J. Hyg., Camb. (1976), 77, 377
Printed in Great Britain

The treatment of soil infested with the human whipworm, *Trichuris trichiura*

By D. J. BURDEN
Institute for Research on Animal Diseases, Compton, Newbury, Berkshire

A. WHITEHEAD
Rothamsted Experimental Station, Harpenden, Herts.

E. A. GREEN
Cell Barnes Hospital, St Albans, Herts.

J. A. McFADZEAN
Research Laboratories, May & Baker Ltd, Dagenham, Essex

AND R. J. S. BEER
Brentwood, Newsome, Huddersfield, Yorks.

(*Received* 28 *May* 1976)

SUMMARY

The soil fumigants methyl bromide, chloropicrin and Basamid or mixtures of Basamid and chloropicrin proved to be of no use in killing *T. trichiura* ova in soil. However, on untreated plots the eggs died at a rate such that only 20 % of the ova remained viable after 18 months.

INTRODUCTION

Infection with the human whipworm, *Trichuris trichiura*, is quite prevalent among the patients of Cell Barnes Hospital, St Albans (Lynch, Green, McFadzean & Pugh, 1972). During the summer of 1973 various open-air play areas used by some of the younger patients were found to be contaminated with *T. trichiura* eggs, and in a letter to the British Medical Journal Green *et al.* (1973) speculated that these areas constituted the main risk of infection by this worm. In the same communication it was suggested that as chloropicrin (trichloronitromethane) was found to kill *T. suis* ova in the laboratory, this compound should be evaluated for use as a fumigant against *T. trichiura* in the soil. Thus a trial was set up to test chloropicrin and it was decided that other soil fumigants in common use should be tested at the same time.

MATERIALS AND METHODS

In August 1973 the play area of Ward 18 was closed off to patients, and ten plots, each 10 ft. long and 6 ft. wide were marked out with wooden stakes. The plots were

arranged in 2 rows of 5 with 2 ft. between each plot and 5 ft. between each row. The plots were treated in the following way:

Plots 1, 6
Methyl bromide at 2 lb./100 ft.^{2} (97 g./m.^{2}) (soil surface sheeted with polythene)

Plots 3, 8
untreated control

Plots 5, 10
chloropicrin injected 6 inches deep at 2 lb./100 ft.^{2} (75 ml./m.^{2}) (soil sheeted)

Plots 7, 4
Basamid (= Dazomet)* – rotavated in at 2 lb./100 ft.^{2} (99 g./m.^{2}) (soil not sheeted)

Plots 9, 2
Basamid + chloropicrin – chloropicrin injected 6 inches deep at 2 lb./100 ft.^{2} (75 ml./m.^{2})
Basamid rotavated in at 1 lb./100 ft.^{2} (49 g./m.^{2}) (soil not sheeted)

Soil samples (about 2 kg. each) were taken from each plot immediately before treatment using a small auger which removed soil down to a depth of about 20 cm. Further samples were taken at the following times after treatment: 8 months, 10 months, 13 months and 18 months. *T. trichiura* eggs were recovered from the soil by a sieving and flotation technique as follows.

(1) Soak samples overnight in 2 gal. of water.

(2) Stir vigorously, allow 20 sec. for sedimentation of large particles and pour supernatant through a 125 μm. pore diameter sieve into a second bucket.

(3) Allow filtrate to sediment and discard supernatant.

(4) Transfer sediment to centrifuge bottles and spin at 1500 rev./min. for 10 min. Discard supernatant.

(5) Stir sediment and fill bottles with saturated magnesium sulphate solution. Centrifuge at 1000 rev./min. for 10 min.

(6) Collect supernatant, pass through 20 μm., pore diameter sieve and examine residue.

The recovered eggs were examined under a light microscope (magnification × 160) and their state of development determined using the characteristics described by Beer (1973).

In addition to the above, at the time of the last sampling (18 months after treatment) soil was taken at the following depths (in.) using a 3 in. bore soil sampler: 0–4, 4–8, 8–12, 12–16, 16–20 and 20–24. The soil from each depth was examined as before and it was hoped to show the extent to which the eggs had leached down through the soil.

RESULTS

Table 1 shows the number of embryonated, unembryonated and degenerated eggs found, expressed as a percentage of the total number of eggs in the sample. Fig. 1 shows graphically the percentage of potentially infective eggs (unembryonated plus embryonated eggs) recovered on all ten plots. As can be seen, on all the

* Basamid = tetrahydro-3,5-dimethyl-2*h*-1,3,5-thiadiazine-2-thione.

