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MONTHLY FLUCTUATIONS OF LARVAL AND PUPAL DENSITIES OF *Culex pipiens* (L.) WITH SPECIAL REFERENCE TO THE EFFECT OF AQUATIC PHYSIOCHEMICAL PROPERTIES ON THEIR HABITATS AT KAFR EL-SHEIKH REGION

Abou-Attia F.A.; A.S. El-Khodary; S.M. I. Metwally and H.M. Hassan
Economic Entomology Department, Faculty of Agriculture, Kafr El-Sheikh, Tanta University, Egypt.

ABSTRACT

Population density and seasonal fluctuations of *Culex pipiens* (L.) immature stages were detected through one year from April, 1997 to March, 1998. Also, certain physical and chemical water properties affecting its habitats were concerned.

Larval densities reached their maximum during July, 1997 (2943 and 2371 larvae) and October, 1997 (2644, 2226 larvae) in agricultural drains and small pools with stagnant water respectively. While, minimum density was recorded in sewage water (2039 larvae) during July. Significant differences in spring and winter, highly significant in autumn and insignificant differences in summer were found between larval population in all types of water.

High pupal densities were established in small pools with stagnant water (2731 pupae) and agricultural drains (2614 pupae) with peaks observed through July and October low densities were recorded in both sewage water and mixed drains (2223 and 2204 pupae respectively. Significant differences in spring, highly significant in winter and insignificant differences in summer and autumn were recorded among pupal populations in all types of water. Highly significant correlation was found between temperature and both larval and pupal population in all types of breeding sites. Finally, two peaks of population density of the immature stages (larvae and pupae) were recorded through July and October, 1997 and the population density was markedly decreased throughout the period extended from November, 1997 to February, 1998. Highly significant correlation was found between larval and pupal populations during the year of study. Results showed that larvae of *C. pipiens* preffered water with pH ranging between 8.15 – 8.70 and the electric conductivity (E.C.) was ranged between 0.815 – 2.0 ds/m. *C. pipiens* larvae tolerate high concentrations of organic materials as indicated from nitrogen compounds such as ammonia (8.1 – 23.85 mg/L) and nitrate (31 – 35.65 mg/L) and biological oxygen demand (B.O.D.) (5 – 14 mg/L) in breeding sites. Also, they tolerate high salinity as indicated from total soluble salts ranging from 521.6 – 1216 mg/L. The chloride concentrations ranged between 31.95 – 159.72 mg/L. in the afforementioned aquatic larval habitats.

INTRODUCTION

Kafr El-Sheikh Governorate is well known area for rice cultivations which already suitable for mosquito abundance and nourishment. Meanwhile, *Culex pipiens* (L.) is the most spreading species in the Nile valley and the Delta, breed in all sorts of water (Gad and Salit, 1972 and Sadek, 1975). WHO (1991) pointed out that *C. pipiens* (L.) and *C. quinquefasciatus* (Say) are widely distributed in the eastern Mediterranean region. Gad *et al*. (1987) found that larvae of *Culex antennatus* (Becker) in different types of breeding sites such as: flooded rice fields, drains, fresh pools, irrigation channels and

were less common in wells and open cesspits. Beehler *et al*. (1993) found that *C. quinquefasciatus* (Say) is a common urban mosquito species in Southern California, also the larvae are found in poorly maintained swimming pools, ornamental ponds, reclaimed water storage ponds and storm drains. Beier *et al*. (1983) stated that the densities of three species of Mosquitoes were significantly correlated with levels of ammonia of the water. Soliman (1985) found that larvae of both *C. pipiens* (L.) and *C. antennatus* (Becker) hbreeding in sites with a pH value ranged between 6.5 to 8 and Salinity ranged from 0.1 to 1.0 gm. chloride/litre. Kardatzke (1989) stated that increasing water salinity from 1000 to 60000 p.p.m. sodium chloride in which larvae and pupae of *Aedes* sp. were reared with decreasing egg production. Dutta and Dasqupta (1992) indicated that 0.6% water salinity is optimal for *Aedes aegyptii* (L.) to complete its life cycle. Kenawy *et al*. (1998) reported that breeding water of three mosquito species *C. antenatus* (Backer), *Anopheles pharoensis* (Theobald) and *C. perexigus* had pH of 6-8 and salinities of 0.05 – 0.35 gm. chloride/litre. Therefore, the present study was carried out at Kafr El-Sheikh, region to get clear picture about the population density and seasonal fluctuations of larval and pupal stages of *C. pipiens* in different water breeding types and to investigate which physical and chemical factors essentially affecting their habitats.

