

MODERN METHODS
OF
TREATMENT OF RINGWORM
OF THE SCALP.

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MODERN METHODS OF TREATMENT OF RINGWORM OF THE SCALP.

Introduction.

The essential of an adequate treatment of ringworm of the scalp is the eradication of the disease in the shortest possible time.

Among the diseases which afflict human beings, ringworm holds a comparatively trivial position but, from the educational standpoint, it assumes a very much greater significance. During the year last under review by the Education Committee of Mexborough, a district decidedly of the better working class type, and having 2,704 scholars on the rolls of its schools, there is recorded a total of 43 cases. An incidence of 1.6 per centum means a considerable loss in education.

It is now almost the universal practice to encourage the attendance of the patient at school, provided that a washable linen cap be worn; whilst this safeguards the child's education it creates a psychological problem scarcely less serious. The shaved head with its unsightly white covering proclaims more effectively to the child mind the need to shun the sufferer than the cry "Unclean, unclean!" could ever do. And so, like the lepers of old, the unfortunate child finds itself looked on askance and avoided by those who were erstwhile its associates. A small matter to the adult—to the sensitive and nervous child it may well be the beginning of an inferiority complex with far reaching consequences.

The purpose of this thesis is to suggest a treatment at once effective, rapid in its results, inexpensive and convenient; a treatment which has been critically tested in fifty cases.

Historical Outline.

About 250 years ago a draper, Antony Leenwenhock, who employed his leisure in scientific research, astonished the savants of his day by demonstrating the details of moulds, parasitic on the human skin.

It was not, however, until 1842 that Gruby was able to show that ringworm was caused by a mould-fungus. A few years later, in 1853, Bazin confirmed his work and again demonstrated the causal parasite.

Little progress in the study of the organism was made until the last decade of the nineteenth century and the opening years of the twentieth. It is probable that the reason for the passing of almost half a century without any appreciable progress in the study of the parasite was that Gruby, unfortunately, made use of the term "porrigo decalvans" when describing the condition caused by the microsporon; this term had previously been applied to alopecia areata. Thus a misunderstanding arose and as repeated examinations of alopecia for a parasite proved negative, the opinion came to be held that Gruby had drawn considerably on his imagination in the description of a causal parasite. Pride of place must be given to Sabouraud, of Paris, who first classified the various fungi and indicated a medium suitable for their cultivation from the standpoint of differentiation. During this period many observers were at work and gradually many varieties of the parasite were recognised and described. Principal among these early workers on the subject were Drs. H. G. Adamson, H. Aldersmith, Blaxall, E. Bodin, J. Bunch, Aldo Castellani (in Ceylon), Duhring, Colcott Fox, Hartzell, A. Macfayden, Majocchi (in Italy), H. W. Stelwagon and A. Whitfield.

Experiments were carried out in the method of treatment, especially with a view to combining various fungicides with substances which would facilitate their penetration to the organisms, located in the hair follicle and in the hair itself. As early as 1830 and 1836, Plumbe and Rayer, respectively, had recognised the importance of complete epilation. Early in the present century, Adamson, MacLeod, Sabouraud, Walker and others made a valuable advance in treatment by their work on the use of the X-rays; the use of which had first been suggested by Freund, of Vienna, in 1897.

Work was being done about 1915 with vaccines and later with foreign proteins, while in 1919 radium was being used. In 1926 thallium acetate (which had been used and abandoned by Sabouraud almost thirty years earlier) was re-introduced and became the outstanding contribution to methods of treatment; for several years this has largely monopolised the writings on the subject.

Mycology.

Although the classification is not yet absolute, the mould-fungi, which are the cause of ringworm, have provisionally been placed in the order of the ascomycetes ; an order characterised by the method of spore formation, with the development of asci—a true sexual process is absent.

There are two divisions into which the ringworm fungi fall, the microspora and the trichophyta (a word formed from the Greek, meaning hair fungus). These families were originally differentiated by the size of their spores, but it soon became apparent that the different fungi often so closely resembled each other as to be indistinguishable by the microscope. They are now distinguished by cultivation on artificial media. This important advance was made possible by the devising of the media, known as proof agar, by Dr. R. Sabouraud, of Paris. The formula is—agar-agar 18, granulated peptone 10, maltose 40, and distilled water 1,000. On this medium the fungi exhibit their characteristic growths. Tubes are inoculated with the scrapings of the ringworm patch by a platinum needle, or infected hairs, after having the roots cut off by a hot needle, may be planted in the medium.

The mould-fungi of ringworm may live both aerobically and anaerobically. Anaerobically, in the skin, they form a network of mycelial threads. The small pieces (erroneously described as “spores”) into which they break up, especially at the ends, become elongated into mycelial threads and thus, by this process, the fungus is propagated. Aerobically, the true method of reproduction, the fungus is perpetuated by aerial hyphae with lateral and terminal buds.

It is peculiar to certain of the fungi that they live only on the human skin, while certain others may occur in, and be transmitted to man from, the lower animals—these latter are usually the more virulent. It has been suggested that there may be a saprophytic life, but this contention is still without proof.

In this thesis the fungi causal of ringworm in this country will be considered but it should be remembered that observations vary according to the country, and even the district, in which they are made.

Microspora. It has been estimated that 90 per cent. of cases of ringworm of the scalp are caused by the *Microsporon Audouini*, with which will ever be associated the names of Gruby and Sabouraud. It is common in Western Europe and in America, but rare in other countries. Its activities are confined to the human skin and then almost entirely to the scalp of children, tending to die out as puberty approaches. There has, however, this year, been a report of a primary infection in adults.

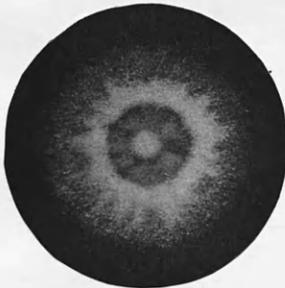


Fig. I.
Microsporon Audouini.
Culture after six weeks.
(From Dr. R. Sabouraud).

On proof agar the cultures appear as white, fluffy and circular colonies ; after a six weeks' growth the culture exhibits its full characteristics ; showing a central, raised, rounded, greyish-white, opaque tuft. Around this is a darker grey circle with radiating furrows ; while the periphery is composed of a whitish cushion thinning to a fine down-like fringe. (Fig. I.)

