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Biology of *Delphacodes lutulenta* (Homoptera: Delphacidae)[1]

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ABSTRACT The biology of *Delphacodes lutulenta* (Van Duzee) was studied in a greenhouse and laboratory under controlled conditions. Eighteen different species or cultivars of plants proved to be host plants; the planthopper produced more progeny on *Triticum aestivum* L. var. Abe than on any other plant tested. Fifteen females produced an average of 243 progeny per female. The sex ratio was 1:1. Average longevities for the male and female were (mean ± SE) 27 ± 2.4 and 33.9 ± 3.3 days, respectively. Average fecundity of nine females was 430 ± 6.9 eggs per female. Unmated females did not produce viable eggs. There was no significant difference ($P > 0.05$) in oviposition between brachypterous and macropterous females. Development was completed in five ($n = 20$) or six ($n = 4$) instars by both males and females. The times required for development of the male (33.4 ± 0.8 days) and female (34.2 ± 0.7 days) were not significantly different ($P > 0.05$).

Of 262 species of *Delphacodes* Fieber reported in the world (Metcalf 1943), 49 have been described from North America (Muir and Giffard 1924). Unfortunately, there is little biological information on delphacids commonly occurring in the United States. Stoner and Gustin (1980) studied and reported that *Delphacodes campestris* (Van Duzee) commonly occurred in South Dakota. *Delphacodes lutulenta* (Van Duzee) is the dominant delphacid planthopper in Fayette County, Ky. (unpublished data). For that reason, we initiated laboratory and greenhouse studies on the biology of this species.

Materials and Methods

D. lutulenta specimens were collected from the field and established on oat plants, *Avena sativa* L., in the greenhouse. The rearing cage was a 30-cm^3 Plexiglas box, ventilated on two opposite sides with nylon screen. Oats were sown in Jiffy mix in a plastic tray (26 by 26 cm). When the plants were 2 weeks old, 12 to 15 pairs (male-female) of delphacids were introduced. In the greenhouse at 26 ± 3°C and relative humidity (RH) 48 ± 5%, the next generation of adults emerged after 35 days. Delphacids required for the following experiments were taken from such a colony.

Host Plant Preference

Six replications of tall fescue, *Festuca arundinacea* Schreb., orchard grass, *Dactylis glomerata* L., Kentucky bluegrass, *Poa pratensis* L., wheat, *Triticum aestivum* L., and oats were arranged in a randomized complete block design. The first three plants were chosen because they were common where delphacids were collected, and the last two were suspected to be susceptible to planthoppers. Different species of plants were grown in separate 6.5-cm-diameter clay pots. A plastic petri dish of the same diameter with a hole in the center was placed on the pot so that the plants passed through the hole. The plants were wrapped with a piece of paper napkin, and ca. 50 g of Flint shot sand was poured around it.

Thirty pots, prepared as described above, were arranged on a bench in the greenhouse and covered by a nylon screen cage (1 by 1 by 0.35 m). Thirty pairs of delphacids were introduced into the cage. Twenty-four hours after the introduction of delphacids, the individual pots were taken out and all delphacids were removed from the plants. These plants were caged individually by placing a 23-cm-long, 6.3-cm-diameter plastic cylinder, ventilated by two screened holes on opposite sides, over each pot. The top was closed by a piece of cloth. Host plant preference was assessed by counting all progeny within each cage after 30 days. Duncan's multiple range test was used to compare the number of progeny on each plant species.

An additional eight species of suspected host plants and three varieties of wheat (Table 2) were tested separately in the greenhouse, using three plants per cage with a pair of delphacids. There were three replications for each plant species. The cages were larger than those described above and the top was covered by a ventilated petri dish. The delphacids were allowed to oviposit as long as they lived. The progeny were checked and counted in each cage after the parent delphacids died.

Fecundity, Sex Ratio, and Longevity

To study fecundity, 15 pairs of males and females were caged with three wheat plants in each cage. To ensure that the females were virgin, nymphs were sexed into 30 males and 30 females and placed in two separate cages. As the adults emerged, they were used in the experiment with one pair introduced to each cage. Unused female nymphs (15) were left inside the cages to determine whether unmated individuals also reproduced. The adult delphacids were transferred to similar new cages each day for as long as they lived. The number and sex of the progeny were recorded as they became adults. The sex ratio was calculated from the total number of male and female progeny. The longevity was calculated from the original 15 pairs of adults.

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We also counted the eggs before they hatched. Nine pairs of adults were used, and the cages were checked for eggs 7 days after oviposition.

