

THE ISOLATION OF DERMATOPHYTES FROM THE FLOORS OF COMMUNAL BATHING PLACES

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It has long been known that communal bathing leads to an increase in the incidence of tinea pedis. Some authorities have stated that such increases are merely apparent, in that frequent bathing causes recrudescence of infection already present in subclinical form (Sulzberger, 1932; Riddell, 1951; Sulzberger and Baer, 1955). Others, e.g., Duncan (1948), are of the opinion that spread actually takes place in the bathing places. One of the main criticisms of this view has depended upon the absence of proof of a mode of transmission. Duncan stated that spread took place by transfer of scales from the feet of the infected to the interdigital clefts of the feet of others. It is not generally disputed that such transfers may result from the sharing of shoes, socks, towels, and so forth; but the rate of infection often seems to increase even when it is known that such articles are not shared. The other obvious source of infection is the floors of shower stalls and the like, but it has not been possible except in a few isolated instances to demonstrate the presence of dermatophytes there, despite the numerous attempts which have been made to do so.

The only detailed reports of isolations of dermatophytes from shower floors are those of Adamson and Annan (1949), who isolated *Trichophyton mentagrophytes* from a piece of skin found on the floor, and Ajello and Getz (1954), who isolated the same species on a medium containing the cycloheximide "actidione"* (Leach, Ford, and Whiffen, 1947) from the shower floors of a penitentiary. Peck, Botvinick, and Schwartz (1944) made over 60 unsuccessful attempts to obtain a dermatophyte from shower floors used by hundreds of workers, many of whom had active infections. They concluded that the fungi were either not widely disseminated on the floors or that they were washed down the drains in sufficient numbers during the procedure of taking showers

to make their recovery difficult with the methods they had available.

A recent survey of epidermophytosis in coal-miners (Gentles and Holmes, 1957) provided laboratory evidence in support of the view that spread of infection took place in bath-houses. As far as could be ascertained the miners did not share their towels or clothing, and attempts were therefore made to find the fungi on the floors of the bath-houses.

Methods

At first swabs from the floors were used to prepare high aqueous dilutions which were spread on plates of 4% malt extract agar supplemented with penicillin, 20 units/ml., and streptomycin, 40 units/ml. Later, when it was possible to obtain it, "actidione," 0.5 mg./ml., was also incorporated in the medium. The first isolation of three colonies of *T. mentagrophytes* was made on this medium spread with a high aqueous dilution of material from the floor of a bath-house where the incidence of epidermophytosis among users was 30%.* However, four subsequent attempts with material from other bath-houses used by large numbers of infected men were unsuccessful, although the method used was the same. It was obvious that failure to isolate did not necessarily mean that fungi were not present, and a more strictly defined method capable of giving a repetitive result was sought. Dr. R. E. O. Williams of the Air Hygiene Laboratory, Colindale, suggested direct sampling as a possible solution, and the following apparatus was constructed for this purpose.

A teak disc, $\frac{1}{2}$ in. thick and 3 in. in diameter, was fixed by a rod 4 in. long to the lid of a metal can 7 in. in height and $4\frac{1}{2}$ in. in diameter. The disc, which was padded with unabsorbent cotton wool and covered with velvet, was held in a central position when the lid was on (Fig. 1).

The cans were sterilized by autoclaving before and after use. To sample a floor the pads were removed from the can, pressed firmly with a slight rotatory movement on to the surface and then replaced in

* Actidione is obtainable from the Upjohn Co., Kalamazoo, Michigan.

* The incidence found in a random sample of men during the survey of epidermophytosis (Gentles and Holmes, 1957).