The appearance presented by an examination of a diseased hair, under the microscope, is of the ensheathing of the hair from

about a quarter of an inch above the scalp level to near the bulb by a mass of small spores, densely and irregularly arranged, and showing no tendency to chain-formation; while within the hair itself can be seen mycelial threads lying in the long axis of the hair and extending down almost to the bulb. In the bulb, little is to be found except, perhaps, a few isolated rows of spores. (Fig. 2). By gently rubbing the hair between the slide and cover-slip the ensheathing spores are removed and the mycelium threads within the hair more easily seen.

When the fungus first reaches the scalp it produces some inflammation and spreads until it reaches a hair follicle; then, passing downwards between the hair and the follicle, the mycelial threads obtain access to the hair under the cuticle which is destroyed by a keratin-enzyme, produced at the growing extremities. The mycelium outside the hair splits into spores which by continuous division finally ensheath the hair. The hair, thus becoming very brittle, breaks off to form a stump at the upper level of the fungus.

Scrapings from a ringworm patch, examined by the microscope, show the threads to be of varying lengths, rectangular in shape and branching irregularly, while they are from 1 to 5 μ in diameter. At varying intervals appears a transverse septum. The spores are round or oval and vary in size from 2 to 4 μ in diameter, and are formed by the longitudinal and transverse splitting of the mycelial threads.

Other microspora may occasionally be found as the cause of ringworm of the scalp; the *Microsporon tardum* has quite commonly produced the condition, others are mostly of animal origin—chief among which is the *Microsporon lanosum* (Fig. 3)—and may produce suppurative conditions. Cultured on proof agar they produce a growth generally similar to that of the *microsporon audouini* but the growth is much more rapid and profuse, without the delicacy of the *audouini* and more opaque. These three varieties are practically the only ones ever encountered in ringworm of the microsporon type, although eight others have been isolated and described.

Trichophyta. The trichophyta are divided somewhat arbitrarily into those which are lodged within the hair and those both within and without the hair and are named respectively the endotranches and the ecto-endotranches. Further sub-division has been made with regard to the resistance of the spores to standardised solutions of potassium hydrate.

The *trichophyta endotranches* are responsible for about 5 per cent. of the cases of ringworm of the scalp in this country, although the percentage is very much higher in Paris. An epilated hair, specially prepared and

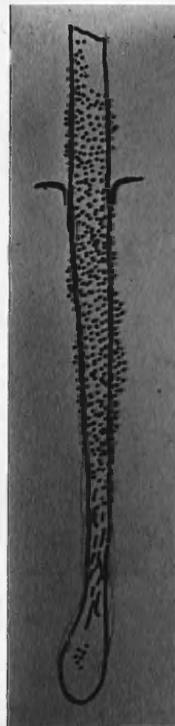


Fig. II.
Diagrammatic drawing of hair, fully infected by *Microsporon Audouini*.

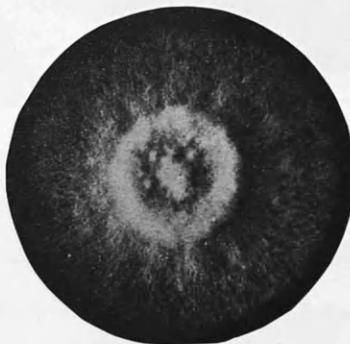


Fig. III.
Microsporon Lanosum—culture on proof agar. (From Dr. R. Sabouraud).

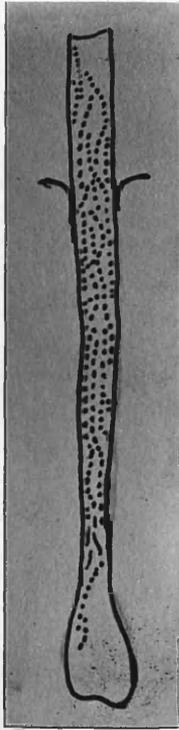


Fig. IV.
Diagrammatic drawing of
a hair, fully infected by
Trichophyton Endothrix.



Fig. V.
Trichophyton Crateriforme.
Culture after 35 days.
(From Dr. R. Sabouraud).

surrounded by a well marked, raised wall. Radiating ridges and furrows may be found in the older growths. The knob in the early stages of culture of the trichophyta acuminatum is covered with feathery spikes, likened by Colcott Fox to "pampas grass."

Other fungi of this class have been described by Marshall, Chambers and Sabouraud, but, as they are mostly of foreign origin, they do not come within the scope of this thesis.

The trichophyta ecto-endothrices are the cause of most of the adult cases of ringworm

examined under the microscope, shows the fungus within the hair and occupying much the same distribution as the audouini but the arrangement of the spores is not so irregular; they tend to be arranged in chains, like a rosary, in the long axis of the hair. In the fully infected hair the mycelial threads outside the hair have disappeared. (Fig. 4). The examination of a scraping will reveal the spores to be square or oblong with rounded corners and about 3 to 8 μ in diameter, while the threads will be found to have a tendency to branch dichotomously.

Clinically the endothrices cause two varieties of the disease, ringworm with stumps and "black-dot" ringworm, respectively ascribed by Dr. Sabouraud to the *Trichophyta acuminatum* and the *Trichophyta crateriforme*. In the former the hair breaks off to form a stump at the upper limit of the fungus; in the latter the orifice of the hair follicle is blocked by a twisted spiral of pigmented hair due to the loss of elasticity of the hair and to the pressure of the scale occluding the orifice; epilation is difficult and the hair should be expressed for examination.

The endothrices attack not only the scalp but also the glabrous skin, beard and nails. They are confined to the human skin but may be transmitted to the lower animals. They may attack the adult scalp and, when they occur in childhood, show no tendency to die out at puberty.

There are four main varieties; the two already mentioned, the *Trichophyta sulphureum*, and the *Trichophyta violaceum*. These can be differentiated only by culture on proof agar, shielded from daylight, when they give rise to a distinctive colouring of the growth; the

trichophyta crateriforme (Fig. 5) having a cream or white centre, the trichophyta acuminatum (Fig. 6) a greyish-yellow centre, while the centre of the trichophyta sulphureum is of a primrose colour. In all these varieties the culture is noticeable about the sixth day and when fully formed presents the appearance of a central knob with a crater-like depression at the middle of it; around this is a circle on a lower level and the whole is



Fig. VI.
Trichophyton Acuminatum.
Culture after 35 days.
(From Dr. R. Sabouraud).

in this country; they attack the scalp, glabrous skin, beard and nails. They are all of animal origin and their attack on the human skin is marked by extreme virulence and the production of suppurative conditions. They may be divided into the two groups, microides and megaspores, according to the size of their spores.

