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Studies on *Sesamia Inferens* Wlk. The shoot-borer pest of Sugar-cane in Sri Lanka.
1. Life cycle and aspects of biology

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Abstract : The ecological studies on *Sesamia inferens* Wlk. as a pest of sugar-cane in Sri Lanka reveal that it prefers to lay eggs in the cane field grasses. Its collateral hosts are enumerated. The nature and scope of its damage at different stages of the host plant and the life cycle of the pest are traced. The natural enemies on the pest are recorded.

1. Introduction

Of the several species of insect pests recorded on sugar cane, the moth borers are the most serious group. *Sesamia inferens* Wlk. the shoot borer, is one of the important pests of this group in Sri Lanka. It is an oriental species occuring in Pakistan, India, South-east Asia, China, Taiwan, Philippines, Indonesia and Solomon Islands.[4]

The larva of the pest is harmful as it bores into the young cane shoots close to the ground level and causes the death of the host plant. The symptom of damage is the characteristic 'dead heart', where the central whorl dries up. The pest is also responsible for the secondary attack on millable cane stalks, causing loss of recoverable sugar.

Besides attacking sugar cane, *S. inferens* has been recorded as a serious pest of rice, maize, wheat, sorghum, kurakkan, finger millet and about 46 other graminaceous plants.[4,5]

2. Materials and Methods

The life cycle of the pest was investigated at the Sugar Cane Research Institute at Kantalai.

Out of a total of 4,250 late instar larvae collected at the field during the period August to November, 1974, about 563 were accidentally killed while examining the damaged shoots where they live. The remaining 3,687 were reared in cylindrical glass jars 10 inches tall and 8 inches in diameter, kept covered by drop-over wire mesh lids. About 25 larvae were placed in each jar containing finely pulverised sugar cane. This medium served as an ideal source of food. Around 2,825 larvae died as a result of parasitization that had already occured at the time of collection or escaped during rearings in the laboratory. The balance 862 larvae pupated over

the period. On pupation they were sorted out depending upon the sex and time of pupation. These were kept in petri-dishes. Of these 4 pupae died and about 858 emerged as adults, in a male to female ratio of 1 : 2. The emerging adults were transferred to bell jars containing grass shoots. Into each jar, one female and three to five males were introduced for mating trials. The grass shoots were examined daily to ascertain the egg laying. The eggs were laid underneath the leaf sheath. They were counted *in situ* and placed in separate bell jars to observe the incubation period.

3. Life Cycle

The adult female lays its eggs on the soil surface near the plant base[1] or in the leaf sheath of cane field grasses close to the cane plants. Details of the life cycle are furnished in Fig. I.

3.1 Egg

The eggs are laid in three to four rows or in clusters ranging from 50 to 150 at a time. A single adult female lays about 150 to 400 eggs in several egg masses. The newly emerged females when dissected have been found to contain as much as 489 eggs in their oviducts. Under laboratory conditions a larger proportion of unfertilized eggs were obtained.

The egg is creamy white in colour and semi-globular, being flattened on the dorsal surface. It is highly sculptured and measures 0.6 mm in diameter.

The incubation period shows some amount of variation during different months, and is influenced by climatic factors. This period lasts for 4 to 5 days during November (mean maximum temperature 90°F and relative humidity 96%) ; 7 to 8 days during January (mean maximum temperature 84°F and relative humidity 95%) ; 8 to 9 days during February (mean maximum temperature 80°F and relative humidity 93%).

By about the third day the eggs change to a light pinkish coloration. The developing embryo is seen on the fourth day as a pinkish streak slightly curled inside the shell. The larva with a prominent head could be made out on the sixth day. Unfertilized eggs turn dark, shrivel up and fail to develop.

3.2 Larva

Issac and Rao[2] described the larva of *S. inferens*. In laboratory rearing, the first instar larvae hatching off the eggs were counted. Each larva was placed in a two inch long grass shoot kept in a three inch specimen tube plugged with cotton wool. Several such tubes were set up depending on the number hatched. They were examined

