Original Articles.

TINEA CRURIS: ITS MANIFESTATIONS, DIAGNOSIS AND TREATMENT.

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MANY medical men in India do not recognise the manifestations of ringworm of the groin (*Tinea cruris*) if it attacks other parts of the body. We have had practitioners with many years of experience in tropical diseases coming to us with such common complaints as *mangoe toe*, and foot-tethers and asking us to diagnose the nature of the lesion, and advise them about its treatment. Some of these manifestations of *Tinea cruris* are illustrated in the leading text-books as gouty eczema, etc., whilst it is only in recent years that the lesion named cheiropompholyx—thought to be due to an error of sweat secretion—has now been proved to be due to ringworm. Again, many of the eczema lesions pictured in text-books on skin diseases are nothing more than primary ringworm infections with secondary streptococcal dermatitis. Castellani in Byam and Archibald's *Practice of Medicine in the Tropics* points out that two of these manifestations of *Tinea cruris*, viz., dermatitis interdigitalis, and dermatitis bullosa plantaris, are due to streptococcal infections secondary to ringworm. Under these circumstances it is not surprising that many mistakes in diagnosis have been made in this common parasitic infection of the skin.

The first difficulty hitherto has been to identify the ringworm fungus in the lesions. One must do more than merely scrape the skin surface and examine the scales under caustic potash; when the mycelial rods are few in number, a thick piece must be taken from the advancing edge and cleared for several hours in 40 per cent. caustic potash before the fungus can be seen under the microscope. When vesicles are forming, the serum inhibits the growth of this fungus, so it is necessary to take off the tops of several vesicles; sometimes as many as 16 pieces have to be examined after prolonged clearing, and then the mycelium may be seen in one or more of these epithelial flakes. In quiescent cases, the spores are very few in number, so one has to resort to cultivation on special media. Cultivation is difficult as it is necessary to get rid of the secondary organisms, and numerous inseminations have to be made before a successful culture takes place on the media. Success in cultivation depends to a large extent on the cleanliness of the skin surface, because other fungi and spore forming bacteria may be present that are impossible to destroy without killing the ringworm fungus. Many of the cases can therefore be more easily diagnosed clinically as ringworm, e.g., cheiropompholyx, ringworm of the feet, etc., for to prove them to be such by bacteriological methods may require a number of trial examinations and cultivations before one is successful.

The second difficulty has been due to insufficient knowledge of the morphology and lesions produced by this fungus. The ringworm that produces these lesions is a higher fungus consisting of roots, surface runners, and aerial hyphæ that carry (spores) end organs. The roots penetrate the basal cell layer as far as the papillæ, and open the lymph spaces, producing vesicles, bullæ, or exfoliation of the skin, depending on its thickness. The serum in turn inhibits most bacteria except streptococci and staphylococci, so that streptococcal dermatitis (eczema) and pustules (cheiropompholyx) are common secondary infections of *Tinea cruris*. Often when the case is first seen, the condition is diagnosed as eczema, etc. but as the inflammation subsides, the ringworm character of the lesion becomes evident. We have abandoned the term eczema from our nomenclature of skin diseases and speak of these cases as streptococcal dermatitis. In our skin clinic, the commonest form of streptococcal dermatitis which we see is that secondary to *Tinea cruris* infection.

The lesions we are about to describe cause a great deal of discomfort and disability in the following ways:—

(*i*) Pruritus, owing to irritation of the basal cell layer by vesicles forming, or denudation of the protective surface layer.

(*ii*) In the dry hot weather, the infected skin becomes hard and dry, and with movement cracks and fissures, causing pain.

(*iii*) Streptococcal infection of the corium; this is a more serious complication producing a localised dermatitis or extending cellulitis.

It is not generally recognised that *Tinea cruris* attacks the feet more commonly than the groin, and that moisture and friction are essential to allow the ringworm fungus to grow on the skin and penetrate through the horny protective layer.

Lastly, the treatment of these conditions is extremely confusing to the practitioner, for some recommend one line of treatment and others another. The reason is, that none of the writers pay any attention to *the nidus of the disease* that is frequently found between the 4th and 5th toes; or to the danger of re-infection that occurs after the remedy has been stopped from being applied to the skin.

Aetiology.

The essential cause of the disease is an infection of the epidermis by the cryptogamic fungus known as the *Tinea cruris* or *Epidermophyton inguinale*. This form of ringworm, although highly infectious, requires certain conditions of soil, temperature, etc., before it can invade the surface epithelium. The infection takes place from man to man by spores reaching the body through the handling of clothes, etc. The dhobi has generally been incriminated as the means by which the disease is spread, but it is very doubtful if he is the only culprit. Most Indian servants have some form of this infection present on their body, and by handling clean clothes are more apt to transmit the disease. During the last 6 years one of us had a bearer who has suffered from *Tinea cruris* of the nails, and if during the hot weather one neglected to take precautions to prevent infection, one would invariably have got an attack of ringworm of the groin. This is not the only method of infection, as we have evidence that this ringworm fungus can grow on moist soil. In this way the feet are often infected in those who walk barefooted on moist soil, such as the Indian maid-servant, and those who frequent public swimming baths. In persons affected with ringworm of the groin, the infected scales falling down from the groin may lodge between the toes, or infect the ground and then in turn infect the toes.

As regards the conditions necessary for infection, the first point one notices is that this fungus invariably chooses those sites of the body where the epidermis is finest in texture and consists of only two layers, a single-celled basal layer and a horny layer which is only three or four cells in depth. These areas of fine skin are found in the inner side of the groin, about the web of the fingers, toes, axilla, inner side of the wrist and about the tendo Achillis. Children are not usually attacked, and some dermatologists consider this is due to thymic function which allows the microsporon to attack the hairs of the head, but prevents the body skin surface from being invaded by *Tinea cruris*. In adults when the thymus disappears, the body is attacked by *Tinea cruris* but not the hair of the head by microsporon, as the soil is unsuitable. The facts hold good, whether the explanation is right or wrong.

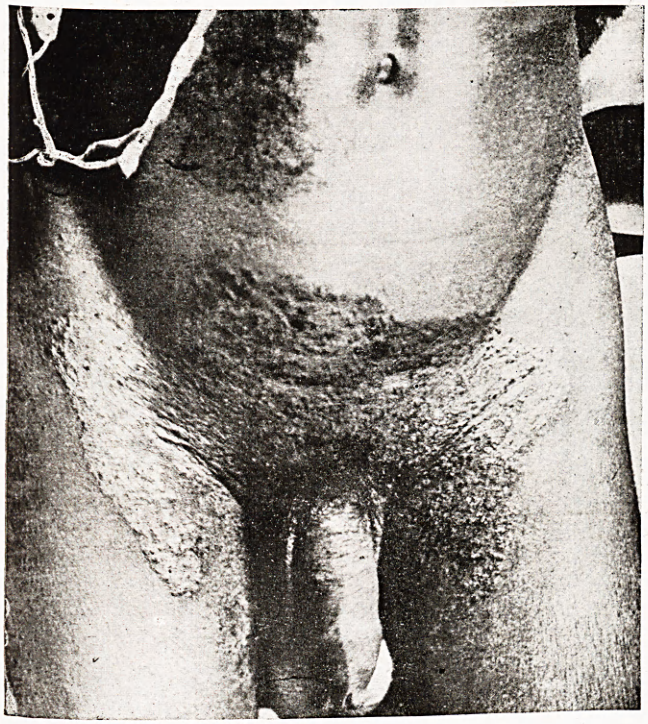
The second point that is observed is that certain conditions are necessary for infection to take place on the body; they relate to moisture, temperature and friction.

Tinea cruris requires a good deal of *surface moisture*, as will be seen from the following facts. Ringworm of the groin is a disease seen almost exclusively in men, and particularly in stout men with sedentary habits. During the hot weather in such individuals the skin in the folds of the groin is invariably in a sodden state. We have only seen the disease twice affecting the groin in women, both of whom were very stout. The disease occurs most commonly on the skin at the cleft between the 4th and 5th toes and is particularly common in those who wear ill-fitting shoes and thick socks. In Indian maid-servants who are continually walking barefooted on damp ground in and about their kitchens the disease is very prevalent.

