patients with organisms initially P.A.S.-resistant (who had had prior treatment with P.A.S. alone) were not protected from the risk of development of streptomycin resistance by the SP treatment. Thus none of the three drugs, isoniazid, streptomycin, or P.A.S., should be used by itself, nor should two of them be used in combination for a patient whose organisms are already resistant to one of the pair. Whenever possible, the drug sensitivity of a patient's organisms should be assessed before chemotherapy is started, to avoid an unsuitable combination of drugs; and also on its completion, in case more chemotherapy is required later.

There is a great need for simple, reliable, and speedy techniques for the culture of tubercle bacilli and for the determination of their sensitivity to chemotherapeutic agents.

The trial was designed so that it could be modified to study fresh problems in the light of information it had itself yielded; at present the effects of two different dosages of streptomycin and two of P.A.S., each in combination with isoniazid, are under investigation.

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M. CANIS RINGWORM AND LOSS OF SCHOOLING

BY

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Cases of ringworm of the scalp produced by the two commonest pathogens, *Microsporum canis* and *M. audouini*, continue to be grouped together as one condition from the point of view of treatment. This is unfortunate. *M. canis* ringworm differs from the *M. audouini* type in being amenable to simpler measures of treatment and in being less contagious. Further, it can be demonstrated that there is no valid reason for excluding *M. canis* cases from school. In the treatment of *M. audouini* ringworm, x-ray epilation is unquestionably the correct procedure, and if it is not carried out the child may continue with the complaint until puberty is reached. As the technique of epilation improves, so do the risks inherent in its use diminish.

In common with others treating ringworm of the scalp, I have experienced the following difficulties. There has been an occasional case of incomplete regrowth of hair; cases in which a marked inflammatory reaction resulted, necessitating incision of sterile abscesses (Fig. 1); and cases in which the first epilation failed to eradicate the infection. Occasionally an anaesthetic has been necessary in toddlers. After x-ray epilation a good regrowth of hair has taken six months in boys and up to a year in girls.

Scalp ringworm caused by *M. canis* need never be treated by x-ray therapy, the following measures of treatment being effective in all cases. The scalp is clipped and the hair kept short, a linen cap is worn constantly, and a simple fungicidal ointment is applied daily. The mildest fungicides are effective, and Whitfield's ointment is adequate. Far stronger fungicides and rubefacients are tried from time to time in cases of *M. audouini* ringworm, but, as yet, no completely effective application has been found. There is no justification for their use in *M. canis* ringworm.

Sharp (1951) described his treatment of 120 cases of *M. canis* ringworm of the scalp (*M. audouini* ringworm is extremely rare in Australia). He used fungicidal treatment only, and the average time taken for cure was 13 weeks. In the subsequent discussion it was apparent that many dermatologists still use x-ray epilation in *M. canis* cases simply because by this method it is possible to get the child back to school in about six weeks.

Distinction Between Types

M. canis and *M. audouini* ringworm cases may be distinguished with reasonable accuracy clinically but only with certainty on culture. It is essential to know which type is endemic locally. For many years a focus of *M. audouini* scalp ringworm has existed in the Blackwood area of Monmouthshire, but practically none of this type of ringworm has been encountered in Newport, 12 miles distant. Of the ringworm cases in the Blackwood area, 91 out of 94 cases have been of *M. audouini*, and in the Newport area out of 32 cases only one has been produced by *M. audouini*.

There are other factors which enable one to make a clinical diagnosis of *M. canis* ringworm. Local tissue reactions are usually more pronounced and there may be erythema, papulation, or even kerion. This distinction, however, is not entirely reliable, and, exceptionally, *M. audouini* cases produce inflammatory reactions (Fig. 2). There is usually a history of an infected puppy or kitten

with which the patient has come in contact. The frequency of tinea circinata in *M. canis* ringworm is well known (Fig. 3). Beare and Cheeseman (1951), describing 1,004 cases occurring in Northern Ireland between May, 1949, and July, 1950, refer to greater brilliance and longer duration of Wood's light fluorescence in *M. audouini* infections. By applying these tests they were able to diagnose correctly 97% of their 71 *M. canis* infections before the results of culture were available.

