Biology of the planthopper Sogatella vibix (Haupt) in Giza, Egypt (Hom., Delphacidae)

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Biology of the planthopper Sogatella vibix (HAUPT) in Giza, Egypt

(Hom., Delphacidae)

By

EL-DESOUKY AMMAR

With 4 figs. and 6 tables in the text and 1 plate

Abstract

Biology of the planthopper *Sogatella vibix* was studied on wheat seedlings in the glasshouse in Giza, Egypt. At 16—21 °C egg incubation period averaged 16.8 ± 0.09 days. At various temperatures incubation period range from 7—47 days. Total nymphal duration averaged 14.2—15 days at 22—30 °C, and 41.8—43 days at 11—20 °C, with no significant difference, in this respect, between the two sexes. At the former temperature, the five nymphal instars were completed in 3.0, 2.6, 2.8 and 3.7 days, respectively. Morphology and certain measurements of eggs and the five nymphal instars are given.

At 11—18 °C pre-oviposition period of adult females was 32.3 days, adult longevity of males was 42.6 days and that of females was 58.1 days. At 14—23 °C, comparable durations were 15.3, 33.6 and 54.7 days, respectively. At the above two temperature-conditions, fecundity of adult females was 97.6 and 158.7 eggs/♀/life, respectively.

Eight successive generations of *Sogatella vibix* were reared on wheat, in the glasshouse, from 11th of September 1973 to 1st of September 1974. The shortest generation occurred in August and lasted 27 days, and the longest occurred in January—March, lasting for 87 days.

Introduction

The planthopper *Sogatella vibix* (HAUPT) (Hom., Delphacidae) is vector of maize rough dwarf virus in the Middle East (HARPAZ, 1966; HARPAZ and KLEIN, 1969). It has been recorded only in Egypt and Israel (FENNAH, 1963), and is known to breed on Agropyron (Panicum) repens, Echinochloa crusgalli, wheat, barley, rye and oats (HARPAZ, 1966). In Egypt, this species was found on rice in Balteem Region, and on maize and various gramineous weeds in Giza Region. In spite of its potential economic importance as a virus-vector, little is known on the biology of *Sogatella vibix*. Thus, in the present work, biology of this species was studied under semi-natural conditions in the glasshouse. Descriptions of the immature stages (eggs and nymphal instars) are also included.

Materials and Methods

Adults of *Sogatella vibix* were obtained by sweeping on rice in Balteem and on gramineous weeds in Giza — (Egypt), during August and September, 1972 and 1973. This species was identified according to the descriptions given by FENNAH (1963), particularly of the male genitalia.

In the present work, the planthoppers were reared exclusively on wheat plants, although they were found to survive and breed as well on barley and rice plants. The cages and techniques used for rearing the planthoppers, and the methods adopted for studying egg incubation period, egg development, adult longevity and fecundity, were essentially the same as described earlier (Ammar, 1975a). However, in studying duration of the five nymphal stadia, nymphs were reared on wheat seedlings confined in glass-specimen tubes

(15 × 2.3 cm) (Taf. 11, Fig. 1). These seedlings were transplanted, in the second leaf stage, into the specimen tubes just before use. In the bottom of the tube, moistened soil (2 cm deep), covered with a layer of sand (0.5 cm high), kept the seedling fresh for longer than a week. Nymphs were observed daily, for moulting, and were changed weekly to fresh seedlings. This technique allowed close observation, even using a stereo-microscope, when necessary, of the planthopper nymphs which developed satisfactorily on the tubecaged-seadlings.

However, adults of planthoppers were reared either in groups on wheat seedlings growing in 10—12 cm pots and confined in chinney glass cages (17 × 7—12 cm), or in pairs contined in tubular PVC cages (30—38 × 4 cm) (1 pair/seedling/cage) as necessary.

Eggs and nymphs to be studied morphologically, were examined live, mounted in Hoyer's solution without prior moderation or staining, or macerated in 10% NaOH and stained in Orange G. Drawings were made from both stained and unstained specimens, whereas all measurements were made on unstained specimens mounted in HOYER's solution. Ten specimens for each of the indicated stages of development were measured, whereas many more specimens were examined for other morphological characteristics.