Friction is also a very fruitful cause in allowing infection of the skin to occur, as the protective horny layer of the skin is rubbed away by the rubbing of coarse wearing apparel, or by continually washing, as in certain trades like washerwomen, nurses and doctors. In the latter class of people, the lesions are frequently seen at the web of the fingers and may spread to the palms. In Bengalees who do not wear socks but only Oxford shoes, they generally get infected on the instep at the site where the tongue and edge of the shoe rubs most. Durwans (gate-keepers) who wear *kharams* (i.e., wooden shoes with a peg which is held between the first and second toes) are usually infected at the first cleft between the great and second toes. In some, owing to the friction of the *dhoti* (loin cloth) in men, and the *sari* in women, the ringworm affects the skin in that area which is subjected to the most friction and moisture. The soles of the feet are particularly affected in those who suffer from flat feet or a tendency to flattening of the arch, and the disease is therefore seen more commonly amongst those who walk barefooted on damp ground, and in Europeans, who wear thick socks and boots. Infection may occur on the thin skin which is situated on either side of the tendo Achillis in Europeans under similar conditions as above. Thus it will be seen that the two most important conditions that are necessary for infection are moisture and friction. The temperature of the air helps in raising the surface temperature of the body and increasing moisture. The disease during the winter months often remains dormant and the only sign then visible is desquamation of the skin surface, but there is nearly always some itching at the site of the disease. It is for this reason that the ringworm disappears on a change to the hills or to a cooler climate like England only to reappear again as soon as the sufferer returns to the plains, or when he leaves Suez and again comes into the tropics. It will be seen that the skin of the cleft between the 4th and 5th toes forms the most suitable place for infection to occur, as the spores are readily picked up from the ground by walking barefooted; the skin is suitable in texture, and moisture and friction occur most at this site. Therefore, the condition known as *mangoe toe* is in the majority of cases *the nidus of the disease*, and when the atmospheric temperature conditions become

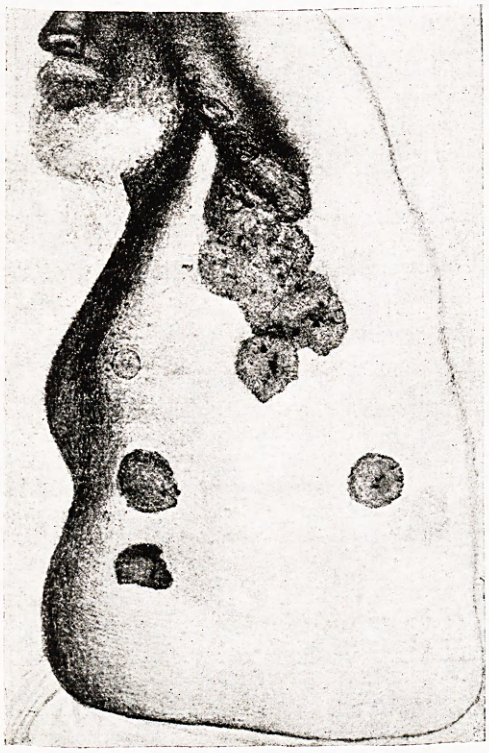
Plate I.

The lesions produced by Tinea cruris *on the body.*

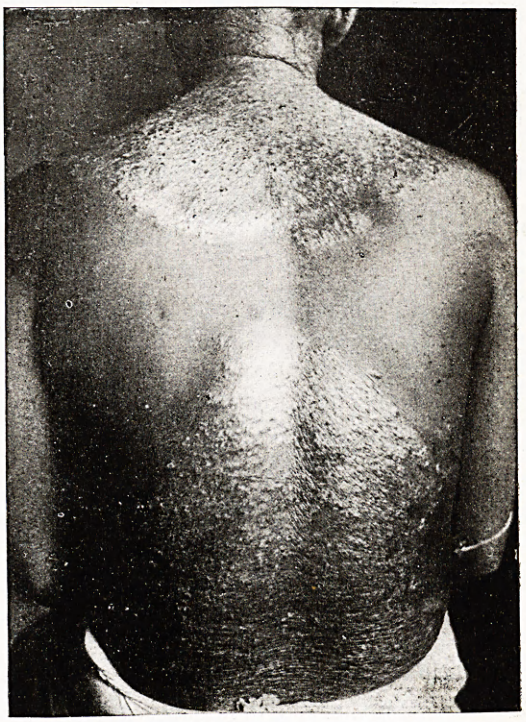


(*a*) *Tinea cruris* of the groin, a chronic case with marked hyperkeratosis.

(*b*) *Tinea cruris* of the body due to the friction and moisture caused by the dhoti.



(*c*) *Tinea cruris* of the axilla and body in a European. The lesions are red and angry looking.



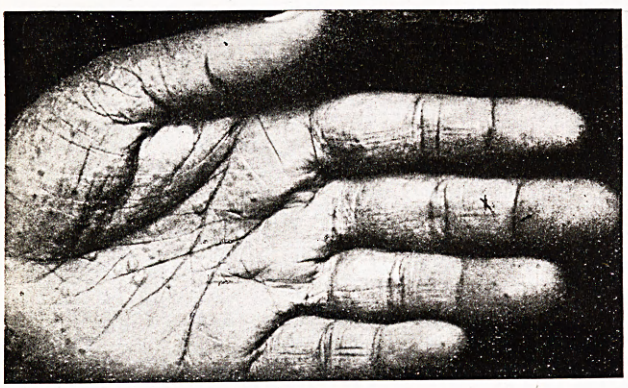
(*d*) Extensive ring-worm infection of the body commonly seen in Ooriahs and boatmen.

PLATE II.

The lesions produced by Tinea cruris *on the hands.*

(*a*) The plaque type with thickening of the epidermis (horny layer).

(*b*) Papular pustular lesions on the back of the hand, extension from the wrist.



(*c*) Small vesicles produced in the skin of the palm—vesicles sterile.

(*d*) Eczematous lesions between the web of the fingers.

(*e*) Cheiropompholyx. The vesicles have been infected by staphylococci and become pustular.

(*f*) Thickening of the skin of the palms (Hyperkeratosis) with fissures.

PLATE III.

The lesions produced by Tinea cruris *on the feet.*

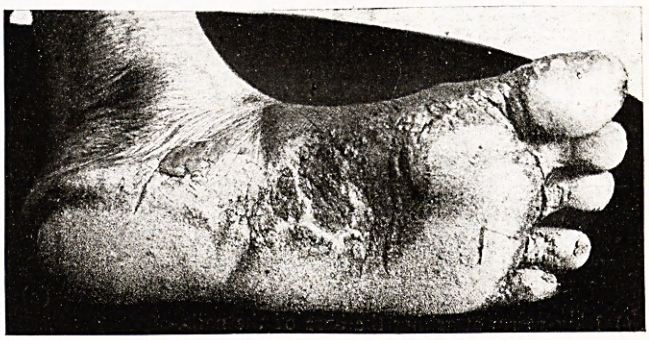
(*a*) Mangoe toe—extensive case—affecting all the clefts between the toes—Note the sodden appearance of the skin.

(*b*) Ring-worm lesions on the instep due to the rub of the shoes.

(*c*) Foot-tethers—plaque-like lesions on the sole with pustulation.

(*d*) Hyperkeratosis of the soles with extensive fissuring of the skin.

(*e*) Ring-worm of the soles of the feet, due to extension from the thin skin on the inner and

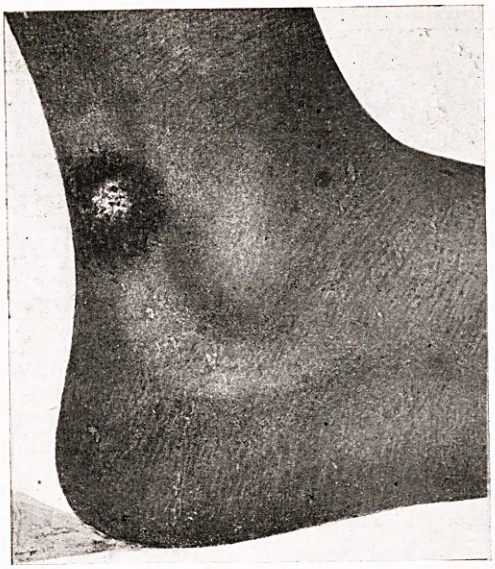


(*f*) Mangoe toe with extension on to the soles of the feet with marked hyperkeratosis and fissuring.

