

ATTEMPTS AT THE BIOLOGICAL CONTROL OF *ELDANA SACCHARINA* WALKER (LEPIDOPTERA: PYRALIDIDAE)

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Abstract

Between 1975 and 1979 in South Africa the following parasites were tested against the pyralid sugarcane borer *Eldana saccharina* Walker: *Descampsina sesamiae* Mesnil, *Sturmiopsis inferens* Towns., *Metagonistylum minense* Towns., *Paratheresia claripalpis* (Van der Wulp) (Tachinidae); *Apanteles flavipes* Cam., (Braconidae); *Trichogramma pretiosum* Riley and *Trichogrammatoidea armigera* Nagaraja (Trichogrammatidae).

M. minense and *A. flavipes* were shown to be unsuitable for this host. *T. pretiosum* was cultured successfully in the laboratory and released in the field but has not become established. *T. armigera* was cultured through three generations in the laboratory, but showed little promise, and the experience with *S. inferens* was similar. Neither *Descampsina sesamiae* nor *P. claripalpis* is considered to have been adequately tested, and further introductions are planned.

Introduction

A number of opinions have been expressed regarding the borer *Eldana saccharina* Walker as a candidate for biological control, and these have not usually been encouraging^{2, 3, 4, 5, 6}. It is known that a number of naturally occurring arthropods, especially ants, take a heavy toll of eggs and young larvae, and an investigation of the measure of control so effected in South Africa and Swaziland is the subject of a current investigatory project. However, during investigations conducted since 1970, when *Eldana* once again became a pest in Natal, no parasites have been encountered, although very many field-collected individuals of all stages have been screened. It was felt that the potential exists for a considerable measure of control to be exerted, especially in the larval stage, by an efficient parasite. For this reason a number of exotic parasites have been given preliminary testing, despite the awareness that chances of success might be poor.

The section which follows lists those insects which have been tried, together with notes on the methods used and the degree of success achieved.

Procedure and Results

Tachinidae

Four species of tachinid fly were imported by air as puparia. A standard type of small wooden box was used in which moss and moistened foam plastic provided protection from battering and from desiccation. A smear of honey solution provided food for any individuals emerging during transit.

Descampsina sesamiae Mesnil

This fly is a west African species which parasitises several lepidopterous hosts, among them *E. saccharina*. Although the latter is not a preferred host, this parasite was an attractive subject for trial because it is a natural African parasite of *E. saccharina* and has not been recorded from southern Africa. It has been recorded as a dominant parasite of sugarcane borers, and its hosts include *Sesamia calamistis*

Hamps⁷, which is common in southern African cane, although a much less serious pest than *E. saccharina*.

Three consignments were received from west Africa, totalling 105 puparia. Mortality in transit was very high and the second consignment included no survivors at all.

Adults were sexed on genitalia and on orbital patterns, and attempts to induce mating were made as recommended by Nagarkatti and Rao⁷. This consists of shaking up pairs of flies in glass vials and exposing them to bright light. No mating occurred and it was thought initially to be a result of sparse and unhealthy material, but subsequent correspondence reveals that workers in west Africa and in the USA have had similar difficulties with this species. No culture was ever established.

A change in staff in west Africa and in airways schedules precluded continuation of the project, which has been shelved. It is hoped that this suspension is temporary for the fly must surely be a promising candidate.

Sturmiopsis inferens Towns.

This species (which closely resembles *D. sesamiae*) is indigenous to India, where it has a number of hosts, including *Sesamia inferens* Walker. The Commonwealth Institute of Biological Control reared it in their Ugandan laboratories on *E. saccharina*, but the work was suspended before extensive field releases could be made⁵. The possibility of establishing it in southern Africa was considered to be worth investigating. Three consignments were imported from India, totalling 280 puparia. About 50% emerged (see Table 1).