All reported experiments were carried out in a glasshouse, built in the open, of screenwire sides and a glass roof. Temperature in the glasshouse ranged from 5.5—24 °C in winter and from 16—36,5 °C in summer, but inside the rearing cages temperature was 0.5—1.5 °C higher. Temperatures mentioned in the results are those in the glasshouse, not in the rearing cages. Relative humidity in the glasshouse ranged from 40—70%, but inside the cages it was 10—15% higher.

Results and Discussion

Egg stage and embryonic development

Description

Newly laid eggs of *Sogatella vibix* measure 730.7 μ in length, and 181.5 μ in width on average (Table 11). These eggs are white in colour, slender, oval, and somewhat curved in shape, with a round posterior end and rather sharp-pointed anterior end (Fig. 1a). The chorion is thin, smooth-surfaced, and transparent. A transverse line in the chorion appears round the egg, near the anterior end. This line appears to indicate a weak ring in the chorion, where the anterior end is detached when pushed forword by the hatching embryo (Fig. 1c).

Embryonic development in *S. vibix* is essentially similar to that in other planthoppers as described by NASU and SUENAGA (1958). In intact live eggs of this species, the mycetome ball appears in deep yellow colour near the anterior pole of the egg (Taf. 11 Fig. 2a). During blastokinesis (reversion movement of the embryo inside the egg), the mycetome ball is moved to the posterior pole. This is followed by the appearance, near the anterior pole, of two bright red eye spots (Taf. 11 Fig. 2b and Fig. 1b). Eggs at the post-blastokinetic (red-eye-spot) stage, are significantly shorter than those recently laid, but egg width is nearly the same in both cases (Table 1).

Oviposition site and egg aggregation in plants

Reared on wheat seedlings at the 3rd-4th leaf stage (1 female, seedling), females of *S. vibix* laid most of their eggs either in the leaf sheaths or in the leaf blades under or close to midrib (Table 2). Very few eggs (0.8%) were found in the leaf blades away from the midrib. In the leaf sheaths, most eggs are inserted by the laying females through vascular bundles, and eggs are laid so that their anterior poles are directed upward in the majority of cases. A high proportion of eggs were found in small groups of two, threes or fours, but few were found singley (Table 2). Duration of egg stage:

At 15.5—21 °C (November), eggs of *S. vibix* hatched 16.8 ± 0.09 days after they had been laid (122 observations). Egg incubation period, however, was as short as 7 days at 20 to 36.5 °C (June—July) and as long as 47 days at 5.5—26.5 °C (January—February) (Table 6).

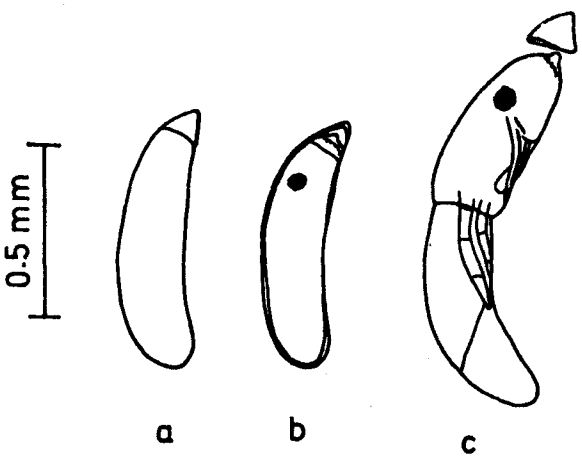

Figure 1. Eggs of *Sogatella vibix.*: a. newly laid, b. at the red-eye-spot stage, and c. during hatching

Embryonic development of *S. vibix* was followed in live intact eggs, dissected out of the leaf-tissues and placed in petridishes lined with moistened filter paper. At 9—16 °C (January to February), the yellow mycetome appeared in 12.6 ± 1.43 days, the red-eye-spots in 26.9 ± 1.23 days, and hatching occurred 34.3 ± 0.72 days after the eggs had been laid. At higher temperature, however, these durations are greately reduced, so that in summer, both blastokinesis and the appearance of the red-eye-spots occur usually in the same day.

Nymphal stage

Description

The five nymphal instars of *S. vibix* are drawn in Figure 2; measurements of total body length, width at pronotum, head width and length of hind tibia of each instar and of male and female adults are presented in Table 3. Significant differences are found in these measurements between each instar and the following one; female adults are larger than males in the same attributes.

