RECENT INTRODUCTIONS OF PARASITOIDS AGAINST *ELDANA SACCHARINA* WALKER (LEPIDOPTERA: PYRALIDAE)

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Abstract

Early attempts at the biological control of the pyralid borer *Eldana saccharina* Walker were discussed in a paper presented at the Congress of the South African Sugar Technologists' Association in 1979. Since then further introductions of both egg and larval parasitoids have been made and include: *Trichogrammatoidea eldanae* Vigianni, *Trichogramma* sp and *Telenomus applanatus* Bin & Johnson (from West Africa); *Trichogramma australicum* Girault (from Taiwan); *Telenomus* sp (from Bolivia); *Descampsina sesamiae* Mesnil (from West Africa); *Allorhogas* sp (from Central America). An account is given of procedures, and results are discussed. Brief mention is made of the release into sugarcane fields of a parasitic bethylid wasp (*Goniozus* sp) which occurs naturally in indigenous Cyperaceae.

Introduction

A programme to combat the pyralid cane borer, *Eldana saccharina* Walker, was mounted soon after the problem was recognized in 1970. It included biological control methods, for which exotic parasitoids were first introduced in 1975. Those early introductions were discussed in a previous paper (Carnegie and Leslie[7]), and included any available larval or egg parasitoids which were considered worth trying. Only one natural parasitoid of eldana was available (*Descampsina sesamiae* Mesnil) which was a tachinid fly from Ghana. Numbers were, however, restricted and no culture was established. Various other species showed some promise under laboratory conditions but, with one exception, insufficient numbers were obtained for realistic field releases to be made. The exception was the North American egg parasitoid *Trichogramma pretiosum* Riley, of which approximately 25 000 were released in the field during 1976 and 1977, but there were no signs of their becoming established.

Concurrently, sugarcane and indigenous host plants were screened for predators and parasitoids of eldana, and the scarcity of parasitoids, especially in sugarcane, soon became apparent (Conlong and Hastings[9]). However, in West Africa, both egg and larval parasitoids of eldana occur commonly on maize (Carnegie;[5] Mohyuddin and Greathead[11]), and a project was started to import and test as many parasitoids as possible from that area. Although priority was to be given to natural parasitoids of eldana, it was planned that any other parasitoid of any potential should be tested. To this end, in 1980 a biocontrol unit was established at Mount Edgecombe and a co-operative project was started with sugarcane entomologists in Ivory Coast. An entomologist from Mount Edgecombe spent 14 weeks in that country collecting parasitoid material and dispatching it to South Africa.

An outline of what has been achieved follows while more detailed accounts of laboratory rearing of eldana, alternate hosts and parasitoids, and of current release methods, are given elsewhere (Carnegie;[6] Conlong and Hastings;[9] Conlong *et al*[10]).

Procedure and results

Trichogrammatidae

The numbers of parasitoids generated within the biocontrol unit fluctuate for various reasons; for example, scavenging mites and natural parasitoids of the alternate host insect periodically contaminate the cultures, thereby reducing numbers of hosts available for parasitism and for mass release of beneficial parasitoids (Conlong *et al*[10]). For this reason, fewer egg parasitoids were released during 1984 than during 1983.

Efficacy of the parasitoids in the field is assessed in two ways (Conlong and Hastings[9]):

- systematic searches are conducted for feral eggs, which are then collected and examined for parasitism
- pieces of cane trash, on which eldana eggs have been laid in the laboratory, are positioned in the field and subsequently collected and the eggs examined for parasitism.

Trichogramma australicum Girault was first imported in 1980 from Taiwan, where it is mass reared and released, apparently successfully, against the noctuid borer *Argyroploce schistaceana* Snellen. In the laboratory at Mount Edgecombe it took readily to eggs of eldana and, although its natural host is of a different family, its affinity for sugarcane and its ability to parasitize eggs in that crop were considered to enhance its potential as a promising candidate. A second consignment was imported in 1982.

T. australicum multiplied satisfactorily in the biocontrol unit, and initial releases into cages placed over sugarcane in the field showed that the parasitoid was able to find eldana eggs. Since 1982, regular field releases have been made at the Shakaskraal field station. Whenever possible, parasitoids have been released once or twice a week, and throughout 1983 numbers each month varied from about 50 000 to over one million.

Field monitoring has shown that parasitization has occurred, especially where larger numbers have been released; but the rate has been very low and there is no reason to believe that *T. australicum* has become established.

