

RINGWORM OF THE SCALP*

PROLONGED OBSERVATION, FAMILY INVESTIGATION, CULTURAL
AND IMMUNOLOGIC STUDIES IN 130 CASES

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Ringworm of the scalp offers an interesting field for the study of superficial mycotic infections of the skin for the following reasons: (1) the clinical diagnosis can be established easily by examination under fluorescent light, (2) the time of infection can ordinarily be determined with reasonable exactness, (3) positive cultures can be obtained in almost 100% of the cases of actual ringworm infection, (4) identification of the causative organism can be made by fairly simple techniques, (5) the local reactions in the scalp are ordinarily not appreciably changed by factors of contact dermatitis in untreated patients (as is so frequently the case in ringworm of the feet in adults), and (6) children are not frequently subject to other forms of ringworm infection, and the interpretation of trichophytin tests is somewhat simplified thereby. In the present study certain new data are added and some reports of recent observers in this country

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confirmed. The new data include (1) the results of a more prolonged observation of the course of untreated and treated ringworm of the scalp than has previously been reported, with the finding that cases of *M. audouini* undergo spontaneous cure more frequently than apparently has been suspected, (2) a somewhat more extensive epidemiologic family study than has yet been attempted, (3) further studies of trichophytin tests in children under 10 years of age with and without evidence of ringworm infections and (4) further demonstration of the importance of simplified methods of mycological study and of clinical examination which have been emphasized in particular by Lewis and Hopper (1). In addition, certain further data on concomitant trichophytin and tuberculin tests have been obtained, and some modification of the current concepts concerning treatment of ringworm of the scalp are suggested.

The fact that different species of fungi tend to elicit varying responses on the part of different hosts has long been known, and has been the subject of considerable study and recent clarifying emphasis in the American literature (1, 2). It has been established that ringworm infections of the scalp caused by "human" fungi, of which *M. audouini* is the most important example, almost always require epilating measures for complete cure while those caused by "animal" fungi, in particular *M. lanosum*, undergo spontaneous cure or respond to a variety of local measures. Many observers have noted that *M. lanosum* causes an inflammatory type of lesion on the scalp and tends to induce a marked specific sensitivity to trichophytin, while *M. audouini* infection is characterized by a non-inflammatory type of lesion associated with low trichophytin sensitivity and extreme refractoriness to local treatment (3). A review of the data on which these statements are based gives convincing support to the statement that ringworm infections of the scalp cannot be intelligently treated without cultural diagnostic studies.

During the past two years we have studied 130 cases of ringworm of the scalp and have examined on one or more occasions all the members of 67 families in which infection of one or more members had occurred. Prolonged observance of many cases has been made necessary by the refusal of parents to carry out

suggested local treatment or to allow a child to undergo x-ray epilation. Social service follow-up has enabled us to examine many cases untreated for long periods after the original diagnosis was made and the responsible fungus isolated.

The 130 proven cases of ringworm of the scalp were drawn from families in the lower economic stratum of central south Philadelphia. Ninety-six per cent of the patients were colored, and eighty-seven per cent were male. The hygiene of the patients varied considerably, but in many patients with ringworm of the scalp, the attention given by the mother compared well with that of individuals living under better economic conditions. However, it is apparent that something in the environment of these families has been conducive to the transmission of ringworm infections of the scalp; in Philadelphia at least, ringworm of the scalp is a comparative rarity in private practice.

The criteria which we have adhered to in the diagnosis of ringworm of the scalp are as follows:

Criteria for diagnosis of ringworm of the scalp

1. Clinical examination.
2. Fluorescence on examination of the scalp with Wood's light.
3. Demonstration of fungi on direct microscopic examination.
4. Positive culture in all cases, and identification of the organism in giant culture, following the relatively simple measures of species determination outlined by Lewis and Hopper, including Wood's light examination.

