Ent. exp. & appl. **29** (1981) 356—362. *Ned. Entomol. Ver. Amsterdam*

SURVEY TRAPS FOR PARASITOIDS, AND COCCINELLID PREDATORS OF THE CITRUS BLACKFLY, *ALEUROCANTHUS WOGLUMI*[1]

BY

ROBERT V. DOWELL[2] and RONALD H. CHERRY[3]

Agricultural Research Center, 3205 S.W. 70 Avenue, Ft. Lauderdale, Fla. U.S.A. 33314

The attractiveness of sticky traps of eight colors for two parasitoids *Amitus hesperidum* Silvestri and *Prospaltella opulenta* Silvestri, and seven species of coccinellid predators of the citrus blackfly, *Aleurocanthus woglumi* Ashby (Homoptera: Aleyrodidae) was evaluated in insectory and field tests.

Yellow traps captured significantly more parasitoids and coccinellids than other colors tested; captures were greatest in traps placed in the lower half of citrus trees. These traps can be used to survey for and monitor the population trends of the citrus blackfly and its natural enemies.

Since the successful implementation of biological control of the citrus blackfly, *Aleurocanthus woglumi*, in Florida (Dowell *et al.*, 1979a) and Texas (Ketner & Rosier, 1978), increased emphasis has been placed on acquiring information useful in approaches to the management of this pest. Survey techniques for *A. woglumi* have been developed in groves (Hart *et al.*, 1978) and urban areas (Dowell & Cherry, 1980), and information obtained on the impact of several pesticides on predators and parasitoids of this pest (Fitzpatrick *et al.*, 1978).

Traps have been devised and used for monitoring changes in citrus blackfly numbers (Harlan *et al.*, 1979, Hart *et al.*, 1978, Dowell *et al.*, 1979b, Meyerdirk *et al.*, 1979, Fitzpatrick *et al.*, 1979) but no equivalent system exists for estimating the abundance of predators or parasitoids of this pest. This information is needed in pest management programs to monitor population levels of the pest and its natural enemies, to time insecticide sprays for maximal pest control with minimal damage to beneficial insects and to aid in the survey for citrus blackfly and its parasitoids throughout the state. Here we present the results of tests with sticky traps to survey and monitor both parasitoids and predators of the citrus blackfly.

METHODS AND MATERIALS

Laboratory tests — The response to different colors of two species of imported parasitoids of citrus blackfly, *Amitus hesperidum* and *Prospaltella opulenta*, was

[1] Fla. Agr. Exp. Stn. J. Ser. No. 2271

[2] *Current address*: Department of Food and Agriculture, IPM, 1220 N Street Room A-328, Sacramento, California. 95814, U.S.A.

[3] *Current address*: 3994 S.W. 12 Terrace, Fort Lauderdale, Florida. 33315, U.S.A.

tested in a cage placed in a screenroom between April and June, 1979. The screenroom — (6 × 8 × 4 m) contained 40—50 potted sweet orange and grapefruit plants harboring *A. woglumi* and both of the parasitoid species. For testing, five parasitoids were collected in 20 ml glass vials which were screwed into the bottom of an octagonal Plexiglass® cage, (9 × 9 × 8 cm) until the tip of the vial was flush with the cage bottom. The cage was suspended with monofilament line at the geometric center of the room. Eight colored slides (5 × 8 cm) (Table I), covered with

TABLE I

(A) Total number of A. woglumi *parasitoids caught on different colored sticky slides under screenroom conditions (April-June, 1979); (B) average number of parasitoids and coccinellids ($\bar{x}$) caught on different colored sticky traps in citrus trees, Fort Lauderdale, Florida (February-July, 1979)*

	Slide Color[1]									
	Yellow	Orange	Red	Clear	White	Black	Blue	Green	X^2	
(A)										
A. hesperidum	59	29	16	18	10	6	9	10	108.9	
P. opulenta	120	120	55	70	22	23	38	24	201.9	
	Trap Color [1]									
(B)									F	LSD
Parasitoïds	4.8	2.9	1.7	0.4	0.9	0.4	0.7	0.8	15.1	0.40
Coccinellids	23.2	10.2	2.2	2.0	3.4	1.3	1.9	2.8	56.6	1.0

(See next table for species)

[1] Federal safety yellow, orange, fire hydrant red, high gloss white, and black, national blue, and forest green; manufactured by Rustoleum Corp., Vernon Hills, Illinois, U.S.A. All standard errors equal to or less than 25% of mean.

