Boll. Zool. agr. Bachic.
Ser. II, 29 (1): 65-80

30 giugno 1997

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Postembryonic development and biology of *Psammotettix alienus* (Dahlbom) (Homoptera Cicadellidae) under laboratory conditions

Abstract - Biological aspects on *Psammotettix alienus* (Dahlbom) were studied under laboratory conditions (27° C, 80% RH and 14L:10D of artificial light photoperiod). Egg and nymph stages were described and illustrated, pointing out those characters (presence or absence and length of wingpads, chaetotaxy of the abdomen and coloration pattern) useful to distinguish each instar. Duration of different developmental stages, life cycle, longevity, fertility, fecundity, survival, life expectance, net reproductive rate, generation time, intrinsic rate of increase and sex ratio were estimated. *P. alienus* completes its life cycle in approximately 43 days and the adults show a longevity of 16.2 days. Females lay a mean of 36.7 eggs with a range from 3 to 100 and a viability of 62.6%. The survivorship curve shows two periods of heavy mortality: the first one occurs before the ecdysis from first to second instar and the second one occurs from the first 4 to 8 days as imagoes. The net reproductive rate "Ro" was 11.42; the generation time "T" was 23 days and the intrinsic rate of increase "r" was ≅ 0.106. The natural enemies observed in field near Viterbo (Italy) belong to the Dryinidae (*Gonatopus clavipes* (Thunberg) and *G. lunatus* Klug) and Pipunculidae (*Eudorylas imperfectus* (Becker) and *Tomosvaryella* sp.) families.

Resumen - *Desarrollo postembrional y biologia de* Psammotettix alienus *(Dahlbom) (Homoptera Cicadellidae) en condiciones de laboratorio.*

Se estudiaron aspectos biológicos de *Psammotettix alienus* (Dahlbom) bajo condiciones de laboratorio (27 °C, 80 % H.R. y un fotoperíodo artificial de 14/10 horas luz/oscuridad). Se describen e ilustran tanto los huevos como los diferentes estadios ninfales, resaltando aquellos carácteres más importantes para distinguirlos como: presencia/ausencia de los esbozos alares, quetotaxia del abdomen y patrones de coloración. Se estimaron los siguientes parámetros: duración de los diferentes estados de desarrollo, ciclo de vida, longevidad, proporción de sexos, fecundidad y fertilidad, supervivencia a diversas edades y esperanza de vida, la tasa reproductiva neta, tiempo generacional y la tasa intrínseca de incremento poblacional. *P. alienus* completa su ciclo biológico en aproximadamente 43 días (desde huevo, a la muerte del adulto) y los imagos muestran una longevidad media de 16.2 días.

(*) In this work, one of the Authors (Guglielmino) paid particular attention to the morphological study and the other Author (Virla) to the breeding. Both Authors carried out data processing and results.

Las hembras depositan un promedio de 36.7 huevos con un rango de 3 a 100 y una viabilidad del 62.6%. La curva de supervivencia muestra dos períodos de máxima mortalidad: el primero ocurre antes de la ecdísis, entre el primer y segundo estadio ninfal, y el segundo sucede entre el cuarto y octavo día de vida adulta. La tasa reproductiva neta "Ro" calculada alcanzó el 11.42, el tiempo generacional "T": 23 días y la tasa intrínseca de crecimiento "r" ≅ 0.106. Los enemigos naturales observados en la región de Viterbo (Italia) pertenecían a las familias Dryinidae (*Gonatopus clavipes* (Thunberg) y *G. lunatus* Klug) y Pipunculidae (*Eudorylas imperfectus* (Becker) y *Tomosvaryella* sp.).

Riassunto - *Sviluppo postembrionale e biologia di* Psammotettix alienus *(Dahlbom) (Homoptera Cicadellidae) in condizioni di laboratorio.*

Aspetti della biologia di *Psammotettix alienus* (Dahlbom) sono stati studiati in condizioni di laboratorio. Vengono descritti ed illustrati l'uovo e gli stadi giovanili, evidenziando quei caratteri (presenza o assenza e lunghezza degli abbozzi alari, chetotassi dell'addome e colorazione del corpo) utili a distinguere ciascuno stadio. Sono stati stimati la durata dei differenti stadi di sviluppo, il ciclo biologico, la longevità, la fertilità, la fecondità, la sopravvivenza, l'aspettativa di vita, il tasso riproduttivo netto, il tempo generazionale, il coefficiente istantaneo di accrescimento della popolazione ed il rapporto tra i sessi. *P. alienus* completa il ciclo biologico approssimativamente in 43 giorni e gli adulti mostrano una longevità di 16.2 giorni. Le femmine depongono una media di 36.7 uova, da un minimo di 3 ad un massimo di 100 ed una capacità di svilupparsi del 62.6%. La curva di sopravvivenza mostra due periodi di elevata mortalità: uno poco prima dell'ecdisi dal primo al secondo stadio ed il secondo tra il quarto e l'ottavo giorno come adulti. Il tasso riproduttivo netto era di 11.42; il tempo di generazione medio "T" era di 23 giorni ed il coefficiente istantaneo di accrescimento della popolazione "r" era ≅ 0.106. I nemici naturali osservati in campo nel Viterbese appartengono alle famiglie Dryinidae (*Gonatopus clavipes* (Thunberg) e *G. lunatus* Klug) e Pipunculidae (*Eudorylas imperfectus* (Becker) e *Tomosvaryella* sp.).