Criteria for cure of ringworm of the scalp

1. Absence of clinical evidence of infection.
2. Absence of fluorescence when the scalp is examined under the Wood's light, no ointment or other local treatment having been applied for several days, and shampooing having been done recently.
3. Negative culture for ringworm on any scale or any other likely material which can be obtained.
4. Fulfillment of all criteria for cure for a period of at least six weeks after original negative findings were obtained, in most cases after six months.

Of the 130 patients with ringworm of the scalp, 125 proved to be due to *M. audouini*, four yielded *M. lanosum* on culture, and one *M. fulvum*.¹

¹ Mycologic studies done in collaboration with the Laboratory of Dermatological Research, University of Pennsylvania.

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Results of cultural studies and inflammatory response in 130 cases of Tinea capitis

	TOTAL	%	NON-INFLAM.	INFLAM.
<i>M. audouini</i>	125	96.2	105 (84%)	20* (16%)
<i>M. lanosum</i>	4	3.1	1	3
<i>M. fulvum</i>	1	0.7	0	1

* Spontaneous inflammation in 11 cases.

It may be of interest to compare these cultural findings with those of various reports summarized by Lewis and Hopper. They found an incidence of 39.6% of *M. lanosum*, 39.3% of *M. audouini*, 7.5% *T. violaceum* and 5.8% *A. schoenleini* in New York City. In the 13 reports which they collected from the literature, *M. audouini* was the predominant organism in six, and *M. lanosum* in four. In the only other series reported from Philadelphia, that of Weidman (5) of 36 cases, 50% yielded *M. lanosum* and 41.7% *M. audouini*. It seems apparent from these studies that the offending fungus in ringworm of the scalp may vary considerably in different locations and, possibly, in different parts of the same city. In any study of the effects of treatment of ringworm of the scalp, the predominant causative organism is of great importance, since it may be of a type which leads to spontaneous cure. This probably explains failures to obtain cures with particular methods of treatment, on which observers in other parts of the country have reported in cases in which cultural studies were not done.

All five cases of "animal" type infection of the scalp became cured spontaneously, confirming the report of Lewis (6) and others indicating that such infections respond without x-ray epilation. All but one of our cases of *M. lanosum* infection showed varying degrees of inflammatory response.

Of the 125 patients in which *M. audouini* was cultured, certain marked differences in the clinical course were observed. In 20 cases, varying degrees of inflammation were noted, from a minor folliculopustular reaction to true kerion. This finding was a matter of surprise to us, and culture was repeatedly done in all these cases, with consistent isolation of typical *M. audouini*. Careful review of the local therapy used revealed that in only 9 cases could the inflammatory response be attributed to the

medication; in the others either no treatment had been used, or mild measures had been employed for considerable periods previous to the onset of the inflammation. In these cases of *M. audouini* infection with inflammation, 14 cases or 70%, became completely cured without x-ray epilation and have remained so for periods of observation varying from 3 to 14 months. Of these 6 cases which did not become cured, five were recognizable as being infected only on examination with the Wood's fluorescent light, by which a few fluorescent hairs could be seen. Of the 19 cases all but one were boys.

Of the same series of 125 *M. audouini* infections, 105 showed no inflammatory reaction. Of these 105 cases, 77 remained uncured, and 28 cured spontaneously or after varying local treatment measures. The results are summarized in table 1.

TABLE 1

Eventual outcome as to cure in 105 cases of non-inflammatory M. audouini infections of the scalp, with local or indifferent treatment

	TOTAL CASES	% OF TOTAL	NOT CURED	% NOT CURED	CURED	% CURED
Male.....	92	87.6	73	79.3	19	20.7
Female.....	13	12.4	4	30.7	9	69.3

Of cases of *M. audouini* infection without inflammation, 28 of 105, or 26.6% became cured spontaneously or with varying treatment.

