BIOLOGICAL CONTROL INVESTIGATIONS

D.E. Bryan, R.E. Fye, C.G. Jackson, R. Patana
W.C. McAda, E.G. Neemann, and R.L. Carranza

Objective: To develop parasites and predators for control of cotton pests and to integrate them into a total management system.

Summary of Progress:

Heliothis

The *Heliothis* parasite, *Palexorista laxa* (Curran), was imported from India and studied in the laboratory to determine its ability to increase in numbers. Successful development from egg to adult occurred within a temperature range of 59-90° F, but survival was only 10% at the extremes. At an optimum range of 77-86° F the female flies lived an average of 30-32 days and produced 60-70 progeny.

Pink Bollworm

Bracon gelechiae Ashmead and *B. greeni* Ashmead

Developmental rates and adult longevity and fecundity have been determined in the laboratory for both species. Both species are difficult to rear on pink bollworms: *B. gelechiae* because it has a high male:female ratio, and *B. greeni* because it develops poorly on this host (survival from egg to adult is approximately 30% as compared with 80% for *B. gelechiae*). Both were released in a small plot of cotton infested with pink bollworms, but no recovery was made. Work has been discontinued with these parasites.

Parasierola emigrata Rohwer

Studies have shown that this Bethylid is moderately good at finding and parasitizing pink bollworms that make cells in trash prior to pupation or diapause, but larvae that make cells in the soil are free from parasitism. It also parasitized larvae that form cells in open bolls in the fall.

Chelonus curvimaculatus was obtained from Ethiopia (via U.S., Riverside). Two strains were received, both egg-larval parasites. Work has just begun to evaluate these parasites for pink bollworm control.

Apanteles sp., a larval parasite, was obtained from Australia (via U.C., Riverside), but could not be cultured because it failed to mate in the laboratory.

Lygus Bugs

Peristenus stygicus Loan

This parasite has been studied extensively by the University of California (Riverside). Attempted establishment failed in California. We obtained it primarily to gain experience in rearing *Lygus* parasites.

Unidentified species

This species was collected in September of this year from an alfalfa field near Tucson. Previous collections in the year (Apr.-Aug.) yielded no parasites. It parasitizes 1st and 2nd nymphal instar *Lygus* and completes a life cycle in about three weeks. Studies on this parasite will be emphasized in the coming season.

Pupation Sites of Pink Bollworms

A study was made to determine potential pupation sites of the pink bollworm, *Pectinophora gossypiella* (Saunders), and the mortality to be expected from cultivation of irrigated cottonfields.

Tests indicate that pink bollworms tend to pupate in loose, slightly lumpy soil in which some trash has accumulated, shaded to be cool and dark (32°-37° C), and somewhat damp (less than 20% moisture). These ideal conditions, which exist in the part of the row directly beneath the plants, become even more favorable as the plant canopy closes and soil temperatures decrease, cultivation ceases, and more trash accumulates. The improved pupal survival contributes to larger, more damaging, late-season populations of pink bollworms. Pressures exerted by cultivation equipment ranged from less than 5 psi to more than 20 psi. Pressures in this range are adequate to kill from 10 to 85 percent of the pupating pink bollworms.

Cultural Control of the Pink Bollworm

On a semi-isolated ranch about 35 miles southwest of Tucson, continuing studies of pink bollworm populations have been made since 1971. In both 1971 and 1972 the grower applied six sprays for control. Although two and three, respectively, sprays were not directed toward the control of the pink bollworms specifically, the insecticides used were effective on the moths. In the fall of 1972 the grower commenced a program of early cotton crop residue destruction and followed most of his cotton with wheat. In 1973, three sprays were necessary in early September for late boll protection. In the falls of 1973 and 1974 the grower intensified his program of early crop residue destruction and followed all cotton with wheat and cotton. Thus, during the winter all the cottonfields on the ranch were tilled and irrigated thoroughly. Small areas of fallow land were also irrigated so that the entire soil surface throughout the ranch was crusted. No sprays were applied in 1974 and a single spray was applied for lygus bugs in 1975. The population data accompanying the study, coupled with prior studies of the sealing of pink bollworm moths in the soil by rainfall and irrigation, indicate that the soil seal accomplished by the tillage and irrigation for wheat and cotton successfully sealed the overwintering pink bollworms in the field. The serious infestations of 1971 and 1972 followed dry winters with insufficient rainfall to seal the pink bollworms in the soil. The data strongly suggest that early crop residue destruction followed by immediate deep tillage and subsequent rainfall or irrigation successfully lowers the overwintering populations of pink bollworms and recovery is delayed in the subsequent season. Thus, many insecticide applications can be avoided and costs reduced.

