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ON
MYCETOMA
OR
THE FUNGUS DISEASE
OF
INDIA



Dr. H. VANDYKE CARTER

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ON

M Y C E T O M A

OR

THE FUNGUS DISEASE OF INDIA

ON

MYCETOMA

OR

THE FUNGUS DISEASE OF INDIA



BY

H. VANDYKE CARTER, M.D. Lond.

H.M. INDIAN ARMY



LONDON

J. & A. CHURCHILL, NEW BURLINGTON STREET

1874

M. J. O'NEILL

THE HISTORY OF THE STATE OF NEW YORK



Dedicated

TO THE MEMORY OF

GODFREY, BALLINGALL AND OTHER PIONEERS IN RESEARCH

AND

Proffered

FOR THE CONSIDERATION OF

WORKERS IN INDIA, AT THE PRESENT DAY

1871

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P R E F A C E

THE observations embodied in the present Monograph, were almost wholly acquired in Bombay, and the greater part of them have already appeared in the 'Transactions' of the local Medical and Physical Society for the years 1860-61-62; but many original notes in full, and drawings in *facsimile*, are now, for the first time, published.

I venture to hope that the data and illustrations thus rendered more accessible than before, may serve to extend a knowledge of the fungus-disease of India, to remove some present misapprehensions as to its true character, and to assist in directing the course of future inquiry. It is, chiefly, with respect to the last-named point—that, namely, of future investigation—that my own interest will rest unabated; but, as regards the doubts of other observers, in both India and England, as to the true nature of Mycetoma, I must, whilst here offering a full account of the malady, be content with reiterating my conviction that the real character of this pathological tumour of the foot, was clearly elucidated thirteen or fourteen years ago. The question of the true nature of the parasitical elements themselves, which are found in this disease, is really a separate question; but in terming these elements 'fungus-particles' (*entophyta*), I mean to express here, also, a decided opinion.

It was hardly to be anticipated that so singular a complaint as 'Mycetoma,' should be at once and unanimously recognised; and since the morbid growth is concerned with a class of organisms, whose manifold relations are yet matter of controversy, it becomes even less likely, that all the suggestions which I have thought fit to put forth, will prove acceptable. Nevertheless, I must here, too, abide, until some clearer light is from other quarters afforded.

The fungus-disease has yet to be suitably introduced to the notice of surgeons and naturalists on the Continent. I, therefore, pass by one or two summary, verbal disposals of the subject, which have appeared in print; and now proffer any additional material for investigation, which on my return to India (and opportunity permitting) may be desired by experimentalists in Europe.

It may seem superfluous to state this, but I am of opinion that the subject of parasitic complaints, in the widest sense of their definition, is one that will soon need more attention than has, as yet, been given to it. I would even add, in particular, the subject of vegetable parasites, as so distinguished. Under this head, I trust that 'Mycetoma' may be found to furnish some useful facts, additional to those already

acquired. What is made known in the present Memoir, has been elicited at some pains, and by personal effort, under the adverse influences of distant and tropical residence. To those surgeons in India, both European and native, who have aided me with specimens and other help, I hereby tender my best thanks. All published sources of information on practical points, I have carefully acknowledged; and as regards other particulars, such as the structure of 'Chionyphe C.,' I should not have hesitated to introduce borrowed illustrations, had it not appeared to me desirable to limit my figures to strictly original views, not hitherto published, and of themselves sufficient to elucidate the text.

Obviously, what has been put forth, can only be very imperfect; and having above referred for solution of certain not irrational doubts, to the facts below displayed and arranged, I should prefer to discussion as to the value of negative or more obscure data, the turning of our attention to such *desiderata* as may be procurable, both in India and elsewhere. For instance:—what are the local conditions, as to soil, water and vegetation, outside the body, under which the two kinds of Mycetoma respectively prevail? Why in one person, the black sort; in another, the pale, shall, in one village, appear side by side? Does this difference depend upon inoculation at a different stage of development of the entophyte? Can botanists tell us under what circumstances fungi and bacteria become interchangeable? And, on the adoption of my views, may not surgeons be able to *prevent* the occurrence of Mycetoma, in much-infected localities?

Then, as concerns the malady itself, it should be well ascertained if it always begins in the same way; precisely, how it spreads in the foot; what its period of incubation; what the conditions of slow or quick growth, within the body. Let the inter- and co-relations of the fungus-particles (entophyta) be elucidated: so let, in all essential details, the correspondence between clinical and natural history of the several varieties of the disease. It is strange, but significant, that these varieties do not co-exist in the foot, and are not, seemingly, connected by intermediate forms: where are the transitional phases that should exist, except upon the view proposed, that even the diverse particles have a common special origin?

When, however, these and like topics, are put forward, one is apt to be discouraged and even somewhat dismayed, at the slender hold upon facts that is available, even in so isolated and uncomplicated a complaint, as is this of the fungus-disease; but still, I will end these prefatory remarks with the expression of a hope, that the work which they herald, may prove to be both interesting to the naturalist and useful to the surgeon, especially in India and the East.

July, 1874.

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INTRODUCTION

I PROPOSE in this place to mention the *Classification* and *Definitions* which it will be useful hereafter to employ.

By the term 'Mycetoma,' is meant a tumour or swelling, which results from the growth within the textures of the human body, of a simply organized vegetable parasite.

Such tumours (which commonly implicate the foot or hand), while presenting in all cases certain uniform external signs, yet differ materially as to their contents; and it therefore becomes necessary to discriminate the several forms which have already been made out. Since the colour of the parasitic elements is, at first view, perhaps their most striking character, I propose to make use of the terms 'Melanoid'¹ and 'Ochroid'² as indicative of the two chief varieties of Mycetoma; and to distinguish the particles themselves which appertain to each variety, by the respective names—'Sclerotia'³ and 'Malacotia,'⁴ as expressive of such differences in consistence as also point to significant distinctive characters.

The proposed arrangement is the following:—

VARIETY OF THE DISEASE	CHARACTERS OF THE FUNGUS PARTICLES
1. Melanoid	<div style="border-left: 1px solid black; border-right: 1px solid black; padding: 0 10px;"> <p><i>Colour</i> :—black or dark brown.</p> <p><i>Size</i> :—from a pin's head, or less, to a bullet.</p> <p><i>Form</i> :—spheroidal (the larger); or compressed and pedunculated (the smaller).</p> <p><i>Surface</i> :—nodular or mulberry-like; or botryoidal.</p> <p><i>Consistence</i> :—hard and friable; or, rarely, softer and like rotting wood. The particles may be named <i>Sclerotia</i>.</p> </div>
2. Ochroid	<div style="border-left: 1px solid black; border-right: 1px solid black; padding: 0 10px;"> <p><i>Colour</i> :—more or less pale; pink, brown, or yellowish.</p> <p><i>Size</i> :—from a minute speck to a dried pea.</p> <p><i>Form</i> :—more or less globular; or ovoid.</p> <p><i>Surface</i> :—bossed or botryoidal.</p> <p><i>Consistence</i> :—caseous or soft; rarely firm. These particles may be named <i>Malacotia</i>.</p> </div>

¹ Mycetoma—from ΜΥΚΗΣ, ηρος; fungus: the termination (from Οΐδημα) is that common to many surgical tumours.

² Melanoid—from μίλας, of black colour.

³ Ochroid—from ὀχρός, of pale colour.

⁴ Sclerotium—from σκληρός, of hard consistence.

⁵ Malacotium—from μαλακός, of soft consistence.

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Examples in illustration of the two forms now indicated, will be found in the cases to be described in the succeeding chapter; and fuller description of the characteristic disease-elements is contained in Section V, Chapter I.

I have said that the signs or external features of Mycetoma are commonly much the same; indeed, not until are ascertained the characters, or contents, of the "discharge" from the sinuses (which are a prominent mark of the tumours), can it be surely said whether a given instance is one of the melanoid or ochroid variety. The reason of this outward similarity in the appearance of the swelling, notwithstanding differences in the parasitic species, is owing to there being, in all cases, but one mode of production of the malady; that, namely, which pertains to the development and growth amid the tissues, and to the subsequent approach towards the free surface, of an organism altogether foreign to the body itself. Thus, the cause and attendant conditions being alike, it is plain that the effects or results, as shown by local signs, will as well be essentially the same. It is in this manner only that I can explain the similarity which, by universal consent, obtains of the common or generic characters of the fungus-disease of India.

But the uniformity of character which is observed in all varieties of Mycetoma is not limited to external appearances only, for it obtains also in the clinical history of cases, as well as in all general features besides; and to me this circumstance appears of great weight, not only as indicating, as I have said, a common cause, but as also pointing to identity in nature of the foreign growths, which are always present in the foot or hand. Thus, since it is shown below that in one form (the melanoid) an undoubted fungus is present, so in the other (the ochroid form) a similar, or a correlated, structure may be looked for; and that such is really to be found, is the conclusion which, from the first, my inquiries have led me to uphold.

The terms genus and species, as here employed, are not intended to mean more than general and particular resemblance.

I propose to consider, in succession, the signs or local characters of this remarkable affection; then its general characters; its pathology and treatment; and, lastly, the natural history of the malady, so far as is known to me. An Appendix will contain the Bibliography of Mycetoma.

MYCETOMA

OR THE

FUNGUS-DISEASE OF INDIA

SECTION I

LOCAL CHARACTERS OF THE AFFECTION

CHAPTER I

HISTORY AND DESCRIPTION OF CASES :—*a*, OF THE MELANOID VARIETY ; *b*, OF THE OCHROID VARIETY ; *BELLARY SPECIMENS

a. Melanoid variety of Mycetoma

CASE 1.—Pandoo, Maratta, age about 35 years, farmer or cultivator of grain by occupation, residence near Poona in the Deccan, admitted into the J. J. Hospital, Bombay, on September 21st, 1859. His right foot is much enlarged, particularly about the ankle ; the general form of the swelling is oval, and somewhat resembling that of extensive scrofulous caries of the part ; the skin is thrown into coarse, corrugated wrinkles. On either side of the ankle-joint, and on the dorsum of the foot near the toe, and also in the sole at this part, are numerous small, soft elevations, one-third to half an inch across, and having connected with them puckered apertures or fistulous openings, around which the colour of the skin is lighter than elsewhere. These elevations (or " tubercles " so called) may be seen in all stages, from a slight raising of the surface to a pointed eminence, on which is found a puckered, fistulous orifice. They are most numerous about the ankle, particularly the outer, where nine or ten may be counted ; and on the dorsum of the toes there are nearly as many. Some other spots appear as if they had become cicatrised. On introducing a probe into one of the apertures, a long but not tortuous sinus is entered, which frequently leads to neighbouring bone, but not always : the discharge from them is scanty, not like the thin curdy pus of a scrofulous abscess, but rather a discoloured, glairy, sero-purulent fluid, in the midst of which may often be seen a few black gritty particles, the size of a pin's head or grain of powder ; or yet larger. The toes are imbedded, separated and displaced upwards (doubtless from implication of their *extensor* tendons) ; and the muscles of the calf of the leg are atrophied. The patient is emaciated and cachectic ; he has never had syphilis. The disease is of twelve years' standing, and its history is as follows :—When wading in a shallow river bed, a thorn stuck in the sole of the foot, bleeding followed, and a small abscess formed ; thence

swelling extended, without much pain, over the foot towards the ankle, which became implicated only a year or so back. Amputation of the leg was performed by Mr W. G. Hunter on October 3rd, 1859, and the patient made a slow but complete recovery.

The amputated member was examined by me within two hours after removal, and a coloured drawing was made of the parts as seen on section of the foot. It needed but a glance to see that the characteristic features of the disease were numerous black masses, studded throughout both hard and soft parts. (*Vide* Plate I.)

The lower end of the *tibia* has imbedded in its cancellous tissue two isolated and spherical masses, the size of a marble, and of the darkest pigmentary hue; the anterior portion of the *os calcis* is occupied by a still larger and more irregular mass, composed in part of smaller black spherical bodies, and also of a fleshy substance intermixed. Beneath the *skin* at the fore part of the dorsum of the foot are numerous round, dark-coloured masses which are seen to be composed of black spherical particles aggregated together; the extensor tendons of the toes have been displaced by this collection. Beneath the *first phalanx* and heads of the *metatarsal bones* are other masses of the same appearance; and before and behind the *ankle-joint* are also glairy accumulations, in which are imbedded black particles. All the other tissues exhibited a normal appearance, and there was here little of that elephantiasis-like thickening of the skin which was subsequently found to be common in the fungus-disease: there was nothing like strumous deposit in the osseous tissue, or such fusion of parts as is observed in cancer, and no caries or inflammation of the articulations. The black bullet-like masses may be picked out quite clean, and the cavities they occupied appear to be lined by a distinct membrane; they were carefully drawn, and figures of them and of the foot itself are preserved. The bones were macerated, and are now preserved in the Grant College Museum. The minute structure of the fungus will be described further on.

CASE 2.—In February, 1860, I received from Bhooj, in Kutch, an entire foot which was kindly forwarded by Mr Sudasew Hemraj, physician to the Rao of Kutch. No history of the case reached me, but having received further information from the donor, I am led to believe that the present specimen was but a type of the cases commonly occurring in Kutch. The whole foot has the globular shape characteristic of these cases: there are several apertures placed in the dorsum and on either side of the ankle and foot, but none in the sole; they resemble those of the first specimen, and some are occupied by little black grains, identical with the particles forming the deposits in the interior, to be presently described. The skin presents white patches scattered around these apertures, and the toes are displaced upwards.

A coloured sketch was made of both exterior, and of sectional appearance. See Plate II, fig. 1, for the external aspect of this specimen.

Description of section.—The *tibia* (and probably the *fibula*) are seen to be free from black deposit in this case: there is, however, a thinning of the walls of the shaft, and there may be noticed a softened spot placed on a part which is paler in colour than the rest of the cancellous tissue, although of the same density; this softened spot has a rather white tint, and it looks as if fat had been deposited there. Also in the *os calcis*, just behind the position of the *bursa mucosa* of the *tendo Achillis*, the osseous tissue is somewhat softened, but not changed in colour. On careful examination of these parts, only a large increase of fat-cells, crystals of stearine (free and contained) and the remains of the medullary membrane studded with granular nuclei, were found: no fungus-particles were detected. The *astragalus* is unaffected. In the fore-part of the *os calcis* is embedded a black mass, half an inch in diameter, granular and firm in consistence, and of the characteristic rounded form. The *cuneiform* bones are occupied by a larger deposit of similar appearance; and beneath the thickened integument covering them, being partially blended with the above, are seen two round black deposits, a quarter of an inch in diameter; also a third deposit a little further back; and again in the soft parts beneath these bones, in the sole of the foot, are two other masses of similar appearance: smaller deposits are seen beneath the toes in front. The integument is thickened somewhat, as seen in elephantiasis, in the dorsum of the foot; and there appears to have been some fibrous thickening amongst the parts in the sole. The joints are unaffected. The osseous tissue is mostly in a normal state, and only absorbed to make room for the new growth, thus leading to the production of small spherical cavities.

As for the fungus masses, compared with those of the first specimen, they are somewhat less firm and regular when enucleated from midst the tissues, but in all other respects they are identical with them: in some instances, e.g. those taken from the cavity in the *os cuneiforme*, the mass is soft, friable, like rotten wood, and splitting in a direction radiating from the centre: their colour is however the same, and similar masses were found in the first specimen.

The minute structure of the fungus will be described further on. A portion of the foot is preserved in the Grant College, Bombay, and one half was sent to England for exhibition to the Pathological Society of London, in May, 1860. This specimen is now preserved in the Museum belonging to the Army Medical School, at Netley.¹

CASE 3.—A third example was forwarded to the Grant College by Dr Asher, Civil Surgeon at Hydrabad in Sind, with the following memoranda²:—"Foot (right) of a prisoner in Hydrabad jail, amputated 31st October, 1860. Disease commenced in the sole of the foot by the appearance of a tubular (?) indolent swelling, at the end of 1856, attributable to no known cause. He previously enjoyed good health. Similar swellings gradually extended over the whole foot, and here and there circumscribed suppurations took place, giving rise to breaches of surface: and these, remaining open, took on the appearance of papillæ from which there came a scanty thin discharge. A deep aching in the foot was merely felt, there being no acute pain at any period of the disease. Progression up to the date of amputation was merely incommoded by the weight of the foot, and for a considerable time previous to the operation, the man was in weak health and much emaciated: he was born and resident all his life in the neighbourhood of Kotri, being occasionally employed in agriculture, but for the most part as a musician."

Description of the specimen.—General external form of foot striking and characteristic: the swelling, of considerable size, involved the whole member, and is particularly large about the ankle-joint; the toes are free. Numerous apertures are scattered over the surface, several being on the sole of the foot; they have the usual pouting appearance. *Section*:—The *small bones* and soft parts are indistinct on account of the growth of a dark-coloured glairy substance, imbedded in which are the black fungi: *tibia*,—in the cancellous tissue of its lower extremity are one or more collections of black particles; in the *os calcis* are others: there being the usual spherical cavities in these bones, as well as in others that are affected. The amount of parasitic development is very considerable, and was, I think, rapidly increasing at the time of amputation. As regards the minute structure of the fungus in this case, it corresponds wholly with that previously observed: but this specimen will be again referred to as one demonstrating the way in which the melanotic form of fungus seems to commence (*see* Plate VIII, fig. 2).

CASE 4.—A Hindoo (male), æt. 30, a carpenter from the Deccan (near Nassick): the left foot is affected characteristically, and to a considerable extent: the disease began one year since with an abscess in the sole, during the cold season. Health reduced: the foot is painful. Amputation was performed at the J. J. Hospital, Bombay, on September 26th, 1861; and the man was discharged cured at the end of October.

In general form and appearance this specimen resembles others previously described. The *tarsus* is chiefly affected: the toes are free. Numerous sinuses open on the dorsum and side of the foot, and a large cluster of openings is seen in the middle of the sole: most of them discharge a thin purulent fluid, and in some of them small black particles may be seen: these are the fungi, and their nature was clearly made out before operation.

A *section* of the foot was made immediately after removal and the appearances preserved in a sketch (*see* fig. 2, Plate II). The black masses and granules located in the spherical cavities and tubular canals were imbedded in a whitish, semi-opaque, glairy substance of homogeneous consistence; the walls of the canals were thin, had an opaque yellow colour, and were readily torn. The soft parts around them were converted into a gelatiniform substance which takes the place of the degenerated muscles, &c.; the tendinous and fatty structures are less altered. Microscopic examinations of these parts were made, and the results will be afterwards referred to: Chapter I, Section V.

¹ The same Museum also contains an entire foot affected with the Ochroid variety of Mycetoma, and both examples were selected (with others of different diseases) by me, during the period I was Curator of the Museum at Grant College, in Bombay.

² Other notes of Dr Asher are these:—"The produce of his native district consists of grain and cotton, but in the culture of the former alone has he been engaged. The small tract of country to which his residence has been confined lies along the right bank of the Indus, and the soil is light clay. Has never known any other person

suffer from the disease under which he labours, but has heard of it from others, and believes it is called in the vernacular 'Nagro'; a term, however, which seems not familiar to many, and apparently not confined to this particular disease. The natives have here no superstitious views as to its cause, nature, or cure; they regard it as incurable, &c.," said never to be known in any other part but the foot; and in the subjects of it no hereditary tendency or particular diathesis can be traced. "Within the last few days, since writing the above, another instance, altogether similar, has occurred in my practice."

CASE 5.—From Kutch. A Hindoo, æt. 27, shepherd: thin and weak, suffers little pain. The right foot is irregularly swollen in both dorsal and plantar aspects, which present numerous small openings, giving exit to a scanty, thin, discoloured fluid. The disease began fifteen months before admission, as a small hard swelling in the sole, with little pain: two months afterwards an opening formed, and black granules, like seeds, began to come out from time to time. Amputation of the leg was performed on November 12, 1861, and the patient made a fair recovery.

The foot is swollen: the toes much extended. The skin has not changed in colour. At the root of the toes, on the dorsum, are three or four small apertures filled with black particles, one or two being situated towards the margin of the foot, and others on the sole at the front. On section it is seen that a considerable growth of the dark *sclerotia* (which vary in size from that of a pin's head to a split pea) has taken place in the soft parts immediately beneath the apertures just described, that is, in the subcutaneous tissue on the dorsum of the foot, at the root of the toes and in the sole, along its whole extent. It does not appear that either the tarsal or metatarsal bones have been attacked; the osseous tissue is healthy.

Minute examination of these various parts was made with results mentioned below.

CASE 6.—An elderly man, resident at Satara, Deccan, a vakil (lawyer) by profession, applied to me on account of a long-standing sore, situated between the toes of one of his feet; it had been there upwards of fifteen years, and not unfrequently there came away from it small, hard, black particles. I found that the cavity of the ulcer extended inwards some distance; there was very little discharge; the black particles were characteristic fragments of the smaller kind described in this work. The interest of this case centered in the long duration and slight progress of the growth; it is possible that a sore may have existed long prior to the introduction of fungus-spores, but I have no evidence bearing on this point.

CASE 7.—J. J. Hospital, Bombay, 1861. A Mussulman, æt. 27, sailor, a native of Bunder Abbas, in the Persian Gulf. The left foot began to enlarge ten years since after a fall; the swelling now presents all the characters of mycetoma; black particles may be picked out of the sinuses, and when examined microscopically exhibit sprouting cells and beaded fibres. This man suffers no pain or constitutional disturbance; and, finding no other remedy proposed than amputation, declines to submit to operation.

Cases 8 and 9.—*Mycetoma of the Hand*.—Two specimens were forwarded to me in May, 1862, by Mr Sudasew Hemraj, medical attendant of the Rao of Kutch; both were examples of the black variety, and figures of them are given in Plate III.

CASE 8.—Ookerdo, a Hindoo cultivator, aged about 70, a native and resident of a village situated to the north of Bhooj, has disease of the *ring finger* of his right hand. Says that about a year and a half ago a small swelling about the size of a pea formed on the palmar aspect of the right ring finger; this swelling began slowly to increase, and in about a year it attained the size of a nutmeg, became painful, burst and gave exit to thin sanious matter mixed with dark-coloured, granular, seed-like particles. After this, the swelling began to extend all over the finger, now and then bursting and discharging matters as above described, and thus the finger has attained its present size.

When examined in Bombay the specimen presented the following characters:—It appears to have been somewhat swollen; the palmar surface opposite the middle phalanx presents four or five rounded openings, in which may be seen imbedded the black fungus-bodies; one or two such apertures are placed at the side, and all are of characteristic appearance, being circular, clean cut, and narrowest at bottom; occasionally they are blended together. On making section through these places, it is found that the disease does not pass deeper than the sheath of the flexor tendons, but extends along them for some distance; the soft parts in front being occupied by cavities two or three lines in diameter, which are filled with the fungus-growth, and which are connected together by small tunnels or canals passing from one to the other, beneath the cutaneous surface; so that these parts are riddled, as it were, by the disease, while all the other textures of the finger seem to be sound. There are no pink stains visible; and further examination elicited no new features of the disease, either general or minute.

CASE 9.—The *hand* (right side) is from a low-caste Hindoo female, native of Wagur; she is unable to give

any account of the commencement and progress of the disease, but says that the discharge from the openings during life contained dark-coloured, seed-like particles. The hand was preserved entire, not being dissected.

Mr Hemraj observes that he had under treatment two more cases of the foot disease, one of which presents a very large tumour ready for operation.

Other rare examples of Mycetoma of the upper extremity are referred to by Dr Colebrook, late Civil Surgeon at Madura; and by Mr P. A. Minas, Honorary Assistant-Surgeon on the Bengal establishment, respectively, in separate communications to me and in publications named in the Appendix.

* *Bellary specimens*

These were sent as ordinary examples of the Foot-disease; and were not accompanied by notes of the history of the cases. Certain peculiar features, which both specimens presented, seem to require the special consideration here given to these examples.

No. 1.—*The smaller foot* has the globular shape common in this disease; the swelling includes the ankle, heel, and foot, uniformly towards the toes, which are yet distinct and prominent. The skin is marked with large white patches. Numerous circular apertures and depressions may be seen scattered over the dorsum, sides, and heel of the foot; they are large enough to admit the point of a probe, or larger, and they are closed by the folds of the thin membrane which lines the sinuses or tubular passages communicating with them. Small brown particles, like little seeds, may be seen in some of the apertures.

