TABLE III.

Forecast of the probable plague incidence in India in 1931.

Area.	Temperatures.			Saturation deficiencies.		Forecast.
	Hot season.	S.-W. Monsoon.	First quarter.	Hot season.	S.-W. Monsoon.	
Bihar and Orissa	+	+	+ —	+ +	+ +	High saturation deficiencies and temperatures indicating low plague incidence in 1931.
United Provinces	+	+ —	+	+ +	+ —	High hot season saturation deficiency; rather low plague incidence in 1931.
Punjab ..	+ —	—	+ —	— —	— —	Very low saturation deficiency in hot season; increased plague incidence likely.
Central Provinces	—	+ —	+	+ —	+	Climatic conditions very slightly unfavourable to plague; about average incidence in 1931.
North Deccan ..	—	—	+	+	+ —	Climate normal; about average plague incidence.
South Deccan ..	+ —	+	+ +	+	+	Saturation deficiencies high and unfavourable to plague. Incidence in latter part of 1930 and first half of 1931 below the average.

The *plague* data are given in Table III on the same lines of those of last year. They include the variations from the normal of the hot weather and monsoon mean monthly temperatures and of the saturation deficiencies for the first two or three cold weather months of the year, the hot season and the rainy season respectively. As previously explained temperatures and saturation deficiencies over the normal, shown in the table by plus signs, favour low plague in the subsequent cold weather and the early hot season of plague prevalence, and *vice versa*. The data for this year's forecast are not for the most part very definite, but as far as they go they point to low plague incidence in Bihar, the United Provinces and the South Deccan, about average figures for the Central Provinces and the North Deccan, and some excess over recent prevalence in the Punjab, but the latter is not likely to be very great in view of the exceptionally low Punjab plague incidence during the monsoon months of 1930.

ACTINOMYCOTIC LESIONS OF THE SKIN OF THE HANDS AND FEET, DUE TO *ACTINOMYCES KERATOLYTICA*, N. SP.

By HUGH W. ACTON, C.I.E.,
LIEUTENANT-COLONEL, I.M.S.,
Director, School of Tropical Medicine and Hygiene, Calcutta,
and
C. McGUIRE, D.T.M. (Bengal),
School of Tropical Medicine and Hygiene.
(Under the Indian Research Fund Association.)

SOME time ago a Calcutta daily newspaper had an editorial on sore backs and cracked heels. The purport of the article was to point out that practically the whole of the rice grown in Bengal for the *aman* or winter crops was all transplanted grain. During the monsoon in July and August, when the fields were flooded, the ryot worked incessantly from early morning to late in the evening transplanting the rice plants from the nurseries to cover fields of over 10 million acres in Bengal. Day after day for weeks on end the ryot is standing in water and saturated by the monsoon rain so that he develops these lesions known as cracked heel and sore back. The suggestion implied in the editorial was that both these diseases were widespread, and yet in spite of this fact, the medical profession had not seriously considered them or suggested a remedy. For some considerable time before the publication of this editorial we had been working at the subject of cracked heels. The criticism levelled in that article could easily be made against the profession about many other more important diseases. The solution of a problem takes time, men and money, for one does not discover the cause of disease by fortunate accidents. At first trials are made, followed by failures, so that by a process of elimination the possibilities become narrow and narrower.

A new method of technique placed us in a position of advantage over our predecessors, who although extremely able men had failed to discover the cause. We may briefly outline what actually occurs during this disease, as material for investigation was only available on and off during the last three years. The lesions are most commonly seen during the monsoon months, i.e., between August and September, and amongst people actually working in the fields, but rarely amongst those living in towns. The ryots rarely come for