TABLE II

Average number ($\bar{x}$) of coccinellids caught on different colored sticky traps in citrus trees, Ft. Lauderdale, Florida (February-July, 1979)

Species [1]	Yellow[2]	Orange	Red	White	Green	Blue	Black	Clear	F	LSD
Chilocornus stigma (Say).	0.6	0.3	0.3	0.3	0.2	0.2	0.1	0.1	35.6	0.1
Cycloneda sanguinea (L)	4.1	1.5	0.3	0.8	0.6	0.4	0.3	0.2	16.2	0.3
Cryptognatha cordiceps (Mshll).	0.7	0.9	0.3	0.3	0.7	0.4	0.2	0.3	2.0	—
Delphastus pallidus Lec.	1.0	0.4	0.1	0.1	0.1	0.1	0.1	0.1	27.2	0.5
Delphastus pusillus Lec.	7.9	3.5	0.7	0.8	0.7	0.5	0.3	0.4	6.9	0.1
Nephasis gorhami Lec.	9.5	3.5	0.5	1.0	0.5	0.3	0.3	0.7	21.9	0.7

[1] *Azya luteipes* Muls, was also trapped, but not in sufficient numbers to be analyzed.

[2] All standard errors equal to or less than 50% of the mean.

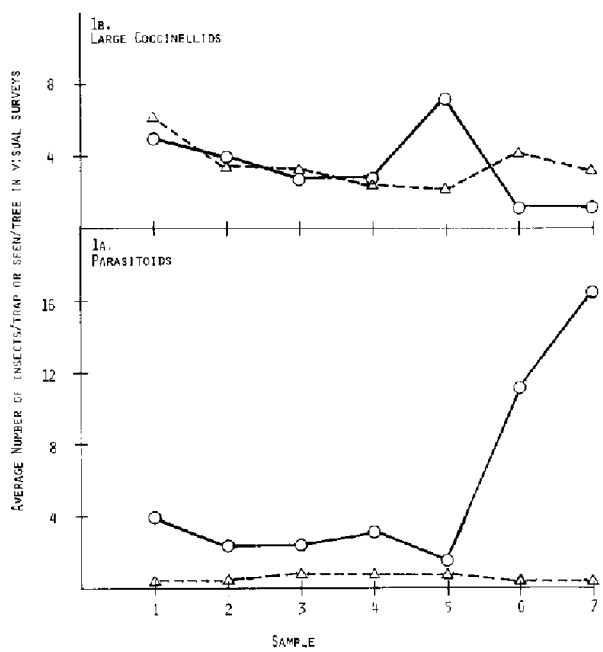
Tanglefoot® were placed along the sides of the cage. Released parasitoids left the vial and adhered to the colored slides upon impact. The position of the slides was changed after five to six releases to avoid positional bias. A total of 629 parasitoids (157 *A. hesperidum* and 472 *P. opulenta*) was tested. A χ^2 - test was used to compare the total number of each parasitoid species caught by the slides.

TABLE III

Average number ($\bar{x}$) of A. woglumi *parasitoids, and coccinellids caught per yellow sticky trap hung in different sectors of citrus trees, Ft. Lauderdale, Florida (July-October, 1979)*

	Trap Position[1]							
	Top				Bottom			
Insect	North	East	South	West	North	East	South	West
Parasitoids	4.6	1.2	2.9	2.4	14.7	9.6	24.4	9.8
	Average (all traps) top = 10.0				Average (all traps) bottom = 54.6			
Coccinellids	12.7	11.8	11.9	9.6	21.3	31.3	20.7	23.7
	Average (all traps) top = 43.1				Average (all traps) bottom = 94.7			

[1] All standard errors equal to or less than 50% of the mean.