Plate IV.

Tinea cruris *of the nails, and some common complications of* Tinea cruris.

(*a*) Verrucose tuberculide secondary to foot-tethers.



(*b*) Small patch of streptococcal dermatitis (eczema) on the thin skin around the ankle secondary to ring-worm.

(*c*) Ring-worm attacking the ends of the nails.

(*d*) Ring-worm attacking the base of the nails.

(*e*) Generalised streptococcal dermatitis secondary to *Tinea cruris*.

favourable, and moisture on the body is abundant, spores can then easily gain access to other parts of the body during bathing or when drying oneself with an infected towel.

Clinical Manifestations.

By text-book descriptions one is led to believe that the commonest site of infection with *Tinea cruris* is in the groin. Here it is seen as a red area on the inner side of the groin with festooned edges, spreading more in the lower and posterior part than on the upper and anterior part, owing to the apposition of the scrotum. This lesion was first described as the marginal eczema of Hebra. In the acute stage the surface is red and raw, owing to the exfoliation of the horny layer leaving the tops of the papillæ bare; at this stage there is generally some oozing of serum. If one examines the growing edge, one sees numerous tiny vesicles which soon lose their horny caps and form deep red inflamed areas. As the condition subsides, the redness disappears and the skin in the groin has a slightly brown colour with surface desquamation. When dormant during the winter months, the staining of the groin is the only thing noticeable. In Indians who have had the disease for a long time and who have not been treated, the surface epithelium becomes thickened and sodden as is seen in Plate I, fig. *a*. Sometimes the disease extends on to the scrotum when the irritation is intense. Usually in these cases there is a superadded streptococcal infection. The disease may also spread to the anal fold and round the anus. In this area sometimes the disease persists when the lesions have cleared up from the groin, and the only symptom that is present is intense itching (pruritus ani). Ringworm of the groin is rarely seen in women, but occasionally in elderly women it attacks the fold between the labia majora or minora. On clinical examination there is no evidence of ringworm except that there may be lesions produced by scratching.

The feet is the commonest site for the ringworm to attack and the site usually infected is the cleft between the 4th and 5th toes. The lesion is popularly known as *mangoe toe* (*see* Plate III, fig. *a*) because it is commonly seen in the very hot season with the ripening of the mangoe. In the dormant state, the only sign seen is the thickening of the skin on the outer side of the interdigital cleft as a small area of thick white sodden skin. From this area the disease frequently spreads to the under surface of the margins of the toes forming thick cornified ridges (*see* Plate III, figs. *d* and *f*). During the hot weather, serum is frequently exuded under this thickened skin, and the lesion becomes very irritable causing the patient to peel off the top of the bleb. As a result, the basal cell layer is exposed and acute streptococcal infections are likely to occur, such as cellulitis. The fungus may also attack the inner side of the arch (*see* Plate III, fig. *e*), and gradually extends towards the under surface of the arch. The disease may extend either from the toe or from the arch to the under surface of the foot and cause two types of lesions.

(1) Plaques of thickened irritable skin, such as one seen in Plate III, figs. *e* and *f;* or (2) the fungus may penetrate deep down and produce vesicles which in turn may become infected by staphylococci, giving rise to pustules (*see* Plate III, fig. *c*), a condition which Cantlie described as foot-tethers. On rupture of the pustules, irregular suppurating areas are formed on the skin at the tread of the feet causing a worm-eaten appearance of the skin. In persons who are continually walking on damp ground and suffering from ringworm of the feet, the skin of the soles is liable to become very much thickened and on movement deep cracks appear which extend right down to the prickle cell layer; these fissures are very painful on walking, and are very difficult to treat (*see* Plate III, fig. *d*). In Bengalees owing to the friction of the shoes at the instep, a plaque of thickened skin is formed which is intensely irritable, and owing to the lack of elasticity the skin is very likely to fissure (*see* Plate III, fig. *b*). In Europeans who wear thick socks and boots, infection of the fine skin is also likely to occur on either side of the tendo Achillis; during the hot weather the lesion is seen as an eczematous patch (*see* Plate IV, fig. *b*); in the winter months a darker stained area of the skin is left with slight desquamation, which reappears in the following hot weather as a weeping eczema.

Infection of the hands is most commonly seen at the inter-digital clefts (*see* Plate II, fig. *d*) in persons who subject the skin to maceration by steeping in water or by continued washing. The lesions appear as minute vesicles containing serum, which are intensely irritable. The tops of the vesicles are soon scratched off and become infected by streptococci; the skin now becomes more irritable, the corium becomes indurated, serum oozes on the surface making it impossible for these people to carry on their profession. Sometimes the fungus attacks the palms of the hands by the roots being pushed out from the inter-digital clefts or from the thin skin of the inner side of the wrists. The lesions of the palm vary according to whether the roots penetrate the prickle cell layer rapidly or slowly. If the roots penetrate slowly, only sufficient serum is exuded between the prickle cell layer and the horny layer to irritate the cells and cause hyperplasia of this layer with heaping up of the epithelium, so that plaques are formed consisting of imperfectly keratinised horny cells which are twice the normal thickness, so that they are raised above the general surface (*see* Plate II, fig. *a*).

Sometimes the disease is more extensive and there is a general thickening of the whole of the horny layer of the palm which becomes hard and in-elastic, and fissures deeply with the movement of the hand (*see* Plate II, fig. *f*). If the ringworm is growing rapidly and the roots penetrate the prickle cell layer, so that serum is exuded between it and the horny layer, small vesicles form with clear contents, containing only serum. The pressure exerted on the nerves by the formation of these vesicles causes intense irritation (*see* Plate II, fig. *c*). Still larger vesicles are sometimes formed which rise above the general surface layer, and infection is very likely to occur with staphylococci, so that the contents of these vesicles become purulent, a condition spoken of as cheiropompholyx (*see* Plate II, fig. *e*).

Finally, the nails may be attacked. The nails of the hands are more commonly affected than those of the feet, probably owing to infection being carried under the nail by scratching the lesions between the toes and in the groin. Infection under the nail bed is comparatively rare, considering the number of cases of ringworm that are seen amongst our patients. There appears to be some evidence that implantation on to the nail only occurs when the nail bed is injured by trauma. The commonest lesion on the nail occurs at the end, when the ringworm causes a great deal of thickening of the horny layer with an alteration in the translucency of the nail. The nail appears to be chalky in colour, brittle and friable, so that bits break off, leaving an irregular shelving edge at the end of the nail (*see* Plate IV, fig. *c*). More rarely the base of the nail is infected, causing a deep furrow such as is seen in Plate IV, fig. *d*. In two or three instances we have seen a ringworm infection of the nail due primarily to a thorn injury and seen as a thickened brittle ridge which extends as far as the root of the nail.

