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SEASONAL CHANGES IN THE POPULATION DENSITY OF *CORANUS AFRICANA* EL-SEBAEY IN EGYPT AS INDICATED BY LIFE TABLE PARAMETERS

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Abstract

Monitoring the changes in the population density of the adult predatory bug, *Coranus africana* El-Sebaey (Hemiptera-Reduviidae) was carried out from February 1999 till January 2001 in Kom Oshim district which situated in the Western Desert Ago-ecosystem (Egypt). The highest number of adults was achieved between July and October, while the lowest level of the population was reported between February and March during the two tested successive years. The effect of the prevailing physical environmental factors on the population density and life table parameters was also studied by raising an artificial population of the predator in field cages. This reduviid completed six overlapping generations in a year. The basic life table parameters, expressed as the net reproductive rate (R_o), gross reproductive rate (GRR), instantaneous rate of natural increase (r_m) and the mean generation time (T) were determined with respect to the date of hatching. The average values of these parameters under natural climatic conditions were 81.16, 902.01, 0.3798 and 12.24, for R_o, GRR, r_m and T, respectively.

Key words: *Coranus africana,* reduviidae, population, seasonal history, natality, weather.

INTRODUCTION

Several reduviid species are commonly used in the biological control programs of certain insect pests and others prey upon various economic pests. Ecological studies on some reduviid predators were undertaken by some authors including Ambrose *et al* (1994); James (1994); Sahayaraj and Ambrose (1997); El-Sebaey 1996, 1998, 2001a, b. Data on the ecology of some reduviids inhabiting Egypt have been documented by El-Shazly and El-Sebaey (1997) and El-Shazly (1998).

Coranus africana El-Sebaey (Heteroptera-Reduviidae) has recently been described from Egypt by El-Sebaey (2001a) who had reported also the occurrence of the predator in various economic crop habitats, including cotton and tomatoes. The objective of the present study was threefold: (1) to study the changes in the adult population as well as the effect of oviposition, hatching and adult emergence dates on the development and reproductive rates of *C. africana;* (2) to determine the approximated number of annual generations in nature; and (3) to estimate the life table parameters of this reduviid under the prevailing climatic conditions of Egypt.

MATERIALS AND METHODS

Seasonal abundance: The selected area of the present study is a reclaimed area located in the Western Desert of Egypt, where several economic crops including olive orchards and some vegetable plants are grown. The studied species lives under wild plants and grasses. Six equal plots, each 10x10 meters, with homogenous wild plant cover were chosen for monitoring the weekly numbers of *C. africana* adults from February, 1999 till January 2001.

Insects: A laboratory culture of *C. africana* was obtained from adult and nymphs collected in September at the study area. Rearing was conducted in plastic jars (15cm diameter x 30cm high) under controlled conditions of 28±1°C and 60 ±10% R.H. Insects were supplied with *Anagasta kuehniella* Zell. larvae as food and ovipositional sites.

Field cages: All experiments were performed in large rearing field cages (40 x 40 cm. and 75 cm. high) constructed of wood and plastic screen. Care was taken to allow partial shading. The roof and each side were divided into halves constructed of wood and plastic screens; thus insects had the choice to sun themselves or to hide from sun. Cages were placed outdoors of Faculty of Science Laboratories, Cairo University.

Development and reproduction: Field cage experiments were undertaken monthly from January to December 2000, the following three experiments were conducted each month. 1- To study the effect of oviposition date on the incubation period and egg hatchability, batches of freshly laid eggs (200 eggs per batch) were placed in 250-ml plastic jars and then in the field cage. 2- Nymphal survival and developmental rate were determined with respect to date of hatching using freshly hatched bugs taken from laboratory-reared colony. These were kept in plastic jars (15cm in diameter and 25 cm. in height) and transferred to field cages. 3- To determine the effect of date of adult emergence on the reproductive biology, 20 pairs of newly emerged adults were segregated, each pair in a 400 ml. plastic vial and then kept in field cages. The different reproductive parameters were recorded with respect to the date of adult emergence. Experimental insects were supplied with ovipostion sites and *A. kuehniella* larvae as food. The field cages were examined daily.

The student's t-test was used to test the hypothesis that developmental and reproductive parameters were influenced by the date of treatment throughout a pairwise comparison among various means on the basis of the two-tailed test at the 0.01 level of significance.