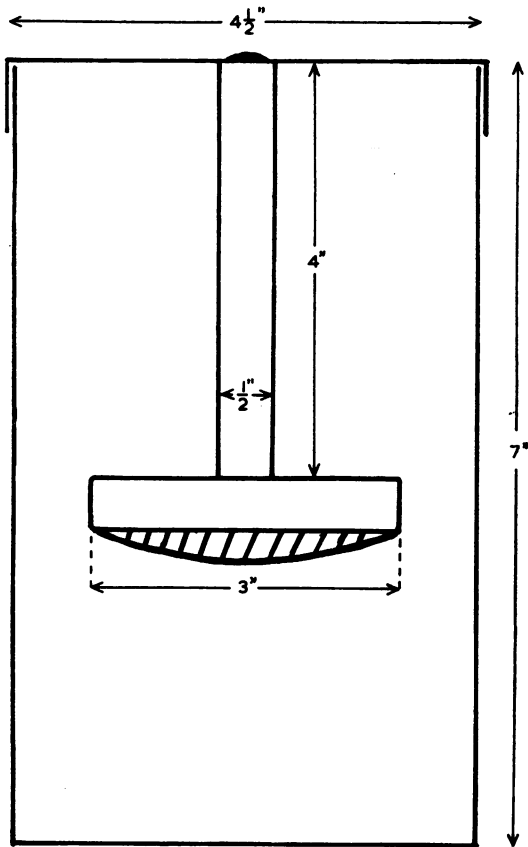


FIG. 1.—Diagram of the direct sampling apparatus used for isolation of dermatophytes from the floors of communal bathing places.

position in the container. A dry circular patch showed the position of each application and pads could be applied two and occasionally three times if the surface was not too wet. In the laboratory each pad was used to inoculate three petri dishes of 4% malt extract agar supplemented with 20 units/ml. penicillin, 40 units/ml. streptomycin, and 0.5 mg./ml. "actidione," by pressing it firmly on to the surface of the medium in each dish in turn. Cans were marked to correspond to the part of the bath-house in which they had been used; petri dishes were similarly marked, and were also numbered to show sequence of inoculation. Incubation was carried out at 28° C. and examination of the dishes for dermatophytes was made at intervals of two to three days. Subcultures and slide mounts for microscopic examination were made of all colonies which could not be distinguished from dermatophytes by their cultural characteristics.

T. mentagrophytes (Fig. 2) was usually identified after seven to eight days' incubation, though on occasion colonies of this species did not appear till

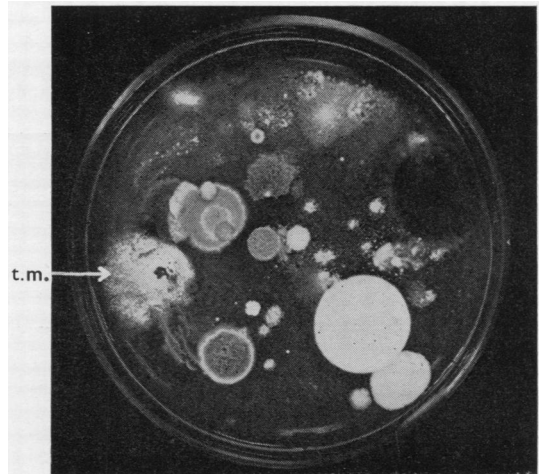


FIG. 2.—Petri dish containing 4% malt extract agar supplemented with penicillin, 20 units/ml., streptomycin, 40 units/ml., and "actidione," 0.5 mg./ml., inoculated with a sampling pad from Pit G and incubated for 10 days at 28° C. A colony of *Trichophyton mentagrophytes* (t.m.) is present on the left-hand edge.

10 to 12 days after inoculation. *T. rubrum*, which has a slower rate of growth in artificial culture, was not definitely identified until three weeks after the plates were set up.

In sampling baths the number of pads used varied from place to place, depending on the number available, the area of floor to be sampled, and the distance between the place sampled and the laboratory.

Results

Before the apparatus was used in the field, laboratory tests were carried out by scattering infected skin fragments of about 0.5 to 1 mm. in diameter over a concrete slab. A quantity of floor dust and soapy water was then added to simulate shower floor conditions. Dermatophytes were successfully isolated and similar tests after spreading a spore suspension of *T. mentagrophytes* over the concrete were also successful.

The shower floors of various baths were subsequently sampled, with the results given in Table I.