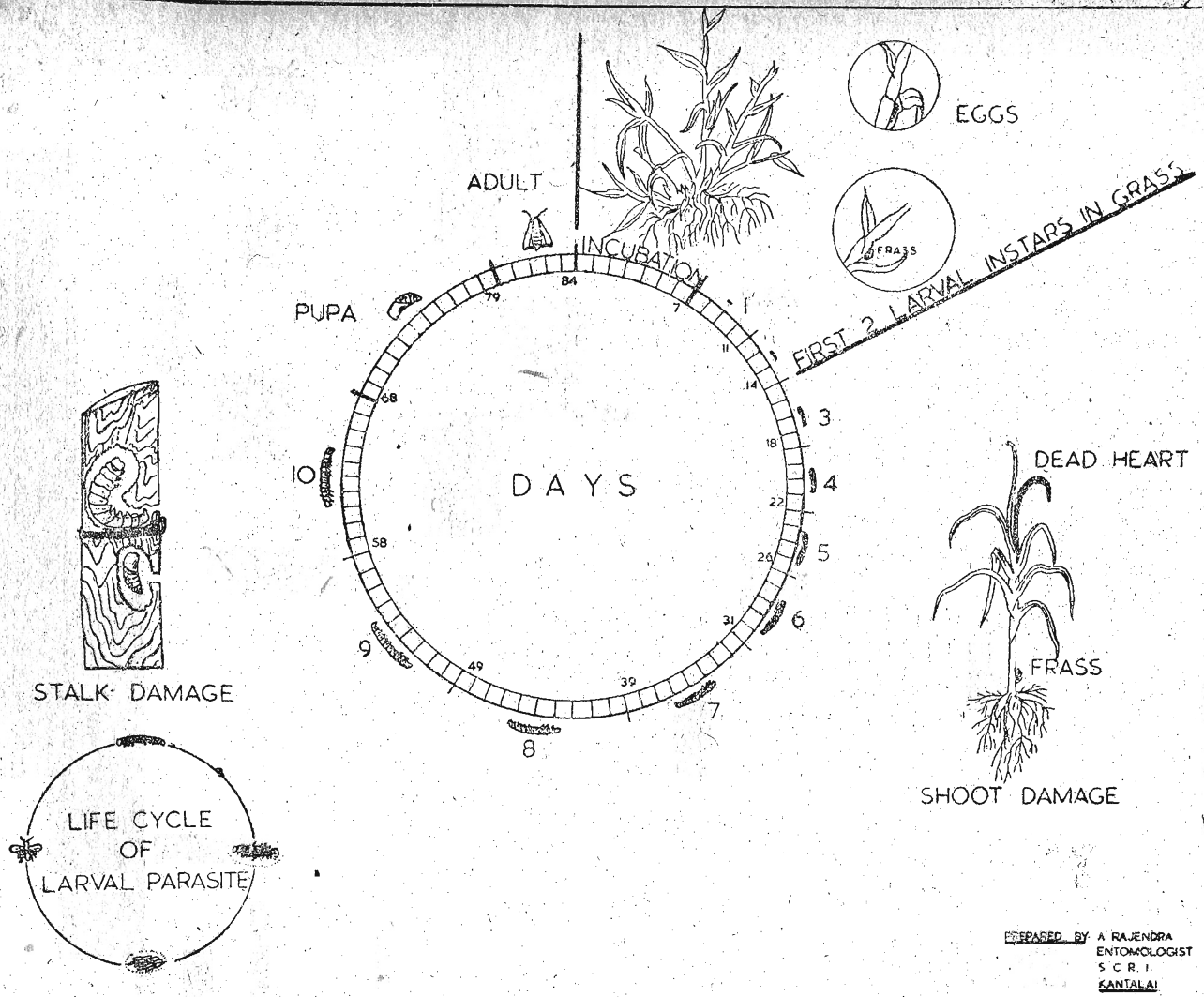

FIGURE 1. Life cycle of the shoot borer *Sesamia inferens*

daily to ascertain the duration of each instar. The fourth instar onwards were reared in pulverised cane kept in glass tubes. In this manner, the number of instars during the larval stage and the duration of each instar were recorded. (Table I).

TABLE 1—Details of Larval Development

Instar	Length of Larva mm.		Width at Broadest segment in (mm.)	Duration in days.
	Range	Average		
1	2.6 — 3.7	3.1	0.3	4
2	3.4 — 5.9	4.3	0.9	3
3	4.0 — 11.1	8.5	1.3	4
4	12.1 — 13.4	12.7	2.2	4
5	15.2 — 18.1	16.6	2.8	4
6	19.0 — 23.6	21.3	3.0	5
7	22.0 — 27.8	24.9	3.2	8
8	26.0 — 32.0	29.0	3.4	10

Jepson[3] found that the number of larval instars in *S. inferens* varied between five to eight but under local conditions some variation is recorded. Generally there are eight instars lasting 42 days but under unfavourable conditions as much as 10 instars were recorded lasting 61 days. The first four instars showed some regularity in their duration beyond which irregularity was observed.

