All efforts should therefore be concentrated on the finding of the necessary funds for the payment of these workers and for the institutions needed to give them the necessary preliminary training. About a crore of rupees will be required annually for the 14 or 15 thousand workers required to cover the whole of India including Native States. An investment of 30 crores will yield this amount of interest. The sooner this is provided the better, but it does not matter if workers are not provided for the whole area at once, provided a definite policy is laid out and adopted.

STUDIES ON *ELASMUS ZEHNTNERI*, FERR., A PARASITE OF THE SUGARCANE WHITE MOTH BORER (*SCIRPOPHAGA*)

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Introduction. The paper deals with the life history, habits and other interesting features of *Elasmus zehntneri*, Ferr., a chalcid parasite of the sugarcane white moth borer (*Scirpophaga*). As far as the authors are aware this wasp has not been mentioned in any of the many publications on South Indian parasites; hence the detailed studies on this wasp.

History of the Parasite. The parasite was first collected from West Java on the sugarcane borer—*Scirpophaga intacta*—and described as *Elasmus* sp., by Zehntner (*Meded v. h. Proefstation v. Suikerriet West Java*, No. 46, 1900, p. 1.). It was named *Elasmus zehntneri* by Ch. Ferriere in his paper on "The Asiatic and African species of the genus Elasmus, Westw, in *Bull. Ent. Res.* Vol. XX. Part IV (1929), pp. 411-423. Besides Java, the parasite has been noted from the Philippine Islands and Formosa. In N. India it was first noted in the Punjab as will be seen from the "Summary of the more important results arrived at or indicated by the Agricultural stations and Research Officers in the Punjab during the years 1930-31—34-35" published in 1936. The parasite has been observed by the authors for the first time in S. India in November 1935 in Scirpophaga attacked stems collected from Coimbatore.

Life History of the Moth Borer. A brief account of the nature of damage caused by the moth borer along with its life history and habits is given here so as to indicate clearly the relationship between the host and its parasite. Out of the characteristic buff coloured egg mass which is generally laid on the under-surface of the leaf of sugarcane plants, tiny caterpillars hatch out and bore into the shoots and destroy the growing point. The caterpillar is often very destructive

to young canes. When the larva is full grown it constructs a short tunnel at right angles to the original tunnel and closes in with a lid constructed from the outermost leaf sheath. It then retreats constructing a number of silken partitions and pupates, and in due course the moth emerges. The total life cycle of the borer is 2 to 2½ months.

Description of the Parasite by Ferriere is given below:—

Female. Head and thorax black with greenish shine; abdomen orange, the two last segments, lines on the sides of the 2nd and 3rd segments, and triangular spots on the sides of the 4th and 5th segments, black. Antennae yellow, the 2nd joint black above. Legs pale yellow, almost white, coxae and femora of the middle and hind legs black on upper margin, the tarsi somewhat brown. Wings hyaline, with yellow nerves.

Female. *Head* short, narrower than *thorax*. *Thorax* long and narrow, flattened above. Mesonotum covered with fine ciliae. Scutellum almost quadrate, longer than broad. Propodeon broad at the basis, concave behind, smooth and shining. *Abdomen* elongated with the form of a triangular pyramid. The ovipositor projects very little beyond tip of the abdomen. Antennae with ten joints; the 1st (scapus) flattened and enlarged below; the 3rd (anellus) very short, oblique; the 4th (2nd anellus) also very short, but longer than the 3rd; the 5th (1st funicle) three times as long as broad; the two following gradually shorter and broader, the three last forming a club. *Legs* with the coxae broadened very much; femara less broadened, tibiae short, and tarsus very long in the hind legs. Hind tibiae with lozenge-shaped lines covered with short rigid hairs. *Wings* with marginal nerve longer than sub marginal, stigmal nerve very short; at basis of wing two narrow hairless parts.