Our material would indicate that *M. audouini* infections may be accompanied by varying degrees of inflammation, and that the presence of even marked inflammatory response is not necessarily indicative of an animal type of fungus (see fig. 1). The chance of spontaneous cure is greatly increased if inflammation occurs, but even in cases in which there is no inflammation, *M. audouini* infections become cured spontaneously in about one-fourth of the cases in periods varying from three months to two years. Varying types of local treatment were employed in these cases, and will be discussed in greater detail below, but no method of treatment seemed responsible for the cures, and the percentage of cures in completely untreated cases was similar to those in which local treatment was employed.

A striking example of the effect of inflammation on cure in

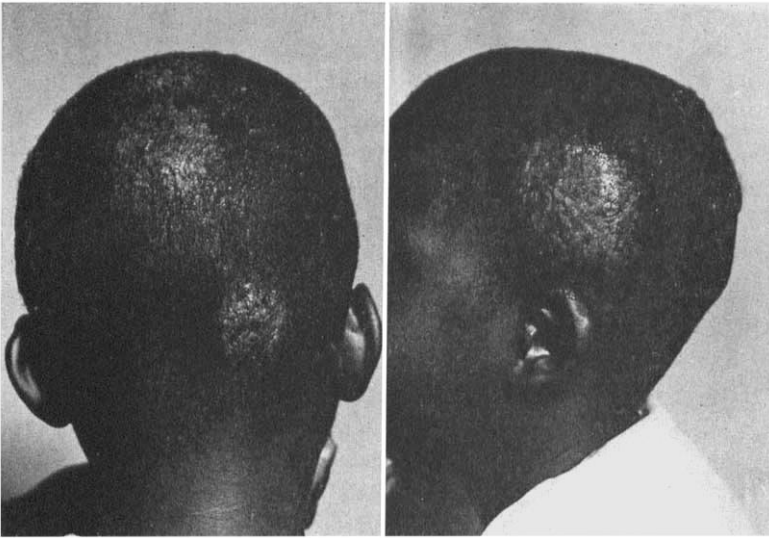


FIG. 1. Kerion reaction to *M. audouini* infection. Cured without depilating measures.

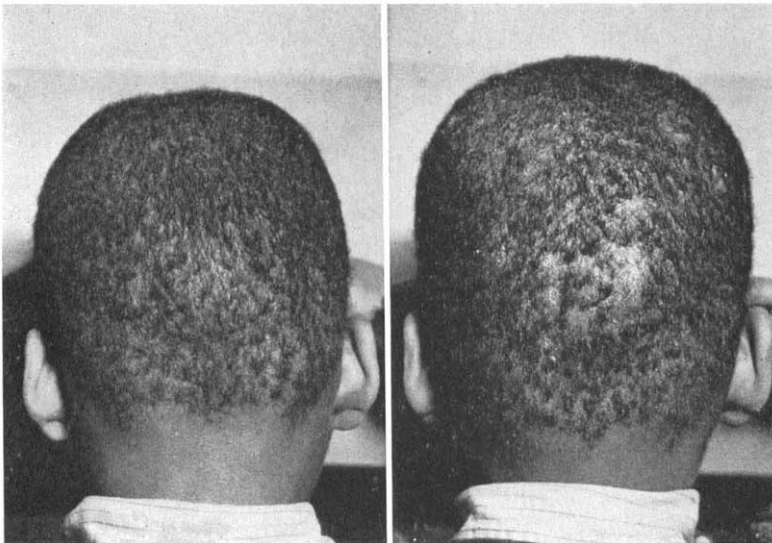


FIG. 2. Coincidental non-inflammatory *M. audouini* in twin brothers with spontaneous cure in one (on left); x-ray epilation necessary in other.

M. audouini infection occurred in three sets of brothers, one brother in each set showing an inflammatory response and be-

coming cured spontaneously in a short time, the other showing no such response and remaining uncured. It seems probable that the infection in the respective brothers was of the same strain of *M. audouini*, and we considered this a rather striking example of the effect of variations in the response of the host to the same fungus. In addition, we have observed concomitant non-inflammatory *M. audouini* infection of the scalp in five sets of brothers (including a pair of twins) in which the infection of one brother in each pair became cured after persistent local treatment, while that of the other did not (see fig. 2).

