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A seventeen-year survey of the ringworm flora of Birmingham

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INTRODUCTION

The main object of this survey has been to ascertain the sources of infection with a view to their eradication. What measure of success has been attained will appear from the facts and figures here set down. A detailed record of every case referred to the laboratory has been kept since 1 January 1945. While it would be idle to suggest that every case of ringworm in the city has been seen at this hospital (because an unascertainable number of cases must undoubtedly have been treated elsewhere), it is reasonable to claim that the body of investigations here discussed constitutes a reliable indication of the distribution of species, their relative frequency and their topographical concentration.

AREA

For the delivery of mail the 80 square miles that comprise the city of Birmingham are divided into thirty-four postal districts. Because patients usually give their addresses in this form the postal district, rather than the ward, was adopted as the most convenient unit for the investigation of the local ringworm flora at the outset of the work. Though no population statistics for the postal districts could be obtained, this proved nevertheless to have been a fortunate choice, for the ward boundaries suffered drastic revision in 1949, whereas the postal districts have remained unchanged since their inception. Comparison of maps 1 and 2 yields a good general idea of the population pattern of the city.

NOMENCLATURE

In the preliminary survey (Carlier, 1954) the recommendations of the Medical Mycology Committee of the Medical Research Council (1949) were followed. In a later edition (1958) a few modifications were introduced. These have been substituted where necessary in the present work.

TECHNIQUE

Infected scalps are inspected under filtered ultra-violet light in the consulting-room and the result communicated to the laboratory. Here the suspected patches are swabbed with petroleum ether which, as it evaporates, produces an appearance of hoar-frost on every infected hair. This device is effective in exposing 'endothrix' infections, as well as the fungi that fluoresce under ultra-violet light, is painless to the patient and saves time, inasmuch as viable specimens can be extracted with the greatest ease in a few minutes.

Samples of the glabrous skin and the nails are obtained by scraping. All specimens, hairs, nails or scales, are divided into two portions, one for immediate examination in warm 20 % KOH under the microscope and the other 'planted' on proof medium and incubated at 20–24° C. for as long as is needed for identification or for at least a fortnight before being discarded as negative. In the case of nail-

Map 1. Map of Birmingham showing density of the total population, 1951–52. One dot represents 150 persons. Reproduced by courtesy of the City Statistician.

scrapings, it has been our practice in recent years to make the primary culture on proof medium containing 0·5 g. of cycloheximide per litre to inhibit the growth of any green-mould spores which the specimen may be harbouring (Georg, Ajello & Papageorge, 1954).

In the majority of cases the cultures confirm the microscopic findings, but over the whole 17 years 5·9 % of all fungi encountered have been incompletely identified

because the cultures failed to grow or were pleomorphic. There are three reasons for this. The main, and fairly constant inhibiting factor is premedication with some fungicide, but, in the course of the work, two other factors appeared, both of which were found to be remediable. In the first year of the survey 20 % of the

Map 2. Birmingham postal districts (including Smethwick, Staffs.). Reproduced by courtesy of H.M. Postmaster General.

Microspora could not be identified exactly on account of the unsatisfactory culture-medium (pure maltose-agar) in use here at the time. When the standard American medium of Hodges (1928) was adopted at the beginning of 1946, followed in June of the same year by the Oxoid medium (Carlier, 1948) still in use, this figure fell to 5 %. Between 1947 and 1949 frequent staff changes adversely

affected the quality of media made from chemically satisfactory ingredients, so that incomplete identifications fluctuated between 11 and 16% in these 3 years. On the appointment of a keen and reliable young technician, this figure dropped at once to 5·7%, falling to an average of 2·3% as she and her assistant gained the experience by which their successors still profit. The present low rate of culture failures of recognizable ringworm fungi (0·6%) is thus attributable to premedication. In addition, there has always been a proportion of specimens which are barely recognizable by microscopy as fungal material at all. They are dead before the patient arrives. It is impossible to say whether the hyphal remnants and shrivelled spores found in the skin samples are those of pathogens or of contaminants. Since 1953, 2·6% of all specimens handled have fallen into this category.