Male. Smaller than female; abdomen paler yellow and the triangular black spots on the sides of the 2nd—5th segments broader; on 5th segment the spots join above so that only the hind border remains yellow. Antennae with long ramelli on 4th, 5th and 6th joints; 7th joint long, as long as two-thirds-of 3rd ramellus; club narrow.

Length, Female 2·8—3 mm., *Male* 2—2·25 mm.

Type locality: West Java.

Host: *Scirpophaga intacta*, Sn., a sugar-cane borer.

Emergence and Behaviour of the Parasite. The adult parasites emerge by cutting small holes through the lid constructed by the host larva before its pupation. Generally the adults are active immediately

after emergence and mating takes place on the same or on the subsequent days. Eggs are laid even as early as two to four days after emergence. The female lays eggs only on such of the caterpillars which construct the outer lid of emergence and in this respect the wasp resembles *Stenobracon nicevillei*, Bingh., and *Rhaconotus scirpophagae*, Wlk., two other parasites of the same host. The parasite, after locating a larva inside the stem, waits till it begins to construct the lid. It then thrusts its ovipositor through the lid, stings the caterpillar and lays eggs in clusters either on the host or attached to the inner circumference of the tunnel. **Table I** gives the egglaying records of ten mated females. The maximum number of eggs in one cluster laid on a host on the first day was 55, the average for ten such clusters being 36. The maximum number of eggs laid by a female was 97 (laid on four hosts, on four different days) and the minimum 30. It is also seen from the table that the average is 53 and that all the eggs are not laid on a single day. **Table II** records the number of adults emerged from parasitised hosts brought from the field. One such larva gave rise to 170 adults, the lowest number was 30 and the average 75. It is seen from the table that there were more females than males, the proportion being 2 to 1. Our studies on the wasp have indicated the occurrence of super-parasitism in this species. Super parasitism, however, does not occur commonly and may take place only when there is scarcity of hosts. It was found that when a parasite was supplied with two host larvae, one a parasitised and the other a healthy caterpillar, it preferred the latter to lay its eggs.

Table I.

Records of oviposition of Ten mated Females of

'Elasmus zehntneri' Ferr.

Female No.	Emerged on	1st batch		2nd batch		3rd batch		4th batch		Died on	Total No. of eggs.	Average.
		No. of eggs laid	Laid on	No. of eggs laid	Laid on	No. of eggs laid	Laid on	No. of eggs laid	Laid on			
1	27 3 36	30	2 4 36	23	3 4 36	27	4 4 36	17	6 4 36	10 4 36	97	
2	27 3 36	38	19 4 36	27	22 4 36					23 4 36	65	
3	27 3 36	55	21 4 36	15	22 4 36					23 4 36	70	
4	9 4 36	39	17 4 36							20 4 36	39	
5	20 4 36	32	23 4 36	20	24 4 36					28 4 36	52	
6	20 4 36	30	23 4 36							30 4 36	30	
7	6 5 36	34	8 5 36							12 5 36	34	
8	20 5 36	30	30 5 36	18	31 5 36					2 6 36	48	
9	21 6 37	34	3 7 37	25	5 7 37					11 7 37	59	
10	22 6 37	37	3 7 37							4 7 37	37	
												53

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		No. of eggs laid	Laid on	No. of eggs laid	Laid on	No. of eggs laid	Laid on	No. of eggs laid	Laid on			
1	27 3 36	30	2 4 36	23	3 4 36	27	4 4 36	17	6 4 36	10 4 36	97	
2	27 3 36	38	19 4 36	27	22 4 36					23 4 36	65	
3	27 3 36	55	21 4 36	15	22 4 36					23 4 36	70	
4	9 4 36	39	17 4 36							20 4 36	39	
5	20 4 36	32	23 4 36	20	24 4 36					28 4 36	52	
6	20 4 36	30	23 4 36							30 4 36	30	
7	6 5 36	34	8 5 36							12 5 36	34	
8	20 5 36	30	30 5 36	18	31 5 36					2 6 36	48	
9	21 6 37	34	3 7 37	25	5 7 37					11 7 37	59	
10	22 6 37	37	3 7 37							4 7 37	37	
												53

Table II.