The influence of inflammation on the course of a superficial mycosis has been emphasized by many observers, and our

TABLE 2

CLINICAL TYPE	METZ. 1-30					LEDERLE 1-30					TOTAL
	0	1+	2+	3+	4+	0	1+	2+	3+	4+	
Inflammatory	1	0	1	9	5	1	3	8	5	0	17
Non-inflammatory—cured* . . .	1	1	6	5	5	5	3	5	4	1	18
Non-inflammatory—not cured.	7	0	11	10	2	9	8	13	0	0	30

* Cured with local or indifferent treatment.

13 of 17 cases of inflammatory ringworm had trichophytin tests of 2+ or more with Lederle 1-30.

10 of 18 cases of non-inflammatory cases cured with local treatment had trichophytin tests of 2+ or more with Lederle 1-30.

13 of 30 cases of non-inflammatory cases not cured with local treatment had trichophytin tests of 2+ with Lederle 1-30.

experience is in accord with the finding that fungus infections of both the glabrous and non-glabrous skin show a higher incidence of cure when an inflammatory response is present. It has also been noted (3, 6) that patients with an inflammatory superficial mycosis tend to have a higher degree of trichophytin sensitivity than those without inflammation. Trichophytin tests have been performed with both the Metz and Lederle preparations in dilutions of 1-30 in 65 cases. The results, divided in accordance with the presence of inflammation and with the observance of spontaneous cure are summarized in table 2.

In table 2 the comparative results with the Lederle and Metz antigens have been presented as a matter of interest, though

further study with the Metz product will not be possible because of its having recently become unavailable. It will be noted that this antigen shows a higher proportion of 3+ and 4+ reactions than does the Lederle antigen. The total tests in the various sub-divisions are not sufficient for statistical analysis. As a possible indication, it will be noted that there were no 3+ or 4+ reactions with the Lederle antigen in the non-inflammatory cases of *M. audouini* infections which did not become cured spontaneously. It might be expected that in cases in which inflammation occurred or spontaneous cure was noted, some heightening of trichophytin sensitivity would be found, but we do not believe that this can be established on the basis of our data. Concomitant tuberculin tests were done with the trichophytin test, but, while no striking evidence of any parallelism of reactivity to tuberculin and trichophytin was noted, the results are not as yet numerically sufficient to be worthy of reporting in detail.

It has been mentioned by many observers that tinea capitis is more common among boys than girls. It has also been established that *M. audouini* infections are more easily transmitted to contacts than are infections due to "animal" fungi. It is safe to assume that in families of lower economic strata there is ordinarily ample opportunity for susceptible children to acquire ringworm of the scalp from infected members. In our dispensary clientele it is commonplace for the entire family to use the same combs and to wear each others' caps and hats and in many instances the children sleep together. In 67 cases of ringworm of the scalp caused by *M. audouini*, all the siblings were studied for evidence of ringworm by clinical and Wood's light examination, the cultural studies done in individuals with evidence of infection. We were reasonably certain that all the children examined had been exposed to the disease by contact with one or more infected members of the family for periods varying from one month to three years, and in many instances examinations were made repeatedly. The results of this epidemiologic study are tabulated in table 3.

There seems no question on the basis of this material that boys

are much more susceptible to ringworm infection of the scalp than are girls. While it is conceivable that a sex linkage to susceptibility may exist, especially since ringworm of the scalp is known to have such a linkage in that it clears up at puberty, it would seem that the length of the hair in girls might offer some protection against infected material reaching the epidermis. In favor of the latter is the fact that we observed six girls who presumably acquired *tinea circinata* from their brothers infected with *tinea capitis* but who were found negative for evidences of ringworm of the scalp on repeated examinations, and in contrast, in boys, we have found *tinea circinata* unaccompanied by *tinea capitis* to be comparatively rare. In additional support of this view, we have noted that in girls, the overwhelming majority of

TABLE 3
Examination of family ringworm contacts (228 siblings in 67 families)

SEX	TOTAL EXAMINED	INFECTED*	NON-INFECTED	% INFECTED
Male.....	127	95	32	74.8
Female.....	101	26	75	27.5

* *M. audouini* cultured in all cases.

ringworm infections of the scalp have their beginning around the sides of the scalp where the hair is short, or along the parts of the hair. The rather marked tendency to spontaneous cure of *tinea capitis* in girls which is noted below suggests comparative inherent immunity which is difficult to explain.