Section.—*General indistinctness of parts.* The surface is studded with round or oval holes, in which are lodged brown particles, identical with those referred to above, or white and opaque granules of a similar form. In some places the colour of the particles is reddish, or even pink. The bones of the *tarsus*, especially the smaller ones, are hollowed into spherical cavities to receive these bodies; the osseous tissue itself is not diseased, only that of the *astragalus* and *os calcis* is, if anything, somewhat condensed. The *tibia* is unaffected, except that its cancellous tissue appears coarser than usual. The soft parts are increased and thickened by the formation of fibrous tissue, and they are almost everywhere permeated by canals and cavities filled with brown fungus-particles; this appearance extends as high as 4 inches above the ankle-joint behind the tibia, or, it may be, quite up to the line of operation (about 5 inches). Deposits of the same brown granules may be seen just beneath the skin, and in the tubes which lead from the apertures on the surface down to the cavities and dilated canals in the interior. There is a greenish, oily, sloughy appearance of the soft parts beneath the skin and running up the leg, which appears to be due to disorganization of tissue, more or less immediately connected with the parasitic growth. The *fungus-particles* are generally of a mahogany-brown colour, but may be of bright pink or of yellowish, or even paler tint; some appear to have been transformed into opaque white granules. They attract attention when the section is first exposed to view, and are exceedingly numerous. Their consistence is firm and friable, almost brittle, and uniform throughout. The *larger* ones are one fourth to one third of an inch in diameter, and their surface is tuberculated; they readily break up or tear in a direction radiating from the centre, and they are clearly not aggregations of smaller particles; except in colour, they resemble some of the larger black particles characteristic of the melanoid or first-named variety of Mycetoma, and they may, perhaps, be regarded as having originally had the same general structure as they. The *smaller* ones, also similar in form and size to the small black fungi, and, like them, present the appearance of a pedicle; their colour and consistence, however, are very different. (For illustrations, see Plate IX, fig. 7.)

The minute structure of these bodies will be referred to subsequently. The opaque white granules mentioned above are wholly formed of delicate, radiate, crystalline spiculae, and are evidently of inorganic nature; such crystals, indeed, are fatty, and the like are not of uncommon occurrence in connection with the parasitic growth of all forms.

No. 2.—*The large foot.* It is much more misshapen than the last specimen, presenting an appearance totally distinct from any affection of the kind which I ever saw in Europe. The anterior half of the foot is

enormously expanded and thickened; only the outer and inner toes are visible, the others being imbedded in the new growth; the circumference at this part attains to 16 inches. The surface is riddled with round holes like those of the last specimen, only more numerous and various in size; they lead down to similar canals and cavities, which are also filled with masses of granular aspect. These masses are perfectly distinct to the unaided eye, and in colour some are pink, others brown or whitish. Their total number must be immense, and as each mass contains dozens of separate smaller ones, and every granule as many fungus-particles, the total number of individuals may be reckoned by thousands. Their minute structure will be described under Section V; it is well worthy of notice.

This specimen was preserved entire, only an incision being made into it, which showed the usual appearances. The posterior part of the foot, around the ankle-joint, was comparatively unaffected.

Although the two examples above described will be afterwards frequently referred to, it may be as well to state in this place, that both of them present features of an intermediate character—as regards the structure and other characters of the fungus-particles—which are most interesting, as aiding to connect forms of growth otherwise in appearance widely distinct.

b. *Ochroid variety of Mycetoma*

CASE 1.—A Hindoo woman, *æt.* 50, an inhabitant of Gogo, was admitted into the J. J. Hospital, in the middle of November, 1859. The left foot is affected; there is considerable swelling; and on the dorsum, and as well around the ankle-joint, are several soft pale elevations of the skin, somewhat larger in size than usual: many of these seem to have burst and were discharging a watery fluid, or occasionally pus, and through them a probe readily passes some way down into the tissues of the foot; the toes are not displaced. On examining the discharge under the microscope, besides numerous pus globules, several small white particles were seen; these possess a distinct *fungus-structure*.

The patient is emaciated, and states that four years ago she was salivated at the Rajcote Dispensary. The history of the case is as follows:—seven or eight years ago she struck the inner part of the foot against a door; an abscess followed, which she opened with a needle; it did not, however, heal, but reappeared several times, when it was frequently opened by means of a thorn. Two or three years subsequently to this, the disease spread gradually, and fistulous openings began to appear.

The leg was amputated November 30th, 1859, by Dr Ballingall, and the patient recovered. Drawings were made of the external and sectional appearances of the specimen. See figs. 1 and 2, Plate IV. In this case the diseased parts consisted of collections of what looked like sloughing tissue, or grey or blackish matter, almost glairy in consistence, and accumulated in loculi, from which they could be readily drawn out; both soft parts and bones being freely excavated to receive them. The principal accumulations were behind the *tendo Achillis*, encroaching on the bones just above the *os calcis*; also in front of the ankle-joint, occupying the position of the anterior part of the *astragalus*, which was in this place partly absorbed; and extending as well beneath the skin. In the arch of the sole, also, is another group of these soft masses, encroaching on the front part of the *os calcis*, and communicating with the last-mentioned mass. On the whole, the bones themselves seem not greatly affected; the lower end of the *tibia* did not contain any of the foreign substance; the cancellous tissue, however, seemed a little softened in one or two places, and there was some enlargement and rarefaction of the compact tissue.

No black granules were seen, and only after careful examination were the pale ones seen in the loculi above mentioned; some of these granules were semi-transparent and others were opaque; when isolated they were barely visible as white dots to the unaided eye; they were abundant in the discharge, and in the glairy substance above mentioned. Their minute structure will be subsequently described. See Section V, and fig. 1, Plate X.

One half of this foot is preserved in a moist state; and one half has been put to macerate, to show the extent of disease in the bones. It was in the macerating foot that the pink mould (*Chionyphe C.*) made its appearance after an interval of many months, as afterwards described. The bones of the foot are shown in fig. 1, Plate VIII; they are very characteristically affected.

The discharge from a recent sinus in the foot was, prior to the operation, examined with the microscope. It was thin and watery, like diluted pus, and irregularly opaque; there were in it numerous small particles barely visible as white dots to the eye, but when magnified found to be of varying size, brownish in tint, darker in the centre than at the circumference, and having a rounded or tuberculated surface; these are the *fungi*, and dozens, or even hundreds of them, must have been daily extruded from the foot. Pus and blood-corpuscles, and granule-cells composed the chief part of the discharge; no other structures were seen. See fig. 1 c, Plate X.

Thus the nature of the disease was diagnosed before amputation, although this example was in many respects obscure. It is an instance well worthy of close attention.

From Madura, sent as a specimen by Dr R. Wilson, June 28th, 1860:

CASE 2.—The patient was a woman about 26 years of age; disease said to be of about four years' standing. She is the wife of a ryot, and has frequently been employed in field labour, in cotton soil and amongst cotton plants; she does not remember having received any injury to the foot. The disease first commenced as a boil in the dorsum; and under native remedies it gradually merged into its present condition, when she applied at the Civil Hospital, Madura, for relief.

The specimen arrived in Bombay on July 21st, and may be described as follows:—*External appearance.*—The whole foot is enormously enlarged, and appears, as it were, spread out, or flattened; hence its resemblance to some other specimens is not great, though, on the whole, very characteristic. It is not enlarged about the ankle-joint so much as towards the front part, where it is enormously expanded and thickened; and the soft parts beneath the toes are so affected that the latter are imbedded and nearly hidden. Scattered over the dorsum of the foot, on the sides, and also in the sole, are numerous apertures seated on eminences or soft swellings, like those peculiar to this disease; in their immediate neighbourhood the skin is white, and frequently the white patches join. I note that the English surgeon would find it difficult to classify this specimen amongst local affections hitherto known to him.

Sectional appearance.—No distinction of parts evident on a glance. The small bones of the foot seem to be almost destroyed, leaving a greenish, slough-like tissue, or, as it is in front, reddish-coloured and of similar consistence. The *tibia* is atrophied and softened, and the *astragalus* is still more affected in the same way; the remaining bones have been scooped out, or excavated, on all sides, by the new growth. The soft parts are also very obscurely indicated; the *skin* is hypertrophied; in it, in the other soft parts, and in the bones, are to be seen cylindrical tunnels and spherical cavities, which are occupied by the glairy substance more or less completely; this latter has a pinkish tint in some parts; fat is abundant and oily matter exudes plentifully from the bones, &c. The peculiar deposit in the canals just referred to is clearly the new growth; the canals join together or run towards the surface, where they open at one of the apertures described above. The fleshy tissue fills them in some parts and lines them in others, where large cavities are formed by the junction of several tunnels; here we meet with broken-up osseous tissue from the exposed bones around, epithelium, masses of pigment, and other *débris*. The pink colour is partly owing to a general diffusion of pigment (tinging even the oil-globules), and partly to the presence of very numerous single or aggregated particles, just visible to the unaided eye, and scattered irregularly amongst the fleshy tissue; at first sight the surface of the section appeared as if strewed with red-pepper grains, and the appearance was so like that of accident, that it might have been mistaken for such. These red particles are the peculiar and characteristic fungus-bodies; their structure will be afterwards described. See Sect. V, and fig. 4, Plate VII.

From Kutch. Specimen and notes sent by Mr S. Hemraj:

CASE 3.—A Hindoo, æt. 40, cultivator; the left foot is swollen to about three times the size of its fellow; more particularly is the sole of the foot affected, in its whole length. Everywhere are found small openings, through which the probe readily passes, and often as far as bone; in some parts are small soft elevations of the surface, which, when they burst, give exit to a quantity of thin matter containing granular bodies, not unlike mustard seeds. The disease is of very long standing; it began by a vesicle on the sole, from which granular and purulent matters were discharged; the swelling then subsided, but seven years ago other vesicles appeared, and the disease has progressed ever since. The patient is somewhat reduced, but does not suffer pain or fever. On

November 26th, 1860, amputation was performed in the upper part of the leg; and the patient progressed favorably afterwards.

I found the diseased foot to be very characteristic in appearance. On section great disorganization of the tissues was seen, bones and soft parts being bored and excavated in all directions, and the canals and cavities being occupied with whitish mulberry-like masses of minute size and soft consistence; their number was very great, and under the microscope they exhibited, besides the usual structure—namely, a finely granular central body surrounded by a crystalline envelope—certain peculiarities not before seen; thus, this crystalline fringe was composed, not of a single row of needles, but, in addition, of superimposed secondary or even tertiary rows, not unlike to *cilia*, or the finer parts of a feather; and also were seen in the interior of many of the particles numerous oblong, granular, rounded bodies, which might readily be taken for a sort of *nuclei*, or even for spores; but it appeared on further examination that they were merely oil-globules of various size, and variously blended together. For further remarks see Sect. V, and also fig. 3, Plate X. It was from malacotioid bodies taken from this specimen that the red mould (*Chionyphe*) was successfully cultivated.

CASE 4.—J. J. Hospital, August 9th, 1862. The left foot of a young man was amputated by me on account of this disease. The peculiar character of the openings in the skin was clearly apparent, as well as some circular lighter-coloured spots, giving a mottled appearance to the surface; the region occupied by the disease was generally of a very dark tint. Only the inner side of the foot and sole was affected; and the limit was curiously well defined. See Plate V. The history of the case presented no peculiar features.

On section the disorganization of tissue was found to be great; canals were seen having precisely the same appearance as found in the last specimen obtained in this hospital (on September 26th, 1861, which was one of the first or melanoid variety of Mycetoma), their walls being composed of an opaque yellowish substance, and their contents consisting of an opalescent, gelatinous matter, sometimes passing into a puriform liquid; in fact, except in the very different character of the fungus-particles, all the accompanying changes were identical. Pink streaks in the skin were not here seen. The particles were of considerable size; it might be thought that they had undergone a change from the melanoid to the present pale state—a change accompanied by suppuration in the cells. Yet in every part of the foot the appearance of the particles was alike, and there was no evidence of a transition from one form to another. The particles had the consistence and other characters seen in former specimens, and their small mulberry-like clusters were found to be composed of fungus-bodies arranged in a seemingly irregular manner.

The following observations were made two and half hours after operation:

A pale granule or particle taken from near the surface of the sole, at some distance from bone, to which water was added, was found to consist of fungus-bodies with their crystalline fringes, of purulent matter with granule-corpuscles, fat crystals, &c., and of some free and well-marked "myeloid" cells of various degrees of complexity. No traces were seen of either spores or cells of a fungus-structure. Numerous radiated masses of fat-crystals were present. The presence of the irregular masses with their crowded, bright nuclei, known as 'myeloid' cells, had no special significance, because the patient was a young man, and the medullary membrane of the tarsal bones of the foot was implicated in the progress of the parasitic growth; hence, doubtless, the presence of these structures, which, however, certainly formed no appreciable addition to the bulk of the growth, and had no special connection with the tumour.

CASE 5.—Suttoo, æt. 30, inhabitant of the Deccan, Satara Collectorate, Bombay Presidency, has his left foot affected with the fungus-disease. He is very thin, and much reduced in strength, but does not suffer from hectic or local pain; he has no other complaint. The foot is enormously enlarged; and in progression he is compelled to crawl on the ground with the aid of the sound limb, pushing the diseased foot onwards in front by means of his hands. The swelling involves chiefly the outer side of the foot and the sole; it does not extend above the ankle-joint, and has all the external characters of "Mycetoma."

The patient states that three years ago, during the hot season of the year, he accidentally pricked his foot (in the sole) with a thorn, and that abscess and swelling followed, the latter continuing to increase until the present time, with the formation of fresh abscesses. None of his family are similarly affected. Cotton is not grown in the immediate neighbourhood of the locality where he resides.

The remarkable feature of this case is the comparatively short duration of the disease with so large a tumour, whose measurements are as follows:—long diameter, 14½ inches; short diameter, 7 inches; circumference at dorsum, 20 inches. Amputation was performed by me on March 28th, 1864.

The outer side of the foot is chiefly affected, but about the inner ankle and sole are also numerous sinuses, from all of which the characteristic fungus-particles were discharged. In one of the larger swellings the little toe is seen to be imbedded. The sole of the foot is convex. See Plate VI.

Section.—The appearances are very characteristic; as presented in the front portion of the foot, they are delineated in Plate VII, fig. 1. Much of the swelling in this instance is owing to fibrous thickening (resembling that occurring in *Elephantiasis Arab.*), which generally, in cachectic constitutions, accompanies the parasitic growth; there are no other peculiarities of appearance to be seen. Notes, &c., were forwarded to England; see Appendix, 'Patholog. Trans. of London,' under date 1864.

CASE 6.—A Hindoo woman, æt. 30, belonging to the oil-makers' caste, and residing near to Satara, came to the Civil Hospital there on January 31st, 1872; her right foot is very considerably swollen, and the whole tumour has the characteristic tendency towards a globular shape; the sole is flattened, the dorsum very convex and smooth; the toes seem a little atrophied, but are otherwise unaffected; they project forward. The disease is said to be decidedly progressing; the number of discharging openings is not yet considerable; thus, there are a few on the dorsum of the foot, and some are threatening; in the sole are others, and two of these are almost characteristic in appearance.

The woman's health is good; the swelling of the foot commenced two years ago.

I opened one of the soft elevations on the back of the foot, and by slight pressure forced out a minute, whitish, soft, grain-like fragment. This was immediately placed under the microscope, and closely examined in a medium of distilled water only; nothing was seen not before noticed in the malacotioid particles.

It may be as well here to remark, that the peculiar roe-like masses were found by me quite beneath the skin, and before any "sinus-opening" was formed, through which they might have been accidentally introduced into the foot; hence a kind of demonstration that the fungus-particles are not an incidental feature, superadded to pre-existing disease of the part.

The patient declined operative interference and returned to her home; no one else in her village was affected in the same manner, and cotton cultivation is not practised in the neighbourhood.

CASE 7.—*Mycetoma at an early stage.*—The specimens described below are the only ones of the kind I have seen; they are interesting as examples of the early stage of the disease, and will therefore be considered in detail. The reason why such samples are comparatively rare, is the circumstance that native patients in India do not, as a rule, present themselves to the European surgeons before their disease has greatly advanced, and then as a *dernier ressort*.

Under date of 10th September, 1860, Dr R. Wilson forwarded to me, from Madura, the following note with the preparations referred to in it:

The accompanying "specimen is just removed from the plantar surface of a boy's foot; the disease was of thirteen months' standing, and no cause can be assigned for its appearance. One or two people in his village had suffered from "tuberculated foot" some years since. The disease in this case made its appearance in the dry season, in the form of a single tubercle, which ulcerated and discharged a fluid said to be aqueous (unlike pus), and which gradually increased in size till this time; this discharge ceased a month or two since. Another small tubercle also formed on the upper and outer edge of the foot a few months ago; this I also removed and now send you. Should this be the genuine disease, it is the first time I have seen it at so early a stage."

Description of the specimens.—The larger piece (fig. 2, Plate VII) has the appearance of an elongated flattened tumour, the rounded surface of which is marked with white patches, and presents seven circular depressed spots of $\frac{1}{2}$ in. to $\frac{3}{4}$ in. or more in diameter. These correspond to the apertures of exit of the fungus-particles, and various conditions of them are seen, from a shallow depression with a dark centre to the deep and more or less conical opening. The cuticle is generally thickened, and at the more perfect apertures may be seen to be perforated obliquely by a passage leading from the surface to the soft spot in the subjacent cellular tissue, which contains the pink or pale particles; beyond this the tissues are healthy. An incision having been made through the dotted line in the figure, it was found, on examination of the structures successively from the surface inwards, that the superficial dark layer of the cuticle is cast off, leaving a very regular, circular white surface, the centre of which presents a depression; this is closed at the bottom by a brownish layer, very thin in the middle as seen after section, when it is also found that a small cavity exists beneath this depressed spot. At other apertures, on section, a tubular prolongation may be detected running down through the remaining thickened cuticle and cutis into the subcutaneous cellular tissue, where it is not difficult to find the fungus-particles, pink

or yellowish coloured, or they may be found in the cavity above named in the superficial part of the cutis, or even on the surface of the latter, the cuticle being raised above the corium. See Plate VII, fig. 3.

The smaller specimen.—On a white patch of skin is seen a small circular aperture, depressed, and closed by an elongated fissure on the surface. After making a section we find below the small circular aperture between the true skin and the *rete mucosum*, and extending also down into the true skin, a small cavity covered in by the depressed valve of the opening, which is very thin at this part; also beneath the oval slit is a larger cavity, similarly covered, but extending into the subcutaneous cellular tissue and giving off winding passages into the surrounding parts; these contain numerous white granules.

I subsequently note that the fungoid granules are quite distinct and of a whitish colour; they are surrounded by a crystalline coat, and appear to be composed of smaller particles aggregated together, because the crystalline rays may be seen in the interior of the masses. True fungus-structure is not to be made out. The crystalline fringe is smaller than usual. Bodies not unlike spores may be occasionally seen.

Perhaps the most noteworthy result of the inquiry above narrated, is the fact of fully formed, pale, fungoid particles, provided with a crystalline fringe, being produced in so early a stage of the disease; yet I have found the small black particles, also, formed in cavities of size just large enough to contain them, and just beneath the skin. This instance is also interesting from its connection with the simple practical measure of local excision.

Additional Specimens and Notes.—The following instances and illustrations may serve to confirm other more precise data relating to both varieties of Mycetoma:

No. 1.—From Guntoor (Madras Presidency) there arrived in Bombay on January 4th, 1861, two large segments of a diseased foot. My impression is that I was indebted for them to J. W. Eyre, Esq., Deputy Inspector-General of Hospitals, I.M.S. I notice that they have a characteristic appearance; “the skin presenting numerous soft swellings, and circular depressed openings. The peculiar tunnels or channels are, though small, exceedingly numerous in many parts, and perforate the bones and soft structures in all directions. The fungus is of the second variety, and the minute soft particles are of a whitish colour. All seem to be fringed as usual; and in some, very distinct indications of a fungus or cellular structure were seen; in others there were countless minute globules resembling in appearance oil, but yet all of the same size and persisting after the action of ether; rows of such globules would form the jointed cellular filaments.” So run my notes; and this evidence tends strongly to confirm the views hereafter proposed as correct.

2.—There were, previous to 1860, in the Museum of the Grant College, Bombay, mounted specimens of this more common variety of Mycetoma. The external appearance of all resembles that of the specimens I have now described, and I may say the bones are affected in a precisely similar manner; hence we may consider these older instances and my own to be of the same nature, although the true character of Mycetoma was not then known.

In illustration of these remarks, the following case and notes may be added. A Hindoo grass-seller, æt. 35, a native of Rutnagerry, was a patient in the J. J. Hospital, in July, 1851. His right foot is swollen to double its natural size, and the swelling is in some places soft and elastic, in others hard and tumid. The toes appear shortened, as if imbedded in the swelling. The skin of the foot is tense, shining, and somewhat discoloured; and there are numerous small openings situated over elevated bases, through which a thin sanious discharge oozes. About three years ago the sole of the foot was pierced by a thorn; abscesses and swelling followed and the man was salivated; hectic symptoms came on and the leg was then amputated; the patient recovered. It does not appear from the history of the case that “the man suffered from syphilis, or manifested any symptoms of scrofula.”—*Summary of a case described by Mr J. C. Lisboa in the ‘Transactions of the Medical and Physical Society of Bombay,’ vol. ii, new series, p. 337.*

The bones of the foot were preserved, and exist now as the preparation marked A. 62 in the College Museum; this presents the following appearances:—The lower extremities of the *tibia* and *fibula* show, especially the latter, marks of chronic periostitis. At the place of the lower tibio-fibular articulation is a small deep cavity, and a shallower one on the fibula, indicating the commencement of absorption. The articular cartilages are healthy. All the bones of the *tarsus* and the adjoining ends of the *metatarsal* bones, and even one or two of the *phalanges*, have been implicated in the disease, and everywhere, with the exception of the upper surface of the *astragalus*, they are perforated in all directions by numerous small spherical cavities large enough to lodge a pea or bean, or even a little larger. The reticulated or areolar appearance thus produced is equally apparent in the

sole and in the dorsum of the foot. The sides and solar surface of the *os calcis* present several of these cavities opening outwards by rounded apertures, and communicating by tubular passages. The head of the *astragalus* is the part principally affected. The osseous substance is generally somewhat rarefied by atrophy and absorption, and in a few places it is marked by new periosteal deposits, but otherwise the texture is healthy in density and colour.

3.—Were further illustration needed of the identity of the affection under consideration in the Bombay, Madras, and Bengal Presidencies of India, it would be furnished by examination of the specimens to be seen in the Museum of the Royal College of Surgeons, London, from both Bombay and Calcutta; and in the Museum attached to St. George's Hospital, where is preserved a foot which I received direct from Madura (Madras Presidency) in April, 1872, and so near to my departure on furlough from Western India, that there was no available time to do more than summarily establish the identity of the fungus-growth in this case with others. I have already referred to specimens contained in the Pathological Museum at Netley; and doubtless there are now others distributed in the several collections of morbid anatomy to be found elsewhere. Special reference may, however, be made to three very characteristic specimens contained in the Museum of University College Hospital—namely, two of the black variety and one of the pale form; these are well worthy of examination, and they are all marked as examples of the "Madura foot."

CHAPTER II

SIGNS AND SYMPTOMS OF THE DISEASE:—*a*, EARLY STAGE; *b*, ADVANCED STAGE

As a rule, the local indications of this disease are the same for all its various forms, as above distinguished; for commonly it is not possible to discriminate the several varieties by simple inspection, or bare clinical history of the case.

These signs or local characters differ according to the stage or period of growth of the tumour; and for the purpose of description it will be needful to distinguish the early and the advanced forms of disease.

A.—The *early stage*, extending, one may say, to a year or two after the first visible or otherwise ascertained appearance of the tumour, is not so frequently seen as the later, nor has there been noticed more than a very general agreement in its indications. There is sometimes a localised induration or thickening of the skin, little elevated, ill-defined at the edges, and not always extending inwards towards the deeper structures; over the affected surface (whose extent may cover a space of one to three or four square inches) the colour is darker than usual, of livid hue, or mottled; but there is no tenderness, and little or no unusual heat of skin. No external aperture is at first to be seen.

Another mode, by no means infrequent, by which the disease makes its advent known, is the spontaneous appearance of a vesicle or bleb (of diameter occasionally equal to one inch) upon a part of the foot to which attention may not previously have been drawn, but which is then found to be somewhat swollen and hard.

Again, it is often stated by patients that the very first sign of the tumour was a small lump, or nodule, projecting above the level of the skin, but yet deep-seated, firm and fixed; the apparent diameter of such lump commonly exceeds half an inch.

As varieties, we find that small abscesses, or boils, have earliest attracted notice,

and it may be stated these were preceded by a wound or hurt; subsequently to their bursting a fistulous opening remains, whence after freely issue the fungus-particles.

To attempt, however, an enumeration of all the known primary indications of this disease would be only to refer to individual cases, and to a kind of hearsay evidence, which cannot claim more than a certain limited value. Amongst all the asserted early signs, I should place most dependence on a degree of firm swelling or thickening of the skin, and I regard the vesicle or abscess rather as an accident. There should, however, be respectively distinguished the superficial, and the deep-seated, position of the localised tumefaction, because these features indicate the existing extent of disease, and may determine the line of treatment. More than in most diseases of the kind, is this discrimination hard to make; and undoubtedly Mycetoma may first show itself in either position.