Statement showing the number of Parasites emerged from each host larva collected from the field.

Ser. No.	Month in which adults emerged.	Total No. of adults.	Females	Males.
	1936			
1	March	55	45	10
2	April	68	52	16
3	August	170	98	72
4	,,	103	56	47
5	,,	125	66	59
6	,,	56	50	6
7	,,	89	55	34
8	,,	78	39	39
9	,,	109	65	44
10	October	42	22	20
11	,,	30	25	5
12	November	53	32	21
13	,,	88	60	28
14	,,	30	26	4
15	December	35	25	10
16	,,	40	28	12
17	,,	50	35	15
	1937			
18	January	79	49	30
19	April	48	35	13
20	,,	72	56	16
21	June	162	98	64
22	July	85	59	26
23	August	34	27	7
24	,,	63	54	9
Average number of adults emerged from each host larva.		75	50	24

Life History. *Egg*: The eggs (fig. 3) are generally transluscent, about $\frac{1}{2}$ mm. long, elongate, cylindrical, curved at the centre with one end more pointed than the other. They are laid attached to the inner circumference of the tunnel or in some cases on the head of the host caterpillar, in the form of a bunch of grapes (fig. 2). Just before hatching, the grub is clearly seen through the transparent egg shell. The egg period ranges from 19 to 21 hours.

Grub: The newly hatched grubs measure $\frac{1}{2}$ mm. If the eggs are laid, away from the host, the grubs when hatched out, glide on the smooth silken lining of the tunnel until they reach the host. They crawl over the host and puncture its skin at some tender part of the cuticle and suck the juice from the host's body. When newly hatched, they are cylindrical, white and transparent and as they ingest food from the host they become opaque by attaining the color of the host. The grubs reach their maximum size of $3\frac{1}{2}$ mm. $\times$ 1 mm. in two or four days (fig. 4) by which time the host larva is completely eviscerated after which they cast their larval skin and turn into naked pupae. The larval period is 2—4 days.

Pupa: The pupa measures $3\frac{1}{2}$ - 4 mm. × 1 mm. in the case of females and $2\frac{1}{2}$ mm. × 1 mm. in males. It is conical with the broadest width at the thoracic region tapering gradually to a point posteriorly (fiig. 5-a). The rudiments of legs and antennae on the ventral side and of the wings on the dorsal side (fig. 5-b) are clearly visible. The freshly formed pupa is uniformly white and 2 days later the eyes assume the reddish brown color and a day later they turn black. The whole pupa turns brownish on the 4th day and three days later it is completely black. It is easy to separate the sexes as the males measure distinctly less than the females. The adults emerge after 7—10 days.

Total Life Cycle. The parasite has the advantage of completing its life cycle in 10—13 days while the host takes four times as much to produce one generation. **Table III** gives the life-history records of 30 parasites.

Table III.

Detailed Life-history Records of 'Elasmus zehntneri', Ferr.