Development

The development of *D. lutulenta* was studied in the laboratory at 23 ± 3°C and LD 12:12. Females were allowed to oviposit on wheat plants caged as described earlier. On day 7 after oviposition, the stems on which eggs could be seen were cut and placed in moist, 8-dram (ca. 14-g) glass vials with fresh stems. Thirty such vials were set up and checked for molting daily. Dates of molts (as indicated by cast exuviae) were recorded, and vials were changed at the time of molt to avoid excessive accumulation of moisture. The wheat stems in the vials were changed every other day.

Results and Discussion

Host Plant Preference

Wheat was the preferred host plant among five tested species (Table 1). Oats and fescue were second and did not differ significantly ($P > 0.05$) from each other. These three host plants were preferred ($P < 0.05$) over orchardgrass and Kentucky bluegrass.

The results of host plant preference tests on additional plant species are summarized in Table 2. The numbers are arranged in order of preference from top to bottom. All the tested plants were from Poaceae and are broadly divided into two categories. More than 100 individuals per cage were found on plants from no. 1 to 6, and less than 100 individuals per cage were found on plants from no. 7 to 13.

Fecundity, Sex Ratio, and Longevity

More progeny were produced by the female which lived longer (Table 3). The longevities of males (mean ± SE = 27 ± 2.4 days) and females (33.9 ± 3.3 days) were not significantly different ($P > 0.05$).

When eggs were counted, the number of eggs per female ranged from 160 to 653 (mean ± SE = 430.5 ± 6.9). This test showed that there were three distinct periods: a preovipositional period ranged from 2 to 4 days (mean ± SE = 3.3 ± 0.3), an ovipositional period ranged from 8 to 53 days (mean ± SE = 31.1 ± 5.4), and a post-ovipositional period ranged from 1 to 9 days (mean ± SE = 2.7 ± 0.8) (Fig. 1). Stoner and Gustin (1980) reported that the highest number of eggs produced by *D. campestris* was 919, which is higher than the highest number for *D. lutulenta*. Manjunath (1977) and Oh (1980) have reported that repeated matings increase fecundity of *Nilaparvata lugens* (Stål). So, it may be possible to increase the fecundity of *D. lutulenta* (430.5 ± 6.9) by permitting multiple mating of females until their death. We did not replace the males as they died in the cages as Stoner and Gustin (1980) did.

Unmated females ($n = 15$) deposited only a few eggs which did not hatch. Therefore, we concluded that unmated female *D. lutulenta* do not produce viable eggs.

Our observation for oviposition site was similar to that described for *N. lugens* and *Delphacodes campestris* by Manjunath (1977) and Stoner and Gustin (1980), respectively. Only 23 eggs were found in five batches on leafblades, whereas all others were on leafsheaths in batches of one to nine, more frequently two to five. Except in a few cases, only one of the two plants was utilized for oviposition, and eggs were more often observed on the lower half of the ca. 8-cm-long stem. When a plant was overcrowded with fecund females (≥ six per plant), the delphacids oviposited from the bottom of the leafsheath to the tip of the leaf, indicating that if they have little choice they can oviposit anywhere on the plant.

Brachypterous forms of some delphacids are reported to be more fecund than macropterous forms by Manjunath (1977) for *N. lugens* and Denno (1979) for *Prokelisia marginata* (Van Duzee). Of our nine female *D. lutulenta*, five were brachypterous and four macropterous. There was no significant difference ($P > 0.5$) between brachypterous (mean ± SE = 427 ± 85 eggs) and macropterous (mean ± SE = 434 ± 92 eggs) forms. Oh (1980) reported results similar to ours for *N. lugens*.

Table 1.—Comparison of progeny produced by 30 pairs of *D. lutulenta* on host plants by randomized complete block design

Host plant	Variety	No. of progeny on each type[a]
Triticum aestivum L.	Abe	162a
Avena sativa L.	Early spring	69b
Festuca arundinacea L.	KY 31	62b
Dactylis glomerata L.		7c
Poa pratensis L.	KY Bluegrass	3c

[a]Numbers followed by common letters are not significantly different at 5% level, by Duncan's multiple range test.

Table 2.—Host plants of *D. lutulenta* as determined by successful reproduction of progeny and arranged in order of more to less preferred hosts

No.	Host plant	Variety	Progeny
1	*Triticum aestivum* L.	Abe Hart Southern Belle Arther 71	
2	*Avena sativa* L.	Early Spring Unknown	>100
3	*Festuca arundinacea* Schreb.	KY 31	
4	*Zea mays* L.	Trozan TXS 114 Unknown	
5	*Sorghum halepense* (L.)		
6	*Lolium multiflorum* Lam.		
7	*Dactylis glomerata* L.		
8	*Poa pratensis* L.	KY Bluegrass	
9	*Digitaria sanguinalis* (L.)		
10	*Agropyron repens* (L.)		<100
11	*Setaria faberi* Herm.		
12	*Bromus sterilis* L.		
13	*Phleum pratense* L.		