treatment, as they accept the disease as an inevitable sequence of having to walk about on damp soil, and know full well that the lesions will disappear during the coming cold weather. A sharp look out therefore was kept in the wards for any patients showing these lesions, and when found they were sent to the laboratory for further investigation. At first we used the crude method of using a 40 per cent. caustic potash in the cold, which destroyed the fine mycelium before the scales were sufficiently cleared to see the fungus. At the same time we employed the usual methods of cultivation, agar, blood agar, Sabouraud's medium, and frequently grew a black Aspergillus which seemed to be the causative organism. As we could not see the mycelial elements in the lesion we hesitated to publish our results. The first real advance was made by the use of McGuire's stain; he saw the possibilities of modifying Ponder's method—a stain used for demonstrating the granules in the *B. diphtheriæ*—to stain these fungi. We were now able to demonstrate the organisms in the lesions in every case, but we were not able to cultivate the organism with any degree of certainty. This was the position we had arrived at when this editorial appeared in this daily paper. The next advance was made when an article appeared in the *Agricultural Journal of India* (Bangalore) published by Norris and his co-workers in July 1929 on a cultural method for enumerating the number of actinomyces in the soil. In October 1929 we sent a paper to the *Indian Medical Gazette* which was published in February 1930 on "Keratolysis plantare sulcatum, a lesion due to an actinomycotic fungus." Since that date with the help of Norris' medium we have been able to cultivate the organism in every case of the 42 different patients discovered in the hospital or out-patient department. We therefore tested different soils from the street, stables, cow sheds, etc., and found that the organism was not usually present in the street soil, but was present in horse and cow-dung and in manured soil. Finally we were able to reproduce the disease in man, and thus give the final proof of the pathogenicity of this organism.

In a private communication from Professor Kayser of Leiden he stated that he had also found the same fungus in Java, but looked upon it as a saprophyte from the soil.

Synonyms.—In Bengali, the lesion known as keratolysis plantare sulcatum (Acton and McGuire) and keratodermia plantare sulcatum (Castellani) is spoken of as *chaluni,* literally meaning a sieve, owing to the pitted condition of the thick skin of the feet. The word *haja* meaning sodden is applied to the sodden condition of the skin between the toes, which often splits giving rise to the deep type of mango toe. The cracked and fissured condition of the heel is spoken of as *phata,* meaning split. In Urdu the word *panki* is used, signifying that the lesion was caused by mud, *pank.*

The term keratolysis plantare sulcatum means that the thick horny skin of the soles of the feet is dissolved in grooves. The term mango toe is used to denote the thick sodden skin that develops between the toes, and this may be due to ringworm or actinomyces, the latter lesion giving rise to deep fissures between the toes. As the lesions are more commonly seen during the mango season (monsoon) hence the name. The cracked or split heel may be due to two main causes, in the monsoon usually it is due to this actinomycotic fungus, and during the cold weather to hyperkeratosis and its various causes. In 1907 Castellani described a lesion which he called *ulcus interdigitale* and this was confirmed by Breinl (1915) and Martinez and Lopez (1918). The lesion commences with itching between the toes, in a few days' time a deep fissure forms, which gradually enlarges into a large oval-shaped ulcer. The margins consist of heaped up sodden epithelium and the base is a dull dark red colour, there is little or no discharge and these ulcers are very painful. The ulcers may also appear on the soles of the feet near the tread of the great toe and the heel. We have found the same fungus in these cases.

Definition.—In India there is a red actinomyces that produces keratolytic changes in the skin of the hands and feet, causing the lesions known as keratolysis plantare sulcatum, mango toe, cracked heel, paronychia, onychomycosis and vesicular eruptions.

Ætiology.—The popular idea is that the lesions are caused by walking about continuously barefooted on damp soil, particularly soil contaminated by horse manure. Our results on soil examination tend to show that the popular belief is true as we have recovered the organism from both horse and cow manure. The lesions are usually seen in adults and we have not seen them in children. The ryot and maid-servants who are continually walking about on damp soil with bare feet are very prone to the disease on the feet. On the other hand *malis* or gardeners very frequently develop the lesions in or about the nail bed. The lesions are most frequently seen during the monsoon months, i.e., during August, September and October. We have seen the disease twice in Europeans, both were first officers on coastal vessels plying between the different ports of India, these officers usually walk about in the morning with bare feet supervising the washing of the decks.