Special media, e.g. thiamine-glucose-agar, are used (as necessary) to accelerate the development of slow-growing and dysgonic fungi (Walker, 1950*b*). Others, of which cornmeal agar, reinforced with glucose is a useful example, serve to discriminate between organisms such as *Trichophyton mentagrophytes* and *T. rubrum* that are liable to be confused on standard proof medium. When the use of such media is indicated, a provisional report is sent to the dermatologist concerned, so that treatment need not be delayed in the interests of botanical precision.

OBSERVATIONS AND DISCUSSION

In the period under review, 1507 cases of ringworm have been referred from all parts of the city. Of these, 1419 were fully identifiable. The remaining 88 were recognized as 74 Microspora and 14 Trichophyta of indeterminate species (Table 1). Of the three genera involved the Microspora are by far the commonest and *Epidermophyton* the rarest (Fig. 1).

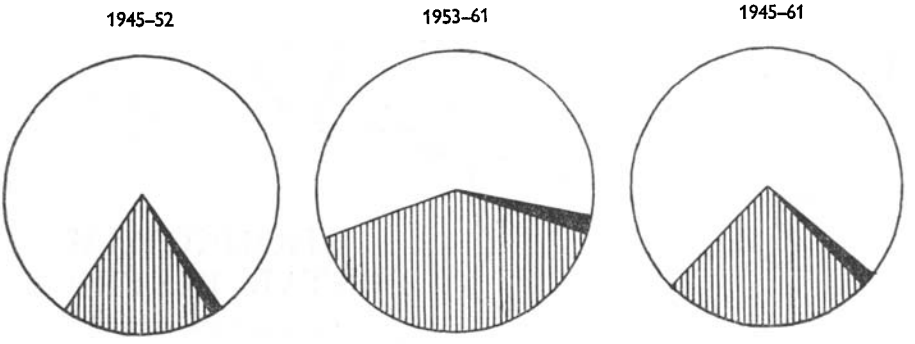

Fig. 1. Relative incidence of the three genera. □, *Microsporum*; ▥, *Trichophyton*; ■, *Epidermophyton*.

Microspora

The geographical distribution of the three species of *Microsporum* is shown in detail in Table 2.

Apart from a minor outbreak of *M. audouini* in an orphanage at Handsworth (Birmingham 20) in 1946, the cases were sporadic and scattered in small numbers

Table 1. *Annual specific incidence*

Species	1945	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	Total
Microsporum audouini	41	78	49	26	13	22	11	13	5	7	10	6	4	1	4	1	1	292
Microsporum canis	19	53	41	91	74	71	88	71	53	32	37	33	31	23	9	3	7	736
Microsporum gypseum	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	2
Microsporum unspecified	15	8	6	14	7	6	3	2	4	4	3	1	.	.	1	.	.	74
Trichophyton mentagrophytes	8	14	10	19	19	14	17	20	18	18	12	7	11	11	13	7	2	220
Trichophyton tonsurans	2	2	2	2	4	5	4	7	4	3	17	8	11	1	5	3	4	84
Trichophyton rubrum	.	.	.	1	2	.	.	3	1	1	1	1	3	1	.	4	.	18
Trichophyton schoenleini	1	.	.	1	2	1	.	1	1	3	5	.	.	.	.	.	.	15
Trichophyton violaceum	.	2	.	1	.	.	.	.	.	.	.	.	1	.	1	.	.	5
Trichophyton verrucosum	.	.	1	1	1	2	.	2	2	.	3	2	1	2	2	2	1	22
Trichophyton unspecified	1	.	2	4	3	1	.	1	2	.	.	.	.	.	.	.	.	14
Epidermophyton floccosum	1	3	3	1	1	1	1	3	2	2	.	.	2	1	.	3	1	25
	88	161	114	161	126	123	124	123	93	70	88	58	64	40	35	23	16	1507