Epidemiology

While there is abundant evidence that *M. canis* infections are caught direct from animals, it is rarely possible to demonstrate direct contagion from child to child. In the 27 cases dealt with in Table I, six animals were known to be responsible for 11 cases. Five of the animals were kittens, which were destroyed.

In other cases some association with a domestic animal was invariable, but this alone is not proof of an animal source of contagion. The possibility of one animal being responsible for multiple cases must not be lost sight of, and

the four children with the non-pigmented subtype (Cases 20-23) were all infected by one dog. Roberts (1909) described the direct infection of 13 persons from a single cat. Thomas, Lennox, and Duncan (1945) reported the infection of nine persons from one dog. Kittens are now recognized as the more usual sources of *M. canis* infections.

Walker (1950) has studied closely the geographical distribution of the dermatophytes. She reported that *M. canis* tended to form local pockets of infections in certain areas, and notably at Leicester, Leeds, Coventry, Reading, Portsmouth, Barnstaple, and villages in South Devon. She thought there was reason to believe that a high percentage of cases were due to child-to-child contacts, but agreed that complete data on transmission were not usually available. She indicated also the tendency for *M. canis* infection to be attenuated by child-to-child transmission, a renewal of the infection from an animal host being therefore necessary for the continued propagation of the disease on children. Referring to the predominance of one organism in certain areas, Dr. Walker thought that the apparent absence of overlapping of the different infections in the small endemic areas suggested that the predominance of one type tended to prevent establishment of another type in the area.

For purposes of contact tracing it is convenient that *M. canis* can be subdivided into three distinct types, distinguishable on culture by the kind of pigmentation they produce in the medium. The first is the orange type, originally labelled *M. felineum*; the second is the pale yellow or citreous type described by Duncan (1948); and the third is the non-pigmented type, formerly known as *M. lanosum*.

Loss of Schooling

In *M. audouini* cases x-ray epilation, if it can be arranged immediately, ideally may enable the child to return to school in about six weeks. The objection to the conservative treatment of *M. canis* cases has been that longer periods of absence from school have been required and an average period of surveillance of about 13 weeks was necessary in Sharp's cases. In the present series the average period of surveillance was exactly 13 weeks.

Beare (1952, private communication) did not find quite the same disparity in the periods of absence required. He concluded that the average time away from school for *M. audouini* cases, assuming that all are epilated and allowing the child to go back to school when he is negative to Wood's light but before much regrowth of hair has taken place, is only slightly less than for *M. canis* cases which are allowed to clear without epilation.

In Newcastle-upon-Tyne, Dixon (1948) reported the occurrence of 1,258 cases over a period of six years. All were excluded from school, although this measure was applied

TABLE I.—Analysis of *M. canis* Scalp Ringworm Cases

Case No.	Age (yrs)	Date First Seen	Date Discharged	Prior Absence from School	School*	M. Canis Type	Contacts
1	12	24/10/50	19/12/50	3 days	A Mixed	Orange	} Siblings
2	9	24/10/50	12/3/51	2 "	B Girls	"	
3	3	24/10/50	19/12/50	"	"	"	} Cousins infected by kitten
4	5	27/11/50	19/3/51	3 weeks	A Infants	Citreous	
5	7½	27/11/50	23/4/51	1 week	A "	"	
6	10	12/12/50	2/4/51	"	I Mixed	"	} Siblings infected by kitten
7	6	15/12/50	2/4/51	"	I "	"	
8	6	19/12/50	11/6/51	6 weeks	C Infants	"	
9	5	22/1/51	16/4/51	7 "	D Boys	"	
10	8	22/1/51	16/4/51	9 "	D "	"	
11	7	23/1/51	23/4/51	20 "	E Junior	"	
12	7	31/1/51	10/4/51	6 "	F Boys	Orange	
13	9	26/2/51	23/4/51	6 "	G "	Citreous	
14	6	12/3/51	11/6/51	6 "	D Infants	Orange	
15	7	4/6/51	30/7/51	3 "	2 "	"	
16	4	27/8/51	13/1/52	Nil	H "	Citreous	} Siblings infected by dog
17	6	17/8/51	Left district	8 weeks	I Mixed	"	
18	7	27/8/51	22/10/51	12 "	J "	"	
19	8	24/9/51	5/11/51	6 "	2 "	Orange	
20	9	22/10/51	8/2/52	4 days	K "	Non-pigmented	
21	4	22/10/51	8/2/52	"	"	"	
22	7	22/10/51	8/2/52	1 week	K Mixed	"	
23	11	12/11/51	17/3/52	2 weeks	L Infants	"	
24	6	2/12/51	18/12/51	8 "	1 "	Orange	
25	9	4/2/52	"	2 "	2 "	"	
26	11	8/2/52	3/3/52	Nil	3 Mixed	"	} Infected by same dog
27	9/12	3/3/52	"	"	"	Non-pigmented	

