RINGWORM INFECTION IN A CUCUMBER GREENHOUSE

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Of infections of skin and hair by dermatophytes those caused by some of the *Microsporum* species are apt to be encountered in epidemics. Cases of which *M. gypseum* is the cause are, however, much less frequent than those caused by *M. canis* or *M. audouini*. Warren (1956) recorded epidemics of over 1,000 cases with only two examples of infection due to *M. gypseum*. La Touche (1952) recorded *M. canis* as the predominant strain in Leeds. He related this finding to the animal reservoir.

The report of the Medical Mycology Committee of the Medical Research Council (1956) does not mention *M. gypseum* as a prominent cause of ringworm and devotes attention to *M. canis*, which is known to have an animal habitat, and to *M. audouini*, which is known to spread essentially by human contact.

M. gypseum has been repeatedly isolated from soil since Vanbreuseghem and Van Brussel (1952) took advantage of its keratinophilic properties to evolve a technique for the isolation of keratinophilic fungi from soil by baiting with hair.

The present paper records, for the first time, an epidemic caused by *M. gypseum* in which the fungus was grown from soil which confirmed that infection was actually contracted from the soil itself. An epidemic was recorded by Whittle (1954) which was associated with work in a greenhouse, but the causative fungus was not isolated from the soil.

The Outbreak

In the course of a few days at the end of August, 1960, one of us (J. A.) was consulted by five patients who had ringworm of glabrous skin. Three of them had either one or two lesions, the fourth had five, and the fifth had no fewer than 27. All told a similar story of working in a cucumber house, and in fact they described their lesions as "the cucumber rash." Further, they declared that all people working in this greenhouse had similar lesions. They associated the start of the infection with a particular period of two days (August 11 and 12) when the old cucumber plants had been uprooted and discarded.

The lesions were round and up to about 1½ in. (3 cm.) in diameter, with an entire edge, and were roughened and scaly. There was a minimal inflammatory reaction and the lesions appeared at first sight to be eczematous. They were situated on limbs, face, and upper part of the trunk. This story was told to a consultant dermatologist, who at once suggested that the lesions were ringworm due to *M. gypseum* and instanced Whittle's (1954) report.

This stimulated interest, and all who had worked in the particular greenhouse on the days in question were examined.

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There were 12 people (Cases 3-14, see Table) associated with this clearance of cucumber plants from the greenhouse, and all had ringworm. Two other people (Cases 1 and 2) who had attended the growing plants had a history of typical lesions some two to three weeks before the main outbreak. One of these had actually been to the surgery with his lesion on August 11. A ringworm also occurred on the arm of the man (Case 15) who had removed the cucumber bed soil from the greenhouse on August 14.

Details of Cases

Case	Sex	Age	No. of Lesions	Skin Scrapings		Distribution
				Micro.	Culture	
Worked in greenhouse and developed lesions in mid-August						
1	M	52	2			Arm
2	M	31	1			"
Worked in greenhouse August 11 and 12 and developed lesions at end of month						
3	M	18	2			Arm
4	F	46	1			"
5	F	42	1			Leg
6	F	21	1			Arm
7	F	2	2			Leg
8	F	40	1			Not recorded
9	F	40	2			Arm
10	M	16	34	—	+	Face, neck, trunk, limbs
11	M	19	3	—	—	Arms
12	F	34	1	+	+	Arm
13	F	5	4	+	+	Arm, leg, trunk
14	M	7	5	+	+	Face, arm, leg, hand
Worked in greenhouse August 14 and developed lesions in early September						
15	M	30	1	—	—	Arm
Contacts of Cases 11, 13, and 14. Developed lesions in mid-September						
16	F	5	1			Leg
17	M	8	1	+	+	"
18	M	4	1			Trunk
19	F	10	1	—	+	"
20	F	11	1			"
21	M	16	1	+	+	Arm
Contact of Cases 1, 11, and 21. Developed lesion in October						
22	F	45	1			Neck

Skin scrapings were taken from six of these patients, and from four of the scrapings *M. gypseum* were isolated. The skin scrapings had been examined in potash preparations in the ordinary way and had been cultured on Sabouraud's medium and on wort agar containing varying combinations of penicillin, streptomycin, and actidione. There was good growth of the dermatophyte in the positive cultures at five days.

By this time (about the middle of September) a second outbreak involving children had become evident, and *M. gypseum* was isolated from three of them. Another case occurred in October, bringing the total to 22.

Working Conditions

The cucumber plants were grown in raised beds in a greenhouse 50 by 110 ft. (15.2 by 33.5 m.). Throughout the growing season of three and a half months this house was maintained at a temperature between 70 and 100° F. (21.1 and 37.8° C.) with the necessary high humidity. Hoof-and-horn fertilizer was applied as a top dressing every five to seven days.

