested.

Human population and domestic animals density were estimated in the village. Over 80% of the households contained at least one domestic large animal. Most of the houses are consisted of more than one room and the villagers there used to keep the animals with them indoors. Free ranging dogs and cats were numerous in the village, but the census underestimated them. Other potential hosts such as birds and rodents were not surveyed.

Blood meals were identified using the direct enzyme immunoassay (ELISA) developed by Beier *et al.* (1988) with slight modification by Bahgat (1997). The forage ratio was determined according to Hess *et al.* (1968). This ratio was calculated for each host category as the percentage of positive blood meals divided by the percentage of available hosts, with ratios >1 indicating preference, ratios <1 indicating avoidance and ratios approaching 1 indicating little preference or avoidance. The probability of interrupted feeding was determined according to the method described by Burkot *et al.* (1988). Data was statistically analyzed using statistical package "Microstate".

RESULTS

Mosquitoes collected from indoors and outdoors were exclusively *Cx. pipiens*. Based on the total number of mosquitoes collected during the study period, blood fed *Cx. pipiens* were almost twice abundant in indoors as compared to the outdoor ones (Table 1).

Table 1: Host blood meal sources of *Cx. pipiens* female mosquitoes collected from indoors and outdoors in El-Abtal village, Ismailia Governorate.

Hosts	Indoor collected (% total)	Outdoor collected (% total)
Human	50.7	14.6
Bovine	4.9	12.2
Ovine	1.4	4.8
Equine	13.4	39
Dog		--
Cat	1.4	9.8
Rat		--
Unknown	14.1	9.8
Mixed meals	6.5	9.8
Total	142	82
	$\chi^2=201.57$ (P = 0.000)	$\chi^2=37.11$ (P = 0.00004)

The host-feeding pattern of *Cx. pipiens* differed between indoors and outdoors. Engorged mosquitoes collected from indoors (65.8%, n=142) ($\chi^2 = 201.57$, 4 degree of freedom, P = 0.000) were Significantly feed on human, whereas about 56.1% (n=82) out of the total engorged *Cx. pipiens* collected from outdoors fed predominantly on mammals other than humans. Equine group represented the most significant blood source for outdoor *Cx. pipiens* (39%, n=82) followed by bovine group (12.2%, n=82) ($\chi^2 = 37.11$, 3 degree of freedom P =0.00004).

Monthly estimates of available human and domestic animal hosts in selected households during the study period were done and the average ratios were used to calculate the forage ratios among engorged females of *Cx. pipiens* for each host (human, cows, buffaloes, sheep, goat and donkeys). Highest forage ratio (indoors and outdoors) was for Equine and bovine, the high forage ratio for ovoid was recorded among engorged *Cx. pipiens* collected from

outdoors. The engorged *Cx. pipiens* collected from both indoors and outdoors showed a high degree of avoidance towards humans blood, forage ratio <1 (Table2).

Table 2: Forage ratio for *Cx pipiens* female mosquitoes collected from indoors and outdoors in El-Abtal village, Ismailia Governorate

	Human	Bovine	Ovine	Equine
Animal census	0.92	0.04	0.02	0.02
Indoor forage ratio	0.55	1.23	0.7	6.7
Outdoor Forage ratio	0.158	3.05	2.4	19.5

Mixed meals were recognized at ratios of 14.1% (n =142) and 9.8% (n =82) out of the total engorged females collected from both indoors and outdoors respectively (Table 1).

Out of 20 indoor mixed meals about 60% were on humans and other mammals such as equines and bovines and about 40% were on mammals rather than human such as, bovines equines and cats. Outdoor mixed meals were on the blood from bovines and equines (50%), or bovines and ovines (50%) (Table 3).

Over all, the predicted probability of a blood meal being interrupted was 0.02. The proportion of mixed meals estimated the probability of interruption of *Cx. pipiens* meals is shown in Table 4.

Table (3) Multiple blood meal sources of *Cx. pipiens* mosquitoes in El-Abtal village, Ismailia Governorate.

Blood meals	Mosquito blood host %	
	Indoor	Outdoor
Bovine/ Equine/ Cat	10	—
Equine/ Cat/ Human /Bovine	5	—
Human /Equine	30	—
Human/ Bovine	20	—
Bovine/Equine	10	50
Bovine/ Ovine	15	50
Cat / Ovine	5	—
Human / Ovine	5	—
Total No.	20	8

Table (4) Probability of *Cx. pipiens* being interrupted during blood feeding.

	No. human Meals	No. mixed human meals	Total meals	Proportion of mixed human Meals	Predicted Q	I _H
Indoor	86	14	142	0.01	0.512	0.02
Outdoor	12	-	-	-	-	-

Q = Proportion of meals with only human blood + (proportion of mixed human meals/2)

I_H = Probability of interruption of human blood meal.

I_N = Probability of interruption of non human blood meals

Assuming I_H = I_N = Proportion of mixed meals / Q (1-Q).

