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(Original Article)

Highlights on Insects and Fungi Associated with Mosquitoes Inhabiting Agricultural Drain Water in Different Areas of Assiut Governorate, Egypt

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Abstract

The objective of the study was to determine the species composition of mosquitoes and their associated insects and fungi inhabiting drain water in different agricultural areas of Assiut governorate, Egypt. During 72 inspection visits and 164 examinations of drain water pools in seven areas of Assiut governorate, results indicated the presence of six identified mosquito species. *Culex pipiens* is considered the most frequent mosquito species with the highest Incidence Area Weight value IAW21. All six identified mosquito species were encountered in El-Badary area with an Incidence Species Weight ISW value of 14.

Nine insect species belonging to five orders were recorded. *Pantala flavescens* (Odonata: Libellulidae) is considered the most frequently associated insect species in all areas. Incidence Area Weight IAW for each identified species indicated that *P. flavescens* had the maximum value of IAW 14. Also, the maximum value of Incidence Species Weight was ISW 22 in El-Badary area.

Twenty-four fungi species were identified from agricultural drain water pools. Aquatic fungi were twenty-two species inhabiting agricultural drain water and Nine fungi species were isolated from the associated insects. Some of these species recorded as entomopathogenic fungi for mosquitoes including *Fusarium oxysporum*, *F. solani*, and *F. incarnatum*. The incidence values of all fungi species isolated reached the maximum of 17 in Spring. So, the associated insect species and fungi with mosquitoes in the present study can play an active role as biological control agents in Integrated Pest Management (IPM) approach. This contributes to achieving the Sustainable Development Goals (SDGs).

Keywords: *Associated insects, Mosquitoes, Agricultural drain water pools*

Introduction

Mosquitoes are dipteran insects that acting as biological and mechanical vectors for many parasites and pathogens responsible for communicable diseases. The World Health Organization (WHO) developed a Global Vector Control

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Response (GVCR, 2017-2030) to implement vector control strategies that are sustainable (WHO, 2019). Family Culicidae of order Diptera comprises 41 recognized genera incorporating about 3,500 mosquito species (Foster and Walker, 2019).

The genus *Culex* is the most common one, with 800 species that develop on every continent (Baz *et al.*, 2022). The *Cx. pipiens* acquires the most interest because of its large geographical distribution in tropical and subtropical countries, which causes a socio-economic impact and can adapt to all habitats and biotopes (Versteirt, 2012). In Egypt, *Cx. pipiens* is widely distributed in rural as well as urban areas and transmits terrible diseases that cause severe morbidity and death in humans and animals as well as dermatitis in people, especially children (Baz *et al*., 2022) Reviewing the literature concerning the publications interested in insects associated with mosquitoes indicated that most aquatic insects belong to orders Ephemeroptera, Odonata, Hemiptera, Coleoptera and Diptera. It is of interest to point out herein that some of the associated insects can play a role as predacious biological control agents preying on immature stages of mosquitoes (Scholte *et al*., 2003; Shaalan and Yanovisk, 2009).

Also, insects associated with mosquitoes and inhabiting agricultural drain water can play an active role in the dissemination of entomopathogenic fungi. Fungal diseases in insects are widespread. There are more than 700 species of entomopathogenic fungi currently known (Inglis *et al*., 2000).

So, the above-mentioned information out lightening the goal to submit the present study entitled “Highlights on Insects and Fungi Associated with Mosquitoes Inhabiting Drain Water in Different Agriculture Area of Assiut Governorate Egypt”.

Materials and Methods

1. Experimental site

This study was conducted in seven areas in Assiut Governorate, Egypt 31° 11' 21.4188" E Longitude: “27° 10' 48.4824" N” Latitude. The work was carried out during the period 2021-2022 in seven localities representing different quarters of Assiut Governorate. Areas chosen include the villages of El-Nikhila and El-Matiaa, in addition to the districts of Dairout, Manfalout, Abnoub, Sahel Seleem, and El-Badary (Map1).

Map1. The seven areas in Assiut Governorate Northern Upper Egypt for collecting mosquitoes, fungi, and associated insects inhabiting agricultural drain water.