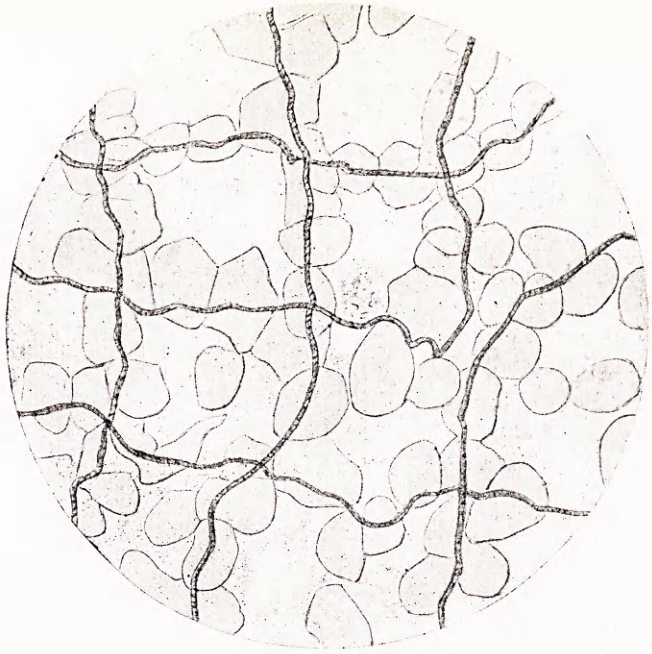
Lesions on the body.—In Indians, *Tinea cruris* often affects the small area of skin in the region of the iliac crest which is subjected to friction of the loin cloth. The lesion is seen as an ovoid area of thickened skin with an irregular outline, and vesicles situated at the edge where the disease extends and is active. More rarely it extends right across the abdomen under the *dhoti* area (*see* Plate I, fig. *b*). *Tinea cruris* is also very commonly seen, especially in stout people, affecting the axilla. The infection is more common in Europeans than in Indians. The lesion appears as a bright red weeping eczema with an irregular circinate edge and the characteristic vesicles, (*see* Plate I, fig. *c*). In this plate, the ringworm is seen mainly affecting the axilla, but here and there are circular areas of ringworm situated on the flanks. In some Indians, especially amongst Ooriahs and manjis, the disease becomes much more extensive, leaving the *dhoti* area and attacking the body surface as far as the neck (*see* Plate I, fig. *d*). In these people the lesion resembles *Tinea imbricata* owing to the hyperkeratosis of the horny layer, but there is not the ridged ring-like appearance that is seen in *Tinea imbricata*. Moreover, at the growing edge, numerous small vesicles are seen which are liable to break down and become infected by pyogenic organisms. Occasionally in Europeans, especially those who wear coarse underclothing, the disease may be widespread over the body and appear either as a circular red area or areas which may merge the one into the other. In some cases, the disease may be so extensive as to affect the whole of the trunk, arms, legs, i.e., areas of the skin that are not exposed to the air and are subjected to friction by the coarse underclothing.

Finally, it may be said that *Tinea cruris* never extends above the neck on to the face although it may attack any other part of the body.

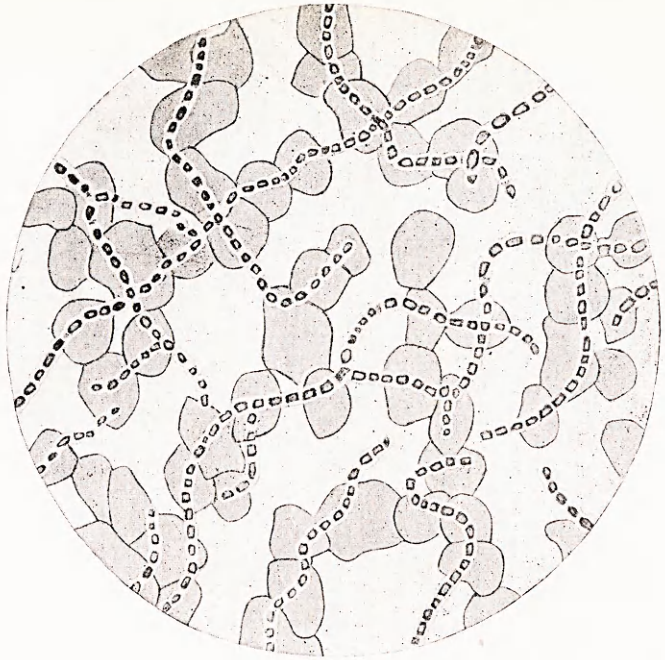
Complications.

The commonest complication of *Tinea cruris* is some form of streptococcal infection, which varies from the superficial infection called impetigo to the deeper infection of the corium, so-called eczema. These eczematous lesions are as a rule confined to the ringworm affected area. Occasionally the infection may become generalised (*see* Plate IV, fig. *e*), where the streptococcal infection involves the skin of the body, limbs and face area, giving rise to a condition resembling acute exfoliative dermatitis. These cases are often a mixture of arsenical dermatitis with a secondary streptococcal infection, as many of them have been diagnosed as syphilis, and have then been treated with one of the organic compounds of arsenic on the market. There are two factors that make this type of dermatitis fairly common in the Indian. Firstly, the doses that are given are often too large for the body weight, as the majority of our patients are well under 10 stone. The second factor, which we will speak about in a later paper, is that the basal layer in pigmented races contains some substance which is capable of oxidising many metallic salts. Frequently in *mangoe toe* streptococcal infections are produced by peeling off the top of the bullæ, which may cause an acute cellulitis starting from the interdigital cleft and extending up the foot. This type of cellulitis is more commonly seen during the hot weather.

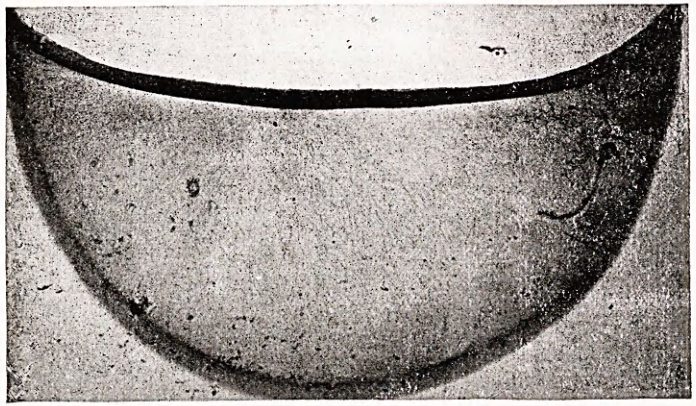
The next common complication is infection of the vesicles by staphylococci, giving rise to pustulation of the vesicles, or bullæ situated in the horny layer of the palms and soles, a condition known respectively as cheiropompholyx and foot-tethers. The rarest complication is an infection of the ringworm lesion of the foot by the *Bacillus tuberculosis*; this



(*a*) The young unsegmental mycelium from a caustic potash preparation magnification 1|6th objective.



(*b*) Older mycelia segmental caustic potash preparation 1|6th.



(*c*) Microphotograph of a section through the growth on an agar slope 1″ objective—(2) Dense layer of surface runners—(3) Fine *roots.*

(*d*) Same as (*c*) but magnified obj. 2|3rds.
(*i*) aerial hyphae.
(ii) surface runners.
(iii) roots.

(*e*) Microphotograph of roots in agar—1|6th objective—young mycelia unsegmental—old mycelia segmental.

organism gives rise to a verrucose tuberculide such as depicted in Plate IV, fig. *a*. The regions that are commonly affected are those situated on the under surface of the foot, then those in the digital cleft, and finally in the lesion on the instep. There appears to be little doubt that this condition is due to infection of the skin by the *Bacillus tuberculosis* of human origin which gains access to the corium from the ground by walking on bare feet. We have not seen this complication in Europeans.

Mycology.

The detection of the fungus by scrapings made from the skin lesions of Tinea cruris. The lesions that should be selected should be those of recent origin, and actively extending but not affected by secondary infection. A scraping of the surface skin is made from the growing edge of the lesion, and fairly thick scales should be taken for examination. When the lesion contains vesicles as in cheiropompholyx, it is best to select those vesicles which only contain serum and are not purulent. With a sharp knife, like a corneal knife, the whole of the top of the vesicle is cut away and placed on a slide with the under surface upwards. The scales of the tops of the vesicles are best cleared in a 40 per cent. caustic potash solution and then examined with the microscope as for unstained objects. Owing to the variation in the thickness of the skin, it takes from 2 to 24 hours before the epidermis is properly cleared before the mycelium can be seen. In many text-books, especially the English ones, it is recommended to facilitate the clearing by heating the caustic potash solution. We do not recommend this procedure as the mycelium is very apt to be broken up. It is far better to wait until next morning, when the epidermis will be quite clear and the mycelium can easily be seen with the $\frac{1}{6}$th inch objective.