The microscopic examination of a hair fully infected by the ectothrix presents an appearance similar to that of a hair infected by a microsporon. Mycelial threads and chains of spores ensheath the hair and threads and chains of spores are found within the hair, lying in the long axis and ending near the bulb. In a typical example it may be distinguished from the endothrix by the presence of the fungus outside the hair; and from the microsporon in that the irregular mosaic of spores outside the hair is replaced by spores in definite rows or chains. (Fig. 7).

Cultured on proof agar it has been possible to differentiate about fifteen varieties, divided by Sabouraud into three groups—namely, those which give (A) powdery cultures, (B) downy cultures, and (C) corrugated cultures like favus.

(A) The large powdery cultures are produced by the microides; the growth appears about the third day, the centre gradually becoming powdery in appearance and from it radiate hyphae like the rays of a conventional sun; the centre meantime becoming more opaque. Variations in the cultures occur with the causal fungus; for example, the *T. asteroides* (Fig. 8) has long fine rays, while the *T. radiolatum* has shorter rays; the *T. lacti*-colour is cream in colour while the *T. persicolor* produces a velvety peach-coloured growth; the *T. granulosum* and the *T. farinulentum* produce no rays, the former appearing like irregular chalky granulations while the latter produces a mealy culture.

(B) The large downy cultures are produced by the megaspores; *T. niveum radicans*, *T. niveum denticulatum* (chiefly affecting dogs and cats), *T. equinum*, and *T. rosaceum* (Fig. 9)—transmitted to man from fowls, in which it causes "white-crest."

(C) Corrugated cultures are usually not stellate but present a corrugated appearance, peculiarly smooth and gelatinous. Of this the *T. violaceum* affords a good example—this fungus has been demonstrated as the cause of suppurative ringworm of the scalp; others of this group are the *T. ochraceum* (found often in those who tend cattle) giving rise to a canary yellow culture; the *T. verrucosum* (occurring in domestic animals) a greyish white culture; and the *T. discoides*—a foreign

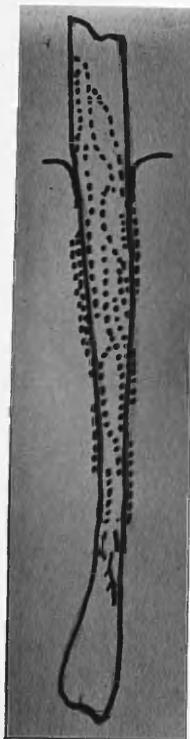


Fig. VII.
Diagrammatic drawing
of a hair, fully infected
by *Trichophyton*
Ectothrix.

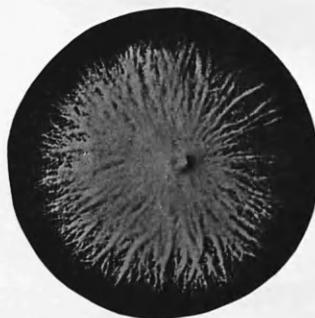


Fig. VIII.
Trichophyton Asteroides. Culture
on proof agar. (From Dr. J. L.
Bunch).

fungus giving a cribriform culture with a white fringe which resembles that of favus. Most of these are very rarely encountered, indeed almost every ectothrix infection is due to one of three fungi,—the asteroides, rosaceum and ochraceum.

In all, over thirty varieties of the trichophyta have been described.

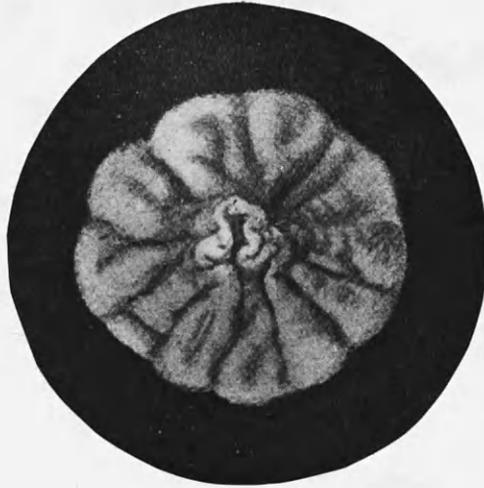


Fig. IX.
Culture of *Trichophyton Rosaceum*.
(From Dr. R. Bolam).

Clinical.

The manifestations of tinea vary according to the variety of fungus producing the lesion, the susceptibility of the individual skin and the part of the body affected.

The fungus acts in two ways—a destructive or corrosive action on the skin, hair and nails brought about by the secretion by the fungus of a keratolytic ferment ; and an irritant action due to the toxic influence of the ferment and to the rapid growth of the organism. The irritation of the skin produces inflammation, varying in degree from a very mild erythema to vesicular, pustular and granulomatous lesions. The greater susceptibility of the skin of certain individuals does not appear to be in any way connected with the general health or constitution.

On the glabrous skin the lesions may be flattened, reddish-coloured macules covered with easily detachable scales. These are usually caused by the microsporon, usually in children and commonly about the face or neck associated with ringworm of the scalp. Raised pink spots surrounded by concentric, raised rings, covered by scales, is another manifestation ; or the lesions may be raised, reddish, well-defined, circular or oval plaques. Still other lesions are suppurative, intensely painful and oozing a yellow serous discharge ; or there may be reddish-purple granulomatous nodules, breaking down into ulcerations—attention to this latter condition was first called by Majocchi. Occasionally in severe cases the lesion may resemble a carbuncle.

Ringworm of the crutch is a special variety of that affecting glabrous skin. It begins as raised, rounded papules presenting a raw sodden appearance ; these coalesce into patches of irregular outline, sometimes covered with thick scales and sometimes with oozing vesico-pustules. This variety never affects the hairs and is always found on parts of the body which are moist and warm. Dhobie's, or washerman's, itch is an affection found in tropical and sub-tropical countries and is allied to tinea cruris.