2. Collecting samples

Intensive and extensive observations were used to collect the immature stage of mosquitos and the associated insects from different agricultural drain water in Assiut Governorate. Ambient weather factors recorded including the air temperature (Max. and Min.°C) and (Temp., and PH) of the drain water pools. Mosquitoes larvae, fungi and associated insects were collected by dipping method (using small ladle) (El-Zeiny *et al*., 2017). Collected sample were picked up in airy flasks and transferred to the laboratory for experimental studies.

3. Identification of mosquitoes

For identifying the species of mosquitoes, the 3rd and 4th of mosquito larval instars were selected from the samples picked up from pools. Larvae were kept in 70% ethyl alcohol in glass tubes and labeled for identification (Abdel-Hamid *et al*., 2009).

The larvae were identified using the keys of Harbach (1988), which identified the subgenus *Culex* of Southwestern Asia and Egypt, and Gillies and Coetzee (1987), which identified the Anopheles of South of the Sahara. Also, the larval mosquito identification was authenticated at the Medical Entomology Institute, Dokki- Giza, Egypt. Identified species of mosquitoes were examined and prepared under laboratory conditions in the Biological Control Unit, Plant Protection Dept., Assiut Univ., Assiut, Egypt.

4. Identification of associated insects

The insects were identified at the Plant Protection Research Institute, Dokki, Giza, Egypt (ARC). Also, the collected specimens of species were identified by comparing them with species identified in The Biolo. Cont. Unit, Plant Protec.

Dept., Assiut Univ., Assiut, Egypt. Also, collected insect's species were submitted for isolation of associated fungi.

5. Survey of fungi inhabiting agricultural drain water

Isolation of fungi

Drain water samples with immature stages of mosquitoes and associated insects collected from different agroecosystems of Assiut Governorate were used to survey the associated entomopathogenic Fungi. Samples were treated to allow the passage of immature stages of mosquitoes and associated insects and to prevent the passage of impurities. Then a certain amount of previously handled water (250ml) was taken, and a bacterial antibiotic was added besides a sterilized boiled sesame. The sample water was distributed on three petri dishes supplied with data and incubated at a temperature of 28℃ for 7–10 days and then monitored daily for the appearance of fungal colonies.

The previous step was applied to all samples in all regions during the study period. Isolates fungi were cultured on Potato Dextrose Agar (PDA, Difco, BBL/USA) and Sabouraud dextrose yeast agar (SDYA) (Sabouraud, 1982). Three replicas were done. for sesame, larvae, pupae, and associated insects to ensure the accuracy of the results. The agar plates were incubated at 28℃ for 3–5days and then monitored daily for the appearance of fungal colonies.

Identification of fungi

The isolates fungal were subcultured separately to obtain pure cultures on PDA, SDA, and CYA for identification at Moubasher Mycological Centre Assiut University, Egypt (AUMMC).

The isolated fungi were identified according to morphological characteristics (e.g., structure, size, color…) and microscopic examination described in fungal atlases.

6. Analysis of data

Collected data were codded as the following and then subjected to statistical analysis Incidence weight: absent (−) = 0, rare (+) =1, frequent (++) = 2 and more frequent (+++) = 3. The Incidence Area Weight (IAW) for each identified species (i.e., each insect species appeared more frequently in all studied areas).

The Incidence Species Weight (ISW) for each identified area (i.e., all the classified insect species were recorded in each studied area).

Results and Discussion

To determine the species composition of mosquitoes, associated insects, and fungi, the collected samples of different agricultural drain water were analyzed, and the obtained results can be explained as follows:

1. Species composition and incidence of mosquitoes, associated insects and fungi inhabiting agricultural drain water

Species composition and incidence of mosquitoes

Species composition of mosquitoes

Data in Table1 include a taxonomic list of mosquito species collected during four seasons in 2021 and 2022 from seven geographical areas in Assiut Governorate. Six mosquito species were surveyed namely *Anopheles muliticolor*, *Aedes caspius*, *Culex antennatus*, *Cx. perexigaus*, *Cx. pipiens*, and *Uranotaenia unguiculata*. These species display the number of mosquitos belonging to the family Culicidae, subfamily Anophelinae, and subfamily Culicinae. The family Culicidae is comprised of 41recognized genera incorporating about 3,500mosquito species. As reported by Foster and Walker (2019).