Key words: *Psammotettix alienus,* postembryonic development, life cycle, populational parameters, natural enemies.

Psammotettix alienus (Dahlbom) is a species of economic importance because it is vector of the "Russian winter wheat mosaic virus" (RWWMV) and the "Wheat dwarf virus" (WDV) (Harris, 1983; Conti & Vidano, 1988; Nault & Ammar, 1989). The RWWMV (Rhabdoviridae) is a propagative virus and causes a lot of damage to the wheat, its main host (Conti & Lovisolo, 1984); WDV (Geminivirus) is a circulative virus and its host plants are Graminaceae, including important species of cereals as wheat, oat, rye and barley (Conti, 1993).

P. alienus, an Holarctic species, lives on grasses and cereals, and is widespread in xerophilous, mesophilous and hygrophilous biotopes. It overwinters in the egg stage (Raatikainen, 1971; Conti & Vidano, 1988) and is bivoltine in Central Europe (Schiemenz, 1969) and trivoltine in Northern Italy (Conti & Vidano, 1988). Regarding the postembryonic development of this Cicadellid, Vilbaste (1982) provided the following characters useful to describe the V nymphal instar: body pattern brown; vertex shorter than wide; anterior body with longitudinal bands; abdomen distinctly darker than thorax.

No data about quantitative population attributes of this species is known. The knowledge of these characters is important and literature data show that laboratory construction of life and fecundity tables under controlled conditions provide useful information for characterizing population processes in Cicadellids (Madden, Nault, Heady & Styer, 1984; Hogg, 1985; Sedlacek, Yeargan & Freytag, 1986).

Considering the phytopathological role of *P. alienus* and its abundance on crops, this study provides data on its postembryonic development and biological parameters (as fertility, egg viability, duration of different developmental stages, longevity, survivorship and life expectance) to increase the knowledge on this leafhopper.

MATERIALS AND METHODS

Females of *Psammotettix alienus* were collected in field near Viterbo (Italy) and brought into the laboratory. Here they were reared in a climatic cell under the following conditions: 27°C, 80% RH and 14L:10D of artificial light photoperiod.

Two generations were observed. The breeding was done in Plexiglas cages of 30 x 20 x 20 cm. For aeration, the top and two lateral sides were closed by nylon mesh cloth. To insert the aspirator, one hole was on a lateral side. Each cages was placed erect on pots containing oat seedlings (*Avena sativa* L.).

To study the life cycle, number of the laid eggs and duration of each postembryonic stage, fertilized females were placed in glass tubes of 12 x 2,5 cm with a daily changed oat leaf. These leaves were observed until the eclosion of the eggs. Each nymph was then isolated in one glass tube and reared with pieces of fresh oat leaves. These tubes were checked daily to ensure the quality of the oat leaves and to determine instars, by counting exuviae, as well as mortality.

To record the egg distribution, mated females were placed in 13 plexiglas cages with *Avena sativa* L. seedlings at 4 leaves stage for 48 h; then the plants were dissected to determine the oviposition places.

To study the number of the eggs-laid and fecundity of this species, we only recorded data from the females that lived more than 8 days. We considered as "fecundated eggs" all those that developed eye spots. Also unfertilized females were reared under the same conditions to observe the number of the laid eggs and other aspects of their behaviour.

To make the horizontal life table and to estimate the population parameters, we used the methodology described by Deevey (1947), Birch (1948), Rabinovich (1978) and Madden (1985). Summarized life tables were constructed by combining the observational data of two generations. The net reproductive rate "Ro", generation time "T" and instantaneous rate of population increase "r" were estimated from the summarized life tables using the following equations:

$$Ro = \sum_{x=0}^{\infty} l_x m_x$$

$$T = \frac{\sum x\, l_x\, m_x}{\sum l_x\, m_x}$$

$$r \cong \frac{\ln Ro}{T}$$

Drawings and measurements of the immature stages were made on specimens preserved in 70% alcohol and acetic acid. The following dimensions were taken from the juvenile stages: total body length, from the vertex to the distal apex of the abdomen; thoracic length, from the anterior margin of the pronotum to the posterior margin of the metanotum; maximum thoracic width. For the description of immature instars especially those characters, such as chaetotaxy and colour patterns useful for diagnostic purposes, were pointed out (Walter 1975, 1978; Vilbaste 1982; Wilson & Claridge 1991). The chaetotaxy, particularly that of the abdomen, is considered an important character in Deltocephalinae (Vilbaste, 1982). For the description of the chaetotaxy of the abdomen and the coloration of the dorsal surface of the body (fig. 1), we used the formula and the terminology proposed by Walter (1975). The first instar is described, but only the most important differences are given for the other instars.