MATERIALS AND METHODS

The research area chosen to conduct the present study contained different water types such as: (1) agricultural drains which always filled with polluted water; (2) mixed drains formed from water collection of agricultural and sewage drainage system; (3) sewage water including, cesspits water; (4) careless small pools with stagnant water.

Sampling the immature stages of *C. pipiens* started from April 1997 to March 1998. The immature stages were collected from a fixed number of breeding site at each type of water using a dipper formed of white enamel (8 cm. diameter and 5 cm. deep) attached to a short handle about one meter long, two samples were taken from one side and at equal distance along every selected water stream. The volume of each sample was one liter composed of four dippers of 250 ml. Eight Samples with thirty-two dippers per month were taken for all water streams with a total amount of 8000 ml of water. The collected larvae and pupae were emptied in polyethylene wide mouth bottles, half filled with water, tightly closed and labeled with the site number and date of collection and transferred to the laboratory for identification and counting.

Water chemical and physical analysis in larval breeding places:

Water samples were collected from each breeding site to determine its chemical properties. The water was sampled in labelled polyethylene, Kept in refrigerator, untill transferred to laboratory of the soils, Water and Environmental Res. Inst. (Sakha Agric. Res. Station) for chemical analysis

according to the procedures described in standard method for the examination of water and waste water APHA (Greenberg *et al*. 1995).

The parameters used to indicate the chemical characteristics of water in the different mosquito larval breeding sites were: (1) biological oxygen demand B.O.D.; (2) Ammonia and nitrate; (3) salinity [total soluble salts (T.S.S.)]; (4) chloride; (5) pH value and electric conductivity (E.C.). A year divided to four seasons: spring, summer, autumn and winter to indicate differences between both larval and pupal populations of *C. pipiens* in all types of breeding sites. The obtained data were statistically analyzed using the "MSTAT" statistical package on a computer (Freed, 1986). Correlation analysis was calculated according to Fisher (1950).

RESULTS AND DISCUSSION

Monthly fluctuations of mosquito larval and pupal densities :

a. Larval stage:

C. pipiens larvae from first to fourth larval instars were recorded as a total numbers in all types of breeding sites; agricultural drains, sewage water, mixded drains and careless small pools.

Data presented in Table (1) and Fig. (1) clearly revealed that in agricultural drains, showed two high peaks for larval stages during 1997, the first one was higher than the second and represented by 2943 larvae through July at 26.5°C, while the second was represented by 2644 larvae collected during October at 21.8°C (Table 3).

Table (1): Monthly fluctuations of *C. pipiens* larval density in the four breeding sites from April 1997 to March 1998 at Kafr El-Sheikh region.

Month	Agricultural drains		Sewage water		Mixed drains		Careless small pools with stagnant water	
	Total* No. of larvae	Average No. of Larvae/ sample	Total No. of larvae	Average No. of Larvae/ sample	Total No. of larvae	Average No. of Larvae/ sample	Total No. of larvae	Average No. of Larvae/ sample
April/97	179	22.37	286	35.75	156	19.5	351	43.87
May	900	112.5	705	88.12	636	79.5	1107	138.37
June	1551	193.87	1730	216.25	1464	183.0	2269	283.62
July	2943	367.87	2039	254.87	2121	265.12	2371	296.37
August	2337	292.12	1838	229.75	1736	217.0	2287	285.87
September	2389	298.62	1678	209.75	1800	225.0	2177	272.12
October	2644	330.5	1567	195.87	1839	229.87	2226	278.25
November	1968	246.0	542	67.75	971	121.37	2047	255.87
December	752	94.0	302	37.75	536	97.0	1042	130.25
Jan/98	659	82.37	208	26.00	268	33.5	450	56.25
February	704	88.0	269	33.62	318	39.75	470	58.75
March	740	92.5	338	42.25	393	49.12	673	84.12
Total	17766	2220.72	11502	1437.73	12238	1529.73	17470	2183.71

