

The Mayfield Experiment:

an attempt to eliminate bilharziasis from a small community by repeated treatment of the infected people combined with intensive snail control.

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INTRODUCTION.

Mayfield Farm, 880 hectares in extent, is situated 40 km west of Salisbury and is 1 400 metres above sea level, overlooking the Mazoe Valley. The farm grows maize and seed maize, and maintains a pedigree herd of Aberdeen Angus cattle. There are two streams on the farm; on the main stream which rises on a neighbouring farm there are two dams impounding 113 600 m³ and 254 500 m³ of water. Before the stream leaves the farm it is joined by a second stream which arises on the farm. A concrete weir on this stream diverts storm water into a channel which leads the water to discharge it above the larger of the two reservoirs on the main stream. There are seven small reservoirs on the farm which are used for watering cattle in the paddocks.

The farm is worked by the owner and his son in partnership, and employs 60 to 70 labourers who, with their wives and children, totalled 184 in 1971. The labourers live in brick houses or traditional pole and mud-walled houses with thatched roofs. Water for domestic use is derived from boreholes delivered to stand-pipes in the living area, but there is no doubt that there is considerable use made of the water in the streams and reservoirs for laundry and fishing. There is a farm school with two teachers, attended by 80 children, about 30 of whom come to school from adjacent farms.

In 1967 the resident population was much higher — 231 — when tobacco growing was an important part of the farming operations. In 1968 the population had fallen to 131, but as a result of diversification of operations, has now risen to its present level of 184. This number is composed mainly of farm labourers and their families many of whom have been in employment on this farm for many years. The wives, accompanied by their younger children, tend to return for short visits to their Tribal Trust Lands. It is common to find the sons when they grow up, marrying the daughters of other

labourers on the farm. The community can be considered a stable population, but by no means a static one.

The prevalence of bilharziasis in the Mayfield community was first assessed in July, 1967, in order to see if it would be a suitable locality to undertake field trials of oral and intramuscular hycanthone. The prevalence rates for *Schistosoma haematobium* and *S. mansoni* were 37 and 12 per cent. respectively, and there were many double infections.

A snail survey was carried out by a field officer in August, 1967. The main stream on which there are two large reservoirs, showed fair numbers of *Bulinus (Physopsis) globosus* throughout its length and in the reservoirs. *Biomphalaria pfeifferi* snails were found in the same situations, but in lesser numbers except for a heavy concentration below the second and largest reservoir. The second stream showed scanty populations of *B. (P.) globosus* and fewer *B. pfeifferi*. No vector snails were found in the smaller reservoirs. A programme of intensive snail control based on the use of the molluscicide Bayluscide was initiated on 4th August. The two large reservoirs were sprayed from a boat using a power sprayer, and the streams were sprayed using hand-operated pumps. The waterbodies were re-surveyed on 2nd October, 1967, and only one vector snail was recovered. Another survey on 25th May, 1968, showed no vector snails though fair numbers of *Lymnaea* and *Bulinus (Bulinus)* snails were found. Despite regular checks by a snail ranger and the field officer, no vector snails were found until June, 1969, when *B. (P.) globosus* were found in the main stream above the upper reservoir, in the two main reservoirs, and along the main stream. The water-course and the reservoirs were treated with Bayluscide molluscicide by the system of surveillance (Clarke and Shiff, 1968). In the period June, 1969, to October, 1971, no vector snails were found after careful and repeated searching, and despite the presence of both species in the headwaters of the main stream on the neighbouring farm. However, in December, 1971, following heavy rains, a very few snails of both vector species were found and were eliminated by focal application of Bayluscide. In fact, Mayfield has, since August, 1967, been virtually free of vector snails.

By the time the first drug trial was staged in March, 1968, it can be claimed that there was little if any chance of the resident population of Mayfield being exposed in their domestic environment, to infection by either schistosome species. The first drug trial of hycanthone has

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been recorded by Clarke *et al* (1969). The results were encouraging enough to lead on to an attempt by chemotherapy to eliminate bilharziasis in a small population group living on a farm.

