STATUS OF INTRODUCED LARVAL PARASITIDS OF TOMATO FRUITWORM

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SUMMARY

Microplitis croceipes (Cresson), a larval parasitoid of tomato fruitworm (*Helicoverpa armigera*) (Hubner), introduced into New Zealand to complement the recently established parasitoid *Apanteles kazak* (Telenga), was released into Gisborne, Hawkes Bay and Auckland tomato and lucerne crops in 1987 and 1988. Laboratory experiments confirmed the specificity of *M. croceipes* for tomato fruitworm (TFW). *M. croceipes* is unlikely to competitively displace *A. kazak*, which attacks smaller larvae, and normally cannot develop in TFW larvae already parasitised by *A. kazak*. *M. croceipes* was recovered from most lucerne release areas in Gisborne and Hawkes Bay and was found in tomato crops, sweet corn and soybeans. In unsprayed tomato crops in 1989 levels of parasitism by *A. kazak* were consistently high (36-99%).

INTRODUCTION

Tomato fruitworm (TFW) (*Helicoverpa armigera*) occurs on a wide range of plants in New Zealand and is a major pest on tomatoes and sweet corn. The larval stage of TFW was not parasitised in New Zealand until the introduction and establishment of *Apanteles* (= *Cotesia*) *kazak* in 1978-80 (Cameron and Valentine 1985). *A. kazak* was introduced because it was specific to TFW and attacked small larvae, usually before they moved onto flowers and fruiting parts. Cameron and Valentine (1985) showed that *A. kazak* significantly reduced the proportion of large larvae in TFW populations which resulted in a reduction in crop damage. However, in unsprayed tomatoes those TFW which escape parasitism may cause over 20% fruit damage. This prompted the importation of a second larval parasitoid, *Microplitis croceipes*. This species is the most successful and wide-ranging parasitoid specific to *Helicoverpa* and *Heliothis* species in U.S.A. (Marsh 1978). *M. croceipes* prefers host larvae slightly larger than those preferentially attacked by *A. kazak* (Hopper and King 1984).

This paper describes experiments undertaken to test the specificity of *M. croceipes* and to examine the interactions between the two parasitoids. We record the establishment and dispersal of *M. croceipes* and show seasonal patterns of parasitism for *M. croceipes* and *A. kazak* in tomato, lucerne and sweet corn crops in Gisborne, Hawkes Bay and Auckland in the 1988-89 season.

METHODS

Laboratory tests

M. croceipes was received from the USDA, Stoneville, Mississippi in eight shipments from March 1986 to February 1988, totalling 1075 cocoons. It accepted TFW as a new host and cultures were established in this species. Specificity of the parasitoid to TFW was examined by presenting adult female *M. croceipes* with larvae of six common noctuid species in a no-choice oviposition test. Noctuids tested against *M. croceipes* were TFW, *Thysanoplusia orichalcea* (soybean looper), *Mythimna separata* (cosmopolitan armyworm), *Agrotis ipsilon* (greasy cutworm), *Chrysodeixis eriosoma* (green looper) and *Diarsia intermixta*.

To determine if *M. croceipes* would develop in TFW larvae already parasitised by *A. kazak* and vice versa, we compared both parasitoids using all feasible oviposition sequence options (shown in Table 1). Each TFW larva was individually stung by both parasitoid species and then reared to determine which species succeeded in development.

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Field releases and surveys

Releases of *M. croceipes* were made between January 1987 and April 1988 in Gisborne, Hawkes Bay and Auckland. Parasitoid cocoons and parasitised TFW larvae were released into unsprayed tomato and lucerne crops. TFW populations in each release area were surveyed every 3-4 weeks from January to April in 1988 and 1989 to assess parasitism by *A. kazak* and to check for recoveries of *M. croceipes*. TFW larvae were collected from four tomato sites and four-five lucerne sites in Gisborne and Hawkes Bay, and two tomato sites and one lucerne site in Auckland. TFW larvae were collected from sweet corn crops in the Gisborne region and occasional collections were made in soybeans in Gisborne and Auckland. Larvae were reared individually on artificial diet to determine their fate.

RESULTS

Laboratory tests

In specificity tests, *M. croceipes* made no attempt to attack or oviposit in larvae other than TFW. Successful parasitism of larvae greater than 10 mm long by *A. kazak* was not common (2 out of 17) but *M. croceipes* parasitised TFW larvae as small as 4-5 mm. This defines the usual limits of competition between the two parasitoids. Competition experiments indicated that *A. kazak* is dominant in smaller larvae (4-10 mm) regardless of the sequence of parasitoid attack (Table 1). This was partly overcome by *M. croceipes* when it oviposited 1 day earlier than *A. kazak* but even when *M. croceipes* oviposited 3 days earlier, *A. kazak* still competed successfully and emerged from the majority of TFW larvae (< 10 mm). The only combination in which *M. croceipes* was clearly superior was when it had a 3 day advantage in larger hosts (>10 mm).

TABLE 1: Competition between *Apanteles kazak* (Ak) and *Microplitis croceipes* (Mc) parasitising tomato fruitworm (*Helicoverpa armigera*).

