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Efficiency of Three Predators, *Geocoris bullatus*,[1] *Nabis americoferus*,[2] and *Coccinella transversoguttata*,[3] Used Alone or in Combination Against Three Insect Prey Species, *Myzus persicae*,[4] *Ceramica picta*,[5] and *Mamestra configurata*,[5] in a Greenhouse Study[6]

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ABSTRACT

The efficiency of 3 predators, *Geocoris bullatus* (Say), *Nabis americoferus* Carayon, and *Coccinella transversoguttata* Faldermann, used singly and in combination, was evaluated against 3 prey species, the green peach aphid, *Myzus persicae* (Sulzer), the zebra caterpillar, *Ceramica picta* (Harris), and the bertha armyworm, *Mamestra configurata* Walker, on caged sugarbeet plants in the greenhouse. Coccinellids used alone or in combination with other predators were effective in reducing populations of green peach aphids. Also, nabids or geocorids alone were effective in reducing the population of aphids for about 1 week if the initial population averaged no more than 14 aphids per plant and if the predators were present at a rate of about 1 per plant; however, when the population of aphids was 34 per plant, nabids or geocorids alone were not effective. Nabids alone or in some combinations were superior to all other treatments in reducing the population of the noctuid species when these larvae were small.

In the Yakima Valley of eastern Washington, the insect predator complex in vegetable and sugarbeet crops is composed mainly of coccinellids, geocorids, nabids, anthocorids, syrphids, and chrysopids. The impact of this complex on the prey complex is poorly understood, but if an integrated control program for vegetable and sugarbeet crops is to be successful it is essential to know the impact of these predators acting separately and in combination against a specific prey or a prey complex.

Many of the predators can be seen actively feeding on different prey species in the field, but it is difficult to conceive of a way to evaluate the effectiveness of each or of the complex as a whole. However, cage tests in a greenhouse might be a preliminary step in establishing an index of predator efficiency against each prey species. Such an index could then be used to determine the correct timing for augmentation of beneficial populations and the correct scheduling for applications of insecticides advantageous to the various vegetable and sugarbeet crops. The tests were made at the Potato, Pea, and Sugarbeet Insects Investigations Laboratory at Yakima, Wash. in 1970.

Materials and Methods

Three identical proximal greenhouses were used concurrently in all tests. Also, all tests were made with 61×61×10-cm metal flats containing 9 sugarbeet plants spaced 15 cm apart (6/greenhouse). A 66×66×30-cm high cage (Fig. 1) with fitted saran cloth walls and a removable plastic lid was placed over each flat.

Shortly before the test, 1 or 2 species of the prey

[1] Hemiptera: Lygaeidae.
[2] Hemiptera: Nabidae.
[3] Coleoptera: Coccinellidae.
[4] Hemiptera: Aphididae.
[5] Lepidoptera: Noctuidae.
[6] In cooperation with the College of Agriculture Research Center, Washington State University, Pullman 99163. Received for publication 30 Sept., 1971.

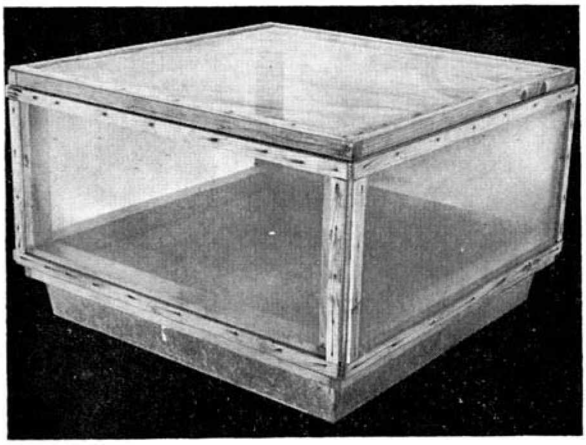

FIG. 1.—A typical cage used in the greenhouse to isolate predator and prey insects.

complex, green peach aphids *Myzus persicae* (Sulzer), zebra caterpillars, *Ceramica picta* (Harris), and bertha armyworms, *Mamestra configurata* Walker, were placed on the plants (obtained from laboratory colonies) as follows: green peach aphids were introduced at the rate of 5 apterous adult viviparae/plant 3–6 days before the introduction of predators; the 2 Lepidoptera were added as neonate larvae at the rate of 2/plant 4 hr before the introduction of the predators.

