THE PROGRESS OF AN UNTREATED OUTBREAK OF *NUMICIA VIRIDIS*, MUIR

by A. J. M. CARNEGIE

The green leaf-sucker, *Numicia viridis*, Muir (Homoptera: Tropiduchidae) was first recognised as a pest of sugarcane in 1962, when its activities caused conspicuous damage on an estate in Swaziland, (Dick, 1963). It is an indigenous insect which has been recorded now from 32 grass species, and it can be found on cane, if only in small numbers, in most cane growing areas of South Africa and Swaziland.

In April 1965 an opportunity arose of following the course of an infestation of *N. viridis* in a field of irrigated cane (N:Co.310) at a large sugar estate in Swaziland. At the time of writing the infestation has been visited ten times, at approximately monthly intervals, and notes have been made and material collected for subsequent laboratory examination.

At the time these observations started numbers of *N. viridis* adults and nymphs suddenly became very numerous in four fields on the estate. Three of these were treated by aerial application of malathion 5 per cent dust, but the management of the estate kindly agreed to leave one field of five month old cane of variety N:Co.310 untreated, and placed it at our disposal. Each time the untreated field was visited the general state of the cane was noted, samples taken and counts made. Regular samples included the following:

1. *Adults and nymphs*

In six randomly selected places cane was shaken over a one yard square piece of black plastic sheeting, and all. *N. viridis* adults and nymphs which dropped were collected for subsequent counting and examination.

2. *Eggs*

Egg samples were taken both in cane and in grasses growing in the vicinity of the field. Grasses included the following species: *Panicum maximum*, *Pennisetum thunbergii*, *Pennisetum clandestinum*, *Rhynchelytrum repens*, and the sedge *Cyperus sexangularis*. Whenever available, egg samples from grasses included some from leaves and some from inflorescence stems.

Subsequent treatment of samples

Adults and nymphs collected by shaking were counted, examined for parasites, and the adults sexed.

Table I

Numbers of *N. viridis* collected by shaking cane. Total shown is for six randomly chosen sites on each occasion

Date	Total *N. viridis*	% Nymphs	Adults		% Parasitised by Dryinids
			% Female	% Male	
8.6.65	201	6.9	52.9	47.1	3.5
29.6.65	194	39.1	53.4	46.6	2.6
20.7.65	350	94.3	35.0	65.0	2.3
18.8.65	395	99.7	0.0	100.0	0.0
15.9.65	445	98.2	37.5	62.5	1.5
11.10.65	114	88.6	38.4	61.6	0.9
14.11.65	82	34.1	42.6	57.4	3.6
14.12.65	13	38.4	12.5	87.5	30.8
17.1.66	17	29.4	75.0	25.0	11.6

Egg batches from all media were dissected and divided into the following categories: hatched, unhatched, parasitised by *Oligosita* sp. (Trichogrammatidae), parasitised by *Ootetrastichus beatus* Perkins (Eulophidae), degenerated through causes other than parasites, still likely to hatch.

Before these observations started and until the time of writing, similar weekly or fortnightly sampling for eggs, nymphs and adults in cane has been done also by the agronomy section of the estate. All leaf material containing eggs has been forwarded to the Experiment Station and has been treated as mentioned above; their figures for nymph and adult counts have also been made available.

From data accumulated it has been possible to obtain figures for *N. viridis* populations, as eggs, nymphs and adults from May 1965 until the present time.

Eggs

Numbers of unhatched eggs per leaf are shown in Fig. 1a. There was an increase in numbers while adults were plentiful, and a decrease as numbers of adults fell and nymphs became plentiful (Fig. 1b). The slight increase in egg numbers in September is unexpected since numbers of adults were low then, but the increase in numbers in October and November followed the appearance of a second generation of adults. Numbers of eggs then decreased.

Nymphs and adults

Numbers of both nymphs and adults were high when sampling began in April, with numbers of nymphs falling rapidly as the adult stage was reached (Fig. 1b). This was followed by a fall in numbers of adults, which had died after copulation and oviposition. There was then a further increase in nymph numbers as a second generation arose, and this was followed by a small increase in adult numbers between October and mid-November, with a subsequent drop in numbers of both nymphs and adults.

Factors causing reduction in numbers

A reduction in numbers with metamorphosis and from adults dying after copulation and oviposition is to be expected, but the extent to which numbers of all stages were reduced, and the failure in production of even larger following generations cannot be explained only in these terms, and attention was paid to a number of other factors.