First instar nymphs are creamy white in colour, with bright red compound eyes. In the second instar, most nymphs are also creamy white, but some may show brownish markings on the thoracic nota and less pronounced ones on abdominal tergites. In the third instar, these brownish markings become more pronounced and more common; compound eyes become darker in colour (wine-red). In the fourth and fifth instars, nymphs show the above markings with various degrees, and eyes are somewhat darker than in previous instars. Extensions of the second and third thoracic nota start appearing in the third instar; but become distinct and somewhat overlapped in the fourth. In the fifth instar, the two overlapping wing pads may reach the end of the second abdominal segment.

With regard to the structures on hind legs (Fig. 2 and 3) first instar nymphs are distingueshed by the presence of one lateral spine on the external side of hind tibia, whereas in all other instars two spines are present in this position. Second instar is distinguished from older instars, by the plain (toothless) outer edge of the movable spur at apical end of hind tibia. In older instars a number of teeth are present on this edge, starting with two teeth in third instar, 7—10 in fourth and 17—19 in fifth instar. The number of processes at apical end of hind tibia, apart from the movable super, in 3 in first and second instars and 5 in older instars. Two tarsal segments are present in all legs of instars I—IV, but a third segment appears in the hind tarsus of instar V. Adults posses three segments in all legs. The

Table 1
Length and width (in microns) of eggs of *Sogatella vibix*, at two embryonic stages of development

	Stage of development		S.E.	Variance ratio	P
	Preblasto-kinetic	Postblasto-kinetic	(μ)	(F)	<
Length (μ)	730.73	694.11	6.85	14.27	0.01
Width (μ)	181.49	183.08	3.52	0.10	NS

NS = not significant

Table 2
Aggregation of *Sogatella vibix* eggs in wheat seelings (eggs were laid by four females (1 ♀/seedling) in a 10-day period)

	Eggs laid in leaf sheaths					Eggs laid in leaf blades					Away from midrib	Total
						Under/close to midrib						
	1^s	2^s	3^s	4^s	Total	1^s	2^s	3^s	4^s	Total		
No.	3	20	15	16	54	2	10	39	24	75	1	130
%	2.3	15.4	11.5	12.3	41.5	1.5	7.7	30.0	18.5	57.7	0.8	100

Table 3
Measurements (in microns) of nymphs and adults of *S. vibix* (10 individuals were measured in each case)

Stage of development	Total body length (μ)	Width at pronotum (μ)	Head width (μ)	Length of hind tibia (μ)
Nymphal instars:				
I	1088.93	261.09	249.94	183.08
II	1394.59	413.92	343.87	249.94
III	1821.25	534.91	453.72	355.02
IV	2050.50	654.31	546.06	491.93
V	2359.34	724.36	581.08	563.57
Adult:				
Male	2553.57	711.62	611.33	711.62
Female	3021.62	832.62	660.68	838.98
S.E.	45.22	16.72	10.03	14.52
L.S.D.: (P < 0.05)	133.73	47.66	28.82	41.07
(P < 0.01)	180.54	64.34	38.91	55.44
(P < 0.001)	234.03	83.41	50.44	71.87

Table 4
Duration (in days) of the five nymphal instars of *S. vibix* under two temperature-conditions (means of 18—60 nymphs in each case)

Average Temp. °C	Months (1973 -1974)	Duration of instars:					S.E.	L.S.D.
		I	II	III	IV	V		P < 0.05
11. 2—19.4	Nov. -Jan.	6.47	6.50	7.55	8.04	14.11	0.36	1.02
22.0—30.0	September	3.00	2.62	2.61	2.83	3.72	0.22	0.62

number of processes at apical end of the first (basal) tarsal segment is 4 in first and second instars, 5 in third, 6 in fourth and 7 in fifth instar. Three spines appear in the middle of the second tarsal segment in instar IV, (in hind leg) but not in other instars. In instar V, 4 processes appear at apical end of the second tarsal segment (of hind tarsus).

The differences indicated above, between various nymphal instars of *S. vibix*, are very close to those found between various instars of another Delphacid vector: *Javesella pellucida* (AMMAR, 1975b).