Trichogrammatoidea eldanae Viggiani was first introduced from Ivory Coast, West Africa, in November 1980. It took readily to eggs of eldana *in vitro*, and was able to parasitize eldana eggs on cane in the field when plants were enclosed in cages.

In Ivory Coast, *T. eldanae* has been studied mainly on eggs of eldana recovered from maize (Cochereau[8]) because eggs are far easier to find on maize than on cane. It is assumed that eggs on sugarcane also are attacked.

Since may 1983, regular mass releases have been made. Initially this was done in one field at Tongaat, but from September 1983 onwards, releases were made into a second field in the Compensation area. During 1983, between 125 000 and 1,5 million parasitoids were being released per month.

As a monitoring device, pieces of cane trash on which eggs had been laid in the laboratory were used, and from these, parasitized eggs have been recovered from the field. Numbers were similar to those of *Trichogramma australicum*, and there is no evidence that *Trichogrammatoidea eldanae* has yet become established.

Trichogramma sp was an unnamed species which, in November 1980, was included unintentionally in a consignment of egg parasitoid material from Ivory Coast. It parasitized eldana eggs *in vitro* and in cages which were placed over cane plants in the field.

During the last two months of 1983, between 500 000 and 700 000 individuals were released regularly at the La Mercy field station. Releases have continued less frequently but there have been no recoveries.

Scelionidae

Telenomus applanatus Bin & Johnson, a natural egg parasitoid of eldana in West Africa, was first imported from Ivory Coast in October 1980. It was collected from eldana eggs on maize in the field and, in West Africa, was found to be easily reared on eldana as a laboratory host. Being more robust than trichogrammatids and of a more limited host range (Bin and Johnson;[4] Conlong *et al*[10]), *T. applanatus* was considered to be a promising agent for biological control.

It was propagated without difficulty in the biocontrol unit, although only eldana could be used as a host insect, for it would not reproduce on eggs of laboratory hosts such as *Phthorimaea operculella* (Zeller), *Chilo partellus* (Swinhoe), *Anagasta kuehniella* (Zell.), *Sitotroga cerealella* (Olivier) or *Galleria mellonella* L. It could not therefore be produced as copiously as could trichogrammatids.

Releases into small field cages began in July 1981, and into larger cages (3 m×4 m×2 m) the following month. Full details are recorded elsewhere (Anon;[1] Conlong and Hastings[9]) and an outline only is given below.

A copious supply of eldana eggs in the field cages was assured, partly by releasing large numbers of gravid moths into them, and partly by introducing many pieces of dry cane leaf on which eggs had been laid in the laboratory.

T. applanatus was released by hanging cards containing eggs, which had been parasitized in the laboratory, at randomly selected points within the cages which had been erected over mature sugarcane. During the period August 1981 to February 1984, approximately 12 000 parasitoids were released each week. Initially, releases into field cages were made at the Mtunzini field station. In addition, releases into the open field were regularly conducted at Mtunzini and at La Mercy, taking advantage of fields which supported large populations of eldana.

Results were carefully monitored, both by the retrieval of placed eggs and by searching for feral eggs. Parasitized eldana eggs were occasionally found, including (on rare occasions) feral eggs in the open field. However, in view of the concentrated and copious amounts of parasitoid material released, the rate of recovery was very poor, and after 30 months the project was shelved. Occasional spot checks are still made in the fields into which the parasitoids were released.

The only other scelionid tested so far was an unnamed species of *Telenomus* received from Bolivia, a natural egg parasitoid of *Diatraea rufescens* Box. In the laboratory it would not accept eggs of eldana and was therefore not tested further.

Braconidae

Allorhogas sp was introduced in February 1984 from a laboratory culture held in Trinidad. This wasp is indigenous to Mexico where it parasitizes the larvae of *Acigona loftini* (Dyar), a noctuid stalk borer of grasses. In some areas of Central America, this borer has recently become associated with sugarcane (Bennett, Cock and Diaz[3]). It parasitized eldana far more successfully in the laboratory than has any larval parasitoid yet introduced, and proved easy to rear on eldana, *C. partellus* and *G. mellonella* as laboratory hosts.