1. *Egg parasitism*

Two egg parasites of *N. viridis* have been noted in most areas where the host has been collected. These two minute wasps, *Ootetrastichus beatus* and *Oligosita* sp. were present in the field under discussion throughout the period, and notes were made of their activities. Both parasites exercise a controlling effect on their host's numbers by laying their own eggs inside those of the host.

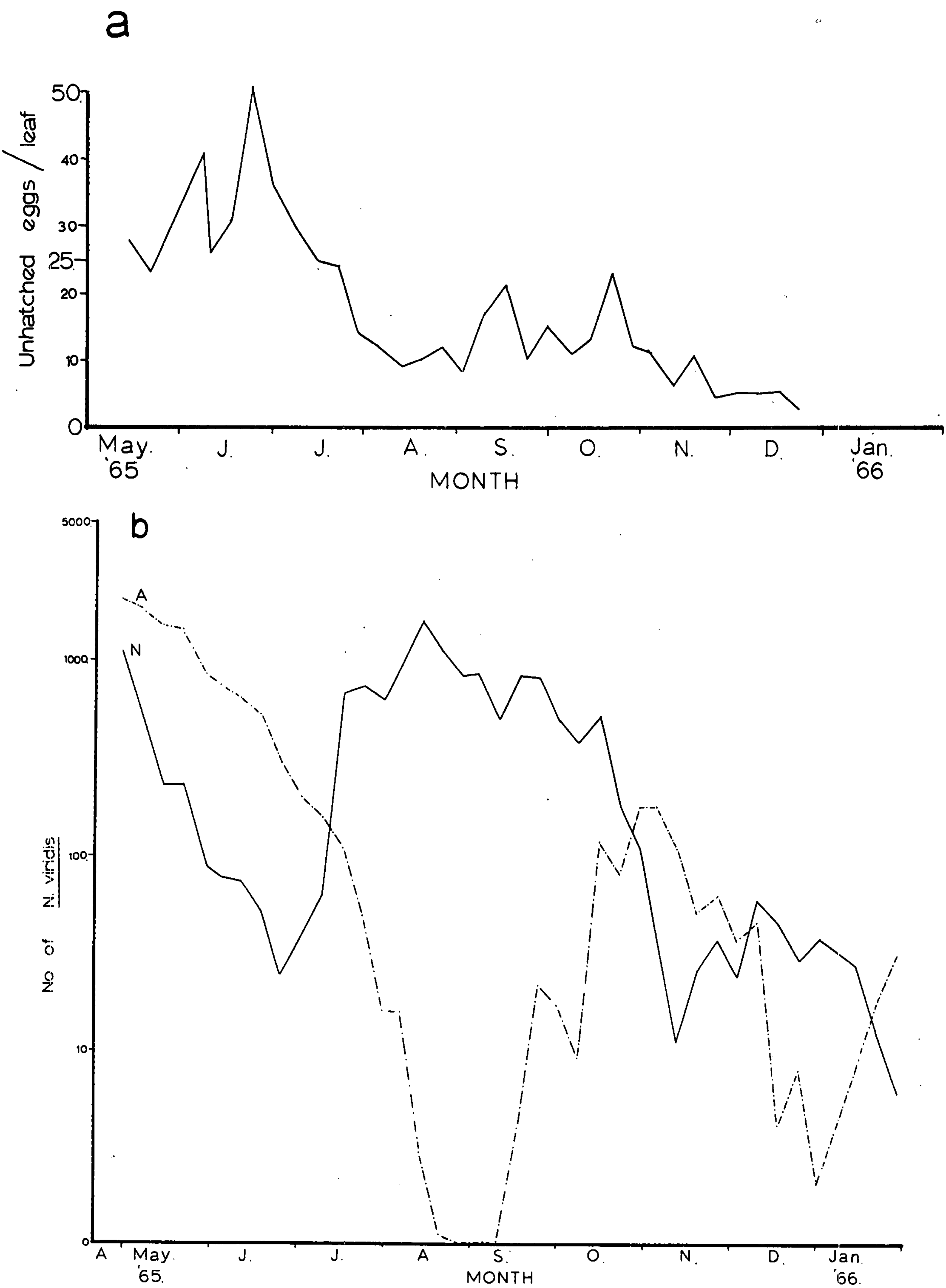

FIGURE 1 : Population figures for *N. viridis* in an untreated cane field; (*a*) eggs, (*b*) nymphs and adults