Clinical types.—In 1930 Acton and McGuire described the lesion known in Bengal as *chaluni* or pitted feet in detail and suggested that this fungus may give rise to other clinical lesions. Since then we have been able to prove that there are four other types of lesions that can be caused by this fungus which are shown in Plate I, figs. 1–4.

Fig. 1.—Showing keratolysis of the skin of the palms; extension is occurring from infection of the finger skin between the fingers and the wrist.

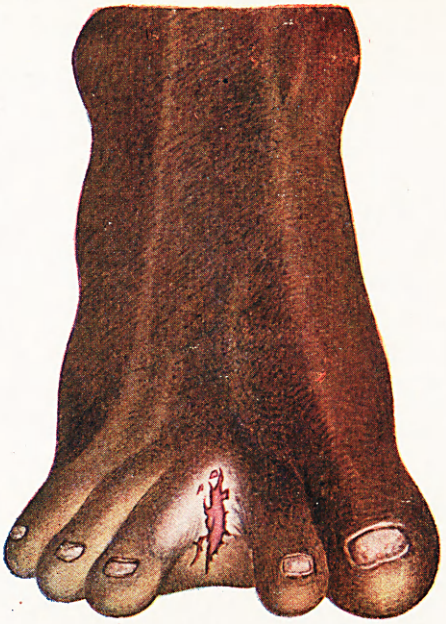

Fig. 2.—The deep fissured type of mango toe due to this fungus; notice the sodden condition of the skin between the toes known in Bengal as *Haja*.

Fig. 5.—A plate culture of the scales on Norris' media; note the small red actinomycotic colonies which have to be dug out of the media for subculture.

Fig. 3.—Infection of the nails which frequently occurs at the base; often it is preceded by paronychia as seen in the third finger. The edge is thickened and raised from the nail.

Fig. 4.—The keratolytic and cracked condition known as *Phata* or split heel in Bengal.

The commonest is the deep type of fissured mango toe depicted in Plate I, fig. 2. The epidermis on the sides of both toes at the interdigital cleft is thickened, white and sodden in appearance, usually on separating the toes a deep fissure extends through the corium into the subcutaneous tissues, is extremely painful and is likely to be infected by streptococci. At other times the infection takes place as an intertrigo between the web of the fingers or toes and extends on to the thick palmar or plantar surface as a gyrate area of keratolysis (*see* Plate I, fig. 1). More rarely the fungus produces a paronychia about the nails of the hand (*see* Plate I, fig. 3), so that the skin margin is thickened and lifted off the nail and an orange stick can be passed under it; sometimes the base of the nail is involved showing the characteristic brittle, moth-eaten appearance shown in Plate I, fig. 3. Recently Dr. Ganapati Panja has shown in four cases that an eczematous lesion commencing on the inner side of the instep on the fine skin of this region and extending on to the soles with the production of vesicles was due to this fungus (*see* Plate II, fig. 5). Hitherto we had regarded this lesion as a manifestation of *Tinea cruris* infection on the feet. The lesion known as ulcus interdigitale (Castellani) is also fairly commonly seen amongst persons who are continually walking about on damp soil, and have a good deal of friction to their feet, such as cooks, etc. The ulcers are seen about the interdigital cleft (*see* Plate III, fig. 1). Sometimes they are seen on the great toe and heel (Plate III, fig. 2). Sometimes these ulcers extend very deeply into the interdigital cleft (Plate III, fig. 3) and may even cause amputation of the toe by the secondary sepsis involving the joint (*see* Plate III, fig. 4). At first sight sometimes these ulcers and amputations look like trophic lesions, and the cases are mistaken for leprosy. The painful character of these ulcers and fissures readily distinguishes them from the anæsthetic trophic lesions of leprosy. There is also no involvement of the nerves, anæsthesia, etc.