Generation number and life table analysis: The number of annual generations and the life table parameters for each generation were determined by constructing age-specific survivorship and fecundity tables for 200 eggs laid at the beginning of January 2000 and reared in field cages. The first batch of eggs that was laid from each generation was treated in a similar way till the end of the year. A life table was constructed for each generation.

The instantaneous rate of population growth was determined by the Euler equation:- $\Sigma 1x\ m_x \exp(-r_m) = 1$.

Where r_m is the instantaneous rate of population growth, x is the female age (in weeks), 1x is the number of living females as a proportion of unity at age interval x and m_x is the number of female progeny per female per week. The mean generation time (T) was calculated from the formula:

$$T = \frac{\log_e Ro}{r}$$

Where Ro is the net reproductive rate ($Ro = \Sigma\ 1x\ m_x$). The gross reproductive rate (GRR) was also estimated for different generations as described by May (1981).

Meteorological records of Giza and Faiyoum agroecosytem were obtained from the Egyptian Meteorological authority for the two successive years of the study.

RESULTS

Seasonal abundance: Fig.1 shows the average fluctuation in the weekly numbers of *C. africana* adults per plot from February 1999 till January 2001 and the corresponding meteorological records of temperature and relative humidity. It appears that the predator adult individuals occur all the year round. The highest population level, however, was observed between July and early October for (1999-2000) and one month later, i.e, between August and October in the second year (2000-2001). The population decreased obviously during winter (January-March) in the two years. The relationship between weather factors and the abundance of *C. africana* populations was estimated as shown in Table 2, which indicates that simple correlation values "r" were significantly positive between the abundance of *C. africana* and the ambient field temperature in the two years (0.71, for 1999 / 2000 and 0.80, for 2000/2001). However, correlation between *C. africana* and relative humidity showed negative values during the two successive years (-0.8 and -0.68) for 1999/2000 and 2000/2001, respectively.

Life history: The incubation period of *C. africana* eggs was significantly the longest in January and the shortest in August. Variation in the incubation periods between eggs laid in summer and early autumn (June and September, respectively) were insignificant. Egg hatchability ranged from 78.32% in February to 89.51% in July, Table 2. The same table indicates that hatching date had a significant effect on nymphal duration and survival. The highest percentage of nymphal survival (86.11%) was recorded in July, while the lowest (60.25%) was recorded during January. The higher mortality rate of nymphs which hatched in January could be attributed to the exposure of the insects to the decreasing temperature during their nymphal life.

Reproductive biology: It was found that the pre-oviposition period varied from an average of 76.98 days for adults that emerged in November to 6.32 days for adults that emerged in July, Table 3. The mean number of eggs laid per female *C. africana* in field cages increased from an average of 225.82 eggs for females that emerged in January to 317.86 eggs for females that emerged in July, Table 3. The adult life-span was significantly shorter for adult emerged late during spring and summer (May-August) and longer in winter (December-February). Table 3 shows also that females generally live longer than males. The reproductive life of the female was confined between the

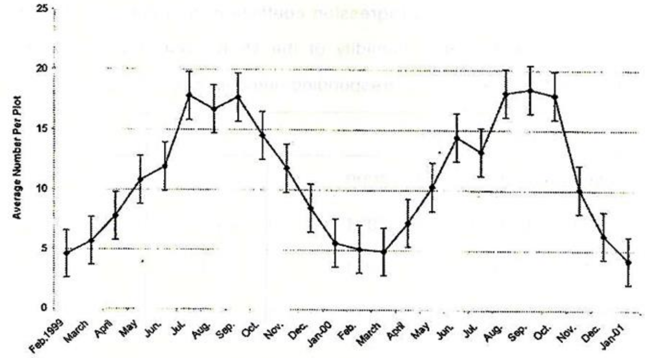

Fig. 1-A. seasonal abundance of *C. africana* adults between February 1999 and January 2001 at Kom Oshim, Faiyoum Governorate.

