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ABSTRACT – Four parasitic insect species were tested in laboratory experimentation for adaptability to the European corn borer (ECB). *Apanteles sesamiae, Apanteles flavipes* and *Chelonus knabi* did not adapt to the ECB, *Lixophaga diatraeae* was able to survive on ECB. Three othr species, *Macrocentrus grandii, Eriborus terebrans* and *Lydella thompsoni,* all known parasites of ECB, were obtained and reared in the laboratory on ECB for propagation, release and ecological studies. Methodology for experimentation and propagation of parasites was described.

European corn borer, *Ostrinia nubilalis* (Hubner) (Lepidoptera: Pyralidae) (ECB), is one of the most important insects on corn in the United States. Many parasites have been imported and released in the past decades for biological control of this insect (Baker, *et al.* 1949). In the north central region, *Lydella thompsoni* has been established and over 20% parasitism have been recorded. For unknown reasons, it has disappeared since the mid 1960's. Currently, *Macrocentrus grandii* is considered the most prevalent, yet only at a very low level of parasitism (less than 10 percent).

Biological control has always been considered a useful tool in insect control. But situations with marginal to moderate effectiveness tended to be dismissed or overlooked. However, in the context of integrated pest management, any natural enemy has its place in the ecosystem of the pest insect, however slight its effect may be. Toward this end, we initiated a program to enrich the parasite fauna of ECB in Minnesota. We thus obtained parasites to determine their adaptability to the ECB and/or to develop methodology of mass propagation. This program is feasible because ECB are reared on artificial medium in the laboratory.

Materials for Experimental Parasitization

Four species of parasites of which the normal hosts are other than the ECB were tested for their adaptability to ECB.

1. *Apanteles sesamiae* (Hymenoptera: Braconidae). This is a parasite of the African corn borer, *Busseola fusca* Fuller. Specimens were collected by Dr. M.C. Walters of the Summer Grain Centre, Potchefstroon, Republic of South Africa at the Potchefstroon Research Station in the spring of 1977. Six consignments of parasite cocoons were shipped to the United States in April and May, 1977, in a container of special design (van Rensburg and Walters, 1977), which is a modification of the method for transport of predatory mites (Wallace and Walters, 1974). The material arrived at the Beneficial Insect Research Laboratory (BIRL), Newark, Delaware, in good condition, Wasps then emerged and were sent by BIRL to us, free of other organisms. They arrived in good condition in St. Paul.

This parasite has been sent from South Africa to Canada in 1934 by Ullyett (1935) who remarked that the parasite "gives promise of usefulness against the European corn borer." No information on the outcome of the importation is available, and our interest is to find out if indeed the parasite would survive in ECB.

2. *Lixophaga diatraeae* (Diptera: Tachinidae). This is a parasite of the sugarcane borer, *Diatraea saccharalis* (SCB). The insects were originally collected by Dr. Fred Bennet of Commonwealth Institute of Biological Control (CIBC), in Trinidad in the spring of 1976. The parasite was cultured on SCB for 14 generations at the USDA ARS Bioenvironmental Insect Control Laboratory (BICL) in Stoneville, Mississippi. The BICL sent us puparia in May and June, 1977. It is known that the parasite survives on the wax moth *Galleria mellonella L.* (Chiang, 1977), and that a parasite of ECB, *Lydella thompsoni,* also survives on *G. mellonella* (Hsiao, *et al.,* 1966). Thus, there is a likelihood that *L. diatraeae* may "jump" its host to ECB.

3. *Apanteles flavipes* (Hymenoptera: Braconidae). This is a parasite of *Chillo sp.* in India. Dr. E.G. King of BICL collected it in Florida in the fall of 1976, and cultured it on SCB. In May and June, 1977, 600 cocoons were received from BICL. Since these hosts (regular and adopted) are of the same family (Pyralidae) as ECB, especially if *L. diatraeae* would survive in ECB, there is ground to hope that *A. flavipes* might "jump" its host one more step.