An eczematoid form of ringworm is liable to affect the extremities of the body. The lesion is a deep seated vesicle, about the size of a pin-head, and has been compared to a sago grain embedded in the epidermis. There is little or no inflammation and in a few days, as the vesicle dries, the scale falls off leaving a shiny moist surface surrounded by an upturned scaly edge. A vesico-pustular type affects the interdigital clefts and spreads from there to the dorsum of the foot or back of the hand. Sometimes the soles of the feet and palms of the hands become horny with parchment-like scales. The acute condition may become chronic and present scaly patches leaving, when the scales fall off, a raw glazed surface.

Ringworm of the beard is comparatively rare; it may show as a perifollicular abscess, appearing as a smooth red nodule from which issues a sero-pus, drying to form a crust ; or it may take the form of patches of scaly, partially bald areas surrounded by well defined margins,—over the scaly spots may be seen blocked follicles resembling “black-dot” ringworm. If the lesions clear up in the centre they appear as rings.

The eyelashes and eyebrows may be the seat of both the dry and the suppurative types of tinea.

Ringworm of the nails is common in the far east but more rare in this country ; the infection usually takes place under the free border, the fungus attacking the epidermis of the nail bed

causes scaly thickenings which raise the nail. By the infection spreading backwards the nail-matrix becomes involved as does the nail substance itself, becoming opaque in discoloured patches, granular, spongy and friable at the edge, resulting in malformation and destruction of the nail. The nail may present a grooved or pitted appearance. This condition is due to the trichophyta.

Tinea versicolor is a condition due to the *Microsporon furfur* and shows as patches of yellowish or brownish macules, usually on the upper part of the trunk, frequently occurring in phthisical patients.

Trichophytides, attention to which was first drawn in 1911, by Jadassohn, occurs occasionally, connected with deep seated suppurative ringworm. *Microsporides* closely resembles it but occurs in relation to microsporon infections. The condition seems to be due to a blood infection caused by toxins eliminated by the fungus or to poisonous substances excreted by the tissues as a reaction to the toxins. The small follicular papules, pale pink in colour, may be distributed diffusely, mainly on the trunk, less commonly on the limbs and rarely on the face. The fungus is usually absent in the papules which occur coincident with the acute state or more often as the acute stage of a suppurative ringworm is passing off. It is marked by perifollicular inflammation, and a dilatation of the follicle which sometimes contains a horny plug or spine. Sometimes the eruption is in the form of a scarlatiniform rash suggestive of a suppurative reaction. The eruption may remain from a few days to several weeks; subjective symptoms are usually absent, but fever, anorexia, enlargement of the spleen and lymphatic glands, conjunctivitis and polymorpho-nuclear leucocytosis have been noted.



Fig. X.—Ringworm of the Scalp caused by *Microsporon Audouini*.

Ringworm of the Scalp. For descriptive purposes ringworm of the scalp will be dealt with under three headings: namely, (1) the *Microsporon* ringworm of children, (2) ringworm of the scalp due to the Trichophyta endothrix, and (3) suppurative ringworms.

(1) *Microsporon ringworm* is by far the most frequently encountered in this country and, as has been already stated, is usually caused by the *Microsporon audouini*. It is common in children between the ages of five and fourteen, tending to spontaneous cure as puberty approaches. It is most important to recognise the earliest sign, which is a small reddish



Fig. XI.—“Black-dot” Ringworm of the Scalp.

macule or scaly patch, the scales being most prominent at the orifices of the hair-follicles. As this spreads it forms a rounded area of mild erythema with a slightly raised, well-defined margin. The area is covered by adherent greyish-white scales and among the healthy hairs can be seen broken off stumps about a quarter of an inch in length; the stumps being thicker than the natural hair, presenting a greyish frosted appearance and having a conical scale at the base. Owing to the loss of elasticity the hairs are bent in all directions. (Fig. 10). The follicular openings may be prominent giving to the area the appearance of “goose-flesh.” The appellation “disseminated ringworm” has been suggested by Aldersmith where there are small and widely distributed patches. But the individual foci usually keep on spreading, if untreated, and tend to coalesce into large irregular patches, until occasionally the whole scalp is involved. Itching, to a varying degree, may sometimes be a symptom. In the infant the centre of the patch clears up thus leaving a ringed lesion—in many such cases there is little loss of the hairs. An examination of the rest of the body for sub-cultures is a wise proceeding.

Constitutional symptoms are absent and the patient is not immune to future attacks. The appearance of a typical patch may be greatly altered by the presence of some other skin condition. Complications may arise due to a superinfection by pathogenic organisms introduced by rubbing or scratching. Suppuration may occur when the infecting *Microsporon* is of animal origin or when the scalp is particularly sensitive to the invading fungus. Howard Fox has recorded a case of suppurative ringworm due to the *Microsporon audouini*. Alopecia is some-

times a later complication, the hairs being shed instead of breaking off, but this seldom persists after a few months. It has been suggested that this complication is more often due to an endothrix fungus.

(2) *The Trichophyton endothrix variety* is met with in adults as well as in children. It is characterised by rounded or irregular scaly patches, somewhat resembling the last variety but usually smaller in size. In some cases stumps are present but more often the hair breaks off at the orifice of the follicle which it plugs, as described in the section on mycology, producing an appearance of black specks—to which the name “*black-dot*” ringworm was applied by Aldersmith. (Fig. 11). The *Trichophyton endothrix* is usually of human origin and this type is the most intractable to treatment of all the ringworms of the scalp.

(3) *Suppurative ringworm* of the scalp may, rarely, be due to a microsporon of animal origin, especially the *Microsporon lanosum*, or even to the *Microsporon audouini*, but usually results from an infection by a trichophyton ecto-endothrix of animal origin. It may occur at any age and the majority of cases of ringworm of the adult scalp are due to this infection. The lesions are acutely inflamed, raised and “boggy” with well-defined and often irregular edges. The affected area is shiny, raw, reddish or purplish in colour and covered by multiple small perifollicular abscesses which ooze pus. There are broken off stumps of hairs and the area often presents a fluctuant soft feeling on palpation somewhat resembling the feeling of



Fig. XII.—Ectothrix Ringworm of the Scalp—Kerion.

an abscess. (Fig. 12). Upon occasion, when the swelling has been incised, no pus escapes but only a serous fluid, often blood-stained. Contrary to what may be expected the lesions are seldom painful although itching is often a troublesome feature. In rare cases, a pronounced rise in the evening temperature has been recorded.