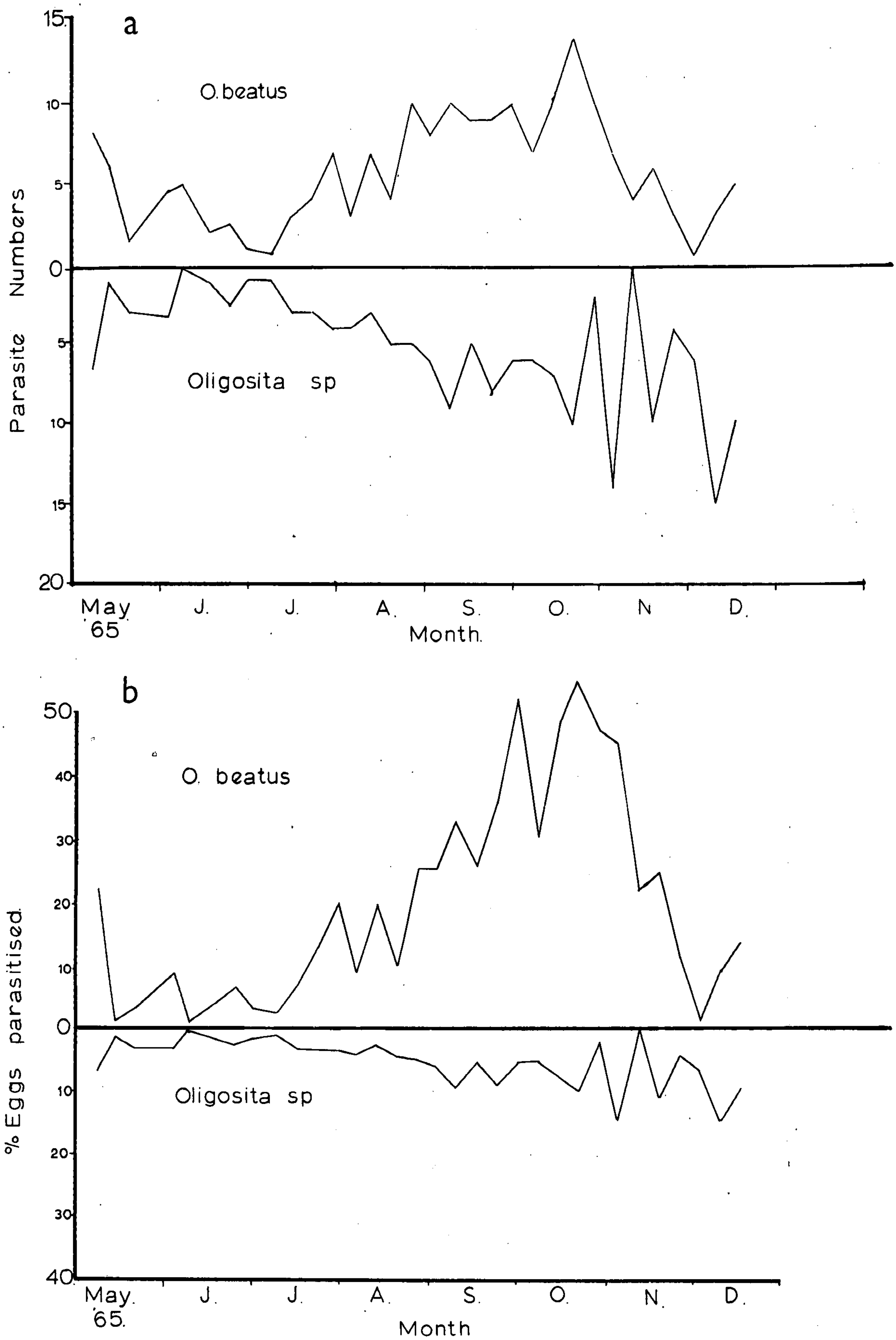

FIGURE 2 : Relative importance in biological control of two egg parasites, *Ootetrastichus beatus* and *Oligosita* sp.
(*a*) respective numbers of parasites (relative to total eggs).
(*b*) eggs parasitised by each parasite (as percentage of total eggs).

The young grub hatching from the egg of *Oligosita* sp. feeds on the contents of the host's egg in which it completes its larval development and in which it pupates. The adult wasp emerging from the pupa bites its way to the exterior through the egg chorion and the leaf midrib. Thus one wasp larva accounts for one *N. viridis* egg.