4. *Chelonus knabi,* Viereck, (Hymenoptera: Braconidae). This is a parasite of the wild rice borer, *Chilo plejadellus* Zincken. It was collected by Mr. James Sargent of the Department of Entomology, Fisheries and Wildlife, University of Minnesota in Aitkin County, Minnesota, in the spring of 1977. Again, *C. plejadellus* belongs to the same family as ECB, and the parasite is well adapted to the Minnesota climate. Thus, if it survives on ECB, climate will not be a problem for establishment in the area.

Materials for Developing Mass Propagation Methodology.

Research was initiated to develop the methodology for mass propagation of three species of parasites of ECB. The ability to mass produce the parasites will enable us to make possible not only ecological studies on the parasite-host relationships, but also field releases for suppression of ECB populations.

1. *Macrocentrus grandii* (Hymenoptera: Braconidae). As mentioned earlier, this is currently the prevalent parasite in the north central region. ECB larvae were collected by Dr. Dharma Sreenivasam of the State Department of Agriculture

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in various areas in Minnesota in the fall of 1976. We received them and kept them at 25°C in the spring of 1977 and obtained parasites. Out of 51 larvae, 2 produced 27 *M. grandii* wasps. During the 1977 season, we collected ECB on the University of Minnesota Southern Experiment Station at Waseca, Minnesota, and obtained numerous wasps.

2. *Lydella thompsoni* (Diptera: Tachinidae). As mentioned earlier, this species had significant impact on ECB population prior to the mid 1960's, but has disappeared since then (Hill *et al.* 1973). Through a PL 480 program, Dr. R. J. Dysart of the USDA, ARS BIRL obtained ECB larvae from Yugoslavia. He obtained many *L. thompsoni* puparia. We were sent 590 flies for propagation work.

3. *Eriborus terebrans* (Hymenoptera: Ichneumonidae). Three local ECB larvae collected in 1976 produced three female wasps, and no attempt was made to produce offspring. But through Dr. Dysart of BIRL, we obtained 63 females and 29 males in three shipments from the Yugoslavian consignment of ECB. We also obtained more wasps from collections of ECB at Waseca in 1977.

Methods for Experimentation or for Propagation.

Parasitization was initiated in the following manners:

A. Dipterous parasites: Adult flies were kept in screen cages (1 ft. ^{3}) and supplied with sugar and dry milk in separate dishes, and water in a vial with a wick. At 25 ^{0} C and 80-90 percent R.H., *Lixophaga* females became gravid in 10-15 days and had a total longevity of 12-18 days; *Lydella* females became gravid in 2-3 weeks, and had a total longevity of 3-4 weeks. Uteri from gravid flies were dissected out and maggots removed. The latter were placed on the thoracic region of corn borer larvae, most suitably the 4th and 5th stages. The maggot then enters the host larva. The host larvae were then kept on diet and the success of parasitism was manifested by exit of mature maggots, which form puparia outside of the host.

B. Hymenopterous parasites: Adult wasps were placed in screen cages (1 ft. ^{3}) and supplied with honey or sugar water soaked in a piece of cheesecloth on top of the cage. The cage was kept at 25 ^{0} C and 80-90 percent R.H. The wasps were ready to oviposit in one to two days, and will live for two weeks.

For parasitization with *Macrocentrus* and *Eriborus, we* placed 8-10 pieces of corn stalks, cut to 1 inch or shorter in a dish (7½ inches diameter and 3 inches deep). On the pieces of corn, we placed 20-30 2nd and 3rd instar ECB larvae for one day. This was to allow the larvae to feed and to produce frass. We then placed this dish in the cage for one to two days during which time the wasps responded to the frass and oviposited. The dish was removed from the cage and the larvae were dissected out of the corn tissues. Larvae were kept in individual vials and supplied with fresh corn tissue or diet when needed. Parasite larvae emerged in about three weeks at 25 ^{0} C. A new dish with corn pieces, frass and larvae was placed in the cage for more oviposition. The process was repeated as long as wasps were alive.