Table 2. *Distribution of the* Microspora *over the city of Birmingham*

Postal district	*Microsporum audouini* 1945	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	*Microsporum canis* 45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	*Microsporum* unspecified 45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	Total
1	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	1	1	1	2	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	—
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4	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	2	5	1	3	.	.	.	1	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	19
5	.	1	1	.	.	.	.	1	.	.	.	1	.	.	.	.	.	1	1	3	1	4	.	1	3	3	.	.	.	.	1	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25
6	3	4	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	7	7	4	2	1	1	.	9	.	.	1	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	49
7	2	3	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	2	3	1	7	3	2	6	5	2	1	.	.	3	2	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	46
8	2	2	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	2	2	4	4	3	1	1	3	5	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	33
9	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	5	1	.	.	2	1	4	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22
10	2	1	1	1	.	2	.	.	.	1	1	1	.	.	.	.	.	.	.	2	3	4	6	1	9	8	9	6	6	4	2	2	.	.	1	.	.	3	.	.	.	1	.	.	.	.	.	.	.	.	.	77
11	.	2	6	4	.	1	1	2	.	.	.	.	.	.	.	.	.	1	4	6	13	5	2	5	3	1	4	5	.	.	.	.	.	.	.	.	1	4	.	3	.	.	.	.	.	.	.	.	.	.	.	.	73
12	5	2	6	4	.	.	3	1	1	.	.	.	.	.	.	.	.	1	5	6	4	12	7	3	2	7	3	.	1	6	9	.	1	.	1	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	93
13	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
14	2	2	.	1	.	.	.	1	2	.	.	.	.	.	.	.	.	1	2	1	14	7	.	.	.	1	3	2	1	1	1	2	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	47
15	5	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	2	.	3	1	9	2	2	1	.	.	.	1	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	31
16	.	3	1	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	3	1	4	2	2	.	.	2	.	.	.	.	.	1	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	25
17	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	5	1	1	.	3	1	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16
18	1	.	1	1	2	1	1	2	.	.	.	.	.	.	1	.	.	.	3	4	12	4	3	4	6	2	1	3	.	.	1	.	.	.	1	.	.	1	.	.	.	1	2	.	.	.	.	.	.	.	.	58
19	.	6	1	.	1	6	.	1	.	.	.	.	.	.	.	.	.	4	2	3	4	1	4	7	5	.	.	2	.	1	2	.	1	2	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	54
20	1	26	6	2	.	.	.	.	1	.	1	.	.	.	.	.	.	.	3	.	1	1	1	3	1	.	.	.	.	.	.	.	.	.	.	1	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	51
21	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
22*a*	.	1	.	1	.	3	.	.	.	.	1	2	.	.	.	.	.	.	3	.	.	1	3	5	4	2	2	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	31
22*b*	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	1	.	.	.	.	.	.	.	.	8
22*c*	1	4	4	5	8	1	1	1	.	4	6	1	4	.	.	.	.	2	1	4	3	.	1	3	4	.	.	6	1	.	.	1	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	68
23	2	.	.	1	.	2	.	.	.	.	.	.	.	.	.	.	.	.	7	.	5	.	2	7	5	2	.	2	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	37
24	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4
25	1	.	2	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	3	1	2	1	.	3	.	1	.	.	.	.	1	.	.	.	.	1*	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	18
26	5	2	2	1	.	.	.	2	.	.	.	.	.	3	1	.	.	.	3	1	.	4	1	3	2	2	.	.	1	3	.	.	.	.	.	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	41
27	.	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	2	4	3	1	4	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	25
28	.	1	.	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	2	1	.	.	2	.	.	.	.	2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	15
29	2	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	1	3	.	.	2	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.	.	1*	.	.	1	.	.	.	.	.	22
30	3	5	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	3	3	1	5	1	1	1	.	.	.	.	.	.	1	1	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	32
31	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	1	3	.	2	1	3	.	.	2	.	.	.	1	1	.	.	.	.	1	.	.	2	.	.	.	.	.	.	.	.	21
32	.	1	3	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	.	.	1	2	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	3	2	2	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
34	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
P.P.†	3	3	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
Total	41	78	49	26	13	22	11	13	5	7	10	6	4	1	4	1	1	19	53	41	91	74	71	88	71	53	32	37	33	31	9	3	7	15	9	6	14	7	6	3	2	5	4	3	1	0	0	1	0	0	0	1104
	292																	736																	74 +2 (gypseum)																	

* Gypseum. † Private patients, address undisclosed.

over most of the city. At no time during the survey has the incidence of this species approached epidemic proportions in Birmingham. Adamson, in 1895, considered that 80–90 % of all ringworm cases in England were due to *M. audouini*. Indeed, of the 232 cases of *tinea capitis* referred to this hospital from Cheltenham between 1945 and 1948, 90 % were in fact identified as *M. audouini*. Following World War II numerous outbreaks of scalp ringworm among children were reported from all over Great Britain and Ulster. The literature of the subject was thoroughly reviewed by Walker (1958). Many such outbreaks, especially those in remote rural districts, must have been due to initial contact with evacuees from centres of infection. In an East Anglian village, for example, Whittle (1956) found a 'carrier' who had harboured *M. audouini* for two years. At about the same time major epidemics involving 565 children in Hagerstown, Md. (Schwartz *et al.* 1946), some 6000 in Detroit, Michigan (Carrick, 1946) and over 800 in St Paul, Minnesota (Steves & Lynch, 1947) were reported from the U.S.A.