The life cycle of *O. beatus* is slightly different, and has not yet been worked out in detail; but that of a similar species, *O. pallidipes*, has been described (Williams, 1957) and the pattern is similar. The young larva feeds on the contents of the host's egg until the last instar is reached, by which time it fills the egg. It then leaves the host's egg and may pupate immediately in the surrounding plant tissue, or it may feed on adjacent eggs, consuming as many as six, before pupating. The resulting adult wasp bites its way through the midrib to the exterior. It is of interest that during its final instar the larva of this parasite may eat eggs already parasitised by its own species or by *Oligosita* sp.

From regular leaf samples sent to us by the estate it was found that as a biological control factor *O. beatus* was the more important of the two egg parasites (Figs. 2a and b). Even where numbers of the two parasite species were similar, more host eggs were accounted for by *O. beatus* than by *Oligosita* sp.

It is of interest to compare the state of egg parasitism in cane leaves with that in adjacent grass species (Fig. 3a and b). The figure shows percentages of parasitised eggs in cane leaves, leaves of the grasses *Panicum maximum*, *Pennisetum clandestinum* and *Pennisetum thunbergii*, in inflorescence stems of *Panicum maximum*, *Pennisetum thunbergii* and *Rhynchelytrum repens*, and in stems of the sedge *Cyperus sexangularis*. All these were growing in the immediate vicinity of the cane field, and the same patches of grass were sampled each visit. In the figure readings represent all available grass stems and all available grass leaves respectively. Figures for the sedge are plotted separately.

Egg parasitism followed the same trends in grass stems and leaves and in the sedge, being generally higher in the sedge than in any of the grasses, and always higher in grass leaves than in stems. The explanation for this could lie in the texture of the plant tissue concerned. In the course of field observation it has been noted that the wasps insert their eggs through that side of the midrib or inflorescence stem which is opposite the egg operculum. This necessitates penetration of the plant tissue, and softer plant tissue may result in more successful parasitism. Inflorescence stems of grasses are tougher than leaf midribs, and in the case of the sedge, the hosts' eggs were always laid along one of the ridges of the six-angled spongy stem, through which the wasp parasite should easily insert her egg.

In cane the same general trend was not followed (Fig. 3b) and parasitism was generally lower than in grass leaves and in the sedge. In Figure 3b the unbroken line represents egg parasitism in green cane leaves selected at random throughout the infested area of the field, and the broken line represents egg parasitism in green cane immediately adjacent to the sedge *C. sexangularis*, in which a similar egg parasitism pattern is not reflected.

Wherever egg parasitism in grasses has been compared with that in cane (including other localities and other grass species) figures have shown it to be less successful in cane. There are probably several reasons for this including: the relatively tough texture of cane leaf midribs, periodic harvesting (often accompanied by burning) destroying parasite populations, the greater height of cane may make host's eggs more difficult to find for parasites which are adapted to a more horizontal and closely-packed grass community.

In the course of egg examinations records were kept of all parasites which had died in the plant tissues without reaching the exterior, and it was found that more parasites died in cane than in grasses (Table II). In cane *Oligosita* sp. in particular experienced difficulty in biting its way out of the leaf midrib. A high proportion died also in grass stems, but in grass leaves most survived. The rather high percentage of dead parasites in the sedge was unexpected; parasitism there was also high (Fig. 4a). Figure 3 suggests that there was a "rhythm" of parasitism in indigenous host plants which was not found in cane.

Table II

Parasites which died without leaving plants; expressed as percentage of total number of each species.

Medium	*Ootetrastichus beatus* % Dead	*Oligosita* sp. % Dead
Cane leaves . . .	12.6	54.8
Grass leaves . . .	13.7	5.3
Grass stems . . .	7.9	30.3
Cyperus stems . .	21.2	25.0

2. *Further causes of egg mortality*

It was noted also that a number of eggs had degenerated through causes other than parasitism. Some had become translucent but hard, some had collapsed and appeared to consist of a chorion only, and others appeared to have been destroyed by a fungus. Numbers of such eggs from various plant hosts are shown in Table III. On nearly all occasions figures from grasses were higher than from cane. Fewer still were destroyed in the sedge, but parasitism there was so high (compare Figure 3a) that the sample of eggs degenerated through causes other than by parasitism was too small to give significant results. In cane the rigid structure of the leaf midrib protects eggs of *N. viridis* from mechanical damage. It has been noted that eggs will hatch even from completely dry cane leaves which have been lying on the soil in a crumpled condition for more than a week.