In the active lesions, that are rapidly growing, the mycelium is seen as a greenish grey coloured unsegmented mycelium and forms an irregular mesh work (*see* Plate V, fig. *a*). It is necessary to point out that when the lesions examined are vesicular, as in cheiropompholyx, or when the disease is not active a large number of scales have to be examined before the mycelium is seen. We have often had to examine as many as 16 vesicles before the mycelium was detected by the aid of the microscope. The method of using 40 per cent. caustic potash and giving sufficient time to clear the horny cells of the epidermis is far the best method of detecting the fungus in these lesions. In some books it is recommended to scrape the scales, place them on a slide smeared with albumin and remove the fat from the scales. The slides are then placed in equal parts of absolute alcohol and ether in order to fix the albumin and scales; stain for one minute with Manson's borax methylene blue. This method is only useful when the lesion is actively growing and is more applicable for *Tinea versicolor* and seborrhœa than for *Tinea cruris*. One rarely sees the mycelium in *Tinea cruris* infections by using the latter method.

Method of cultivation.—In India, the difficulty in obtaining primary cultures is owing to the number of other organisms that are commonly found on the skin. We are dealing with Indian patients, and one of their favourite remedies is to cover the lesion with cowdung or turmeric (*haldi*). Under these conditions we generally get numerous other organisms, such as staphylococci, yeasts, and spore-forming bacteria, which overrun the media and stifle the growth of the ringworm fungus. At first we used Sabouraud's maltose agar, and found that we had to use from 6 to 8 tubes with 5 to 7 inoculations on each tube, before we got a growth of these fungi. This meant that we had to do in each case some 30 to 40 inseminations. To prevent any secondary organisms from growing, we first tried the effect of drying the scales. The scales were placed between two sterile slides wrapped in paper and kept in the desiccator for from 7 to 10 days. We found that drying inhibited most of the staphylococci and yeasts, but did not affect the spore-forming bacilli. We also tried to sterilise the scales by utilising the actinic power of the sun, exposing the scales to direct sunlight for two or more hours. This method also failed completely to eradicate the spore-forming bacilli and other organisms. We next tried growing them on plaster of Paris platforms in the presence of moisture. A circular small platform 3 inches in diameter and $\frac{3}{4}$ of an inch in height is made of plaster of Paris; this is sterilised by hot air and placed in a sterile petri dish with about $\frac{1}{4}$-inch depth of sterile water. On top of the platform a large number of scales or hairs were scattered and a little water added by a sterile pipette to moisten the surface. On the surface of the platform, the scales remained moist owing to the continued percolation of water through the plaster of Paris platform. From the 3rd to the 5th day, the fungus was seen to be growing from the scales. By this method, we were able to inhibit the growth of staphylococci, yeasts, but not spore-forming bacilli, as the ringworm fungus could grow on these moist scales, whereas there was insufficient nourishment for the other organisms. So far, we have found this method to be the best for obtaining primary cultures free from other organisms.

Secondary cultures.

Secondary cultures were made, either from the primary ones on Sabouraud's agar or from the plaster of Paris plates. We use a soft iron

wire as a needle bent at a right angle, the projecting end being about an $\frac{1}{8}$th of an inch long. This needle can also be made of stout platinum wire, but the iron wire ones are cheaper and are as good as the platinum needles. The culture is scraped with this iron wire hook, care being taken to select the right area of growth. The best results are obtained from the growing edge of the primary growth, as the secondary cultures are less likely to be pleomorphic in character. When the material is taken from the downy area, the secondary cultures are always pleomorphic in character. As a rule, one tried to get the growth from the surface of the agar so as to include the surface runners. Plate VI, figs. *a* to *d* shows the appearance of the secondary cultures on Sabouraud's maltose agar. Three things will be noticed in these cultures: (1) The cultures are all circular in shape, as the spread occurs centrifugally from the point of insemination. (2) Circular rings will be observed on the cultures, which denote waves of growth, like the yearly rings of growth seen on section of the stem of a tree. (3) There are deep furrows which are caused by the roots contracting and infolding the surface of the growth, so that in the earliest cultures one sees three lines of tension like a Y, and in the later cultures nine or more tension lines arranged in a regular manner.

As regards colour variations, it will be seen from Plate VI, figs. *d* to *i* that there are also numerous colour variations in these cultures in which all the organisms have the same morphological characters.

The study of the colour variations.—Castellani and others have held that there are several species of *Tinea cruris*; the first author has definitely named three species. In this study we will show that these colour variations are purely due to substances in the media. It will be noticed that the colour variations vary from growths which have no colour, such as Plate VI, fig. *d*, to growths which are yellow or orange in colour, and in some the central area is a reddish purple colour, such as Plate VI, fig. *g*. Sometimes the primary growths are coloured and the secondary growths are devoid of colour, whilst at other times the reverse holds good. To test these colour variations we inoculated these six colour varieties on the following media (*see* Plate VII, fig. 1). On Sabouraud's maltose agar, the primary growth may be yellow, and the secondary growth a purple red, as is shown in the plate. On glucose agar the cultures were nearly always purplish in colour. On ordinary agar they had a slight lemon colour. On Dorset's egg media with glycerin, the growth was very scanty and of a deep purple colour. On 2 per cent. saccharose agar, the growth had an orange colour.

We therefore see that these colour variations are not due to special varieties of the fungus, but are purely dependent on the chemical substances present in the media, as one sees the identity of the cultures when several different media are employed for the secondary cultures. Looking at Plate VII, one also notices the differences in the development of the rings on these different media, as well as the variation in the extent of the furrowing. Pleomorphism or downiness likewise was most marked on glucose agar and least on blood agar. We next took the six different colour variations of *Tinea cruris* that are depicted in Plate VI, figs. *d* to *i* and planted them on a synthetic media which we had devised, consisting of sodium aspartate, tryptophane and argenine nitrate. On this media (*see* Plate VII), the colour and general appearance of the secondary cultures turned out to be identical (fig. *ii*), showing that all these variations were those of a single species. We can, therefore, state definitely that all these variations in colour, pleomorphism, rate of growth, and lines of tension are dependent on variations in the media. One has no right to call a white, pink or red rose a different species of rose, but they are merely colour variations in the same species; no more should one consider these variations in *Tinea cruris* as due to different species.

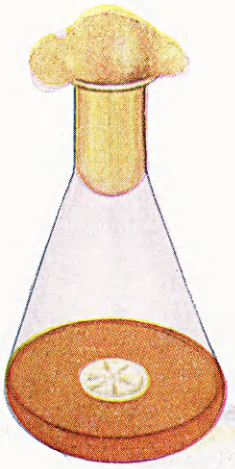
Morphology.

The morphology of the *Tinea cruris* fungus was studied by three methods:—

(1) In every case a study of the aerial hyphæ and the end organs was made by hanging drop preparations on Sabouraud's maltose agar. The technique is as follows:—A deep well slide is taken and sterilised, the coverslip is sterilised by heat, and a large drop of melted Sabouraud's maltose agar is placed on the inverted surface on the coverslip, and allowed to solidify. The whole of this technique should be done aseptically in order to prevent any infection of the agar. The agar on the inverted coverslip is now inoculated with the culture to be tested for morphological characters. The edge of the coverslip is well smeared with vaseline and a sterile welled slide placed on the inverted coverslip. The culture is now placed in a sterile air-tight chamber, and should be kept in the dark and examined at weekly intervals for a month or six weeks. There are three types of end organs seen on the aerial hyphæ of all the growths that we have classified as *Tinea cruris*. The first end organ [*see* Plate VIII, *a*(*i*)] is a segmented spindle shaped end to the hyphæ, which the French call fuseaux. The second type of spores are the bunched conidia which are oval or round spores or conidia occurring in bunches; these are shown in Plate VIII, *a*(*ii*). The third type of conidia are the single round or oval conidia. Besides these end organs, tendrils may be seen along the hyphæ, as in Plate VIII, *a*(*iii*), corresponding to the tendrils

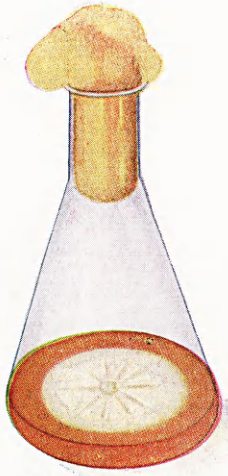
PLATE VI.

Culture of Tinea Cruris *on Saboraud's Maltose Agar.*



(*a*) First week.