Table 3.—The number and sex ratio of the progeny produced by, and the longevity of, 15 pairs of *D. lutulenta*

No. of pairs	No. of progeny			Sex ratio of progeny	Longevity of parent	
	Male	Female	Total		Male	Female
1	88	79	167	53:47	21	28
2	96	108	204	47:53	25	28
3	145	127	272	53:47	22	33
4	103	107	210	49:51	32	36
5	113	107	220	51:49	15	34
6	82	105	187	43:57	37	30
7	107	92	199	54:46	20	25
8	129	99	228	57:43	11	29
9	181	169	350	52:48	41	50
10	180	185	365	49:51	39	63
11	125	132	257	49:51	29	34
12	101	110	211	48:52	34	24
13	189	190	379	50:50	14	47
14	184	169	353	52:48	35	44
15	19	23	42	45:55	30	14
Total	1,842	1,802	3,644		405	509
Mean	122.8	120.1	242.9	50.5:49.5[a]	27.0	33.9
± SE			23.2		2.5	3.3

[a]Percentage obtained by 1,842:3,644.

Table 4.—Developmental period (mean ± SE days) from oviposition to the emergence of male and female *D. lutulenta* on wheat at 23 ± 3°C and a photoperiod of LD 12:12; number reared indicated within the parentheses (a = five instars, b = six instars)

Sex	Egg stage	Nymphal stage						Total period, egg to adult	Mean development period[a]
		1st	2nd	3rd	4th	5th	6th		
Males: a(11)	10.0 ± 0.1	4.7 ± 0.2	3.36 ± 0.1	3.63 ± 0.2	4.09 ± 0.5	6.81 ± 0.7	—	32.81 ± 0.8	33.38 ± 0.8
b(2)	9.5 ± 0.5	4.0 ± 0.0	3.5 ± 0.5	3.0 ± 0.0	3.5 ± 0.5	4.5 ± 0.5	8.5 ± 2.5	36.5 ± 2.5	
Females: a(9)	10.22 ± 0.2	4.55 ± 0.2	3.33 ± 0.2	3.77 ± 0.1	4.44 ± 0.4	7.0 ± 0.4	—	33.33 ± 0.4	34.18 ± 0.7
b(2)	9.5 ± 0.5	5.0 ± 0.0	3.0 ± 0.0	3.5 ± 0.5	3.0 ± 1.0	5.0 ± 0.0	9.0 ± 2.0	38.0 ± 2.0	

[a]Mean of 13 males and 11 females. There is no significant difference at 5% level (*t* test).

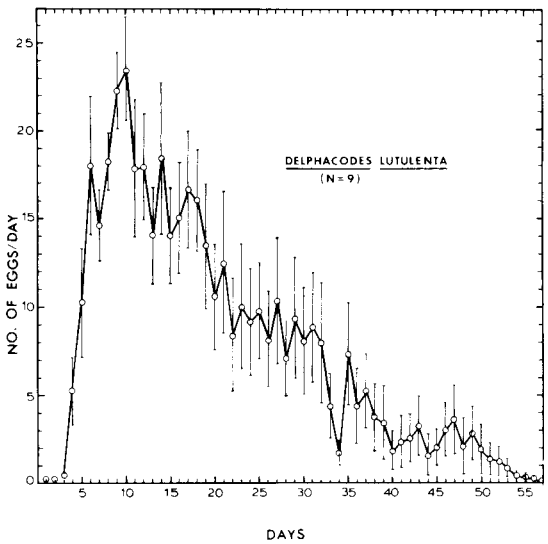

FIG. 1.—Oviposition of *D. lutulenta* on *T. aestivum* L. var. Abe. Eggs were counted 7 days after oviposition.

Development

Of 24 delphacids that reached adulthood, 20 had five nymphal instars and four had six nymphal instars (Table 4). The latter required one more instar to develop and this may have been due to nutritional deficiency, because there was yellowing of some of the stems on which they fed. Males (n = 13) required 33.4 ± 0.8 days and females (n = 11) required 34.2 ± 0.7 days (mean ± SE) to develop from oviposition to adult emergence. However, neither the developmental periods for five- and six-instar adults nor the mean developmental periods for male and female were significantly different ($P > 0.05$, t test).

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