*** Total No. of larvae/month represented by eight samples**
Sample size = 4 dippers (one litre).

One peak of *C. pipiens* larval population was recorded only during July (2039 larvae) at 26.5°C in sewage water. In mixed drains two peaks of larvae were recorded, the first one was higher and represented by 2121 larvae and occurred through July, while the lower peak was established during October and represented by 1839 larvae. Small pools showed two peaks during July and October under previous temperature and represented by 2371 and 2226 larvae, respectively.

Fig. (1): Monthly fluctuations of *C. pipiens* larval density in the four breeding sites at Kafr El-Sheikh (April, 1997 – March, 1998).

When larval densities reached to its minimum numbers by 659, 208, 268 and 450 larvae during January 1998 for agricultural drains, sewage water, mixed drains and small pools, respectively, degree of the temperature was only (11.7°C). Statistical analysis showed that significant correlation between temperature and larval population in agricultural drains ($r = 0.650$), while highly significant correlation was found between temperature and larval population in sewage water ($r = 0.852$), mixed drains ($r = 0.769$) and small pools ($r = 0.741$). Also, statistical analysis showed significant differences among the types of breeding sites of *C. pipiens* larvae in spring and winter, while highly significant differences were found in autumn. Only insignificant differences were recorded between the types of breeding sites of larvae in summer.

b. Pupal stage :

The pupal stage density gradually increased until reachies the first peak in agricultural drains, sewage water, and mixed drains during July, 1997 which was represented by 454, 302 and 327 pupae, respectively, at 26.5°C. While in small pools the first peak appeared during June (397 pupae) at 25.3°C. Second peak was recorded during October and represented by 313, 279 and 331 pupae in agricultural drains, sewage water and small pools, respectively, at 21.8°C. While in mixed drains the second peak appeared during September (306 pupae) at 23.5°C (Table 2 & Fig. 2).

On the other hand, the total pupal densities of *C. pipiens* in small pools (2731 pupae) and agricultural drains (2614 pupae) were higher than those of sewage water (2223 pupae) and mixed drains (2204 pupae). Statistical analysis showed that highly significant correlation was found between temperature and pupal population in agricultural drains (r = 0.829), sewage water (r = 0.754), mixed drains (r = 0.880) and small pools (r = 0.856). Also, statistical analysis indicated significant differences among the types of breeding sites of *C. pipiens* pupae in spring, while highly significant differences was recorded in winter. Insignificant differences was found between types of breeding places of pupae in summer and autumn.

Table (2): Monthly fluctuations of *C. pipiens* pupal density in the four breeding sites from April 1997 to March 1998 at Kafr El-Sheikh region.

Month	Agricultural drains		Sewage water		Mixed drains		Careless small pools with stagnant water	
	Total* No. of pupae	Average No. of pupae/ sample	Total No. of pupae	Average No. of pupae/ sample	Total No. of pupae	Average No. of pupae/ sample	Total No. of pupae	Average No. of pupae/ Sample
April/97	79	9.87	59	7.37	90	11.25	102	12.75
May	268	33.5	178	22.25	196	24.5	247	30.87
June	428	53.5	253	31.62	313	39.12	397	49.62
July	454	56.75	302	37.75	327	40.87	356	44.5
August	236	29.5	273	34.12	275	34.37	332	41.5
September	299	37.37	264	33.0	306	38.25	316	39.5
October	313	39.12	279	34.87	207	25.87	331	41.37
November	216	27.0	161	20.12	177	22.12	238	29.75
December	95	11.87	130	16.25	101	12.62	114	14.25
Jan/98	51	6.37	116	14.5	75	9.37	94	11.75
February	63	7.87	110	13.75	55	6.87	80	10.0
March	112	14.0	98	12.25	83	10.37	124	15.5
Total	2614	326.72	2223	277.85	2204	275.58	2731	341.36