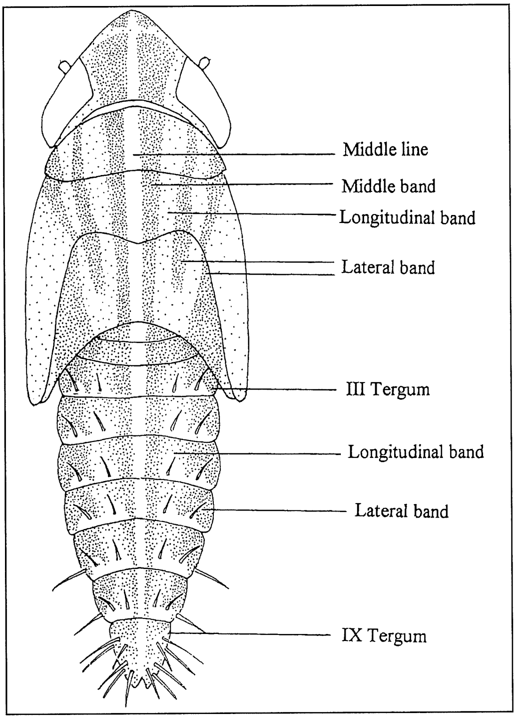


Fig. 1 - Schematic drawing of dorsal surface pattern showing the different bands used for the description of the *Psammotettix alienus* (Dahlbom) nymphs (from Walter 1978, modified).

RESULTS

Descriptions of the egg and immature stages (figs. 2-9)

Egg (fig. 2)

Dimensions: length 0.90-0.96 mm; width 0.20-0.24 mm.

The egg is ellipsoidal with the anterior pole pointed and the posterior one rounded;

the ventral surface is slightly concave and the dorsal side convex. The sculpture of chorion is not discernible. At oviposition, the *P. alienus* egg is creamy-white; its colour changes to yellowish during the embryonic development.

First instar (fig. 3)

Dimensions: body length 0.96-1.32 mm; thoracic length 0.26-0.36 mm; thoracic width 0.24-0.34 mm.

Head: wider than pronotum; vertex, bare, wider than long, obtusely angular; transition between vertex and face rounded angular.

Face: pale yellow.

Wingpads: absent.

Chaetotaxy of the abdomen: -/-/-/-/3/3/2. This formula emphasizes the number of spines on each side of the tergites III-IX.

Pattern of dorsal surface: abdomen darker than thorax, with 4 brownish longitudinal bands.

Middle line: absent on head and thorax; well visible on the abdomen.

Middle bands: absent on head and thorax; the head shows a brownish elongate spot near each eye; the thorax has a pale brownish area on the anterior margin of each tergum; narrow and well defined middle bands on the abdomen.

Longitudinal bands: absent on head and thorax; well defined on the abdomen.

Lateral bands: absent on the head; present but not well defined on the thorax; brownish and very wide on the abdomen.

Ventral side: pale yellow, with tarsi pale brownish.

External genitalia: absent.

Second instar (fig. 4)

Dimensions: body length 1.30-2.14 mm; thoracic length 0.40-0.56 mm; thoracic width 0.38-0.54 mm.

Wingpads: present; mesonotal wingpads not longer than median lobe.

Chaetotaxy of the abdomen: 2/2/2/2/3/3/3-3

Coloration of the body similar to that of the I instar.

External genitalia: absent.

Third instar (fig. 5)

Dimensions: body length 1.80-2.60 mm; thoracic length 0.40-0.72 mm; thoracic width 0.52-0.80 mm.

Wingpads: mesonotal wingpads slightly longer than median lobe.

Chaetotaxy of the abdomen: 2/2/2/2/3/3/3-3.

Middle line: pale yellow, narrow, continuous from vertex to IX tergum.

Middle bands: well defined and extend from head to IX tergum.

Longitudinal bands: pale and very narrow on the head around the eyes; not well defined and slightly pigmented on the anterior margin of each tergum of the thorax; pigmented brownish yellow, not well distinct from the middle and lateral bands and with pale areas surrounding the spines on the abdomen.