In the cane fields, the first instar larva enters the grass shoot that is in proximity to the egg and lives within. Its presence in the grass can be easily made out by 'frass' coming out of the aperture made on entry. Should the grass shoot die, the larva abandons it and attacks fresh ones in the neighbourhood. Entry into cane takes place by about the third instar.

The size of the larva varies according to the season and availability of food. The first instar larva measures 2.6 mm to 3.7 mm in length. The final instar larva measures about 26 to 32 mm in length, is pinkish in colour and is popularly known as the Pink borer. (Fig. 2).

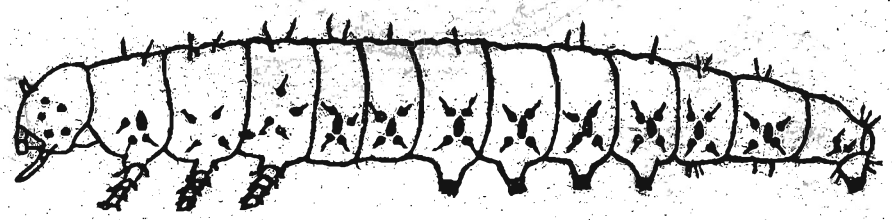

FIGURE 2. Larva of *Sesamia inferens*

3.3. Pupa

The pupa is brownish in colour and measures 15 mm to 17 mm (Fig. 3). The sex of the borer can easily be distinguished during this stage. Males are smaller with tapering abdomens and carry two small 'bumps' in front of the genitalia, while the females are larger with broad abdomens and devoid of any markings. Pupation is noted to take place in the leaf sheath from where adults emerge. The pupal stage lasts from 9 to 11 days, the norm being 11 days. No hibernation is recorded locally.

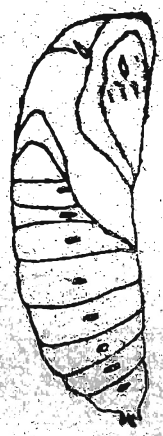

FIGURE 3. Pupa of *Sesamia inferens*

3.4 Adult

The adult (Fig. 4) is nocturnal in habit. It is brownish with wings off-white in colour. The female measures 14 mm to 16 mm in length with a wingspan of 28 mm, while the male is about 13 mm in length, has a tapering abdomen and wingspan of 25 mm. The sexes can thus be separated easily. The adults live for five to seven days, the norm being five days.

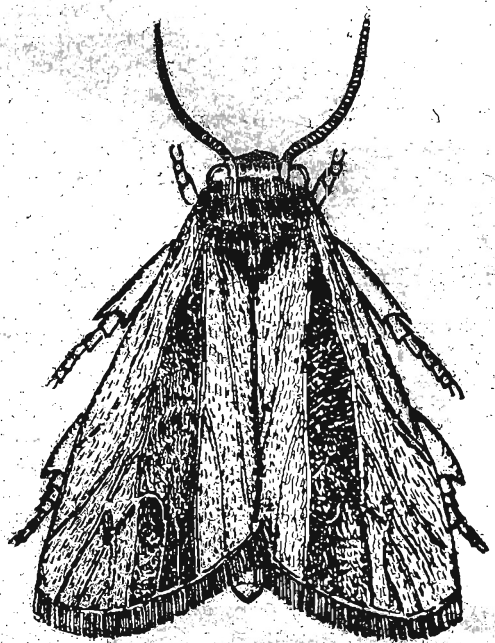

FIGURE 4. *Sesamia Inferens*

3.5 Emergence and Dispersion

The pupa which takes 9 to 11 days before adult emergence was closely watched every hour from the ninth day onwards. The pattern of emergence was studied from 626 pupae over a period of 100 days between 6th September and 12th December, 1974. Over 79% of the pupae emerged as adults after nightfall (between 7 p.m. and 6 a.m.). Although it was also noted to take place during daylight hours, most of the adults that emerged during this period showed deformed wings, were incapable of flight and died within a few hours. A peak of over 47% emergence took place between 8 p.m. and 12 midnight. About 17% emerged before this peak period between 4 p.m. and 8 p.m., and about 26% emerged after the peak period between 12 midnight and 6 a.m. (Fig. 5).