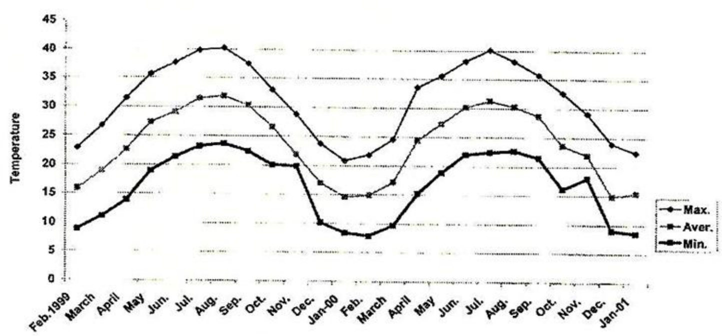

Fig. 1-B. Minimum, maximum and average temperature in Kom Oshim between February 1999 and January 2001.

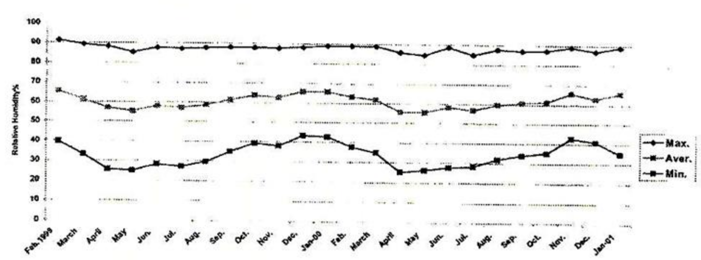

Fig. 1-C. Minimum, maximum and average relative humidity in Kom Oshim between February 1999 and January 2001.

Table 1. Simple correlation "r" and regression coefficient "b" values for the effects of temperature and relative humidity of the study area (Kom Oshim-Faiyoum Governorate) area on the corresponding numbers of *C. africana* adults.

Parameter tested	"r" *	" b "
Average Field temperature 1999 / 2000	+0.711	+1.21
Average Field temperature 2000 / 2001	+0.803	+1.62
Average Relative humidity 1999 / 2000	-0.812	-0.65
Average Relative humidity 2000 / 2001	-0.683	-1.15

*r values were significant ($P < 0.05$).

Table 2. The changes in the developmental and survival rates of *C. africana* reared in field cage (Giza, Egypt).

Egg stage			Nymphal stage		
Date of oviposition	Incubation period in days (± SD)	Percentage of hatchability	Date of hatching	Nymphal duration in days (± SD)	Percentage of survival
Jan. 3	23.61±1.03	79.15	Jan. 6	43.13 ± 2.60 A	60.25
Feb. 17	16.17±0.95A *	78.32	Feb. 9	42.16 ± 3.10 A	68.14
March. 6	16.01±0.87 A	80.32	Mar. 11	34.18 ± 1.13 B	79.76
April. 11	14.03±1.04	79.79	Apr. 17	33.29 ± 2.17 B	80.13
May. 9	8.13±0.12	83.17	May. 14	26.18 ± 1.17	85.22
Jun. 15	6.21±0.03 B	85.77	Jun. 16	20.22 ± 0.11 C	83.19
Jul. 17	6.13 ±0.01B	89.51	Jul. 17	21.31 ± 0.17 C	86.11
Aug. 14	5.98 ±0.02B	88.13	Aug. 10	23.17 ± 0.38	84.93
Sep. 6	6.16±0.36B	82.22	Sep. 11	63.70 ± 6.13 D	71.89
Oct. 12	11.91±1.02	81.13	Oct. 15	56.16 ± 3.11	65.19
Nov. 17	16.31±1.13A	80.16	Nov. 13	65.14 ± 3.80 D	62.79
Dec. 15	19.28±2.16	80.12	Dec. 20	51.17 ± 2.81	63.12

* Means followed by the same letters are not significantly different (P = 0.01), as indicated by pairwise comparisons of the means using "t-test".

Table 3. The fluctuations in the reproductive parameters of *C. africana* reared in field cages (Giza, Egypt).