The period of time above named as that during which these beginnings appear is merely approximative, for as regards rate of growth, no more uniformity obtains than as regards first outward manifestation of the tumour.

Immediately consequent on the vesicles and abscesses, and sooner or later following the hard lump (which becomes softened at one part, and furnishes a soft bleb, soon bursting), there appear sinuous openings, from which exudes a thin, sanious, or sero-purulent discharge, containing the characteristic fungus-particles. Respecting these openings, I notice that when they succeed to a vesicle their appearance is peculiar, if not pathognomic; see Plate VII, fig. 2; in other instances they are small, pouting orifices, having either firm margins, or pale, soft surroundings.

Rarely does a single orifice last long alone; fresh indurations, or nodosities, appear, and may blend at once, to be followed speedily by fresh openings, and at the same time the whole thickness of the foot shows signs of enlargement.

During this time there are very seldom indeed noted any *general symptoms* connected with the local malady; and even local sensations are but rarely the subject of much complaint. The indolent swelling may impart a degree of stiffness or even pain, increased on movements or on pressure; a sense of itching has been noticed prior to the appearance of the vesicles; but there are seldom or never marks of active inflammation attendant on the softening of the indurated lumps or deeper-seated nodosities.

The sole of the foot and plantar surface of the toes, or the sides of the foot less often, and still less so its dorsum, are usual localities where first is seen the new growth; and in the hand it has been noticed that the palm, and the corresponding aspect of the fingers or thumb, are also usually selected spots. One finger (thumb) or one toe (the great toe) may long remain the only part affected, and I think that physical conditions may determine this limited expansion, there being here little room to spread, and around unyielding soft parts only. Finally, I may add that the space between two toes is not an infrequent spot where some of these early signs appear; and one is reminded thereby of the locality selected by the *Acarus* wherein to lay her eggs—the cuticle being thin, and lodgment more secure.

B.—The *confirmed stage* is reached when there is present a decided tumefaction of a part of the member, having its surface studded with openings, which give exit to a discharge of mixed character. It would seem that on the establishment of these apertures growth may proceed more rapidly than before, both superficially and deeper in the textures. The appearances of a typical instance of Mycetoma are remarkable, and even unique; thus,

the greater part of the foot (*e. g.*) has become imbedded, as it were, in a globular swelling, whose dimensions can hardly be said to be limited; and the surface of the mass is riddled with holes; the sole of the foot is flat or even convex; the toes remain distinct, but are more or less widely separated, and their nails are unaltered; the heel, too, commonly persists as a region, but the parts about the ankle-joint may be not less enlarged than elsewhere, and the lower part of the leg itself be evidently implicated. The general globular shape of the tumour may be modified by aggregation of swellings, so as to become elongated, lobulated, or flattened. The colour of the integument is not necessarily much changed; commonly it is darker than natural (congested); white patches may be present, which are scars or the results of vesicles and exfoliation of the cuticle, or if due to loss of pigment, of not more pathognomic value than are such incidents. The consistence of the mass is remarkably firm, not of stony hardness, but possessing a degree of elasticity rather difficult to describe, yet differing from that of almost every other tumour of the foot; it is, too, for the size, very uniform. Œdema is rare, and I have thought that the greater degrees of tumefaction occur in cachectic conditions of the system rather than in robust and less irritable, for then congestions and serous effusion seem to be most frequent.

Of the *specific gravity* of the Mycetoma I have, unfortunately, no notes; but my impression is that the tumour is a heavy one.

The temperature of the affected limb does not necessarily rise, and I have noticed that the tumour itself may be cooler than other parts of the body; sensation over it remains unaffected.

The discharge from the sinuses above mentioned is usually scanty, but welling out on pressure; it is serous, or sero-purulent, or sanious, and has a faint putrid odour sometimes; but it is neither laudable pus nor sanies. The particles which it contains in greater or less numbers are the characteristic and diagnostic elements of the disease; their number varies considerably, but they should be carefully searched for in the discharge, and will mostly be seen. The sinuses themselves are commonly rather long and tortuous; whether or not they all lead to bone is matter of accident. Their lining membrane seems to pout at their orifice, and there form folds. They are numerous, and commonly narrow at their termination on the surface.

If any distinction is to be made between the two chief varieties of the disease, as regards these local characters, I should be disposed to insist upon the greater size and the softer consistence, at least in parts (*e. g.* in the neighbourhood of the sinuses), as commonest in the ochroid variety; while the more compact, globular shape, and uniform hardness, would especially mark the melanoid form. The one sufficient means of discrimination will, however, be found in the character of the particles discharged from the foot; these characteristic structures are fully described below.

It is not superfluous to add that any region of the foot may be more affected than the rest; and I have preserved a drawing of the case in which the inner margin alone of this member was implicated in a large tumour (see Plate V, and case at page 10). The first specimen of the black variety which I saw, was attended with comparatively slight general swelling of the foot; in fact, but for its displaying the typical sinuses and growths, the diagnosis would have been obscure. When, however, the essential characters of the affection are present, such attendants as local tumefaction, inflammatory complications,

and the like, are not to be estimated, as regards either diagnosis or treatment, at beyond a certain obvious value, which is not necessarily commensurate with their apparent prominence.

Further details of variations in the growth of Mycetoma will be found in Chapter II, Sect. II. The several illustrations appended to this memoir will also aid to convey, sooner than words, a comprehensive idea of the parasitic tumour, as regards differences in both its external and structural characters.

The *symptoms* attendant upon the advanced stage of this disease are by no means numerous or marked. Thus, as regards local suffering, some pain in the foot is invariable; and as this is increased on pressure (should the sole be much affected), the patient cannot place the foot flat upon the ground, but walks on the heel, thus assuming a rather characteristic gait. Afterwards, too often, he cannot in any way put the foot to the ground, but sitting on his haunches pushes it before him, making use even of his hands to support the swollen member. The amount of pain attendant even on the largest growths is not nearly so great as would be anticipated by us; it is not commonly increased at night, or accompanied by starting of the limb, &c. A degree of hectic fever may be present, but this is rare; and, in short, the constitutional irritation is far less severe than occurs in caries, or localised constitutional affections. All observers are agreed upon this point. That so chronic an affection should not ultimately sap the strength, and reduce the bulk of its victim, is not to be expected; and patients are often (not always) thin and weak. Further, that a long-continued and wide, though scanty, suppuration should eventually affect the system, was to be anticipated; and possibly in the diarrhœa or dropsy that at length appears, we may infer evidence of amyloid degeneration, the consequence of prolonged suppuration connected with bone. It is somewhat remarkable, I think, that so little pain attends this parasitic growth when it extends amongst the nerves and unyielding fasciæ of the palm or sole.

No specially distinctive marks are peculiar to Mycetoma of the *hand*; here, indeed, the palm may be most swollen, and the sinuses frequently extend back to the dorsum, or upwards to, or beyond, the wrist. All the cases I am acquainted with, were of the first or melanoid variety; and the right hand was much the oftenest affected.

CHAPTER III

THE ANATOMY OF MYCETOMA:—*a*, EARLY STAGE; *b*, LATE STAGE; *c*, CHANGES PRODUCED IN THE BONES

The materials of this chapter are more especially derived from my own observations.

a. Early stage.—External appearance and section:—The tumefaction or induration of the skin is due to the presence of a deposit, or more properly a growth, within and below the cutis. As regards the *Black* variety, such detached and early deposits may be seen in almost all specimens; and as I have not had the opportunity of examining the incipient

growth in separate specimens, my description must be taken from these isolated portions of the more advanced disease. Here is found an irregular and extended accumulation of a gelatinous, slimy or slough-like, and greenish tinted substance, which, on close inspection, is seen to be distinctly isolated from the neighbouring tissues; and interspersed amidst this peculiar material are noticed the black, gritty particles, of dimensions varying from $\frac{1}{30}$ th to $\frac{1}{10}$ th in., the majority being about the size of a grain of gunpowder or a pin's head: no certain order in their interior disposition has been detected.¹ Should a sinus have formed, it will be found to lead from such deposit outward to the free surface. More than one of these accumulations usually coexist. On removal of the new growth the resulting cavity in the textures appears to be of a rounded or spherical form; it could not be mistaken for a small abscess, for there is apparent no unusual vascularity or purulent collection. Around, the connective tissue may be hypertrophied, and that seemingly from irritation only.

In the instance of the *Pale* variety I have been enabled to thoroughly examine the parts, with the results recorded above (page 11): here the growth was altogether superficial, and not attended with decided marks of local irritation. The diagnosis was regarded by the surgeon as not certain; but the use of the microscope would, doubtless, have removed any doubts, because malacotioid bodies were present in even these incipient sinuses, or mere excavations of the integument.

With regard to the *vesicles* which are not uncommon as very early signs of Mycetoma of both varieties, the impression in the cuticle left by them is usually of circular form, measuring $\frac{1}{2}$ in. or more across, and of conical shape, owing to the successive layers of epithelium removed, being narrowest at bottom and widest at top; the deep centre presents a small orifice leading to a subjacent cavity, where are lodged the new growths. When small *abscesses* are conjoined as early signs (owing, doubtless, to some attendant irritation), purulent matter will be found in addition, and probably some increased vascularity.

It is evident from the above remarks that in some cases the incipient disease is at first wholly superficial; and I believe it to be often so. It is seldom, indeed, that the surgeon has an opportunity of seeing this earliest stage before a sinus has formed and discharge of the particles commenced: when these events occur the growth is established, for its ripening has happened. More frequently, perhaps, the inoculated germs seem to pass inwards, and there develop and grow; subsequent approach to the surface being then heralded by no more marked local signs, than those of an incipient growth which has never left the superficies; but anatomical investigation will, in such cases, demonstrate the existence of wide ramification within, although there be hardly any sign beyond tumefaction externally visible. These remarks are to some extent anticipatory, but may be useful in elucidation of the subject now under consideration.

b. Advanced stage.—External and sectional appearances. Much of the swelling at this stage is due to firm infiltration, or real hypertrophy, of the connective tissue situated beneath the skin, and in the looser interstices of deep-seated parts. The masses of new growth may, however, be of considerable size, and of themselves sufficiently large to form

¹ In an article by Dr W. J. Moore, published in the 'Ind. Med. Gaz.' November, 1873, it is noted that in one specimen the small black bodies were "usually multiple, generally from four to eight," and were loosely connected by a bluish-white thin membrane Should this

observation of an apparent order in the disposition or succession of these melanoid growths be confirmed, further advance in our knowledge may be expected to follow; and no occasion for careful examination of specimens should be passed over.

a distinct tumour. In the case of the *black* variety there are large accumulations in the areolar tissue; and connected through them, or more directly with the surface, are similar accumulations within the substance of the deeper hard and soft tissue of the foot. In the first specimen¹ which I examined (Plate I), it was found that the cavities containing the black, spherical masses (which may in the interior parts attain a diameter of upwards of half an inch), are well defined and lined by a distinct, though thin membrane; they all intercommunicate, or are connected with the free surface, by means of tunnels or canals (whose lumen may equal that of a small quill), also lined with a continuation of the same membrane, and passing outwards in a more or less direct course, to terminate at the orifices on the skin before mentioned. A probe directed down a sinus may or may not, according to circumstances, reach bone. The attendant "elephantoid" swelling was in this case but very slight; and the fungus-growth, contrary to usual, formed the mass of the swelling.

Respecting the *pale* variety of the disease, in every instance which I have seen it was possible, on careful dissection, to make out a similar arrangement of parts. The new growth is here of a pink, orange, or buff colour, of small size, and of soft consistence, but it is embedded in a similar sloughy, glairy, or fleshy substance, variously tinted and equally homogeneous; and the whole is contained in like defined and lined cavities, joined by canals, and finally thus connected with the free surface. Growth of this kind is frequently more luxuriant than the last described: it may even project externally as a large, lobate, pale mass, which I have never yet noticed in the black variety. That the attendant irritation may be considerable in these instances, is possible enough: suppuration may be conjoined, but sloughing of the soft parts, or necrosis of large fragments of bone does not occur; nor is there any great general vascularity. So thoroughly permeated may be the entire foot that the bones become wholly absorbed, the muscles disappear, and their place being taken by dense fibrous tissue, the mass seems to be converted into a sort of fibro-cartilaginous tumour, which may be readily cut with the knife. The super-addition of inflammatory action, with its consequences, is, however, rare even in this case.

I will now mention some common features, and such variations in the anatomy of this parasitic affection, as require separate notice.

A section of a much diseased foot presents, at first sight, an appearance of general confusion of parts; but this apparent disorder will be found, upon attentive examination, to resolve itself into some degree of method. The pale or non-vascular appearance of the section is another marked feature; there is less vascularity than even in health. The cavities in which are lodged the fungus-particles are neither abscesses nor cysts: the membrane lining them and the canals is sometimes thin, but as often thick, velvety, pale, non-vascular, and friable; it is thrown into folds running longitudinally in the canals, but in the larger cavities (which are but lateral or terminal dilatations of these passages, and on section give rise to the semblance of cysts) the membrane is frequently arranged so as to

¹ Godfrey long since (1845) noticed the black growth: thus he states that in one specimen a "cyst or excavated tubercle contained melanotic matter, about the size of a small walnut" . . . "its recent appearance was angular and brilliant, much resembling fragments of coal" . . . and he adds, "at present I consider it to

be an accidental product in, but not forming part of, this peculiar disease of the foot."—*Bellary Dispensary Reports*. There are surgeons who would agree with the last sentence here quoted; and there are also others who would regard the black fungus as the only truly fungus material.

impart to their inner surface a sacculated or even follicular aspect, owing to the formation, by its foldings, of numerous, closely-aposed, secondary loculi, in each of which is lodged a separate accumulation of fungus-particles; probably an even more intricate arrangement may obtain in the largest growths, but by patience the true disposition can always be made out. I have not usually found in the black variety, other than the simpler prolongations and foldings mentioned above. Commonly that surface of the investing and limiting membrane which is in apposition with the normal tissues, presents a thin lamina or coating of opaque yellow, orange, or even pinkish hue; and it has seemed to me that this thin outer layer may be the line of advancing growth, and so correspond in character to the more defined pink stains, or streaks, which are placed in the skin. These small cutaneous tinted streaks are also common to every variety of the disease; they are found either near to, or at a distance from, the openings on the surface; and they only become visible to the eye when the cuticle is removed and the cutis laid bare: on section they are found to dip down to the subjacent areolar tissue, and may be found to branch in their course, as if prefiguring future canals. See Sect. V, Chap. II.

Respecting the sinuses and their openings, it would seem that they may become closed after a time, when probably all the products of entophytic growth are discharged from one spot; but this event is certainly of the rarest, and it is probably then always limited to one part of the affected member. In no undoubted specimen of Mycetoma have I ever found the whole of the growth—whether dark or pale—to have disappeared; and I should require the complete history and clear actual evidence, in any instance when it is supposed that swelling, tunnels, cavities, and sinuses *without fungus-particles* had really been found; such a phenomenon would, to me, be like an effect without a cause; I should be inclined to doubt the accuracy of diagnosis, and fullest knowledge of the case from the first would be called for, in addition to present signs. Yet, were clear instances known of entire spontaneous expulsion of the parasite, their extreme rarity would not interfere with ordinary prognosis and treatment; and difficulties of diagnosis might prove slight.

I will now state how are implicated the normal textures in the neighbourhood of the parasitic growth. First, as regards the *bones*, I have sometimes thought that by preference they were most affected, but the impression is probably not well founded: so characteristic, however, is the manner in which they suffer, that I have added a separate and illustrated demonstration of the subject. *Vide* Plate VIII, fig. 1.

The *muscles*, even when not directly implicated, are frequently atrophied and pale. The *fibrous tissues* (connective) are usually thickened and hypertrophied, and this may ensue to such an extent as almost to warrant a comparison with Elephantiasis, or even a fibro-cartilaginous growth; but such feature is often wanting, and hence it is not essential: the *tendons* and *fasciæ* may escape direct implication here, just as they do in other tumours, and I have thought that the unyielding *sheaths* of the former and *bands* of the latter do not seldom determine the direction—perhaps extent—of the parasitic growth. The *joints*, in Mycetoma, are not specially affected; and they may, even in the most advanced cases of disease, be entirely sound, or unchanged, except by mere pressure.

The results of microscopic examination of all these structures, which are of some interest, are described in Chapter II, Section V.

In conclusion, I abstain from mentioning in this place negative facts, or features common to local maladies already well known, which do not appear in Mycetoma: their

non-existence is therefore implied by the absence of any reference to them in the above account.

c. Changes produced in the Bones.—These have been referred to by many early writers, but have not, so far as I know, been fully described. All the macerated specimens I have seen, are strikingly different from others of diseased bone; and the changes which they present would almost lead to the conclusion, independently of other considerations, that some *organic* agency had been in operation.

The cancellated tissue of the long bones of the leg, and of any or all of the bones of the foot, is the seat of cavities more or less spherical in shape, and sometimes most perfectly so, which vary in diameter from one fifth to two thirds of an inch; and which have for their walls the open cancelli. These cavities, when in close juxta-position, frequently open into each other, thus producing larger vaulted gaps or spaces; and not only so, but every cavity, large or small, has a free communication, direct or indirect, with the external surface. When superficially placed, some of their parietes being formed by soft parts, the excavations in the bones look like mere round holes of various depths; but when deeper situated, a regular tunnel, more generally straight than curved, serves as the channel of communication with the exterior; and the diameter of these passages varies, being sometimes equal to that of the cavities themselves. In the recent state the sinuses of the soft parts, where they do not end in the superficial collections of fungi, lead down to these tunnelled passages, or into the rounded holes formed in the bones.

These cavities appear to be a main seat of fungus growth, and their form would then be readily understood from the disposition which the fungus possesses (as was clearly seen in examples of the dark variety of Mycetoma) to acquire a globular shape, and hence to produce a corresponding excavation, doubtless brought about by pressure, in the tissues hard and soft; even in the more common variety of the disease, be that another stage or not of the first, the pale, soft granules may be seen to be aggregated in many cases into globular mulberry-like masses lodged in similar cavities. The osseous tissue seems to be generally healthy in texture, and only acted upon by the mere pressure of these new growths; or a little "rarefied," as if from increased vascularity. Sometimes, however (as stated in Case 2, p. 4), softened spots, apparently unconnected with the presence of a fungus mass, are found, which may assume a spherical form on drying; in the case just referred to these cavities are best seen in the *tibia*, and they have connected with them small tunnelled passages leading to the exterior, yet not a particle of pus, or anything like strumous deposit, was contained in the cavities, and there appeared to be only an accumulation of fatty matter; but it is probable that fungi had been there, subsequently being expelled, or having undergone a fatty change. In no other instance were seen either caries or softening of the bones, either independent of or in connection with the characteristic cavities; and commonly the latter alone are present, without attendant complications of any kind.¹

¹ I was informed by Surgeon Stedman, late Civil Surgeon at Hyderabad (1859), that he had there seen a case which was probably one of the first variety of this disease, black masses and tunnelling of the bones being present, but there was also softening of the cancellous tissue, in parts. It should be remembered, I think, that this may occur from either thinning (as produced by mere pressure), or from simple wasting, without there necessarily being any morbid deposit in the cancelli, or

their lining membrane. In either case the cancelli either remain of their normal size (as occurs in Mycetoma), or, if they be expanded, other very manifest signs of increased vascularity, as enlarged vascular apertures, roughening of the surface, &c., would be readily apparent. In Cancer or Struma there is a visible deposit or fleshy growth, and the bones are affected very variously in mode and degree. It may be thought that circumscribed abscess of bone might simulate the appearances above

Changes in the *periosteum* of the bones of the leg, and larger tarsal bones, generally coexist. The presence of the fungus seems to induce, by irritation, a chronic inflammatory process; and roughening of the surface, expansion of the compact tissue, and throwing out of osseous spiculæ, often in abundance, are the consequence; these alterations are not, however, characteristic of any disease, but occur invariably under certain circumstances, and they may to some extent mask the peculiar features of the fungus-disease.

It has been already stated that the *articulations* of the part are never primarily affected, but, like the osseous tissues themselves, only in a secondary or indirect manner; that is, by mere pressure, or in consequence of the irritation caused by the presence of a foreign body. In parts, the edge of the articular cartilage may be seen to be quite sharply divided, when a "cavity" happens to have been formed across a joint.

Finally, in recent specimens it will be found that the cavities and tunnels are closely lined by an easily separated membrane, continuous with the external surface of the part; where, commencing at one of the apertures in the skin, it starts like a funnel-shaped tube, dipping down to these passages and spaces in the bones; and it is probably along this route that the contents of the latter are conducted to the surface and expelled from the body.

The illustration hereto appended (fig. 1, Plate VIII) is taken from the foot of the woman whose case is described at page 8; the form of disease was one of the ochroid variety of Mycetoma, but I have since seen abundant evidence of the common resemblance, as concerns the point under notice, of all forms of this disease; this conclusion was only to be anticipated from the general identity of the exciting cause. Doubtless the amount of bone-disease varies considerably, and reference should here be made to the description of another specimen given in the note at page 12, in which the cavities in the bones were smaller and more numerous than as above described, and by so much more like the result of ordinary caries; but yet without the essential characters of the latter.

described, but a little reflection would suffice to dispel this notion.

It has been stated on more than one occasion that, in Mycetoma, the cancellous tissue or medullary part of the shaft of the long bones may contain a dark or black grumous fluid or semi-fluid substance, by which the textures are, as it were, infiltrated: I have never met with such appearance, and cannot suppose that it essentially belongs to the fungus-disease. The essential and the incidental must be discriminated, here as well as in other circumstances; and there ought to be no possibility of mistaking products of blood-change for *sclerotioid* particles; or for the *malacotia* any form of tubercular purulent or other pale-coloured and soft deposits in the bones and elsewhere. Such terms as "worm-eaten," "honey-combed," "carios;" or such

description as "irregular cavities"—all of which have been used—do not convey a correct or adequate impression of the bone-affection in Mycetoma. I may add that having seen some photographs of specimens procured in the Madras Presidency, through the kindness of Surgeon F. Day, it was easy to recognise in them the characteristics now mentioned, and thus to acquire additional evidence of the general identity of the fungus-disease. Lastly, the changes in the bones have been compared to those seen in ordinary "necrosis"—see Prep. 5387 in the museum of University College Hospital, and description in catalogue: but to my mind equally without precision of language: it is true that the bones of the foot may be indirectly affected by the new growth, but my object above is to show the changes which are immediately due to the presence of the parasite itself.

SECTION II

GENERAL CHARACTERS OF MYCETOMA

CHAPTER I

AS REGARDS THE SUBJECT :—1, SEX ; 2, AGE ; 3, OCCUPATION ; 4, CASTE ; 5, RACE

1. *Sex*.—The fungus-disease is much more frequent among *men* than among *women*. Thus, in my own knowledge were only 4 cases in women out of a total of 18; and Colebrook states that only 3 women and 2 boys, out of 75 cases, came under his notice. Dr Eyre has also remarked this peculiarity in an even greater contrast, 114 of his cases being males and but 4 females. In Northern India a similar ratio prevails; thus, Mr Minas notes in a total of 37 cases, that 5 only were females. These data are sufficient to establish the main fact of the decided preponderance of Mycetoma amongst males, the mean ratio being 15 to 1 female; and they may even serve to indicate that the ratio varies according to locality, it being about 26 males to 1 female in Southern India, 7 to 1 in Northern India, and about 4 to 1 in the West: at present, however, I do not know that any use can be made of these proportions, which, doubtless, correspond only with varying degrees of exposure to infection.

By way of comparison, it may be remarked that the feature now discussed is also a prominent one in the Guinea-worm disease; thus, in one statistical series respecting *Dracunculus*, there were 228 males to 53 females, the ratio being about 4 males to 1 female, which is lower than obtains in Mycetoma; and this diminished ratio is perhaps due, I may add, to the influence of occupation of the two sexes; thus, men are almost universally agriculturists, and hence inimical to fungus-inoculation, while women are the usual water-carriers, and so in the way of meeting with the *Filaria*.

2. *Age*.—No particular period of life is obnoxious to the foot-disease, only it would seem that patients are usually above the age of puberty, and that advanced years are no bar: from 15 to 50 is, perhaps, the common range. Dr Colebrook told me he had only 2 lads out of 75 cases, and Dr Eyre's tables and conclusions (the former giving a range of 20—60 years) are also confirmatory. In Northern India, too, Mr Minas has noticed the same wide range of years, during which liability to disease prevails; the average age of his male patients being 31 years; of the female, 35 years; but the youngest male was only 12 years, and the oldest 60 years of age; amongst females the range was more limited, the numbers being 20 and 45 respectively. This feature is not without its bearing on the etiology of Mycetoma; thus, it is probably a matter of accident that so few cases occur at an early period of life, but the advent of the disease at any age is also an incidental

circumstance; since, as was observed above, liability of exposure to the exciting cause seems to determine the relative frequency of occurrence of the complaint. Children of either sex stay more at home, during damp or wet weather.