The cucumber compost was taken from the top 4 in. (10 cm.) of a near-by pasture. The surplus topsoil from this same pasture was stacked out of doors for use next year.

At the end of the growing season the cucumber plants were pulled up and put in a heap to rot out of doors. The soil from the raised beds was dug out and put in a separate heap also out of doors.

There were thus four possible sites for the collection of soil samples: (1) the greenhouse itself, where samples

were taken from soil on window-ledges and pipes, and also from the surface of the paths; (2) the soil from the cucumber beds that had been dumped outside; (3) the heap of rotting plants: in these an effort was made to obtain what had been surface soil—that is, the junction of stem and root with adherent soil; and (4) the surplus uncultivated pasture topsoil.

A sample was also taken of the hoof-and-horn preparation. This came from the bag that had been in use in the greenhouse. It was from a reputable firm, who stated that the raw material had been boiled for four hours, ground, and then dried to a brittle state in a steam oven.

Investigation of the Soil

An attempt was made to grow the fungus from soil samples, using human hair as a bait. The technique of Vanbreuseghem was followed in that a quantity of soil was put into a Petri dish and moistened with sterile distilled water. On to the surface of this sterilized human hair was placed and the preparations were incubated at 27° C. Within five days a good growth of fungus could be seen to be affecting the hair. In the preliminary attempts made by one of us (A. P. P.) hairs were not subcultured till the eighth day. By this time various contaminant fungi, notably of the *Penicillium* species, had made their appearance and had overgrown any possible dermatophytes.

A sample of hoof-and-horn fertilizer and 26 samples of soil from the four sources indicated above were sent to Dr. J. C. Gentles and Miss C. O. Dawson, of the department of bacteriology, University of Glasgow, who reported as follows.

Mycological Report

"The soil samples were put into Petri dishes baited with autoclaved horse-tail hair and incubated at 24° C. Those samples which were not large enough for investigation alone were bulked with another sample from the same source. In all, 10 Petri dishes of soil (four from site 1 and three each from sites 2 and 3) and one dish of hoof-and-horn meal were investigated. No growth of *M. gypsum* or other keratinophilic fungi was obtained from the fertilizer, but all 10 samples of soil yielded a heavy growth of *M. gypsum*. The dermatophyte enveloped the hair bait and could be identified within 3 to 4 days. Within 8 to 10 days small spherical structures approximately 1–2 mm. in diameter had developed. These were identified as the perfect or sexual state of the fungus recently described and named *Nannizzia incurvata* by Stockdale.* So far as we know, this is the first occasion on which *N. incurvata* has been isolated direct from soil in Britain.

"All six samples of the pasture soil surplus to requirements in the greenhouse (site 4) also yielded *M. gypsum* when incubated at 24° C. with horse-tail hair bait. In these samples, however, the growth was scanty, took longer to develop, and the sexual state was formed in only one of the six samples. The keratinophilic fungus, *Keratinomyces ajelloi*, was also isolated from four of the six samples.

"It is clear that *M. gypsum* was introduced to the greenhouse in the pasture soil and that the frequent top-dressing of the keratinaceous fertilizer, together with the prevailing conditions of temperature and humidity, resulted in rapid growth and much increased concentration of the fungus in the soil. Persons working in the greenhouse must therefore have been exposed to an abnormally heavy concentration of the dermatophyte."

*Stockdale, Phyllis M. (1961) *Nannizzia incurvata* gen. nov., sp. nov., a perfect state of *Microsporium gypsum* (Bodin) Guiart et Grigorakis, *Sabouraudia*, 1, 41.

Epidemiology

For the sake of simplicity the patients affected have been numbered 1 to 22 (see Table). Cases 1 and 2 developed lesions in the second week in August. At the end of the same month Cases 3–15 were affected. Only Cases 1–15 had been in the greenhouse.

In the second and third weeks of September Cases 16–21 developed ringworm for the first time, and Cases 10 and 13 had second attacks. A final case (No. 22) occurred in the middle of October. The probable routes of infection are shown in the Chart.

Case 1 was the husband of Case 22; his lesions were slow to resolve, and it is felt that the wife developed her typical lesion after contact with her husband rather than from contact with her two sons (Cases 11 and 21). These sons shared a double bed, and the fungus was transmitted from 11 to 21, who had no access to the greenhouse.

Cases 13, 14, and 10 were the children of Case 12. Cases 12, 13, and 14 were all exposed to infection in the greenhouse, and developed their lesions at the same time.

Cases 16, 17, 18, 19, and 20 were all children who played regularly with Cases 13 and 14. Case 16 was the daughter of Case 2, but it is felt that she is more likely to have caught her ringworm from her playmates, Cases 13 and 14, than from her father.

Case 7 was the daughter of Case 6.