Lateral bands: absent on the head; pale brownish and wide on the thorax; brownish, very wide and with pale areas surrounding the spines on the abdomen.

External genitalia: visible.

Fourth instar (fig. 6)

Dimensions: body length 2.30-2.88 mm; thoracic length 0.56-0.80 mm; thoracic width 0.68-1.00 mm.

Wingpads: mesonotal wingpads extend over halfway the length of metanotum, but do not reach the posterior margin.

Chaetotaxy of the abdomen: 2/2/2/2/3/3/3-3.

Coloration of the body similar to that of the third instar.

Longitudinal bands: better defined on the thorax, with pigmentation sparse on the anterior margin of pronotum, absent on the anterior margin of the meso- and metanotum.

Lateral bands: divided into two or three pale brownish narrow streaks on the thorax.

External genitalia: visible.

Fifth instar (figs. 7-9)

Dimensions: body length 3.0-3.2 mm; thoracic length 0.76-1.08 mm; thoracic width 0.80-1.08 mm.

Wingpads: well-developed and extend to posterior margin of metanotum.

Chaetotaxy of the abdomen: 2/2/2/2/3/3/3-3.

Pattern of dorsal surface: body with brownish bands; abdomen darker than thorax.

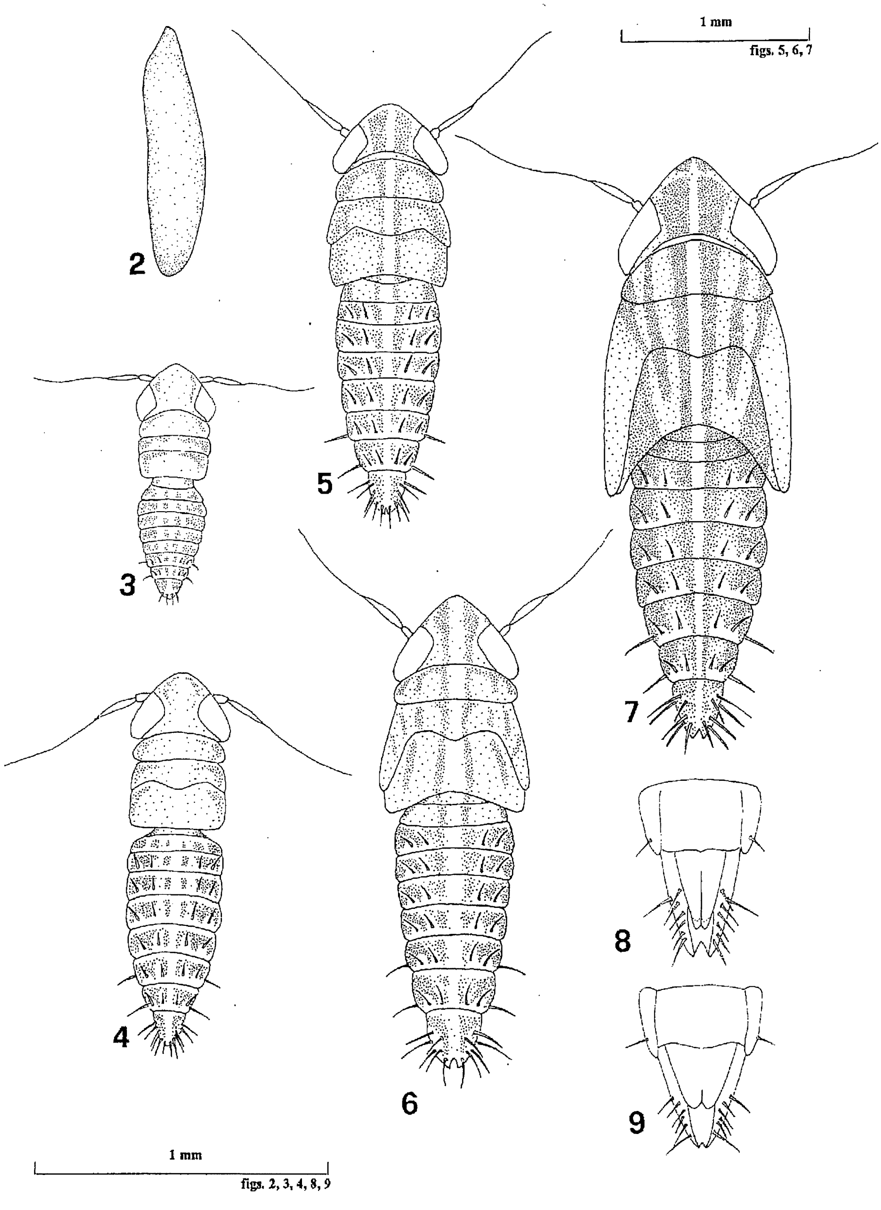
Middle line: yellow, narrow.