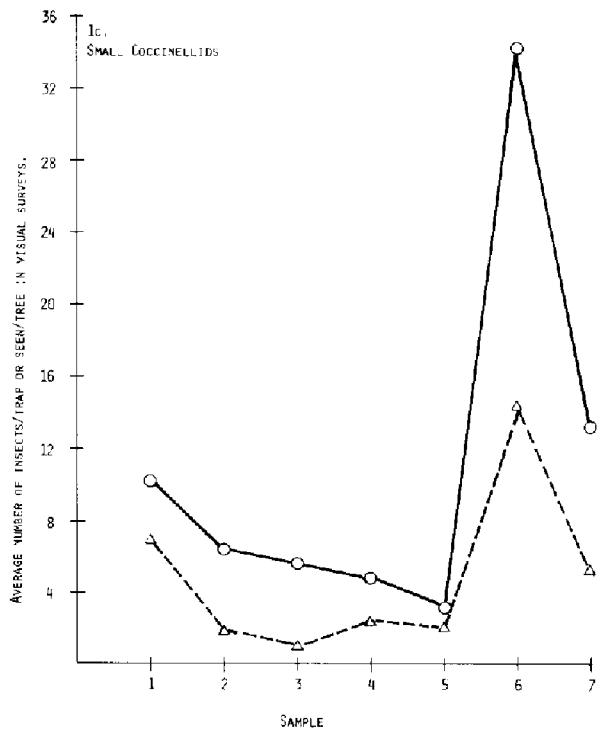


Figs. 1a—1c. Average number of parasitoids (*A. hesperidum* plus *P. opulenta*), large coccinellids (*C. stigma* plus *C. sanguinea*) and small coccinellids (*D. pallidus* plus *D. pusillus*) caught per trap compared with the average number seen per tree in visual surveys during the same sample period between April-October 1979. Open circles are trap data and triangles are visual survey data.

Field tests — Tests were conducted using colored sticky traps to compare color preferences of the parasitoids in the field with those observed in the insectory. Numbers of coccinellid species (Table II), known to feed on *A. woglumi* (Cherry &

Dowell, 1979), caught per trap were recorded in addition to the two parasitoids. Eight traps (one trap/color (Table 1)) were attached at a height of 2 m around the periphery of each of 15 citrus trees (> 4 m tall) located in residential yards in Fort Lauderdale, Fl. from February to July 1979 (six replicates). Seven traps were made from coffee can lids (Harlan *et al.*, 1979) spray-painted with the appropriate color. The eighth was a transparent plastic disc of the same size. All traps were covered with Tanglefoot®. Trap position was changed monthly among the replicates to reduce positional effects. After collection, the traps were covered with cellophane and returned to the laboratory where the number of parasitoids and coccinellids was counted. Analysis of variance was used to determine the color preference of the coccinellids and parasitoids.

The possibility that trap position influenced catch was also investigated. Only yellow traps were used as the previous test showed this to be the most effective color. Eight traps were attached on the periphery of ten citrus trees (> 4 m tall) similar to those used before. One trap was placed in each of the four cardinal compass points in the bottom and top half of each tree from July to October, 1979 (four replicates). Trap heights were 1—1.5 m and 3—3.5 m, respectively. Collection intervals and handling procedures were as previously described. A t-test was used to compare total catch between the top and bottom halves of the tree and analysis of variance used to compare the data among the quadrants.



We compared population trends obtained from the trap data with those from visual surveys for both parasitoid species and four species of coccinellids (*Chilocornus stigma* (Say), *Cycloneda sanguinea* (L.), *Delphastes pallidus* Lec., and *D. pusillus* Lec.). The visual surveys were done from April-October 1979 on seven trees in the vicinity of those harboring traps. Each sample consisted of a record by two observers examining the tree for 5 min (10 man-min) of the number of parasitoids and coccinellids seen (Fitzpatrick *et al.*, 1978, 1979). Some problems were encountered in identifying parasitoids in visual surveys.

RESULTS AND DISCUSSION

Yellow-colored slides caught significantly ($P < 0.005$) more *A. hesperidum* than the other colors tested, while yellow and orange were significantly ($P < 0.005$) more attractive to *P. opulenta* in the screenroom test. (Table I). The comparison with the clear slides indicates that parasitoids were indeed attracted to the slides rather than randomly flying into them. Yellow sticky traps caught significantly more parasitoids and coccinellids ($P < 0.005$) in the field tests (Table I). Data for both parasitoid species were pooled as very few *A. hesperidum* were trapped. Yellow was the most attractive trap color for five of the six coccinellid species tested (Table II), with the only exception being *C. cordiceps*. Too few *Azya luteipes* were captured to allow analysis (18) but yellow and orange traps caught the most insects, five each.

Yellow traps hung in the lower half of citrus trees caught significantly ($P < 0.01$) more parasitoids and coccinellids than traps hung in the upper half. There were no significant differences in catch for either parasitoids or coccinellids by quadrant (Table III). This corresponds to the distribution of *A. woglumi* (Cherry & Fitzpatrick, 1979). Because numbers of *A. hesperidum* and *P. opulenta* were low during this study, visual surveys failed to reveal more than three individuals on seven sample trees on any given day. The traps consistently performed better than this (Fig. 1a). There was good correspondence between trap and visual survey data for *C. stigma* plus *C. sanguinea*, and the *Delphastes* spp. Discrepancies, when present (samples 5 & 6 Fig. 1b and 4 Fig. 1c) stem from the differences between the two techniques-traps sampling the target population continuously while visual surveys are taken at particular times. The advantage of the traps is especially obvious in reference to the parasitoids (Fig. 1a) where, for example, the visual surveys at samples 6 and 7 failed to show significant increases in parasitoid numbers.