The predator complex consisted of 3 species (all adults commonly found in and collected from alfalfa), *Coccinella transversoguttata* Faldermann, *Geocoris bullatus* (Say), and *Nabis americoferus* Carayon. However, different combinations were used as treatments as follows: (1) 8 *G. bullatus,* (2) 8 *N. americoferus,* (3) 4 *C. transversoguttata,* (4) 4 *G. bullatus* + 2 *C. transversoguttata,* (5) 2 *C. transversoguttata* + 4 *G. bullatus* + 4 *N. americoferus.* Treatment (6) was the control (no predators). Since plants in each of the 3 greenhouses were exposed to all 6 treatments, each treatment was replicated 3 times.

Results

Prey: Myzus persicae

Two tests were made to evaluate the effectiveness of the 6 treatments against *M. persicae* (Table 1) when it was the sole prey species. In Test 1, the pretreatment count averaged 13.5 aphids/plant, an average of 122 aphids/cage, and the 3 treatments that included coccinellids were the most effective against this population. The nabids used alone tended to reduce these populations more than the geocorids used alone, but the difference between the two was not statistically significant. All treatments significantly reduced the population of aphids below the control.

In Test 2, the pretreatment count averaged 15 aphids/plant, an average of 136 aphids/cage and the efficiency of the treatments in reducing populations was similar to that obtained in Test 1. However, in this test, the 3 treatments with 1 species each did not differ significantly except at day 2 when treatment with coccinellids alone was more effective than other treatments. Again, all treatments significantly reduced the populations below that of the control.

Fig. 2 summarizes both tests graphically and illustrates the trends of the populations. Treatment with either nabids or geocorids alone gave only temporary suppression; after 6–8 days the number of aphids increased. In contrast, treatments containing coccinellids all produced a declining population of aphids although there were some temporary upsurges.

Prey: M. persicae + C. picta

In another test, the same treatments were used against 2 prey species, the green peach aphid and the zebra caterpillar. Again, coccinellids alone or in combination with other predator species suppressed the populations of green peach aphids in a manner similar to the test with only the green peach aphids as prey, despite the presence of the zebra caterpillar (Fig. 3). However, the treatment with geocorids alone only slowed the growth of the population of green peach aphids slightly for a few

Table 1.—The effectiveness of 3 predators used alone or in combination against populations of the green peach aphid.

	Avg no. green peach aphids/9 plants on indicated day posttreatment[a]							
	In Test 1			In Test 2				
Treatments	0	3	6	0	2	5	8	13
4 *Coccinella*	114 a	<1 a	0 a	139 a	7 a	<1 a	0 a	0 a
2 *Coccinella* + 4 *Geocoris* + 4 *Nabis*	100 a	9 a	<1 a	154 a	60 b	5 a	2 a	6 a
2 *Coccinella* + 4 *Geocoris*	131 a	7 a	1 a	140 a	48 b	13 a	13 a	4 a
8 *Nabis*	117 a	46 b	27 b	134 a	73 b	35 a	23 a	64 a
8 *Geocoris*	112 a	54 b	45 b	108 a	70 b	46 a	95 a	247 a
Control	157 a	217 c	416 c	141 a	165 c	298 b	670 b	1839 b

[a] Means followed by the same letter are not significantly different at the 5% level of confidence by Duncan's multiple range test.