Date of adult emergence	Pre-ovipostion period in days (± SD)	Total unmber of eggs / female (± SD)	Number of eggs / female / day **	Longevity in days (± SD)	
				Male	Female
Jan. 9-12	23.34±2.18 A	225.82±19.60 A	2.37±0.03 A	117.38±8.51	151.19±11.16 A
Feb. 11-14	25.18 ± 6.15 A	227.91±17.51 A	2.27±0.04 A	125.18±7.15	127.88±13.12
March 10-15	19.97 ± 2.88 B	279.98±14.56 B	2.91±0.07 B	107.18±9.61	116.17±8.11 B
April 22	16.85 ± 1.37	280.72±13.55 B	3.04±0.02 B	96.14±3.18	102.17±3.28
May. 7-11	11.78 ± 1.16	283.15±13.89 B	3.49±0.05 C	82.16±3.15	93.15±7.80
Jun. 3-5	6.49 ± 0.17 C	312.91±11.43 C	3.67±0.03 C	79.15±7.13	85.13±6.14 C
Jul. 14-16	6.32 ± 0.09 C	317.86±15.91 C	4.16±0.05	80.82±4.18	81.28±5.16 C
Aug. 15-16	7.10 ± 0.02 C	315.19±19.12 C	4.70±0.03	81.76±3.15	80.383±2.0 C
Sep. 1-3	18.85 ± 2.53 B	308.96±13.75	3.28±0.02 B	103.22±5.14	114.69±8.11 B
Oct. 15-18	31.97 ± 4.61	260.19±17.38 D	2.89±0.08 C	119.25±0.17	121.89±8.5
Nov. 25-28	76.98 ± 11.37	254.67±8.95 D	3.71±0.02 C	139.15±0.19	142.19±8.6
Dec. 16-20	61.25 ± 8.91	273.93±19.31	3.65±0.14	131.18±8.16	147.89±13.81 A

* Means followed by the same letters are not significantly different (P = 0.01), as indicated by pairwise comparisons between different means using "t-test".

** Pre-and post –ovipsition periods were not considered.

pre-and post-oviposition periods.

Number of annual generations and life table analysis: To Determine the number of annual generations completed by *C. africana* in one year, the development of newly laid eggs was followed up in field cages from the beginning of January 2000. These eggs hatched after about 20 days. Nymphs began to enter the adult stage at the beginning of March; adults started to lay eggs of the second generation at the end of March. Development of successive generations was followed until the end of the year. The population parameters of successive generations are given in Table 4. The same table indicates that all population parameters varied with the starting date of each generation. Net reproductive rate (Ro) was highest in the fourth generation where emergence of mothers occurred in the beginning of summer. This rate declined gradually in the next generations to reach its lowest value in the sixth generation, where birth of mothers occurred in the beginning of autumn (September). However, a gradual increase in natality was observed from the first generation and onwards. The gross reproductive rate (GRR) showed a similar pattern between the fourth through the sixth generation, Table 4.

The high value of (GRR) in January generation could be attributed to the long generation time (T=18.61). On the other hand, the instantaneous rate of population growth (r_m) showed a cyclic pattern in successive generations. The maximum value of this variable was assumed in July generation and the lowest in January generation. The mean generation time (T) was negatively correlated with the ambient field temperature, while the instantaneous rate of increase (r_m) exhibited a significant positive correlation with temperature, Table 5.

DISCUSSION

C. africana has recently been described from Egypt (EL-Sebaey, 2001a). There was no available information about its seasonal history or ecology before the present work. However, seasonal abundance studies, Fig. 1 indicates that the predator occurred all the year round and the highest population levels were obersved between June and August. There was a positive correlation between the ambient field temperature and the relative abundance.

Table 4. Life table statistics for successive generations of *C. africana* reared in field cages under natural conditions in Giza, Egypt.

Generation	Starting date *	R_O	T	r_m	GRR
First	Jan. 4,1999	72.85	18.61	0.2304	1355.94
Second	April 3,1999	98.1	12.32	0.3722	1209.06
Third	Jun. 1,1999	73.88	10.32	0.4169	762.14
Fourth	Jul. 3,1999	100.62	9.03	0.5107	908.39
Fifth	Aug. 7.1999	75.61	10.54	0.4139	790.16
Sixth	Sept. 25.1999	65.9	12.72	0.3293	383.37
Average	__	81.16	12.24	0.3798	902.01

* Starting date of each generation is the date of the first group of eggs deposited by females of the previous generation (except for the first generation, i. e, starting experiment).

Table 5. correlation between ambient field temperature and different population parameters of *C. africana* under natural climatic conditions in Egypt.