In addition to the isolates of *T. mentagrophytes* indicated in Table I, this species was also obtained in culture from a piece of skin found in floor sweepings from Pit G which were brought back to the laboratory. In all cases pure cultures of the organisms were obtained. The isolates of *T. mentagrophytes* were of the usual foot interdigital type, and, though those of *T. rubrum* were less vigorous than isolates from clinical material, they nevertheless had the definite cultural and microscopical characteristics of the species.

TABLE I
RESULTS OBTAINED BY DIRECT SAMPLING OF FLOORS IN FIVE COMMUNAL BATH-HOUSES

Location of Showers	Estimated Incidence of Tinea in Users (%)	Type of Floor	Isolates	No. of Pads Used in Sampling	Time of Sampling	Remarks
Pit G bath-house ..	17*	Asphalt	<i>T. mentagrophytes</i> 3 colonies	11	After shift	Isolates from 2 separate shower stalls
Pit F " " ..	16*	Concrete	<i>T. mentagrophytes</i> 1 colony	24	" "	Antiseptic troughs at entrance to showers
Pit C " " ..	50*	"	<i>T. rubrum</i> 2 colonies	18	" "	<i>T. rubrum</i> predominant species in foot infections. Both isolates from same shower stall
Athletic ground pavilion	Unknown	"	<i>T. mentagrophytes</i> 3 colonies	10	After sports meeting	All isolates from one shower stall
Publicswimming bath	"	Worn terrazzo	<i>T. mentagrophytes</i> 2 colonies	24	After baths closed	Isolates from 2 separate shower stalls
Total ..			11	87		

* The incidence found in a random sample of men during the survey of epidermophytosis (Gentles and Holmes, 1955).

Common saprophytes such as *Penicillium*, *Aspergillus*, various yeasts and bacteria developed in the inoculated petri dishes, but only in the dishes inoculated with the pads used in the floor of Pit C was the contamination rate unduly troublesome. On this occasion large numbers of colonies of a rapidly growing species of *Cephalosporium* developed in addition to the usual contaminants. Careful examination of the petri dishes showed that in most cases each one of the series inoculated from a single pad showed a very similar pattern of colonies of saprophytic moulds. Dermatophyte colonies, on the other hand, were never duplicated and developed as often in the second or third dish of the series as in the first.

Discussion

It is apparent that direct sampling is more satisfactory for the isolation of dermatophytes from floors than any method previously described. That isolations were made from each place sampled by this method suggests that these fungi are present in some quantity on floors of communal bathing places. The small number of colonies isolated from Pit C, where the incidence of infection among users was 50%, may be partly accounted for by the relatively slow growth rate of *T. rubrum* in medium culture and partly by the high rate of contamination with *Cephalosporium*.

Whether the dermatophytes are present on the floors as saprophytes or in skin fragments is not quite clear. Peck *et al.* (1944) proved they could exist for long periods of time on concrete floors and that the pH of aged concrete was compatible with growth, but they did not show that growth actually took place. Duncan (1948) admitted the possibility of growth on wooden floors, but Riddell (1951) was of the opinion that infections were not obtained from organisms living saprophytically on the floors.

Peck *et al.* (1944) could grow isolates from sterilized concrete only after vesicles on the feet of infected persons who walked on the surface had been ruptured. Colonies grown under such conditions probably came from infected skin fragments, which are present on floors under normal conditions, as is shown by the findings of Adamson and Annan (1949) and Gentles and Holmes (1957). There is little indication, however, that saprophytic colonies are formed from these fragments, and such a development is in fact rendered improbable by the frequent use of disinfectants on the floors. The duplication of colonies of saprophytes on successive applications of a pad used to sample floors, and the absence of such colony duplication in the case of dermatophytes, also favours the theory that such saprophytic growths do not generally exist.

Summary

A satisfactory method for isolating dermatophytes from shower floors is described. Parasitic fungi (*T. mentagrophytes* or *T. rubrum*) were grown from the floors of all five communal bathing places where it was used. In all, 11 isolates were grown from 87 samplings. Two colonies of *T. rubrum* were grown from 18 samplings of one floor.

T. mentagrophytes was also isolated on two additional occasions; from one of five attempts when floor material was spread in high dilution on a selective medium and from a fragment of skin found in floor sweepings.

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