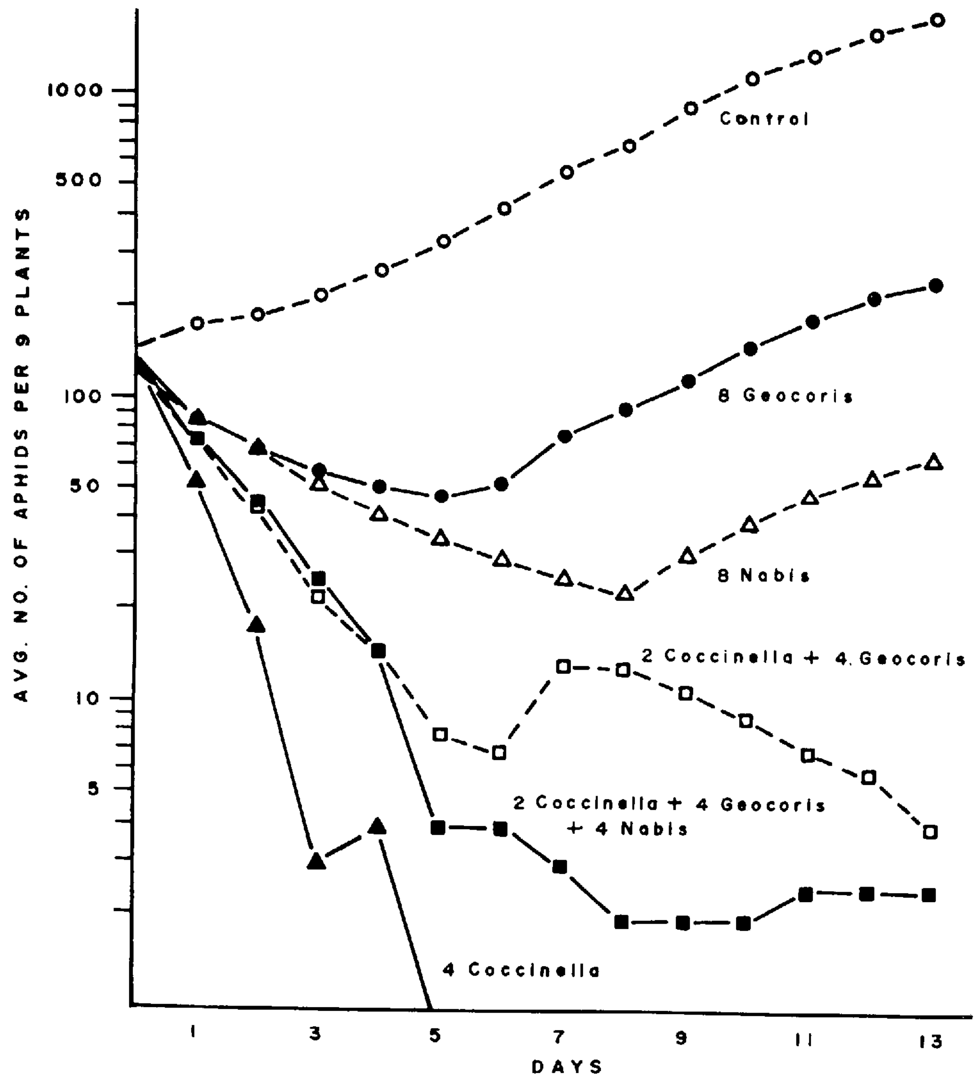

FIG. 2.—Effectiveness of 3 predators, used alone or in combination, against populations of the green peach aphid.

days compared with the control; thereafter, the numbers of aphids in that treatment were similar to the numbers in the control. With nabids alone, the rate of increase of the aphid population was again less than that of the control the 1st few days, but thereafter it was similar, although the total numbers were different. Thus, with either nabids or geocorids alone, an average of less than 1 predator/plant was not sufficient to reduce a population of aphids that was initially 34/plant; in the previous tests, the same treatments did suppress populations that started at 14 aphids/plant. Thus, failure of the geocorids and nabids did not occur primarily because an alternate prey was present; it probably occurred as a result of the high initial population of aphids that had a rate of growth beyond the suppressive capacity of the nabids and geocorids.

The zebra caterpillar larvae confined in the cages with the green peach aphids were, of course, exposed to the same predators. After 2 days the populations of larvae exposed to geocorids alone were slightly reduced but were not significantly different from the populations in the control cages where no mortality occurred (Fig. 4). At that time, all other treatments had reduced the initial population of larvae 56–79%; however, after this 1st mortality, the rate of predation decreased considerably, and after 9 days, the population was reduced 72–94%. This gradual reduction in the rate of predation of zebra caterpillars can be attributed to the great increase in the size of the caterpillars which probably provided them with some immunity from attack. Nabids used alone or in combination with other predators were usually more effective than treatment with coccinellids alone or with coccinellids + geocorids in suppressing populations of zebra caterpillars.

Prey: M. configurata

In the 3rd test, the bertha armyworm was exposed to the same treatments used previously, but no aphids or zebra caterpillars were present as alternate food sources. By 3 days after the introduction of the predators, the treatments had produced different degrees of reduction in the prey population but were not significantly different in effectiveness ($P = 0.05$) (Fig. 5). After 6 days, both treatments containing nabids had suppressed populations more than all other treatments, and 3 other treatments did not differ significantly in effectiveness. After 10 days, treatments containing nabids had caused the greatest percentage reduction in populations but treatments containing coccinellids and geocorids were statistically similar in effectiveness to the treatment containing all 3 predators, and no significant differences existed between treatments with coccinellids alone, geocorids alone, or the control. The poor performance of the treatment containing coccinellids only, compared with the good control obtained with coccinellids against the zebra caterpillar, was probably the result of differences in behavior of the 2 prey species: early instars of bertha armyworm are much quicker and more active than those of the zebra caterpillar.