Laboratory rearing is based on the method of Bennett, Cock and Diaz[3] where plastic drinking straws were used as a substitute for grass stems. A sewing machine was used to pierce holes in 100 mm lengths of the straws, into which the host larvae (eldana, *C. partellus* or *G. mellonella*) were then placed. Sugarcane pith was extracted with a cork-borer and was used to close the ends of the plastic straw. Prepared straws were placed in 500 g plastic honey jars, into which parasitoids were introduced. Parasitoid cohorts consisted of five females and a minimum of two males, for which ten late-instar host larvae were available. The latter were attacked through the holes in the plastic straws.

Alternatively, five or six *Allorhogas* females and a minimum of two or three males were placed in a one-litre glass 'Consol' jar containing five or six short pieces of sugarcane which had been bored with a cork-borer. These were artificially 'infested' with late-instar eldana larvae, the number used corresponding with the number of female parasitoids introduced. Parasitization occurred satisfactorily. In each case, a wad of tissue paper soaked in a solution of honey and water was provided for the adult parasitoids to feed on. The ends of the cane pieces were treated with paraffin wax to prevent desiccation.

Fourteen days after being placed in the jars, the larvae were checked for parasitism. At this stage, pupation of the parasitoid offspring has occurred and this facilitates handling. If the offspring are handled before pupation, care must be taken not to dislodge the developing parasitoid larva from its host which tends to become inactivated after parasitization. Each parasitoid larva was then placed in a plastic vial and checked daily for adult emergence. Emerging adult parasitoids were used either to expand the culture or for field releases.

Each month since April 1984, approximately 1 800 females of *Allorhogas* sp have been released into a field at the Shakaskraal field station in which eldana numbers were high (88 per 100 stalks). From the third to the seventh month after releases started, encouraging recoveries were made, with a level of 9% parasitism being recorded on one occasion. This level of parasitism has, however, not been maintained or improved and this parasitoid cannot yet be considered as having become established. Subsequent host surveys in this field showed that eldana numbers decreased to 15 per 100 stalks, five months after releases began. Similar decreases were recorded in many areas in which no parasitoids had been released.

Tachinidae

Descampsina sesamiae Mesnil was first introduced from Ghana in 1975, but a satisfactory culture was never established (Carnegie and Leslie[7]). An opportunity for further importations from West Africa was offered in 1981 and a small consignment was received from Ghana in November last year. With considerable difficulty, a culture was established on *Sesamia calamistis* Hamps., to which *D. sesamiae* takes much more readily than to eldana (Conlong *et al*[10]). However, even on this host it was not possible to produce vast numbers of the tachinid, despite further importations (from Nigeria).

In November 1982, the culture was strong enough to permit small-scale field releases to be made. These were done mainly into large field cages (2 m×3 m×4 m) which were erected over mature cane in which eldana and *S. calamistis* were present. On occasions, potted maize plants, *Cyperus immensus* C.B.Cl. and *C. papyrus* L. were also placed in the cages. In addition, releases were made into smaller cages and into open fields in which high eldana populations were present. Between November 1982 and December 1984, 26 such releases were made, with numbers of gravid females varying from two to twenty on each occasion.

Surveys were conducted at appropriate periods after each release into the cage and open field, but very few recoveries were made. On only three occasions were parasitized eldana found and then only from cages. Parasitized *S. calamistis* were found on six occasions, but no recoveries were made from either species following releases in the open field. Altogether, 216 gravid females were released, which is a small number considering the effort required in the culturing.

During 1984, eldana larvae which had been parasitized were dissected and it was found that the parasitoid was being encapsulated. Recently it has been suggested that, even in West Africa, *Sesamia* spp rather than eldana, are natural hosts of *D. sesamiae* (D. J. Greathead, personal communication), and this project has now been shelved.

Indigenous parasitoids

Concurrently with the programme outlined above, a project was implemented for screening sugarcane and indigenous host plants for feral parasitoids (Carnegie[6]). Early in the programme it was realised that in South Africa, feral parasitoids were relatively scarce. Only very rarely have parasitoids been collected from sugarcane, although so far seven larval parasitoids have been collected from indigenous host plants. Egg parasitoids have never been encountered.

Goniozus sp, a bethylid larval parasitoid, was collected in March 1982 from late-instar eldana in flowering heads of *Cyperus papyrus* at Kozi Bay, and was later found to be common in coastal papyrus. It was never collected from sugarcane but was easily reared on late-instar larvae in that host plant in the laboratory (Conlong *et al*[10]).