Diagnosis. In ringworm, uncomplicated by other skin conditions, the diagnosis is seldom difficult. The stumps of hair, opaque and greyish and bent in different directions, or the "black-dots" together with the dull greyish scales are pathognomonic and usually serve to distinguish it from other affections of the scalp, such as favus, alopecia, eczema and seborrheic dermatitis. A skin reaction from sterilised cultures has been recommended for diagnosis but this appears unnecessary. The diagnostic criterion is the examination of the diseased hair and the finding, microscopically, of the hyphae and spores; this procedure should always be followed. The detection of diseased stumps is made easier by rubbing the involved part with cotton wool soaked in chloroform, this accentuates the frosted appearance—chloroform does not whiten hairs affected by favus. Further, in favus the hairs are not broken off in such a regular manner; while favus shows sulphur-yellow, cup-shaped, dry crusts, often more or less permanent alopecia and often atrophic scars. The appearance in alopecia areata presents no signs of inflammation nor of scaling; the skin being entirely bald, smooth and shiny. The scales in seborrheic dermatitis may be dry or greasy—if the former they are fine and easily detached, while if the latter, they cover the affected area with a thick crust; there are no broken off hairs, and pustulation is usually absent.

A scraping of the affected part is performed with a blunt knife and the scales placed on a slide. A drop of 10 per cent. liquor potassae is added, heated for a few seconds and the coverslip applied. To obtain a diseased hair for examination the hair should be epilated with special epilation, or blunt pointed forceps, traction being applied in the axis of the hair so as to obtain the bulb intact. In the "black-dot" variety a scale should be removed and the hair expressed like a comedo. The hair is then washed in aether to remove grease, placed on the slide, treated with 10 per cent. liquor potassae, or 15 per cent. sodium hydroxide, and warmed, allowing sufficient time, usually about fifteen minutes, for the hair to clear. The coverslip must not be pressed down otherwise the softened hair will be damaged. If it be desired to keep the specimen a drop of glycerin may be run under the coverslip and the edges sealed with melted paraffin. For diagnostic purposes a medium powered lens will be sufficient.

It has been indicated that the differential diagnosis of the various fungi can be done satisfactorily only by culture on proof agar; if, however, it be desired to compare the size of the spores a high power lens should be used and the hair should not be treated by liquor potassae which causes the spores to swell. In this case the hair is soaked on the slide for some minutes in ozonic ether and, when dry, treated for ten to thirty minutes with a mixture of one part of a 5 per cent. alcoholic solution of gentian violet to three parts of aniline water. After drying, the stain is fixed by steeping for five minutes in Gram's solution. It is again dried and soaked for a sufficient time in pure aniline to which a little iodine has been added; finally it is washed for a few seconds in pure aniline, then in xylol and mounted in balsam. Everything, except the fungus, is decolorized by this method. Another method of staining is by Sahli's blue, containing a saturated aqueous solution of methylene-blue, 24 parts, and a 5 per cent. solution of borax, 16 parts, with 40 parts of distilled water. The hair, having been freed from fat by chloroform, is placed in formic acid, which is heated for a few minutes until it boils. The acid is washed out with distilled water; the specimen stained for one minute with Sahli's blue, again washed with distilled water, treated with absolute alcohol, cleared in xylol and mounted in balsam.

Wood's light is a valuable diagnostic method depending on the fluorescence of ringworm infected hairs under an ultra-violet light. This phenomenon was first remarked in 1925 and described by P. Vigne as follows : "A small piece of Wood's glass is used ; it is a dark violet glass containing oxide of nickel which allows to pass only a very little red and visible violet rays and some long ultra-violet rays of a wave length of from about 3,600 to 3,300 Angstrom units. The Correx filter of red-purple or blue-purple glass has sometimes been used instead of Wood's glass. The patient's head is examined in a darkened room by the light from a mercury vapour or a tungsten arc lamp and the rays passed through the piece of Wood's glass. Normal hair fluoresces only very slightly in this light but hairs infected by the ringworm fungus fluoresce brilliantly with a greenish light." Even when the infected hairs have broken off level with the scalp a brilliant fluorescence is seen at the mouth of the hair follicle. This is of practical value in the cases of "bald" ringworm. Kinnear has reported that no reliance can be placed on this method of investigation when the infecting fungus is an endothrix or an ectothrix.

The use of this light is of value after treatment in deciding whether the condition has been completely eradicated, and it is of value also in the examination of other members of the family. It should be remembered that a trace of vaseline on the scalp will fluoresce brilliantly.

The age incidence has been fully dealt with ; both sexes may be affected and the general health, constitution and season appear to affect neither the incidence nor the course of the disease, although individuals vary in their susceptibility. The fungus may be transmitted by direct contact especially in school children but more often it is transmitted by infected caps, towels, brushes and combs. Organisms of animal origin are usually transmitted directly to the persons having the care of the animals. The danger of the transmission of the disease makes early diagnosis and treatment a matter of the greatest importance.

Prognosis. The prognosis of ringworm of the scalp varies according to the causal fungus and the age of the patient. The microsporon variety, if left untreated, will usually persist until puberty and in many cases it has been found intractable to treatment ; in the infant it is more amenable. The endothrix ringworm has also been found intractable to treatment and its reappearance is often due to small patches which have escaped treatment. Suppurative ringworm, or kerion, is the most amenable to treatment, but baldness due to scar tissue formation may persist.

A guarded prognosis is usually prudent and to be commended.

In all cases it is wise to allow a month to elapse after treatment is discontinued and then a careful re-examination should be made before the condition is pronounced as "cured."

Treatment.

The difficulty of treatment of ringworm of the scalp lies in the difficulty of bringing the fungus in the hair and in the hair follicle into contact with the antiseptic which can destroy it. That this has been a real difficulty is evidenced by the great variety and number of the remedies which have been from time to time advocated. The rationale of treatment is to cause a loosening of the hair and the shedding of it together with the fungus.

Precautions against the spread of the disease are of first importance ; the modified isolation of the patient and the wearing of a close fitting white cap should be recommended ; while towels, brushes and combs should be set apart for his use and frequently disinfected.

It is advisable to cut off all the hair with barbers' clippers so that no small focus is overlooked. When a diagnosis of ringworm is made, the scalps of all the other children in the family should be examined.