Day and sequence of exposure			Size of host at 1st exposure					
			4-5 mm		6-10 mm		11-15 mm	
Day 1	Day 2	Day 4	No. of parasitoids emerged					
			Ak	Mc	Ak	Mc	Ak	Mc
Ak, Mc			14	0	16	1	—*	
Mc, Ak			8	0	13	1	—	
Ak	Mc		13	0	12	0	2	9
Mc	Ak		10	3	12	6	—	
Ak		Mc	23	0	—		—	
Mc		Ak	10	11	12	4	0	6

* not tested

Field releases and surveys

Over 18,000 *M. croceipes* cocoons and parasitised TFW larvae were released in 1987 and 1988 in the Gisborne and Hawkes Bay regions, mainly into lucerne crops. In April 1987 small numbers were recovered from two Gisborne sites, one Hastings site and at the Pukekohe Research Station. All recoveries originated from lucerne. In 1988, recoveries in January demonstrated that *M. croceipes* had overwintered in Gisborne and Hawkes Bay. The number of recoveries also increased in 1988 particularly in Hawkes Bay. However, the number of *M. croceipes* recovered was small, totalling 8 in 1987 and 29 in 1988. The widespread occurrence of these recoveries, and the collection of most developmental stages suggested that *M. croceipes* had established, and releases were discontinued in April 1988.

Surveys early in 1989 again confirmed overwintering in Gisborne and Hawkes Bay. Table 2 shows the levels of parasitism of field-collected TFW larvae over the 1989 season. *M. croceipes* was recovered from all but one lucerne sample site in Gisborne and

TABLE 2: Levels of parasitism of field collected tomato fruitworm (*Helicoverpa armigera*) larvae in 1989. Percentage parasitism by *A. kazak* based on larvae <15mm and parasitism by *M. croceipes* based on all larvae not parasitised by *A. kazak*. Parasitism in corn based on all larvae.

Area		17-19/1		31/1-2/2		21-24/2		14-16/3		4-6/4	
Crop		No.	%	No.	%	No.	%	No.	%	No.	%
Gisborne											
lucerne (1-5 sites)	<i>M. croceipes</i>	0	—	0	—	2	20	6	12	5	12
	<i>A. kazak</i>	16	38	4	17	19	59	45	54	59	58
	Total TFW	44		25		32		92		101	
tomatoes (3-5 sites)	<i>M. croceipes</i>	0	—	3	33	0	—	1	25	2	67
	<i>A. kazak</i>	22	50	47	85	54	96	71	99	45	88
	Total TFW	45		58		56		75		52	
corn (6-14 sites)	<i>M. croceipes</i>			0	—	0	—	0	—	2	0.4
	<i>A. kazak</i>			0	—	0	—	33	18	54	10
	Total TFW			19		24		184		533	
Hastings											
lucerne (2-3 sites)	<i>M. croceipes</i>	11	31	—		15	65	64	42	41	34
	<i>A. kazak</i>	2	5	—		0	—	58	29	60	36
	Total TFW	39		0		23		213		181	
tomatoes (2-5 sites)	<i>M. croceipes</i>	0	—	0	—	0	—	2	33	0	—
	<i>A. kazak</i>	19	39	114	68	31	65	4	36	55	87
	Total TFW	50		177		57		14		63	
Auckland											
tomatoes (2 sites)	<i>M. croceipes</i>	0	—	0	—	0	—	0	—	0	—
	<i>A. kazak</i>	4	36	25	64	23	86	20	69	14	82
	Total TFW	11		44		37		29		17	

Hawkes Bay. In one large lucerne area near Hastings, rates of parasitism by *M. croceipes* varied from 58 to 100%. *M. croceipes* was recovered in small numbers from three out of ten tomato crops in Gisborne and Hawkes Bay. *M. croceipes* was also recovered from one sweet corn and one soybean crop in Gisborne. The location of all recoveries shows that *M. croceipes* had dispersed 3-5 kms from the original release areas. No *M. croceipes* were recovered from the Auckland region in 1989.

A. kazak was present in high numbers at nearly all tomato sites throughout the season. Parasitism levels were especially high at Gisborne in February through to April (Table 2). In lucerne, parasitism by *A. kazak* was generally low in January and early February and coincided with small populations of TFW. As TFW numbers increased in late February, levels of parasitism by *A. kazak* in lucerne also increased.

DISCUSSION

Our laboratory experiments confirmed that *M. croceipes* is specific to TFW in New Zealand and that *A. kazak* should remain the dominant parasitoid of small TFW larvae (<10 mm). *M. croceipes* preferred larger larvae and competed successfully with *A. kazak* only in larger hosts. *M. croceipes* should therefore complement *A. kazak* by attacking larvae which have escaped this parasitoid.

M. croceipes has overwintered twice in Gisborne and Hawkes Bay and appears to be firmly established. It is more common in lucerne, which supports the choice of this field crop as a favourable release site. This perennial crop allows *M. croceipes* to pupate in undisturbed soil. The parasitoid is now commonly reared from TFW at one large lucerne area near Hastings. It has been slow to appear in tomato crops but the dispersal and more frequent recoveries of *M. croceipes* in tomatoes in 1989 indicate establishment in this crop. Lewis and Tumlinson (1988) showed that *M. croceipes* locates host larvae

through association with chemical cues from the food of its host. Thus *M. croceipes* adults reared on lucerne-feeding TFW are attracted to lucerne. The small recoveries of *M. croceipes* in tomatoes and recently in sweet corn and soybeans suggest *M. croceipes* is still adapting to TFW feeding on these 'new' crops.

A. kazak achieved very high rates of parasitism, especially in Gisborne tomatoes in 1989. As documented by Cameron and Valentine (1985) these rates of parasitism reduce the proportion of larvae reaching damaging size. Where *A. kazak* achieves high rates of parasitism our experimental results suggest that *M. croceipes* will tend to be excluded. This is supported by preliminary field results in which *M. croceipes* has been recovered mainly from larger TFW larvae (unpublished data).

The rate of parasitism by *M. croceipes* should increase naturally over the next few years particularly on TFW in new crops. We plan to continue to assess rates of parasitism and the seasonal occurrence and interactions of both parasitoids. If parasitism leads to further reductions in crop damage, it may be possible to adjust insecticide based control programmes for TFW.

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