PLAN OF OPERATIONS.

An annual whole population prevalence survey was undertaken in February or March of each of the years 1968-1972 inclusive, and all persons found infected with *S. haematobium* or *S. mansoni* or both infections, were treated or retreated with Etenol (Winthrop). On one occasion in April-May, 1969, an exception was made when Niridazole (Ambilhar CIBA) was administered using the graded dose/weight scale described by Clarke and Blair (1969), in which the maximum dosage was 40 mg/kg daily for six days. Follow-up visits to collect stool and urine specimens from treated persons were made to check the results of drug therapy. The opportunity was taken during these visits to collect urine and stool specimens from new arrivals on the farm and children attending the farm school for the first time. Stool and urine surveys were carried out by the methods described by Blair *et al* (1969a and b). This consists of

collecting terminal urine samples between 10.30 a.m. and noon; these are left to sediment and 15 ml containing the deposit is centrifuged. Egg counts were made on 0,05 ml of the final deposit. If no eggs were seen, a large drop was then examined. All specimens in which eggs were found were subjected to hatching and miracidia hatching accepted as evidence of the viability of infection. Stools were passed by the patient on dry ground and a portion transferred by him to a wide-mouthed bottle containing hypertonic saline. The stool samples were processed by sieving, sedimentation in a conical flask, followed by centrifugation. An estimate of egg numbers was made on a small drop of about 0,05 ml of the deposit and the remaining contents of the centrifuge tube subjected to miracidia hatching by the addition of pond water, and observed on at least six occasions over 48 hours. The method described was rigidly adhered to for the annual prevalence surveys, and also for the post-treatment follow-up surveys. A measure of the co-operation of the patients and their employers is that it was possible to see the whole farm population at the annual prevalence surveys and that each subject produced a urine and a stool specimen for examination.

Table I.

RESULTS OF ANNUAL PREVALENCE SURVEYS.

T = total population examined.

O = resident for at least one year.

N = newcomers since previous survey, including children from neighbouring farms attending the Farm School.

Year	Date of Survey	Group	Number examined	Urine Survey		Stool Survey	
				<i>S. haematobium</i> positive	% positive	<i>S. mansoni</i> positive	% positive
1968	13 Feb.	T	131	70	53	65	50
1969	14 Mar.	T	212	23	11	46	22
		O	179	9	5	21	12
		N	33	14	42	25	76
1970	2 Mar.	T	209	32	15	22	11
		O	180	10	6	6	3
		N	29	22	76	16	55
1971	5 Mar.	T	220	19	9	38	17
		O	184	12	7	25	14
		N	36	7	19	13	36
1972	13 Mar.	T	152	11	7	14	9
		O	119	5	4	11	9
		N	33	6	18	3	9