Table 1: Taxonomic list of mosquitoes inhabiting agricultural drain water in the studies areas of Assiut governorate from 2021 to 2022

Order Family Subfamily	Scientific Name
Diptera Culicidae Subfam. 1. Anophelinae	*Anopheles Multicolor* (Cambouliu)
Subfam. 2. Culicinae Tribe 1: Aedini Tribe 2*:* Culicini Tribe 3: Uranotaeniini	*Aedes caspius* (Pallas)
	1.Culex antennatus (Becker) *2.Culex Perexigaus* (Theobald) *3.Culex pipiens* (Linnaeus) 1. *Uranotaenia unguiculata* (Lynch Arribálzaga)

Data in Table 2 and Fig. 1a,1b show the Incidence Area Weight IAW for each identified species (i.e., each insect mosquito species appeared more frequently in all studied areas). Results indicate that *Cx. pipiens* had the maximum value IAW 21. The incidence of *Ae. caspius* reached IAW 18followed by *Cx. perexigaus* IAW 9, *An. muliticolor* IAW 7, *Ur. unguiculata* IAW 6 and *Cx. antennatus* IAW 4. So, *Cx. pipiens* was considered the most frequent mosquito species in all the seven studied areas.

Table 2. Incidence weight of mosquito species in the studies areas of Assiut Governorate from 2021 to 2022

Drain water sites	Inspection		Mosquito Species						Water				Air Temp℃		Incidence*	
									Temp℃		PH					
	No.	Pools No.	*An. muliticolor*	*Ae. caspius*	*Cx. antennatus*	*Cx. perexigaus*	*Cx. pipiens*	*Cx. pusillus*	Min	Max	Min	Max	Min	Max	Sp. No.	Wt.
El-Nikhila	8	17	-	+++	-	+	+++	-	15.0	29.5	8.25	8.85	20.0	39.0	3	7
El-Matiaa	8	8	-	++	-	++	+++	-	11.0	30.0	7.59	8.50	21.5	39.0	3	7
Sahel Seleem	16	48	++	+++	+	++	+++	++	10.0	37.5	8.31	9.23	25.5	39.0	6	13
El-Badary	14	28	++	+++	+	++	+++	+++	11.0	32.0	8.23	8.55	20.0	40.0	6	14
Abnoub	7	21	+	++	-	-	+++	-	15.0	31.9	7.76	8.57	25.0	39.0	3	6
Manfalout	9	21	-	++	+	++	+++	-	19.8	30.0	7.20	8.77	29.0	41.0	4	7
Dairout	7	21	++	+++	+	+	+++	++	20.0	41.0	8.74	9.33	20.0	41.0	6	12
Incidence* Area	**72**	**164**	**4**	**7**	**4**	**6**	**7**	**3**	**10.0**	**41.0**	**7.20**	**9.33**	**20.0**	**41.0**	**(3:6)**	**(6:12)**
Wt.			**7**	**18**	**4**	**9**	**21**	**6**								

*Incidence weight: absent (−) = 0, rare (+) =1, frequent (+ +) =2 and more frequent (+ + +) =3.

Concerning, the value of Incidence Species Weight, the maximum value was ISW 14 in El-Badary area (i.e., all the six classified species were recorded in the studied area). However, the value of ISW reached 13 and 12 in Sahel Seleem and Dairout. The value of ISW was 7 in the three areas, Manfalout, El-Nikhila, and El-Matiaa. The lowest value of ISW was 6 in Abnoub area. Generally, all six species of mosquitoes were encountered in El-Badary area. The above-mentioned results proved that *Cx. pipiens* is considered the most frequent mosquito species in Assiut Governorate studied areas. Also, all the six identified mosquito species inhabiting agricultural drain water were recorded in El Badary area, followed by Sahel Seleem and Dairout areas.