Birmingham, which was systematically bombed every night for a year, so far from being a catchment area, evacuated as many children as possible. This undoubtedly explains the low and declining incidence of *M. audouini* at a time when much of the world was experiencing a recrudescence of a parasite which had been well controlled for the quarter-century before the war. It is interesting to find that within the city boundary the highest average incidence up to 1957 should occur at Kingstanding (Birmingham 22[c]), one of the oldest redevelopment zones. This reflects the influx of children from slum areas during the 'thirties'. The highest actual local concentration of patients amounted to 26 at Handsworth (Birmingham 20) in 1946, and this little outbreak never got out of control. The over-all incidence has gradually declined to one case per annum in the last 2 years.

In Fig. 2 the incidence of *M. audouini* is compared with that of *M. canis* at 6-monthly intervals for the whole 17 years. The cases, especially those caused by *M. canis*, are not confined to *tinea capitis* but comprise all lesions traced to the genus.

Until the introduction of griseofulvin (Gentles, 1958) *tinea capitis* was the occasion of prolonged absence from school in this country. In the U.S.A., where schoolchildren are not segregated for ringworm of the scalp, major epidemics have occurred. Neither misfortune need befall the modern child. The topographical distribution of *M. audouini* and *M. canis* present rather different pictures. *M. canis* which was even more ubiquitous than *M. audouini*, only one postal district being exempt, occurred frequently, though never attaining epidemic proportions, in three adjoining slum and industrial areas, Birmingham 10, 11 and 12, with 62, 49 and 67 cases respectively. Even here the cases must be regarded as essentially sporadic (see Table 2). The northern and central slum region, Birmingham 6, 7, 18 and 19, taken as a unit, constituted another focus of *M. canis* infection, with an aggregate of 157 cases.

The spectacular increase from nineteen cases of *M. canis* over the whole city in 1945 to ninety-one in 1948 was fully described in the earlier survey. The subsequent decline could hardly have been predicted at the time, because it appeared that the steep fall in incidence during the summer of 1952 might be counteracted by an equally steep rise before the end of the year, which proved to be the case. Fig. 3,

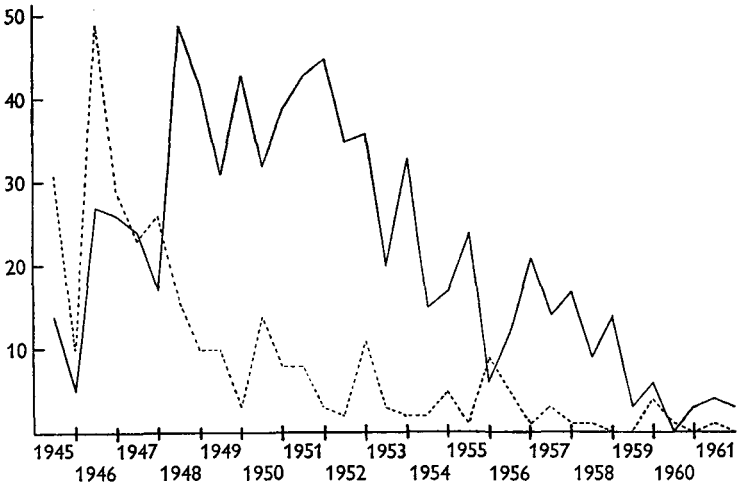

Fig. 2. Sporadic cases of small-spored ringworm, including the Handsworth outbreak, based on the 6-monthly figures, estimated on 30 June and 31 December in each year. The broken line represents *M. audouini* and the entire line *M. canis*.