(*b*) Second week.



(*c*) Third week.

(*d*) Fourth week.

The different color varieties of Tinea Cruris.

(*e*)

(*f*)

(*g*)

(*h*)

(*i*)

of many climbing creepers; sometimes these tendrils grow and produce knots along the mycelium.

(2) *Surface runners.*—The surface runners form segmented on non-segmented mycelial threads which run on the surface of the agar and spread from the centre in a centrifugal manner, they can be studied by scraping off the aerial hyphæ and examining the surface; they are best studied on blood agar. The spread often occurs as waves of growth, giving rise to the concentric ringed appearance of the surface of many of these cultures.

(3) *The deep roots.*—The deep roots are best studied by taking young cultures on Sabouraud's media, breaking the test tube and making freehand sections of the agar with a Gillette razor blade transversely through the media; then staining these transverse sections of the agar with weak carbolic fuchsin. In Plate V, fig. *c* is a microphotograph of such a section taken with a 1-inch objective. The surface roots form a thick plaque on the surface, extending from side to side of the agar tube. From the under surface of the runners, roots are sent down in a radiating manner right down to the bottom of the tube. Looking at a culture from the side, the roots appear fine and diaphanous like a jelly fish, extending deep down into the agar. If the section of the agar is now examined with the $\frac{2}{3}$rd. inch objective (*see* Plate V, fig. *d*) the aerial hyphæ will be seen at (1), the surface runners at (2) which form a very thick layer, and the roots in the media at (3). If the roots are examined with a higher magnification, viz., $\frac{1}{6}$th-inch objective, the root mycelium will be seen to be of two kinds, (*see* Plate V, fig. *e*) fine unsegmented roots of the young mycelium, and coarser segmented roots of the older mycelium. We will discuss the importance of these roots later when dealing with the morbid anatomy of the changes that occur in the skin in ringworm lesions.

From the morphological study, it will be seen that there is only one species of *Tinea cruris* which is uniform in the shape of its end organs, surface runners and roots. The variations that have been observed in the general appearance of the cultures, in their colour and pleomorphism are not sufficient to justify one in subdividing *Tinea cruris* into several species. Moreover in studying these ringworm fungi, which are higher fungi consisting of roots, surface runners and aerial hyphæ with different end organs, all these morphological characters should be first studied before one can differentiate them into different species, and not as has hitherto been done mainly by examining the surface appearance of the cultures. Further it must be remembered that for the production of aerial hyphæ and end organs of fructification, the right media should be used, otherwise the hyphæ may be sterile and carry no end organs of fructification.

Morbid anatomy.

Recently we have been working on the general histology of the skin and find that in certain parts of the body where the skin is thin, it consists of only two layers, a layer of horny cells, 2 or 3 cells in depth, and a basal layer. It is in such areas of skin that the *Tinea cruris* fungus generally starts growing and spreads to neighbouring areas of thicker skin. The spread takes place by the surface runners penetrating in between the layer of horny cells. From these surface runners, roots penetrate down through the basal layer into the papillæ, particularly at the growing margin, so that the lesions produced are frequently circular in outline with thickened sodden epithelium in the middle of the lesion, and small vesicles at the edges where the roots are penetrating. When these vesicles rupture, they expose the tops of the papillæ tufts, giving rise to a typical lesion which is described as eczema. If the roots penetrate rapidly into the basal cell layer and much serum is exuded under the horny layer, the whole of the surface epithelium comes off, leaving a raw weeping surface, most commonly seen in the groin, and first described as the marginal eczema of Hebra. The surface runners may extend from the areas of fine skin of the hands and feet to the thicker areas such as occur on the palms and soles. Here the roots penetrate the prickle cell layer, and it depends on the rate of penetration and exudation of serum as to the type of lesion seen on the skin surface.

(1) If the roots penetrate slowly so as to irritate the prickle cell layer and produce the condition of spongiosis, the excess of serum in this area causes a hyperplasia of the prickle cell layer, so that a larger amount of horny cells are formed and the lesions appear as plaques of thickened skin, imperfectly cornified.

(2) When the roots penetrate the prickle cell layer rapidly and a large quantity of serum oozes under the horny layer, a vesicle is formed (*see* microphotograph Plate VIII, fig. *b*). In Plate VIII, fig. *c* the same vesicle has been drawn with a higher magnification and the mycelium is seen at (2) and grouped conidia at (1). In the nail (Plate VIII, fig. *d*) the roots penetrate the horny cells of the nail causing areas of liquefaction in their downgrowth; this allows air to enter and gives the nail that dull opaque, brittle-like appearance which is so characteristic. With a $\frac{1}{12}$th-inch objective (Plate VIII, fig. *e*) the fine non-segmented root mycelium is seen at (1), and areas of liquefaction in the keratin are seen at (2).

Sir Almroth Wright has shown that the antitryptic property of serum is capable of inhibiting most organisms, but such serum is favourable to the growth of the cocci, viz.,

staphylococci and streptococci. For this reason, as soon as serum collects under the skin to form vesicles, they become infected by staphylococci, and pustules are formed, such as in cheiropompholyx and foot-tethers. When the papillæ are exposed by exfoliation of the horny layer, as occurs in the fine skin of the groin and the web of the hands and feet, invasion by streptococci is extremely common giving rise to the clinical lesion called eczema, which is characterised by induration of the corium, intense irritation, and some type of exudation depending on the amount of serum exuded and the toxicity of the strains. In India, the majority of our cases that would be classified as eczema are cases of *Tinea cruris* infection of the skin with secondary streptococcal invasion of the corium.

As regards these secondary infections, (1) *Staphylococcus albus* or *aureus* can usually be isolated from the turbid vesicles, blebs or from the surface of the eczematous lesion by plating on ordinary agar. The colonies at the end of 24 hours time are large round colonies, white (*albus*) or golden (*aureus*), or small coloured colonies (*mollis*).

(2) Streptococci are more difficult to isolate from these lesions and they are best cultured in the weeping stage when the serum becomes clear after the application of evaporating lotions. The method we adopt is to take a loopful of this serum or serum from the deep fissure and then plate on glucose agar or blood agar. The colonies are seen as fine transparent colonies after 24 hours and are usually hæmolytic when grown on blood agar. We have isolated strains of these hæmolytic streptococci which differ slightly from those that have been previously described in bacteriological text-books.

Prognosis.

As regards a permanent cure the prognosis is very bad amongst out-patients, but a temporary cure is readily brought about by the various remedies that one uses in the treatment of ringworms. The difficulty in obtaining a permanent cure is due to the fact that as soon as the patient obtains relief, treatment is stopped and he still resides in the infected locality. It is impossible for the ordinary out-patient to realise that the fungus still lurks in his clothes, shoes, and the room in which he lives, nor will he discontinue walking about on damp soil with bare feet. With private patients, the prognosis is very much better, as they will follow one's instructions and use preventive measures against the reappearance of the disease. Climate has a profound effect on the growth of these fungi, for they disappear in a few days time in a cold climate and reappear when the patient comes down from the hills and returns to the heat. When the disease has been extensive and the patient can afford it, a change to the hills will bring about this period of quiescence, and then one can employ strong remedies and eradicate the disease. As the patient's skin forms a suitable site for the growth of this fungus, it is not surprising that recurrences take place, if no precautions are taken to prevent infection.

Treatment.

