

*mosana*, *Metasyrphus confrater*, *M. corollae*, *Syrphus serrarius*; *S. vitripennis* Meiger, *Syrphophagus* sp. of Encyrtidae attacks *Epistrophe balteata*, *Ischiodon scutellaris*, *Syrphus serrarius*, *Paragus tibialis*, *P. serratus*; *Pachyneuron* sp. of Pteromalidae attacks *Epistrophe balteata*, *Ischiodon scutellaris*, *Syrphus serrarius*, *Sphaerophoria formosana*.

c. Parasites of aphid lion: Egg parasite, 1 sp. of Scelionidae attacks *Chrysopa boninensis*, *C. septempunctata*; pupal parasites, *Isodromus axillaris* Timb. of Encyrtidae attacks *Chrysopa boninensis*; *Lygocerus* sp. of Ceraphronidae attacks *Chrysopa boninensis* and *C. septempunctata*; *Isadelphus* sp. of Ichneumonidae attacks *Chrysopa boninensis* respectively.

#### PARASITES OF APHIDS

Aphids parasitized by Aphidiidae, Aphelinidae, before being mummified, are preyed upon by larvae and adults of coccinellids or larvae of hoverflies and aphid lions.

Aphid predators and aphid parasites exist in the same place but aphid parasites are effective and more in number. The aphid population is usually reduced by aphid parasites, but not by aphid predators, e. g. *Aphidius gifuensis* checks *Myzus persicae* of Chinese mustard in winter and *Ephedrus persicae* of citrus in spring. Aphid predators, either coccinellids or hoverflies, check aphid population below economic level very often during late spring to early summer in vegetable fields and from late autumn through to early summer in citrus groves.

#### V. Evaluation of aphid predators in citrus groves

The surveyed citrus grove was treated with 10% Azodrin WSC around the base of main trunk or bases of branches on April 30, May 5, 19, 26, June 2, 9, 18, July 8, 19-20, 29-30, August 10, 20, 30, September 18-19 and October 9, 1970 respectively.

The citrus varieties were Golden Seal, Lungchingkong and Jeffa, 3, 4 and 5 years old. 580 plants were treated and investigated. The main purpose was to control citrus leafminer, *Phyllocnistis citrella*, the aphids, *Toxoptera citricida* and *Aphis spiraeicola*, mealy bug, *Nipaecoccus filamentosus*, soft scale, *Coccus viridis*, armored scale, *Lepidosaphes gloveri*, stink bug, *Rhynchocoris humeralis* and red mite, *Panonychus citri*. The control was very good. Besides this bark treatment the same method was used with Dieldrin 1% w.p. in May, 1970 around base of trunk for the control of longicorn beetle, *Anoplophora maculata*. The absence of spraying meant there was no pesticide residue left on foliage which kill both injurious and beneficial insects.

The survey was done on November 19-20, 27-28 and December 8, 10, 1970. The new foliage was found to attract aphids and predators. The record is shown in table 13.

Table 13. Field evaluation of aphid predators in

Items observed	<i>Toxoptera citricida</i>	<i>Aphis spiraecola</i>	<i>A. gossypii</i>	<i>T. citricida</i> & <i>A. spiraecola</i>	<i>T. citricida</i> & <i>A. gossypii</i>	<i>A. spiraecola</i> & <i>A. gossypii</i>	without aphid colonies
Without predators plants	82	3	14	—	3	2	—
Presented predators plants	97	22	7	7	5	2	37
Percentage of	55	12	4	4	3	1	—
<i>Lemnia swinhoei</i>	430	97	4	2	14	6	43
<i>Scymnus</i> sp.	60	39	8	34	1	6	1
<i>Pseudaspidimerus japonensis</i>	23	8	2	1	—	1	14
<i>Leis dimidiata</i>	6	1	1	1	—	—	7
Total of coccinellids	519	145	15	38	15	13	65
<i>Epistrophe balteata</i>	136	28	1	—	4	3	10
<i>Syrphus serrarius</i>	4	1	1	—	—	—	2
<i>Asarcina aegrota</i>	39	1	2	—	—	1	1
<i>Ischiodon scutellaris</i>	—	4	—	—	—	—	1
Total of syrphids	179	34	4	—	4	4	14
<i>Eumicromus sauteri</i>	1	—	—	—	—	—	—
<i>Chrysopa septempunctata</i>	46	13	—	—	—	—	—
<i>Chrysopa boninensis</i>	3	—	—	—	—	—	—
Total of chrysopa & hemerobiids	50	13	—	—	—	—	—
Total of predators	748	192	19	38	9	17	83
Average number of predators per plant	7.56	8.73	2.71	5.43	3.80	8.50	2.14