TABLE 1
Results from three consignments of *Sturmiopsis inferens*

Item	Consignment number		
	1	2	3
No. of puparia received	79	120	81
No. emerged	43	72	26
% survival	54,5	60,0	32,1
No. of females	12	26	12
No. mated	6	4	10
No. producing maggots	3	3	3
No. <i>Eldana</i> larvae inoculated	70	43	35
Puparia from <i>Eldana</i>	11	3	1
% parasitism of <i>Eldana</i>	15,7	7,0	2,9
No. <i>Sesamia</i> larvae inoculated	52	0	36
Puparia from <i>Sesamia</i>	6	0	7
% parasitism of <i>Sesamia</i>	11,5	0	19,4

Adults were sexed as for *D. sesamiae*, and were fed on a solution of sugar or of honey. Before mating they were kept in ventilated boxes 70 mm x 90 mm x 150 mm, in which moistened foam plastic maintained a high humidity.

To induce mating one male and one female were placed together in glass vials 100 mm x 20 mm and were shaken in bright sunlight or artificial light. If mating occurred it did so within five minutes of this treatment, and it lasted for as long as 15 minutes, although more usually flies

remained coupled for only a few minutes. The most successful mating was achieved using freshly emerged females and older males.

Mated females were placed together in a box similar to the one in which they emerged. The box was examined daily, and any dead females were removed for dissection. Males were placed in a larger wooden ventilated box 300 mm³, and were retained as stock, to be used again as required.

The abdomen of gravid females were dissected in a small volume of 2% saline. Any maggots were removed and stored in distilled water at 4°C, under which conditions they would survive and remain active for 4 or 5 days. If stored at room temperature they would not live for more than two days.

Only active maggots were used for inoculating host larvæ. With a small single-haired brush two or three maggots were deposited on the host larva. Survival of maggots was best when they were placed just posterior to the head capsule. Before inoculation the host larvae were dipped briefly in a 2% solution of sodium hypochlorite as a precaution against fungal infection.

After inoculation each larva was placed individually in a petri dish and examined periodically to determine the fate of the maggots. It was found that very frequently the maggots would be removed when they were scraped against thread spun by the host larvae, or the host larva would pick the maggot off with its mandibles. If necessary the larva was re-inoculated. Once penetration by the maggot was complete the parasitised larvae were placed in closed plastic boxes (210 mm x 300 mm x 50 mm) which contained longitudinally split pieces of cane stalk. These had been sprayed with a 0,002% solution of streptomycin sulphate to reduce secondary infection. This culture was examined regularly for puparia, which were placed in small wooden emergence boxes of the sort already mentioned.

Other techniques were tried. For example, inoculated larvae were placed in small glass tubes (70 mm x 10 mm) which contained either sections of cane or a small quantity of artificial diet¹. (See also Table 2). No successes were achieved when small larvae were inoculated, and in all cases fourth or fifth instar larvae were therefore used. Results are summarised in Table 2.

TABLE 2

Techniques used when inoculating *Eldana saccharina* larvae with tachinid maggots

Technique	Remarks
Maggots placed directly on larvae	Standard
Maggots and larvae placed together in petri dish containing fresh cane and frass	No advantage
Maggots injected into larvae	No advantage
Larval pre treatment:	
(a) straight from culture medium	Standard for Tachinids
(b) from medium, but mixed with and fed on macerated cane before parasitisation	No advantage with Tachinids, but essential for <i>Apanteles flavipes</i>

Although there were high parasite mortalities some successful parasitisation did occur and a laboratory culture was maintained on *E. saccharina* for two generations before it faded. It was not possible to build up numbers to a level where field releases could be justified.

Metagonistylum minense Towns.

A trial consignment of this new world species was received from Brazil, where it is cultured and released as part of a biological control programme against the cane borer *Diatraea saccharalis* (Fabr.). Of 121 puparia received only 12 did not emerge and ten were contaminants (*Paratheresia claripalpis* (Van der Wulp)). Of the survivors 35 were females and 23 of these mated successfully and produced maggots. This species was much easier to maintain than either *Descampsia sesamiae* or *Sturmiopsis inferens*. No difficulty was encountered in inducing mating. The flies were simply placed as puparia in a cylindrical gauze cage in which a high humidity was maintained, and the emerging adults mated readily, becoming active in the presence of a normal tungsten table lamp.