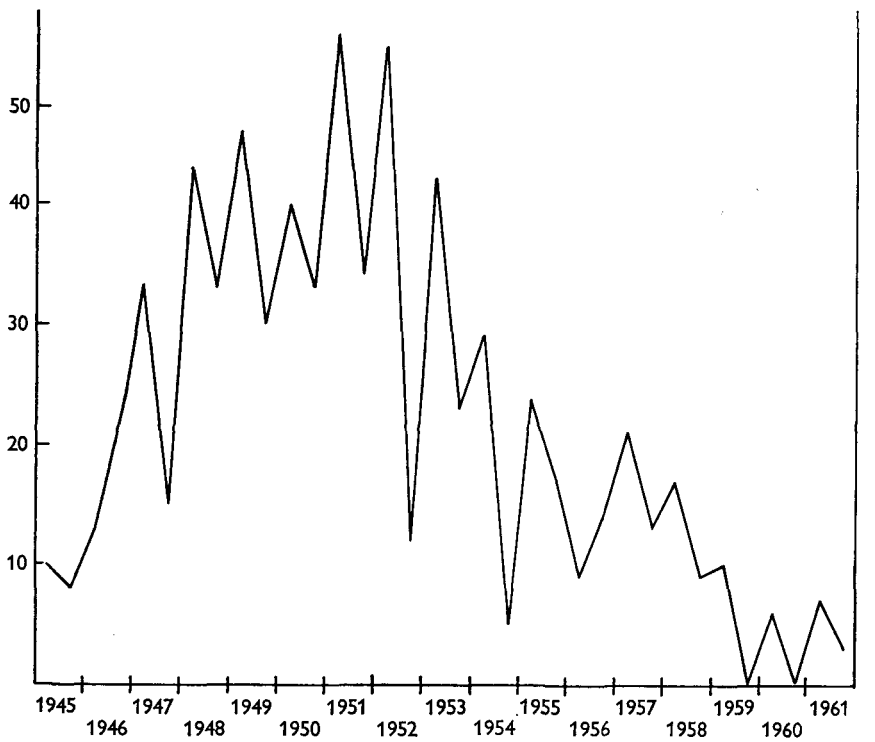

Fig. 3. Seasonal fluctuation in the incidence of *M. canis*, at 6-monthly intervals, calculated on 31 March and 30 September.

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which records the seasonal fluctuation in *M. canis*, makes the course of the outbreak clear. From September 1945 to March 1947 the incidence of the species rose continuously, the normal summer trough having failed to appear in 1946, probably due to the severe rationing in force at the time. Naturally the hospital figures cover human cases only. Nothing is known of the incidence among cats and dogs, but it may be assumed with some confidence that domestic pets, relying largely on kitchen scraps for their food, were underfed at this time and probably shewed reduced resistance to the infection. By the end of 1958 the outbreak was over, i.e. before griseofulvin came into general use.

It has been observed elsewhere that from 70 to 80 % of cases of ringworm due to *M. canis* are transmitted from child to child (Walker, 1950*a*). According to Cruickshank (1953) such infections can pass from one child to a succession of others, becoming attenuated in the process and dying out after four to six transfers. In New Zealand, where *M. canis* is rife, Marples (1956) found only 13·9 % of the infected families could trace their infections definitely to a human source, with the probability of a further 7·9 %. She obtained evidence of the following types of transmission: cat to child, dog to child, child to child, child to adult, cat to cat, child to cat, dog to cat and cat to dog.

In Birmingham there is little direct evidence as to how the infection has been contracted, because few pets are brought to the laboratory for examination. However, for four years from 1953 the number of patients was correlated with the number of households involved with the following result:

1953 54 patients from 53 households.
1954 32 patients from 27 households.
1955 31 patients from 27 households.
1956 31 patients from 23 households.

This, together with the geographical scatter, seems to indicate that most of the human cases have been derived direct from animal sources. Two instances, in which child-to-child infection occurred months after the destruction of the kitten concerned, were proved. In other cases, where all the members of a family have had access to the same infected pet, it is impossible to judge whether child-to-child infection actually occurred. In one instance two children from Nechells (Birmingham 7) and their cousin from Aston (Birmingham 6) were known to have played with the same cat, which thus infected two households a mile or so apart.