A similar character of age-limitation attends the Guinea-worm disease; thus, in a large series, 71·5 per cent. of all cases happened beyond the age of puberty (Waring).

3. *Occupation*.—It has long been my impression that the fungus-disease will be found to be prevalent amongst tillers of the soil, in a larger proportion than amongst other classes of the community; but adequate statistical data are still wanting to determine this point. It is, however, common experience that the ryots or agriculturists are oftenest affected; such was the case in Bombay. Eyre has noted the same fact; and Minas gives the occupation of 20 out of 28 patients as that of agriculturists. I am aware that several considerations are involved in this question, but their discussion must be deferred till a more suitable time. It may, indeed, be admitted that no occupation is probably exempt from liability to this affection, inasmuch, as some time or other, most or all persons may be exposed to its exciting cause in a country having so large a rural population as has India. It is worth noting that a case is recorded by Mr Minas of a man whose occupation was that of a potter, and whose right hand was alone affected: such men work largely in wet earth, with their hands. I should add that natives of India, of all grades and occupations, are by habit and custom prone to go barefooted: socks, boots, or tight-fitting coverings for the feet are unknown; and the shoe in common use leaves a large part of the foot exposed. The lower orders often, or commonly, go barefooted outside their houses (within which all classes doff the shoe); and they will seldom pass a pool of water on the road, while on a journey, &c., without washing or cooling their feet in it. Such cracks or abrasions on the feet as are necessarily common, would also favour the entry of spores or germs.

4. *Caste*.—All castes are liable to Mycetoma, and probably none particularly so, except as its members are unusually exposed to the exciting cause of the disease. On this point, however, there is little now to be said, because the materials necessary for its discussion must gradually accumulate. In Northern India I observe that Brahmans of both sexes have been known to be affected; and I have been acquainted with a sufferer who was a Marathi Brahmin, as well as a resident in a large town; yet, commonly, patients belong to the inferior castes, who are, of course, the most numerous element of the population. Rich and poor are both inimical to the complaint.

5. *Race*.—Here, too, there is little to remark. Up to the present time no European has been attacked by the fungus-disease; nor, so far as I know, has it been shown that the Eurasian or Indo-European is liable to it: both these classes habitually wear shoes, with other covering for the feet, and seldom or never go barefooted. There is another race—the Mussulman—whose members are in the habit of wearing a loose slipper, but seldom socks, and often, on occasions, no covering whatever for the feet: Mussulmans have the disease in Gujerat, where many are agriculturists. In Western India neither Jew nor Parsee has come to my notice as suffering from this disease; both, more commonly than most Hindoos, wear shoes out of doors, and they are not, as a rule, engaged in strictly agricultural operations.

CHAPTER II

AS REGARDS THE DISEASE:—1, ITS SINGLE LOCAL MANIFESTATION; 2, OCCASION AND INCUBATION; 3, COMMENCEMENT; 4, COURSE; 5, DURATION; 6, TERMINATION AND COMPLICATIONS

1. *Local Manifestation.*—The tumour is single, and seated most commonly in the foot; but it is occasionally seen in the hand.

Within the range of my own experience, the *right foot* was oftenest affected; and several observers have noticed this local election of the growth to be, at times, very decided: *e.g.* in continuons series of six or eight instances, happening in different districts, the foot on the right side alone has been attacked; yet a wider experience tends to show that both feet are about equally liable to suffer, such, at least, being Dr Eyre's conclusion on this point; and I know of no *à priori* reason why the right rather than the left foot should be obnoxious to the affection, unless we suppose that it is more liable to accidental hurts, through means of which the spores of *Chionyphe* might find unusual facility of entrance into the tissues of the foot: this point has, however, yet to be determined.

As the subject is not without interest, it should be inquired into in different districts of the country, and with reference to sex and variety of occupation. At present, experience indicates that in Sinde, Northern India, Western India, and some parts of Southern India, the right foot is decidedly oftener affected with Mycetoma than is the left; but yet that the largest statistical data (*i.e.* those from parts in Southern India) which have been published, do not favour this view. The right hand, too, is seemingly oftenest attacked. It is said that both feet may be simultaneously implicated; but this occurrence must be excessively rare. An instance from Sinde was communicated to me, but the details are not in my possession; and I may mention that Dr Collas (*vide* Appendix) is stated to have seen a case at Bangalore in which "the left hand and both feet were attacked; but it was easy to see," he adds, "that the attack had commenced in the right foot, and that the left hand had been last invaded." Instances of this kind which might appear to indicate, by their symmetrical or consentaneous character, the constitutional nature of Mycetoma, are, in my opinion, precisely such exceptions as prove the rule of its strictly local origin; because they may be readily explained on the view of successive, or even simultaneous, inoculations, such as I believe to be frequent in one and the same member; and that one part may be the means of infecting another, *e.g.* a foot the hand which is doubtless often applied to it, is a supposition sufficiently credible; an apparent exception would thus become a forcible illustration.

Lastly, the fungus-disease has been said never to extend beyond the ankle-joint, or to implicate the leg; but here, again, wide experience shows the fallacy of trusting to scanty evidence. I have above mentioned an instance in which the lower third of the leg was affected; Dr Bidie had seen the granular and caseous matter (2nd variety of Mycetoma) reach as high up as the middle third of the leg; and "Colebrook and Lovell had each

had a case requiring amputation above the knee, and we have ourselves seen the disease extending high up the leg." (Reviewer, 'Madras Quart. Journ. Med. Sc.,' April, 1862.

Respecting Mycetoma of the *hand*, the occurrence of the disease in the upper extremity is comparatively very rare. Thus, Dr Colebrooke informed me (1860) that in the whole of his eleven years' experience, including upwards of 80 cases, he had only once seen the disease in the hand; and Mr Minas records only two examples in the right hand, out of a total of 37 cases. I have not myself had a single case of the kind, but am enabled to give two illustrations of this occurrence, taken from the specimens obligingly sent to me by Mr S. Hemraz, which are described at page 6. I find, too, Dr W. J. Moore observing that he has "seen the disease, in an individual under the care of Dr Lowndes, present in the *shoulder*;" and would venture to suggest that instances of the kind might be usefully recorded in full, due regard being had to the absolute necessity of ascertaining the presence of the fungus-particles themselves, before deciding on the nature of cases at all obscure in their signs, history, or symptoms. That the *right* hand is more often affected than the *left* is very probable; yet such selection is not invariable.

Individual segments of either hand or foot may be alone, or at first, affected; thus, either *toes* or *finger* are sometimes early or only diseased, and illustrations, in abundance, of this fact may be found in the history or description of recorded cases. The palmar surface of the finger or thumb, and the plantar surface of the toe; or the interspace between two toes, are the localities oftenest first attacked.

That other regions of the body than those already mentioned may become the seat of entophytic growth is, of course, possible enough; but the whole tendency of experience has, hitherto, been emphatically in favour of a very limited local manifestation of such growth; and one cannot help noticing, in this place, how much more likely it is that the foot, of all parts, should be affected, on the supposition that the germs of a fungus growing on the soil find their way into it through the pores of the skin, or through some small abrasion of the integument.

The presumption of such local inoculation, on the ground stated, appears to me as well based as that of the entry through the skin of the ova or young of the Guinea-worm. Irrespective of its locomotive powers (which far transcend any faculty of extension possessed by the fungus), this animal parasite is commonly found in the foot, or lower limb: thus, in a series of 210 instances, in 187 the worm, or worms, lodged in the foot (120), or between that and the knee (67); and in but 3 cases out of the whole number was the creature found in any other locality, alone, than the lower extremity; namely, in the forearm (2) and scrotum, &c. (1). There is here, then, analogical evidence, not only indicative of the parasitic nature of Mycetoma; but pointing to infection of the body from the soil, upon or near to which both *Filaria* and *Chionyphe* flourish.

2. *Occasion and Beginning.*—The occasion of the swelling is commonly attributed to a scratch, puncture, abrasion or other trivial hurt accidentally inflicted, and oftenest upon the plantar surface of the member; sometimes it is stated that the foot was pricked by a thorn, either of some of the *Acacias* (which possess spiked appendages of formidable dimensions), or of other of the numerous prickly trees and shrubs so wide-spread in the East; and sometimes bruising of the foot against a stone is specified. Not rarely, however, the patient is unable to intelligibly account for the local onset of the growth;

and this is a circumstance in no way remarkable, regarding a complaint of so chronic a character as Mycetoma. A local hurt, slight but sufficient to remove the cuticle, and thus possibly favour entry of the spores of *Chionyphe*, would not probably be remembered by a patient, after an interval of months or years; during which time no evidence or sign of disease has been felt or seen by him. Yet, apart from these considerations, it may be advanced that such spores could find their way inwards through a natural channel of the integument, and hence that the intervention of artificial inoculation is by no means a *sine quâ non*. Most probably, I think, the plant-germs are introduced in this simpler and more direct manner: thus, in a layer of damp soil or muddy deposit, tenaciously sticking to the feet, any active spore (Amœboid), or protoplasmic germ (Microzyme), which happened to be present in a state ready for development in any suitable *nidus*, might easily, so far as physical conditions are concerned, find its way along a sweat-duct and thence into the parenchyma; it might pass between the laminae of the thinner cuticle of the sides of the foot, or between the toes; the dorsum of the foot is seldomer the seat of inoculation. I would observe that, since the sweat-glands are found only in those aspects of the feet and hands, where the parasitic growth is more often than elsewhere seen to appear, there is such concordance between hypothesis and observation, as serves at least to direct and encourage future inquiry into this subject of earliest local onset of the malady. The natives of India are subject, I might add, to excessive perspirations of the palms and soles; and this functional state, which is presumably attended with an unusually pervious condition of the sweat-ducts themselves, should be inquired into with reference to its possible connection with Mycetoma, in fresh instances of the disease.

In the preceding remarks I do not mean to imply that it is impossible, or even unlikely, that more than one mode of infection obtains, in this entophytic malady; but it is hardly needful, in my opinion, to discuss the view that spores or germs might reach the foot through means of the general circulation, or of the ingesta and other conceivable indirect channel, because no evidence of, or necessity for, such notion has ever presented itself to notice.

Connected with the present topic is that of the *incubation* of the growth, *i. e.* of the period which elapses between inoculation and the pathological phenomenon of a tumour, vesicle, or abscess; and I could desire that there existed adequate means of determining the duration of such latent state. Outside the body, and under conditions which may be termed normal, it has been ascertained that the parent fungus (*Chionyphe C.*) appears only at a certain season of the year (namely, in spring); lasts but for a few weeks, and, after passing through the stages of fructification, disappears until the same recurring season of a succeeding year. It seems to me highly probable that, even under the abnormal conditions which necessarily obtain within the human foot or hand, there would still be found a tendency to maintain such natural cycle as the above, could we but learn all the data needful for a chronological estimate. But the advent of a tumour or vesicle in the sole of the foot, is no true indication of a stage in the growth of the parasite: it is, in a measure, an accident, or at most a circumstance attending the outward progress of the entophyte; and though pathologically important, such local sign cannot, in my opinion, be connected otherwise than broadly with the fructification of *Chionyphe*. That a period of time does elapse between inoculation and the presence of a tumour, &c., may be admitted, and it is probably never less than a year; because, when such tumour is opened, the fungus-particles

are found to contain aborted *sporangia*, or fructifying organs, which are of themselves indicative of a completed cycle in the history of the plant. I now refer to the smaller black or sclerotoid particles, which will be described more fully below. It is likely, from the statements of patients, that even a longer time elapses, and I have thought that two years was a not unusual duration of the incubating period now referred to; but in the absence of the needed data of reckoning, I could not strongly insist on this estimate.

No relation has yet been established between the *season of the year* and the outward manifestation of the growth; but careful observation may elicit such concordance, which is to be anticipated from the parallel instance (here so fitly applicable) of the Guinea-worm affection; and already I note that the "cold" season (winter) is not rarely mentioned by patients as that of the outcoming of the tumour, or other sign of the entophytic malady. That inoculation of the foot takes place at a certain season is probable from the natural tendency of *Chionophye* to appear and fructify, only at a stated period; and it is at such time—viz. the wet season—that *Bacteria*, which have moisture as their essential medium, flourish and abound in the same localities as the mould. The application of this remark seems especially fit to such commonly arid localities as the sandy plains of Western India, where the subsoil, as well as surface, is for long months parched to a degree, and at no time superficial moisture ever, or long, abundant.

3. *Commencement of the Growth*.—As has been said above, the earliest signs of Mycetoma are neither uniform nor characteristic; and this is evident from their being severally described as discolorations or indurations of the skin; as swellings, tubercles, knots and lumps, of varying dimensions; which are sometimes compared to boils, but are usually larger, non-sensitive, and more diffused, and either movable or apparently limited to the integument, or deep seated and fixed; a constant character is their firmness: they are indolent and very slow in progress. Sometimes the swelling, even when superficial, is by no means prominent or defined, and when deep-seated it may be more perceptible to touch than to sight. In connection with the above signs there appear, sooner or later, vesicles or pustules, or more limited elevated points; and the former burst or the latter ulcerate, when there occurs a thin and scanty discharge, in which the fungus-particles are at once to be found; and a fistulous opening remains, whence the latter continue to issue. It is rare for a wound or sore to precede the formation of a tumour of this kind.

Since the affection does not make its appearance in one manner only, so may it be concluded either that it does not commence in any single tissue or region of the foot, or that its mode and rate of growth are not the same in all cases. Some observers have expressed the opinion that Mycetoma begins in the skin itself, and afterwards extends inwards, destroying bones and joints, &c.; and this is sometimes unquestionably the case. On the other hand, it is asserted that the growth begins in the bones of the foot, and may be confined to them; and as this view is of even greater practical import than the other, I will here, by anticipation, add that it is held by Dr Eyre and Dr Collas; the last-named writer being of opinion that the foot-disease is a "myeloid" growth, and the former that it is of a "strumous" nature. While holding an altogether different opinion, I have myself been struck with the extent to which the bones may be affected; but on full consideration of this subject I conclude that in all cases the actual commencement of the growth takes place in or not far below the integument, but that its after progress depends

on varying local circumstances (as I shall attempt to show below), or upon varying motile progress of the entophyte itself, respecting which nothing very definite is positively known. It is, I may observe, perfectly easy to understand that spores entering the foot through the skin may speedily pass some distance inwards and there mostly grow, until a deep-seated tumour is formed which afterwards approaches the surface; and in such case the swelling would have all the appearance of commencing in the deeper parts, whereas its originating cause had really been derived *ab extrâ*. Inoculation of the foot never seems to leave a strictly defined local mark. The first sign of the disease is revealed by its consequences, that is to say, commonly by a tumour which sooner or later communicates with the exterior; and then for the first time appear the fungus-particles. Previously to the existence of these channels of communication (or, in other words, these characteristic sinuses of Mycetoma) there is no sign of fungus-growth, and no passage visible by which such growth could find its way into the deeply affected tissues. That the entophyte should, sometimes, speedily extrude its fruit-bearing products, and at other times rather continue to grow deeper into the foot, and only after a prolonged period approach the free surface for elimination of such products, are contingent events which I am not able to explain; but I doubt not they will be eventually understood, and that, too, on the data which I have above intimated: at present, one might term it matter of accident, whether or not the first sign of Mycetoma is a superficial or a deep-seated tumour. It may be either one or the other, as experience clearly teaches.

4. *Course of the Disease.*—While there is here no really analogous affection with which to compare Mycetoma, the course of the latter may yet be described as tardy. The history of the case is commonly to be reckoned by years rather than by months; but occasionally within even one year after its first outward sign, the growth may spread over a great part of the foot.

When by extension a decided tumour has been formed, and, through the several sinuses in it, the abnormally developed buds or gemmules become provided with a means of exit, the progress of the entophytic growth is by no means arrested; on the contrary, it proceeds in most instances continuously, and, from appearances which I have observed, I judge it may progress even more rapidly than before; owing possibly to repeated auto-inoculation of parts adjoining the apertures of discharge.

The irritation arising from locally applied, stimulating remedies, has seemed to induce quicker growth than previously.

That the local progress of the affection may actually vary under conditions apparently similar is, of course, not unlikely; but this subject has yet to be studied. I am, however, of opinion that a ready understanding of the course taken by the entophytic growths, in various instances, will be derived from consideration of the region of the foot (or hand) which may happen to be implicated. I now refer to the anatomical disposition of the plantar (or palmar) fascia, and of the strong tendinous sheaths, and as well of the bones themselves, as determining the direction of growth. It is reasonable to suppose that, like the entozoic *Filaria* which lodges solely in the connective tissue, the entophytal *mould* will by preference grow in the direction of least resistance, which must obviously be determined by the arrangement of the same tissue, with its modifications, in the sole or dorsum of the foot, or about the ankle-joint; and so on. From actual knowledge one may admit that no tissue whatever can resist the direct onset, as it were, of the living mass; but

presuming that the consideration just mentioned is valid, its application may be thus illustrated:—A growth commencing in the skin over a spot where the fascia is weak, may grow inward by adapting its progress to best overcome obstacles in the way, so as to reach the bones themselves; and then passing between or through them, it could speedily reach the dorsum of the foot. On the other hand, if a firm, resisting surface be early met with by the advancing growth, this latter would, for a time at least, be turned aside and made to spread in lateral directions. I long since dissected a specimen of Mycetoma showing a long, tubular prolongation of the parasitic mass running upwards alongside the *tendo Achillis*, where, as is well known, the areolar tissue is unusually lax; and we may conceive that the course of other tendons in the foot, whether flexor or extensor, will be able to determine the line of advance of the new masses: I have indeed found in the tendinous sheaths themselves, evidence (to all appearance) of incipient and presumedly advancing growth. Respecting all ligamentous structures, it is known that they yield to ordinary pressure less readily than the osseous tissue; and this fact is applicable in explanation of not a few instances of Mycetoma, in which the *os calcis* or *astragalus* will be found to be perforated, while the softer textures escape. There being, so far as I know, no attractive influence exercised by any tissue of the foot, and no apparent tendency of the entophyte to spread in certain lines only; one cannot but infer that the varying and often intricate course followed by the parasitic growth in this disease, may best be thus interpreted in connection with the structural anatomy of the parts concerned.

Subsequent to open display of the affection, its further extension is not attended by any peculiar features; thus, the nodosities, lumps or indurations, both superficial and deep-seated, which at first were perhaps few and isolated, become by growth larger and finally blend together; and the sinuses pertaining to them equally multiply, until the foot seems to be one mass, riddled with holes.

Whether the hard or soft variety of this disease grows at quickest rate is not yet accurately determined; only I think that the latter finally attains the largest dimensions, and these perhaps in a comparatively short time—so far, at least, as may be judged from statements of the patients themselves.

5. With reference to the *duration* of the disease, this in advanced cases is always protracted. Patients who apply for advice regarding a foot, which has at length become not only useless, but an intolerable burden, will name a period of 4, 6, 8, 10 or more years, as that which has elapsed since the first appearance of their complaint: and in this respect my own hospital experience accords with that of other observers. Dr Eyre assigns an average prolonged duration of 3, 5, 7 or more years; and Mr Minas records the shortest and longest periods of all his cases, when coming before him, as being amongst men 2 months, and 26 years, respectively,—and amongst women 10 months, and 7 years. These general statements, indefinite as they are, must serve until more precise information is available. Tumours of all sizes are, in a wide experience, to be seen; and where the duration in any instance is given, the apparent degree of growth, as measured by dimensions, might be at the same time noted: in this way it may be found that the parasitic tumour advances more equably than do most other growths attacking the human frame. The influence of sex and age should be inquired into; and, as well, that of the form of fungus-growth which is present. The smaller-sized tumours are generally those of shortest duration, and more than this cannot yet be said.

So long a period as 30 years has been named (with what accuracy is not certified) by an aged man, as the actual duration of his complaint. Hence it is evident that, under ordinary circumstances, the fungus-disease not only progresses at a slow rate, but that it has no defined or limited duration in time; and doubtless the power of endurance of its victims is the main determining influence of its continuous extension. So far as is known, the physical condition of the patient does not, in general, influence the earlier course of the disease; but when the growth has become so great as to press upon the constitutional powers, one may well suppose that the strength of the latter must in great measure regulate the further duration of the parasite prior to final exhaustion of its host.

What huge size the affected limb occasionally attains, may be surmised from what has been above recorded: and the foot, in Mycetoma, has been known to exceed in bulk four or five times its fellow, to acquire a circumference of upwards of 20 inches, and a weight of a dozen pounds, or even more.

6. *Termination and Complications of the Fungus-disease.*—While by no means denying, in the abstract, the possibility of such event, I have not myself met with an instance of spontaneous cure; but in every case the tumour has seemed to progress in dimensions, in some measure according to its duration. Nor have I become acquainted with any indubitable examples of such desirable termination, as natural subsidence of the growth.

With the reservation above implied, and should surgical aid not be sought in time, this true and practically unlimited parasite continues to grow until the system of the patient becomes exhausted by the abnormal drain upon its nutritional resources, and by the burden, pain, and irritation of a hugely developed excrescence. At length, as happens in other chronic and exhausting complaints, fatal diarrhœa, or dysentery, or anasarca, supervenes.

For some other remarks on these points see the Prognosis of Mycetoma, Sect. IV, Chapter I.

I have not become acquainted with any facts which would even suggest the idea of an infection of the whole system by entophytal spores or the like; nor are there, so far as I know, any *complications* proper to the fungus-disease, affecting either superficial parts distant from its seat, or central organs of the body. So slight may be the local irritation attendant upon the progress of the growth, that the subcutaneous lymphatic glands in the groin, &c., are by no means usually tender or enlarged; and all the textures of the affected member, excepting those actually implicated, are commonly in a healthy state.

While the extrinsic character of the malady is thus sufficiently apparent, it would still be as well to make use of available opportunities for post-mortem examination, because it is desirable first to have even well-founded inferences confirmed by accurate observations; and next, to determine whether or not the amyloid and other degenerations of tissue, which are known to attend prolonged suppurations connected especially with bone, do actually supervene in Mycetoma, and by their influence account for the maladies of exhaustion, which, as has been above stated, attend the closing stages of the malady.

Finally, that purulent or septic infection of the system is a common event at any stage of the fungus-disease, does not appear; nor has there seemed any reason to suppose that this local affection is essentially related to other endemic or general disease prevalent in India.

CHAPTER III

1. DIAGNOSIS OF MYCETOMA:—*a*, EARLY STAGE; *b*, ADVANCED STAGE
2. ITS ANALOGIES WITH THE *Filaria*-DISEASE

1. *Diagnosis of Mycetoma*.—This subject will be considered with reference to the early and advanced stages of the affection; and as regards its comparison with the following diseases, viz. Guinea-worm, Elephantiasis, Caries, Struma, Enchondroma, Malignant Tumours, Articular Leprosy, or with a conjunction of such maladies—these being the conditions most likely to simulate fungus-disease in the foot. The succeeding observations are, of course, equally applicable, *mutatis mutandis*, to fungus-tumour of the hand.

A. Early Stage.—Mycetoma does not, as I have said, make its first appearance in any invariable manner: thus, there may be little or no swelling, but only a slight thickening or induration of the skin, attended or not with a dark mottled appearance, which has been compared to tattoo marks. At this time, diagnosis would probably be aided by consideration of the patient's history and place of residence, and of the position of these marks; but there are not necessarily any other earlier signs than such as would attend the presence of a *foreign body* of small dimensions, within the substance of the skin, excepting only that no spot or mark of its entrance, or perforation of the integument, would be visible in the parasitic disease. But an opening (of exit) once being formed, the characteristic fungus-particles appear, and diagnosis becomes irrefragable. This is the main condition to be borne in mind, namely, the detection of these particles.

Not seldom Mycetoma is stated to have commenced by a *vesicle*, or bleb; and, to such extent, it might be confounded with *Filaria*-disease: this coincidence of early sign is noteworthy, as doubtless resulting from causes essentially identical, viz. the approach from below to the surface of a living growth, or body foreign to the tissues; thus is produced irritation of the cutis and effusion of liquor sanguinis. After an interval, a tumour and a sinus follow, and then doubt is at an end.

Or an *abscess* may be the first sign, followed by a fistula, and attended by induration in the neighbouring tissues. Such abscess may be due to the actual presence of the parasitic elements, and these will then be found on careful search. I have, however, seen an instance in which the abscess was said to have been followed only after a long interval—of years it was stated—by black particles, and on consideration I admit that a pre-existing opening or cavity might subsequently to its formation become the seat of plant-inoculation, with its consequences: still, I remark that an ordinary abscess will heal up; and therefore a persistent opening, however small, if unconnected with bone, should be regarded with suspicion, and its discharge should be frequently examined with care. The early fungus-tumour does not generally involve the bones; but exceptions occur in certain situations, and when the swelling is a deep-seated one.