Breinl (1915) described the extreme form of ulcus interdigitale as a separate lesion under the name of ulcus interdigitale destruens. The lesion starts as a small fissure which gradually forms a painful ulcer and then spreads fairly rapidly up towards the toe and down to the sole of the foot. The ulcer is deep and has irregular edges, and the granulation tissue is covered by an irregular dirty grey scab. The floor of the ulcer is reddish and uneven, and discharges a good deal of thick yellow pus. The ulceration may spread upwards between the toes and may gradually lead to complete loss of the affected toe, as is seen in Plate III, fig. 4. When healing occurs without amputation the adjoining surfaces of the toes may grow together. The ulcers are very chronic and may cause considerable deformity of the foot, when the toes are amputated and others grow together on the adjoining surfaces. There is no need to classify these ulcers by a special name, as they are only extreme cases of this interdigital ulceration that occurs in the condition known as *haja* or mango toe.

We are now employing greater care in diagnosing these lesions, which were originally regarded clinically as due to ringworm, by staining and cultural methods, so that frequently we are finding that many of these lesions on the feet are due to this actinomycotic fungus. The staining method of McGuire's is particularly useful in arriving at a correct diagnosis of intertrigo, as we see the different organisms which are present in these lesions, monilia, endomyces, ringworms, actinomyces, etc., and one can then make up one's mind as to whether the ringworm or actinomyces are of greater importance than the endomyces or monilia. Cultural methods that were first used were of little help as the endomyces and monilia soon overrun the surface of Sabouraud's medium and prevent the slower growing fungi from being seen in the media.

Mycology.—The tissue for examination is taken from the side of the pits or sulci in keratolysis plantare sulcatum, the edge of the keratolytic lesions on the palms and soles, or the tops of the vesicles. The tissue is placed on a slide and a few drops of the following stain poured on, i.e., toludine blue grm. 1, acetic acid 2 c.c., alcohol 4 c.c., distilled water to 100 c.c. As the tissue is often too thick and too deeply stained in 30 seconds for examination, the stain is mopped up with blotting paper and a few drops of glycerine placed on the slide to clear the tissue. A cover glass is placed on the top, pressure applied to flatten out the epidermis, and the specimen examined with a No. 10 ocular and a 1/12th oil-immersion objective. The mycelium is seen to consist of very fine branching hyphæ, segmented or non-segmented. The oldest hyphæ are very finely segmented and on superficial examination appear like a chain of fine streptococci. The appearance of the mycelium has already been shown in Plate I, fig. 2 of our previous paper, *Indian Medical Gazette*, No. 2, February, 1930.

Out of 42 cases consecutively examined by this method of staining we were able to confirm our clinical diagnosis in every case by finding the typical mycelium.

Culturally the best method for isolating these fungi is that described by Norris and his coworkers, 1929. The medium which they advocate has the following formula:—

Soluble starch	2 grms.
Dipotassium phosphate	0.5 grm.
Hydrated magnesium sulphate	0.2 grm.
Calcium chloride	0.05 grm.
Ferric chloride	0.01 grm.
Sodium nitrate	0.05 grm.
Asparagin	0.05 grm.
Agar	20 grms.
Water to	1000 c.c.