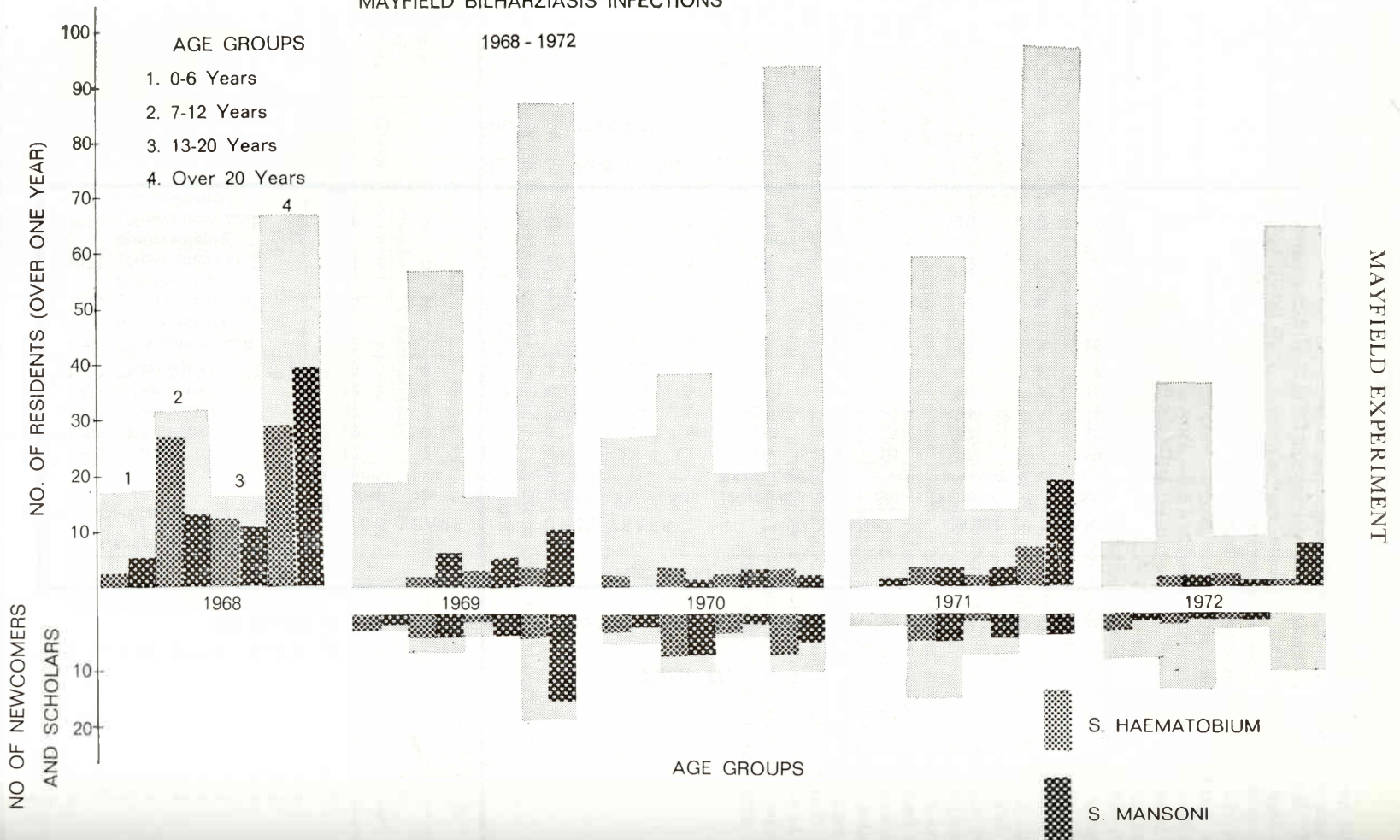
Table II.

INFECTIONS FOUND IN ANNUAL SURVEYS IN RESIDENTS AND NON-RESIDENTS: MAYFIELD.

Group and Year of Survey	Age Grouping														
	0-6 YEARS			7-12 YEARS			13-20 YEARS			OVER 20 YEARS			TOTAL		
	Number examined	Sh. +ve	Sm. +ve	Number examined	Sh. +ve	Sm. +ve	Number examined	Sh. +ve	Sm. +ve	Number examined	Sh. +ve	Sm. +ve	Number examined	Sh. +ve	Sm. +ve
1968 (Total)	17	2	4	32	27	12	16	12	10	67	29	39	132	70	65
1969 (Residents)	19	0	0	57	2	6	16	3	5	87	3	10	179	8	21
1970 (Residents)	27	2	0	38	3	1	21	2	3	94	3	2	180	10	6
1971 (Residents)	12	0	1	60	3	3	14	2	3	98	7	18	184	12	25
1972 (Residents)	8	0	0	37	2	2	9	2	1	65	1	8	119	5	11
1969 (Newcomers and non-residents)	3	3	1	7	5	4	4	2	4	19	5	16	33	15	25
1970 (Newcomers and non-residents)	5	3	2	10	8	7	4	3	1	10	8	6	29	22	16
1971 (Newcomers and non-residents)	1	0	0	15	6	6	7	1	4	3	0	3	26	7	13
1972 (Newcomers and non-residents)	8	3	1	13	2	1	2	1	1	10	0	0	33	6	3

Sh. = *S. haematobium*.Sm. = *S. mansoni*.