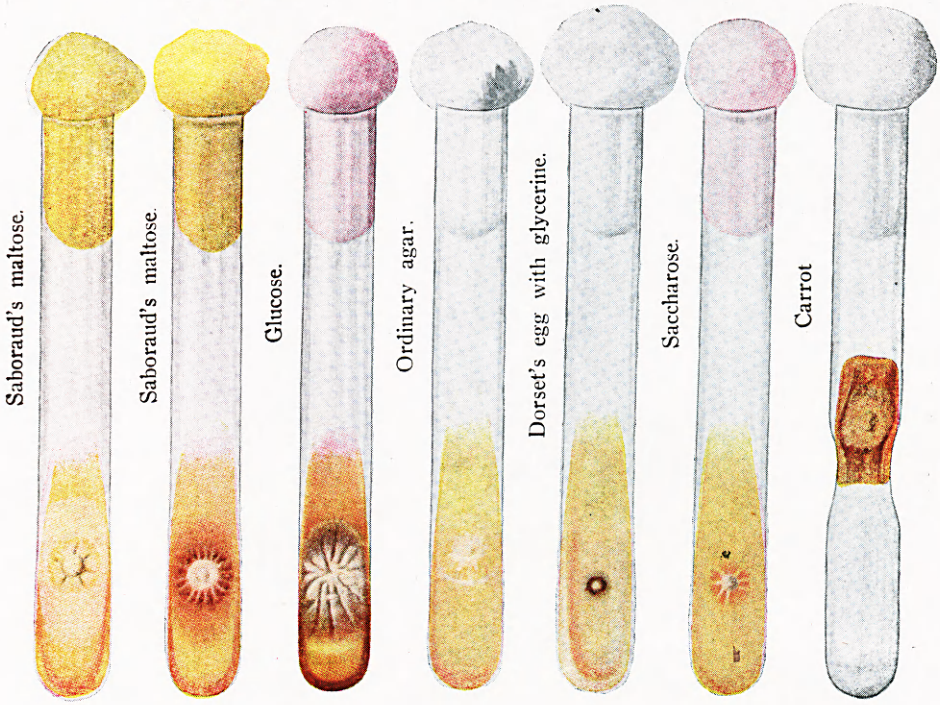
The essential points to realise in these different lesions of *Tinea cruris* on the body are (1) that during the acute stage, whether the lesion is pustular or eczematous in appearance, the infection is always secondary to ringworm, but the septic condition has to be dealt with first. (2) As the primary lesion is due to *Tinea cruris*, a cure cannot be obtained until the ringworm fungus is destroyed, but strong parasiticidal remedies can only be used after the septic infection has subsided. (3) There is every possibility of the patient becoming re-infected after a complete cure, as the skin forms a suitable soil for the growth of the *Tinea cruris*. Treatment can therefore be subdivided into three stages depending on the stage at which the infection is seen.

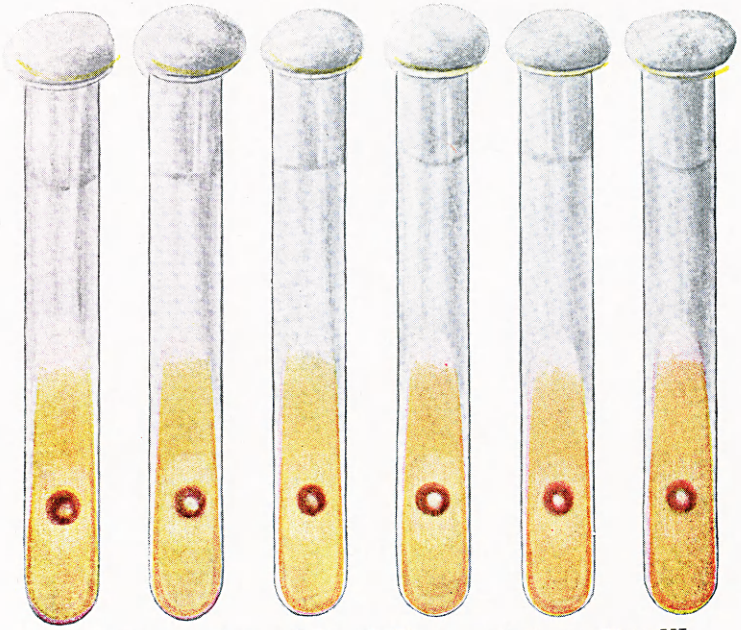
(1) *Acute stage.*—When there are excoriations on the surface, weeping or vesiculation only the very mildest remedies can be used; otherwise an acute spreading dermatitis may be set up if any energetic treatment is used during this stage. Most of the acute cases of exfoliative dermatitis have been caused by injecting large doses of arsenical compounds, in the mistaken diagnosis that the lesion was a syphilitic one, or by using strong applications like chrysarobin. During the acute stage, when the infection is due to streptococci, the best application to use is lotio calaminæ (extra B. P.). This should be applied on an open piece of lint and kept moist all the time by dipping the lint back into the lotion. Evaporation should be aided as much as possible by fan action or by the lint being left uncovered. Its main action is due to the cold, which constricts the superficial vessels and prevents the oozing of serum which is so necessary for the growth of the streptococci; at the same time the lowered skin temperature markedly inhibits the marginal spread of the ringworm parasite. When pruritus is marked, carbolic acid 3 to 5 minims or aqua lauracæi 1 dr. to each ounce, can be added to the above mentioned lotion. When impetigo is present, one combines the use of unguentum hydrarg. ammon. dil. 5 to 10 grs. to the ounce at night, with lotio calamine during the day. When staphylococcal infection is marked, pustules should be opened up, and we prefer the use of acriflavine 1 : 1,000 for the lesions on the hands and feet, but it must be remembered that it will dye the clothes.

Stage of resolution.—As the cold constricts the capillaries and prevents exudation of serum, the weeping stops and the vesicles dry up, the surface skin becomes very hard and

PLATE VII.

The growth of Tinea cruris *on different media.*





The different color varieties of *Tinea cruris* from Plate VI grown on a Synthetic medium containing Sodium Aspartate, Arginine Nitrate and Tryptophane.

dry and on movement tends to fissure. At this stage the best treatment is a combination of lotio calaminæ during the day and the application of Lassar's paste without salicylic acid at night; this keeps the skin moist and pliable. In India, the ordinary formula for Lassar's paste is too strong, as the paste becomes thick and difficult to spread on the skin; we therefore use the following formula.

Zinc oxide	..	grs. 30
Starch	..	grs. 30
Adeps lanæ hydrous	}	½ an ounce of each.
Liq. petroleum pure	}	

(2) *The treatment of the ringworm lesion.*—When the acute symptoms of the secondary infection have subsided, and there is only thickening of the horny layer without any exposure of the prickle cell layer or the apices of the papillæ, we are then in a position to use parasiticidal remedies, otherwise there is a great danger of stirring up the disease. The aim of all these parasiticidal remedies is to set up a rapid surface desquamation in order to remove the roots of the fungi. This can be done mechanically by the judicious use of pumice stone, or preventing the thickening of the skin by protecting the instep from the irregular pressure of rubbing in wearing socks. Numerous keratolytic and reducing agents are used, and in our opinion the following are the best. Whitfield's ointment, containing 25 grs. of benzoic acid, 15 grs. of salicylic acid gives the best all round results, except in certain situations. Should this ointment irritate, we use it combined with calamine lotion until all irritation ceases, i.e., apply the ointment at night and the lotio calaminæ during the day. When the ointment is applied the hands and feet should be covered by cotton gloves or socks. If the body is affected, only fine linen underclothing should be worn next to the skin.

In *mangoe toe*, when there is great thickening of the skin in the inter-digital cleft, the best remedy is resorcin 1 drm. dissolved in 1 ounce of tinct benzoinæ co. This is applied every night until the surface skin is removed and the underskin becomes thin and healthy. Its action should be carefully controlled, otherwise an acute inflammatory condition may be set up. On the appearance of any redness or irritation the lotion should be discontinued the next night, and some simple ointment be applied like boric ointment. The stains from the benzoin lotion can easily be removed by spirit. The resorcin ointment is usually too strong to be applied to any lesion situated on the fine skin, such as about the fingers, ankles, etc., but it is very useful in the extensive cases that look like *Tinea imbricata*. The strongest remedy is chrysarobin, but it has to be carefully controlled, and should never be used when fissures or the slightest signs of inflammation are present in the lesion. As an ointment it is messy and stains all underclothes and sheets indelibly. It can be employed in two ways. (1) Chrysarobin 10 to 40 grs. dissolved in an ounce of pure chloroform painted on the surface of the lesion, and as soon as the chloroform has evaporated the surface is painted over with two or three layers of collodion flexile. (2) Traumaticin. This is made by dissolving 1 drm. of india-rubber or gutta-percha in an ounce of chloroform, but it takes about a week before the indiarubber has been completely dissolved in the chloroform. In this liquid the requisite amount of chrysarobin is dissolved, varying from 10 to 40 grs. to the ounce, and is then applied on the lesion. This preparation is not so powerful as the simple chloroform solution.