Approximately 12 days after mating, or if they died before then, females were dissected and the maggots removed. An average of 295 live maggots and 94 dead maggots were produced per female. Seventy-six *Sesamia calamistis* larvae and 111 *Eldana saccharina* larvae were inoculated using active healthy maggots. Results are summarised in Table 3; and suggest that although in some cases penetration occurred and the host died, neither host was suitable for this parasite and it never developed to produce a second generation.

TABLE 3
Results of inoculating larvae with maggots of *Metagonistylum minense*

Item	<i>Eldana saccharina</i>	<i>Sesamia calamistis</i>
No. of larvae inoculated	79	62
No. died	23	15
No. died as pupae	14	8
No. adults surviving	42	39

Paratheresia claripalpis (Van der Wulp)

A trial consignment of this new world species was received from Brazil at the same time as *M. minense*. It too is a natural parasite of *Diatraea* spp. From 108 puparia received 38 adult males and 37 females were obtained. As with *M. minense* mating occurred readily and culturing promised to be a simple process. However, the culture became infected by a local fungus (tentatively identified as *Entomophthora* sp.) and failed before maggots were obtained. Why this happened is not known, because the culture received the same treatment as did *M. minense*.

BRACONIDAE

Apanteles flavipes Cam.

This small braconid wasp was introduced successfully from the orient into the West Indies against the new world pyralid cane borer, *Diatraea saccharalis*. It resembles *A. sesamiae* Cam., a common parasite of the borer *Sesamia calamistis* in South Africa. *A. flavipes* has subsequently been introduced into various South American cane-growing countries, and in some of them it plays an important role in their applied biological control programmes.

In 1978 a trial consignment of pupae was received from Brazil for laboratory testing against *E. saccharina*. Emerged wasps were released into a cage of 300 mm³. Three sides were of fine gauze and the other of clear perspex, beyond which was placed a 60 watt bench light which caused the wasps to congregate on the perspex. *E. saccharina* larvae for parasitisation were removed from laboratory culture medium and placed in split cane stalks or in macerated cane for at least 24 hours

before being exposed to the parasites. If this treatment was omitted the larvae were not attractive to the parasites. A late instar larva was then exposed to the congregating wasps which would readily oviposit in it. One female wasp would sting a larva about three times, usually just posterior to the head but sometimes on other parts of the body.

TABLE 4
Results of parasitisation by *Apanteles flavipes*

Item	Generation number							
	1	2	3	4	5	6	7	8
No. of larvae	28	64	25	25	28	22	30	14
<i>E. saccharina</i>	4	34	17	36	41	32	14	2
<i>S. calamistis</i>	1	0	0	4	13	32	34	36
<i>C. partellus</i>								
No. of larvae producing cocoons	0	0	0	0	0	0	0	0
<i>E. saccharina</i>	1	4	3	12	10	13	6	0
<i>S. calamistis</i>	1	0	0	1	4	15	11	14
<i>C. partellus</i>								

The parasitised larva was then removed and placed in a petri dish containing a block of diet medium on which it would continue feeding.

Results are summarised in Table 4, and show that although this parasite could be reared on *Sesamia calamistis* and on *Chilo partellus* (Swinh.) it would not reproduce in *E. saccharina*, although it would kill the particular larva in which oviposition occurred. Towards the end of this trial an *Apanteles sesamiae* contaminant began to confuse the results.

TRICHOGRAMMATIDAE

Although it is felt that a larval or pupal parasite stands most chance of effecting an efficient measure of control, two trichogrammatid egg parasites which became available were tested against *E. saccharina*.