A more detailed study of our families, which is omitted for sake of brevity, revealed that certain families differ strikingly as far as number of infected members are concerned and suggests that different strains of *M. audouini* are more infectious, or that environmental, dietary, and constitutional factors in individual families play an important part in the epidemiology of the disease which we have not been able to analyze accurately.

Of the 125 cases of *M. audouini* infection which we have studied, only 14 occurred in girls, and in only one girl did the process become inflammatory. In 9 of the 14 girls infected,

spontaneous cure was observed as compared to spontaneous cure in 38 of the 111 boys infected with *M. audouini*.

Treatment

Although we did not observe a large number of cases infected with "animal" fungi, our finding of spontaneous cure in all of these supports the opinion of previous observers that these cases should be treated locally and not subjected to x-ray epilation. In addition, the high percentage of cures which we observed in 20 cases of "human" fungus infection in the presence of an inflammatory reaction, lead us to suggest that x-ray epilation should be withheld for at least one month in such cases.

While cure in "human" fungus infections without inflammation was noted without resort to x-ray epilation in slightly over $\frac{1}{4}$ of non-inflammatory cases, this did not occur for periods varying from 3 months to two years. It is obviously not justifiable to allow a child with a demonstrably infectious ringworm to go untreated if competent x-ray epilation can be carried out. In such cases, however, careful study of other children in the family should be done, in order that the child subjected to x-ray epilation may not immediately be re-infected by a sibling. In this connection also, we believe that more effort should be made to set up reasonable restrictions on such cases in regard to school attendance. It is extremely difficult to obtain any ruling in regard to ringworm of the scalp from school authorities, and the regulations seem to vary from year to year and from school to school. We have at times been discouraged by the prospect of carrying out adequate treatment for ringworm of the scalp, with the immediate prospect of the child returning to a focus of ringworm infection in his class at school.

While we cannot set up any criteria for probable cure by local measures in cases of *M. audouini* infections, it is our belief that x-ray epilation should be delayed for one month in children with localized patches showing no marked tendency to spread, especially if there is marked spontaneous epilation in the affected patches, and the number of fluorescent hairs shows a decrease.

As stated before, we have noted no regular good effect from

any single type of fungicide employed in this series. The preparations used have included tincture of iodine, tincture of iodine with 2% Aerosol (a wetting agent), iodine ointment in strengths varying from 2 to 4%, with and without a wetting agent incorporated in the base, phenylmercuric nitrate 1-1500 in varying bases with and without wetting agents, ammoniated mercury, sulphur and salicylic acid, and a buffered oil-in-water emulsion type ointment at a pH of 3.2.

We have been particularly interested in the possibility that incorporation of adequate amounts of a wetting agent in a lotion or ointment would increase the penetration of the fungicide by reduction of the surface tension about the hair follicles. It is possible that the wetting agents have some value, but not to any striking degree. This confirms our previous unsatisfactory experience with a triethanolamine iodine ointment on which Maynard (6) reported favorably in a series of cases in which cultures were not available.

SUMMARY

1. Ringworm of the scalp offers an interesting field for the study of superficial mycoses because: (a) The methods of clinical and cultural diagnosis are relatively simple and satisfactory. (b) The time of onset of the infection can ordinarily be determined exactly; and the interpretation of local and general immunologic response is usually not complicated by previous ringworm infection nor by dermatitis from other sources.

2. In a series of 130 cases of ringworm of the scalp occurring in a small city district, *M. audouini* was isolated in 125.