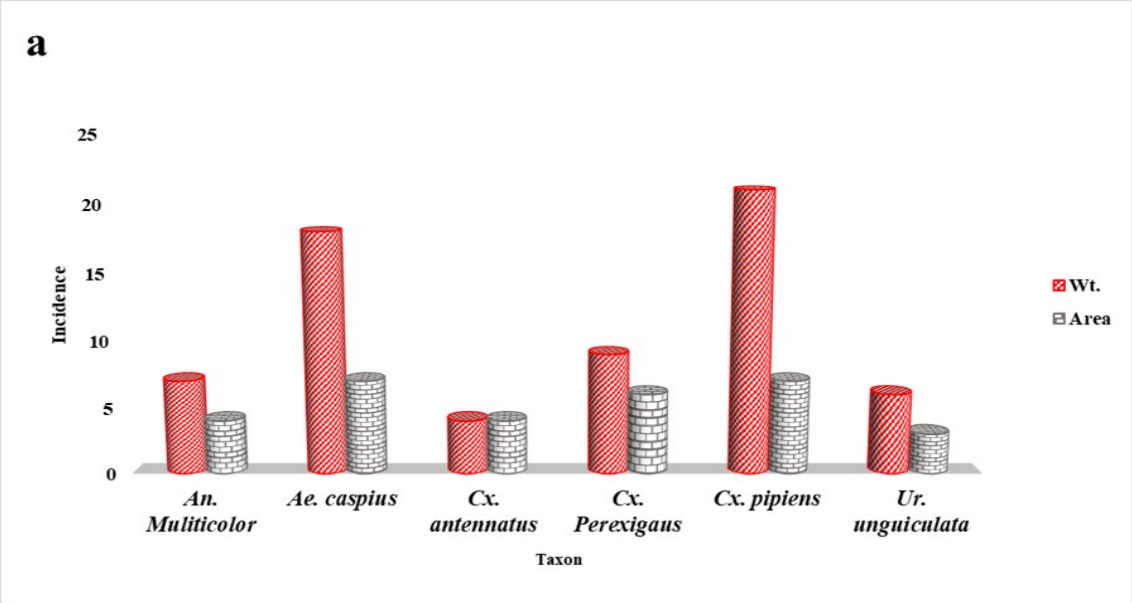


Fig.1a: Incidence Species Weight ISW in seven areas of Assiut Governorate from 2021 to 2022

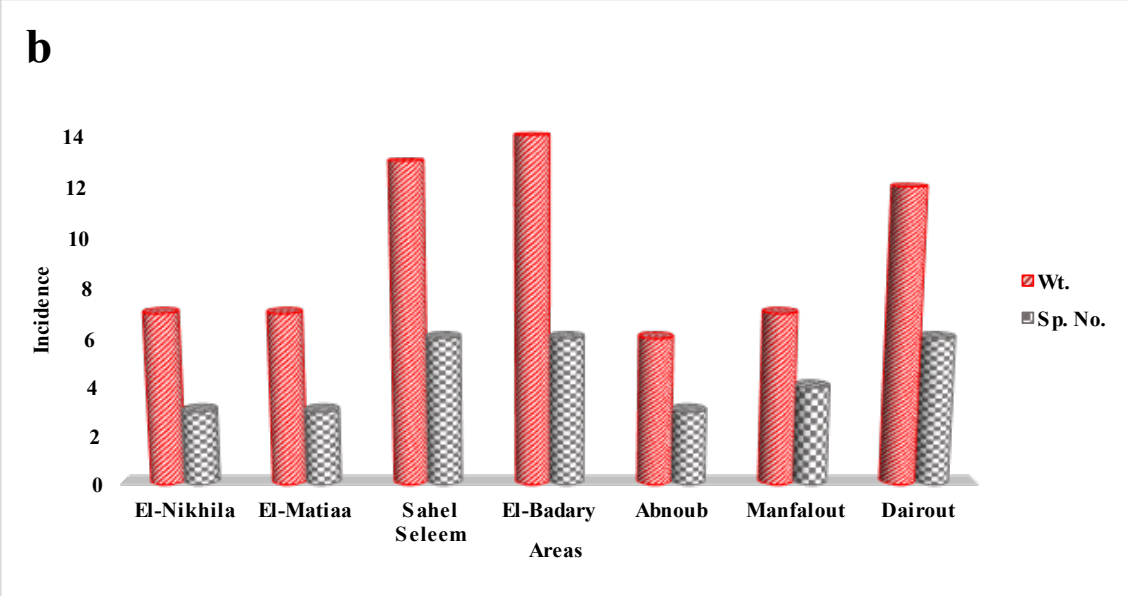


Fig.1b: Incidence Area Weight IAW in seven areas of Assiut Governorate from 2021 to 2022

It is of interest to point herein that in Egypt *Cx. pipiens* is widely distributed in rural as well as urban areas and transmits terrible diseases that cause severe morbidity and death in humans and animals as well as dermatitis in people, especially children (Radwan *et al*., 2022)

However, in the Nile Delta of Egypt, periodic *Bancroftian filariasis* is focally endemic, especially in the Governorates of Qalyubiya, Sharkiya, Dakahliya, and Damietta, where the main mosquito vector, *Cx. pipiens* is abundant. In contrast, filarial infections appeared to be absent in most of middle and Upper Egypt, except for small hypo endemic areas in Assiut and Sohag Governorates (Dyab *et al*.,2015). Thus, the spread of mosquitoes in Assiut Governorate especially *Cx. pipiens* is attributed to the presence of agricultural drain water, which was formed due to a poor drainage system resulting from a change in the irrigation system in Upper Egypt. Therefore, it must be pointed out to the extent of the danger of the presence of these pools.