3. *Parasitism of nymphs and adults*

A wasp parasite, *Lestodryinus* sp. (family Dryinidae. has been reared from both nymph and adult *N. viridis*) The female wasp inserts her egg into the host's body,

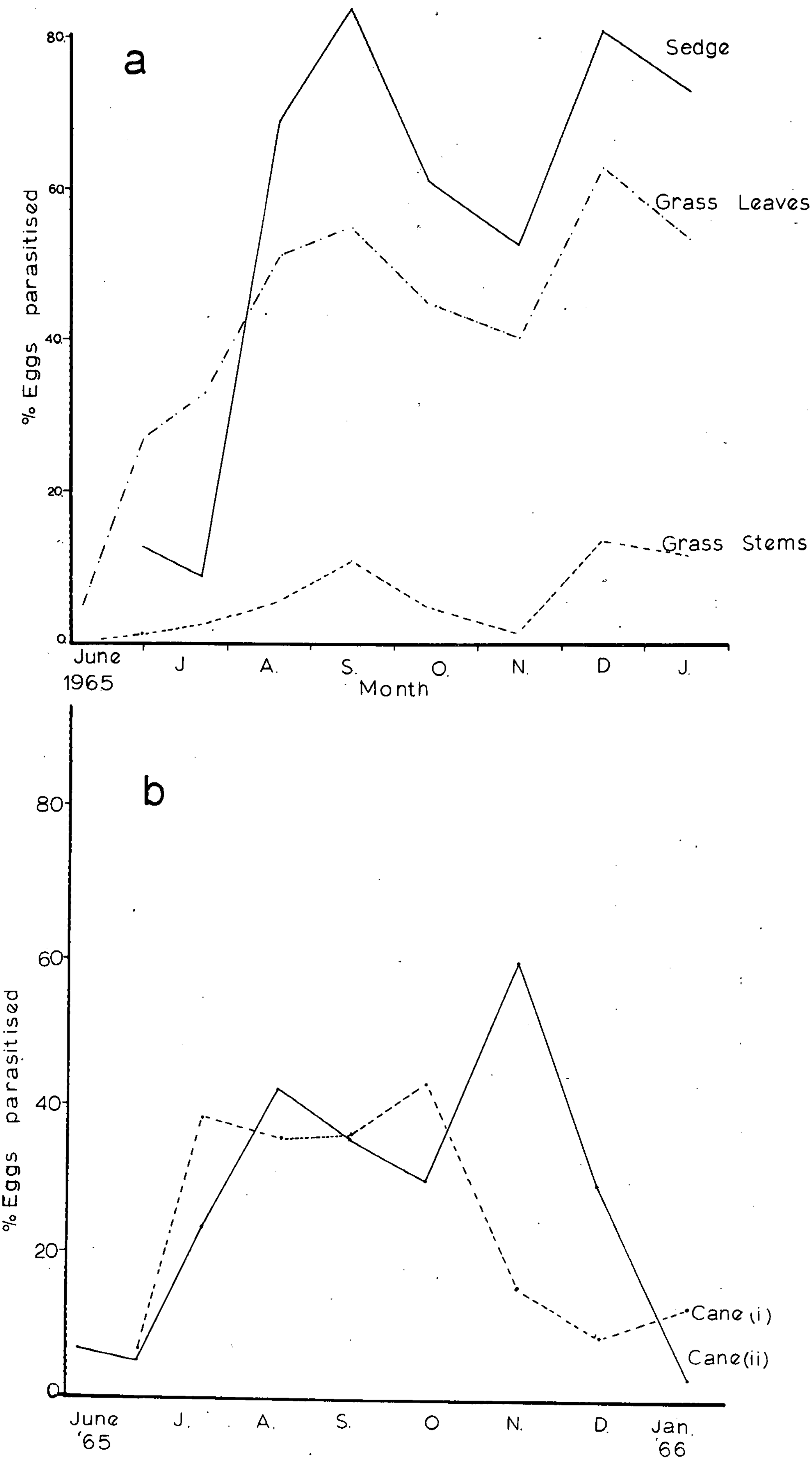

FIGURE 3 : Comparison of egg parasitism in various media, (both parasites considered together).

(*a*) indigenous host plants.
(*b*) sugarcane.