Trichogramma pretiosum Riley

A strong culture of this minute North American parasite is maintained in Pretoria where it is being tested against various lepidopterous crop spoilers. In 1975 at Mount Edgecombe it was tested on eggs of *E. saccharina* in a laboratory culture. The eggs were successfully parasitised and seven generations were reared on *E. saccharina* eggs alone, before the culture faded. Between September 1976 and May 1977 approximately 25 000 *T. pretiosum* were released in the field. Two sites were used. One was on the shores of a dam at Mount Edgecombe where the wild host plant *Cyperus immensus* grows abundantly and is heavily infested with *E. saccharina*. The other site was a heavily infested cane field at Gingindhlovu.

Parasites were received as parasitised eggs of the laboratory host *Sitotroga* sp. deposited on sheets of filter paper. In the field they were released either by pinning the filter paper to the host plant with due protection from ants being provided; or else they were placed in perforated plastic petri dishes which were attached to wooden stakes. Adhesive bands around the stakes afforded protection against ants.

At the same sites recovery cohorts of *E. saccharina* eggs were distributed periodically. These eggs were laid on paper towelling which was placed on wooden stakes, sheltered from sun and rain by conical plastic light shades, and protected from other insects by plastic mosquito gauze and adhesive banding. Recent recovery cohorts have been sprinkled with scales from adult moths in case some kairomone attraction might apply. So far no recoveries have been

made and there is no evidence that *T. pretiosum* has become established.

Trichogrammatoidea armigera Nagaraja

Parasitised host eggs were received from a Pretoria culture for testing against *E. saccharina* in the laboratory. Level of parasitism was much lower than that shown by *T. pretiosum*, and the culture faded after only three generations. No field releases have been made.

Discussion

Although considerable doubt has been cast on the possibility of controlling *E. saccharina* biologically, it is encouraging that a number of parasites will attack it. Since no natural parasites have yet been recorded from either Swaziland or South Africa, there is a possibility that a successful introduction might be achieved, which might reduce the level of crop damage. It is of interest that a number of natural parasites have been recorded in other parts of Africa, and priority should perhaps be given to these. Of them so far only *Descampsina sesamiae* has been tried, and insufficient numbers were introduced for the trial to be fair or for sound assessments to be made. One of the greatest difficulties with this species is its reluctance to mate under laboratory conditions.

Difficulty with mating was also the main reason why the culture of *Sturmiopsis inferens* failed. Females need to be freshly emerged and males need to be a day or more older; so unless numbers are plentiful, ideal pairs are seldom available.

The prospects of eventual field establishment are speculative. In the parasites' favour are a mild climate, an abundance of host insects (including other lepidopterous species) and plentiful host plants. Chances are lessened by the general biology of *E. saccharina*. It is a cryptic insect, the eggs often being hidden in inaccessible places. The very active larva is an internal feeder and is protected by its spinning habit and by its ability in its later instars, to emit a repellent alkaline fluid. When pupating, it spins a cocoon, which affords further protection.

It has been demonstrated that ants take a heavy toll of *E. saccharina* eggs, and it might seem therefore that what is required is an efficient larval parasite. The efficiency of natural tachinid parasites has not been fully assessed. Their searching ability is not known, and a gestation period of 12 to 18 days would render gravid adults very vulnerable to attack by predators in the field.

The larval parasite *Apanteles flavipes*, which has achieved such successes in the new world, will kill its *E. saccharina* host, but will not reproduce in it and is most unlikely to be of any practical use in its biological control.

The egg parasite *T. pretiosum* showed some promise in the laboratory, but it has not been recovered in areas where field releases have been made. *E. saccharina* oviposition habit is cryptic, and it would require a high level of searching ability for an egg parasite to be efficient. It is doubtful whether *T. pretiosum* would be self-propagating in the field.

New world parasites are considered unlikely to show promise against *E. saccharina*, which is recorded only from Africa and surrounding islands, and *Metagonistylum minense* has proved unsuitable, as has the oriental Braconid, *Apanteles flavipes*. *Paratheresia claripalpis* will be tried again.

There remain other potential parasites to be tried. These include various species which are natural parasites of *E. saccharina* elsewhere in Africa, and others which parasitise

similar species in other continents and which might possibly adapt to our conditions.

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