Euplectrus laphygmae as a Potential Biological Control Agent in Eastern Ethiopia

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Abstract

The biology of the eulophid *Eupletctrus laphygmae* (Ferrière) was studied at Alemaya, eastern Ethiopia. Females laid 1-13 eggs on the second to fourth instar larvae of *Helicoverpa armigera*, *Plusia* spp, *Spodoptera exempta* and on an unidentified noctuid attacking *Vernonia galamensis*. The average duration of the incubation period, larval, pupal and adult stages were 2.1, 1.7, 6.2 and 4.5 days, respectively, in the laboratory. The ability to locate different hosts in different plants, ability to attack early larval instars and to produce as many as 20 generations in one season are among the useful features of *E. laphygmae* that makes it a potential candidate for biological control of lepidopterous larvae.

Introduction

In 1994, an interesting eulophid parasitoid was observed in large numbers on *Helicoverpa armigera* (Hubner) and on an unidentified noctuid (designated as 'vernonia worm') attacking *Vernonia galamensis* (Cass) Lessing in the Alemaya, the Babile and the Harar areas. The parasitoid was subsequently identified as *Euplectrus laphygmae* (Ferrière) (Hymenoptera: Eulophidae). Studies were undertaken on the biology and host range of this parasitoid with the objective of assessing its potentials as a biological control agent.

Materials and Methods

The biology of *E. laphygmae* was studied at Alemaya University of Agriculture in 1994 to 1996. Initially, field observations were made to establish host preference and the role of the parasitod on the population of its hosts. In this observation it was found that *E. laphygmae* attacked *Helicoverpa armigera*, *Plusia* spp and the vernonia worm. A large number of the vernonia worm larvae attacked by *E. laphygmae* were collected from the Alemaya, the Babile and the Harar areas. These were then maintained in the laboratory on vernonia leaves in Erlenmeyer flasks to see emergence of parasitoids and their hyperparasitods.

To study the life cycle of *E. laphygmae*, caterpillars of the vernonia worm with the parasitoid eggs were collected from *V. galamensis* and these were put in separate Erlenmeyer flasks. The caterpillars were then supplied with fresh leaves of *V. galamensis* every day until they died. Development of the eggs, larvae and pupae of *E. laphygmae* and the vernonia worm were followed in the laboratory at room temperatures of 22 ± 4°C and relative humidity of 60 ± 5%. Adult parasitoids that emerged in this study were used to assess acceptability of *H. armigera*, *Plusia* spp and the vernonia worm.

Five pairs of adult parasitoids were confined for five days to different larval instars of the three noctuids. Due to difficulty of mass-culturing in the laboratory, five field collected caterpillars of each instar of the noctuids were maintained in 250 ml Erlenmeyer flasks. *Helicoverpa armigera*, *Plusia* spp and vernonia worm larvae were supplied with fresh leaves of chickpea, sweet potato and vernonia, respectively. Only field observations were made on *Spodoptera exempta* during the armyworm outbreak season of 1996.

Results and Discussion

Euplectrus laphygmae is a gregarious ecto-parasite of may noctuids. After temporarily paralysing the host larva, *E. laphygmae* females deposited eggs singly or in clusters of two to 13 (mean 4.1±0.89) on the first three abdominal segments. Eggs were laid mostly on the second or third instar larvae and on average incubation took 2.1 days (Table 1). The gravid female appeared to select the longest larval period to ensure that incubation and larval development are completed within one stadium and none are lost during moulting (Table 2). Neser (1973) reported a similar observation in which ovipositing females of *Euplectrus* sp nr *laphygmae* did not accept the first and last instar larvae of *Plusia acuta*, as well as moulting larvae or those about to moult.

Over 60 percent of the host larvae kept along with the parasitoid did not receive eggs, but all such larvae ultimately died due to feeding by adult parasitoids. Gerling and Limon (1976) also made similar observations in which they stated that adult parasitoids feed on the host larvae and all hosts punctured by the parasitoid died, whether or not oviposition has occurred or parasitoid larvae have developed.

From the present observations it can be concluded that *E. laphygmae* is a synovigenic parasitoid showing non-concurrent oviposition with destructive feeding. Such parasitoids which feed on their hosts but do not oviposit on the same host or *vice versa* are known to significantly lower the equilibrium level of their host by high energy extraction during feeding, and lower maintenance, search and egg production costs (Kidd & Jervis 1989).