*** Total No. of pupae/month represented by eight samples**
Sample size = 4 dippers (one litre).

Fig. (2): Monthly fluctuations of *C. pipiens* pupal density in the four breeding sites at Kafr El-Sheikh (April, 1997 – March, 1998).

Data in Table (3) and Fig. (3) indicated that the total *C. pipiens* larval density during a year was (58976 larvae). Two peaks were observed during July and October, 1997 and represented by 9474 and 8276 larvae, respectively. The lowest larval density was recorded during January, 1998 (1585 larvae) with relatively low temperature. Also, in general total pupal density of *C. pipiens* during a year reached 9773 pupae. Two peaks were observed during July and September, 1997 represented by 1439 and 1185 pupae, respectively. The lowest number of pupae reached 308 pupae in February, 1998.

During the present study, temperature ranged between 11.7 – 26.5°C in all types of *Culex* breeding sites at Kafr El-Sheikh, from the results recorded it was evident that temperature was a limiting factor in determining the population densities of immature stages during the year of study and the statistical analysis assured this phenomenon. Also, highly significant correlation (r = 0.942) was found between larval and pupal populations during the year. The obtained results confirmed by the findings of WHO (1975) reported that the average optimum temperature for the immature most mosquito species development are around 25 - 27°C, while permanent high temperature over 30°C will reduce the average life span of mosquito populations. Kenaway and El-Said (1989) found that nine culicine species in Egypt breed in water temperature ranging between 14 - 39°C.

Table (3): Population density of the immature stages of *C. pipiens* through 1997-1998 at Kafr El-Sheikh region

Month	Larvae		Pupae		Mean temperature °C
	Total No.* of larvae	Average No. of larvae/sample	Total No.* of pupae	Average No. of pupae/sample	
April/97	972	30.37	330	10.31	22.16
May	3348	104.62	889	27.78	21.73
June	7014	219.18	1391	43.46	25.31
July	9474	296.06	1439	44.96	26.55
August	8198	256.18	1116	34.87	25.01
September	8044	251.37	1185	37.03	23.54
October	8276	258.62	1130	35.31	21.82
November	5528	172.75	792	24.75	17.7
December	2632	82.25	440	13.75	13.49
Jan/98	1585	49.53	336	10.5	11.79
February	1761	55.03	308	9.62	12.3
March	2144	67.0	417	13.03	13.04
Total	58976	1842.96	9773	305.37	

*** Total No. of larvae or pupae/month represented by 32 samples**
Sample size = 4 dippers (one litre).

Physiochemical properties of water in different types of mosquito aquatic breeding sites at Kafr El-Sheikh region :

Results in Table (4) indicated that minimal pH value measurements ranged between 7.65 – 8.65 in mixed drains and maximal value ranged between 8.66 – 8.75 in sewage water. The electric conductivity of water ranged between (0.72 – 0.91 ds/m) in agricultural drains and (1.26 – 2.74 ds/m) in sewage water. Water organic content was as indicated from biological oxygen demand ranged between (2-8 mg/L) in sewage water and (7 – 21 mg/L) in small pools. Ammonia ranged between 3.6 – 12.6 mg/L) in small pools and (13.5 – 34.2 mg/L) in mixed drains. Nitrate ranged between (27.9 – 34.1 mg /L) in agricultural drains and (13 – 40.3 mg/L) in sewage water. Salinity of water as indicated from total soluble salts (T.S.S.) with minimal value ranging between (460.8 – 582.4 p.p.m.) in agricultural drains and maximal value ranging between (806.4 – 1625.6 p.p.m.) in sewage water. Chloride ranged between (28.4 – 35.5 mg/L) in agricultural drains and (35.5 – 284 mg/L) in sewage water.