The medium is made up to pH of 7.4. The cultures are incubated at 25° to 35°C. or room temperature for a fortnight. The feet should first be well scrubbed with soap and water and a nail brush to get rid of all the dirt and then the surface of the foot swabbed over with 75 per cent. alcohol. The tissue is selected from the sites mentioned above, i.e., the side walls of the sulci, the edges of the keratolytic lesions and the tops of the vesicles, and left in normal saline for 2 hours until quite soft. It is there teased between two needles into smaller bits and then placed in absolute alcohol for 1 minute. The small pieces of tissue are planted direct on this medium without washing as the alcohol dries and the bits of epidermis are planted here and there over the plate. In four days' time small pink raised colonies are seen, gradually becoming deeper in colour (*see* Plate I, fig. 5), still later they become flat, dark in colour, and have a moist appearance. This synthetic medium inhibits the growth of most organisms like cocci, etc., commonly found on the skin. If the primary culture is not quite pure, sub-cultures are again made on the same medium by rubbing on the contaminated colony after washing in saline on plate cultures. By this medium and plate cultures we were able to obtain successful cultures in all of the last 42 cases of this disease seen. The organisms grow best at room temperature, and aerobically; with partial anaerobiasis the growth is scanty, and with complete anaerobiasis there was no growth on the medium after a month. The cultural appearances on Sabouraud's test media, whey agar, serum, peptone water and blood agar have already been described in our previous paper of 1930. The following sugar media were tested: dextrose, lactose, sucrose, maltose, glycerol, but no acid or gas was produced in any of these sugars, there was a profuse growth on dextrose and glycerol. Litmus milk was turned slightly acid with the appearance of a pink ring at the surface, it was slightly clotted and the medium had a musty odour.

Morphology.—The fungus is best studied as regards its morphological characters by cultures on ordinary test tubes by growing on Sabouraud's medium, whey agar, etc. The mycelium will be found to consist of three types of hyphæ; aerial hyphæ can be studied by carefully scraping off the top of the colony and staining by McGuire's method; the surface runners and root hyphæ by breaking the glass tube and making free hand sections through the root area with a sharp Gillette razor blade. The thin sections of agar are allowed to dry for 24 hours, then stained by weak carbol fuchsin 1—20 and again dried for 24 hours and mounted in Canada balsam. The hyphæ are very fine, about 0.8 μ in diameter, usually segmented in all the different hyphæ.

In the stained preparation made by taking a bit of the surface growth two weeks old, the end organs are best seen. The end organs are of two kinds (*see* Plate II, fig. 1). (*a*) Terminal fuseaux or spindles; these occur at the end of the hyphæ, are slightly curved and consist of 2—3 segments, they are probably of the nature of chlamydospores. (*b*) Intercalary chlamydospores which form spore-like bodies along the hyphæ. (*c*) Conidia are rounded spore-like bodies 1 to 1.5 μ in diameter, they may be seen singly or grouped (*grappes*) occurring at the end or along the course of the hyphæ, in old cultures they surround the aerial hyphæ. As far as one can see they are not of the nature of aleuriospores but true conidia.

This fungus therefore is a very highly specialised plant, consisting of deep penetrating roots extending into the solid media often to a depth of half an inch or more. The surface runners are arranged radially and spread centripetrally on the surface, giving rise to the limpet-shaped colony. Projecting into the air are the aerial hyphæ carrying fusiform chlamydospores at the end, or single and grouped conidia along the course of these hyphæ. The centripetal spread is important in determining the shape of the pits and the gyrate lesions produced by this fungus, whilst occasionally the deep root hyphæ are able to penetrate as far as the prickle cell layer, open up the lymphatic spaces in this region, and give rise to vesicles. The fungus appears to have a marked lytic action on the horny layer of the epidermis of the soles of the feet and sometimes on the palms of the hand.

Bergey (1930) defines the genus *Actinomyces* as organisms growing in the form of a much branched mycelium, which may break up into segments that function as conidia; sometimes parasitic, with clubbed ends on radiating threads conspicuous in lesions in the animal body. Some are macro-aerophile or anaerobic, non-motile. These fungi belong to a much higher order than the EUBACTERIALES, so that morphological characters are more important in classification than cultural characters. In cultures, the colonies are seen as limpet shaped, red or black in colour, with deep roots penetrating the media, exactly similar in appearance to a fungus we have isolated several times from cases of Madura foot. On microscopical examination of the cultures the hyphæ are fine, about 0.8 μ in diameter, about the same thickness as *Actinomyces bovis*, but much coarser than the *Actinomyces asteriodes*. In the tissues, the hyphæ break up into small segments, and appear like a chain of streptococci. There are no club-shaped ends formed in the tissues, as in *Actinomyces bovis*. The conidia are small round-shaped bodies formed along the course of the aerial hyphæ, at the ends or growing out laterally. At first they are single but in old cultures they are grouped and surround the aerial hyphæ like the head of a stork.