On emergence from the puparium, the adults are with rudimentary wings. The wing development is observed to take place in two stages. The first is the growth stage. Data obtained from 560 observations reveal that it takes about 16 minutes for the wings to grow from the wing buds (range : 5 minutes to 28 minutes) and is held in an upright position which is the second stage for a further period of about 13 minutes (range : 7 minutes to 25 minutes), before it is folded over the body to assume the characteristic position common to moths.

On completion of the wing development which takes about 30 minutes, the moth takes to its wings and disperses within the grasses in the boundary and the headlands of the neighbouring cane area, or, if the crop is mature, seeks grassy patches within. *S. inferens* females are capable of ovipositing immediately after dispersion. The egg-laying is noticed to take place in these grass associations from where the cycle is repeated. *S. inferens* is found throughout the year completing its cycle in about 65 days (8 instars) to 84 days (10 instars). Sugar cane is planted during the period March to August at Kantalai and the shoot stage of cane is available for the pest over a long period. The first brood occurs during May and June. The generations overlap one another. There are about four to five broods per year.

4. Host Plants

Though regarded primarily as a cane pest, *S. inferens* finds more congenial conditions for its egg laying in cane field weeds, where it spends the first two larval instars before attacking cane.

About 9 species of local cane field grasses are recorded as collateral hosts of the shoot borer. They include species such as *Eragrostis diplachnoides* steud., *Panicum repens* L., *Cyperus compressus* L., *Cyperus iria* L., *Digitaria ascendens* H.B.K. *Amaranthus viridis* L., *Echinochloa colonum* Link., *Brachiaria mutica* Stapf. and *Brachiaria distachya* Stapf.

5. Nature of Damage

S. inferens passes its early larval instars in cane field grasses before attacking cane. Damage to sugar cane takes place during the shoot and stalk stages.