Duration and mortality

At 22—30 °C (September), total nymphal duration in *S. vibix* averaged 14.2 and 14.98 (±1.0) days for males and females respectively. At 11.2—19.4 °C (November to January), however, total nymphal duration averaged 41.8 and 43.0 (±1.1) days for the two sexes respectively. No significant difference between the two sexes is found in either case. However, significant differences were found between durations of various stadia (Table 4), with the fifth nymphal stadium being longer than any other.

Nymphs preferred moulting on the leaf sheaths than on leaf blades on wheat plants (proportion = 2:1). Mortality during the five nymphal stadia was 3.7, 6.7, 2.1, 3.2 and 10.9%, respectively ($X^2 = 9.65$, $P < 0.05$).

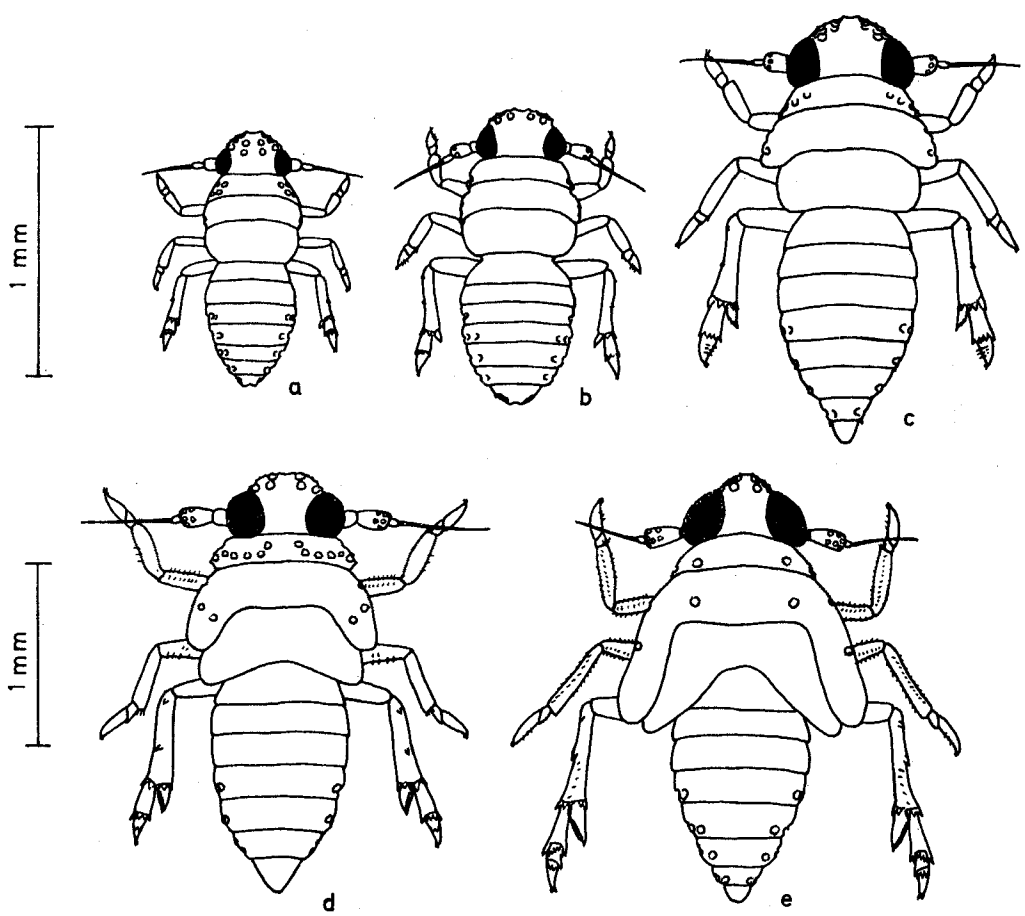

Figure 2. Five nymphal instars (a—e, respectively) of *Sogatella vibix*

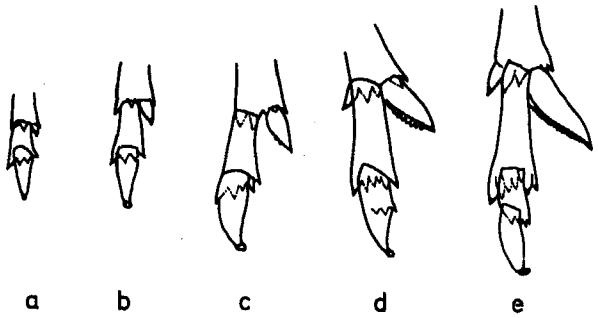

Figure 3. End of hind tibia and hind tarsus of each of the five nymphal instars (a—e, respectively) of *Sogatella vibix*