Oviposition also appeared to inhibit feeding and moulting of the host larva. This ability of *E. laphygmae* to attack and debilitate early instars of its host larvae before they inflict damage on the crop is an advantageous feature.

Eggs of *E. laphygmae* hatched into greenish apodous larvae that remain in a cluster and do not change their position until they are ready to pupate. The larval period took 1-3 days. Pupation also took place on the underside of the dead host larva in a loosely woven silken cell formed between the host remains and plants. The pupal period ranged from 5 to 7 days.

In the laboratory, almost all parasitoid larvae completed their development normally. No multiparasitism or hyperparasitism was observed in the field-collected larvae attacked by *E. laphygmae*. Parasitoid mortality during development is one of the important factors that reduces parasitoid efficiency (Waage & Hassel 1982). However, *E. laphygmae* appears to suffer little from larval mortality.

Mating took place immediately after adult emergence and adults lived for 2-10 days in the laboratory (Table 1). The male to female ration was 1:4. This predominance of females makes E. laphygmae a very good candidate in biological control.

Table 1. Duration of different life stages of *Euplectrus laphygmae* in the laboratory at Alemaya

Life stage	Days		Mean±SE
	Minimum	Maximum	
Egg	1	3	2.1±0.21
Larva	1	3	1.7±0.21
Pupa	5	7	6.2±0.20
Adult	2	10	4.5±0.69

The total life cycle was completed in 7-13 days while that of its host took 25-33 days (Table 2). Completion of the life cycle took 11.7 days in Israel (Gerling & Limon 1976) while it took 7.5 to 9 days in South Africa. *Euplectrus laphygmae* was found throughout the rainy and post-rainy seasons (July to October), but peak population was observed in August. From these observations it can be concluded that two to three generations of this parasitoid may be produced within one generation period of its host and, 10-20 generations within one season.

Table 2. Duration (in days) of different life stage of the vernonia worm in the laboratory at Alemaya

Life stage	Minimum	Maximum	Mean+SE	Variance
Egg	3	5	3.6±0.3	0.8
Larval	11	15	13.0±0.3	1.3
1st instar larva	1	2	1.8±0.1	0.2
2nd instar larva	3	5	4.2±0.2	0.5
3rd instar larva	2	3	2.6±0.1	0.3
4th instar larva	1	3	1.9±0.2	0.4
5th instar larva	2	3	2.3±0.1	0.2
Pupal	10	16	13.6±0.4	2.8
Egg to adult	25	33	30.1+0.5	4.5

The average rate of parasitism by *E. laphygmae* on the vernonia worm was 14.2% at Alemaya and 26.7% at Babile. At Alemaya the highest parasitism (32.2%) took place in September while the lowest (6.2%) was in July.

All adult *E. laphygmae* reared from larvae of *H. armigera*, *Plusia limbirina* Guenée, *Plusia orichalcea* F., *S. exempta* and the vernonia worm on different host plants (Table 3) fitted the original descriptions of *E. laphygmae* by Ferrière (1941).

Table 3. Noctuid larvae and their host plants from which *Euplectrus laphygmae* was recorded in eastern Ethiopia

Noctuid host insects	Host plants	Locality collected
Helicoverpa armigera	Chickpea, haricot bean, tomato	Alemaya
Plusia limbirina	Sweet potato	Alemaya
Plusia orichalcea	Hot pepper, potato, sweet potato	Alemaya
Spodoptera exempta	All grasses	Alemaya
Vernonia worm	*Vernonia galamensis*	Alemaya, Babile, Harar

Both in the laboratory (Table 4) and field observations *E. laphygmae* showed a distinct preference for the vernonia worm and *H. armigera* over *Plusia* spp. *Euplectrus laphygmae* was recorded from *H. armigera* on tomato in Ethiopia (Tibebu 1982) and Uganda (Nyiira 1970); from *P. acuta* in South Africa (Neser 1973); on *S. exempta* in Kenya (Graham 1961); on *Spodoptera exigua* (Hubner) in Sudan (Bashir & Venkatraman 1986); and on *S. littoralis* (Boisduval) in Egypt (Hagazi et al. 1977).

The advantage of this polyphagic nature of *E. laphygmae* is that it will be able to maintain an effective population in some hosts in the absence of others on different plants, including weeds. Its ability to locate polyphagous hosts like *H. armigera* on different plants (Table 3) is another advantage that makes it a potentially useful biological control agent. The likelihood of its switching from the intended pest species (e.g. *H. armigera*) to endemic non-pest insects (e.g. *Plusia* spp) may, however, reduce its efficiency.