The X-rays are now widely used for the epilation of the diseased hairs. The use of the X-ray is unnecessary in the treatment of the microsporon ringworm of infants, when parasiticide treatment has proved efficient ; its use between the ages of 3 and 13 years has been recommended, while beyond that age the natural dying off of the fungus renders mild antiseptic applications satisfactory. For the endothrix variety of the scaly type the X-ray has been advocated as the most efficient treatment, while in the ectothrix variety its use is absolutely contraindicated. In suppurative ringworms antiseptic applications usually tend to increase the inflammatory processes with a resultant shedding of the hairs. In these cases the X-ray may cause severe dermatitis and permanent baldness ; this is one of the dangers of X-ray treatment which is not without other attendant risks, the production of temporary or permanent baldness without dermatitis and the risk of injury to the brain. It has been suggested that epilepsy has followed exposure to the rays, although Dr. J. M. H. MacLeod, after a series of experiments, has definitely declared against this possibility. It would appear at least desirable not to apply the rays to a head the fontanelles of which have not yet closed. X-ray treatment should be in experienced hands but it has a further disadvantage of not being always easily available. The rays do not kill the fungus and cultures can easily be obtained from diseased hairs after exposure and epilation. The difficulty of keeping the head of a child immobile during the exposure has been overcome by the special couch and calico helmet devised by MacLeod. In the author's somewhat limited hospital practice, X-rays have given satisfactory results in 95 per cent. of the cases treated.

It is thought that the rays temporarily suspend the functions of the hair papilla, with the consequent interference with the nutrition of the hair. No apparent change takes place in the appearance of the scalp after exposure until in about fourteen days a toxic reaction, probably due to toxins eliminated by the degenerating bulb cells, occurs with itching and general erythema of the scalp. During the following week the hairs fall out and the growth of new hair occurs from the second to the sixth month after exposure.

Before exposure to the rays any inflammatory process present should be subdued by sedative applications such as lead lotion, and if there be any likelihood of an impetigo or other septic infection on the devitalized skin it is well to treat the scalp with mild antiseptics for a few days prior to the exposure.

When the whole scalp is to be exposed the Kienböck-Adamson method may be employed. The tinea-marker, as described by MacKee and Andrews may be used or five points may be marked on the scalp with a skin pencil, namely, (1) about $1\frac{1}{2}$ inches behind the frontal margin of the hair line of the scalp, (2) just above the lower border of the scalp at the lower part of the occiput, (3) on the upper part of the scalp in a line with and midway between points (1) and (2), and (4) and (5) just a little above and to the front of the right and left ears, respectively. The distance between any point and its neighbour is five inches, and lines joining the points will meet at right angles, thus dividing the scalp into four triangular areas. The skin below the hair line is protected by a lead protector. To the front of the shield is fitted a special localiser, "consisting of a metal rim fitted with three soft-wood tapering pegs which converge to a distance of an inch and a half from each other and are of such a length that when the scalp is placed in contact with the tips of the pegs it is 16 cm. from the anti-cathode." Each point in turn is placed midway between the tips and a dose of the rays given—the dose should be carefully controlled by a measuring pastille. Should a second exposure be necessary, three months should be allowed to elapse after the previous treatment.

When the hairs begin to fall out the process may be hastened by epilation with forceps or with adhesive strapping; during this period there is danger of the disease being disseminated by the hairs unless a cap, which should be washed daily, be worn. In cases in which it has not been necessary to expose the entire scalp the application of a mild antiseptic to the remainder of the scalp will prevent its contamination by epilated hairs. The use of parasiticides after the exposure to the rays is to be recommended for the destruction of remaining spores.

Barium sulphide, with equal parts of zinc oxide and starch, made into a paste and applied to the scalp for several minutes has been found to have a depilatory action. There is, however, the danger that it may give rise to distressing boils—the author has the record of such a sequel to a case occurring in his private practice.

The epilation of the hairs by *forceps*, especially in extensive areas, is not to be recommended, both on account of the painfulness of the method and the likelihood of diseased hairs being overlooked.

Thallium Acetate. The internal administration of thallium acetate for the treatment of ringworm was first used by Sabouraud but was abandoned by him as being unsafe; he reported haemorrhage and purpura following its use. It is quite likely that he made use of too large a dosage. About thirty years later, in 1927, attention was again drawn to this method by the reports of Dowling, Drummond, Dixon, Firth, Kelman and others. Exhaustive researches were carried out by Buschke, at first alone and later associated with Peiser, with special reference to dosage. Urueña, however, makes the claim that the credit for the systematic treatment by thallium belongs to Mexico; he further states that the treatment is more useful in the large spored cases.

Buschke recommended a single dose of the drug to be dissolved in sweetened water and given by the mouth when the stomach is empty. He advised a dose of 8 mg. per kilogram of body weight. Dowling advocates a dose of 8.5 mg. for general use, and 9 mg. in the case of children with stout, coarse black hair and also when the lesions are situated on the crown of the scalp. The dose must be exact and the difficulty of the weighing of the drug may be overcome by buying it weighed up in decigrams, centigrams and milligrams. McCurrich

has discovered that the difficulty of the use in this country of the metric system can be overcome by dividing the weight of the child in pounds by 18, the result is the dose of thallium in grains. The use of the drug is definitely contraindicated in persons whose urine contains albumen or casts ; thus a careful examination of the urine should precede its administration. Thallium has no local action ; it acts through the sympathetic nerve supply and on the endocrine system. Professor W. E. Dixon has suggested that it acts by the heightening of the sympathetic excitability.

In seven to nineteen days after the administration of thallium the hairs fall out ; with the dose indicated there is no epilation of the hairs of the pubis, axilla or of the beard. Removal of hairs which are long in falling out is to be recommended by epilation forceps or by the sudden removal of a strip of adhesive strapping. The new hair begins to grow early, often in the second week after defluvium, and this constitutes a danger to a cure inasmuch as the new hair may be infected by the remaining diseased hair.

Perhaps the most successful technique was recommended by Buschke ; the use of a 10 per cent. sulphur ointment from the first day of treatment and then, from the time of defluvium until a fortnight after the diseased stumps are out, the use of a fungicide ointment and tincture of iodine on alternate days.

Should a second administration be necessary it is unsafe to give it within two months. A satisfactory test to determine when the drug is out of the system would be an advantage.