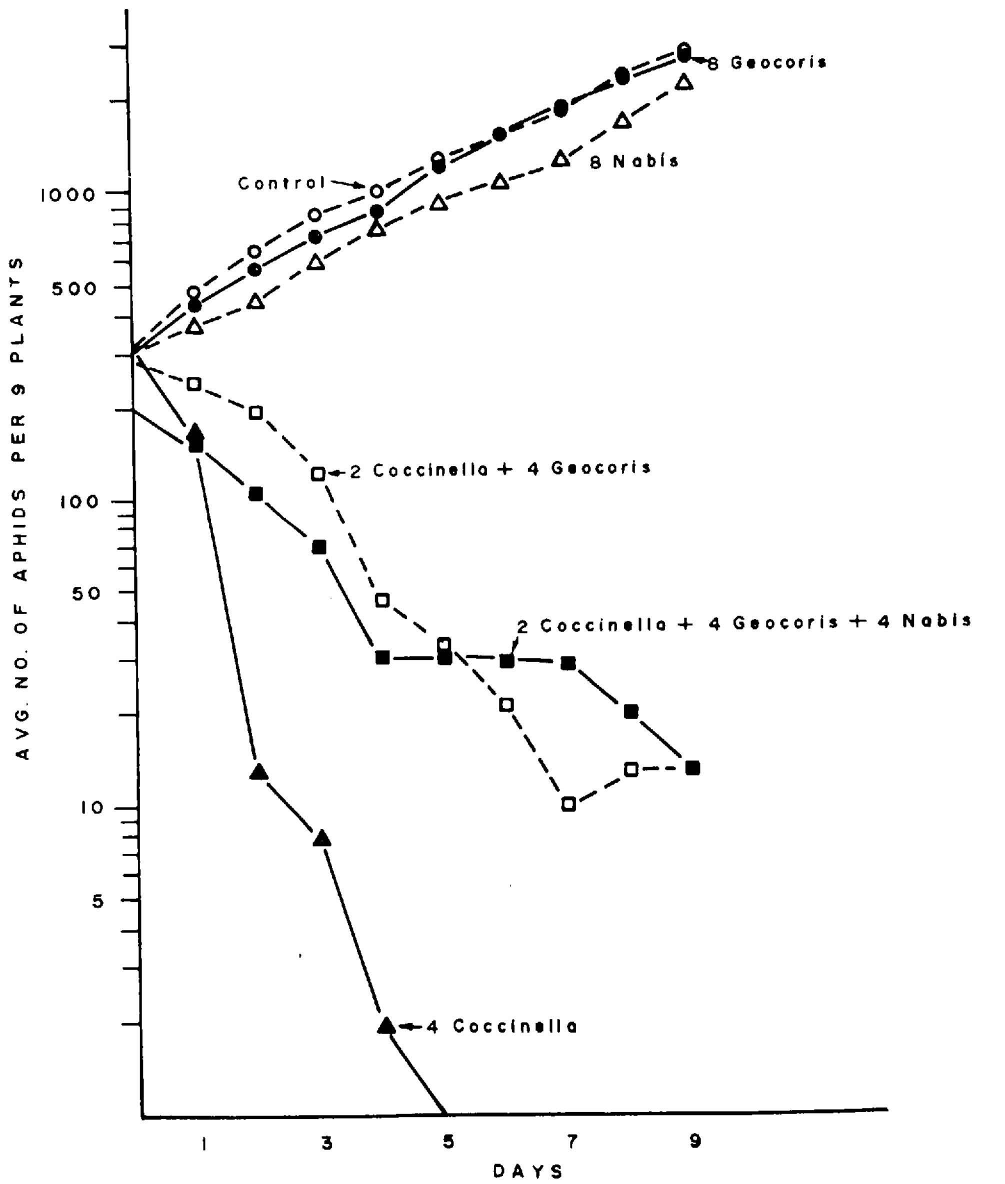

FIG. 3.—Effectiveness of 3 predators, used alone or in combination, against populations of the green peach aphid when another prey species, the zebra caterpillar, was present.

Discussion

In our enclosed system, treatments containing coccinellids which are voracious feeders, suppressed the populations of aphids more than other treatments which contained twice as many geocorids and/or nabids. However, geocorids or nabids reduced populations of aphids when the starting populations were low (14 aphids/plant), although they were able only to slow the rate of increase (compared with the control) when the starting populations were high (34/plant).