Species composition of associated insects

Data in Table 3 show the taxonomic list of the associated insects linked with mosquitoes inhabiting agricultural drain water in the experimental area of Assiut governorate from 2021 to 2022.

Results revealed the presence of five insect orders, Ephemeroptera (1 family, 1genus, and 1 species), Odonata (3 families, 4genera, and 4 species), Hemiptera (1 family, 1genus, and 1 species), Coleoptera (2 families, 2 genera, and 2 species) and Diptera (1 family, 1 genus, and 1 species). Nine identified species are considered predaceous insects.

Table 3. Taxonomic list of associated insects of mosquitoes inhabiting agricultural drain water in the studies areas of Assiut Governorate from 2021 to 2022

Order	Family	Scientific name	Common name
1- Ephemeroptera	Polymitarcyidae	*Polymitarcys savignyii* **(Eaton)**	Mayfly
2- Odonata	1. Aeshnidae	*Anax ephippiger* **(Burmeister)**	Vagrant emperor
	2.Coenagrionidae	*Ischnura senegalensis* **(Rambur)**	Common bluetail
	3.Libellulidae	***a***. *Trithemis aurora* **(Burmeister)**	Crimson marsh glider
		b. *Pantala flavescens* **(Fabricius)**	Backswimmer
3-Hemiptera	Notonectidae	*Notonecta glauca* **(Linnaeus)**	Globe skimmer Globe wanderer
4- Coleoptera	**1.** Hydrophilidae	*Hydrophilus triangularis* **(Say)**	Gant black water beetle Giant water scavenger
	2. Dytiscidae	*Cybister* sp. **(Curtis)**	
5-Diptera	Chironomidae	*Chironomus plumosus* **(Linnaeus)**	buzzer midge

Incidence of identified associated insects' species.

Data in Table 4 and Fig. 2 a, b show the incidence values of nine identified associated insect species in seven areas during 72inspection visits, and in 124agricultural drain water pools in Assiut governorate area from 2021 to 2022.

Concerning the value of Incidence Species Weight ISW, the maximum value was 22 in the El-Badary area (i.e., all the nine classified species were recorded in the studied area).

However, the value of ISW reached 21 in Sahel Seleem and Dairout, while the value of ISW reached 6 and 5 in Abnoub and Manfalout, respectively. The lowest value of ISW 3 was in El Nikhila and El-Matiaa.

Analyses of the data in Table 4 reveal the Incidence Area Weight IAW for each identified species. Results indicate that the backswimmer *Pantala flavescens* (Odonata: Libellulidae), had the maximum value of IAW 14 (i.e., each associated insect species appeared more frequently in all studied areas). The IAW of *Notonecta glauca* reached 13followed by *Anax ephippiger* 10, *Hydrophilus triangularis* and *Cybister* sp., 9, *Chironomus* sp., 7, *Ischnura senegalensis* 6 and *Trithemis aurora* 5. So, *P. flavescens* of the order Odonata is considered the most frequently associated insects' species in all the seven studied areas. Recently, Mohammed *et al.* (2022) reported that mosquitoes have many natural enemies such as invertebrate predators, which play an important role in reducing the mosquito larval populations. Odonata (dragonfly) is considered one of the common predators for mosquito control and play an important role in mosquito control many years.

Concerning the above-mentioned results, mosquitoes in agricultural drain water pools can be attacked by predacious insects. These results agreed with the finding of Koenraadt and Takken (2003), Mandal *et al*. (2008) and Shaalan and Yanovisk (2009).