Parameter studied	Correlation Coefficient	P
Ro	0.641	NS*
T	-0.793	$P \leq 0.05$
r_m	0.842	$P \leq 0.01$
GRR	0.635	NS

* NS = Not significant

The correlation between the relative humidity and population fluctuation was not considered because of the sharp daily variations of the relative throughout the year round. Repeated field studies showed that variations in wind velocity did not influence the occurrence of this species because it lives under shrubs and it is always found hiding among low vegetations. In general, the population of *C. africana* grew with the rise of temperature. This was also true for other Heteroptre in Egypt including *Eysarcoris inconspicuous* (=*ventralis*) (Pentatomidae) and *Scantius aegyptius* (Pyrrhocoridae) (El-shazly, 1994).

In the present work, field cage studies were undertaken to determine the seasonal history, number of generations per year and the natality of the species under natural climatic conditions. Again, the ambient field temperature, which varied with the date of oviposition and hatching, was the main factor controlling the rate of egg development and the nymphal duration of *C. africana,* Table 2. It is generally accepted that the rate of embryonic development is a function of temperature.

The polyvoltinism and the continuous development of all stages of *C. africana* all the year round, Tables 2-4 could be attributed to the favourable climatic conditions which prevailed during the field cage study period. Working with *Nysius vinitor* Bergroth, McDonald and Smith (1988) pointed out that the rate of development of this lygaeid in northern Victoria (Australia) during spring was more rapid than that predicted by phenological simulation based on ambient temperature and laboratory-derived day-degree estimates because of the absorption of solar radiation. Solbreck (1991) pointed out that *Lygaeus equestris* population declined to an unprecedented low level in south-east Sweden during the summer of 1987, which was characterized by an exceptional deficit in sunshine hours.

The intrinsic rate of natural increase (r_m) was defined as an actual rate of increase of a population under specified constant environmental conditions in which space and food are unlimited, when there are no mortality factors other than physiological ones. Price (1984) stated that under optimal conditions, "r_m" or "r_{max}", represents the innate capacity for increase (i. e., a population expressing its biotic potential). Such definitions dictates that each living species is characterized by a single and unique r_m value. Thus, several values of r_m for a single species raised on different density dependent and independent factors such as food and temperature can be accepted only for comparative purposes. The different values of r_m for successive generations of *C. africana* are given in Table 4; consequently, the true intrinsic rate of natural increase of *C. africana* could be designated as the maximum value of r_m in all treatments, in other words the biotic potential or r_{max} of this species is 0.5107.

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رصد التغيرات الموسمية فى عشائر *Coranus Africana* El-Sebaey (رتبة نصفية، غير متجانسة الأجنحة: عائلة ريديوفيدى) فى مصر كما حددتها جداول الحياة

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تمت دراسة التغيرات النسبية فى عشائر الحشرات الكاملة للبق المفترس من نوع *Coranus Africana* El-Sebaey (التابع لرتبة نصفية، غير متجانسة الأجنحة : عائلة الريديوفيدى) على مدى عامين متتالين اعتبارا من فبراير ١٩٩٩ حتى يناير ٢٠٠١ فى منطقة كوم أوشيم وهى منطقة مستصلحة تتبع محافظة الفيوم وتقع فى الصحراء الغربية لمصر ولم يظهر منحنى العشائر هبوطا أو صعودا حادا على مدى العامين ولكن وجد أن اعلى تعداد كان بين يوليو وأكتوبر واقل تعداد سجل بين فبراير ومارس على مدى العامين. هذا وقد تم أيضا دراسة عدد الأجيال ومعدلات زيادة الاهلات فى البيئة الطبيعية باستخدام أقفاص حقلية. ووجد أن هذا النوع يكمل ستة أجيال فى العام تحت الظروف الجوية الطبيعية فى مصر ، وتم أيضا تعيين معايير نمو الاهلات تحت الظروف الجوية الطبيعية حيث وجد أن متوسط القيم العددية لصافى معدل التكاثر (R_o) والمعدل الكلى للتكاثر (GRR) والمعدل التوى لزيادة الاهلات (r_m) ومتوسط زمن الجيل (T) فى أقفاص حقلية وتحت الظروف الجوية الطبيعية كانت ٨١,١٦ و٩٠٢,٠١ و٠,٣٧٩٨ و١٢,٢٤ .