The case for the use of thallium is made by Seaston and Wilson—they state that it is 90 per cent. efficient, speedier in its action than the X-rays, the growth of new hair is not so long delayed and that permanent alopecia does not result. They make the suggestion that the drug should be used fresh as the acetate may, in contact with the air, become a carbonate—there is, however, no proof of this contention.

Complications and dangers have been many. Dowling reports toxic effects in 14 per cent. of cases thus treated ; characterised by joint pains, especially in the lower limbs, coming on from the eighth to the tenth day and disappearing in three or four weeks ; loss of appetite ; malaise, probably due to temporary damage to the thyroid gland, and irritability. Hypochlorhydria and choreic convulsions in children have been reported. For hypochlorhydria he recommends thyroid, suprarenal extract and dilute hydrochloric acid. A number of deaths have been reported as a result of the treatment usually through an accident or through the idiosyncrasy of the patient. Very young children show a greater tolerance to the drug than do their elders. The conclusions of Lynch and Spencer Scovell seem to be of special importance ; an epilating dose is unsafe for adults and children about 10 years of age ; its use should be limited to children under five or better under three years of age ; the margin between the epilating and the toxic dose is so small that it does not allow for idiosyncrasies ; that since, even in small doses, it has been found to produce slight degenerative changes in the brain cells of rats there is no reason to believe that it may not, at least, hinder brain development in the child ; its toxic action is markedly similar to lead and that it is not advisable to use it as a routine treatment. At the best its results are much less certain than those of the X-rays. In the case of children with a marked disproportion between age and weight and in the case of adults it has been suggested that thallium treatment may be combined with the X-rays—one half the epilating dose of each being given—this, it has been contended, diminishes the risks of both treatments.

Radiation with ultra-violet rays appears to have no effect upon the course of the disease.

Radium also has been used to produce epilation, especially by Mazzoni in Florence ; he uses an applicator in the shape of a cap with heavily screened tubes and has reported favourably on the treatment, which he has carried out without any untoward happenings. A mild erythema appears after about five days and the hairs begin to fall out in a fortnight after the exposure. Where the whole of the scalp has to be treated several sittings are necessary—the treatment is, therefore, costly in both materials and time without showing any compensating advantages over the roentgen-rays.

Suppurative ringworm has been the subject of much experiment. It has been treated by deep freezing with carbon dioxide by Freeman, who has reported successful results.

Vaccines. Kerion has been found to clear up quickly when the filtrate of pounded up cultures from virulent ringworms has been injected. In the blood of a patient appears to exist a specific anti-body capable of producing a complement-fixation test. Foreign proteins, in the form of a typhoid bacilli suspension, have been injected for ringworm of the megaspore type. In this case a general reaction occurs in two to six hours and a gradual clearing up of the ringworm patches ; it has been recommended as a treatment for both children and adults but not in the case of persons in delicate health nor those suffering from heart or kidney disease. The injections are made intravenously ; intramuscular injection appears to have no effect. No change has been noticed when small-spored ringworms have been treated by this method. Immunity is not conferred or is of very short duration : many cases of re-infection have been recorded on the cite of a recently cured lesion. The necessity for such a treatment does not appear to be obvious ; bathing with hydrogen peroxide (10 volumns), boric compresses, the application of a 3 per cent. ammoniated mercury ointment and starch poultices have been found to give rapid and satisfactory results ; the injection method has the distinct disadvantage of producing a general reaction and pustules at the point of injection.

Treatment by the Application of Parasiticides and Irritants. These methods have been adopted universally before the advent of the X-rays. They are still used when the rays are unavailable, in the treatment of the microsporon variety in infants and at puberty and in the suppurative types. The vast number of these applications, which from time to time have been advocated, testify to the intractability of the disease to treatment. At best the length of time taken to effect a cure is considerable and many such cases have been seen persisting after two years' treatment.

No attempt will be made to mention all the applications which have been used ; among the most favoured are sulphur ointment 20 per cent., acidi salicylici 5 per cent., 20 per cent. carbolic acid, 3 or 4 per cent. ammoniated mercury, formalin, betanaphthol, tar, resorcin and hypo-sulphite of soda. The difficulty in the treatment by parasiticides of bringing them into contact with the fungus has already been mentioned ; to overcome this difficulty they have been used with turpentine, aether, lanolin and many other substances to facilitate their penetration. The ointments should be rubbed thoroughly into the scalp for ten minutes twice a day. Iodide of sodium has been used to aid the penetration of the biniodide of mercury—a 1 in 4 solution having been used. Kingery reported successful results from the use of 1 per cent. thymol and 1 per cent. cinnamon in a solution of gutta-percha.

The production of inflammatory processes by irritants has produced better results in the scaly type of ringworm than has any parasiticide. Too energetic treatment with irritants

may lead to ulceration and permanent baldness, while they have the further disadvantage of producing considerable pain and itching and the aggravated inflammation may cause the parents some uneasiness. It is wise in this method of treatment to commence with weak irritants and carefully supervise the reaction ; the production of blistering and pustulation is distinctly to be avoided. Among the most popular irritants are tincture of iodine ; picric acid 2 per cent., either alone or, as recommended by Williams, combined with camphor ; croton oil made into a 10 per cent. ointment with lanolin and vaseline or used alone, as described by Aldersmith ; 2 to 10 per cent. chrysarobin ointment, or a saturated solution in chloroform ; an ointment composed of equal parts of ordinary sodium chloride and vaseline, and the oleates of mercury and copper.

Under the most favourable circumstances these methods take from several weeks to many months, and, as they must be used daily and the reactions carefully watched, they are trying to the patience of the physician and the pocket of the patient. Before the use of irritants scales and crusts must be removed by washing and when sufficient inflammation has been produced the loosened hairs are extracted by forceps.

Dockrell, in 1889, reported very successful results from the use of hydronaphthol. After washing the scalp with 5 per cent. hydronaphthol soap and hot water, he applied a cap of 10 per cent. hydronaphthol plaster. After four days a 20 per cent. plaster was applied—when this was removed infected stumps were adherent to the plaster and the disease was cured.

Vidal aimed at destroying the trichophyton by excluding oxygen ; he used the essence of turpentine and tincture of iodine as fungicides and smeared the scalp twice daily with vaseline and covered with a cap of caoutchouc.