For many years the two important reservoirs of *M. canis* persisted. What finally led to their elimination is not easy to determine. No statistical relationship can be traced between the changing population figures occasioned by slum clearance and the disappearance of the fungus. Demolition of outworn buildings—however desirable from many points of view—can have no direct effect on such an organism as *M. canis*, which normally disseminates by short-lived and not by resting spores. More probably the extirpation of individual cats, whether ordered by a dermatologist or considered expedient by the owner on moving house, is the explanation. At its worst, the problem was a small-scale one. A single popular kitten—or a pathetic little stray—can infect a lot of children in the close proximity of slum

conditions. What is surprising is that the highly mobile human population failed to spread the infection by public transport and that even in the peak years no epidemic ever developed.

In culture four variants of *M. canis* appeared. Thirty-eight specimens were of the citreous and three of the non-pigmented (*M. canis*, var. *album*) type, described by Walker (1950*b*), five were pleomorphic and the rest produced typical normal colonies.

M. gypseum is rare in Birmingham. Only two cases have occurred several miles apart at an interval of 7 years. No information could be elicited about the first case. The second was traced to the patient's dog. As *M. gypseum* is known to lie dormant in the soil, samples of garden soil collected from about half the postal districts of Birmingham were 'baited' with human and horse-hair by the method of Vanbreuseghem (1952) in an attempt to ascertain if there is much of it in the saprophytic state in this part of the world. Though another keratinophilic fungus, *Keratinomyces ajelloi*, was found in every sample, no single instance of *M. gypseum* appeared and the experiment was abandoned for lack of time.

Trichophyta

Of all the Trichophyta the small-spored *Trichophyton mentagrophytes* is much the commonest. It occurs throughout the city in small numbers, with no discernible focus of concentration. The highest incidence is in the suburbs that constitute Birmingham 14, but the numbers are too small to admit of any generalizations about them. This is a zoophilic fungus with a large variety of known animal vectors, including wild ones, such as rodents and the hedgehog. Two cultures of the hedgehog type with the characteristic golden subsurface pigmentation, have been seen in the laboratory and remembered, but their origin went unrecognized until an exact description was published by English, Evans, Hewitt & Warin (1962). They were included among the *asteroides* type when they were recorded and cannot be extracted at this stage, so their exact location is lost.

Of the 220 *T. mentagrophytes* specimens isolated, 129 were of the *asteroides*, 74 of the *interdigitale* and 17 of the *niveum* types. The last is the cat *Trichophyton* of Sabouraud (1910) and in several of the local instances was actually traced to cats.

Patients of both sexes and all ages have appeared with ringworm due to this species of fungus. The sites affected are the scalp, the beard region, the glabrous skin and the nails. *T. mentagrophytes* var. *interdigitale* is the commonest cause of 'athlete's foot' in this locality.

T. tonsurans was a rare species here until the local outbreak that began in 1954 and lasted for 4 years. Thirty-nine cases, of which eighteen came from Monyhull colony (Birmingham 14), were referred from the city, mainly from the outer suburbs. Within this period seven patients from Staffordshire, five from Warwickshire and one from Worcestershire were seen with the same infection. The scalp was attacked in ten cases, all children; the nails in four, all adults; and the smooth skin alone in the others.

Only five of the thirteen varieties listed by Sabouraud (1910) as separate species, including the four recognized by the M.R.C. (1949), occurred in primary culture.

Table 3. *Distribution of the* Trichophyta *and* Epidermophyton

Postal district	*Trichophyton Mentagrophytes*																Other Trichophyta																*Epidermophyton floccosum*																Total
	1945	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	
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7	1	.	.	.	.	1	.	1	2	1	.	.	.	2	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	13
8	1	.	2	.	1	.	1	2	1	.	1	.	2	1	1	1	.	.	.	1	2	1	.	.	3	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	25
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11	1	1	1	.	1	1	1	.	.	1	5	1	.	.	.	.	.	.	.	1	.	1	1	.	.	2	.	2	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	22
12	1	2	.	1	.	3	.	2	.	1	.	.	1	.	1	.	1	.	.	.	.	.	1	1	.	.	.	1	1	1	.	.	1	.	1	.	1	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	22
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Total	8	14	10	19	19	14	17	20	18	18	12	7	11	11	13	7	2	4	4	5	10	12	9	4	14	10	7	26	11	16	4	8	9	5	1	3	3	1	1	1	1	3	2	2	0	0	2	1	0	3	1	403
	220																	158																	25																	

* Private patients, address undisclosed.