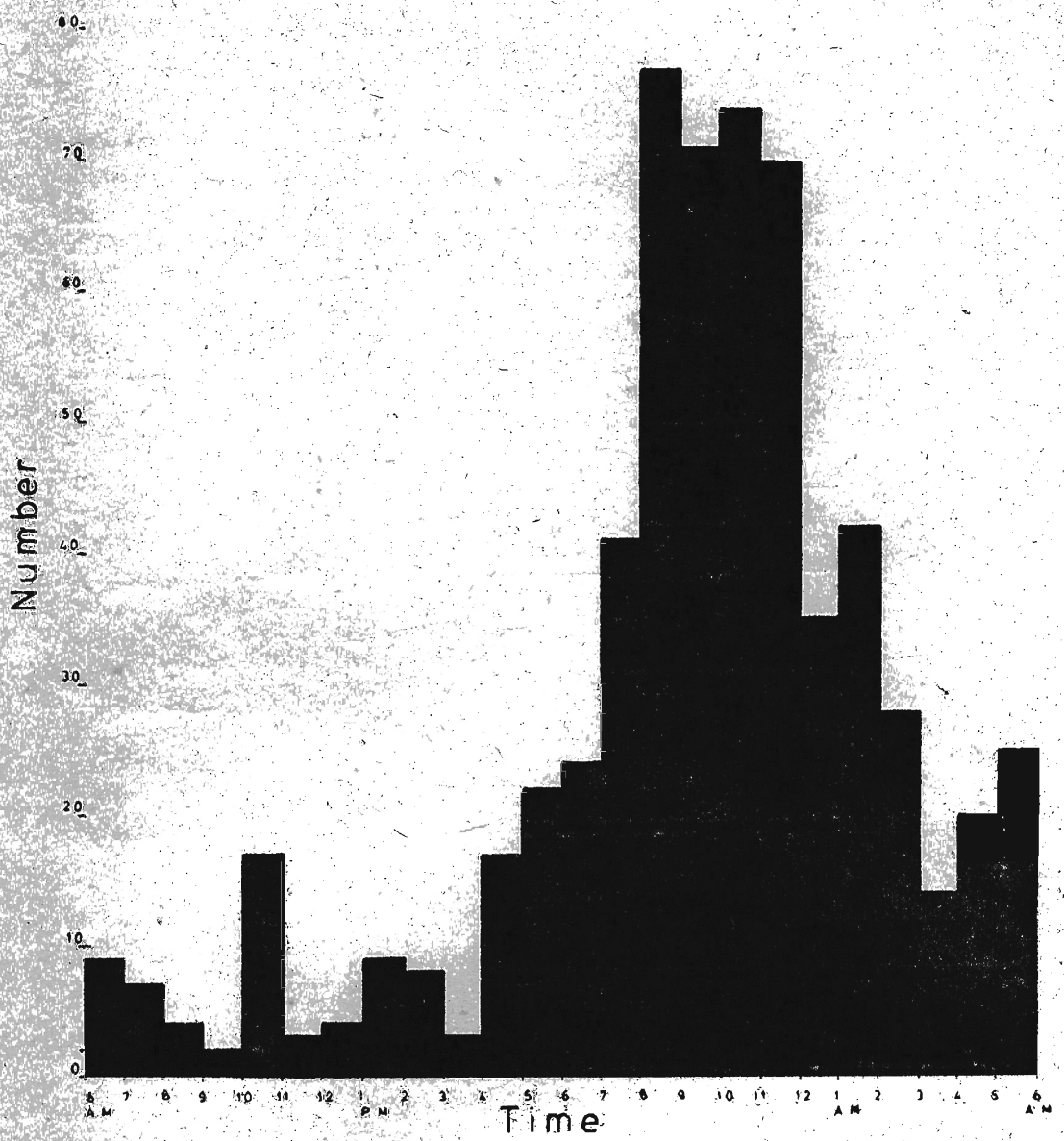

Fig.5. Sesamia inferens adult emergence

5.1 Shoot damage

Entry into the shoot stage of cane takes place by making a tiny hole in the lower portion of the shoot. It eats up the inner tissues of the plant and the 'frass' passes out through the aperture made on entry. This causes the central whorl of the shoot to dry up into what is known as the 'dead heart'.

A 'dead heart' is invariably the result of the damage by a single larva. When the shoot dies before the completion of the larval period, the larva abandons it to attack new shoots. Investigations carried out daily over a period of 3 years from 1968 to 1971 by sampling a standard unit of 100 damaged shoots or stalks reveal peaks of infestation in the field depending upon the age of crop. Table 2 depicts the shoot damage at 4 months recorded in December 1969 wherein about 25% of the borer damaged shoots were found to contain live borers, from which it could be concluded that at least four young plants may be damaged by a single larva.

TABLE 2—Percentage Borers in Damaged Shoots and Stalks

Date	Shoots December 1969 (Age 4 months)	Stalks March 1970 (Age 7 months)
1	—	7
2	31	—
3	—	—
4	27	4
5	23	4
6	19	3
7	10	—
8	—	—
9	—	5
10	9	4
11	12	5
12	22	10
13	24	9
14	23	7
15	21	—
16	0	4
17	22	10
18	23	7
19	19	5
20	17	4
21	34	2
22	29	—
23	—	7
24	19	9
25	—	6
26	34	7
27	27	—
28	30	10
29	41	—
30	—	—
31	31	4
Average	24.08%	5.8%

5.2 Stalk damage

S. inferens is primarily a shoot borer but when the pest gets established in the young crop, the subsequent generations that breed in the neighbouring grasses feed on mature stalks. This may be regarded as a secondary damage. The larva causes damage to about two to four nodes per stalk eating up the inner tissues, which results in galleries ranging from one to four inches in length. In mature cane, about 6% to 10% of the damaged stalks contained borers in them so that a single borer may be responsible for the damage of 10 to 16 stalks. Table 2 reveals the number of borers expressed as a percentage of the damaged stalks as recorded in a seven month old crop in March 1970.

6. Natural Enemies

A few species of insects parasitic on the shoot borer have been recorded. They include :—

(*a*) Larval Parasites :—

Megaselia spp. (3)	Phoridae
Apanteles chilones Munakata	Braconidae
Apanteles flavipes Cam.	Braconidae

(*b*) Pupal Parasites :—

Tetrastichus israeli Mani and Kurian	Eulophidae

The larval parasite *Apanteles flavipes* Cam. is a prominent species which affords considerable control of the shoot borer (Fig. 1).

7. Discussion

S. inferens is restricted to Kantalai as a major pest of sugar cane. During the period 1964 to 1968 the occurrence was sporadic and this species showed the peak of larval incidence in December. This was so because cane was planted from June to August and the crop was in its shoot stage until December. With improved knowledge of cane culture, planting of cane is now carried out between March and August and this has resulted in the pest occuring throughout the year.

The pest makes its appearance in the newly planted areas by March and is at its peak by April/May. One of the conditions conducive for its rapid multiplication and spread is the presence of cane field weeds which act as collateral hosts. The pest completes its life cycle in 65 days to 84 days, depending upon environmental factors. Overlapping of generations is generally observed and there are about four to five broods per year.

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