Although it appeared not to have become adapted to parasitizing eldana in sugarcane, even in areas where cane and papyrus had been grown side by side for 50 years and more, attempts at releasing it into sugarcane were considered worthwhile.

During 1983 a mass rearing programme was started and by September of that year, numbers were sufficient to permit field releases to be started. These were done initially at Mount Edgecombe and La Mercy, first into small field cages and later into larger ones, before a programme of releases into the open field was implemented. It was apparent that *Goniozus* sp would find and attack the appropriate stage of its host, not only in field cages but in the open cane field as well. In small field cages, releases were made whenever sufficient parasitoids were available and between September 1983 and February 1984, 480 females were released. On most occasions no subsequent parasitism was recorded, but on one occasion there was a parasitism rate of 23%. Over the same period, 500 females were released into a large cage, in which parasitized individuals were recovered more frequently but the maximum rate of parasitism was 5%. Open field releases were started in November 1983 at La Mercy and during the following three months, 650 females were released but no parasitism was recorded. Between July and December 1984, similar releases were repeated at Mtunzini field station where between 1 900 and 9 000 females were released each month (a total of 35 041). Parasitism was recorded on all but one occasion with a maximum of 16%; (since only late-instar larvae are attacked, the true level of parasitism would be rather higher).

Similar tests are planned for the indigenous tachinid *Schembria* sp and for the braconid *Orgilus bifasciatus* Turner, both of which have been collected from papyrus.

Discussion

A wide range of exotic parasitoids have been tested in the laboratory against eldana and some have been mass released in sugarcane fields. The programme is continuing, but three species may be considered to have been fairly tested and to have proved disappointing. One, the trichogrammatid *Trichogramma australicum*, was being tested against an unnatural host insect, but in the same crop that is attacked by its natural host. Another, the scelionid *Telenomus applanatus* was tested against its natural host and in a crop in which it is assumed to be successful in West Africa where eldana occurs in maize and sugarcane. It is surprising that this egg parasitoid appears not to have become established, especially since it was reared exclusively on eldana eggs in the laboratory and was occasionally recovered after field releases had been made. Routine monitoring continues. The tachinid *Descampsina sesamiae* has been the subject of especial effort because it was felt that, as a natural larval parasitoid of eldana, it was a particularly promising candidate. The opinion has been expressed that the greatest hope for biological control of eldana lies in the successful introduction of an efficient larval parasitoid (Carnegie and Leslie[7]). *D. sesamiae* is one of two tachinid parasitoids which are common in West African sugarcane. (The other is *Sturmiopsis parasitica* Curran, which was less readily available. Although individuals were included in the consignments of parasitoid material received from Ghana and Nigeria there were too few to culture). Since *D. sesamiae* becomes encapsulated by the parasitized eldana host further investigations are probably not warranted. *S. parasitica* will be tested if material becomes available.

The other trichogrammatids have not yet been fairly tested in the field and their mass rearing and release continue. Because of contamination by mites (*Tyrophagus putrescentuae*) and by the natural but unwanted parasitoid *Bracon hebetor* Say, the laboratory culture of *Anagasta kuehniella* deteriorated during 1984 and the number of parasitoids released that year had to be reduced.

The immediate and successful parasitization of eldana by *Allorhogas* sp in the laboratory was encouraging, particularly when it was found that it would attack larvae in cane pieces. Under natural conditions, it attacks a noctuid stalk borer in relatively thin grasses by puncturing the stem with its ovipositor, and it was though that the thickness of a cane stem might constitute a barrier. It is disappointing that the early recoveries have not been maintained, but the insect is easy to rear and field releases will continue.

Although screening has shown that feral parasitoids of eldana in sugarcane are extremely rare, several species have been obtained from indigenous host plants. One of these, the bethylid *Goniozus* sp (from papyrus) has proved easy to rear in the laboratory, and has been released in large numbers in sugarcane. It has been argued that, if it had any potential as a biological control agent in sugarcane, it would already have followed its host from papyrus into sugarcane in those areas where the two eldana host plants have been grown side-by-side. Experimental releases have shown that this species may be self-propagating in sugarcane, and the release programme continues.

Since 1975, many candidate parasitoids have been tested against eldana and although, under laboratory conditions, some have appeared promising, in the field success has been limited. During the culture and release procedure, attention is now being given also to attempts to select strains of parasitoids with improved adaptation to local conditions.

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