Pupation Sites of Bollworms, Tobacco Budworms, and Beet Armyworms

A study was made to determine the potential pupation sites of the bollworm, *Heliothis zea* (Boddie); tobacco budworm, *H. virescens* (F.); and beet armyworm, *Spodoptera exigua* (Hbn.). When offered a choice of dry, moist, wet, and very wet soils bollworm prepupae demonstrated no preference. The tobacco budworm prepupae showed a slight preference for wet, but not very wet soils; and the beet armyworm prepupae preferred the moist soil, and avoided the very wet soil. When given a choice of sifted soil, sifted soil with small clods, large clods of soil, and cracks in dry, irrigated soil, the bollworms had no preference. The tobacco budworms showed a slight tendency to avoid the large clods, and the beet armyworms demonstrated a preference for cloddy or cracked soil and virtually ignored the sifted soil. Thus, the bollworms demonstrated no particular preferences, the tobacco budworms showed a slight preference for wet soil without clods, and the beet armyworms preferred a cloddy, dry to wet soil. Generally, the beet armyworms attached themselves to the sides of the clods, a tendency demonstrated throughout the experimentation. When given a choice of soil temperatures in which to pupate, the prepupae of all three species generally selected the temperatures below 38° C. The potential mortality due to cultivation was also studied. When buried from one to six inches, bollworm moths emerged in declining numbers as the burial was deeper, and larger numbers of the moths were deformed. There was no difference in the emergence from clay and sandy loams. The emergence trend from buried tobacco budworm pupae was similar to the bollworms, but mortality of beet armyworms from beet armyworm pupae buried six inches was considerably greater than the mortality of the bollworms and the budworms. When bollworm and tobacco budworm pupae were placed in artificial pupation cells the emergence was greater than from pupae buried four and six inches without being placed in the cells. Greater numbers of deformed moths emerged from the naked pupae. Emergence of bollworms and tobacco budworms from pupae in soil that was irrigated was considerably lower than in soils that were not irrigated due to sealing of the emergence tunnels. The irrigation caused little mortality to beet armyworm pupae due to their positions near the surface of the soil. Nearly total mortality of bollworms, tobacco budworms, and beet armyworms occurred when pressures of 1.0 pounds, 0.85 pounds, and 0.4 pounds per square inch, respectively, were applied to the naked pupae. When pressures were applied to beet armyworm pupae in their earthen cells total mortality did not occur when 1.5 psi was applied. Generally, at the higher pressures small numbers of pupae survived due to a "squirting" action when the pressure was applied. Thus, the cultural practices of cultivation and irrigation would cause severe mortality to pupae of these three species.

Development and Rearing

Laboratory cultures of bollworms, beet armyworms, pink bollworms, saltmarsh caterpillars, tobacco budworms, and cabbage loopers are maintained in the laboratory. These cultures are used for studies of parasites and predators and also for maintenance of these parasite and predator cultures in the laboratory.

Microplitis croceipes (Cresson)

During 1975, work has been done toward improving the rearing of Microplitis croceipes in the laboratory. Individual cups for rearing the parasites have not been used for about six months. Slices of diet used for rearing pink bollworms have been substituted instead. This has resulted in a lower return of parasites, approximately 30% as opposed to 65% with individual cups; but it has resulted in over a 60% decrease in the labor involved. Work is being continued to improve the efficiency of this system.

Exorista mella (Walker)

A laboratory culture of Exorista mella was increased to determine the effectiveness of this parasite of the saltmarsh caterpillar, Estigmene acrea (Drury), in a field release against the range caterpillar, Hemileuca oliviae Cockerell, in New Mexico. The parasites were reared in the laboratory on saltmarsh caterpillar larvae. To insure greater numbers of flies for release, tests were conducted to determine the effects of cold storage on the puparia. Puparia were stored in a cold box which averaged 48° F. They were left in the box for one, two, three, four, five and six-week periods. Puparia left one and two weeks in the cold box showed no difference from unrefrigerated puparia with respect to emergence, adult longevity, and progeny production. Puparia stored three weeks and over had lower emergence, shorter longevity, and over three weeks did not produce progeny. Puparia production for a five-week period from July into August averaged over 800/week and averaged 0.66 puparia per larva.

Lygus hesperus Knight

Lygus hesperus nymphs were fed on plant and insect materials to determine their effect on survival and development. Five diets were tested: (1) green beans, (2) lettuce, (3) green beans + heat-killed beet armyworms, (4) lettuce + heat-killed beet armyworms, and (5) heat-killed beet armyworms. The results showed that green beans were better than lettuce for both survival and developmental time and that the addition of beet armyworms was an improvement over both plant foods alone. Nymphs fed on beet armyworms alone developed faster than on any other diet, but survival to adults was reduced. The best diet in terms of both survival and developmental time was green beans + beet armyworms.

A study is presently under way to test the effects of the different nymphal diets on longevity and fecundity of the adults and on egg fertility. Preliminary data show that the addition of dead beet armyworms to the plant foods increases adult longevity by 10% and fecundity by 35-45%. Egg fertility appears to be the same for all diets.

MONITORING INSECT PARASITES IN A COTTON PEST MANAGEMENT PROGRAM

F.G. Werner and C.E. Mason

Objective: To develop a feasible technique for incorporating the monitoring of adult parasitic insects into a pest management program, and to provide a means of evaluating and disseminating the information.

During the first year of this project, Dr. Mason and his assistants routinely sampled the parasitic insects in cotton and in adjacent fields in the Pinal County Pest Management Program. They identified all of the parasitic insects taken in the sampling, and were able to describe the parasite situation very soon after they took the samples. However, we came to the conclusion that routine sampling was too time-consuming an activity to become part of a Pest Management program as currently practiced.