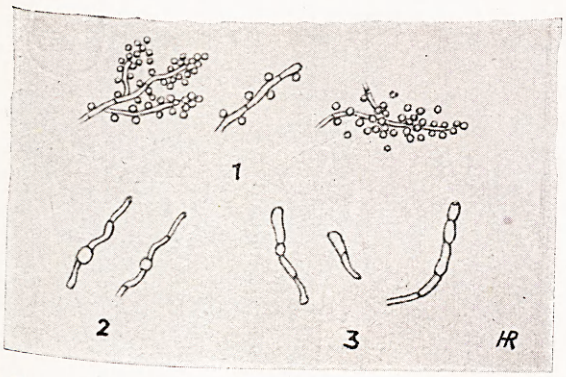

Fig. 1.—Drawings made under the 1/12th objective showing the various end organs of the fungus. (1) Single and grouped conidia, (2) intercalary chlamydospores, and (3) end chlamydospores.

Fig. 2.—Keratolysis between the fingers with fissuring corresponding to mango toe on the foot.

Fig. 3.—Early stage showing the sodden condition of tbe epidermis between the fingers.

Fig. 4.—Keratolysis plantare sulcatum. Notice the pitting of thick horny skin on the sole of the foot.

Fig. 5.—An eczematous patch on the thinner skin of the arch of the foot due to this fungus with secondary streptococcal dermatitis and formation of vesicles at the edge.

Fig. 1.—Deep ulcers on the little toe and extending to the ball of the great toe from the interdigital clefts.

Fig. 2.—Deep ulcers on the great toe and in the interdigital cleft of the 4th and 5th toes resembling trophic ulcers.

Fig. 3.—Deep interdigital ulcer between the 4th and 5th toes.

Fig. 4.—The ulcers on each side of the 4th toe have amputated this toe.

The *Actinomyces bovis* has the same type of conidia, as well as the *Actinomyces maduræ* of Vincent. The *Actinomyces asteriodes* has no conidia. The terminal chlamydospores are segmented and named by Sabouraud *fuseaux*, and are seen in this fungus as well as in the *Actinomyces bovis* but not in *Actinomyces maduræ* (Vincent). In this fungus which causes keratolysis of the skin of the hands and feet, there are also intercalary chlamydospores which are not seen in *Actinomyces bovis* and *Actinomyces maduræ*. The fungus is therefore a new species, because it has the following differentiating characters from those hitherto described. In the tissues, the mycelium is seen to consist of branching segmented or non-segmented hyphæ depending on the age of the hyphæ, the ends are not clubbed. In cultures the colony is limpet-shaped, red or black in colour, and the pigment diffuses into the media. The fungus consists of roots, surface runners, and aerial hyphæ; the latter carry the following end organs, round conidia 1 to 1.5 μ in size, occurring singly or grouped at the ends and sides of the aerial hyphæ.

Terminal chlamydospores, spindle-shaped and broken up into 2 or 3 segments and slightly curved, as well as thickenings along the hyphæ, intercalary chlamydospores. We therefore propose to name this fungus *Actinomyces keratolytica* (n. sp.) on account of its property of dissolving the thick horny layer of the palms of the hands and soles of the feet.

We have been able to find the fungus in every case of the disease, and also to grow it from every case on artificial media so as to free it from other organisms or from the tissue fluids. Finally, to carry out Kock's postulates we have to reproduce the condition in man or animals to prove that the organism is pathogenic.