Nabids are reported to consume 4–23 aphids/day (Hendrick 1967[7]); healthy adult *C. transversoguttata* have been observed to consume 200 aphids/day (Palmer 1914); and we estimate that geocorids consume 2–10 aphids/day. Thus, at high densities of aphids, coccinellids would be the primary suppressing agent, but at low densities, the normally aphidophagous coccinellids would be less effective, because the limited amount of food would probably cause them to emigrate to find a larger supply. Conversely,

[7] R. D. Hendrick. 1967. Field and laboratory studies on the ecology and morphology of *Nabis americoferus* Carayon and its parasites in California. Ph.D. thesis, University of California, Riverside. 151 p.

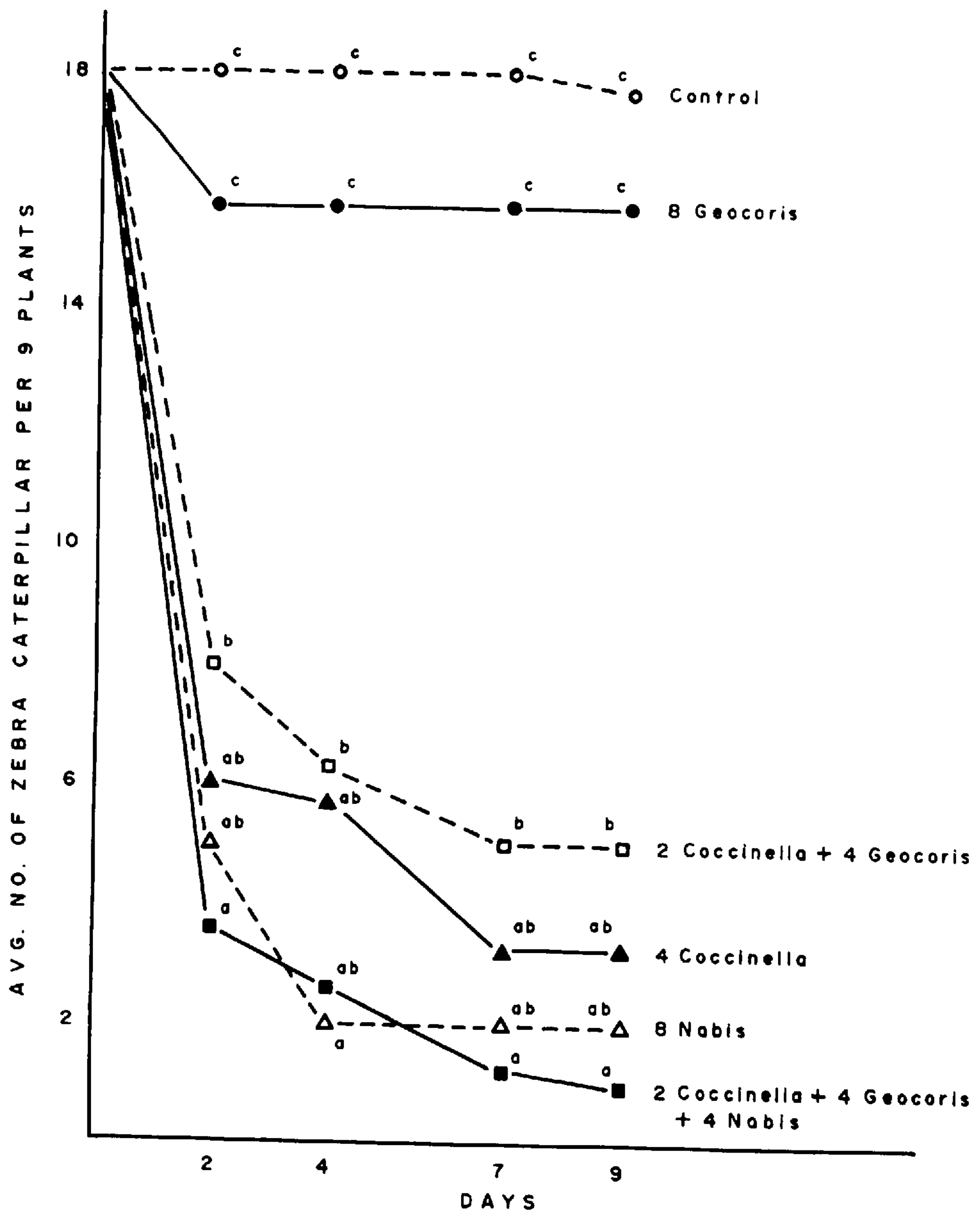

FIG. 4.—Effectiveness of 3 predators, used alone or in combination, against populations of the zebra caterpillar when another prey species, the green peach aphid, was present. Means for 1 date followed by the same letter do not differ significantly at the 5% level of error.