In conclusion, yellow traps are generally as good as, or better than visual surveys at monitoring the population trends of both parasitoid species and the four coccinellid species (Figs 1a—c). Since these yellow traps are also effective in monitoring *A. woglumi* numbers, we feel that this one trap can be used to survey and monitor citrus blackfly and its natural enemies.

We thank Steve Pastor Jr. for his technical assistance in this study.

Mention of a trademark does not imply endorsement by University of Florida.

Partly supported by Cooperative Agreement 12-14-7001-1148 between USDA and University of Florida.

RÉSUMÉ

PIÈGES POUR ÉVALUER LES POPULATIONS DE PARASITOIDES ET DE COCCINELLES PRÉDATRICES DE L'ALEURODE, ALEUROCANTHUS WOGLUMI

Nous avons évalué l'attraction de *Amitus hesperidum* Silvestri et *Prospaltella opulenta* Silvestri, parasitoïdes d'*Aleurocanthus woglumi* Ashby et de 7 espèces de Coccinellides prédatrices de cette espèce, par des pièges à glu de 8 couleurs différentes (jaune, orange, rouge, bleu, vert, noir, blanc et transparent).

Les pièges jaunes capturent significativement plus de parasitoïdes et de coccinelles que les autres couleurs; les captures sont plus importantes avec des pièges placés dans la moitié inférieure des citronniers. Ces pièges peuvent être utilisés pour suivre et contrôler l'évolution des populations d'*A. woglumi* et de ses parasitoïdes et coccinelles prédatrices.

REFERENCES

CHERRY, R. H. & DOWELL, R. V. (1979). Predators of citrus blackfly (Aleyrodidae). *Entomophaga* **24** : 385—391.

CHERRY, R. H. & FITZPATRICK, G. E. (1979). Intra-tree dispersion of citrus blackfly. *Environ. Entomol* **8** : 997—999.

DOWELL, R. V. & CHERRY, R. H. (1980). Detection of, and sampling procedures for the citrus blackfly in urban southern Florida. *Res. Pop. Ecol.* **21** : (in press).

DOWELL, R. V. FITZPATRICK, G. E. & REINERT, J. A. (1979a). Biological control of citrus blackfly in southern Florida. *Environ. Entomol.* **8** : 595—597.

DOWELL, R. V., HOWARD, F. W., CHERRY, R. H. & FITZPATRICK, G. E. (1979b). Field studies of the host plant range of the citrus blackfly, *Aleurocanthus woglumi* Ashby (Homoptera: Aleyrodidae). *Can. Entomol.* **111** : 1—6.

FITZPATRICK, G. E., CHERRY, R. H. & DOWELL, R. V. (1978). Short-term effects of three insecticides on predators and parasites of the citrus blackfly. *Environ. Entomol.* **7** : 553—555.

FITZPATRICK, G. E., CHERRY, R. H. & DOWELL, R. V. (1979). Effects of Florida citrus pest control practices on the citrus blackfly (Homoptera: Aleyrodidae) and its associated natural enemies. *Can Entomol.* **111** : 731—734.

HARLAN, D. P., HART, W., GARCIA, C. & CABALLERO, J. (1979). A yellow coffee lid trap for the citrus blackfly, *Aleurocanthus woglumi* Ashby. *Southwest Entomol.* **4** : 125—126.

HART, W., MEYERDIRK, D., SANCHEZ, M., STONE, W. & RHODE, R. (1978). Development of a trap for the citrus blackfly *Aleurocanthus woglumi* Ashby. *Southwest Entomol.* **3** : 219—225.

KETNER, C. F. & ROSIER, J. G. (1978). Citrus blackfly controlled biologically. *Tex. Agric. Prog* **2** · 19—20.

MEYERDIRK, D. E., HART, W. G. & BURNSIDE, J. (1979). Evaluation of a trap for the citrus blackfly, *Aleurocanthus woglumi* (Homoptera: Aleyrodidae). *Can. Entomol* **111** : 1127—1129.

Accepted: November 6, 1980