Adult stage

Longevity and pre-oviposition period

At 11—18 °C (December—February), adult longevity of males and females of *S. vibix* was 42.6 and 58.1 days, respectively ($F = 6.9$, $P < 0.05$). At 14—23 °C (February—April) males and females lived for 33.6 and 54.7 days, respectively ($F = 14.7$, $P < 0.001$). The differences in adult longevity, between the two temperature conditions mentioned above are not significant (Table 5).

Pre-oviposition period in adult females of *S. vibix* averaged 32.3 days at 11—18 °C and 15.3 days at 14—23 °C (Table 5). These two durations are significantly different ($P < 0.001$). As indicated in Table 6, pre-oviposition period differed greatly with temperature, reaching only 4 days at 23—35 °C (August).

Fecundity (Egg production)

At 11—18 °C (December—February) adult females of *S. vibix* produced 18—246 eggs/female/life (average = 97.6 eggs). At 14—23 °C (February—April), females produced 25—235 eggs/female/life (average = 158.7 eggs). The difference in fecundity between females in both cases is significant ($P < 0.05$, Table 5). The average number of eggs produced per female per day of the oviposition period was 3.87 and 4.03 eggs, in the above two conditions respectively. When females were transferred daily to fresh seedlings (1 female/seeding), at 11—18 °C, the number of eggs produced/female/day ranged from 0—26 eggs.

Table 5
Longevity; pre-oviposition period and fecundity of adult *S. vibix*, under two temperature — conditions (means of 17—20 adults in each case)

Attribute	Mean at:		S.E.	Variance	P
	11—18 °C (Dec.—Feb.)	14—23 °C (Feb.—Apr.)		ratio (F)	<
Longevity (days):					
Male	42.58	33.63	3.78	2.36	NS
Female	58.06	54.71	3.99	0.41	NS
Pre-oviposition period (days)	32.29	15.29	1.37	77.14	0.001
Opiposition period (days)	25.25	39.41	3.25	9.23	0.01
Fecundity (eggs/♀/life)	97.63	158.71	15.70	7.30	0.05

NS = not significant

Table 6
Durations of eight successive generations of *Sogatella vibix*, reared on wheat plants in the glasshouse in Giza, Egypt, from Sept. 1973 to Sept. 1974

Generation no.	Date of 1st emergence of:			Min. duration (days) of:			Total duration (days)	Temp. °C	
	eggs	nymphs	adults	egg	nymph	Pre-oviposition in adult		min.	max.
1	11. IX. 73	22. IX. 73	18. X. 73	11	26	7	44	19	35
2	25. X. 73	7. XI. 73	17. XII. 73	13	40	23	76	10	24
3	9. I. 74	25. II. 74	27. III. 74	47	30	10	87	5.5	26.5
4	6. IV.	18. IV.	3. V.	12	15	3	30	12	35
5	6. V.	17. V.	1. VI.	11	15	3	29	16	35
6	4. VI.	11. VI.	29. VI.	7	18	6	31	20	36.5
7	5. VII.	12. VII.	30. VII.	7	18	6	31	21.5	35
8	5. VIII.	13. VIII.	28. VIII.	8	15	4	27	22.5	35
9	1. IX.	—	—	—	—	—	—	—	—

Brachypterous (short-winged) females

Brachypterous females of *S. vibix* were occasionally encountered, in the planthoppers reared singly during the nymphal stage. Brachypterous females were also encountered in the field. The factors affecting the appearance of brachypterous forms in this species are not yet known. However, in another Delphacid; i.e. *Javesella pellucida* FAB., crowding, sex and conditions of the food plant were the most significant factors affecting the induction of wing forms (RAATICKAINEN, 1967; AMMAR, 1973).