Respecting small chronic indurations compared to pimples—afterwards becoming pustular—and the like, which are found in the sole of the foot in natives living in districts

where the fungus-disease is common, and are stated to be due to pricks of thorns, &c., opinion may fitly be guarded, until the proper contents of the swelling are ascertained.

A finger or toe may alone be affected; and it is not uncommonly stated that the first sign is here a pimple or small, hard lump: I should say that the nearest approach to such mark would be made by a thorn or other foreign body lodging in the part; but probably there would then be a history to guide, and some remains of an opening, sufficient to eliminate error in diagnosis. I have thought that the tough, ligamentous structures here serve to check the fungus-growth, as long as it is confined to such segment of a limb.

Indurations of the skin, or a deep-seated, indolent, ill-defined and hard tumour, may respectively, for a time, be mistaken for syphilitic or strumous deposit, or for incipient enchondroma, cancer, or other affection of the bones, &c.; but here again the sinuses and characteristic discharge therefrom, would sooner or later furnish adequate means of discrimination. This remark is of general application: for diagnosis may proceed by exclusion, until it becomes possible to lay hold of positive characters; and in no disease affecting man, are the latter more eminently diagnostic than here.

In all circumstances a combination of distinctive signs should be sought for; but first of all, I repeat, should the character of the discharge from the sinuses be carefully, and if a single result be negative, then repeatedly examined; a lens may be needed, and any suspicious-looking, granular particles being detected, they should be removed on the point of a scalpel or knife-blade, and transferred to a glass slide, gently washed with distilled water, and submitted to the scrutiny of the microscope. An object-glass of half-inch focus would always prove sufficient to bring out the characters of the ordinary fungus-particles; but for the purpose of minute investigations, the highest available powers, and conjoined use of reagents, will be necessary.

B. Advanced Stage.—Tumefaction of the foot, when of considerable size, might be confounded with *Elephantiasis* (Arabum) of the same part; but it is not of a puffy or œdematous character; it extends to the sole of the foot, or may be limited to one region only; it rarely passes above the ankle-joint; it is hard, nodulated and irregular; and is permeated by sinuses, whose apertures are peculiar, and discharge characteristic. The Elephantous swelling differs in all these particulars; it may, indeed, be marked by minute vesicles, or weeping cracks and fissures in the skin, but these signs are altogether unlike the fistulous openings above referred to. The skin is thrown into broad and characteristic folds; and almost always the leg is implicated. There happens too, at times, fever with local exacerbation of the swelling; and, as well, implication of the lymphatic system, which is never affected in Mycetoma.

Sectional appearance of the fungus-foot, after amputation, may, in its non-vascular tint and evident thickening of the fibrous tissues, somewhat resemble *Elephantiasis*; but there the comparison ceases, for Mycetoma has additional characters altogether its own.

In *Caries* the form of the swelling may at first be similar, but its mode of origin is different, its progress quicker, and its ultimate size and shape never equal to, or resembling, those of Mycetoma. The sinuses are less numerous, and characteristic particles are *absent* from the discharge: this is diagnostic. Marked local inflammation and pain precede the advent of abscess, and before long the constitution of the patient suffers; he cannot stir

about his village as he does in Mycetoma, with a foot far more hugely affected than it ever is in simple caries.

As several writers have expressed the opinion that the disease under consideration is really a form of caries, attended with hypertrophy, &c., and have referred for evidence of this to its anatomical characters, I will subjoin the description of a carious foot which I amputated in Bombay, about the time my earlier inquiries were being pursued (September, 1860).

CASE.—A Portuguese man, *æt.* 27; caries of the left foot of seven years' standing; no signs of scrofula; syphilis some years back; the local affection is attributed to a sprain; there is emaciation, but no urgent constitutional depression.

Externally, there is the absence of the peculiar distorted form of the foot, and also of the numerous openings and small hard swellings or lumps in the skin, which belong to the fungus-disease. There are no white patches on the surface. The discharge from the few fistulous openings is a thin, purulent fluid, in which no fungus-particles are to be detected.

Section.—The bones appear as if loaded with oily matter; and there is increased vascularity of all parts. The osseous cancelli are filled with a deep, yellow-tinted, oily deposit; or else in parts they are occupied by a vascular, gelatinous, but firm substance, which invades the bony tissue in no regular manner. The smaller tarsal bones are excavated by a large irregular cavity, having a vascular lining, like that of a common abscess. The joints are specially affected, even when the bone beneath the articular surfaces is but little implicated by the gelatinous deposit: their cartilages and ligaments are more or less destroyed, and covered with the well-known vascular membrane. The cancellous tissue of the smaller bones is everywhere, and almost uniformly, softened. A gelatinous deposit similar to the above has invaded the periosteum of the lower end of the tibia, in front, producing much thickening; in this mass is a carious, osseous fragment detached from the astragalus; this bone is ankylosed to the os calcis, which is roughened in its outer surface by numerous small, pointed out-growths. The microscope shows only exudation-cells, forming the new deposit; as well as numerous capillaries. . . . When dried, the bones had none of the characters of fungus-disease.

In the above account will be noticed hardly a single prominent feature belonging to the parasitic affection, and many points of fundamental divergence; thus, I note the extent of joint-disease, the increased general vascularity, the carious abscess, the marked softening of the bones, the gelatinoid deposit in the cancellous tissue, periosteum, &c.; and never have I seen these conjoined alterations in Mycetoma. That caries may coexist with, or follow upon, the entophytic ravages, is a supposition not in itself improbable; but, as yet, in my experience it has not occurred. Reference should here be made to the account of the bone-changes in Mycetoma, at page 20.

Strumous disease of the bones of the foot is to be distinguished as are ordinary carious affections, there being also present other outward signs of the diathesis, or characteristic complications, or general symptoms equally marked; none of these, however, are present in Mycetoma, for the strumous diathesis is very seldom noticed in its victims, and a conjunction of the affections thus becomes a rare event. I therefore insist, first, upon the positive signs of the parasitic malady; and secondly, upon the positive signs of its supposed countertype. That the peculiar fungus-particles, even of the pale, soft variety, are "tubercles" so called, is a position that cannot, in my opinion, be sustained; and the black-particles are certainly not less distinct and characteristic. The ordinary grey blending and diffused deposit of tubercular matter within the osseous cancellous tissue, even when not attended with joint-affection, is not to be confounded with the pale or black, isolated, and encysted fungus-growth of Mycetoma; for no two anatomical conditions could be more unlike.

Enchondroma of the foot.—A tumour of this sort might be confounded with incipient Mycetoma, when the induration attending the latter is defined, deep-seated, fixed and hard; but then fistulous openings will have formed, and present for notice their characteristic discharge. The hardness may indeed be considerable in the parasitic affection, but it is due to a general thickening of parts, and not to the formation of a substance so compact as cartilage or bone; it has no cyst or bony deposit belonging to it: it inevitably, and soon, approaches the surface, and there bursts; the swelling is invariably single.

An *osseous tumour* of the foot would be even less likely to be confounded with Mycetoma—there is here no hardness like that of bone.

Myeloid Disease and Malignant Growths.—These may be considered together, so far as their signs of difference from Mycetoma are concerned. The rapid growth, irregular swelling, implication of the skin, and final termination in foul ulcers, are points of discrimination: add the cachexia of the cancers, the glandular deposits, &c.; and the limited age-period obnoxious to Myeloid tumours, which does not obtain in the parasitic disease. The physical characters of these affections are essentially diverse; and diagnosis should be comparatively simple. For other remarks, see Section III.

That *Leprosy* attacking the foot should simulate this disease is a view which requires but brief consideration: leprous tumours are superficial and scattered, and never confined to one limb; the foot may be swollen from inflammation, and necrosis of a metatarsal bone, &c., but this state is not comparable with any feature of Mycetoma. That white or pale patches appear on the skin of the foot in this last-named affection is true, and they are sometimes apparently chromopathic only; but there is no attendant anæsthesia, shrivelling of the skin, or atrophy of the toes.

That *Chronic abscess, corns*, the entry of *foreign bodies*, the detention and degeneration of a *guinea-worm*, and the like accidents, may give rise to a small indolent tumour of the foot, is undoubted; but the diagnostic sign of Mycetoma is not to be found in connection with swelling alone, and correct discrimination need not be long delayed; the lancet or even grooved needle, with the aid of the microscope for examining any solid particles removed, would speedily remove all possible doubts.

In the above summary remarks external appearances have, for the most part, been considered, for they alone will be found upon comparison sufficiently characteristic; and no reasonable doubt as to the nature of a tumour ought to exist prior to operative procedure, should that be contemplated.

As an occasional aid to diagnosis may be mentioned a peculiar (though not altogether pathognomonic) *gait* of the patient; thus, when the tumour has acquired a considerable size, or has much implicated the sole of the foot, the man or woman will walk with the *heel* alone upon the ground; and so by halting steps. This mode of progression is doubtless instinctively adopted for avoiding pressure upon the now sensitive plantar surface.

I have intimated that a *strumous* diathesis is not frequent in Mycetoma, and will now add that a *sypilitic* affection of the system, of any kind or degree, is even rarely associated with this disease.

All observers have stated, and several have more than briefly commented upon, the circumstance that aching, wearing pains in the foot, starting of the limb, nocturnal exacerbations of suffering; and hectic fever, rigors, sweating, emaciation and other marked

features of cachexia and general debility, are less evident in this affection than in those considered to be of a constitutional origin or nature. Here the patient complains of the weight and inconvenience of the enlarged foot, rather than of suffering caused by it; and I will add, that if not relieved by operation, he will sink, not from distant or visceral complications, but from a termination of exhausting complaints not uncommon in the East, such as colliquative diarrhœa, chronic dysentery, or serous effusions.

It will be quite obvious from the above remarks, and still more so from a reference to the appended Bibliography, that not a few experienced observers have, besides myself, looked upon the affection under notice as unlike all others hitherto discriminated in Europe or the East; hence, on the grounds now stated, of outward signs and clinical history, I now venture to maintain the affirmative proposition, that we have here a malady *sui generis*; and this conclusion will be found to be confirmed by other considerations offered in the following chapter.

Lastly, some of the more prominent general features of Mycetoma may be usefully ranged together in this place, for the purpose of summary comparison with those of other affections already named.

<i>Fungus-disease</i>	<i>Other diseases</i>
*Is endemic.	Hence differs from caries, struma, cancerous and non-malignant tumours.
*Has a single local manifestation.	Hence differs from cancer, struma, leprosy.
*Is much more frequent in men than in women.	Differs from cancer, struma, and to a less extent from leprosy, elephantiasis.
*And during the middle period of life.	This is more marked than in struma, cancer.
*Is not hereditary.	Differs from all these general affections.
*Is not accompanied by fever, &c.	Differs from elephantiasis.
*Or by marked local inflammation.	Differs from caries.
*Or by constitutional taint.	Unlike struma, cancer.
Is very protracted in duration.	Differs hence from cancerous growths.
Excision is a cure.	Not the case in cancer, struma, leprosy.

2. *Analogy of Mycetoma with Entozoic Disease.*—In those particulars marked by a star, thus *, this affection resembles the *animal* parasitic complaint known as that due to the Guinea-worm, or *Filaria medinensis*; and the coincidences are, in my opinion, sufficiently striking, not only to claim attentive notice, but of themselves to point to the true nature of Mycetoma.¹

¹ That the two parasitic affections may coexist is obviously possible, but it is not a common occurrence. The following instance is mentioned by Mr B. Rustomji, in his paper published in the 'Transactions of the Medical and Physical Society of Bombay,' vol. v (1859). Case 2 had the following history:—"About nine years ago he had first a guinea-worm in the sole of the foot at its middle; the worm came out, and a small tumour made its appearance in the same situation. This tumour gradually increased in size till it reached two inches in diameter, when it was removed by a European surgeon, and after this the patient experienced complete relief for a period of twenty months; but then (i. e. about two years after the first appearance of the malady) a vesicle not unlike

that of *Draacunculus* appeared on the same spot, and since that time (seven years since) the disease began to make its ravages by invading the interior and encroaching on the exterior of the foot." On the views which I propose for adoption, one would here suppose that the infecting *Filaria* and Mould-spore entered the foot at the same spot, perhaps in the same manner also—either at one time of year, or the latter after an interval of time; but whether entophytic inoculation took place soon or late, the more serious consequences which it entails are clearly illustrated by the comparative results now described. There are other noteworthy features in this interesting case which I may hereafter refer to, in the conviction that the record is as trustworthy as it

In order to complete the comparison now drawn, I will mention points of contrast which, hardly less than those of similarity, are characteristic of the parasitic growths. Thus, the *Filaria*-disease is very definedly endemic in its range: it attacks Europeans as well as natives; it lasts for one year, as a rule; it ends in spontaneous cure, and is seldom a serious affection. On the other hand, the Fungus-disease, though endemic, is yet more widely spread; it has never been seen in a European; it lasts for several years; it is not spontaneously cured, and is commonly a very serious affection. Each of these points of difference is explicable by the nature and habits of the respective parasites concerned: the *Filaria* lives in water for a time at least, and on damp soil, but the Fungus (*Chionyphe*) occurs in the most arid districts; and the circumstance of Europeans not having yet been seen attacked by the latter, is readily understood from the fact of coverings for the feet being habitually worn by them out of doors: the immunity is one which no general or constitutional disease in my recollection decidedly presents; or if there be such, I know not that the immunity referred to can be so satisfactorily explained as here. The present comparisons might be pursued into further details, but if what has been now advanced should stimulate inquiry and research, one of my objects will be gained.

is plain and unbiassed; but I again now point out the occurrence of a *vesicle* as an early mark, at times equally common to the two parasitic diseases.

As bearing upon the views here suggested, the following remarks may be quoted from Mr H. J. Carter's article in the Appendix, under 1862:—"I would also add my opinion that the black-fungus of the human body is a monster-form, from its sporangia, or large cells apparently identical with sporangia, never, to my knowledge, containing anything but an amorphous albuminous mass (abortive state of sporidia, which is chiefly the seat of the black colouring matter, and ultimately becomes resinous or fatty?), and thus that this fungus is no more capable of putting forth a true embryo which can propagate the

species from one human body to another, or even out of the body, than the Guinea-worm; and that the natural habitat of the species is therefore, like that of the Guinea-worm, out of the body." Respecting the valid similarity just indicated, I must remark that, whilst from the embryo *Filaria* so abundantly emitted by the parent-sac it has not been proved possible to verify a return to the normal species-form, yet from the fungus-products of *Mycetoma* reversion to the parent-species has actually been witnessed on more occasions than one. I infer, too, that direct re-inoculation of the foot by these products may occur; and hence can hold only with obvious modifications the opinion above quoted.

SECTION III

PATHOLOGY OF MYCETOMA

CHAPTER I

ITS PREVALENCE IN TIME AND SPACE

a. As regards *Time*.—For illustrating this subject I am compelled, in absence of other data, to again have recourse to the analogous *Filaria*-disease. That parasitic affection, as is well known, is much more frequent at one season of the year than at others; thus, in the Bombay Presidency and Central India, &c., it abounds most from May to August inclusive, with a limitation which on inquiry will be found to be tolerably precise, and only surpassed under exceptional circumstances; and, further, this peculiar feature of the affection appears to be connected with the development or growth of the entozoic *Filaria*.

I have always regarded the fact as sufficiently established, that the Guinea-worm probably gains entry into the body, and after a certain period of latency or incubation within the tissues, makes its exit therefrom, at certain seasons only; namely, about the advent and earlier falls of the annual rains brought by the periodic S.W. Monsoon gales. At that time various organic germs come quickly, or even suddenly, into active life, after lying dormant during the preceding dry season; and the outburst of animal and vegetable growth is then very remarkable, commencing as it does in some instances, when the air begins to be loaded with moisture (as in the month of May), and rapidly approaching the maximum when the atmosphere becomes so overcharged as to precipitate copious rains, during the months of June, July and August. It is then, when heat and moisture are combined influences, that the young *Filariæ* are brought to the surface of the body by a movement we may call instinctive on the part of the matured parent, now literally charged with the young worms, which are finally liberated on rupture of the integument, and extrusion of their containing generative sac.¹ The same period is doubtless that of the normal production of these parasitic animalcules; and about the same time (after development, *i. e.* of their ova) doubtless occurs the infection of the human tissues.

¹ Then happens admission into hospital, which event thus becomes a sort of index of the maturity of the *Filaria*. I quote the relative number of such admissions for future comparisons; from March to August, $\frac{1}{2}$ ths; in September and October, $\frac{2}{3}$ ths; in the four next cold months, $\frac{1}{4}$ th. In December and January the admis-

sions are always few; in February there is a slight increase; in March the admissions are at once quadrupled; and in May and June the maximum number is reached.—“Statistics of the Meywar Bheel Corps.” Dr T. H. Hedley, ‘Ind. Med. Gaz.’ 1872.

That the *Fungus-disease* is in like manner marked by a limitation in time, I regard as highly probable. Thus, there is the demonstrated fact that the normal or parent-mould (*Chionyphe*) makes its appearance during this same season in India, and at a corresponding time in England; and at no other period has it been seen. Below I have recorded the spontaneous occurrence of the pink mould upon specimens of diseased foot; and, besides, with other inquirers, have induced it to grow by semination in suitable soil of particles, or granules, taken out of such pathological specimens: in each case, I repeat, the new growth, or reverted form, appearing only at a definite period of the year. This circumstance I, therefore, regard not only as indicative of the natural habit of the parent-mould of Mycetoma, but as furnishing a clear link of analogical connection between this malady and the corresponding entozoic disease; in how many other respects the two affections correspond, I need not here again insist upon.

Regarding the periods of growth of the entophyte while in connection with the body, nothing certain is yet known, and that for obvious reasons;—thus, the inoculation of the foot is a process which probably happens only within definite limits of time (*i.e.* only at a certain stage of development of the plant-germ), and commonly passes unnoticed, or at least undetermined by competent authority; next, not as obtains in Guinea-worm, there is here no outward sign that a definite period of growth intervenes between date of supposed inoculation and first extrusion of “particles;” it would, indeed, seem as if the entophyte might continue to grow continuously for more than one year, or normal cycle; and no essential difficulty attends this supposition, for it may be assumed that the vegetable parasite, as a lower endowed organism, is susceptible of appearing under wider chronological, as of morphological, range. Again, the Guinea-worm lodges only in the loose connective tissue under the skin or deep fasciæ, and as it further possesses considerable locomotive power, it can readily approach the surface for casting forth its young: on the other hand, the mould is fixed, and grows in a seemingly irregular manner, or at least in directions which may or may not lead to a free surface, within limited periods of time; and I have shown that the circumstances thus controlling the progress of the new growth, may be physical and accidental, and not to be overcome, except in one way, by the less pliant parasite within. In conclusion, I regard it as highly probable, that the extension, and extrusion, of the pathological tumour may be regulated by the natural habit of the foreign growth which it encloses; but that incidental circumstances, by their influence, commonly prevent clear signs of such annual or cyclical tendencies, as we observe in the Filaria-disease. Future observation may do much to elucidate this subject; and the present remarks are offered chiefly as suggestions towards intelligent search for the data, which are still needed to complete our knowledge of perhaps the most remarkable human parasitic disease yet detected. The statements of native patients should be carefully sifted whenever it seems worth while to do so; because they are often distinct enough, and capable of being tested.

Lastly, I prefer to wholly ignoring this interesting topic, thus to treat it in a manner which may be regarded as simply hypothetical: but any one, without difficulty, may foresee various practical considerations which will, even here, follow in the train of advancing knowledge.

b. Limitation in Space.—Mycetoma is an endemic affection, but it is very widely spread in India; and its range and distribution might very well correspond with those of

a tropical *fungus*. Already known localities of the disease are the following :—in Northern India, the Punjab from Jhelum to Hissar; Bhawalpur, Jeypur, Ulwar, Bikanir and other native states in Northern and Western Rajputana; thence on the one hand, in Sindh the disease is not uncommon; and in Kutch, Kattiawar and Gujerat; on the other hand, by report I understand that it prevails in the North-West Provinces; and it has been seen in Lower Bengal. Known districts of Western India, besides the above named, are the Deccan upland, and the Concan sea-board; and, as outlying localities, I may mention the occurrence of the affection (black variety) in a native of Bussorah on the Persian Gulf, whom I saw in Bombay; and Aden has been named by one observer. In Southern India, the disease is common in districts as widely separated as Guntoor and Madara, as well as the intervening ones of Bellary and Cuddapah: to these portions of the Madras Presidency may be added Mysore, Trichinopoli and Pondicheri. Thus, excepting the Central Provinces, respecting which information is yet deficient, there are, it will be seen, few districts of large size in which the fungus-disease is not already ascertained to occur; and as regards these last, it may reasonably be supposed that when the complaint becomes better known, their number will diminish. Nay, it is probable that countries external or contiguous to British India, may eventually be found to belong to this list: to say more would be to enter upon mere speculation, but it is hoped that the present memoir will be of use in exciting, as well as directing, the researches of some of the numerous competent observers, who are suitably located in the country.

That an affection essentially identical with the fungus-disease of India is ever seen in Europe, may be doubted; the presumption, indeed, is that none such occurs.

Owing to the circumstance of the earlier examples of *Mycetoma* having been seen in localities where the soil is of that kind—namely, the *regur* or black soil—best suited for the growth of cotton, the idea was long entertained that this affection is either limited to, or much more frequent in, such localities; but a wider experience has shown that it would be incorrect to suppose that the fungus-disease occurs only among people living on cotton-soil, and it now appears doubtful whether the affection is really more common in cotton-districts than elsewhere. I am not aware of any data precise enough to settle this last question; and will therefore only remark, that should there eventually appear such a preference in the habit of *Chionophæ*, as makes it to flourish best on a certain kind of soil, the fact would be a sufficiently intelligible explanation of some endemic features of the fungus-disease. That a certain mould grows best on earth derived from magnesian limestone, and on cotton-soil (which also contains a quantity of magnesium-compounds), or best on plants, &c., peculiar to such soils, is a reasonable enough supposition; but it must be remembered that not by any means seldom does the same mould (according to my views) prevail upon arid, and even sandy, soil, and in semi-desert regions, where rain-fall is scanty and heat intense. The chemical composition of such soils, *e. g.* of Sindh, Kutch, Rajputana, &c., may, however (so far as I know), show a similar peculiarity; and this subject is clearly one of those needing elucidation. On *à priori* grounds one might suppose an alluvial soil periodically soaked or overflowed (as in the many deltas of Indian rivers), to be an especially suitable one; and this point might also be taken into future considerations. Speculation apart, it may be remarked that the chances of detecting in its natural habitat, the parent-mould of *Mycetoma*, are much increased by this its wide distribution over so many parts of India. Systematic search should be entered upon; and if

carried on for a complete year, success would be more likely than after a more temporary scrutiny.

The results of some examinations of cotton-soil, are, I may add, given below in Chap. III, Sect. V.

So far as my information goes respecting the *comparative prevalence* of the several forms of Mycetoma, it would seem that whilst, in most localities, both pale and dark varieties occur simultaneously, that is, side by side, yet that in Northern India there is a decided predominance of the melanoid form, and so perhaps in Western India; but in the South, *e.g.* in many parts of the Madras Presidency, that the ochroid forms are the more common. It is true that the black fungus-particles (as described in this memoir) were evidently long since there noticed by surgeons; but it will be evident enough to those inquiring into the history of Mycetoma, that it was the pale, soft bodies which attracted most attention; and I would here observe, it is to the form of foot-disease presenting these peculiar ochroid granules, that the term "Madura Foot" should more properly be applied. The black particles which it fell to my lot to first particularise and describe as equally characteristic, were (and may, indeed, by some still be) regarded as incidental, or at most, as a mere form of the once better known roe-like, or poppy-seed-like, granules.

As an inclusive denomination of Mycetoma, the term "Madura Foot" is therefore inappropriate; and it is now needless.

CHAPTER II

NATURE OF MYCETOMA

That a very singular and serious affection of the foot and hand, widely prevalent in India, had hitherto been distinguished by various special names, is a circumstance sufficiently indicative of the peculiar character of the malady; and, I may add, also of its obscure relation to better known European diseases, to one or other of which, however, it has been commonly relegated by independent observers.

The following names occur in the bibliography of this Indian foot-disease:—"Morbus tuberculosis pedis; Madura foot; a tumour affecting the foot; diseased foot; the fungus-disease of India (Mycetoma); a peculiar disease (tubercular) of the foot; Godfrey and Eyre's tubercular disease; endemic degeneration of the bones of the foot; Morbus pedis entophyticus; Chionyphe Carteri, or fungus-foot, &c.: other terms have also been employed, as, originally, Ulcus grave; then, Caries; Hypertrophy with caries; Podelkoma, &c.; and an analogue has been sought in Nélaton's "Affection singulière," or perforating ulcer of the foot.