We had to investigate first the possibility that it was not a widespread saprophyte of the soil. Different types of soil were cultured on Norris' medium and we could only find the organism in horse- and cow-dung and in manured garden soil, but not in ordinary street or room scrapings. During the microscopical examination and insemination of the tissues on culture media, the soles of the feet were thoroughly washed, and in hospital cases a protective bandage was applied for a couple of days before taking the culture. The skin was then carefully swabbed over with 75 per cent. alcohol to obviate the possibility of growing saprophytic organisms from the surface. Moreover the organisms were seen invading deep into the horny layer. We also examined the fæces of 100 patients in the hospital and we were not able to recover the organism from them. In cases of chronic diarrhœa, in whom the fæces contained Charcot-Leyden crystals, but no *Entamœba histolytica* or non-lactose fermentors of the dysentery group, we were able to isolate this fungus. These cases responded to iodides by the mouth, and will be dealt with in a separate paper. Cultures were inoculated into guinea-pigs and monkeys superficially, intradermally, subcutaneously and intraperitoneally with negative results. On a human volunteer the skin was scraped between the 3rd and 4th toes on the under surface of both feet during the month of August and on the right foot the culture was smeared over the raw surface. In September a definite keratolytica area appeared on this foot but not on the other, by the end of September the lesion had spread as far as the sole. Microscopical examination and a culture made from this area showed that the fungus was present deep in the epidermis and was isolated in pure culture on Norris' medium. The lesion then cleared up with formalin lotion.

Differential diagnosis is extremely difficult if we have to rely only on clinical means, as the differences in the lesions are usually too subtle for anyone who has not had considerable clinical experience to differentiate them from ringworm. Even under these conditions an erroneous diagnosis would be made if we had only to rely on the naked eye diagnosis. The use of McGuire's modification of Ponder's stain is simple and does not require anything more than a microscope, slides, cover slips, the stain and some glycerine. Lesions due to hyperkeratosis such as tylosis of the hands and feet, those due to syphilis and yaws known under the title of keratodermia punctata and acrodermatitis perstans, can be readily recognised by the numerous large well staining vesicular nuclei in the scales. The ringworm fungus can easily be differentiated from this type of actinomyces, the mycelium is much thicker and can be readily seen by the 1/6th objective. In the older lesions of actinomyces numerous coccal forms are seen resembling staphylococci and one may have to examine several pieces of tissue before the fine branching mycelium is seen characteristic of this fungus. Clinically the condition known as *chaluni* or pitted soles is usually very easy to diagnose, but the same lesions on the hand are rare and may be possibly mistaken for the lesion known as keratodermia cribrata or punctata, a manifestation of syphilis, when pit-like depressions are formed on the palms by removal of solid horny balls from the surface epithelium. The paronychia attacking the skin round the margin of the nail, non-ulcerative thickening, and raising of the margin off the surface of the nail is very characteristic of this disease. Again the fungus attacking the base of the nail is more characteristic of lesions produced by this fungus than ringworm which usually attacks the free margin of the nail from the nail bed. The deep-fissured type of mango toe is more characteristic of actinomyces than of ringworm. On the other hand ringworm extending to the soles of the feet from the web of the toes or

the fine skin at the instep produces more of an exfoliative type of lesion with large blebs of pustules simulating dermatitis repens and causing foot tethers (Cantlie), whilst the actinomycotic lesions generally show more keratolysis and the production of smaller vesicles and pustules. Anyhow one can confirm one's clinical diagnosis by actually seeing the causative fungus, and if this be not seen one must search still further until a cause is found for the production of the lesion. The cultural confirmation of the lesion is a refinement necessary for the research worker who is attempting to classify the causative agents present in these different lesions, which clinically simulate each other very closely.

