PARASITIZATION OF 6 LEPIDOPTERAN COTTON PESTS
BY CHELONUS BLACKBURNI [HYM. : BRACONIDAE] (1)

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When eggs of 6 species of lepidopteran cotton pests were offered to Chelonus blackburni CAMERON, all were parasitized except those of the saltmarsh caterpillar, Estigmene acrea (DRURY). However, the parasite did not distinguish between parasitized and unparasitized eggs, so superparasitization was common. Of the 5 accepted species (pink bollworm, Pectinophora gossypiella (SauNERS), cotton bollworm, Heliothis zea (BODDIE), tobacco budworm, Heliothis virescens (F.), cabbage looper, Trichoplusia ni (HÜBNER), and beet armyworm, Spodoptera exigua (HÜBNER), pink bollworms and cotton bollworms were the most suitable hosts. When all 5 species were offered, the order of preference was as follows: pink bollworms = cabbage loopers > cotton bollworms > tobacco budworms > beet armyworms. In paired preference tests the parasite consistently preferred pink bollworms.

Chelonus (Microchelonus) blackburni CAMERON, a uniparental, egg-larval parasite, was first imported from Hawaii and released as a parasite of the pink bollworm, Pectinophora gossypiella (SauNdERS) in Texas and Mexico between 1932 and 1944 (NOBLE & HUNT, 1937; Rude, 1937; MCGOUGH & NOBLE, 1955). These authors stated that parasitized larvae were collected but gave no indications as to numbers or percentage parasitized.

The parasite was imported again in 1970 by Dr. BLAIR BARTLETT of the University of California, at Riverside. We subsequently received a subculture, developed mass-rearing techniques, and made mass releases on cotton infested by P. gossypiella (BRYAN et al., 1973, 1976). The seasonal average of pink bollworms parasitized was only 8.7 % (2-25 %), even though C. blackburni deposits an average of ca. 75 eggs per ♀ per day (900 total eggs) in the laboratory (JACKSON et al., 1978). Since the ratio of parasite to pest larvae peaked at ca. 1:12, the percentage of larvae parasitized was lower than expected. The following studies were undertaken to find some of the factors that determine the effectiveness of the parasite.

PROCEDURES AND RESULTS

HOST ACCEPTANCE — The eggs of the following 6 species of lepidopteran pests of cotton were used : pink bollworm, cotton bollworm, Heliothis zea (BODDIE), tobacco budworm, H. virescens (F.), cabbage looper, Trichoplusia ni (HÜBNER), beet armyworm,

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Spodoptera exigua (Hübner), and saltmarsh caterpillar, *Estigmene acrea* (Drury). An uncounted number of eggs from laboratory cultures of each species was exposed simultaneously in a cage used for parasitization (Bryan et al., 1973) to ca. 3,000 parasites for 2 h. Samples of 100 eggs of each species were then placed in saline solution on microscope slides and gently mashed under a coverslip and inspected for the presence of parasite eggs.

Eggs of all species except saltmarsh caterpillars were parasitized. Many host eggs were parasitized numerous times, even though adjacent eggs were missed. This was true for beet armyworm eggs, which are laid in clusters, as well as for those eggs deposited singly. Since only 1 *C. blackburni* develops in a single host, superparasitism was prevalent under the conditions utilized in this test.

**HOST SUITABILITY** — To determine the suitability of the 5 accepted species (the saltmarsh caterpillar was not accepted) as hosts of *C. blackburni*, we simultaneously exposed 150 newly deposited eggs of each species to 3000 parasites in a parasitization cage. One hundred eggs from the same egg sheets were held as checks. The test was repeated 4 times with the 1st group of eggs exposed for 10 min and each succeeding group was exposed for an additional 5 min to increase superparasitization. All egg sheets were held at a temperature of 28-29°C, ca 40% R.H. and 15 h light daily. Fifty of the exposed eggs of each species were examined as described for host acceptance to determine the average number of parasites per egg for each exposure time. The other 100 eggs were allowed to hatch and the percentage of hatch was noted and compared with the percentage in the check. The neonate larvae were then placed individually into 30-ml clear plastic cups partly filled with lima bean-gelcarin diet (Patana, 1969) and allowed to develop. The cups were examined twice weekly, and the following information was recorded: 1) the number of hosts that survived to the pupal stage, signifying that either they were not parasitized or they survived parasitization; 2) the number of hosts that formed a pupation or "death" cell in the diet but did not pupate or produce a parasite; and 3) the number of parasite cocoons produced.

The results of this test are shown in table 1. The number of parasites per egg for the various host species was controlled only by exposure time and is, therefore, variable. The effects of increasing numbers of parasites per host varied with host species, and the effects on the larval stage did not always follow the same trend as for the egg stage.

A large number of parasites per host (18.4) was necessary to substantially reduce the hatch of cotton bollworm eggs, while a smaller number (9 parasites per host egg) was required for beet armyworms. In contrast, there was a general decline in hatch of cabbage looper and pink bollworm eggs as the number of parasites per egg increased. There was little difference in hatch of tobacco budworm eggs containing a range of 3.2 - 13.5 parasites.

*Chelonus blackburni* readily deposited its eggs in the eggs of all 5 host species, but there was a considerable difference in successful development of the parasite in the different hosts. Some of this difference is probably attributable to the capabilities of the various hosts to encapsulate the parasite eggs or larvae and the effects of superparasitism on this capability. This point was demonstrated most clearly when beetle armyworms were used as a host. When 1 parasite was deposited per host, 64.7% of the beetle armyworms were able to escape parasitization, but this was reduced to 12.5% when 2.7 parasites were deposited per host. Cotton bollworms were less capable of overcoming parasitization, but successful parasitization increased from 59.4% to 90.2% when the number of parasites per host increased from 1.9 to 5.8. A large proportion of exposed beetle armyworms and tobacco budworms, and to a lesser extent cabbage loopers, stopped feeding, formed cells in the diet, and eventually died without further development of