Some of the indigenous or vernacular names of this disease are the following:—Keerenagrah; Kirudeo; both implying the work of worms; Ghootloo Mahdeo, from a

supposed resemblance of the pale, soft particles to the eggs of insects; the natives of India, as their congeners in the West, being fond of imagining "worms" in diseased parts the seat of gnawing pains; and as well of associating therewith Satanic influence: Pincal, Anaycal, are other Dravidian terms for the same affection, or for others confounded with it.

I have said that all, or almost all, European surgeons visiting India agree that here is a peculiar malady, but in what respect this peculiarity consists there is not an agreement; only an attempt is generally made to identify the affection with a pathological form recognised in Europe. It should be mentioned, however, that a few surgeons have refrained from expressing an opinion regarding the nature of the foot-disease, although well qualified to judge; thus Dr Ballingall calls the complaint "A tumour affecting the foot;" and, again, the well-known denomination "Madura Foot" had this advantage, that it was sufficiently distinctive without implying a guess as to the nature of the complaint: advancing acquaintance with the latter makes these reticences now needless.

I may, therefore, briefly consider some of the positive opinions indicated in the above list of names, before stating my own views.

First, then, is the foot-disease of India simple *caries* of the tarsal or metatarsal bones; or *mutatis mutandis*, of the hand-bones? I answer, no; because it has neither the typical local nor common general characters of caries; and, also, because it possesses a special feature in its attendant discharge of small organic particles, which caries in Europe has never been known to present for notice.

Next, is it correct to compare this localised Indian malady with *strumous* or *tubercular disease* of the bones or skin, such as is in general recognition in Europe? Are the pale, soft granules belonging to the former, the same as "tubercles," or tubercular deposits, characteristic of the latter; and are the typical black granules often found, only early forms of tubercles, or mere accidents such as *blood-clots*; or a complication, as *melanosis*?

I must trust that it will not be needful to enumerate in detail the reasons which lead me to reply to all the above questions, and the like, with a decided negative. First, however, I may say that the *bones* of the foot and hand are not earliest implicated in the Eastern disease—that is, not necessarily so; for in numerous instances, perhaps oftenest, when seen at an early stage the superficial soft parts are alone found to be affected. And the anatomy of the disease does not support the view of tubercular or strumous destruction of the bones, as the basis of all its signs. What affection of the *skin*, then, shows small sinuses discharging peculiar granules or particles, such as we here find? or what can that affection be which, commencing in the skin, extends through the entire thickness of the foot, converting it into a globular mass; and yet having no other pathognomonic sign, but very numerous openings, shedding a thin discharge, frequently, if not at all times, containing distinct particles comparable to small seeds, as of the poppy, or to clusters of the ova of fishes; or, if of black colour, and hard, comparable to grains of gunpowder, or black peas, &c.? And all the time the patient remains free from constitutional irritation, and in fair health; he is in appearance neither strumous nor syphilitic; he has no marks of similar disease, or any disease in other parts of his body; none of his family are in like manner affected; and on the tumefied foot being amputated, his health, if depressed, quickly rallies. Examination being made of the excised member, a very

peculiar tunnelling, as it were, of the tissues is noticed, and an abundant growth of bodies like to, but of larger size than, those discharged at the terminations of the cavities and channels, lodging and isolating them while in the foot: and, besides, nothing more is seen except, perhaps, such swelling or degenerative change of the normal tissues, as might naturally attend the prolonged presence, and constant advance, of a foreign body, within their midst.¹

It has never been shown by minute investigation that pathological "tubercles," or tubercular deposits really exist, as a main feature of the foot-disease, in either bone or soft parts; and their absence has been, on the other hand, repeatedly demonstrated. I remark that the articular surfaces of the bones of the foot have, in my experience, never been specially attacked; and they have been often seen to wholly escape.

I now turn for a brief space to the views put forth by a French surgeon resident on the east coast of the Indian peninsula, who had studied with care the local foot-disease. The memoir of this author is referred to in the Appendix (1861). Dr Collas observes "by the expression 'endemic degeneration' of the bones of the foot, I mean a localisation in one foot of a benign diathesis, which develops itself in a marked manner more frequently in men than in women, and is characterised by the production of a particular element, which, occupying the place of the bones of the foot, ends by inducing their destruction. I give it a name to prejudge nothing of its nature . . . the secret will be revealed by the microscope" . . . he considers the disease to be an alteration of the bones produced by a diathesis, such as he supposes to belong to the myeloplastic formations generally . . . "it is impossible that this malady can be anything else than a tumour, of which the pathological element is made up of myeloplaxes, produced by a diathesis *sui generis* and by hypergenesis, *i. e.* in a proportion much exceeding that encountered in the substance of the bones in a normal state" . . . myeloplaxoma is the name of the material forming the tumour . . . Dr Collas makes the following remarks on the microscopic appearances connected with the disease; and the absence of "myeloid cells," as they are commonly recognised, is (as it seems to me) peculiarly against his own views, while the structure actually described is not inconsistent with my own observations of the black fungus-particles:—"There is no pus in the discharge (from the sinuses), which has peculiar characters, and is thin watery, foetid, gelatinous . . . it may contain granular matter, fibro-plastic cells of great length, oil-globules, and a great number of little bodies of blackish or reddish-brown colour, having an irregular, triangular form,

¹ An experienced observer, and one whose opinion carries weight, has very recently stated: "I certainly have seen cases of disease of the foot involving both soft tissues and bones, and presenting all the destruction of tissues noticed in the Fungus-disease, without either black material, red specks or white granules. In the absence of such distinctive marks, the cases have been noted as 'scrofulous.' Another question therefore arises, is this so-called Fungus-disease simply a scrofulous affection to which, from externally, some fungus element has been added?"—Dr W. J. Moore, in the 'Ind. Med. Gaz.,' Nov., 1873.

In this place it is right I should state, that not one case which presented all the characters of Mycetoma *excepting* the typical form of discharge, in some or other

of its varieties, has ever been seen by me. I am therefore compelled to suppose that in these instances of the disease above referred to, there had occurred the rare event of expulsion of the entire parasitic growth; and should indeed rejoice to learn that such occurrence was even possible. Surgeons having full notes and complete history of cases of fungus-disease in which the parasitic element was wanting, would impart a singular benefit to surgical science by making all the details public; only there must be eliminated all likelihood of error in diagnosis. Unless such cases are positively known, doubts as to the true nature of Mycetoma appear to me to be at least premature; and of even such instances the explanation suggested may be temporarily advanced.

which in the clearer parts seem to be formed of small cells, transparent and unaffected by water, acetic acid, ether, sulphuric acid; and lastly, small rounded nucleated cells which ammonia appeared to make more distinct, but which I have not yet completely studied”

I do not think it will be necessary to follow Dr Collas further, because the same objections apply to his views as to those last considered. Thus, the *bones* of the foot are *not* necessarily first affected; and as to the presence of myeloplasmic cells, the author does not describe them, but another structure; and, in fact, no evidence of their abundance is forthcoming. I have myself seen and figured myeloid cells in the foot of the young man whose case is described at page 10; but here they were obviously mere accidents, and doubtless sprang from the endosteum of the attacked tarsal bones, whose cancellous tissue was laid bare by pressure of the advancing parasitic growth. It is to me as singular as possible, that a careful observer could venture on an hypothesis like the above, whilst so many facts oppose such view: and where, I may ask, are the sinuses and peculiar discharge of myeloid tumours to be found recorded by surgical authorities?

That Nélaton's disease of the bones of the foot, or indeed any form of caries or necrosis, known in Europe to attack the upper or lower extremity, could be confounded with Mycetoma, is no longer a possibility; and I trust the present work will aid in dispelling any lingering doubts regarding this subject.

Having already indicated the diagnostic features of the Indian foot-disease, I need not here recapitulate how in its nature, it cannot be confounded with fibrous, bony or cartilaginous tumours of the foot or hand.

I therefore pass on to discuss the opinion that here is a malady *truly parasitic* on a part of the human body.

It is stated in the Appendix that Dr Ballingall compared the new growth to a parasite; and the remark was, in my opinion, a very sagacious one, because there was no direct evidence in his possession of such view, beyond the general features of the affection; and Dr Ballingall had not seen the particles which *par éminence* are clearly of fungus-structure. A similar remark applies to Dr Bidie's very interesting article (see Appendix), but I do not think, from the observations alone recorded therein, the author could maintain the accuracy of the name “*morbus entophyticus*.”

The manner in which my own views were formed is briefly as follows:—In October, 1859, I examined an amputated foot immediately after operation (see page 4), and found the clearest possible evidence of the true fungus-structure of the *black* particles now well enough known. This observation has been invariably confirmed within my experience.¹

Now immediately afterwards, viz. in November, 1859 (see the case recorded at page 8), I examined before and after amputation a diseased foot; and I found in it, and in the discharge from the openings on its surface, numerous minute *pale* particles, which also presented a decided fungus-structure. The appearances were universally recognised by the members of the Medical and Physical Society, who, at a subsequent meeting held in the Grant College, examined my specimens. Hitherto, however, as far as I have heard,

¹ As the latest, and a very sufficient, confirmation of the main point to be here established, I may refer to the ‘*Pathological Transactions of London*,’ vol. xxii, 1871,

wherein Dr Bristowe has described and figured the structure of the bodies termed in this work—*sclerotia*. See the appended Bibliography.

no one else has been similarly successful; and as my later sphere of observation was, as regards this disease, very limited, no other like case has come before me. The discovery is still valid; and it is a main basis of my views, because in affections of the foot altogether like that of this woman, I find particles of similar general character, although not having a distinct fungus-structure. The *status quo* is, therefore, this—in two diseases presenting many similar local characters, but differing as to the minute structure of one of their elements in the following way, namely that in one case a distinct fungus-structure is present, and in the other only a seemingly obscure structure (which is not like anything hitherto observed)—what is the fittest conclusion that may be drawn respecting the connection of these two affections; and, respecting their common nature, should it be decided that they are alike? The patient who furnished me with positive evidence, had a foot diseased as usual; she came from Gogo, which is a town in a district known to be infested with the common foot-disease; and what valid objection there can be to regarding the example as a typical one I cannot surmise. Yet, if this inference be tenable, the conclusion becomes inevitable, that in this instance the characteristic particles were seen a certain stage, either before or after they assume their more doubtful appearances; and on such basis my views partly rest. There remains only to add that ordinary pale particles found in this disease are very peculiar in their structure, being comparable to no known pathological product; and this negative feature I may, if I choose, take to confirm these views, but in reality there are indications of positive value, and, as will be shown in a subsequent place (Sect. V, Chap. I), such as point to an organic and even fungus-origin of these much-debated bodies. Reference may be here made also to the circumstance that *Chionyphe* has been seen to spring from these pale particles, as well as from the black granules and other forms.

There now remains to consider the true relation between the parasitic growth and the phenomena of disease in the foot; the question being whether or not the former is merely an incidental feature, and unconnected with the causation of the malady. I have, indeed, above intimated my own opinion on this point, but would now offer some further remarks bearing upon it.

First, then, there is no *à priori* difficulty in the conception that the spores of a plant can enter, and live within the living tissues of the human body; and there become developed into forms which may be more or less abnormal. I suppose the idea has been that without air it is impossible for fungi to live; and that it is difficult on physical grounds, to understand how one of these growths could penetrate so deeply into the tissues. Yet *Sarcinæ* and *Bacteria* are found within the organism; and amongst plants it is not unusual to see fungus-spores penetrating below the cuticle and extending within the substance of leaves and stems, there to develop into quasi-abnormal forms (*sclerotia*); which are strictly illustrative of the black masses often found in the diseased foot and correctly to be regarded, in my conception, as sclerotoid forms of *Chionyphe*. I shall soon show the entry of such spores into the human foot to be feasible;¹ and although the present

¹ In addition to this reference, the following illustration may be added:—"The objection is often raised that mildew may be found in the interior of uninjured eggs, nuts, &c., where it was impossible for the spores to reach. However, the spores settling on the surface of such

substances, a slight moisture causes them to germinate; and the germinating utricles, especially those from a full-grown mycelium filament, penetrate into the enclosed space, piercing through (as is proved by minute observation) the closed egg-shell, and even the hard and solid

instance may transcend previous experience of analogous maladies, yet that circumstance is no valid objection to the adoption of the views proposed. It is the actual rather than the likely, which has to be considered, in dealing with obscurely known and variable forms of organic life, such as are here concerned.

I venture, then, to maintain in this place, that the foot-disease of India is not a carious, strumous or myeloid, or any like affection; but a veritable parasitic disease, due to the growth and extension within the tissues of the human foot, of an indigenous *mould* or fungus of true plant nature. This statement involves three considerations: namely, first, that a parasite is present; next, that this is a vegetable form; and third, that it is the immediate cause of disease. Taking the first of these points for disposal here, I remark that, in the view proposed, the obscurities and difficulties met with in the clinical history, mode of origin, course and event, local characters, anatomy, both general and minute; all peculiarities in the limitation and distribution; and, in short, such characteristics of the affection as are, when taken in their proper combination, inexplicable on other grounds, now become not only easy of comprehension, but in great part convertible into evidence directly supporting this view; and hence the demonstration which is required for rendering the latter valid, appears to be both adequate and logical. A summary of the instance, thus viewed, would be the following:—The foot-disease presents certain characters; none but parasitic diseases display these characters, and hence the former belongs to the greater category included by the latter. This method of reasoning is made complete by the assertion, that the foot-disease presents no other characters than those implied: and I believe it to be equally well founded, as my subsequent remarks are intended to show. The parasite in question is represented by the little bodies termed in this memoir “fungus-particles,” &c.; and in some of its forms, I regard it as being always present—doubtful exceptions apart, which have been already referred to.

It may next be observed that the second of the considerations above named, namely that the parasite in the foot-disease is a vegetable form, will be discussed in the next chapter more fitly than here, because concern is now had with the main preliminary questions of the existence and true relations of a foreign growth, whose real nature may afterwards be better inquired into.

I now come, lastly, to the opinion that these “fungi” of Mycetoma—even if really such be their nature—are to be regarded not as true causes of disease, but as incidental attendants on a pre-existing or co-temporary morbid process. This view is, I believe, commonly entertained; but as it has never, so far as known to me, been formally stated on sufficient evidence, it is somewhat difficult to controvert. The following remarks must therefore be of a general character; and they will simply convey the reasons which have convinced me that the views which I originally proposed and now hold are, notwithstanding objections, strictly correct.

It is not easy to convey in writing the force of an impression received by ocular

membrane of fruit-stones, nuts and woody fibres.”
 . . . Respecting the need and supply of air, or oxygen, the views of Pasteur are doubtless well founded. “He says the fungus must absorb oxygen when it vegetates. If this be sufficiently supplied to it by the atmosphere, it absorbs it thence, vegetating luxuriantly and burning the substratum on which it grows; but if it

do not find oxygen free and in the air, then it draws it from the compounds of which the substratum is composed, and this gives also a further impulse to the decomposition of these compounds.”—Quoted from the ‘Quarterly German Magazine,’ No. II, 1872, “On Mildew and Fermentation,” by A. de Bary (London: Williams and Norgate).

demonstration, but I shall not readily forget the first occasion when, on bisecting a recently amputated foot, the large, firm, black masses came into view; located in cavities interspersed amongst the tissues, into which they accurately fitted and whence they could be readily lifted out. On their removal it became further apparent that only a simple membrane separated them from the normal tissue, whether of bone or fibrous tissue, in near contact with them; and, next, were noticed the canals or tunnels leading from these cavities towards the surface of the skin, lined with the same membrane, and also containing in abundance black, granular particles, evidently of the same nature as the larger impacted masses. I saw no morbid deposit, or marks of inflammatory process, in addition to this foreign growth: no tubercle or strumous disease of bone, no caries of joints; no fleshy growth or tumour of any kind; and, in short, no sign of a pre-existing or accompanying local disease, upon which the parasite might have been engrafted. What could have been the effective antecedent malady, preparing a way through the midst of the tissues; furnishing a special envelope; and then altogether disappearing, so that close scrutiny failed to detect any physical traces of its pre-existence, I was, and am, at a loss to even imagine. No such antecedent could, in fact, be supposed to exist. In other cases I noticed more signs, perhaps, of attendant irritation in greater thickening of the connective tissues, and consequent larger size of the tumour; but the essential features were still the same. One could conceive the whole foreign substance might be lifted away, out of the tissues, leaving them, when not absorbed, either thickened or wasted, but hardly inflamed, or even congested; and certainly not occupied by tubercle or any ordinary pathological deposit. The investing membrane of the growth might be compared, in its relations and even structure, to the walls of an Hydatid cyst, or to the outer integument of the *Filaria*-parent; and in these suggestions are intimated the nearest approaches, so far as I know, to an analogous affection of the human frame.

As regards the pale, soft variety of the complaint, the same line of argument applies: for all the forms are connected by main, common characters; and as concerns the particulars on which the distinction of varieties in *Mycetoma* has been based, they are probably not more than divergencies from a common centre, no greater or more marked than normally occur amongst organisms of the class to which *Fungi* and the *Schizomycetes* belong.

Inquirers may, indeed, hesitate to admit that these pale, soft particles could have made their way inwards; and by their presence, have led to so much disorganization as usually exists in the affected foot. Yet independently of considerations proving their connection with the black particles, and of the probability that their original or their perfect condition is not usually seen; if their presence in the foot be accidental, what or where, must I ask, is the original malady? What complaint tunnels the tissues, and yet leaves the bones and joints whole? Is tubercular matter ever found capsulated, or lying loose in distinct cavities hollowed out of the tissues, and not either cretified or in a state of sphaecelus? The impressions which I have gained from examining specimens of this yet widest-known form of foot-disease, would rather lead me to compare the cavities and loculi to small hydatid cysts scattered about; and the collections of ochroid particles which are lodged in them, look like groups of the eggs of the blow-fly—so extraneous to the normal tissues do both these structures appear. There is no evidence, however, of entozoic growth that I have detected, in any form, stage or degree of this complaint.

Respecting the great disorganization of tissue and the quantity of glairy material which frequently accompanies these particles, I would ask if both be not due to the presence of the latter; on the presumption that their growth necessarily leads to the decomposition of the medium in which they live? Fermentation and putrefaction are the result of the growth of certain organisms with which I shall afterwards compare the structures found in this foot-disease; and why may not disintegration of tissue attend the growth of these last?¹

The peculiar and characteristic bodies in question display, moreover, a special structure which is emphatically not that of tubercle, cancer or the like; or, indeed, of other known pathogenetic bodies, either homologous or heterologous; but which may yet, as I think, be properly recognised. They sometimes form, to all appearance, so small a proportion of the altered disease-mass that we might hesitate to attribute to them so important a rôle as is here implied; yet their presence and growth are doubtless a cause of much and peculiar irritation; and their actual number is always considerable, notwithstanding their persistent drain outwards, and departure from the loculi in which they are formed. Finally, as they may, so far as my experience goes, invariably be found in the innermost recesses of the tunnelled tissues, one cannot suppose that they, or their germs, had accidentally, as it were, dropped upon a foot, already riddled with holes, from which pours outwards a continuous if slight discharge; and had afterwards become developed or enlarged. This supposition, and the like, are on mere physical grounds simply untenable; and that fungus-spores could reach the foot through the general circulation is so obviously unlikely (although the only alternative), that this idea, too, may be dismissed.

Let me add that in order of time, the fungi are to be seen at the moment when a sinuous opening is formed; and the latter seems to be produced for the purpose of giving exit to the particles. The fact I have myself established; and the inference is a necessary one.

That the foot-disease, of any form, begins in a sore or abscess, whence it may spread into the foot, would not, I repeat, appear to be usual or even frequent; on the contrary, the whole progress of the parasitic growth is clearly determined by its own innate capacity of spreading; this alone produces those tunnels and cavities in the tissues which exist in no other disease, and which are not here revealed to our view until the growth is matured, and its products come to be discharged at the orifices of the sinuses. That the channels may persist after the whole growth has been expelled may seem to be theoretically possible, but so far as my inquiries go, they lead me to assert that the event is unknown; and I cannot even conceive of a true Mycetomatous affection in either hand or

¹ It is intelligible that a fungus which grows on an organic substance can give rise to both putrefaction and fermentation—the former when it grows upon a surface freely exposed to the air; the latter when its mycelium has penetrated into the depths of the substratum where the oxygen of the air cannot reach . . . (De Bary) in this last case, the needed oxygen is derived from the disintegrated tissues themselves, and it will be a future point of great interest to ascertain what really occurs in the fungus disease; meanwhile I cannot but infer that the peculiar substance which attends the fungus-particles of all kinds while growing within the foot, is

greatly due to the decomposing or disintegrating action of the parasitic growth upon the normal textures of the body. I purposely do not enter upon theoretic discussion of many interesting topics connected with the disease, but may here remark that abundance of nutrition is at hand and a high uniform temperature; and that under such conditions a fungus may well grow with vigour. It is possible, too, that some tissues (*e. g.* the adipose and the marrow of bones) may be special sources of the needed carbon, and hence be consumed more than others by the spreading entophyte.

foot, being, at any stage, devoid of its attendant characteristics. A combination of the fungus-disease with other local maladies, has yet to be made out. When, after careful searching, neither black, tinted nor pale particles are to be found in any part of a peculiarly disorganized foot, I pronounce the affection to be different from Mycetoma; and the observer of such a malady as this, would, in my opinion, be entitled to proclaim a rare discovery; for he would add to our nosological lists, a local affection wholly inexplicable in its origin, character and course. Let the successive features of the disease whose real nature I am endeavouring to disclose, be patiently considered in the light of adequate collateral knowledge, and I doubt not that similar views to my own will be adopted: only there must be exercised the requisite means and method, first, of inquiry, next of observation, and lastly of inference; for in this example the argument is sometimes a cumulative one, and always the more emphatic when most widely based.

I have referred chiefly to the pathological anatomy of Mycetoma, for evidence on which to found a right conception of its true nature; and now add that such evidence is but one link in a series of data, which, like a connected bond, renders indissoluble fact and conclusion. Want of space would prevent my here discussing at length the views and opinions of other observers; and I must be content with again urging the importance of seizing upon the typical features of this malady, duly discriminating and avoiding crude analogy.

Were the whole history of Mycetoma unravelled, it would probably be as hard to follow as is that of the entozoic maladies; and as a matter of fact, already the complaint has revealed an identity with organisms whose metamorphoses are, to all, still mysterious.

I need not indicate, in detail, the points which seem the more obscure, but would here remark that the relation of the black and pale fungus-particles is yet but indifferently elucidated; it is not such as has been sometimes thought, on pathological evidence alone, and to future observers must be relegated the work of fully establishing the connection which undoubtedly exists between these organisms, as forms of one common growth. So far as I have advanced, it appears that the two are substitutionary, the one of the other; that the co-existence of sclerotia and malacotia is not to be anticipated; and that a divergence of development takes place, under circumstances as yet unknown to me, at the commencement of growth, which is never restored until from the several fruit-products, the parent mould again springs forth outside the body of its temporary human host.

In conclusion, despite the obscurities which yet attend some parts of the subject, I cannot but maintain upon these several grounds, both clinical and anatomical, my original thesis, namely that *the foot-disease of India, in all its varieties, is a single and well-defined affection of a purely parasitic nature.*

I shall afterwards (Section V) endeavour to show that this parasite is of *entophytic* character; but I would here express my desire that due weight be allowed to the collected data which have already been submitted for consideration, because upon them alone might be based a determination of the kind of malady presented in the complaint under notice.

Addendum.—In the comprehensive Nomenclature of Diseases, recently compiled under the auspices of the Royal College of Physicians of London (1869)—in the Appendix containing a list of 'Human parasites'—subdivision 'Entophytes'—is found the following identification:—*Chionyphe Carteri* (Berk.).

Definition.—A cotton fungus occurring in the disease called Mycetoma.

Habitat.—Deep tissues and bones of the hands and feet.

I need not here point out that subsequent research would, to some extent, modify certain terms in this definition. The parent-mould is probably not a "cotton" fungus.

CHAPTER III

CAUSES OF MYCETOMA

1. There is no evidence that plethora or anæmia, or any special state of the system, *predisposes* to the advent of Mycetoma. On general principles, indeed, it might be thought that debility and the like influences would render some individuals more obnoxious than others in more perfect health, to the onset of the entophytic malady; yet this notion has not been supported by my experience, and as is the case with the Filaria-disease, all observations tend to demonstrate the independence of the parasitic complaint, as regards any particular or weakened state of the body at large.

As to unusual personal predisposition arising from local causes, those latter only require mention which might affect the entry of spores, &c., into the tissues at a certain time of year, such as spontaneous cracks or fissures in the sole of the foot, or sore places; or the accidental abrasions, scratches or punctures which men or women working bare-footed in the fields, or tending cattle on grazing grounds, would be so likely to meet with. It may also be supposed that an habitually soiled state of the feet from adhesion of damp mud, or tenacious black soil, or of animal excreta (upon which fungi are so apt to grow), would render more likely the local affection of the foot; owing to the probability of spores being present in such matters, and so ready to enter the sweat-ducts or lodge in a wound. A chronic ulcer, perhaps deep and hidden, would also seem a favorable nidus or substratum for the growth of a mould-fungus; or foul secretions; but of all these various states or circumstances not one can be shown to be needful to the entry of the entophytic germs, and I am compelled to conclude that these, like the young *Filariæ*, may and commonly do, enter the foot through an unbroken surface, without any adventitious aid; and further, that infection may occur under local circumstances or attendant external conditions, respecting which hardly anything is yet known.