FIGURE I
MAYFIELD BILHARZIASIS INFECTIONS



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Table III.

S. MANSONI INFECTIONS (80 PATIENTS).

TREATMENT AND RE-TREATMENT OF PATIENTS WHO ARE MAYFIELD FARM RESIDENTS, MARCH, 1968- MARCH, 1971.

I. SCHEDULE OF TREATMENTS GIVEN.

19 March, 1968: Comparative trials of hycan-thone (Clarke *et al.* 1969), oral hycan-thone 2,5 mg/kg/day for 3 days, second group for 4 days.

15 October, 1968: Single injection intramuscular hycan-thone 3 mg/kg and fourth group 3,5 mk/kg. Single intramuscular injection of Etrenol, 3,0 mg/kg.

28 April-3 May, 1969 Niridazole (Ambilhar CIBA) twice daily for 6 days.

23 April, 1970: Etrenol 3,0 mg/kg single injection intramuscularly.

2 November, 1970: Etrenol 3,0 mg/kg single injection intramuscularly.

5 March, 1971: Etrenol 3,0 mg/kg single injection intramuscularly.

II. RESULTS OF TREATMENT AND RE-TREATMENT:

S. HAEMATOBIMUM INFECTION (74 PATIENTS).

1. Cured after a single treatment	65
(a) 3 days oral hycan-thone	9
(b) 4 days oral hycan-thone	10
(c) Intramuscular Etrenol	44
(d) Ambilhar	2
2. Still infected after first treatment with Etrenol	1
3. Cured after a second treatment	5
(a) 3 days oral hycan-thone and Ambilhar	1
(b) 4 days oral hycan-thone and Ambilhar	1
(c) 3 days oral hycan-thone and Etrenol	1
(d) Etrenol	2
4. Cured after three treatments: two with Etrenol and one with Ambilhar	1
5. Probable re-infection after cure of first infection	2

1. Cured after a single treatment	44
(a) 3 days oral hycan-thone	3
(b) 4 days oral hycan-thone	3
(c) intramuscular Etrenol	26
(d) Ambilhar	12
2. Still infected after first treatment with Etrenol	6
3. Cured after second treatment	13
(a) 3 days oral hycan-thone and Ambilhar	1
(b) 4 days oral hycan-thone and Ambilhar	1
(c) 3 days oral hycan-thone and Etrenol	1
(d) 4 days oral hycan-thone and Etrenol	2
(e) 2 Etrenol	4
(f) Etrenol and Ambilhar	4
4. Cured after third treatment	9
(a) 3 days oral hycan-thone and 2 Etrenol	1
(b) 3 days oral hycan-thone, Ambilhar and Etrenol	1
(c) 4 days oral hycan-thone, Ambilhar and Etrenol	1
(d) 2 Etrenol and Ambilhar	5
(e) 3 Etrenol	1
5. Three treatments with Etrenol, one with Ambilhar and still infected	1
6. Cured after fourth treatment, three with Etrenol and one with Ambilhar	1
7. Five treatments, one 4 days oral hycan-thone and four Etrenol and still infected	1
8. Probable re-infection after cured of original infection	2
Number of infected subjects followed-up in the trial	114
Number of those who had double infections of <i>S. haematobium</i> and <i>S. mansoni</i>	40

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RESULTS OF THE ANNUAL PREVALENCE SURVEYS

Table I sets out the prevalence of *S. haematobium* and *S. mansoni* infections in their groups; firstly in the whole population, then in the population resident more than one year; and finally, the third group which included newcomers and school children from neighbouring farms. The surveys make clear the higher prevalence of both infections in the new population as compared with the resident population. Persons from any group, who had been treated on the results of a prevalence survey, appear in subsequent surveys as still suffering from an infection despite treatment, or they may show reinfection. Table II and Figure 1 show the prevalence of infection in four age groupings for both *S. haematobium* and *S. mansoni* and demonstrates how much is contributed to the total by the newcomers and school children from neighbouring farms.