Treatment.—The best treatment for the lesions of *chaluni*, pitted feet and paronychia round the nail beds is painting the area twice a day for three weeks with a lotion containing formaldehyde (commercial 33 per cent.) ℥i to the ounce of water, and for the nails we usually make up the lotion with glycerine. In cultures we found that a 1 : 400,000 solution of gentian violet was capable of inhibiting this fungus. We now use a 5 per cent. solution of this dye for the deep-fissured type of mango toe as the dye does not irritate the tissue. The pigment, consisting of resorcin ℥i and tinct. benzoin co. ℥i cures the thick sodden skin between the toes, when applied once a day for a week or so, but it is too dangerous to use it if the prickle cell layer is exposed or fissures are present between the toes.

Prevention would be simple if our patients could give up their occupation of walking barefooted on sodden soil, but this is impossible in Bengal for the ryot, servants, etc. The use of formalin lotion applied from time to time during the monsoon months at night would prevent the lesion spreading deep down into the tissues and crippling the patient, thus preventing him from doing his work in the rice fields.

Conclusions.

(1) The clinical lesions known as *phata* cracked heels, *chaluni* pitted soles, some types of deep mango toe *haja*, are all due to an actinomycotic fungus.

(2) More rarely it causes paronychia, onychiomycosis, keratolytic vesicular lesions of the hands and feet.

(3) The predisposing causes are constant contact with wet earth so that the epidermis of the hands and feet becomes sodden and loses its protective power through the horny layer.

(4) The fungus has been found in horse- and cow-dung, but not in human fæces except on rare occasions, and it is not usually present in the soil.

(5) The lesions are widespread in Bengal amongst the ryots, maid-servants, etc., who are obliged to walk barefooted on damp soil.

(6) The popular idea that it is due to walking barefooted on damp soil, particularly soil contaminated by horse manure, has experimental support from the laboratory.

(7) We have found the fungus in 42 cases microscopically, and by using Norris' medium have been able to isolate it in every one of these cases.

(8) We have been able to reproduce the lesion in man from our cultures.

(9) The fungus resembles in culture an organism we have isolated from Madura foot in several cases, but differs in many important morphological characters, i.e., the presence of fuseaux, single and grouped conidia, and intercalary chlamydospores.

(10) The fungus producing these lesions is a new species of Actinomyces for which we propose the species name *Actinomyces keratolytica* (n. sp.).

(11) Lesions are readily curable by a lotion of glycerine-formaldehyde ℥i to ℥i or 5 per cent. gentian violet applied twice a day for three weeks.

(12) The lesion known popularly as cracked or split heel, *phata*, seen during the monsoon months is due to this fungus; in the winter months it is due to hyperkeratosis and its various causes.

REFERENCES.

Acton and McGuire (1930). *Indian Medical Gazette* (February).
Bergey (1930). *Determinative Bacteriology.*
Breinl (1915). *Annals of Tropical Medicine and Parasitology,* Vol. IX.
Castellani (1919). *Manual of Tropical Medicine.*
Castellani (1923). *Byam and Archibald's Practice of Medicine in the Tropics.*
Chalmers and Kamar (1917). *Journal of Tropical Medicine and Hygiene* (June).
Gutierrez (1923). *Archives of Dermatology and Syphilology* (September).
Gutierrez (1925). *Archives of Dermatology and Syphilology* (October).
Martinez and Lopez (1918). *Report de Med. y Cirurg.,* Vol. X, No. 10.
Norris, Subrahmanyan and Ganesh Rao (1929). *The Agricultural Journal of India* (July).

A SIMPLE AND CHEAP APPARATUS FOR THE AFTER-TREATMENT OF CLUB FOOT.

By A. MARTIN-LEAKE, V.C., F.R.C.S. (Eng.),
Chief Medical Officer, Bengal Nagpur Railway.

THE treatment of talipes equino-varus depends for its success on keeping up the position of over-correction until walking has been well established. Whatever treatment has been used to get the foot into the over-corrected position the deformity will recur unless the correction is well maintained. On account of the cost and difficulty in obtaining orthopædic appliances in this country the following apparatus was designed. It can be made by the local tin-smith and *mochi** and the cost is

* Leather-worker.