Table 4. Mean percentage oviposition by *Euplectrus laphygmae* on three larval stages of three noctuid host species in the laboratory.

Host insect	Larval instar			Mean+SE
	II	III	IV	
Helicoverpa armigera	53.3	33.3	0.0	28.9+9.5
Plusia spp	53.3	40.0	0.0	31.1+8.9
Vernonia worm	80.0	46.7	20.0	48.9+10.6
Mean	62.2+10.0	40.0+9.0	6.7+7.0	

Species of *Euplectrus*, including *E. comstockii*, *E. laphygmae*, *E. platypenae* Howard and *E. puttleri* Gordh. have been successfully used in biological control programmes elsewhere (Waddil & Puttler 1989, Sinha 1982, Harten & Miranda 1985). Adults of *E. laphygmae* are known to live by feeding on their hosts (Gerling & Limon 1976). Adults are known to survive on sugar solution for as long as 30 days (Pulido Fonseca 1980). Possibilities, therefore, exist for mass culturing *E. laphygmae* on its host as well as on artificial diet to use it in biological control.

Euplectrus laphygmae was originally described from *Spodoptera exempta* (=*Laphygma exempta*). However, there is no quantitative information on this host. Studies on fecundity and development on the different hosts, including *S. exempta*, and its searching ability, host preference in free-choice and no- choice conditions must be further studied in order to exploit its potentials in biological control.

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References

Bashir MO, Venkatraman TV. 1968. Insect parasite complex of berseem armyworm *Spodoptera exigua* (Hubn.) (Lepidoptera: Noctuidae). Entomophaga 13:151-58.

Ferrière C. 1941. New species of Euplectrini (Hym, Chalcidoidea) from Europe, Africa and Asia. Bulletin of Entomological Research 32:17-48.

Gerling D, Lima D. 1976. A biological review of the genus *Euplectrus* (Hymenoptera: Eulophidae) with special emphasis on *E. laphygmae* as a parasite of *Spodoptera littoralis* (Lepidoptera: Noctuidae). Entomophaga 21:179-87.

Hagazi EM, Hammad SM, EL-Minshawy AM. 1977. Field and laboratory observations on the parasitoids of *Spodoptera littoralis* (Boisd.) (Lepidoptera: Noctuidae) in Alexandria. Zeitschrift fur Angewandte Entomologie 84:316-321.

Harten A van, Miranda AMC. 1985. Importation, rearing, release, recapture of parasites of pests in Cape Verde during the period March 1981-March 1983. Revistas Investigacáo Agrária, Centro de Etudos Agrários, A No. 1:13-25.

Kidd NAC, Jervis MA. 1989. The effect of host feeding behavior on the dynamics of parasitoid-host interactions, and the implications for biological control. Research in Population Ecology 31:211-50.

Nafus D. 1991. Biological control of *Penicillaria jocosatrix* (Lepidoptera: Noctuidae) on mango on Guam with notes on the biology of its parasitoids. Environmental Entomology 20:1725-1731.

Neser S. 1973. Biology and behavior of *Euplectrus* sp nr *laphygmae* Ferriere (Hymenoptera: Eulophidae). Entomology Memoir, Department of Agriculture Technical Service, Republic of South Africa No. 32:31.

Pulido Fonseca J. 1980. Studies on the mass-rearing of *Euplectrus*, a new species near *comstockii*, a parasite of *Anticarsia gemmatalis*. Revistas Colombiana de Entomologia 4:11-18.

Sinha AK. 1982. Integrated pest control programme in intermediate savannahs of Guyana. Caribbean Plant Protection Newsletter 1(2): (unpaginated).

Tibebu Habtewold. 1983. A contribution to the biology and management of the African bollworm, *Heliothis armigera* (Hubner) (Lepidoptera: Noctuidae) on chick pea in some middle highland localities of Shoa, Ethiopia. MSc Thesis. Addis Ababa University: Addis Ababa, Ethiopia.

Waage JK, Hassel MP. 1982. Parasitoids as biological control agents-a fundamental approach. Parasitology 84:241-68.

Waddil VH, Puttler B. 1980. *Euplectrus puttlerie* established on the velvet bean caterpillar, *Anticarsia gemmatalis*, in southern Florida. Environmental Entomology 9:781-82.