(i) cane immediately adjacent to the sedge *Cyperus sexangularis*;
(ii) cane sampled at random throughout infested area.

and the hatching parasite larva feeds at first within the host's body and soon appears as a protrusion of the host's integument. The protrusion grows, the parasite feeding on the body contents of the host without immediately killing it. When mature, the caterpillar-like parasite larva leaves the host and pupates nearby, usually on a cane leaf. The host dies. From the pupa the adult wasp emerges.

The impression is that when outbreaks of *N. viridis* first occurred these parasites were more common than they are now. Certainly they can have had little effect on the infestation under consideration. In the course of collecting nymph and adult *N. viridis*, records were kept of dryinid parasites, and there was no appreciable build up as the infestation grew, (Tables I and IVa). The parasite's activity is checked to some extent by a secondary parasite, *Chiloneurus* sp. (family Encyrtidae). In Table I latest figures for percentage parasitism by Dryinids are relatively high but they are calculated from such small total numbers as to be of little significance.

4. *Other causes of reduction in numbers*

As this infestation proceeded it became apparent that the general arthropod fauna of the field was becoming richer. While sampling for *N. viridis* by shaking cane the numbers of general predators and omnivorous insects which fell on to the sample sheet, including numerous spiders, some ladybird beetles

Table III

Eggs destroyed through causes other than parasitism; expressed as percentage of total eggs

Medium	Date 8-6-65	30-6	22-7	19-8	15-9	12-10	15-11	14-12	18-1-66
Cane leaves	0.4	0.1	1.2	9.7	2.2	7.6	12.4	4.3	0.2
Grass leaves	10.3	13.8	13.2	18.2	14.6	17.2	12.4	10.6	19.2
Grass stems	13.9	20.8	13.5	22.4	13.9	9.2	11.6	13.1	14.6
Cyperus stems	*	0.9	6.2	2.3	2.6	2.7	4.9	3.8	6.7

* No figure available.

Table IV

Average number of Arthropods collected by fumigating cane (3 to 4 stools at a time) in (*a*) an untreated field, and (*b*) a field dusted with malathion 5 per cent dust

Date	*N. viridis*	Spiders & predacious mites	Ladybird beetles	Dryinid parasites	Other insects	% Other insects	% Predators
			A				
15- 9-65	101.0	46.0	0.0	0.5	135.0	47.8	16.3
12.10.65	116.0	38.0	2.0	0.0	103.0	40.6	15.8
15.11.65	31.4	25.7	0.0	0.3	78.0	57.6	19.0
15.12.65	4.0	13.0	0.5	1.0	36.0	92.6	22.2
18. 1.66	4.0	2.0	0.0	0.0	15.5	72.1	9.3
			B				
12-10-65	2440.5	53.5	10.0	0.5	100.0	3.8	2.4
15-11-65	92.2	21.6	7.0	0.03	64.3	34.6	15.4
18- 1-66	16.0	17.0	0.0	0.0	10.0	23.3	39.6

and the small predacious mite *Anystis baccarum* (Linn.), appeared to increase. To investigate the fauna more thoroughly a method was devised of sampling by fumigation.

A plastic canopy was placed over three or four stools of cane at a time in the form of a tent. Ground sheets were placed under this, and insecticide fumigant tablets ignited within it. After a suitable period everything which fell was collected and preserved for later examination. Results of preliminary sortings are listed in Table IVa. From the figures available (September 1965 onwards) it can be seen that while numbers of *N. viridis* were high so were numbers of other arthropods, and it might be assumed that the action of predators accounted for the gradual fall in numbers of *N. viridis*. But in Table IVb fumigation figures are shown for another field, which was dusted with insecticide in May 1965. In this field (discussed in the next section) numbers of arthropods other than *N. viridis* were proportionally lower and could not account for the drop in numbers which occurred there between October and November (Fig. 4b). This drop in numbers may have been due to natural mortality following copulation and oviposition