*Lettered schools=Newport County Borough; numbered schools=Monmouth County.

FIG. 1.—Unusual scalp reaction following x-ray epilation in a case of *M. audouini* ringworm.

FIG. 2.—Case of *M. audouini* ringworm with exceptional degree of reaction, shown as crusting and papulation.

FIG. 3.—Typical *M. canis* infection of scalp with multiple small lesions on glabrous skin of neck.

with some reluctance because the disease is of such a long-term nature as to result in the loss of a high percentage of a child's school career. The cases were of the *M. audouini* type, and the average period of absence from school was assessed as 180 days if the treatment was by ointment and manual epilation. If x rays were used an effort was made to have the children back in school in three weeks after irradiation.

Carslaw (1951) treated 208 cases of tinea tonsurans, all mainly *M. audouini* type, and found that the 104 children of school age were able to return to school in an average of 45 days.

It is usual to discuss the period of treatment and surveillance but to overlook the period of absence from school before special treatment is sought. In the children dealt with in Table I this period varied between 1 day and 20 weeks. A variety of excuses, mostly unsatisfactory, were offered, but the fact remained that some children, with either type of microsporiasis, managed to evade both school and clinic, while at the same time mixing with siblings at home and playmates in the street. The mean loss of schooling before attending clinic in these cases was 33 days. This figure must be added to the 91 days of surveillance when estimating the average loss of schooling which would have been entailed by the attack of scalp ringworm had the children been excluded. It would thus have amounted to 124 days. (Holiday periods have not been deducted from these figures.)

National Survey

In order to assess the incidence of scalp ringworm in England and Wales a questionnaire was circularized to 104 major education authorities. The results are summarized in Table II. The following facts emerged.

(a) *Prevalence*.—There was a rise in incidence towards the end of the last war and in the immediate post-war years, but this seems to be subsiding again. That scalp ringworm is a problem only of the minority of regions is shown by the fact that in 63 areas the number of cases occurring annually is now either very low or nil. In Table II the

TABLE II.—*Summary of Replies to Questionary Received from 91 Major Education Authorities. Both M. canis and M. audouini Types of Scalp Ringworm are Included*

		Exclusion from School		Recent Annual Case Incidence			
		Total	Conditional	0-10	11-20	21-30	31+
County councils	29	23	6	16	5	3	5
County boroughs	62	58	4	47	6	4	5
Total	91	81 (89%)	10 (11%)	63	11	7	10

figures quoted refer to the last year for which full information was available, and is usually 1951, although 1950 is taken in a few instances. As examples, Bristol had 131 cases, Liverpool 82, Newcastle-upon-Tyne 136, Northumberland 65, Reading 48, Durham 58, and Monmouthshire 42 in 1951.

(b) *Routine Culture*.—Some 42 authorities (46.1%) stated that cultures from infected hairs were taken as a routine. Particulars were not usually available, however, because the patients were dealt with in the dermatological departments of hospitals. Where information was obtainable it was shown that in the county boroughs *M. canis* was predominant in 12, *M. audouini* in 7, and the infections were mixed in 4. In county areas *M. canis* was preponderant only in 2, whereas *M. audouini* was found in 10, 3 areas showing a mixture.