Middle bands: very wide on the head with 2 little brownish triangular spots at the apex of the vertex; narrow on pronotum and abdomen.

Longitudinal bands: very narrow on the head; pale, wide and well defined on the thorax; pigmented brownish yellow, not well distinct from the middle and lateral bands and with pale yellow areas surrounding the spines on the abdomen.

Lateral bands: absent on the head; divided into two or three wide brownish streaks on the thorax; brownish and very wide on the abdomen, with pale areas surrounding the spines.

External genitalia: visible; sexes easily recognizable: the female has the outgrowths on the VIII and IX sternum well developed; the first pair of outgrowths on the VIII sternum shows a long apical slit along the center (fig. 8); the male shows a large subgenital plate with a short apical slit (fig. 9).



Figs. 2-9 - *Psammotettix alienus* (Dahlbom). 2: egg; 3: first instar; 4: second instar; 5: third instar; 6: fourth instar; 7: fifth instar; 8-9: fifth instar, ventral view of abdomen tip; female (8), male (9).

LIFE CYCLE AND BIOLOGICAL PARAMETERS

Egg-laying and distribution (fig. 10)

The females laid their eggs in the mesophyll of the *Avena sativa* L. leaves and they were entirely thrust into the plant tissue.

In the experiment carried out to determine the egg distribution (fig. 10), we observed that 50% of the laid eggs are arranged in the first leaf (the oldest one); 40.91% in the second one; 8.08% in the third one and only 1.01% in the fourth leaf (the youngest one); it is important to point out that 10.1% and 6.56% of the eggs were laid in the apex of the first and second leaf respectively. From 198 eggs recorded, 60.10% were laid in the leaf lamina, 39.90% in the insheated portion of the leaf. No eggs were laid in the ligulae. The egg stage lasted 8-15 days (table 1).

Table 1 - Duration in days of Psammotettix alienus *(Dahlbom) egg and nymphal stages at 27° C, 80% RH and 14L:10D of artificial light photoperiod.*

STAGE			n	X	S.D.	range
Eggs		Total	191	10.7	1.32	8 - 15
		1st Generation	83	10.8	1.32	9 - 14
		2nd Generation	108	10.6	1.32	8 - 15
1st nymphal	instar	Total	191	2.99	0.77	1 - 6
		1st Generation	83	2.90	0.71	2 - 6
		2nd Generation	108	3.06	0.81	1 - 6
2nd nymphal	instar	Total	191	2.69	0.73	1 - 8
		1st Generation	83	2.57	0.57	1 - 4
		2nd Generation	108	2.78	0.82	1 - 8
3rd nymphal	instar	Total	191	2.59	0.71	1 - 5
		1st Generation	83	2.39	0.70	1 - 5
		2nd Generation	108	2.74	0.69	1 - 5
4th nymphal	instar	Total	191	3.01	0.60	2 - 6
		1st Generation	83	2.84	0.48	2 - 4
		2nd Generation	108	3.13	0.66	2 - 6
5th nymphal	instar	Total	191	4.63	0.90	1 - 9
		1st Generation	83	4.49	0.67	3 - 7
		2nd Generation	108	4.74	1.04	1 - 9

n = number of specimens; X = average; S.D. = standard deviation.

Duration of the stadia

The average duration of the egg and nymphal stages observed on the whole and in each generation is given in table 1. The life cycle from egg to adult stage is summarized in table 2; in this table, data on the specimens which developed in females and males are discriminated. In both tables, we considered only data about specimens observed from egg to adult stage.

Table 2 - Duration (days) of Psammotettix alienus *(Dahlbom) of egg and nymphal stages at 27° C, 80% RH and 14L:10D of artificial light photoperiod.*

		n	X	S.D.	range
Total	Total	191	26.7	2.61	22 - 43
	1st Generation	83	26.0	2.07	22 - 33
	2nd Generation	108	27.2	2.85	22 - 43
Females*	Total	100	27.1	2.85	22 - 43
	1st Generation	41	26.1	2.13	22 - 33
	2nd Generation	59	27.7	3.11	22 - 43
Males*	Total	91	26.3	2.26	22 - 33
	1st Generation	42	25.9	2.03	23 - 31
	2nd Generation	49	26.6	2.40	22 - 33

n = number of specimens; X = average; S.D. = standard deviation; * = discriminated data about eggs and nymphs that developed males or females respectively.

We observed that 98.45% of the individuals passed through five nymphal instars and 1.55% through six.