In the seventeen years of the survey the Birmingham incidence is as follows: *T. tonsurans*, var. *flavum*, 35 cases; var. *sabouraudi*, 17 cases; var. *sulphureum*, 8 cases; var. *tonsurans*, 5 cases; var. *plicatile*, 7 cases.

T. rubrum, though known to be on the increase in many parts of the country is still a rarity here. According to Walker (1950*a*) this species, 'a native of the Far East, is increasing in Britain, aided by importations from abroad chiefly from South-East Asia'. She cites three cases known to have originated in India out of seventeen proved importations. In all, only eighteen cases have been diagnosed at this hospital. There is no apparent connexion between the low annual incidence shown in Table 1 and the large Indian and Pakistani population at present in the city. If these people had introduced *T. rubrum* it should have become apparent by this time. *Tinea pedis* is the commonest manifestation of this species. Our records show fourteen such cases, one of *T. barbae*, one of *T. unguium* (confined to the finger-nails) and two of *T. cruris*.

Trichophyton schoenleini is even rarer in Birmingham. Nine of the fifteen cases belong to two families. The rest occurred singly, two in institutions. The favus is confined to the scalp in all instances.

T. violaceum is rarer still. In three of the five cases there was a history of importation from Poland, the Far East and Holland. About the other two no information was forthcoming, one being an Arab with no English.

Even in a heavily industrialized city cattle ringworm is not unknown. Slaughtermen are liable to it and children sometimes bring it back from country holidays. *T. verrucosum* at the rate of about 1·5 cases a year can hardly be considered a serious menace, though some of the lesions are severe with painful kerions. Half the cases seen involved the hair of either the scalp or the beard region. *T. verrucosum* var. *discoides* is the usual colonial type here, var. *ochraceum* having been seen three times and var. *album* once.

Epidermophyton

Epidermophyton floccosum occurs singly. Ten of the patients showed groin involvement, two *tinea pedis* and the rest lesions of the limbs, axilla and neck. No case of nail-ringworm due to *E. floccosum* has been treated here. Most of the patients were ex-service personnel and their contacts.

CONCLUSIONS

It is of some interest to compare the incidence of species peculiar to man with those common to man and one or more of the lower animals.

Zoophilic fungi are:

Microsporum canis	*Trichophyton mentagrophytes*
M. gypseum	*T. verrucosum*

There is some uncertainty about whether *M. gypseum* should be included under this heading because, although it is known to infect a variety of animals, wild and domestic, there is evidence that it can attack man without any animal host as

intermediary (Ajello, 1953; Whittle, 1956). In any case, our two instances are of small statistical significance.

The anthropophilic species comprise:

Microsporum audouini	*T. schoenleini*
Trichophyton tonsurans	*T. violaceum*
T. rubrum	*Epidermophyton floccosum*

Sabourand (1910) suggested that the *T. flavum* (*cerebriforme* in his nomenclature) variety of *T. tonsurans*, which he regarded as a separate species, might have an animal host, despite his failure to find one. This guess has been disproved in recent years by several mycologists working independently. The monospore culture method of Georg (1957) and the hyphal fusion technique of Davidson, Dowding & Buller (1932) applied in the U.S.A. by Taschdjian & Muskatblit (1955) and in this country by the author, should be enough to dispel the idea that *T. flavum* constitutes a species at all. The whole species, including this variety, may thus be confidently classified as anthropophilic.

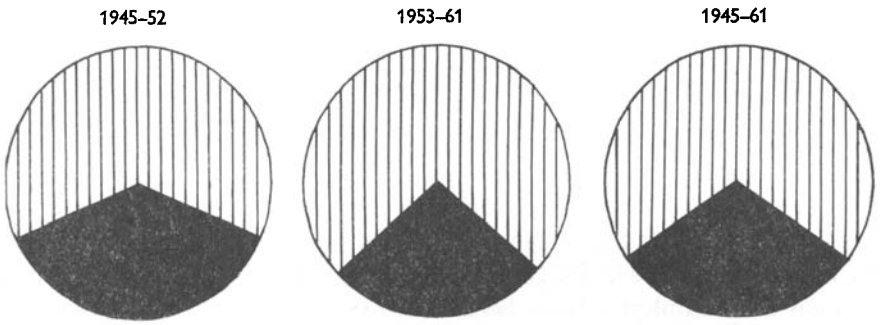

Fig. 4. Relative proportion of zoophilic and anthropophilic species. ▥, Zoophilic fungi; ■, anthropophilic.