Generations per year

Eight successive generations of *S. vibix* were reared on wheat plants in the glasshouse, from 11th of September 1973 to 1st of September, 1974 (Table 6, Figure 4). The shortest generation occurred in August (at 23—35 °C) lasting for 27 days. The longest generation occurred in January to March (at 5.5—26.5 °C), and lasted for 87 days. Development of this species did not seem to stop at any particular stage during winter (in Giza, Egypt); but during winter months, durations of the nymphal stage, pre-oviposition period and egg incubation period were considerably long.

The number of generations per year has not been studied earlier for any planthopper (Fam. Delphacidae) in Egypt. However, 8—9 generations per year, in Egypt, have been reported for a number of leaf-hoppers (Fam. Cicadellidae), viz. *Empoasca distinguenda* PAOLI and *E. decipiens* PAOLI (HERAKLY, 1970); *Cicadulina chinai* GHAURI (AMMAR, 1975a) and *Cicadulina bipunctella zeae* CHINA (AMMAR, 1975c).

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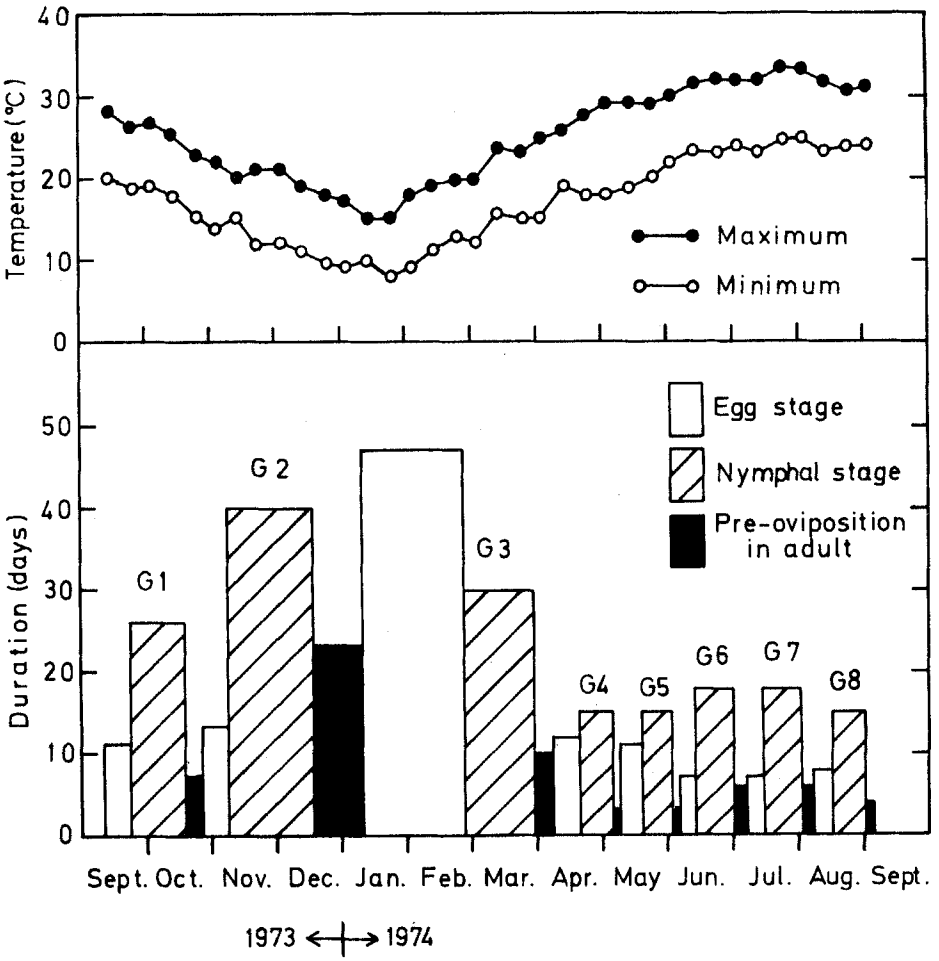

Figure 4. Durations of eggs, nymphs and pre-oviposition period in adults, in eight successive generations (G1—G8) of *Sogatella vibix*, reared on wheat plants in the glasshouse from Sept. 1973 to Sept. 1974

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