The older remedies appear to leave much to be desired in the matter of treatment, both as regards reliability and the length of time required for satisfactory results. The X-rays so far offer the best method of treatment—satisfactory results have been fairly consistent and the time taken to effect a cure has been greatly reduced. This method has obvious disadvantages, principal amongst which is that it must be in the hands of the expert. There appears to be, as indicated in the introduction, the necessity for a remedy such as will be consistently effective in the eradication of the disease, rapid in its results, inexpensive and convenient. Since by far the majority of cases of ringworm are seen in general practice ; since the need for treatment is as great, if not greater, among the poorer classes, and in consideration of the fact that immediate treatment is so much to be advocated to prevent the spread of the disease, a weapon, deadly to the ringworm fungus, should be in the armoury of the General Practitioner.

The technique of *the treatment recommended in this thesis* is as follows :—

The entire scalp is examined by Wood's light, or if not available, sponged over with chloroform on cotton wool, and a careful examination made for patches of the disease. Should only one or two be found, the hair is clipped to a distance of an inch and a half around the ringworm. The hair of the entire scalp is clipped in cases where a number have been found and in all cases where the consent of the parents can be obtained ; it is seldom difficult to obtain their acquiescence in this procedure. The ringworm is now sponged with ether or methylated spirit and the part painted to a distance of one inch beyond the affected area with liquor iodine or a one in four concentrated tincture of iodine. In fifty cases this procedure has been followed, even for the scalp of young infants, without any untoward result from the use of

the strong solution of iodine. A narrow strip of cotton wool is soaked in hot water and applied in a circle around the area. Ethyl chloride is now sprayed over the painted part until the tissues are deeply frozen—the hot cotton wool prevents the liquid flowing down the child's neck, which otherwise causes apprehension on the part of the patient.

The mother is instructed to rub in an iodine ointment night and morning for a fortnight and given instructions to bring the patient for examination at regular intervals—at least on three occasions, at the end of the first, second and sixth weeks. On the first and second of these occasions, should any diseased hairs still remain, they are removed by a piece of adhesive strapping pressed down over the entire area and then quickly removed.

When crusts have formed a starch poultice is used prior to the treatment—the poultice is made by mixing four tablespoonfuls of starch with a little cold water, boiling water is then stirred in until a paste is produced—this is applied direct to the scalp for at least four or five hours. Before treatment the starch is thoroughly removed.

At the end of six weeks, that is, four weeks after all treatment has ceased, a careful examination is made for infected hairs—where possible hairs should be epilated and microscopically examined.



Fig. XIII—A photograph of the scalp of a child six months after the author's treatment.

During ten years, fifty such treatments have been recorded—in forty-eight of these there was only one application of the treatment and at the end of six weeks the patients showed no signs of infection. In the remaining two cases a second application achieved equally good

results ; one of these cases was due to an endothrix and the other appeared to have been infected from a cat although there was no suppuration. Twenty-nine of the cases were seen after six months and in every case the hair had regrown and appeared normal.

One case was complicated by impetigo, the starch poultice was applied, then the treatment as described above but in place of the iodine ointment, an ammoniated mercury ointment was substituted and both infections cleared up.

Of the fifty cases, three were in infants, two of which showed typical "ringed" lesions ; four others under the age of five years ; two in adults and the remainder in school children. Three were suppurative in type and two were of the "black-dot" variety.

The photograph shows the condition of the hair of a girl six months after treatment (Fig. 13). This child was eight years of age and had one large well defined area on the crown of the head ; she had been under treatment for two years both privately and at a school clinique when she came under the author's treatment.

Since most of these ten years have been spent in general practice the number of cases which have come under observation has been comparatively small but the striking results of the treatment described in fifty cases warrants the attention of the medical profession.

Conclusions.

1. Early diagnosis and treatment, and precautions against the spread of the disease are of primary importance.

2. The dying off of the microsporon at puberty suggests that an attempt to render the scalp of the child an unsuitable soil for the growth of the fungus might be a profitable research.

3. *The older methods of treatment by fungicides and irritants :*

These are useful when the X-rays cannot be obtained, in kerion and in the microsporon infections in infancy and at puberty.

Too energetic treatment by irritants may produce considerable pain, ulceration and permanent baldness. At best, results are unreliable and extremely slow.

4. *X-rays :*

Favourable results are fairly consistent and eradication of the disease is effected fairly rapidly.

Their use appears to be contraindicated in infancy and in the suppurative types, while it is unnecessary in cases occurring at puberty.

This treatment should be in the hands only of experts ; too small a dose will result in failure while too large a dose may produce dermatitis and permanent baldness with perhaps possible injury to the brain.

Results seen in the author's hospital practice have been 95 per cent. favourable.

The X-rays are not always readily available.

5. *Thallium acetate :*

At best, this treatment appears to give no better results than the X-rays, except that its action may be more rapid.

It is dangerous in persons in delicate health and in those with albuminuria ; there are also dangers on account of the ease with which accidents may occur and on account of idiosyncrasy of the individual. It may give rise to distressing toxic effects and may hinder brain development.

Its use is limited to cases in children under the age of five or three years and as most of the cases of ringworm occur in school-children it cannot be considered as offering much towards the solution of the problem of treatment generally.

It is difficult to conceive the justification for the use of a highly dangerous and poisonous drug in the treatment of a non-fatal disease, especially when the only claim that can be made for it is that its action is slightly more rapid than that of the X-rays.

6. *Epilation of barium sulphide and by forceps* may be positively cruel by reason of the painfulness of the process and satisfactory results are not consistent.

A painful case of boils following the use of barium sulphide came under the personal observation of the author.

7. *Ultra-violet rays* appear to have no effect on the course of the disease.

8. *Radium* treatment is very costly both in time and materials without showing any special advantage over treatment by the X-rays.

9. *Vaccines* :

The use of vaccines is dangerous in persons in delicate health and in those with heart and kidney disease. It produces troublesome local and general reactions.

The reason for the use of vaccines does not appear to be obvious for suppurative ringworm responds well and rapidly to simple antiseptic treatment.

10. *The treatment recommended in this thesis* has been tested in only 50 cases but it has given 100 per cent. satisfactory results ; it has proved rapid in its results; inexpensive in both time and materials, and is convenient for use in the surgery of the general practitioner.

It has been equally successful in all types of ringworm.

Such a record warrants attention and further investigation.

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