Table (4): Physiochemical properties of water at different mosquito breeding sites at Kafr El-Sheikh (1997-1998).

Types of breeding sites	Parameters						
	pH	Ammonia mg/L	Nitrate mg/L	B.O.D. mg/L	EC ds/m	T.S.S. mg/L	Cl mg/L
Agricultural drains	8.58-8.67 8.62	12.6-17.1 14.25	27.9-34.1 31.00	8-9 8.5	0.72-0.91 0.815	460.8-582.4 521.6	28.4-35.5 31.95
Sewage water	8.66-8.75 8.70	8.1-21.6 14.85	31.0-40.3 35.65	2-8 5	1.26-2.74 2.0	806.4-1625.6 1216	35.5-284 159.75
Mixed drains	7.65-8.65 8.15	13.5-34.2 23.85	31.0-37.2 34.1	5-6 5.5	1.45-1.55 1.5	928-992 960	74.5-110.1 92.3
Small pools with stagnant water	8.38-8.66 8.52	3.6-12.6 8.1	31.0-37.2 34.1	7-12 14.0	0.49-2.32 1.402	313.6-1484.8 899.2	106.5-213 159.72

Fig. (3): Population density of the immature stages of *C. pipiens* at Kafr El-Sheikh region through 1997-1998.

The obtained results are in agreement with those obtained by Gad *et al*. (1987) who found that pH value ranged between 6.4 – 7.4 for culicine breeding sites. It appear from the results that high levels of B.O.D. and ammonia were considered to be one of the limiting factors for successful larval and pupal developmental stages of *C. pipiens.* Similar results were obtained by Thavasclvam and Kalyanasundaram (1991).

High nitrate content was recorded in all breeding types, ranged between 27.9 – 40.3 mg/L. This may reveal that *C. pipiens* larvae and pupae at Kafr El-Sheikh can tolerate these levels of nitrate. Salinity levels was proved to be a limiting factor for *C. pipiens* larvae and reduced population densities, Ouda and Chalabi (1986) they mentioned that, salt water of pond, irrigation, wells, drains and sewer reduced egg hatching and larval survival. Soliman (1985) found that larvae of both *C. pipiens* and *C. antennatus* breed in sites with a pH value ranged between 6.5 to 8 and salinity ranged from 0.1 to 1.0 gm. chloride/litre. Abdel-Mohsen (1986) reported that *Aedes caspius* and *C. pusillus* were present in breeding sites with pH between 7.4 to 7.8 and salinity from 2.1 to 4.9 gm. chloride/litre. Kenawy *et al*. (1998) reported that breeding water of 3 mosquito species, *C. antennatus*, *Anopheles pharoensis* and *C. perexigus*. had pH of 6 – 8 and salinties of 0.05 – 0.35 gm chloride/litre.

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دراسة الكثافة العددية والتذبذبات الشهرية ليرقات وعذارى البعوضة المنزلية *Culex pipiens* (L.) وتأثير خواص الماء الفيزيائية والكيميائية على بيئة التوالد للبعوض فى منطقة كفرالشيخ

فايز على أبوعطية، أحمد سعدالدين الخضرى، شوقى محمد إبراهيم متولى، هانى محمد حسن

قسم الحشرات الإقتصادية – كلية الزراعة بكفرالشيخ – جامعة طنطا

تعتبر محافظة كفرالشيخ إحدى المحافظات الهامة لإنتاج الأرز فى مصر لذا يعتبر البعوض من أكثر المشكلات التى تواجه المحافظة وأكثر الأنواع انتشارا هو النوع المعروف بالبعوضة المنزلية *Culex pipiens* (L.) .