2. The one *exciting* cause of the disease with which I am acquainted, is the entry of fungus-spores, or other germs, into and beneath the skin of some part of the living foot. There, the materials and stimulus favorable to their subsequent growth and development are abundant, continuous and uniform: the near soft textures, at least, present no obstacle to increase of size and luxuriance of ramification; and no natural conditions could be, one may suppose, so likely as this of tissues bathed in lymph, to induce such erratic or monster forms of development and growth as are hardly to be paralleled outside the human body.

Respecting the actual introduction of such spore or germ, however, there are no other than presumptive data. Obviously it is in the highest degree improbable, that a

competent observer should witness the natural inoculation of the foot: experiment upon man would be inadmissible; and the accidents named by patients in connection with the apparent commencement of their complaint, are neither alike nor constant. It is therefore by inference, chiefly, that the view proposed can be supported: but I must add that there are no preliminary objections to its adoption, and upon other hypothesis the exciting cause of the foot-disease is not to be better explained or understood.

That the assertions of patients are altogether untrustworthy may be doubted. A desiccated and dead thorn, lying upon the ground, which on the advent of moisture becomes covered with a mould, may be the means of introducing spores into the human foot; by an individual either accidentally treading upon it, or making use of it as a lancet to open a boil or small abscess. A bruise leading to the effusion of blood beneath the cuticle, might so produce a favorable substratum for the growth of a parasite; just as a bruise of an apple, or pear, is by experiment known to favour the same occurrence. The sole of the foot would here, too, be most liable, or the palm, to such injuries.

It is however evident from the same kind of evidence, namely the clinical history of these cases, that not seldom the tumour began of itself. I should therefore next show that without infliction of any hurt, the fungus-spores may readily enter the foot. Already (p. 44) analogous instances have been referred to; and here special mention may be made of Mr Carter's paper which is abstracted in the Appendix (1862). The following remarks will suffice to show that there is no physical obstacle to the entrance and passage of the spores of *Chionyphe*, into and along the natural channels into the skin, which are presented by the sweat-ducts: thus, the dimensions of these spores being $\frac{1}{8000}$ by $\frac{1}{4000}$ of an inch, the diameter of the openings on the cutaneous surface of the sweat-ducts ranges from $\frac{1}{800}$ to $\frac{1}{200}$ in.; and at their narrowest, when joining their deep-seated glands, the ducts are still upwards of $\frac{1}{1000}$ in. in diameter, or four or five times as wide as the spores themselves. There are no other natural openings in the skin in any part, except the orifices of hair-follicles and sebaceous glands, but neither one nor the other of these organs is present in the sole of the foot and palm of the hand; here, however, the earliest outward signs of Mycetoma commonly present themselves, and this circumstance thus becomes a sort of argument in favour of the view, that fungus-spores usually are introduced through the sweat-ducts, or as an alternative (but less frequent) channel, directly through the skin itself. It is common, I may repeat, for natives of India to present an excessive perspiration of the palms and soles; so that the permeability of the sweat-ducts is probably constant.

As the calibre of the hair-follicles and the attendant sebaceous glands is considerably larger than that of the sweat-ducts, the same line of argument as here adopted, would apply to them: these structures are found in all other parts of the foot than the plantar and inter-articular surfaces, and with them sweat-glands are also present. Possibly their viscid contents would impede rather than favour the inward progress of spores; but it need not be questioned that inoculation of the foot or hand may take place upon their dorsal surface or margins, besides on the palm or sole.

I have, in conclusion, now indicated the three routes by which local infection may occur: namely, through the hair-follicles and glandular ducts, and across their thin walls; directly through the skin, between the layers of epithelium; and lastly, through means of a lesion of the cutaneous surface. As regards the first-named channel, I notice that in

the sole of the foot only sweat-glands are found, and their ducts are here so numerous as to count upwards of 2000 in the square inch.

3. The *proximate* or immediate cause of the swelling of the foot or hand, and of all the hurtful results of the disease in question, is the growth within the textures of these parts of a vegetable parasite.

Of the accuracy of this inclusive statement, I do not myself entertain any doubt; and for evidence must refer to the previous and following sections of this Memoir, which, on each side, convey the necessary proofs.

Addendum.—The question has not here been raised, because there has hitherto seemed no need, as to the possibility of this parasitic affection being transmitted through contact from one person to another. Theoretically the sequence is a possible, nay even a probable one; especially if it be shown that from such small, persistent, and often active organisms as *Bacteria* are ever reproduced the entophytic forms ravaging the foot: as far, however, as my experience extends, I have not seen clear reason for suspicion of contagion, and future observers may be trusted to bear this point in mind. It has already been stated that the system in general is not infected by the entophytic growth, although there seems reason to believe that this latter, in some of its forms, presents the characters of a race of organisms, such as are recognised as vehicles of contagion and systemic infection. A factor almost yet undetermined, is, however, on all occasions concerned; and the mere presence on either cutaneous or mucous surfaces (where indeed they *commonly* abound) of minute particles of living protoplasm, by no means necessarily leads to implication, either local or diffused, of the body at large. Under ordinary circumstances what this factor is which determines that one or two persons only shall become inoculated with the entophyte, where it would appear that several individuals have been subjected to the same influence, is a question I am unable to answer; because of ignorance whether the condition in question attaches to guest or host, or to both in conjunction. By-and-by, these doubtless simple data will be clearly ascertained.

SECTION IV

PROGNOSIS AND TREATMENT OF MYCETOMA

CHAPTER I

PROGNOSIS OF THE DISEASE

THIS subject is one of great interest, but it cannot yet be treated so fully as it merits from want of adequate and suitable data. It may be discussed with respect to both the disease (*a*), and operation (*b*).

(*a*.) Considered with reference to the possibility of either cessation of growth or a spontaneous subsidence of the disease, prognosis must be regarded as unfavorable. When left to itself the malady does not, as an almost invariable rule, cease to spread; and, finally, it causes the death of its victim as surely as does an homogeneous parasite, or tumour formed of zoo-plasmic elements.

Such is the concurrent testimony of all observers who in their writings have expressed an opinion upon this subject: it is, too, my own belief; and, further, I judge that the same conclusion would result from a practical consideration of all that is yet known of the origin, course, and characters of this affection, apart from any theoretical views of its nature. Reference is now made to *advanced cases*, or such instances as commonly come before the European surgeon: and respecting this degree of growth, Dr Eyre well remarks—"the natural course of it is fatal."

I have above stated that the parasitic growth of Mycetoma has no limited duration or life-period; that is to say, the extension of its mass is practically unlimited, and so far from being confined to the foot (in the lower extremity) it has been known to reach far up the leg, and in the upper extremity, the forearm for some distance above the wrist-joint may be implicated: in both instances how much further its encroachments might extend is not known, because the patient has been either relieved by amputation of the affected limb, or he has become so reduced in strength as to be no longer able to sustain the drain on his system, and sinks exhausted in that stage already reached, but not final, as regards his malady.

With present experience, I repeat, it is not possible to correctly surmise whether or not the disease is ever spontaneously arrested in its advance;¹ nor, so far as I am aware,

¹ The only approach to what may be termed a subsidence, or cessation of growth, which I have noticed, possibly occurred in a case which early came before me,

and which I will briefly relate. An adult man, native of an infected district, but ten years resident in Kurra-chee (Sinde), had a swollen and carious foot for upwards

can it be said from examination of specimens illustrating its fullest known degrees of development, that the growth may undergo such a change as is indicative of spontaneous decay; *i. e.* a degeneration of the fungus-mass such as happens with tubercular matter, or with hydatid cysts. Common experience, indeed, is not applicable to such singular disease as that under consideration, which is without analogue in the list of maladies hitherto discriminated. Further, too little is known of the manner in which progresses growth of the fungus-particles and consequent extension of disease, to enable me to say whether or not the former are ever wholly expelled from the human body; but until such event does ensue, closure of the sinuses and subsidence of swelling could not be anticipated. There are many physical difficulties concerned in the bare conception of such favorable termination of Mycetoma, especially as regards its melanoid variety; and on the whole I conclude that the event just mentioned, being improbable, is a term of no practical value in a prognostic calculation.

That a growth of the character producing Mycetoma should be most active and luxuriant at its circumference, or spreading margin, is probable enough, and it may be found that the first-formed *nidus* ceases to furnish new particles after a time; but the ever-spreading ramifications will continue to be fruitful, and no real cessation of these characteristic fruit-products, which cram the tunnels and at last come outside, is at all likely while favorable conditions of growth and development are presented in the human hand or foot.

I will now advert to the prognosis of Mycetoma at *early stages* of the disease. The first remark which here applies is the necessity of accurate diagnosis, for obviously upon a true apprehension of the nature of the tumour, must a correct forecast depend. The diagnostic signs I have already said to be few, but clear: one alone is quite pathognomonic, and that is the presence in the foot of fungus-particles; but for full details I must refer back to Chapter III, Section II.

A true Mycetoma, when small, will certainly grow; hence the prognosis at once merges into other considerations: those, namely, connected with the proper treatment of the growth. This subject will be discussed in the following chapter.

(*b.*) In short, the prognosis of Mycetoma is essentially the same as that of other simple or non-malignant tumours, of a wholly different nature, indeed, but alike in their effects upon the general condition of the frame: and the only modification of this statement

of nine years; the parts about the ankle-joint being alone affected. His history was as follows: he contracted syphilis several years ago, and was salivated; he lost health, and his feet became oedematous, and "soon after this a small hard swelling in the right heel came on" . . . he was again salivated. Finally, Mr B. Rustomji amputated the leg: he found in the removed foot increased vascularity, hardening of the osseous tissue, purulent matter, and impacted in one part a piece of dry date, which had doubtless been there some years, and was introduced accidentally at the time the patient was using date-poultices to his swollen foot; the man some time before had caries of the skull. Mr Rustomji (*loc. cit.*) includes this case amongst others of undoubted Mycetoma, but he notes that it was altogether a peculiar one; and a part of the amputated foot being sent to me at a very early period of my investigations, I recorded as follows (First Memoir, 1860). . . . There is

a part of the foot, including the heel; the outer surface presents depressed openings like cicatrices and white patches. The former led down through thickened integument to cavities in the bones precisely resembling those of other specimens; in front of the ankle-joint there seems to have been the greatest collection of the growth. No white granules were to be detected in the hollow cavity of the bones—*having probably all been discharged prior to amputation*—but a few branches of radiated crystals. . . . The italics I now add. On reconsideration of this instance, with fuller information respecting both the case itself and the disease to which it is referred, I am of opinion that it is not of sufficient authority to warrant a positive statement that Mycetoma may spontaneously subside; for even admitting that the instance belonged to the parasitic affection, yet complications, both local and general, were such as to altogether destroy its typical character.

which seems to be needed is this, namely, that as the fungus-growth ramifies greatly in its progress, its probable real extent should be estimated after the manner of tumours which have a tendency to involve the tissues near them, to a greater extent than at first sight appears. In making this comparison I am aware that the mode of local infection is probably different in the two instances; but the caution implied is not superfluous, and it may be supposed (on grounds which I have elsewhere intimated) that in the skin, and deeper on the exterior of the limiting membrane, or cyst, of the fungus-growth, germs or spores not uncommonly are present amongst the adjoining tissues, and should be excised with the whole mass in order to reduce to a *minimum* the probability of a return of the tumour.

Respecting the rate of growth, or the time which may elapse before a large tumour is formed, there are available no certain data: in Chapter II, Section II, is stated what has become known to me on this subject.

Obviously, removal of a part or whole of a tumour, even if this include the entire growth, does not necessarily interfere with the possibility of a second local infection of remaining hand or foot, or portion thereof.

When, however, a reappearance of the malady occurs at or near the place of prime excision, the strongest presumption will commonly be, that here is an extension of growth from an unremoved fragment previously left behind and unnoticed. Auto-inoculation of a member may indeed, in my view, occur at a distance of some inches from the main seat of growth; and of its existence there need not necessarily be any external sign whatever, for a time; hence there is some risk of spots already infected being left behind, *e. g.* in the flaps, or in untraced deeper tunnels; and this contingency is the condition qualifying the remark last made. There is in this subject room for much careful consideration with reference to prognosis, especially after limited operations on the foot or hand. Amputation is by far the surer cure; and it is to be recommended in those doubtful cases admitting of its entry into a discussion. The ordinary rules of conservative surgery are here applicable, only with obvious limitations which it is enough to here indicate.

Having before stated my opinion that no risk exists in Mycetoma, of the system generally becoming contaminated with organic germs derived from the entophytic growth, I would yet repeat that there are needed for the full completion of our knowledge, such facts as can be derived from autopsy only. Removal of the diseased structures "cures" the patient, in every sense of the word; but whether the measure is a prospective, as well as present, cure, is a question which might not have arisen but for ingenious surmise.¹

¹ I refer to an opinion of Surgeon Godfrey; for once this eminent surgeon wrote thus:—"In a practical point of view it may be observed that should these cases continue without any vestige of disease as at present" (*i. e.* soon after operation) "we have good grounds, free from speculation, to incline to the opinion of this tubercular malady being of local origin in a part destructive of surrounding tissue, and we may fairly infer from the progress of analogous affections, that the whole or some remote parts of the system would ultimately have be-

come affected by the non-removal of the local affection, by contamination."—"Medical Reports," Madras, 1850, page 349.

If it be said that such prospective idea is not yet positively disproved, I will, while withholding consent to the validity of the main argument, yet admit that in the absence of a few trustworthy and thorough *post-mortem* examinations, Surgeon Godfrey's conception may remain to be quoted still.

CHAPTER II

TREATMENT OF MYCETOMA :—*a*, PROPHYLAXIS ; *b*, GENERAL TREATMENT ; *c*, EXCISION OF THE DISEASE ; *d*, LOCAL APPLICATIONS

Treatment of Mycetoma.—This subject may be considered either with regard to the extent of local disease, or with respect to the kind of remedy proposed. I have, however, said that Mycetoma must be practically viewed as belonging to the class of non-malignant tumours, and hence its surgical treatment most demands attention. A few remarks may precede that topic, in order to render the whole subject of treatment more complete.

a. Prophylaxis, or *preventive* measures, have yet to be defined ; but on the views here proposed, may be recommended strict cleanliness of the feet, especially during the rainy season, the wearing of shoes out of doors, the avoiding of injury to the bare foot, or the use of thorns, &c., to open abscesses. If the local conditions were thoroughly studied in a village or limited tract, where Mycetoma has proved to be endemic, it is probable that a surgeon and botanist would be able to devise a means of preventing or destroying the parent fungus, during its brief time of flourishing, by some simple measures which would save much suffering when applied to the country generally. The daily application of wood ashes or tarry liquids to the feet during the rains, may be provisionally recommended as an additional prophylactic ; and some sort of sandal should always be worn.

b. Next, it may be sufficient to briefly state that the *general treatment* of this affection cannot, so far as present experience goes, be regarded as at all satisfactory in its results. I believe it is the universal opinion that, as far as local swelling is concerned, the use of tonics, whether general or special, and of absorbefacients, such as the preparations of iodine, &c. (mercury would be inadmissible as an experiment), is not attended with decided benefit. The health of the patient may by certain measures be improved, and the advantage is to be noted ; but as long as the local growth remains there is no approach to a cure. This fact is a very important one, both in itself, and in its bearing on our views of the true nature of the malady. I will, therefore, repeat that were Mycetoma of a simple carious or strumous nature, we might hope to do much good by constitutional treatment, aided by rest of the limb, and by removal, it may be, of the more affected structures ; because, under these circumstances, a beneficial reaction of the system sometimes results,—local morbid processes ceasing, and a more healthy state supervening. Of course, strumous disease or simple caries of the tissues (*e. g.*), when it has arrived at a stage entailing so much disorganization that partial excision would obviously be of no use, is not to be cured in such manner ; but so desirous have English surgeons always been, of preserving for use even parts of a member, that had this end been as attainable in the Indian foot-disease as it sometimes is in strumous affections, &c., amputations of the leg would not have been so commonly and long resorted to. This topic is one regarding which opinions will differ, but I view it as a significant fact that surgeons in India, while commonly regarding the foot-disease as a tubercular or a constitutional affection, have in practice

not hesitated to amputate the leg, without persisting in attempts at relief by general treatment and limited local measures.

In the absence of adequate personal experience respecting this particular subject, I must have recourse to the recorded opinion of others whose opportunities of trial have been greater than my own.

Mr Eyre remarks (*loc. cit.*):—"In one case I made fair trial of issues and a course of Liq. Arsenicalis, but without the least benefit, although the instance was a favorable one, the disease not having made great progress, and the patient's constitution being yet good. The man returned a year after with the foot in an advanced stage of disease, underwent an operation, and quite recovered."

Dr Collas (*loc. cit.*) observed:—"Tonics were fully tried, according to the idea that he had to treat with a scrofulous affection; but they had not the least effect, whereas they had never, in the author's previous experience, been inefficacious in *caries*."

Mr Bajonji Rustomji comments, in his notes (*loc. cit.*), to the following effect:—"Looking upon the disease as a species of *caries* peculiar to India, he treated the first case, in an early stage, with the remedies which are useful in true *caries*. He gave his patient cod-liver oil in two-drachm doses twice daily, after meals, for a month, and tried the potassic iodide in small doses twice daily, in infusion of chiretta, for a fortnight, without benefit. Accordingly, Syme's operation was performed, and the boy recovered. He was still well seven months afterwards."

Other surgeons have in a manner more summarily, but equally emphatically, declared their opinion that general treatment occupies but a subordinate place in the cure of Mycetoma; and this common concurrence must properly, I think, be regarded as decisive, although it may be admitted that full and adequate trial of drugs has, seemingly, seldom been made. I could not myself hope to see eradicated the growth in this disease, whether in its early or in its later stages, from the internal exhibition of any remedies with which I am acquainted; nor is this statement made solely on account of the views of its nature, which I hold to be correct. Should, however, these views be adopted, the inadequacy of general treatment will become, as it were, self-evident.

Nothing here said is intended to interfere with suitable medical treatment previous to or during, or after surgical aid has been ministered, and in any form bearing upon improvement of the general condition of the patient.

c. Local Surgical Treatment.—This includes all excisions by the knife, with the object of directly removing the whole of the foreign growth. The use of caustics and application of the actual cautery, in order to destroy the tumour, leaving it to slough away; and the employment of other chemical agents, will be afterwards considered.

1. *Excisions.*—Under this head I include cutting operations. These are (*a*) amputations and (*b*) excisions so-called.

(*a*) *Amputation.*—Commonly the disease is seen only in its advanced stages; that is, when the foot (for example) is hugely swollen, utterly useless to the patient, and a source to him of inconvenience, debility, and disquiet. Under these circumstances *amputation* of the leg is the only known remedy; and it is a perfect method of relief, inasmuch as the patient's sufferings are by it ended, and his disease is completely eradicated. I have already remarked how little the largest tumours may have implicated the general health; and this feature is an encouraging one, with respect to the prospects of so serious an operation as amputation of the leg. A certain risk is inevitable, but how slight this is as compared with that pertaining to amputation under other circumstances, where, for instance, the constitution is implicated, or local violence has preceded, sufficiently

appears from the recorded experience of independent observers in many parts of India.

Numerous isolated instances will be found distributed through the medical journals published of late years in India, of amputation or other operation on the foot on account of this disease; the result being in all of them, so far as appears, that the patient survived and was restored to health. The several cases which I saw, or had charge of, in Bombay and Satara, also recovered after operation (capital). The seven cases recorded by Mr B. Rustomji, namely, six of amputation of the leg, and one of Syme's operation on the foot, all recovered: another successful instance is included by the writer, but I regard it as a doubtful example of the fungus disease. We possess, however, even more satisfactory, because larger and more continuous, data in the account furnished by Mr Eyre (*loc. cit.*), who writes as follows under date 1859:—In Bellary the diseased member has been removed 34 times, and in 30 with perfect recovery: in Guntoor 26 cases operated on all recovered, and in Cuddapah 4 cases were successful. Mr Minas, too (*loc. cit.*), gives notes of 26 amputations or other operation for this disease, after all of which complete recovery ensued. For convenience, the combined number of the two last-named authors embodying their experience up to a certain date, may be thus arranged:—

<i>Surgeons</i>	<i>Eyre</i>	<i>Minas</i>	<i>Total</i>
Cases recorded	70	37	107
Amputations	64	26	90
Successful	60	26	86
Deaths	4	0	4
Death without operation	4	1	5
Refused operations	2	0	2
Otherwise treated	0	10	10

It hence appears that the fatality of amputation of the leg, on account of Mycetoma, is rather more than 4 per cent.; and small as is this ratio, it would be less were I to add the other successful cases above referred to. There is not, however, any need to insist upon a point now sufficiently obvious: I therefore conclude that operative procedure for the cure of Mycetoma has proved to be singularly free from risk; and this fact will serve both to encourage the surgeon in India, and to enlighten him respecting the true nature of the affection he is dealing with.

Respecting the variety of disease in the above instances, I may add that Mr Minas' cases from N. India were all of the first or black form; and Mr Eyre's from S. India probably belonged, in most part, to the second or ochroid variety of Mycetoma: the distinction is noteworthy, but need not be insisted on here.

Further details regarding these statistics are the following. The fatal cases after operation were first:—A man who was a drunkard; the wound was doing well, but violent delirium came on, ending in fatal coma. In two other cases a cachectic state was present, resulting in dropsy and diarrhœa. Of the fourth there is no record. Two patients refused operation, only to return long after with a foot much diseased and health impaired; they sank from diarrhœa, without any operation, and such termination would seem to be a 'natural' one. A scorbutic state, I may add, is not an uncommon complication in India.

In concluding that Mycetoma is a purely local affection and its removal a complete cure, Mr Eyre adduces the following valuable memorandum:—The history of twenty-two individuals has been traced subsequent to the operation with these results:—eight between 6 and 12 years, and fourteen between 2 and 5 years had the

remaining foot sound and health good.¹ Some other writers have also been able to speak favorably of the after results of complete excision of the disease; and on the views propounded in this memoir, there are rational grounds for supposing a perfect cure to ensue in all instances of mycetoma thus treated.

Of amputations of the *thigh* on account of Mycetoma I know nothing, except by report. Instances of this operation have seemingly occurred, but with the details I am not acquainted. At the present day such extension of the growth would rarely happen from surgical aid not being available in time, before disease was checked.

Respecting the mode of amputation to be preferred, opinions will vary; the circular method is that which I adopt for the leg, and it has always been readily performed.

Lastly, it is not a useless caution to insist upon the necessity of thoroughly examining both soft parts and bones belonging to the stump at time of operation, in order to make sure that no outlying branch of the growth is left behind.

b. Operations on the Foot or Hand.—In the hope of saving a portion of the member, surgeons have sometimes had recourse to the operations known as Syme's, Pirigoff's, and Chopart's; amputation of the toes only and of the fingers has also been practised. It is commonly said that these limited excisions were successful at the time, but it is not certainly known, in the great majority of cases, whether or not the malady reappeared in the leg or hand. There is, indeed, no valid reason for supposing that if the removal of the growth by these methods is absolutely complete, an effectual cure has not been obtained. I would, however, invite attention to my remarks on the pathological anatomy of Mycetoma, and on the modes of growth of the tumour; because, if a fragment of the fungus-bearing tunnels and cavities be left behind, or a portion of skin containing incipient disease, there would be imminent risk, in my opinion, of the continuance of growth and appearance of a fresh tumour. And herein lies the difficulty, that previous to operations of this kind, it cannot be positively determined that the growth does not extend beyond or above the lines of incision.

No idea can be more fallacious than the presumption that the bones of the leg are never affected in Mycetoma.² There is, indeed, no sure guide whatever in this matter; and I have myself found, in the first case reported above (page 3), that where the tumefaction

¹ In a supplementary note Mr Eyre subsequently adds that he has received information from another of the more infected districts of Southern India; Dr Colebrook writing to him from Madeira thus: "During the eleven years of my incumbency in the Madeira Zillah I never knew the disease to reappear." This emphatic testimony is very valuable and entirely corroborative of experience in other quarters. Having searched into official documents Mr Eyre appends the results.—I have extracted 40 cases of this disease of the foot from the Returns of the Dispensary at Madura, in all of which amputation of the leg was performed, the consequences being in 32 recovery, and in 8 death. Four other cases having been seen at Bellary, the grand total of instances of mycetoma within the range of Mr Eyre's investigations now becomes 114; amongst these 108 amputations were performed, with the result of 96 recoveries and 12 deaths, or a mortality of about 12 per cent. This ratio is considerably higher than that mentioned in the text, and so far the latter should, perhaps, be modified; but it is obvious that while a large variation exists in the rate of mortality after capital operation

in this disease, this rate does not ever attain the high per-centages we are familiar with in Europe. Not inappropriately, therefore, does Eyre remark, "The utility of the Civil Dispensaries (in India) receives an additional testimony from this one disease. The natural course of it being fatal, sixty lives have, within a limited period of time, been saved in the Bellary and Guntour districts by the surgical means afforded at the Dispensaries."