Table 4: Incidence of associated insects in the studies areas of Assiut Governorate from 2021to 2022

Drain water sites	Inspection		Associated Insects Incidence									Incidence*	
	No.	Pools No.	*Caenis stephens*	*Anax ephippiger*	*Ischnura senegalensis*	*Trithemis aurora*	*Pantala flavescens*	*Notonecta glauca*	*Cybister* sp.	*Hydrophilus triangularis*	*Chironomus* sp.	Sp. No.	Wt.
El-Nikhila	8	17	+	+	-	-	+	-	-	-	-	**3**	**3**
El-Matiaa	8	8	+	+	-	-	+	-	-	-	-	**3**	**3**
Sahel Seleem	16	48	++	++	+	++	+++	+++	+++	+++	++	**9**	**21**
El-Badary	14	28	++	++	++	+	+++	+++	+++	+++	+++	**9**	**22**
Abnoub	7	21	-	+	+	-	++	++	-	-	-	**4**	**6**
Manfalout	9	21	-	+	-	+	+	++	-	-	-	**4**	**5**
Dairout	7	21	+++	++	++	+	+++	+++	+++	+++	++	**9**	**21**
Incidence* **Area**	**72**	**164**	**5**	**7**	**4**	**4**	**7**	**5**	**3**	**3**	**3**	**(3:9)**	**(3:21**
Wt.			**9**	**10**	**6**	**5**	**14**	**13**	**9**	**9**	**7**		

*Incidence weight of Associated insects: absent (−) = 0, rare (+) =1, frequent (+ +) =2 and more frequent (+ + +) =3

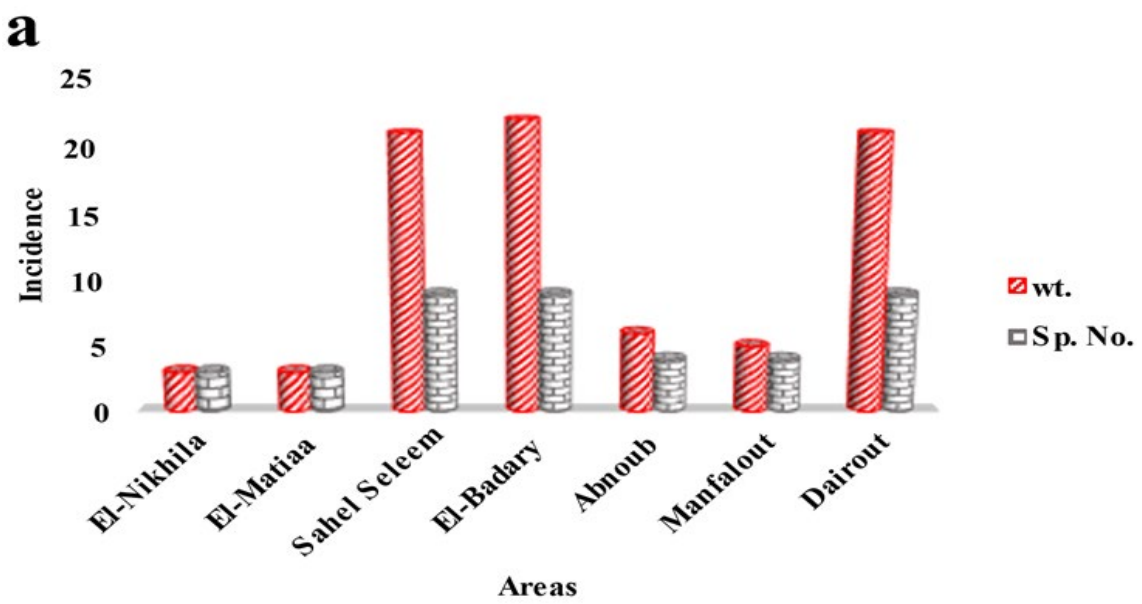
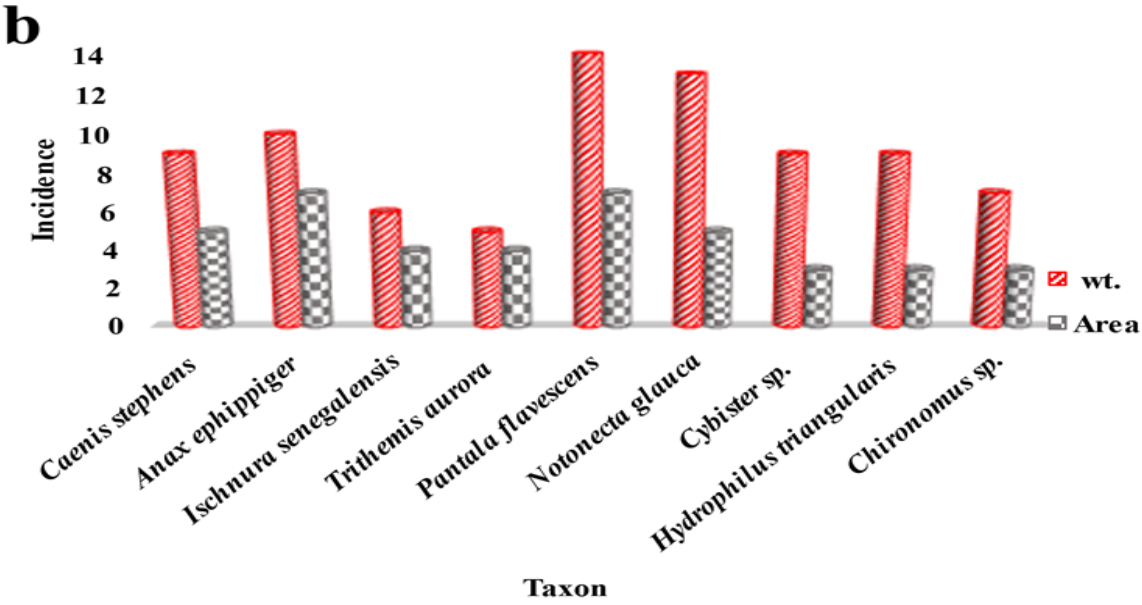