Sex ratio and adult longevity

The progeny reared had a sex ratio of about 1:1. The longevity was very variable (table 3). The females lived more than the males. The specimens of the first generation lived more than the ones of the second generation under the same conditions. We also observed that on the whole 50% of the adults lived more than 7 days; 25% lived more than 20 days and only 1% more than 46 days.

Different longevity duration was observed among the females; considering only those that lived more than 7 days, we recorded that their longevity was 31.59 ± 18.63 days in the fertilized females and 22.7 ± 12.5 days in the unfertilized females.

Table 3 - Adult longevity of Psammotettix alienus *(Dahlbom) at 27°C, 80% RH and 14L:10D of artificial light photoperiod.*

Longevity		n	X	S.D.	range
Total	Total	215	16.2	15.0	2 - 74
	1st Generation	107	18.2	17.0	2 - 74
	2nd Generation	108	14.2	12.6	2 - 46
Females	Total	106	19.8	17.4	2 - 74
	1st Generation	47	23.3	20.2	2 - 74
	2nd Generation	59	17.1	14.4	2 - 46
Males	Total	109	12.7	11.3	2 - 62
	1st Generation	60	14.2	12.7	2 - 62
	2nd Generation	49	10.8	8.94	2 - 40

n = number of specimens; X = average; S.D. = standard deviation.

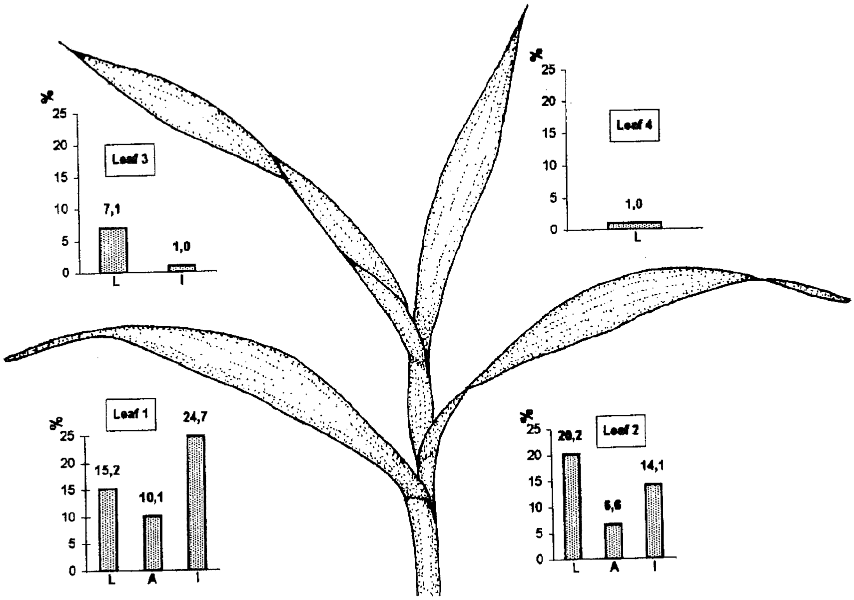


Fig. 10 - Scheme of *Avena sativa* L. seedling showing the distribution and percentage of *Psammotettix alienus* (Dahlbom) eggs.
L = Lamina; A = Apex; I = Insheated portion.

Number of eggs and fecundity

Fertilized females

The following data were obtained by studying 37 fertilized females. The beginning of the oviposition was very variable; on average, the mated females began their egg-laying after 5.35 ± 2.25 days from their emergence (range: 1-11) and finished 3.35 ± 2.94 days before their death (range 1-15). We observed that only 2 (5.41%) of the fertilized females began to lay eggs on the 2nd day of life, 4 (10.81%) after 4 days, 25 (67.57%) between the 5th and 8th day of life and the remaining 6 (16,21%) laid eggs after 9 days. On the whole, the females laid eggs 35.46% of the days of their life (range: 12.1% - 54.5%). A single female could lay an average of 36.7 eggs (range 3-100); considering the high percentage of days in which these females did not lay eggs, a mean of 1.16 ± 2.03 eggs/day, with a maximum of 12 eggs/day was calculated.

The studied females laid, on the whole, 1359 eggs, of which 1023 (75.28%) were fecundated. We obtained 851 (62.62%) nymphs and recorded an embryonic mortality of 12.66%.

Unfertilized females

The eggs laid by the virgin females did not develop. We studied the ability of these females to lay eggs. In the unmated females observed (34), the egg-laying began after 5.91 ± 3.58 days from their emergence (range: 2-20) and finished 3.09 ± 2.82 days before their death (range: 0-10); of these females, only 2 (5.88%) began the oviposition on the 3rd day; 4 (11.76%) after 4 days, 25 (73.52%) between the 5th and 8th day of life and the remaining ones (8.84%) laid eggs after 9 days of life. On the whole, the females laid eggs 27.7% of the days of their life (range: 6.3% - 58%). A single virgin female laid an average of 19.3 eggs (range 1-62); a mean of 0.85 ± 1.75 eggs/day, with a maximum of 17 eggs/day was calculated.