(c) *Exclusion from School*.—This is rigidly enforced for all types of scalp ringworm by 89% of authorities. Four county boroughs and five county councils allow some relaxation of this rule, but in none of these areas is ringworm common. The usual condition insisted upon is that the lesions are capable of being adequately covered by some form of headwear. In one district single cases are excluded, but if several children are infected simultaneously

they are allowed to attend school with head coverings. Exclusion was enforced in all the localities where *M. canis* is the endemic infection.

Present Investigation

The number of *M. canis* cases in Newport was only 14 between 1945 and 1950, but at the end of the latter year the incidence rose sharply. It was decided to allow all children with *M. canis* ringworm to return to school immediately, provided that certain precautions were observed. The precautions consisted in the wearing of a linen covering or a cap, the use of the ointment provided, and the weekly attendance at the ringworm clinic. The school health authorities willingly co-operated in this plan. Few objections were raised from any quarter. Parents were gratified that their children were able to continue at school, and satisfaction was felt at the clinic because regular weekly attendance was ensured. A solitary complaint was expressed from one child, who felt self-conscious about his headgear.

Details of the plan were as follows. At the first visit of the child to the ringworm clinic a decision was made regarding the probable nature of the dermatophyte and a specimen for culture was taken. A printed list of instructions was then handed to the parent with a promise that if clipping was adequately carried out and the other instructions were followed the child would be allowed to return to school. At his next visit to the clinic a certificate was issued stating that the child was suffering from a type of ringworm of low infectivity, that progress was now satisfactory, and that it was perfectly in order for him to continue at school.

The scheme was put into operation in February, 1951, and a careful note made of the school from which any subsequent case came and also of the subtype of *M. canis* involved.

Results

The results of the experiment are set out in Table I. By studying the type of organism, the time lapse between cases, and the school involved, it was possible to determine whether the infection had been propagated to another child. In fact, not one case of direct infection followed the return to school of any of the 24 children. It would have been well within the bounds of possibility for coincidental infections with the same type to occur in a school, but even this seems not to have taken place during the period under review.

Case 14 attended the same school group as Cases 9 and 10, but a different organism was involved. Case 25 was in the same school group as Cases 15 and 19, but none of these children was infected at the same time. No new case in a schoolchild has been reported in Newport for four months.

Discussion

The main consideration in scalp ringworm is the loss of schooling brought about, especially in the scholarship year. With the common childish complaints, such as the acute specific fevers, the period of absence usually is only a matter of weeks, but with ringworm it may be a matter of months. Efforts to avoid this loss of tuition merit serious attention. In localities where *M. canis* is the exclusive dermatophyte there need be no interruption in school attendance because of ringworm.

The possibility of allowing children with active ringworm to attend school has been raised before. In the annual reports of the Chief Medical Officer of the Board of Education (1927, 1933) it is stated that in rural areas where x rays are not available the child's hair must be clipped short, appropriate ointment applied, and a linen cap worn, and in such circumstances affected children may be allowed to attend school. No distinction in types of cases is made here, and, from my survey, little use has been made of this concession, particularly as x rays have become more generally available. Whether it would be profitable to allow *M. audouini* cases in school is a matter of conjecture and one which is being pursued.

It is not possible to calculate accurately the number of cases of *M. canis* ringworm excluded from school in one year, but the figure must be high. Apart from the question of contagion, with which I have dealt, there can be no objection to these children being in school, because no subjective illness is produced in ringworm. The risk of child-to-child contagion is slight anyway, and it is virtually impossible if simple precautions are taken.

Summary

The importance and methods of distinguishing between *M. canis* and *M. audouini* scalp ringworm are indicated.

Some epidemiological considerations regarding *M. canis* ringworm are presented.

The role of microsporium ringworm as a cause of loss of schooling is discussed.

The results of a survey of the incidence of ringworm in the areas of the major education authorities of England and Wales are tabulated and analysed.

An experiment, carried out in Newport, where the scalp ringworm is almost exclusively of the *M. canis* type, and in Monmouthshire is described. Twenty-four children were allowed to continue at 19 schools, the exclusion rule being waived. In no case was the infection propagated.

The conclusion is reached that children with *M. canis* ringworm should neither be treated by x-ray epilation nor be excluded from school.