DISCUSSION

Culex pipiens was the most common mosquito species in the study area, an observation which is in accordance with most previous studies which have shown that *Cx. pipiens* is the most abundant species in Egypt (Hurlbut & Weitz 1956; Hoogstral *et al.* 1979; Kenawy *et al.* 1987). It appeared to be fairly endophagic as most of the engorged *Cx. pipiens* female mosquitoes were collected from indoors and less partially from outdoors.

The indoor-engorged *Cx. pipiens* fed predominantly on human and other large mammals mainly equine and bovine. This may attribute to the movement of mosquitoes from room to room within houses searching for proper hosts (animals slept inside most of the

surveyed houses). Outdoor collections provided less biased samples of engorged mosquitoes than indoor ones, the outdoor human feeding rate was 14.6%. Earlier studies reported that *Cx. pipiens* from the Aswan (kenawy *et al.* 1987) showed marked anthropophagi. Zoophagy was reported for female *Cx. pipiens* from Gharbiya Governorate (Zimmerman *et al.* 1985).

Much of the geographic variations in host by mosquito species in Egypt can be attributed to relative host abundance, which is largely a reflection of ecological conditions and human customs (Zimmerman *et al.* 1985; Beier *et al.* 1987). Forage ratios for indoor and outdoor collected mosquitoes based on the proportion of humans and three other classes of large mammals, especially equines, bovines and ovines. Earlier studies in Fayium Oasis reported similar results where this species exhibited an elevated forage ratio for bovines and ovines (Beier *et al.* 1986).

Although the abundance and relative proportion of large mammals was estimated monthly the census may be not accurate enough and underestimated the wild animals as a risk factor for the transmission of a human parasitic diseases such as *W. bancrofti* as the infective mosquito which moves from a human host to a non human host would loose part of its filarial larvae (L₃) (De Meillion *et al.* 1967). In the present study, no data were collected concerning mixed human feeds (human / human) such feeds are designated as cryptic mixed meals by Boreham & Garrett Jones (1973) and differentiated on the basis of their blood groups. Accordingly the opportunistic feeding habits of *Cx. pipiens* and its ability to switch from human to non-human vertebrate hosts probably affect its efficiency as a human filariases vector. This is counter balanced by its tremendous abundance in Egypt.

The proportion of mixed feeds including human and other mammals represented 9.9% of all feeds and the probability value for any of *Cx. pipiens* blood feed to be interrupted was 0.02. The effect of interrupted feeding is to increase the number of total feeds taken by a mosquito with consequent epidemiological implications (Burkot *et al.* 1982). It may be that the increased number of feeds taken increase the vectorial capacity of the population by increasing the chances acquiring and transmitting the agents of zoonotic diseases. It is not known, however, if this stands for RVF virus infection if is introduced to such new settlements. This shows that multiple blood feeding by mosquito vectors still needs more studies to evaluate the significance of interrupted feeding in both human and zoonotic diseases.

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الملخص العربي

السلوك الأعتدائي لبعوض كيولكس بيبينز (رتبة ثنائية الأجنحة - كيولسيدي) في قرية الأبطال

محافظة الاسماعيلية - مصر

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تمت دراسة التفضيل الغذائي لبعوضة كيولكس بيبينز أثناء فترة نشاطها الموسمي (مايو-نوفمبر) خلال عام ١٩٩٩ في قرية الأبطال التي تمثل مناطق الاستصلاح الحديثة في محافظة الاسماعيلية. خلال هذه الدراسة تم تحليل ٢٢٤ من البعوض المتغذي على وجبة دم باستخدام الطريقة المباشرة لقياس الادمصاص المناعي الانزيمي. وقد شكل الاغتداء على دم الإنسان نسبة ٥٠,٧% من عدد ٤٢ من البعوض المجمع من داخل المنازل. أما عن البعوض المجمع من خارج المنازل فقد اظهر تفضيل لدم الثدييات الأخرى دون الإنسان حيث شكل الاغتداء على الثدييات نسبة ٦٥,٨% من مجموع العينات التي تم تجميعها وتحليلها (٨٢ بعوضة). وبالنسبة للوجبات المركبة شكلت نسبة ١٤,١% (من ٤٢ بعوضه) و ٩,٨% (من ٨٢ بعوضه) وذلك بالنسبة لإنات بعوض كيولكس بيبينز المجمع من داخل وخارج المنازل على التوالي. وتعتبر دراسة نسبة الوجبات المركبة من دم الإنسان والثدييات الأخرى والنتيجة عن إزعاج البعوض أثناء اعتدائه وكذلك قدرة معدل الاغتداء على كل عائل منسوبا آلي النسبة التي يشكلها من التعداد الكلي للعوائل المختلفة بغرض تقييم كفاءة هذا النوع من البعوض (كيولكس بيبينز) كعائل وناقل لبعوض الأمراض الخاصة بالإنسان وكذلك الأمراض المشتركة بين الإنسان والعوائل الحيوانية الأخرى.