In chronic cases, especially where there is a good deal of thickening of the stratum corneum such as occurs on the palms, soles and instep, these keratolytic agents are of very little use, as they cannot penetrate the thickened horny layer. For these cases we advise *x*-ray treatment. We are indebted to Major J. A. Shorten, I.M.S., the Honorary Radiologist of this School for details of the treatment that he uses for these cases. His technique is as follows:—

The apparatus used for the treatment of *Tinea cruris* by *x*-rays at the School of Tropical Medicine is one which gives a constant voltage of 70,000 volts, and 3 milliampères current. The skin distance ordinarily used is 8 inches from the target. If for any reason this distance has to be increased, allowance in exposure is made in accordance with the law of inverse squares.

Three variations in exposure are used:—

(1) Unfiltered pastille doses, the time exposure is 5 minutes.

(2) Filtered pastille doses filtered through 1 millimetre thickness of aluminium. A pastille is placed on the distal side of the filter at half the skin distance time, 18 minutes, 36 seconds.

(3) Filtered fractional doses through a 1 millimetre aluminium filter, exposed for 5 minutes. Five such doses cause complete epilation in normal skins without inflammatory reaction.

The cases who were treated were those who did not yield to the ordinary methods by ointments, etc., and to begin with were given a series of fractional doses up to a full pastille dose. Later if necessary $\frac{3}{4}$th to $\frac{4}{5}$th of a pastille dose was given with intervals of not less than one month between each series.

When secondary pyogenic infection is present, great care should be exercised in the length of the exposure. Treatment should be stopped on the slightest signs of any reaction. From an experience gained in treating a large number of cases of *Tinea cruris* of the glabrous skin, especially on the hands and feet, one

knows that relapses are apt to occur within 12 months after the *x*-ray treatment. The disease never progresses as far as the original attack, and responds readily to the *x*-rays. Three or four such relapses are common; each relapse diminishes in intensity, and finally the treatment results in a permanent cure. For this reason, we advocate the use of parasiticidal remedies for a few weeks after the *x*-rays, in spite of the fact that the lesions appear to be cured by them.

When ringworm attacks the nails, the disease is singularly intractable to treatment. If the nail has been extensively involved, cure is impossible unless the nail is removed by avulsion. The thickened nail bed should be scraped until all signs of the disease have been removed and healthy matrix is reached. The nail bed should be dressed with a parasiticidal ointment such as Whitfield's until the healthy nail has grown. When the disease is seen early before the invasion of the nail bed has occurred much beneath the anterior border, a cure may sometimes takes place by adopting the following treatment. The nail plate is softened by using an alkali such as soft soap or a solution of caustic potash, this should be applied continuously under a rubber stall. The alkali should be applied daily until the nail is thoroughly softened. The nail should now be paired down as thin as possible with a piece of glass. This is followed by the continuous application of some strong keratolytic agent such as mercury, iodine, chrysarobin, etc. A 2 per cent. hydrag. perchlor, in rectified spirit is clean and efficient, but the senior author's assistant Dr. K. P. Banerjee has elaborated a blunderbuss mixture containing all the three parasiticidal remedies, but it stains the nails.

During the course of the *x*-ray treatment we generally recommend these patients to use a simple ointment like Lassar's paste and to continue the application of Whitfield's ointment for two or three weeks after the last exposure. The treatment should always be continued for at least two weeks after all lesions have apparently disappeared on the skin.

The prevention of relapses.—We have seen that patients are particularly susceptible to infection by *Tinea cruris,* as the skin forms a suitable soil owing to moisture, friction, etc. The first thing to be done is completely to eradicate the disease from the skin surface, and we have pointed out that *the nidus of the disease* may lurk in the thickened area of the skin in the interdigital cleft between the 4th and 5th toes, or it may be seen in the groin where the skin is slightly dark in colour with a slight furfurous desquamation. These two sites are easily overlooked, unless the skin is carefuly examined in a good light.

The next important procedure is to prevent re-infection. This may occur by walking about the house barefooted and also in public baths when no shoes are worn by the bathers. The remedy is obvious; to prevent infections by both these means. Re-infection may also occur through infected shoes, or socks; these can be disinfected by swabbing the shoes with pure lysol and boiling the cotton socks after use. Infection of the skin surface can easily be prevented by the use of a sulphur antiseptic powder as the spores are then on the surface and can easily be reached by antiseptics. When the mycelium penetrates deep down into the horny layer, these antiseptic powders are of little use and only act by preventing moisture. We prefer a sulphur camphor powder consisting of 1 part each of sulphur precipitata, camphor, and boric acid, 2 parts of zinc oxide; and 3 parts of starch. Some use a salicylic talcum powder or antiseptic lotions. We recommend that after the morning bath the likely areas of infection, i.e., between the toes and groin should be very lightly dusted with this powder, using a powder puff to apply it. It should be done during the hot weather; dusting the surface every other day or so is sufficient to prevent infection in these areas. On the other days, a bland absorbent powder should be used to keep these parts dry. Sulphur is an irritant to the skin, and if freely applied is apt to set up a dermatitis.

We have already seen that friction and the prevention of moisture play an important part in allowing infection to occur. Friction can be prevented by the use of proper underlinen and properly fitting boots and clothes. Moisture can be prevented by dusting the parts with an absorbent dusting powder and allowing free ventilation by the use of properly fitting clothes, etc.

A SHORT DESCRIPTION OF AN EPIDEMIC DISEASE OF CHILDREN PREVALENT IN GOA SINCE 1921.

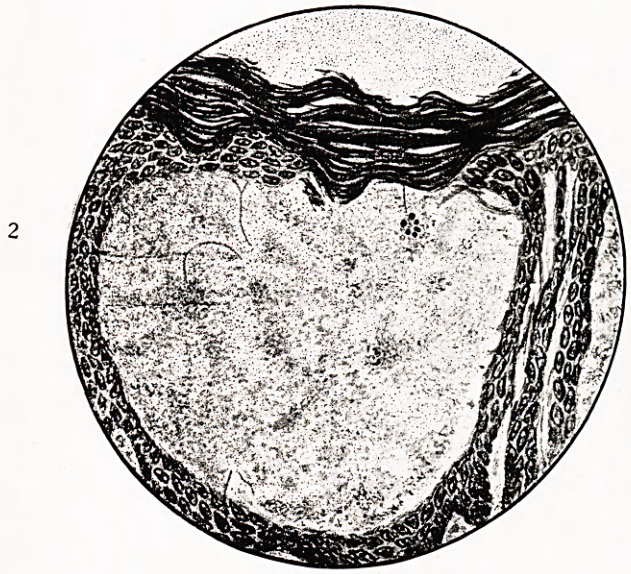
By AUGUSTINE PAES, M.B., B.S. (Bombay), D.T.M. (Bengal),
Goa, Portuguese India.

The disease may be divided into three forms:—

Benign.—In this, the child vomits either the food that it was just then taking or had taken at a previous meal and, soon or immediately after, falls into a torpor and somnolence from which it is extremely difficult to awake it, although just before the vomiting it was apparently in perfect health. Even if it is wakened up by strong counter-irritants such as hot baths, it at once falls back into somnolence and there is no contraction of any part of the body, but on the contrary complete flaccidity of every muscle in the body. Pulse 100 to 120 and respirations 20 to 30. Pupils slightly or moderately dilated. Spleen and liver normal. There is constipation and slight tympanites. The sensibility of the

(*a*) Drawing of a hanging drop culture 1|6th objective, (1) Fuseaux, (2) Grouped conidia, (3) Tendrils, (4) Knots.

(*b*) Microphotograph of a vesicle on the hand—2|3rd objective contents consist mainly of serum.



(*c*) Drawing enlarged of (*b*) showing (1) mycelium with grouped conidia, (2) mycelium.

(*d*) Microphotograph of ring-worm of the nail 2|3rd objective, note the liquefaction caused in the nail bed by the mycelium.

(*e*) Drawing made from (*d*) 1|12th objective. Note the fine mycelium(1) and the areas of liquefaction(2).