وقد أجرى هذا البحث فى منطقة كفرالشيخ وذلك خلال عام كامل من أبريل 1997 الى مارس 1998 وتم اختيار 4 أماكن لتوالد البعوضة المنزلية *C. pipiens* وهى المصارف الزراعية – ماء الصرف الصحى – المصارف المختلطة – البرك الصغيرة ذات المياه الراكدة بهدف دراسة الكثافة العددية والتذبذبات الموسمية ليرقات وعذارى بعوض الكيولكس ودراسة تأثير بعض العوامل الفيزيائية والخواص الكيميائية لبيئة التوالد على تعداد الأطوار غير الكاملة للبعوض (يرقات – عذارى).

وتتلخص النتائج فى الآتى :

- بلغت الكثافات العددية لليرقات أقصاها خلال شهر يوليو (2934، 2371 يرقة) عند درجة حرارة 26.5°م وشهر أكتوبر 1997 (2644، 2226 يرقة) عند درجة حرارة 21.8°م فى المصارف الزراعية والبرك الصغيرة ذات المياه الراكدة على التوالى. بينما سجلت أدنى كثافة عددية لليرقات بمياه الصرف الصحى وكان لها ذروة واحدة فى يوليو (2039 يرقة).
وأوضح التحليل الإحصائى وجود فروق معنوية بين تعداد اليرقات فى أماكن التوالد المختلفة فى موسم الربيع والشتاء بينما كانت الفروق عالية المعنوية فى الخريف. وكانت الفروق غير معنوية فى موسم الصيف.
- كانت أعلى كثافة عددية للعذارى فى البرك الصغيرة ذات المياه الراكدة (2731 عذراء) والمصارف الزراعية (2614 عذراء) وكان للعذارى أيضاً ذروتان: الأولى خلال شهر يوليو والثانية خلال شهر سبتمبر، كما وجدت عذارى الكيولكس بكثافات منخفضة نسبياً بكل من مياه الصرف الصحى (2223 عذراء) والمصارف المختلطة (2204 عذراء). واوضح التحليل الإحصائى وجود فروق معنوية بين تعداد العذارى فى أماكن التوالد المختلفة فى موسم الربيع بينما كانت الفروق عالية المعنوية فى موسم الشتاء وكانت الفروق غير معنوية فى موسم الصيف والخريف كما أوضح التحليل الإحصائى وجود ارتباط عالى المعنوية بين درجة الحرارة وتعداد كل من اليرقات والغذارى فى جميع أنواع أماكن التوالد للبعوض.
- وبصفة عامة يوجد ذروتين لأعداد الأطوار الغير كاملة (اليرقات – العذارى) خلال شهرى يوليو – أكتوبر وأن كثافة التعداد تتناقص خلال الفترة الممتدة من نوفمبر 1997 – فبراير 1998 مع انخفاض درجات الحرارة حيث أوضح التحليل الإحصائى وجود ارتباط عالى المعنوية بين تعداد اليرقات والعذارى على مدار العام.
- وجدت يرقات بعوض الكيولكس فى كفرالشيخ فى أماكن التوالد التى يتراوح تركيز أيون الهيدروجين (pH) من 8.15 – 8.70 والتوصيل الكهربائى للماء (E.C.) من 0.815 – 2 ديسمتر/متر كما وجد أن يرقات البعوض تتحمل تركيزات عالية من المواد العضوية ممثلة فى مركب النتروجين مثل: الأمونيا من 8.1 – 23.85 ملليجم/لتر، النترات من 31 – 35.65 ملليجم/لتر. والمتطلب الحيوى من الأكسجين (B.O.D.) يتراوح بين 5 – 14 ملليجم/لتر وتتحمل اليرقات أيضاً ملوحة عالية والتى تتمثل فى الأملاح الكلية الذائبة (T.S.S.) وتتراوح بين 521.6 – 1216 ملليجم/لتر والكلور الذى يتراوح بين 31.95 – 159,72 ملليجم/لتر.9