My thanks are due to Dr. David Lawrence, medical officer of health for Newport, for permitting me to carry out this investigation and for co-operating so helpfully. Also to Dr. Jacqueline Walker, of the Department of Medical Mycology, London School of Tropical Medicine and Hygiene, for carrying out the culture and identification of the fungi.

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FIELD TRIALS OF NEW ANTIMALARIALS IN WEST AFRICA

BY

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The value of new antimalarials has not always been assessed in the field in comparison with other similar drugs, and specific claims for one or another of the new compounds are difficult to judge when each has had only a limited number of clinical tests. Differences which are known to exist between geographical strains of malaria parasites justify comparative field trials in many tropical areas.

The present difficulties in carrying out chemotherapeutic tests of new compounds in temperate climates on cases of induced malaria and/or on non-immune

volunteers increase the value of properly designed field trials in areas where indigenous malaria is common.

There has been little investigation, especially in tropical Africa, of the value of "camoquin" and pyrimethamine ("daraprim") in comparison with older antimalarials. The present paper reports on results of a chemotherapeutic trial of these drugs and of two other antimalarials, chloroquine sulphate ("nivaquine") and a new compound of the acridine series named "azacrin."

This last drug is a 2-methoxy-6-chloro-9-(5'-diethyl-amino-2'-pentyl) amino-3-aza-acridine dihydrochloride synthesized recently by Messrs. Ward, Blenkinsop and Co. jointly with Messrs. Howards and Sons, Ltd. The first laboratory tests against *Plasmodium gallinaceum* in chicks and *P. berghei* in mice have shown that this compound, given by the mouth, possesses good schizonticidal activity at a dose of 25 mg./kg. in chicks and at a dose of 5 mg./kg. in mice. Its toxicity for experimental animals was found to be low. No data on toxicity of this drug to man being hitherto available, it was taken as a precautionary measure by one of us before using it in field trials on children. The daily dose of 0.4 g. taken for five days having produced only minor side-effects (nausea), it was decided to use this drug for a field trial.

Present Investigation

The method of investigation was that developed by one of us (Bruce-Chwatt, 1951) and subsequently used in the first field trials of pyrimethamine (Archibald, 1951). This method is based on a preliminary selection of an adequate group of African schoolchildren, 5-10 years of age, all naturally infected with malaria. After the administration of a suitable therapeutic dose of the drug to be tested, daily blood examinations of each child are carried out. The parasite rate, parasite density, and any other malariometrical indices are calculated for each group from the results of daily examinations.

Blood slides (thin and thick film) were stained with Giemsa, and parasite rates and counts were based on the examination of thick films. Parasite counts were made from the parasite leucocyte ratio, and the number of parasites per c.mm. was calculated. No film was declared negative before the examination of at least 200 thick-film fields. Parasite density indices were computed as previously described (Bruce-Chwatt, 1951). The speed of decrease of the initial 100% parasitaemia of each group to the lowest level was used as a criterion of the comparative therapeutic activity of the investigated drug against the specific parasite.

For the purpose of the present trial 120 schoolchildren 5-10 years of age were selected after a preliminary investigation and divided into five groups. The first four groups were treated with chloroquine sulphate, pyrimethamine, camoquin and azacrin respectively. The fifth group was not given any drug and represented the control. The administration of each drug was invariably made under our personal supervision.

In the chloroquine sulphate group the drug was given in two different regimens. One-half received 0.75 g. (3 tablets) in a single dose on D day; the other half received 0.75 g. (three 0.25-g. tablets) on D day as a single dose, followed by 0.25 g. (1 tablet) on each of the two following days. In terms of chloroquine base the total dosage was 0.45 g. and 0.75 g. respectively.

The pyrimethamine group also received two different dosages of the drug. One-half had a single dose of 25 mg. (1 tablet) on D day, and the other half had 25 mg. on D day followed by the same dose on the next day. The camoquin group received one dosage only—0.4 g. (2 tablets) as a single dose on D day. The azacrin group was given 0.2 g. (2 tablets) on D day followed by 0.1 g. (1 tablet) on each of the two following days. The dosage of the four drugs is half the usual adult dose. The average age of the