Fig. 2a: Incidence Area Weight IAW for each identified species in seven areas at of



Assiut Governorate from 2021 to 2022

Fig. 2b: Incidence Species Weight ISW for associated insect species of Assiut Governorate from 2021 to 20222.

Incidence of identified fungi associated with insect species inhabiting different agricultural drain water pools in the Assiut area

Data in Table 5 show a list of isolated fungi inhabiting different agricultural drain water pools and their incidence. Results indicated the presence of 24fungus species. Twenty-two species inhabited the agricultural drain water. Nine fungus species were isolated from the associated insects. The incidence patterns of the isolated fungi species during different seasons revealed that the maximum incidence value was 17 in the spring, followed by 15 in both the winter and the summer, and 13 in the fall.

Table 5: List of isolated fungi inhabiting different agricultural drain water, scientific name, isolation sources, and seasons in the area of Assiut governorate from 2021 to 2022

Scientific name	Isolation sources		Seasons			
	Assoc. insects	Water	Winter	Spring	Summer	Fall
Alternaria tenuissima (Kunze) Wiltshire (1933)	-	+	+	+	-	-
Trichoderma harzianum Rifai (1969)	-	+	+	-	-	-
Fusarium oxysporum Schltdl., Fl. berol (1824)	+	+	+	+	-	-
Fusarium solani (Mart.) Sacc (1881)	+	+	+	+	-	-
Fusarium circinatum Nirenberg and O'Donnell (1998)	-	+	+	+	+	-
Fusarium coffeatum L. Lombard and Crous (2019)	-	+	+	-	-	-
Fusarium proliferatum (Matsush.) Nirenberg ex Gerlach and Nirenberg ***(1982)***	-	+	+	+	+	+
Fusarium incarnatum (Desm.) Sacc. 1886)	+	+	+	+	+	+
Fusarium fujikuroi Nirenberg (1976)	+	+	+	+	+	+
Fusarium sterilihyphosum Britz, Marasas and M.J. Wingf. (2002)	+	+	+	+	-	-
Fusarium nygamai L.W. Burgess & Trimboli (1986)	-	+	+	+	-	-
Purpureocillium lilacinum (Thom) Luangsa-ard, Houbraken, Hywel-Jones& Samson (2011)	-	+	-	-	+	+
Sarocladium implicatum (J.C. Gilman & E.V. Abbot A. Giraldo, Gené & Guarro (2014)	-	+	+	+	+	+
Penicillium aurantiogriseum Dierckx, Ann (1901)	-	+	-	-	+	+
Penicillium chrysogenum Thom (1910)	-	+	-	-	+	+
Aspergillus flavus (Link) 1809	-	+	-	-	+	+