Fig. 11 - Survivorship (l_x) and life expectance (e_x) curves of *Psammotettix alienus* (Dahlbom) at 27°C, 80% RH and 14L:10D of artificial light photoperiod. In addition, the mean of the duration of each stage is shown.
I = 1st instar; II = 2nd instar; III = 3rd instar; IV = 4th instar; V = 5th instar; A = adult.

Life tables and survival analysis (fig. 11)

With the data obtained from two cohorts (first and second generation) and considering only the daily mortality from nymph to adult stage, we constructed a horizontal life table (fig. 11). We were unable to determine the exact death day of the eggs.

The survivorship curve shows two periods of heavy mortality. The first one occurs before the ecdysis from the first to second instar; the individuals which survive have

Table 4 - Fecundity table of Psammotettix alienus *(Dahlbom) reared on* Avena sativa *L. at 27°C, 80% RH and 14L:10D of artificial light photoperiod.*

Days	nx_{1000}	l_x	m_x	$l_x \cdot m_x$	$x \cdot l_x \cdot m_x$
1	1000,0	1,00	0,00	0,00	0,00
2	1000,0	1,00	0,00	0,00	0,00
3	1000,0	1,00	0,00	0,00	0,00
4	1000,0	1,00	0,09	0,09	0,38
5	1000,0	1,00	0,23	0,23	1,15
6	1000,0	1,00	0,38	0,38	2,27
7	1000,0	1,00	0,42	0,42	2,93
8	973,0	0,97	0,75	0,73	5,84
9	918,9	0,92	0,44	0,41	3,65
10	864,9	0,86	0,28	0,24	2,43
11	837,8	0,84	0,32	0,27	2,97
12	810,8	0,81	0,53	0,43	5,19
13	783,8	0,78	0,62	0,49	6,32
14	783,8	0,78	0,62	0,49	6,81
15	783,8	0,78	0,33	0,26	3,85
16	783,8	0,78	0,38	0,30	4,76
17	783,8	0,78	0,47	0,36	6,20
18	756,8	0,76	0,43	0,32	5,84
19	729,7	0,73	0,43	0,31	5,91
20	702,7	0,70	0,42	0,30	5,95
21	648,6	0,65	0,33	0,22	4,54
22	648,6	0,65	0,50	0,32	7,14
23	621,6	0,62	0,20	0,12	2,80
24	594,6	0,59	0,36	0,22	5,19
25	594,6	0,59	0,66	0,39	9,80
26	594,6	0,59	0,25	0,15	3,86
27	540,5	0,54	0,75	0,41	10,95
28	540,5	0,54	0,18	0,09	2,65
29	540,5	0,54	0,35	0,19	5,49
30	513,5	0,51	0,24	0,12	3,65
31	486,5	0,49	0,28	0,14	4,19
32	459,5	0,46	0,32	0,15	4,76
33	405,4	0,41	0,67	0,27	8,92
34	378,4	0,38	0,21	0,08	2,76
35	378,4	0,38	0,29	0,11	3,78
36	378,4	0,38	0,50	0,19	6,81
37	378,4	0,38	0,21	0,08	3,00

(table 4 continued)

Days	nx_{1000}	l_x	m_x	$l_x \cdot m_x$	$x \cdot l_x \cdot m_x$
38	351,4	0,35	0,65	0,23	8,73
39	324,3	0,32	0,29	0,09	3,69
40	297,3	0,30	0,14	0,04	1,62
41	297,3	0,30	0,68	0,20	8,31
42	297,3	0,30	0,09	0,03	1,14
43	297,3	0,30	0,68	0,20	8,72
44	243,2	0,24	0,50	0,12	5,35
45	189,2	0,19	0,07	0,01	0,61
46	189,2	0,19	0,21	0,04	1,86
47	189,2	0,19	0,64	0,12	5,72
48	189,2	0,19	0,29	0,05	2,59
49	189,2	0,19	0,50	0,09	4,64
50	162,2	0,16	0,33	0,05	2,70
51	162,2	0,16	0,25	0,04	2,07
52	162,2	0,16	0,42	0,07	3,51
53	162,2	0,16	0,33	0,05	2,86
54	162,2	0,16	0,75	0,12	6,57
55	162,2	0,16	0,67	0,11	5,95
56	162,2	0,16	0,33	0,05	3,03
57	108,1	0,11	0,13	0,01	0,77
58	108,1	0,11	0,63	0,07	3,92
59	108,1	0,11	0,63	0,07	3,99
60	108,1	0,11	0,00	0,00	0,00
61	108,1	0,11	0,38	0,04	2,47
62	108,1	0,11	0,13	0,01	0,84
63	108,1	0,11	0,38	0,04	2,55
64	108,1	0,11	0,38	0,04	2,59
65	54,1	0,05	1,25	0,07	4,39
66	54,1	0,05	0,00	0,00	0,00
67	54,1	0,05	0,25	0,01	0,91
68	27,0	0,03	1,50	0,04	2,76
69	27,0	0,03	0,00	0,00	0,00
70	27,0	0,03	0,00	0,00	0,00
71	27,0	0,03	0,00	0,00	0,00
72	27,0	0,03	0,00	0,00	0,00
73	27,0	0,03	0,00	0,00	0,00
74	27,0	0,03	0,00	0,00	0,00
75	0,0	0,00	0,00	0,00	0,00