Serial No.	Eggs laid on.	Larva hatched on.	Duration of egg period in days.	Pupated on.	Duration of larval period in days.	Adults emerged on	Duration of pupal period in days.	Total life cycle.
1	28 3 36	29 3 36	1	31 3 36	2	9 4 36	9	12
2	28 3 36	29 3 36	1	31 3 36	2	8 4 36	8	11
3	2 4 36	3 4 36	1	6 4 36	3	15 4 36	9	13
4	3 4 36	4 4 36	1	6 4 36	2	15 4 36	9	12
5	3 4 36	4 4 36	1	6 4 36	2	13 4 36	7	10
6	4 4 36	5 4 36	1	7 4 36	2	15 4 36	8	11
7	4 4 36	5 4 36	1	7 4 36	2	15 4 36	8	11
8	6 4 36	7 4 36	1	10 4 36	3	19 4 36	9	13
9	17 4 36	18 4 36	1	20 4 36	2	28 4 36	8	11
10	17 4 36	18 4 36	1	20 4 36	2	28 4 36	8	11
11	19 4 36	20 4 36	1	22 4 36	2	30 4 36	8	11
12	21 4 36	22 4 36	1	24 4 36	2	2 5 36	8	11
13	22 4 36	23 4 36	1	25 4 36	2	3 5 36	8	11
14	23 4 36	24 4 36	1	26 4 36	2	4 5 36	8	11
15	23 4 36	24 4 36	1	26 4 36	2	4 5 36	8	11
16	24 4 36	25 4 36	1	27 4 36	2	6 5 36	9	12
17	25 4 36	26 4 36	1	28 4 36	2	6 5 36	8	11
18	8 5 36	9 5 36	1	11 5 36	2	19 5 36	8	11
19	14 5 36	15 5 36	1	17 5 36	2	26 5 36	9	12
20	31 5 36	1 6 36	1	3 6 36	2	11 6 36	8	11
21	5 6 36	6 6 36	1	8 6 36	2	18 6 36	10	13
22	30 6 36	1 7 36	1	2 7 36	2	9 7 36	7	10
23	6 10 36	7 10 36	1	10 10 36	3	19 10 36	9	13
24	7 10 36	8 10 36	1	11 10 36	3	20 10 36	9	13
25	7 10 36	8 10 36	1	11 10 36	3	20 10 36	9	13
26	8 10 36	9 10 36	1	12 10 36	3	21 10 36	9	13
27	9 10 36	10 10 36	1	13 10 36	3	22 10 36	9	13
28	13 11 36	14 11 36	1	17 11 36	3	26 11 36	9	13
29	14 11 36	15 11 36	1	18 11 36	3	27 11 36	9	13
30	3 7 37	4 7 37	1	8 7 37	4	16 7 37	8	13

Longevity of Adults. It is seen that the parasites feed freely on honey solution under the laboratory conditions. **Table IV** records the longevity of 24 parasites from which it is clear that the maximum length of a female was 26 days while that of a male was 7 days. Without food both males and females did not live for more than three days.

Table IV.

Length of Life of 'Elasmus zehntneri', Ferr.

With food					Without food				
Ser. No.	Emerged on.	Died on.	Sex of the adult.	No of days lived.	Ser. No.	Emerged on.	Died on.	Sex of the adult.	No. of days lived.
1	11 4 36	2 5 36	F	21	1	4 10 36	7 10 36	M	3
2	11 4 36	2 5 36	F	21	2	4 10 36	7 10 36	M	3
3	4 10 36	11 10 36	M	7	3	4 10 36	7 10 36	M	3
4	4 10 36	11 10 36	M	7	4	4 10 36	7 10 36	F	3
5	4 10 36	11 10 36	M	7	5	4 10 36	8 10 36	F	4
6	4 10 36	13 10 36	F	9	6	4 10 36	8 10 36	F	4
7	4 10 36	13 10 36	F	9	7	11 4 37	13 4 37	F	2
8	4 10 36	30 10 36	F	26	8	11 4 37	13 4 37	F	2
9	4 10 36	12 10 36	F	8	9	11 4 37	13 4 37	F	2
10	4 10 36	12 10 36	F	8					
11	4 10 36	9 10 36	M	5					
12	4 10 36	11 10 36	M	7					
13	4 10 36	8 10 36	M	4					
14	4 10 36	11 10 36	M	7					
15	4 10 36	9 10 36	M	5					
16	6 11 36	17 11 36	F	11					
17	12 4 37	18 4 37	F	6					
18	26 4 37	10 5 37	F	14					
19	26 4 37	30 4 37	M	14					
20	26 4 37	4 5 37	F	9					
21	26 4 37	14 5 37	F	19					
22	28 6 37	4 7 37	F	6					
23	28 6 37	11 7 37	F	13					
24	28 6 37	22 7 37	F	24					
Average longevity for males				6					3
Average longevity for females				14					3

Seasonal and Regional Prevalence. Field observations on the incidence of parasites under Coimbatore conditions show that although the wasps are present throughout the year they are found in large numbers only from August to January.