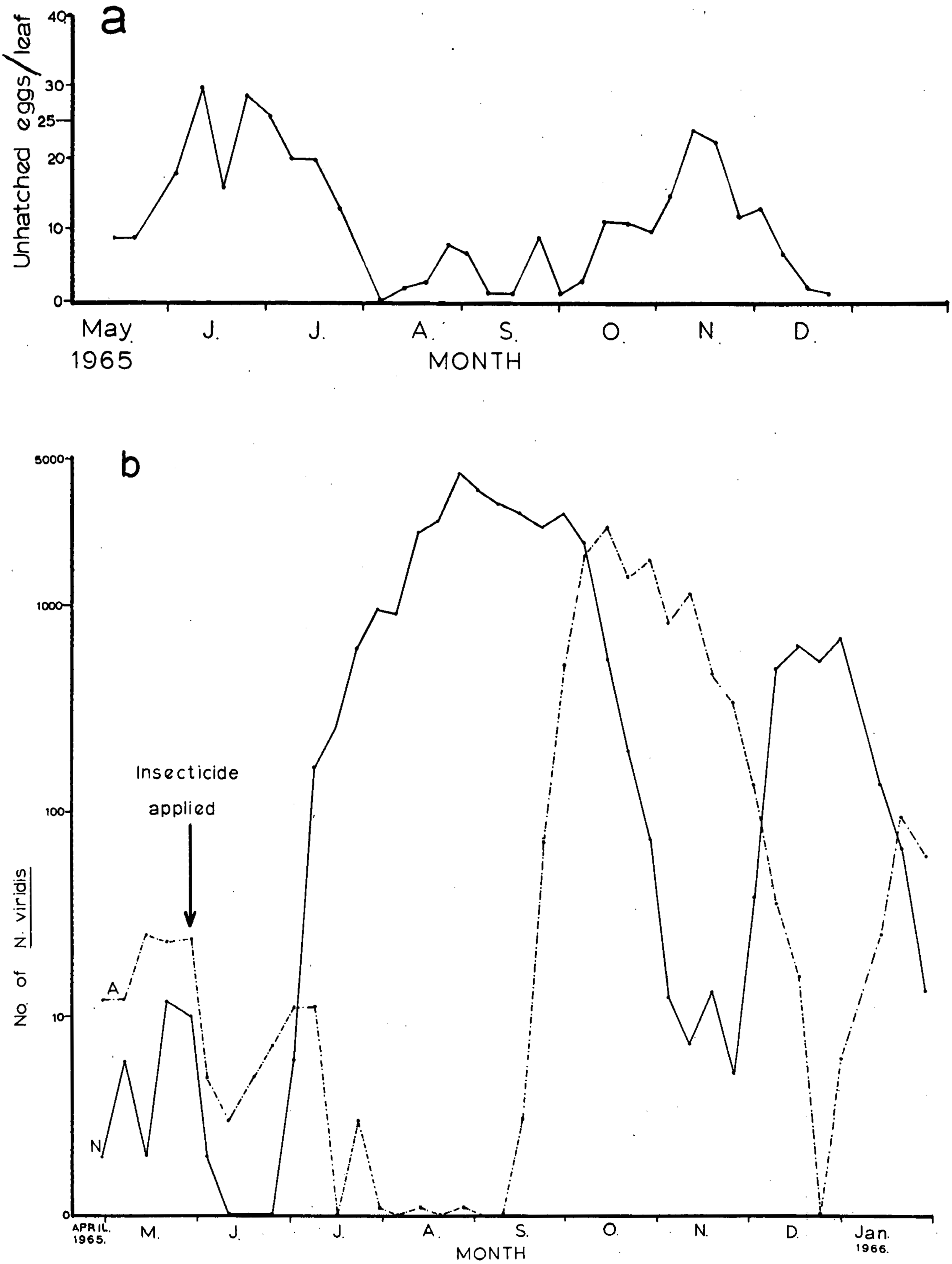

FIGURE 4 : Population figures for *N. viridis* in a cane field dusted once with 5 per cent malathion; (*a*) eggs, (*b*) nymphs and adults.

(only 11.1 per cent of *N. viridis* in October's sample were nymphs), but it seems too great and sudden a reduction to be so explained. If mortality was natural, i.e. followed normal oviposition, a gigantic following generation might be expected.

Other natural causes of mortality which deserve mention are the actions of insectivorous birds and climatic factors. In the field which was left untreated, during the period of greatest infestation several species of small birds were active in the cane, and it is reasonable to suppose that they took their toll. Owing to an outbreak of foot-and-mouth disease it was not possible to shoot any birds for identification and examination of stomach contents. Heavy rain, especially when accompanied by high winds must have an adverse effect on nymphs and adults, and may have contributed towards the drop in numbers in the treated field.

A note on numbers of N. viridis *following insecticide treatment*

Figures for *N. viridis* populations were available for one of the fields which were treated on the 28th May, 1965 (at about the time these investigations started). The field was dusted from the air using malathion 5 per cent dust at the rate of 40 lbs. per acre. Population trends for this field are illustrated in Figure 4.