a relatively high expectation of reaching the adult stage. The second period occurs from the first 4 to 8 days as imagoes; in this phase, the survivorship curve resembles the theoretical type III (Rabinovich, 1978), characterized by a constant ratio of individual death by unit of time (mortality rate approximately constant throughout the adult life).

A remarkable initial critical period was not observed in the first generation.

Fecundity table

From the fecundity table (table 4), we estimated that the net reproductive rate "Ro" was 11.42; because this value was greater than one, under the laboratory conditions used and in absence of natural enemies, the population grew. The generation time "T" was estimated in 23 days. The instantaneous rate of population increase "r" (= intrinsic rate of increase) was 0.106, indicating that the population was growing at a rate of about 0.106 females/female/day.

Natural enemies

Near Viterbo (Italy), nymphs and adults of *P. alienus* have been known to be parasitized by Dryinidae (Hymenoptera) and Pipunculidae (Diptera). Among the Dryinids, we reared *Gonatopus clavipes* (Thunberg) and *Gonatopus lunatus* Klug; of these species, *G. clavipes* was the most common parasitoid of this leafhopper. In other countries, *P. alienus* can be parasitized also by *Gonatopus formicarius* Ljungh (Guglielmino & Olmi, 1997). Among the Pipunculidae we obtained *Tomosvaryella* sp. and *Eudorylas imperfectus* (Becker); until now the hosts of this last species were unknown.

CONCLUSIONS

The five nymphal instars differ among themselves essentially for the following characters: dimensions, presence and extension of longitudinal bands on head, thorax and abdomen, presence and development of wingpads, chaetotaxy of the abdomen and development of external genitalia. The general pattern of the nymph body of *Psammottetix alienus* confirms the characters that Vilbaste (1982) considered typical for this species.

On *Avena sativa* and under the laboratory conditions considered, the life cycle of this leafhopper lasts approximately 43 days. Regarding the oviposition habits, the fertilized and unfertilized females of *P. alienus* prefer to lay their eggs in the oldest oat leaves, embedding them entirely into the leaf tissue. The preoviposition period last at least two days after the emergence of the adults. Females daily lay an irregular number of eggs. It is interesting to point out that unmated females of *P. alienus* lay eggs, whereas in other leafhoppers, as *Empoasca lybica* de Bergevin and *Asymmetrasca decedens* Paoli, it has been observed that these females failed to do so (Habib et al., 1972).

The postembryonic development duration is not significantly different in the opposite sexes, but it differs considerably during the adult stage when the females live longer than the males. The sex ratio is essentially 1:1. Both survivorship and fecundity of this leafhopper on *Avena sativa* indicate that this cereal is a good developmental and ovipositional host for this leafhopper.

The comparison of the population parameters of *P. alienus* on *Avena sativa* and other Graminaceae, particularly on the species of cereals infected by this Cicadellid, under the same laboratory conditions could provide interesting information to know the role and importance of each host-plant on the dynamics of this leafhopper and to plan control programs during the year. Sedlacek et al. (1986) also studied the population parameters of the Cicadellid *Graminella nigrifrons* (Forbes) on Johnsongrass and corn under controlled conditions and concluded that corn was a poor developmental and ovipositional host for this leafhopper; they suggested that the adults colonizing the corn early in the season use this plant primarly as a food host and not as an ovipositional host during this period.

ACKNOWLEDGMENTS

We wish to thank Prof. M. Olmi (Dipartimento di Protezione delle Piante, Viterbo, Italy) and Prof. A. Belcari (Istituto di Patologia e Zoologia forestale e agraria, Firenze, Italy) for the identification of Dryinidae and Pipunculidae species, respectively, and Prof. G. Lilghestron (Centro de Estudios sobre Parasitos y Vectores (CEPAVE), La Plata, Argentina) for his important suggestions concerning the population parameters.

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Accepted 12 June 1997.