For parasitization with *Apanteles,* ECB larvae were placed on a piece of cornstalk in vials for one day. Then 1-2 wasps were put in a vial with each larva. The wasps died in a few days and the larvae were removed from the corn tissues and were supplied with fresh food.

Results of Exploratory Study

As with any exploratory studies, some negative results are to be expected. As it turned out, of the four species for experimental parasitization, *Lixophaga diatraeae* adapted to the new host and none of the three Hymenoptera did. It may be concluded that the transfer of host is more readily achieved in Dipterous than in Hymenopterous parasites.

Having established *Lixophaga* on ECB, the mass propagation of this species was attempted along with the three parasites normal to ECB. Of the two Tachinids, it is interesting to note that we are having greater success with the adopted parasite Lixophaga than with the natural parasite, *Lydella*. Apparently, the conditions most suitable for *Lydella* are yet to be identified. Of the two Hymenoptera, we have greater success with *Macrocentrus,* mainly because one ECB larva yields 6-15 *Macrocentrus,* but only one *Eriborus.*

At this writing, we demonstrated a capability of propagating *Macrocentrus* and *Lixophaga* on ECB, having completed 6 generations each in large quantities. Also, we have fair success in maintaining *Eriborus,* for 5 generations but in small numbers, and *Lydella,* for 2 generations, in the laboratory. We plan to increase their numbers next spring and make systematic field studies on the dispersal, host searching, longevity and fecundity, as well as effects of environmental factors including hyperparasitism.

In the latter respect, we released a few *Lydella* in a field cage placed over corn plants with corn borers. Five *Lydella* puparia were recovered, suggesting that parasitization took place under such conditions. Two of the puparia produced 20 wasps of the family Pteromalidae. This limited experience indicated that 40 percent of *Lydella* suffered from hyperparasitism. Our further tests showed that this wasp will parasitize puparia of housefly and *Lixophaga,* and even a species of sawfly. Thus this parasite is of general occurrence and has a wide host range. Whether this hyperparasitism could have been responsible for the early disappearance of *Lydella* remains to be studied. But the effectiveness of *Lydella* undoubtedly would be proportionally reduced.

The parasites mentioned above killed the borers when the latter had reached the last instar and had done most or all of the damage to the corn plant. Thus they did not protect the crop against injury by the current pest generation. They would, however, reduce the pest population of the subsequent generation. To achieve both crop protection and population reduction, we plan to include in next year's work the egg parasite, *Trichogramma* spp. The killing of eggs would reduce the initial larval population, thus reducing plant injury. We plan to obtain *Trichogramma* from both domestic and foreign sources, just as we did with the larval parasites in the current program.

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Judging Volunteers Invited for International Fair

Associate professors Wayne Wolsey of Macalester College and Lawrence Conroy of the University of Minnesota have issued an advance call for Academy members and scientists or engineers who may wish to serve as judges of exhibits at the International Science and Engineering Fair in 1980, for which the Minnesota Academy will be local host organization.

About 250 local judges will be needed during the international fair, according to Wolsey and Conroy, who are serving as co-chairs of the judging committee. The locally-recruited volunteers will be joined by another 250 judges from other areas.

Judges may be associated with academic institutions, government or commercial laboratories, industry, or medical organizations, and should be at the Ph.D. level. Judging of competitive entries will be concentrated as much as possible within a single day during the fair, which is scheduled for May 4-10, 1980, in St. Paul. Entries are by high school and some junior high students and will include projects in the physical sciences, engineering technology, mathematics, social sciences and health fields.

Many Academy members have previously served as judges for State of Minnesota and regional science fairs and may be familiar with the procedure that involves interviews with the students as well as examination of their exhibition projects. Prospective volunteers for the international program also are welcome to serve as judges of the state and regional programs during 1979 as orientation for the larger International Fair.

Advance arrangements are emphasized because of the scope of the international program, which will bring several thousand students and teachers to St. Paul. Inquiries may be addressed at present to Conroy, Smith Hall, University of Minnesota, Minneapolis, 55455.