Following dusting there was an immediate drop in numbers of nymphs and adults, as was to be expected. But by then many eggs, which are not affected by malathion dust, must have been laid, for by the end of August numbers of nymphs had reached the 4,000 mark (per 10 square yard sample), and six weeks later over 2,000 adults were recorded.

Insecticide dusting, in the presence of unhatched eggs could account for the sudden rise in numbers of nymphs and adults. Parasites within the host's eggs or within the leaf tissue would not have been affected, but any adult parasites on the cane at the time of dusting would have been very vulnerable, and many adults emerging shortly after dusting would have been killed by contact. In addition, natural enemies which do not spend a long egg or pupal period in a protected state, such as spiders and ladybird beetles, would also have been affected. There would therefore have been very little to prevent numbers of nymphs and adults from becoming very great in the following generation, some time being necessary for a build-up of natural enemies.

Should insecticide be used?

Whether or not it is better to leave an outbreak of *Numicia viridis* completely untreated is still uncertain. It certainly depends to some extent on local circumstances such as, among others, the size of the affected area, age of the cane, and presence of natural enemies. Where insecticide is applied it must be done thoroughly and be well timed and should usually be done more than once in the space of a few weeks. In most outbreaks investigated generations of *N. viridis* have not been staggered, so that good timing of application should be possible. There is evidence that insecticide dusting is frequently followed by marked increases in numbers of unwanted insects, including *N. viridis*. Certainly in the case of the fields discussed above the infestation in the untreated field dwindled while that in the treated field went from strength to strength; but this is an isolated case and should at this stage be regarded as an indication rather than as conclusive evidence. The fields discussed were of different cane varieties (N:Co.310 and N:Co.376), and the comparison therefore is not entirely fair. It must be remembered also that the first recognised outbreaks of *N. viridis* which occurred in 1962, (Dick 1963), did not follow insecticidal treatment.

When contemplating insecticidal action the variety of cane affected should also be considered. The matter of varietal susceptibility is being investigated, and it seems that the insect affects some cane varieties more adversely than others. Regarding the fields discussed in this paper, the untreated field (N:Co.310) looked in extremely poor condition and almost beyond recovery in late July and August, although with the subsequent drop in numbers of *N. viridis* it recovered quite rapidly. In the treated field (N:Co.376) it required the presence of very large numbers of the insect over a long period before the cane appeared to be really adversely affected (in November 1965).

The fields concerned have not yet been harvested, and it is impossible therefore at this stage to know the loss in yield resulting from the untreated infestation. Yield is expected to be about 5 tons per acre less than it would otherwise have been, but the loss may be less severe.

Summary

The progress of an untreated infestation of the leaf sucker *Numicia viridis* Muir (Homoptera : Tropiduchidae) in a field of sugar cane is discussed. It was found that after fluctuations in numbers of all stages of the insect, the infestation gradually dwindled and the cane, which had suffered badly, recovered. Causes of the drop in numbers are discussed, mention being made of two egg parasites, *Ootetrastichus beatus* Perkins (Eulophidae) and *Oligosita* sp. (Trichogrammatidae); a parasite of nymphs and adults, *Lestodryinus* sp. (Dryinidae), and various arthropod predators. A comparison is made of natural control factors in grass and in cane and possible reasons given for control being generally better in grasses. A brief comparison is made between arthropod populations in an untreated cane field and in one dusted with 5 per cent malathion, and this is followed by a discussion of the merits of insecticide use.

Acknowledgments

The generous help and co-operation of the management and staff of Ubombo Ranches, Swaziland, is greatly appreciated. Messrs. Kirby and Roodt of the Experiment Station helped accumulate much of the data. The paper includes material being used for post-graduate work in the Entomology Department of the University of Natal.

References

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Mr. du Toit (in the chair): Referring to figure 4b, why are you reluctant to accept that parasites could have caused the fall in numbers of *N. viridis* between October and November?

Mr. Carnegie: Because I consider that, judging by the tremendous increase in *Numicia* numbers following insecticide application, most parasites, excepting those actually in the hosts' egg, must have been killed by the insecticide, and I do not think that by October their numbers could have increased sufficiently to have brought about this control of the host. There may be some other control factor which we do not yet appreciate which may be density dependent, such as the production of infertile eggs, for instance.

Dr. Dick: Ubombo Ranches are to be congratulated for having the courage to leave one field untreated.