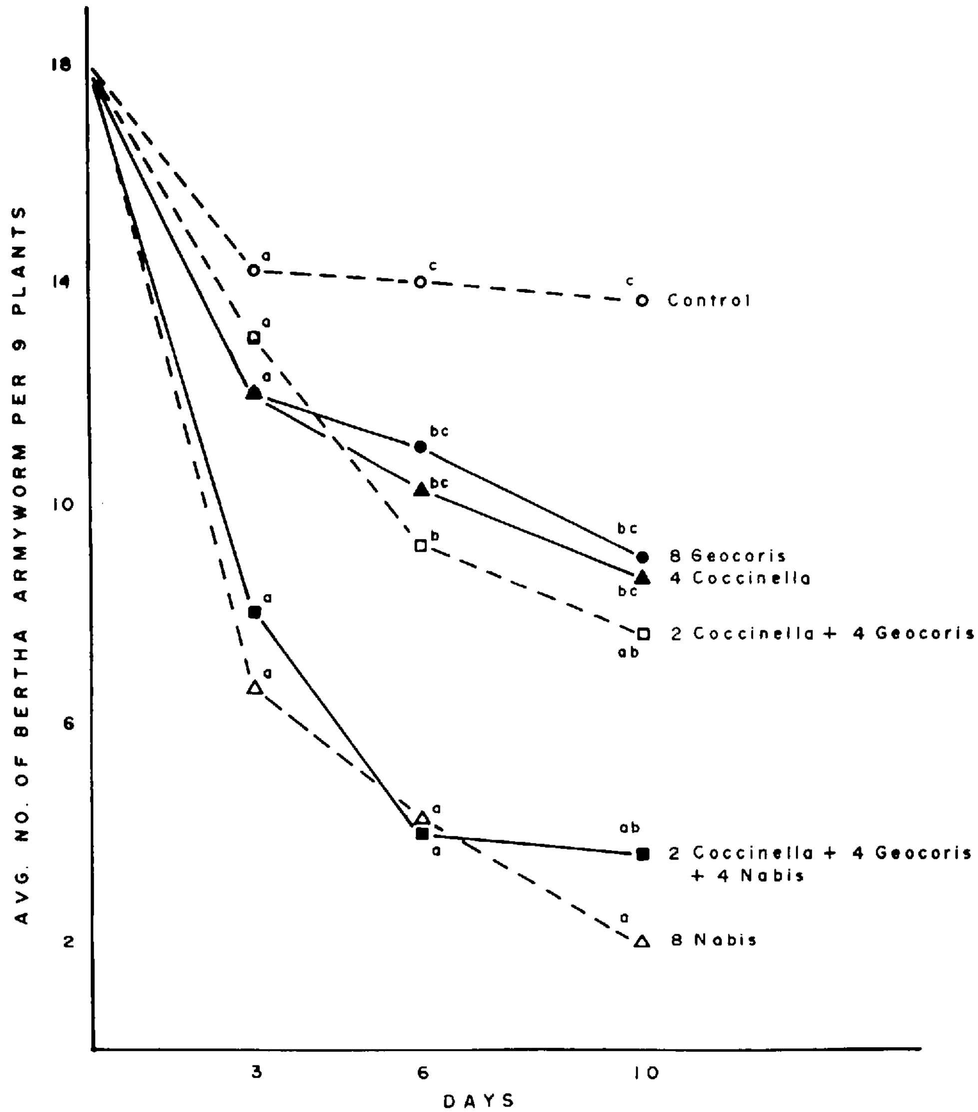

FIG. 5.—Effectiveness of 3 predators, used alone or in combination, against populations of the bertha armyworm. Means for 1 date followed by the same letter do not differ significantly at the 5% level of error.

at low densities, more omnivorous predators, such as geocorids and nabids, would probably be more effective than the coccinellids because they can sustain themselves on fewer prey.

In the test with a mixture of prey (the zebra caterpillar and the green peach aphid), the geocorids attacked only a few caterpillars, so the presence of the caterpillars interfered only slightly with the predation of the aphids. However, at present, geocorids cannot be discounted entirely as an effective predator of Lepidoptera because its predaceous habits on eggs have not yet been investigated.

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