The people infected in the greenhouse developed their lesions on the exposed parts of the body—for example, arms, necks, faces, the women's and children's bare legs, and the upper part of the trunks of the youths, who worked stripped to their waists.

Discussion

M. gypsum has been isolated from samples of soil from various parts of the world not infrequently (Zeidberg and Ajello, 1954; Frey and Durie, 1956; Stockdale, 1958). Soils from farms and barnyards in Tennessee were examined by Zeidberg and Ajello, and from these *M. gypsum* was grown. Frey and Durie examined samples of soil from parts of New South Wales and grew *M. gypsum* among other fungi. Stockdale lists *M. gypsum* among fungi grown from samples of British soil.

The above list is not exhaustive, but it serves to indicate the widespread nature of the fungus. As this

fungus is widely scattered in the soil it is all the more surprising that it has not been incriminated more often as a source of epidemic spread. A factor which possibly contributes to this state of affairs is that most studies on the epidemiology of fungus infections have been made in cities, and such infections may not be investigated when they occur in country districts. Difficulties in transport and either the necessity of sending patients a distance to hospital or unwillingness to collect appropriate samples, together with the rapid response made to treatment of infections with this fungus, all contribute. Another which is possibly applicable only in rural communities was noticed in this epidemic. Treatment of one patient was tantamount to treating several in that, once a diagnosis had been reached on one patient, a number made their own diagnosis and proceeded to share the same ointment pot. Once a patient was satisfied with his own clinical improvement the appropriate medicament was rapidly loaned out to some other group of sufferers. In the present instance this admirable community spirit certainly militated against collection of appropriate skin samples.

Although 13 patients developed lesions on their arms, only two had them on their hands, possibly because the patients washed only their hands after work. There was no history of trauma, but it is not impossible that the coarse texture of the cucumber plants could have caused mild trauma of exposed parts of the body. Under greenhouse conditions the skins were moist with sweat. Although the first lesions seen in the surgery were dry and scaly, half of the total patients had lesions which showed vesicle formation and two patients developed florid ringworms with marked inflammatory reaction. The lesions in the secondary outbreak were all minor and without inflammatory response; that is to say, the ringworms contracted by spread from patient to patient appeared to be less virulent. The two florid lesions with marked inflammatory reactions were contracted from soil.

Multiple ringworms were found only in those patients infected in the greenhouse. Untreated, the ringworms ran a self-limiting course of five to six weeks. Whitfield's ointment was effective in all cases treated.

Two months later two of the patients were seen again, and still showed some discoloration of the skin at the site of their ringworms.

Conclusion

An epidemic of ringworm infection of glabrous skin due to *M. gypseum* is described. This was originally contracted from infected soil and subsequently spread by contact.

Our thanks are due to Dr. J. G. Holmes, who originally suggested the diagnosis, and to Dr. James Gentles not only for his superior mycological skill but also for his literary ability.

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STUDIES IN THE EPIDEMIOLOGY OF TINEA PEDIS

VI. TINEA PEDIS IN A BOYS' BOARDING-SCHOOL

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It is generally believed that tinea pedis is a common complaint of boys' boarding-schools, yet we have been unable to find in the literature any report of a mycologically controlled survey of such a school. The community life and emphasis on sports would, indeed, lead one to expect a high incidence in these establishments. To check this, and to compare the situation with that in day-schools (English and Gibson, 1959, 1960b), we have paid two visits to a small boarding-school for boys.

The Subjects

The school catered for about 200 boy boarders aged from 7 to 18. There were no bathrooms, but all boys took morning showers twice a week and used the same shower baths after games. The school had its own swimming-bath, open in the summer only, to which organized visits were paid once or twice a week; senior boys were also allowed to use the bath in their own time. Visits by boarders to public swimming-baths were officially prohibited, but the school bath was used by 150 day-boys, who might also be using public baths.

Leather lace-up shoes were worn outdoors, light leather slippers indoors, and appropriate footwear for sports and gymnastics. Socks were always worn, but their material was not recorded.

Methods

The boys' feet were classified according to their condition into the first five groups of Holmes and Gentles (1956). Scrapings were taken from the interdigital spaces of all boys, whether they showed lesions or not, and from any lesions elsewhere on the foot, and were examined by the methods used previously in this work (English and Gibson, 1959). About 55% of the specimens were large enough for microscopical examination as well as culture.

The first visit to the school was made in October, 1958, the second eight months later, in June, 1959.

After the first visit, only the names of boys with *Trichophyton rubrum* infections were disclosed to the authorities so that treatment might be offered. All other boys, whether infected or not, continued as usual, being treated as and when they or the school authorities considered it necessary on clinical grounds alone. Unfortunately, it was impossible to obtain details of the boys so treated, but the numbers were probably small. After the second visit the names of all infected boys were disclosed.

Results

At the first visit 212 boys were seen, at the second 215: 197 of these were present on both occasions.