Aspergillus nidulans (Eidam G. Winter (1884)	-	+	-	+	+	+
Aspergillus flavipes (Bainier & R. Sartory) &Church (1926)	-	+	-	+	+	+
Aspergillus niger Tiegh (1867)	+	+	+	+	+	+
Aspergillus candidus Link (1809)	-	+	-	-	+	+
Aspergillus terreus Thom (1918)	+	+	+	+	+	+
Geotrichum candidum Link (1809)	-	+	-	+	-	-
Rhizopus stolonifer (Ehrenb.) Vuill (1902)	+	+	+	+	+	-
Cunninghamella phaeospora Boedijn (1959)	+	-	-	+	-	-
Total species:24	**9**	***22***	**15**	**17**	**15**	**13**

However, some of these species have been recorded as entomopathogenic fungi for mosquitoes such as *Fusarium oxysporum*, *Fusarium solani*, and *Fusarium incarnatum* as reported by Choi and Jung (2015) and Wasinpiyamongkol and Kanchan Phum (2019).

Entomopathogenic fungi infect their hosts through the cuticle, penetrate them, and spread through the body. After the fungus has killed the host, it can grow out of the cadaver and produce more spores, increasing the chance for new infection Farida *et al*. (2018) and Islam *et al*. (2021). So, insects associated with mosquitoes and inhabiting agricultural drain water can play an active role in the dissemination of such entomopathogenic fungi.

Finally, understanding the species composition of mosquitoes, their associated insects, and fungi inhabiting drain water in different agricultural areas of Assiut governorate, Egypt is of great importance from the medical and agricultural point of view. This research will aid in the development of precise management strategies to strengthen the biological control of aquatic insects inhabiting agricultural drain water pools. More research is required to determine the role of the more abundant mosquito species in the transmutation of human and veterinary diseases in the Assiut Governorate area.

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أضـواء على الحشـرات والفطريات المصـاحبة للبعوض القاطن مياه الصـرف الزراعي بمناطق مختلفة بمحافظة أسيوط، مصر

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الملخص

هدفت الدراسـة الى تحديد التركيب النوعي للبعوض والحشـرات والفطريات المصـاحبة في برك مياه الصرف الزراعي بمناطق مختلفة في محافظة اسيوط مصر. أشارت النتائج الى انه من خلال 72 زيارة ميدانية وفحص 164 بركة مياه صرف زراعي في سبع مناطق مختلفة الى وجود سـتة انواع محددة من البعوض. يعتبر بعوض *Culex pipiens* أكثر انواع البعوض التي لها اعلى قيمة تواجد (IAW) حيث بلغت 21 درجة. تم العثور على جميع انواع البعوض الستة المصنفة في منطقة البداري وسجلت اعلى قيمة تواجد حيث بلغت 14 درجة.

تم تسـجيل تسـعة انواع من الحشـرات المصـاحبة للبعوض تنتمي الى خمسـة رتب حشـرية. تعتبر حشـرة *Pantala flavescens* التابعة لرتبة الرعاشـات (Odonata: Libellulidae) أكثر انواع الحشرات المصاحبة تواجدا في جميع المناطق. وسجلت درجة تواجد قصوى (IAW) بلغت 14 درجة. بينما سـجلت اقصـى درجة تواجد للأنواع (ISW) في منطقة البداري حيث بلغت 22 درجة. تم تحديد 24 نوع من الفطريات التي تقطن برك مياه الصرف الزراعي. بلغ عدد الفطريات المائية 22 نوعا وتم عزل عدد 9 انواع من الفطريات من الحشـرات المصـاحبة. سُـجلت بعض انواع الفطريات على انها فطريات ممرضـة للحشـرات وهذه تشـمل *Fusarium oxysporum* , *Fusarium solani* , *Fusarium incarnatum*. بلغت اقصى قيمة للتواجد لجميع انواع الفطريات المعزولة الى 17 درجة في فصل الربيع.

لذلك فان انواع الحشـرات المصـاحبة للبعوض وبعض الفطريات المعزولة في الدراسـة الحالية يمكن ان تقوم بدورا نشطا كعناصر هامة في المكافحة البيولوجية التي تعتبر ركنا هاما في برامج الادارة المتكاملة لمكافحة الآفات (IPM) وهذا يسـهم في تحقيق اهداف التنمية المسـتدامة (SDGs).

الكلمات المفتاحية: *الحشرات المصاحبة، البعوض، برك مياه الصرف الزراعي*