3. Of these 125 cases of *M. audouini* infection, 20, or 16% showed evidence of inflammation before or following local treatment, and 14 of these became cured without x-ray epilation.

4. Of 105 cases of non-inflammatory *M. audouini* infection of the scalp followed for prolonged periods, 28, or 27% cured spontaneously in periods varying from three months to two years.

5. Patients with inflammatory *M. audouini* infection tended toward increased sensitivity to Trichophytin Lederle.

6. Examination of 228 family contacts of cases of ringworm of the scalp demonstrated the markedly greater susceptibility of boys to such infection (76% infection in males, 25% infection in females).

7. Spontaneous cure of "animal" type ringworm infections, as noted by several observers, also occurred in our cases.

8. Cure following little or no local treatment occurred in 33.6% of all cases of *M. audouini* infections.

9. Fluorescent light examination of giant cultures proved an extremely useful adjunct to standard methods of identification of fungus species.

10. The incorporation of wetting agents in vehicles did not increase the clinical effectiveness of various fungicides.

CONCLUSIONS

1. An inflammatory local response occurs in a considerable proportion of *M. audouini* infections of the scalp.

2. Cure without x-ray epilation occurs in 70% of cases of *M. audouini* infection associated with inflammation.

3. Boys are much more susceptible to tinea capitis than are girls, and the tendency to spontaneous cure in *M. audouini* infection is greater in girls than in boys.

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DISCUSSION

DR. J. GARDNER HOPKINS, *New York*: The authors have taken full advantage of an unusual opportunity to observe a large group of ringworm cases. The spontaneous course described is certainly of interest. Most of us have come to think of the Audouini infection as being intractable, but I have seen cases of

felineum infection which were as resistant to treatment as anyone can imagine. I had come to the conclusion that it is not the species of fungus in itself, but rather the degree of inflammatory reaction that determines susceptibility to treatment. This, apparently, does not hold in our experience.

DR. A. C. CIPOLLARO, *New York City*: Within the past few years we have heard a great deal about the treatment of tinea capitis with various local remedies. I think this is a fitting time to emphasize the fact that the best single method of treating tinea capitis is with x-rays, especially if it be of the Audouini type. Some dermatologists fear using epilating doses of x-rays on the scalp. There is no foundation for this fear because we have at our disposal, methods of measuring exactly the amount of radiation delivered to a given area.

Infected areas of tinea capitis are easily seen when examined with ultraviolet rays filtered through a Wood's filter. If careful examination reveals that only one small area is infected I think that it is possible to obtain a cure by epilating this one infected area instead of epilating the entire scalp. Before the use of the Wood's light it was impossible to ascertain the extent of the infection. Where many areas are affected I believe that the entire scalp should be depilated. However if a case presents only one localized infected area which has remained stationary for several weeks, it seems to me that such a case is best treated by depilating with x-rays that one infected area. If this technic is employed then it is necessary that the scalp be examined frequently under the Wood's filter.

DR. GEORGE M. LEWIS, *New York City*: For some years I have been interested in what eventually happened to patients with *M. audouini* infections who were untreated. Apparently no statistics were available. For that reason this paper is of timely interest, particularly in pointing out that there is a tendency to ultimate spontaneous cure.

In going further and trying to decide why there should be a spontaneous cure I am sure that the authors have not told us the complete story, and that they are still working on the problem. It is also of interest, in looking over their data, that in spite of a lack of sensitization to trichophytin there are still cases of spontaneous cure. For this reason one wonders whether the reason for spontaneous cure may not be in the field of hormonal activity, and in that respect, I would like to ask the authors if they have performed any tests on the young patients who recovered, to see if there was a normal amount of estrogenic substance as compared to a series of patients previous to recovery, and whether they have seen coincident acne in any of their patients who recovered, or with patients having the inflammatory type of disease. It might be interesting to attempt animal inoculations with the strains of *M. audouini* isolated from patients who had an inflammatory type of disease and who also recovered even though the usual experience has been that this fungus is not capable of being transferred to animals.