Table 13 showed that 40, 47 and 54 days after bark treatment, there are 4 species of coccinellids, 4 species of syrphids and 3 species of Chrysopa and hemerobiid activity on the new formed foliage and these check the 3 species of aphids very well.

The highest number of predators per plant were found in *Aphis spiraecola* colonies namely 8.73. In combined *A. spiraecola* and *A. gossypii* colonies 8.50 predators were found, in *Toxoptera citricida* 7.56, in *T. citricida* and *A. spiraecola* combined colonies 3.80, in *A. gossypii* colonies 2.71 and 2.14 individuals without aphid colonies. The average number of predators was highest with high aphid populations having 34.82 individuals per plant. With medium aphid populations there were 11.94 individuals per plant and 2.52 with low aphid populations.

Within the coccinellids *Lemnia swinhoei* was the commonest accounting for 73.58% of the total, *Scymnus* sp. was next at 18.4%, followed by *Pseudaspidimerus japonensis* at 6.05% and the rarest was *Leis dimidiata*. *Epistrophe balteata* at 76.15% was the

citrus grove after bark treatment with Azodrin

total of plants	percentage of	high aphid population	median aphid population	low aphid population	predator eggs	predator larvae	predator pupae	predator adults
104	36.75							
149	63.25	11	34	97				
79		7.75	23.94	68.30				
596	73.58	258	187	108	206	206	22	162
149	18.40	29	91	28	—	118	16	15
49	6.05	4	10	21	—	4	—	45
16	1.97	2	1	6	—	—	—	16
810	72.94	293	289	163	206	328	38	238
182	76.15	75	46	51	121	32	29	—
8	3.35	2	1	3	—	6	2	—
44	18.41	12	19	12	16	25	3	—
5	2.09	—	4	—	—	5	—	—
239	21.41	89	70	66	137	68	34	—
1	1.59	1	—	—	—	1	—	—
59	93.65	—	46	13	47	12	—	—
3	4.76	—	1	2	—	3	—	—
63	5.65	1	47	15	47	16	—	—
1112	—	383	406	244	390	412	72	238
6.21	—	34.82	11.94	2.52	2.18	2.30	0.40	1.33

most common syrphid, followed by *Asarcina aegrota* at 18.41%, *Syrphus serrarius* at 3.35% and *Ischiodon scutellaris* the rarest with 2.09%. The *Chrysopa* and *Eumicromus* occurred in too low numbers for study at this time, total population was only 5.65%. On each aphid predator larvae averaged 2.30, eggs were 2.18 but this figure could be higher as *Scymnus* sp. and *Pseudaspidimerus japonensis* were very difficult to find. They are laid under aphid exuviae or along the mid-vein of the leaf. They are a pale yellowishgreen colour, which make them almost invisible.

VI. Chemo-biological control of citrus insects

*Toxoptera citricida* is toxic to a great number of aphid feeding coccinellids, (except *Lemnia swinhoei*, *L. biplagiata* and *Coelophora chinensis*) and all of the species of aphid-lions but most species of hoverfly larvae are not affected. Nevertheless, it is not as abundant as coccinellids. The parasitic wasps, Aphidiidae and Aphelinidae of *Toxoptera citricida* have not been found to be effective yet. The biological control of citrus aphids can not be successfully carried out using indigenous predators.