Fig. 4 shows the relative proportions of zoophilic and anthrophilic fungi of Birmingham from 1945 to 1952, from 1953 to 1961 and over the entire span of 17 years. Though reflecting the fluctuations described in the foregoing section, all three pie-charts show a marked preponderance of zoophilic species.

This has been observed elsewhere on this island, not only in country districts where it is to be expected but in highly industrialized cities, e.g. Coventry, Leeds, Leicester, Portsmouth and Reading (Walker, 1958). A study of rural and urban ringworm in north-eastern Michigan (Georg, Hand & Menges, 1956) revealed that urban ringworm of animal origin is derived mainly from cats and dogs. The same is true here. Fig. 5 shows the relative incidence of ringworm contracted from dogs and cats compared with that of infections associated with other animals.

The outbreaks of *M. audouini*, *M. canis* and *T. tonsurans* have subsided. There remains a small amount of sporadic fungus infection, consisting mainly of *T. mentagrophytes* and *M. canis*, but how much of this is imported and how much indigenous it would be hard to determine.

In the so-called 'twilight' areas, inhabited to high density by Indian, Pakistani

and West Indian immigrants, who live under conditions that provoke continual comment from the local press, there is no demonstrable increase in the ringworm flora.

It is unlikely that an epidemic of ringworm comparable to the *M. canis* outbreak of 1946–58 will ever occur again in Birmingham. As all the common dermatophytes are controllable by griseofulvin administered orally (Gentles, 1959), it is probable that every case that does occur and is promptly treated will be of such short duration that few contacts will be made and that they, in turn, will be limited by the same antibiotic. The main danger will lie in *T. rubrum* infections of the toenails, which are resistant. Such cases do not appear to be on the increase in this region, however.

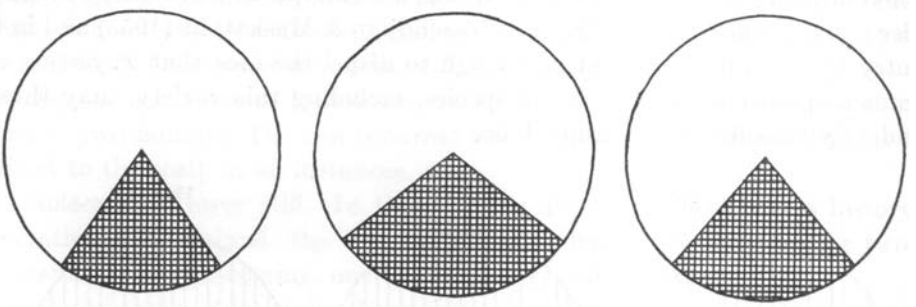

Fig. 5. Animal hosts. □, Cat and dog; ⊞, miscellaneous animals.

Birmingham can no longer be regarded as a centre of much interest to the clinical mycologist, except in so far as fundamental research is concerned; and for that the raw materials are in danger of petering out. For this reason live cultures of the common dermatophytes have been distributed from this laboratory to other hospitals in the vicinity.

SUMMARY

The nature of the ringworm flora of Birmingham over 17 years was investigated and tabulated by species, geographical distribution and concentration.

The rise and fall of such outbreaks as occurred has been charted.

The persistent preponderance of zoophilic species, in spite of the recent decline in over-all incidence, has been demonstrated.

The author is much indebted to Dr Baylis Ash, Dr Avit Scott, the late Dr Cranston Walker, Dr Henly and Dr Hocken Robertson for referring so many interesting cases to this laboratory; to Alderman Sir Albert Bradbeer, Prof. Lancelot Hogben, Mr Alan Neale of the City of Birmingham Central Statistical Office and to Mr W. H. Daley, Allocations Officer to the City of Birmingham Housing Management Department, for municipal statistical material; to the late Dr Dykierman, the late Dr Hirst and Mr Bertram Sealey for the loan of literature; to Sister Simpson and to the Misses G. Hyde, J. Shakespeare, M. A. Lardner, B. Webster, J. Payne and B. Duffill for technical assistance and to Dr Chaplin, Consultant Pathologist to the Group, for certain facilities not available at the Skin Hospital.

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