Table 1. *Percentage recovery of unembryonated, embryonated and degenerated eggs*

Time after treatment (months) ...	0	8	10	13	18
Date of sampling ...	9.viii.73	5.iv.74	6.vi.74	15.ix.74	5.ii.75
Plot 1					
Degenerated	17	94	92	90	97
Unembryonated	16	0	5	0	0
Embryonated	67	6	3	10	3
Plot 2					
Degenerated	36	92	88	—	81
Unembryonated	0	2	7	—	0
Embryonated	64	6	5	—	19
Plot 3					
Degenerated	11	64	60	83	79
Unembryonated	2	0	8	0	0
Embryonated	87	36	32	17	21
Plot 4					
Degenerated	53	56	72	—	89
Unembryonated	3	0	9	—	0
Embryonated	44	44	19	—	11
Plot 5					
Degenerated	4	30	87	—	81
Unembryonated	96	0	0	—	0
Embryonated	0	70	13	—	19
Plot 6					
Degenerated	34	21	70	83	89
Unembryonated	27	0	8	0	0
Embryonated	39	79	22	17	11
Plot 7					
Degenerated	21	32	51	—	86
Unembryonated	30	0	0	—	0
Embryonated	49	68	49	—	14
Plot 8					
Degenerated	16	51	30	—	79
Unembryonated	40	0	3	—	0
Embryonated	44	49	67	—	21
Plot 9					
Degenerated	26	15	20	—	76
Unembryonated	4	0	0	—	0
Embryonated	70	85	80	—	24
Plot 10					
Degenerated	7	12	11	—	61
Unembryonated	0	0	1	—	0
Embryonated	93	88	88	—	39

plots the percentage of embryonated forms recovered fell as the experiment progressed. On the untreated control plots 79 % of the eggs had degenerated during the 18 months of the experiment whilst on the treated plots the degeneration ranged from 61 % to 97 %. Statistical analysis was carried out on the results by taking the number of potentially infective eggs (embryonated +unembryonated)

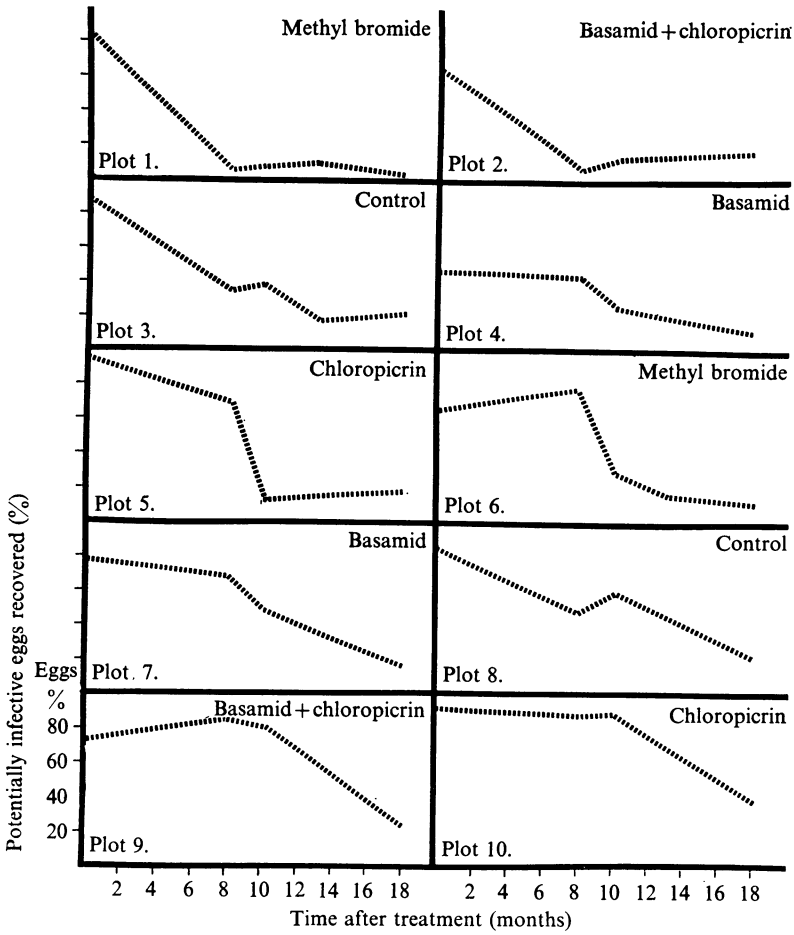

Fig. 1. Percentage of potentially infective eggs recovered from trial plots.

remaining at each time of observation as a percentage of the number of potentially infective eggs present just before treatment. Fig. 2 shows these data arranged in graph form. An analysis of variance was carried out on these data and there were no significant differences between the means of the five treatment groups. However, there were generally fewer embryonated eggs recovered on the plots at each successive sampling.

Table 2 shows the numbers and state of development of the eggs found at various depths in untreated control plot 3, at the time of the last sampling (18 months after the start of observations).

As was expected, the percentage of degenerate eggs increased in the samples from greater depth. This presumably represented the greater age of these eggs found in the lower layers.

This test demonstrates that the ova of *T. trichiura* are not quickly washed through the clay-flint soil at Cell Barnes Hospital and that infective eggs are still present in the surface layers more than 18 months after deposition.