The parasites have been noted from the following places in the Madras Presidency :—Bobbili, Vizagapatam, Godaveri, Chittoor, Tanjore and Coimbatore districts.

Efficacy of the Parasite. It will be seen from the above mentioned habits of the parasite that it has certain drawbacks as well as advantages. Though it is a larval parasite it does not attack caterpillars of different stages but attacks only those very near pupation. Again the female parasite has only a few victims as the eggs are laid in clusters. Against these two disadvantages the following advantages may be mentioned: (1) The parasite has only a short life cycle when compared with that of the pest which takes 2—2½ months to complete one life cycle. Given favourable conditions there are four generations of the parasite for every one of the host. (2) No hyper-parasites have

been noted on the parasite to reduce its efficacy. (3) The parasite has not been noted till now on any other host and hence it is specific in action. (4) The egglaying capacity of the female is also fairly high the maximum and the average being 97 and 55 eggs respectively. (5) The rearing of parasites under laboratory conditions is not difficult as stems with larvae having plugs were readily accepted by the parasite.

From these observations it will be clearly seen that *Elasmus zehntneri*, Ferr., is a fairly efficient parasite of the sugarcane stem borer.

Acknowledgments. The authors take this opportunity of thanking Mr. A. B. Gahan for having kindly identified the specimens.

Research Notes.

I

Mite pests of Citrus.

Insects affecting citrus are many of which the fruit sucking moths, the citrus butterfly, the leaf miner etc., are the most troublesome. Besides insects there are mites (Acarina) which occasionally do some damage. One of these—*Tetranychus*—(*Schizotetranychus*) *hindustanicus*, Hirst. sucks the leafsap with the result that discoloured patches are produced on the leaves. The adult mites which are greenish yellow in colour are found also on Persian neem, margosa and 'curry leaf' plant.

There is yet another mite—an Eriophyid—which attacks citrus fruits. It has been noted for the first time in South India from Penagulur (Cuddappa district) and Poonapalle (Chittoor district). Studies on the mite have shown that as a result of the attack of the pest a rust-like discolouration is produced on the surface of the fruit which appears to be due to the mites feeding on the epidermal cells causing the surface of the fruit to harden. It has however to be stated in this connection that the attacked fruits do not show any difference in taste from the un-attacked ones, but according to the owners of gardens the damage to fruits reduces their value. Detailed studies regarding the pest and its control are in progress.

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II

A Banana from Hawaii.

Of the 5 varieties of Bananas received from Honolulu, Hawaii, *Palua* proved to be *Kaio*. This *Kaio* variety has the look of *Nendran* from the beginning of its growth but on flowering it proved different in that it had neither the persistent bract nor the persistent neutral flowers. It has the ordinary naked axis bearing male flowers. The unripe fruits are excellent, even better than *Nendran* for making fritters (crisps). It is also excellent for other vegetable preparations. The colour of the flesh is the same as that of *Nendran*. The fruit on ripening is found to have the same taste and flavour of *Nendran*. The flesh of the ripe fruit is soft and has sub-acid taste. The ripe fruit does not keep well. The ripe fruit is therefore inferior to that of *Nendran*. This variety has to be tried in the West Coast to see whether the sub-acid taste might undergo any change. A bunch produced at the Banana Experimental Area, Coimbatore, had 9 hands, 91 fingers and weighed 35½ lbs. The shape of the fruit is very peculiar in having no apex at all. Hence the local name *Motta Nendran* is suggested for this variety.

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