I would like to ask Dr. Pillsbury if the patients become spontaneously cured at puberty, or at just what specific ages do they recover?

DR. RICHARD S. WEISS, *St. Louis*: I am very much interested in the authors' report. It is striking and unusual that a series of cases reported from the Eastern

part of the country should be benefited by methods other than epilation with the x-ray.

For many years I have stated that local applications, usually 5% salicylic acid and 10% sulfur in white vaseline, cure the largest proportion of the cases that are seen in the middle West. I have made this statement at many meetings and have met with considerable incredulity. I can recall only two cases that occurred in the St. Louis area that failed to get well under local treatment and had to be treated by x-ray epilation.

DR. MORRIS MOORE, *St. Louis*: I do not know if there is much that I can add. In the past several years I found only two cases that were due to *M. audouini*. The rest were due to *M. lanosum* or *M. canis* and one other. I am rather in agreement with Dr. Lewis, that *M. audouini* is not quite as common as we usually think, and that there are a number of strains of this particular organism so closely related to *lanosum* that I doubt if it is possible to distinguish between the two. I have tried and obtained different types of growth with identical strains over a course of time. We have never made any study to determine family contacts, but one thing seems to be evident—we have found that where infection has taken place in a family, with *Achorion schoenleini*, this has happened only on the female side, for four or five generations. In other types of infections where there is family contact, there is an indiscriminate spread of the infection. Particularly among the Negro population in St. Louis does one find the spread of the organism in the family and in the neighborhood. Microsporosis in St. Louis and the middle West region was found to be largely due to *M. canis*. Only two cases in the past several years have been found to be due to *M. audouini* and only one due to *M. fulvum*.

DR. C. S. LIVINGOOD, *Philadelphia*: We wish to make it quite clear from the outset that we recognize the fact that x-ray epilation is the best single method of treating *M. audouini* infection of the scalp, and a great many of the patients included in our non-cured series were treated in this manner. We have not attempted epilation of a single patch but this method seems promising inasmuch as one sees single patches remain localized for long periods of time. Most of our patients were not epilated because of a lack of cooperation on the part of their parents.

We had the same thought as Dr. Lewis in regard to the ultimate result in those patients who never returned, and it was for this reason that we sought Social Service aid in order to study this group of cases more adequately. As stated in our paper, we found that about $\frac{1}{3}$ of all the *M. audouini* infections observed were cured after prolonged observation, emphasizing the fact that 20 of these cases were inflammatory, either primarily or secondarily.

We had only a small series of *M. lanosum* infections and confirmed the results reported by Lewis and his co-workers, as well as other observers, that these patients are easily cured by local measures and should definitely not be subject to x-ray epilation.

Dr. Moore discussed Dr. Weiss' remarks and answered his questions. It is quite possible that there are a great number of strains which differ in their response to treatment but it is our opinion that the more important factor is the

differences in susceptibility and resistance of the host. We had no difficulty in distinguishing the species of fungi by the method outlined in our paper and it is well to emphasize again that the examination of the giant culture under Wood's light is an extremely valuable aid in identification.

Another point which should be brought out is that we found it rather difficult to isolate the fungus concerned in our inflammatory cases and in some instances it was necessary to repeat the cultures five or six times, but when this is done at frequent intervals, it is almost always possible to grow the organisms unless, of course, the process is seen very late in its course. We have no evidence to suggest that the strain of *M. audouini* isolated from the inflammatory cases was any different from that found in the non-inflammatory cases.

In answer to the age question, we did not include any cases that were near the age of puberty. As it happened the five cases which we observed were resistant to local treatment.

After conducting a clinical investigation of this kind, one is impressed by the many factors, especially those relating to host-resistance and immunity that need to be clarified. The discussion has been stimulating and we hope that continued investigation will answer some of these perplexing questions in the hope that knowledge thus gained can be applied to fungus infections in general as well as to tinea capitis.