RESULTS OF TREATMENT

After each prevalence survey all persons found infected were treated. The first treatment in the series was given on 19th March, 1968, and has been described by Clarke *et al* (1969). Etenol was used as single intramuscular injection at either of two dose levels or by mouth for three days or four days of treatment. All other treatments were by a single intramuscular injection (Etenol Winthrop) at 3.0 mg/kg except for treatment given at the end of April, 1969, at which all persons found infected at the 1969 prevalence survey were treated with Ambilhar.

Treatment with Etenol was entirely without incident and the only side-effects recorded were complaints of nausea by a few patients, with even fewer actually vomiting—generally after the evening meal of the day of treatment. None of the farm labourers or the children attending school were absent as a result of treatment. However, treatment with Ambilhar was not without incident. Of 66 persons treated, seven patients—all adult males—showed toxic side effects serious enough to prevent them working. Four of these were off work for one day, the fourth day of treatment, but completed the full course of therapy without further incident. One, an elderly male, began to have twitching of the face and the arms after the sixth dose at the end of the third day of treatment which was immediately discontinued. He made an uneventful recovery. Another male, a deaf mute, became very agitated after the end of the third day and this was probably caused by the lack of communication; he completed the full course.

The seventh patient was off work for two days complaining of headache and cramp-like pains in the chest. He also completed the full course of treatment on schedule. It is noteworthy that there were no complaints from any of the women or children, and it should be remembered that the children received a much higher dose, mg/kg, than the adults.

Table III gives the schedule of treatments given to those persons considered as farm residents, and shows the numbers of people who were not cured by the first treatment who required subsequent and repeated treatments. This shows clearly that *S. haematobium* infections are more readily cured than *S. mansoni* infections. Each patient treated has had up to as many as 10 follow-up examinations if they were in the group who were first treated in March, 1968. In Table III under the heading of *S. mansoni* infections there are 14 patients who have received three or more courses of treatment. Five of these were adult males, including two over 40 years of age, and there was only one who had a double infection; three were adult females, two of whom had double infections. The remaining six were children ranging in age from eight to 16 years; five had double infections and one had *S. mansoni* only. It is interesting to note that the eight patients in this group who also had an infection with *S. haematobium* were all cured by the first course of treatment in contrast with the poor results in curing the concomitant *S. mansoni* infections. Persons in the February, 1972, prevalence survey who were found infected were treated or retreated with Etenol but the results of this treatment are not yet known and have not been included in Table III.

DISCUSSION.

In the world there is a general attitude of defeatism to the control of bilharziasis by a combination of snail control and mass chemotherapy. Clinicians and public health workers alike tend to argue that treatment of infected persons was a waste of time and effort because they would very soon be re-infected. It is said by them that treatment should be given only to people who were obviously and seriously infected with damage to bladder and ureters or serious damage to liver and the portal circulation. In taking this view too little importance has been given to the insidious effect of even a relatively light infection, especially when it occurs in children.

The work done at Mayfield over five years has shown that it is not difficult to virtually eliminate vector snails from all surface waters on the farm and keep it so with little expense

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and labour, by regular surveillance and focal application of molluscicide when this is called for. It is less easy to eliminate the schistosome worms from their human hosts, particularly so when *S. mansoni* infections are present. However, although complete eradication of the parasites may not occur, the residual infection in persons who have been treated once with hycan-thone or Niridazole appears to be of very small proportions. The evidence of disease in newcomers or school children attending the farm school shows that the prevalence in the population of adjacent farms remains high, and it is therefore interesting to note the smaller number of re-infections in the resident population of Mayfield despite the fact that they move freely, particularly during the week-end, visiting friends and relations on nearby farms. It appears that when they go visiting for social reasons they have little or no contact with surface water on neighbouring farms.