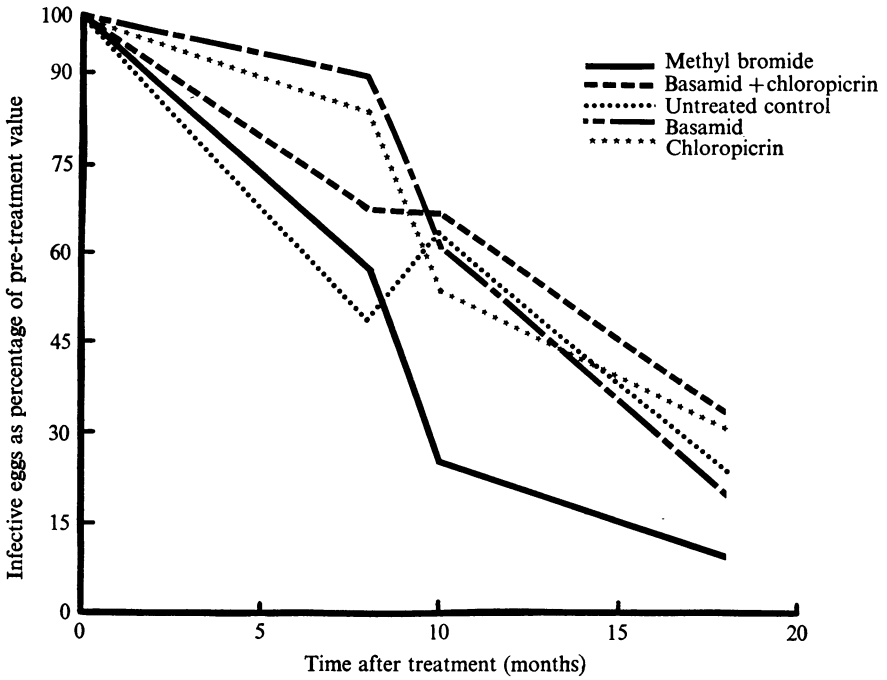

Fig. 2. Potentially infective eggs recovered at various times after treatment measured as a percentage of the pretreatment value.

Table 2. *Recovery of eggs from various depths on control plot* 3, 18 *months after observation began*

Depth (in.)	Weight of sample (kg.)	No. of eggs					Total degenerate (%)
		Total	Without embryo	With embryo	Degenerate with embryo	Degenerate	
0–4	2·1	500	0	120	100	280	76
4–8	2·3	960	0	40	0	920	96
8–12	2·1	260	0	0	0	260	100
12–16	2·5	50	0	0	0	50	100
16–20	2·5	100	0	0	0	100	100
20–24	2·5	980	0	0	0	980	100

DISCUSSION

The rate at which *T. trichiura* eggs died was similar on all the plots and was not influenced by any of the treatments given. The use of these expensive soil fumigants to control *T. trichiura* infestations is clearly a waste of time and money. However, the rate of death of eggs on all the plots was quite rapid, and by the time of the last sampling a mean of 81·8 % of the eggs had perished.

This rapid natural decline in the numbers of infective ova was quite unexpected as it has been generally assumed in the past that the eggs of *Trichuris* spp. worms are extremely long-lived under natural conditions. The literature reveals little

information on the longevity of *Trichuris* spp. ova and no carefully controlled experiments have been reported on this subject. The main evidence for longevity comes from Hill (1957), who demonstrated that pigs could become infected with *T. suis* from ground that had been fallow for 6 years. Our present trial would suggest that the ova of *Trichuris trichiura* are far less long-lived than has previously been rumoured.

Throughout this trial, the patients of ward 18 were not allowed access to grassed playgrounds of the type described. They were treated with difetarsone at the outset, and this successfully reduced the numbers of *Trichuris trichiura* ova in the stools to a low level. However, most of the patients were again passing large numbers of worm eggs in their stools by the end of the trial period. We must conclude that either the drug was not wholly successful in eliminating adult and larval forms or a further focus of infection is present somewhere in the hospital.

We are grateful for the technical assistance of Mr N. Hammet, Compton and Mr P. H. Finch, Rothamsted.

REFERENCES

BEER, R. J. S. (1973). Morphological descriptions of the egg and larval stages of *Trichuris suis* Schrank 1788. *Parasitology* **67**, 263–78.

GREEN, E. A., BEER, R. J. S., JENKINS, D. C., MCFADZEAN, J. A. & PUGH, I. M. (1973). Transmission of *Trichuris trichiura*. *British Medical Journal* iii, 48–9.

HILL, C. H. (1957). The survival of swine whipworm eggs in hog lots. *Journal of Parasitology* **43**, 104.

LYNCH, D. M., GREEN, E. A., MCFADZEAN, J. A. & PUGH, I. M. (1972). *Trichuris trichiura* infestations in the United Kingdom and treatment with difetarsone. *British Medical Journal* iv, 73–6.