The owner of the farm has some interesting comments to make on the results of treatment since 1968 other than the parasitological findings which have been recorded. The number of farm labourers, their wives and families, attending the daily "sick parade" previously were always patients who were seeking relief for minor ailments such as backache, headache, diarrhoea and abdominal pain as well as coughs and colds. Now the number seen has greatly diminished, and for long spells no patients attend. The African schoolmaster and his assistant are convinced that the learning capacity of his pupils has greatly improved, and the examination passes bear this out. Children in past years often ceased attending school because they lost interest, but now the desire to remain at school is so strong that an additional school room has been provided. We have visited the farm to undertake treatment, do parasitological surveys or follow-up treated patients, at least five times a year, and we are impressed with the improved condition of the children, particularly of their skin. It has also been noted that wives show much more interest in turning out for seasonal farm work such as sorting seed maize, thus earning extra cash, whereas previously it was difficult to raise and maintain their interest in the financial rewards of periodic employment. It is, of course, very difficult to give facts and figures to support such impressions, but there is no doubt that all who are concerned with the welfare and efficiency of the farm labour force are convinced that the treatment of bilharziasis and the freedom from re-infection of the residents, has greatly improved their health.

It is felt that the combination of snail eradication and treatment of the human population done together is well worth the effort in view of the general improvement in the health of the people.

Macdonald (1968) in his paper on the dynamics of schistosome infections and his mathematical predictions of the effects of various preventive measures showed that the best results would be obtained by the treatment of the population combined with snail control. He indicated that this combination could reduce the incidence of bilharziasis to a low level in four years. This possibility has been achieved at Mayfield in this time.

SUMMARY.

A 880 hectare farm over a period of five years was kept free from vector molluscs by application of molluscicide and snail surveillance. At the same time an effort was made to eliminate bilharziasis in the human population by chemotherapy, and *S. haematobium* and *S. mansoni* prevalence rates in the resident population was reduced from 53 and 50 per cent. in 1968 to 4 and 9 per cent. in 1972. New infections and re-infections on the farm were practically eliminated. *S. mansoni* infections proved to be more difficult to cure than *S. haematobium*, even after repeated treatment.

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We are glad to acknowledge the supply of Etenol for this study, made by Stirling Winthrop Products.

ADDENDUM.

The supplement in which this paper is published has been rather delayed and a further annual prevalence survey has been completed at Mayfield Farm. During the year snail surveillance has been maintained and only on one occasion a few *Bulinus (Physopsis) globosus* were detected in September, 1972, at one point on the shoreline of the largest reservoir. These were eliminated by focal spraying with Bayluscide.

The prevalence survey was carried out on 6th February, 1973, and comprised 138 persons who each provided a urine and a stool sample. The survey revealed five *S. haematobium* and nine *S. mansoni* infections which included a child aged seven years with a double infection. The people under 21 years of age numbered 65; this included three with *S. haematobium* and four with *S. mansoni* of whom six were in persons who had come to live on the farm or attend the farm school since early 1972. The only resident in this group with an infection was a girl aged 11 years who some years previously had a urinary infection and now appears to have developed a new *S. mansoni* infection. The population aged 21 years and over numbered 73 and in these there were two women with *S. haematobium* — one of whom was a newcomer, and five persons with *S. mansoni* — one a newcomer; one, a male who had been found free from infection in the earlier surveys, and must be considered as a new case, and three old residents who had been treated and re-treated on a number of occasions during the study. One of these cases was a female who, from October, 1969, to March, 1972, was given seven intramuscular injections of Etrenol. During this period she was pregnant on three occasions and delivered three healthy babies who are thriving well. At the present time she is pregnant again and still harbouring a light *S. mansoni* infection.

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