² As illustrating a complication which may attend Mycetoma as well as other morbid tumours, I should refer to an interesting case (2nd variety of the disease) under the care of Drs Miller and McDowall, and reported by Dr McDowall in the 'Bombay Medical Transactions,' vol. ix, p. xxxii (1869). There was obstinate bleeding from the medullary canal of the tibia, necessitating amputation of the thigh; and then only arrested by mechanical plugging of the femoral shaft. Vol. x (1870) of the same 'Transactions,' which I have but just seen, contains "Notes on Mycetoma, &c.," by Mr. Holmsted. —See Appendix.

of the foot was by no means marked, yet the tibia, at a distance of between one and two inches above the ankle-joint, was the seat of two distinct spheroidal growths; and, on the other hand, I have more than once seen a large globular tumour of the foot to be unattended by any implication of the leg-bones. Hence, before an operation of the kind under consideration is concluded, most careful search should be made for burrowing or hidden growths; and whenever, after the performance of an operation, even a suspicion as to their remaining behind arises, the operation should be regarded only as an equivocal cure, for I do not suppose that the process of suppuration will inevitably destroy such remnants, any more than it does overlooked or unseen myeloid or fibro-plastic deposits belonging to other incompletely removed tumours.

Respecting these limited operations upon the foot involving some one or other of the tarsal or metatarsal bones, it is proper to remark that they were long since practised; *e. g.* Mr Eyre states that "Godfrey resorted to amputation of the leg where the bones of the foot were (all) involved in the disease; but to Chopart's operation if the *astragalus* or *os calcis* remained sound;" and of late times there has been witnessed an increased disposition to resort to partial amputations of the foot in place of removal of the whole member. I should myself employ the same more conservative procedure, did occasion seem fully to warrant its adoption; but I am bound to state in this place, that not a little discretion is needed, in both deciding upon the kind of operation to be performed and in giving an opinion as to the subsequent events. That this caution is not unnecessary will appear from even the few unselected instances which I hereto append, since a reappearance of the tumour is actually mentioned more than once; and I would especially draw attention to Mr Minas' case, because one would think that amputation of a segment, so distinct from others, as a finger or toe, would rank as, perhaps, the most favorable of all these partial operations on the foot with reference to prognosis. It is true that the surgeon was of opinion that the disease recommenced *de novo*; but this circumstance is probably open to question in the light of other facts.

What difficulties may be most unexpectedly met with in attempts to cut out the parasitic growth alone, leaving part of the foot itself, will be sufficiently apparent from the account of Dr Spencer's very interesting case quoted below.

The following cases and memoranda will illustrate my remarks:

A woman, *æt.* 22, was admitted into the Jansetjee Jejeebboy Hospital, in August, 1854, whose left foot had been affected for seven years; her general health was good. Syme's operation was performed; but a few months afterwards small abscesses had made their appearance in the neighbourhood of the stump: further treatment was declined by the patient ('First Memoir,' 1860).

I have above referred to a case of Mr B. Rustomji's, in which also Syme's operation was practised: the patient was a lad, *æt.* 17; the duration of the disease is not stated; the patient recovered, but his subsequent history is not stated after the first few months.

Dr Aitchison records (*loc. cit.*) an instance in which he performed Syme's operation, and that at the time with success.

Dr Rogers ('Bombay Transactions,' vol. iv, 1858-59) describes a case in which Chopart's operation on the *tarsus* was performed, also successfully. The subsequent history of this interesting case is, like that of the preceding one, not known: that the disease in both was Mycetoma appears to me almost certain, from both the surgeon's statements and the descriptions appended, but the fungus particles are not particularly noticed in either instance.

Advanced stage of the disease. Pirigoff's operation.—A man, *æt.* 36, had a tumour of the right foot (1st variety), of which the following is a short description:—the foot was swollen and the skin discoloured (black-

ened) to a hue corresponding with the astragalo-scapoid articulation: more skin was involved in the outer than on the inner side; heel free from disease; the small sinuous openings on the dorsum of the foot had all healed excepting one, and from this no black matter was issuing; but there could be no doubt whatever as to the nature of the disease, from the appearance of the foot and the previous history. Pirigoff's operation was practised in this instance; but on examining the stump four or five centres of disease were discovered, and had to be cut out: "this I certainly did not expect to find; these black centres (if I may call them so) were found alike in muscle, fat and skin; the tissue about each spot was destroyed and rendered tough and fibrous; these black bodies were sometimes found loose, as it were, in the muscular structure, sometimes inclosed in a membrane, but more, they were found in funnel-shaped cavities of dense parchment-like tissue. . . . The structure of the tissues in which the black bodies are deposited apparently go to form this parchment-like texture, the original tissues becoming disorganised." "In tracing back the skin of the upper flap I was as much astonished as chagrined to find the end of the *tibialis anticus* muscle projecting from the wound like an opening convolvulus; the skin was reflected back and the mass pulled out and about one inch and a half cut off, well clear of the affected part; the funnels contained black matter . . . : the invasion of the disease was probably of recent date; strong nitric acid was freely applied. . . . *Remarks* by the operator.—My diagnosis was imperfect, but I think I had every reason for coming to the conclusion I did, and none for coming to an opposite conclusion. The colour, touch, and appearance of the foot, all supported the opinion, that by amputation through the ankle-joint, flaps free from disease would be secured. The skin around the internal malleolus being healthy, enabled me to make sure of avoiding the posterior tibial artery. . . . Chopart's operation, I thought, would be too near the disease, but it was not doubted that Syme's or Pirigoff's would be surely and completely beyond it: on the discovery of disease in the flaps, the question arose as to the advisability of at once amputating the leg . . . should the disease re-appear this course can then be adopted.—Dr Spencer's case, quoted by Dr W. J. Moore, 'Indian Medical Gazette,' November, 1873.

Mr Minas (*loc cit.*) records the following interesting notes:—In only one instance was a second operation necessary. In this case I only removed a toe, and after a year I had to amputate the leg. I was not able to ascertain whether the disease began *de novo*, or whether, after the first operation, a diseased portion remained behind unobserved; but as I took particular care to remove all the diseased tissue that I could find, I am inclined to believe that the former was the case. The following appears to be the case alluded to by Mr Minas:—A Mussulman, æt. 35, for two years sick; the disease was confined to the ball of the great toe of the left foot; the toe was removed at its articulation, with the internal *cuneiforme* bone. Three years after the same foot was much worse, and amputation below the knee was required.

c. *Excisions of the Skin or Soft Parts only.*—As attention is now being directed to the detection of Mycetoma by surgeons in many parts of India, it may be anticipated that the disease will become better known, earlier detected, and earlier treated. I may quote the instance mentioned in my first memoir of an early excised tumour as evidence that at a certain *incipient* stage (as it may be termed), the whole of the fungus growth may be removed. Dr Wilson's remarks and my description should be referred to (see page 11). It will there be noticed that the diagnosis of the disease was not positive, but the case proved to be a genuine one: I do not know anything of its further history. In that instance there were two separate and distinct tumours in the same foot, and this circumstance it is important to notice with reference to practical measures.

Doubtless many other instances of removal of the incipient tumour have happened subsequently to the above mentioned; but as I have not met with records so full and clear as some of later date, which, too, especially refer to the early or preventive treatment of Mycetoma as a subject needing investigation, it will be sufficient to select from these latter cases some illustrations of the practicability of the measures in question.

Cases by Dr Eddowes (Ind. Med. Gaz., vol. ii, 1867):

1. A young woman, in good health, had had for seven months, in the sole of one foot, a flattened swelling, or rather thickening of the integument, of an irregular shape, and measuring, in its broadest part, about three

inches. The surface was marked with white patches, and had five or six small circular orifices. Around these openings the skin was indurated, and from them exuded a watery discharge, along with which were occasionally mixed a few black gritty particles, having the appearance of gunpowder.

Treatment.—After the application of poultices for a few days I dissected out the whole of the thickened integument, including a finger's breadth of the adjoining sound skin. Potassa fusa was then carefully applied over all its denuded surface. Afterwards turpentine dressings were used and the wound healed.

2. A second case, remarkably similar in several respects, and from the same village, but not stated to be a relative, is next given. This woman also recovered.

3. A young Brahman, whose foot had been affected twelve months, was next operated upon in a similar way; but it seemed a far less favorable case than the above, because a large surface of both dorsum and sole of the foot was implicated. The operation is thus described:—Under chloroform I carefully dissected off the diseased integument, commencing on the dorsum, and carrying the incision between the toes to the under surface of the foot, removing all the affected tissue, and taking care to include a margin of sound skin. Potassa fusa was applied . . . During the healthy process, in one or two points of the circumference of the wound, a few small black granules appeared; these, which were of a very hard texture, were easily removed by a probe, and the strong nitric acid was applied to the surface on which these granules had formed. No second application was necessary, and the wound healed, leaving a large cicatrix, which, however, gave rise to no inconvenience. The author adds that, in publishing these cases, his object is to show that amputation is not necessary in all cases of the disease.

Dr Jayakar writes from Ahmenadab, in Guzerat, as follows (Ind. Med. Gazette, August, 1871):

CASE.—Commencing fungus disease, in a woman aged 30; the black variety, affecting the right foot. *Operation.*—Having made an elliptical incision widely around the fungus-nodules, I excised the part, the disease being rather superficial. It is to be hoped that this plan may prove efficient in removing the fungus growth in its commencing stage, if it come early under observation; and in time may be the means of saving numerous limbs every year.

Dr W. J. Moore (Ind. Med. Gaz., Nov., 1867) mentions the following case:

An adult Hindoo had his foot affected over a space of one inch and a half in diameter above the external metatarsal bones, where the skin presented a peculiar nodulated, mottled appearance, pathognomonic of the fungus disease.

By manipulation it was found that the diseased structure was apparently free from adhesions beneath. Chloroform being administered, excision was practised by a crucial incision over the diseased skin, and dissection of the morbid tissues . . . I found, however, that the granular blackened formation passed down between the metatarsal bones, and I was, therefore, under the necessity to use the handle of the knife pretty freely, in order to detach this material. The base of the last metatarsal bone appearing affected, a portion of this bone was also removed. For some days black granules were discharged or picked from the wound with forceps, healing being purposely prevented by filling the wound with lint. In the course of a few days a simple purulent discharge alone remained, and the wound healed very favorably.

The same author subsequently (Ind. Med. Gaz., Nov., 1873) refers to the above instance, and mentions others, which I also quote:

In three cases of incipient disease I have incised the integument, and cut or scraped away all the diseased tissue. One of these cases, on the dorsum of the foot and involving a metatarsal bone, "is reported above;" another case was in the sole of the foot, and the disease did not penetrate the deep fascia: the third case was on the dorsal surface of the foot, but involving the bone . . . It was ascertained, more than eight months afterwards, that the two last patients remained well; and as nothing was heard of the first case after the man left, his permanent recovery may be inferred.

Dr Spencer's case of incipient Mycetoma thus treated (quoted by Dr Moore, loc. cit.) was briefly as follows:

The *tarsus* of the right foot was affected, in a woman aged 30, married and in good health. The disease was

of the first variety, black particles being found. The patient suffered a good deal of pain and constitutional disturbance. The bones of the foot were not affected, although the disease had extended down between the metatarsal bones. Complete recovery from the operation ensued. The deposit in this case was evidently superficial (duration of growth eight months). There was little or no swelling. The natural shape of the foot was unaltered, and the sole of the foot was not implicated.

Experience of the kind above narrated will doubtless become more general; but it would be well for surgeons to make such record of their cases as will enable subsequent inquiries to be made, as to the persistence of a cure after two or three years, or such time as might fairly be regarded as a sufficiently long interval to permit of hidden growths, which might be left behind, again coming to light. Only in this way can the proper value of limited operations upon the foot, in Mycetoma, be adequately estimated. At present, it must be said that their permanent utility has yet to be established.

d. 1. *Eradication of disease by application of caustics, or the actual cautery.*—When the fungus disease exists only as a small induration of the skin, it may possibly be treated with permanent success by simple destruction of the parts apparently involved; but the event of such favorable result is, obviously enough, contingent upon complete eradication of the primary growth.

Caustics may be combined with excision, as has been above shown, and I will here add other instances mentioned by Mr Minas (*loc. cit.*), eleven of whose cases were treated otherwise than by amputation, being those referred to in the table at page 57. In all, the disease had first manifested itself in some part of the sole of the foot, and had not extended far, although its duration varied from two months to as long as seven years; of the eleven cases (who were all adults), four were regarded as cured, six were relieved, and one died. The average stay under treatment was only twenty days. "The diseased tissues were destroyed by the application of nitric acid, or removed by the scalpel, poultices being afterwards used: internally was exhibited potassic iodide, with Decoct. Hemed. Indic. Several patients when relief was afforded, and they were able to walk, returned to their homes: those returned as cured I have had no opportunity of seeing, and therefore cannot say whether the cure was permanent or not."

Of the *caustics* to be recommended, those in a liquid form would seem to be preferable, such as the strong mineral acids, chloride of zinc, or potassa fusa; carbolic acid, creasote, the compound tincture of iodine, &c.

The usual precautions would have to be adopted; and part of the tumour, only, at one time, need be attacked.

As an example of the method of eradication by *caustics*, and at the same time as indication of its early adoption by an intelligent graduate of Bombay, I quote the following memoranda from Mr Sudasew Hemraz:—In a case of Mycetoma of the foot, in the early stage of the disease, that is, in which the bones were not as yet affected, I applied strong *nitric acid* repeatedly, as far as I thought the whole of the diseased part was destroyed, and I have every hope to believe that the disease will not return: the following are notes of this case. Kesur, a Mussulman camel-driver, aged 25, native of a village near Khawda, about forty miles to the north of Rhooj, presented himself at the dispensary in the beginning of June last, with a small, hard, flat swelling on the sole of his left foot: this was penetrated by four small openings, which gave exit to thin, sanious discharge, occasionally mixed with dark-coloured granules, like seeds. He said the disease commenced about seven months ago by a small, painless swelling on the sole of the foot: it commenced to slowly extend, and remained painless for about five months; but about two months ago it became very painful, burst, and discharged dark-coloured, seed-like particles, along with some purulent matter. Since then three other openings have formed in a similar way.

Strong nitric acid was applied over the whole of the swelling for five days repeatedly; and afterwards poultices were used, when the whole of the slough came away, leaving a healthy, granulating ulcer, which is slowly healing (July, 1862).

As an illustration of the treatment by the actual *cautery* I may refer to Dr Aitchison's article published in the 'Indian Annals,' No. XIV, 1861 :

The second case therein narrated was the following:—An adult woman had disease of the wrist for two years. No other part was affected than the skin and subjacent tissue, where tubercles were present with superficial sinuses. The actual cautery was applied on the dorsal and palmar aspect of the wrist; the sinuses closed, and on the sore healing no deformity remained. The author being of opinion that this peculiar affection is owing to the deposit of tuberculous matter in the subcutaneous cellular tissue, spreading from hence; also thinks the actual cautery may effect a cure when disease is confined to superficial parts of the foot. While I did not find in the case above referred to, any conclusive proof that the instance was one of Mycetoma (there being no mention of fungus-particles), I would not dissent from the view that there may ensue a permanent cure through efficient use of the cautery, in certain selected cases. Here, however, as elsewhere, it is necessary, for conviction, first, to make a correct diagnosis of early disease; and, next, to obtain evidence of thoroughness of the cure from the subsequent history of the case.

On the whole, the employment of the remedies now indicated would seem to require as much judgment as, and more perseverance than, are needed in the limited use of the knife. As a conjoint means with the latter, they may be very useful when other measures are declined by the patient; but only with an obvious reserve as to future consequences.

2. *Eradication of the disease by local measures other than caustics and the knife.* The use of *parasitocides*.—The plan of directly attacking, as by injections and local application, the entophyte peculiar to this disease, would on first thought seem almost as feasible as it is promising in good results. One could suppose that the life of the parasite becoming extinct and its growth, therefore, arrested, extension of the foreign bodies belonging to it would be effected in the usual way; and so the patient be rid of his malady without, at the same time, enduring the pain or risk attendant on cautery, excision, or amputation; or losing part or whole of a useful member of the body.

But, on consideration, these soon become obvious impediments to the realisation of such desirable results; and these will be found to arise from both the character of the malady, and the want of suitable remedial agents. These points may be briefly discussed, although after a manner which must be viewed as suggestive rather than strictly practical.

First, as regards the complaint itself; only in incipient disease, or where the growth has not extended deeply into the foot, might it be hoped that the canals or tunnels, which contain the parasitic elements, would be accessible to the influence of fluids or solids introduced or injected into their orifices or the skin. When, on the other hand, the characteristic sinuses are numerous, long and tortuous, it would, apparently at least, be impossible that a fluid even forcibly ejected along them, could ever reach the terminal or lateral cavities in which are lodged the larger masses of growth: for these tunnels are either already occupied by liquid discharge, gelatinous material or solid particles; or were they empty, the establishment of a current through them would be contingent on their not being closed at their ends, or freely communicating with other pervious passages. By laying open the more superficial of the tunnels or sinuses, the deeper ones might be more

effectually reached ; but in no case when the growth has ramified, as it may, quite through the foot, could we hope in this way to eradicate the whole. Only this can be said, that a liquid will penetrate further than the point of knife may reach ; and also that one may aim to destroy the vitality of the growth with as good hope of cure as by at once excising it, and with less perhaps of risk.

These before-named objections being really hypothetical, I am not prepared to deny that, by dexterity and perseverance, tumours of small size might become permeated by chemical solutions ; and when of considerable dimensions, that successive portions of them might be thus saturated, with the result of killing the parasite, or at least of preventing its extension.

Thus far for theory : the peccant agent is the parasite, and to get rid of it in an effectual manner is to make a virtual cure. Certain agents are capable of killing other vegetable parasites ; and it is sought to make use of them in this the most serious of all local maladies of the kind.

2. But so far as I know, there has not yet been made known any substance which not being at the same time a caustic, will destroy the life of a compact organism like the *sclerotium* of moulds. There are known, indeed, many substances which prevent fermentation or putrefaction, and, in general, the advent of low vegetable growths ; but few, if any, which, having the faculty of at once killing such growths, could be suitably employed in Mycetoma.

A notable distinction here obtains between preventive and destructive agents ; it being clearly far more difficult to eradicate a plant than to prevent its growth. Thus one or two drops of creasote added to a hundred cubic centimètres of any liquid are sufficient to oppose the development of the spores of fungi and germs of infusoria ; but to kill previously developed organisms, a much larger quantity is required, or else more active agents (Béchamp). From his numerous experiments as to the power of destroying microscopic life, by the addition of some one or other of thirty-four reputed agents of the kind under notice, Dr Calvert (Proc. Royal Soc., Feb., 1872) found none to be thoroughly efficient.

On the views which I uphold, the truest analogues of the fungus of the human foot will be found in the parasitic entophytes which attack plants, and in the epiphytes which are common in the hair, &c., of many living animals. Such treatment, therefore, as has proved useful in eradicating these pests, should be here briefly considered in a practical point of a view.

a. As respects the preventive and destructive treatment of moulds, &c., attacking the cereals, potatoes and hops or the vine, &c., not much that is applicable to the present instance can be gleaned from the records of measures hitherto proposed.

The *prevention* of the smut, or bunt, &c., is recommended on principles inapplicable here : for the soaking of grain, or manipulation of tubers, &c., previous to their being sown, does not concern the present subject.

And regarding the *destruction* of these pests, as a matter of fact there are not known any remedies which on mere application will eradicate them, or which if reputed to be efficacious, could be suitably employed in the cure of the human foot-fungus.

I refer to such agents as the following :

Sulphur—to be dusted on the plant.

Hydro-sulphuret of lime (so termed; and made by boiling together in water, sulphur and caustic lime)—to be sprinkled freely.

Penta-sulphide of calcium (so-called), &c.

Aqueous solution of sulphurous acid; strength 1 to 4—6 water.

Charcoal.

b. As regards the parasiticial agents in common use for destroying Fungi which attack human *hair*, &c., they are numerous enough, and of some it is asserted that they are very efficacious. One advantage which attends their use outside—namely, that they can be thoroughly applied by means of friction—is necessarily wanting in the serious foot-disease; and the defect is almost a fundamental one.

The following is a list of some of these agents; those more likely to be beneficial are italicised, and suggestive formulæ for their use in Mycetoma, may be found in standard works on skin diseases, &c.

Acetic acid.

Corrosive sublimate in aqueous solution.

Carbotic acid do.

Sulphurous acid do.

Sulphuret of potassium do.

Hyposulphite of soda do.

Borax do.

Carbonate of copper do.

Tinct. Iodin. co. (diluted).

Oil of juniper.

Lime-water.

Tar.

Iodide of sulphur.

Mercurial salts (galenical), to be introduced in semifluid forms, &c.

Sulpho-cyanide of potassium, $\frac{1}{2}$ oz. to viij oz. water, is said to be a powerful poison to vegetables, and not in the least poisonous to man as thus used externally.

c. I have above suggested that the parasite of Mycetoma is either originally, or in one of its stages, naturally allied to the *Schizo-mycetes* (de Bary), *i. e.* to *Bacterium* or *Micrococcus*; and since there are known certain non-caustic drugs, which have the property of checking the development of these low organisms, one might hope some good to result from their use in this Eastern foot-disease. By experiment it has been shown (Baxter) that Quinia and the other alkaloids in Peruvian barks, in even weak solution, prevent the growth of *Bacteria*: Sulphate of Berberia is as efficacious as Quinia; Potassic picrate, Strychnia, Sodid sulpho-carbolate, also act decidedly in the same way, while Sodid sulphite and hyposulphite possess little or no effect of the kind.

It seems to me that (taking suitable cases), there would be no objection to making fair trial of a solution of Quinia as an injection, to be forced into the sinuses of the foot affected with the *ochroid* variety of Mycetoma; the intention being to check the increase of the growth, or even to effect its destruction.¹

As, however, the substances above named have avowedly no influence in preventing the development of moulds (as *Penicillium*), one could not anticipate any early good effect from their employment in the *melanoid* variety of the foot-disease.

d. As allied to the last series, I may mention the agents which are reputed to be *antiseptics*, as a group in which might be found remedies serviceable here. There exist

¹ Dr Calvert found that in solutions of sulphate of Quinine vibrios appeared after twenty-six days, but no fungi during the entire period of the experiment.

Pepper, &c., is stated to have the power of preventing the growth of fungi (loc. cit.).

long lists of antiseptic substances, but amongst these are only a few which could be fitly recommended here. Thus in addition to those before named are included—

The mineral acids.	Alum.
The alkaline hypochlorites.	Alcohol.
Common salt.	Pyroxilic spirit.
Nitre.	Creasote.
Chromate of potash.	The ethereal oils.
Chloride of zinc.	The empyreumatic oils.
Sulphate of iron.	Tannic acid.
Sulphate of copper.	

Phenol prevents the appearance of moulds in milk. Benzol interferes with the action of yeast. With respect to the action of sodium sulphite and hyposulphite, arsenious acid, alum and potassium chlorate, they do not prevent meat impregnated with them from becoming putrid and covered with mould, even in the course of a week. Formic acid and metallic formates interfere with the development of fungi, but do not prevent meat becoming putrid.

The tincture of valerian has been strongly recommended as a cure for the *Filaria*-disease in Western Africa, but on fair trial in Western India, I did not find that the drug caused speedy or ready expulsion of the guinea-worm. Assuming that such odorous agents operate by impregnating the lymph-spaces, and so reaching the food of the parasite, their use could not be anticipated as beneficial in Mycetoma, even if effective in *Filaria*-disease.

Summary of this Sub-division.—The prevention of the parasitic growth peculiar to Mycetoma is only to be effected, under present knowledge, by general means, such as cleanliness and protection of the feet, &c.

The spreading of the entophyte within the foot may possibly be arrested by the use of agents which destroy its vitality, or which render sterile the *nidus* or place of growth of the entophyte.

Eradication of the growth is possible by means of caustics, which at once destroy both plant and soil around.

These statements convey the more favorable estimate of such local measures as I have been considering; but future investigations will have to determine the precise means to be employed in attaining useful results, other than are arrived at by the use of the knife: I can here but furnish suggestions.

SECTION V

NATURAL HISTORY OF MYCETOMA

CHAPTER I

DESCRIPTION OF THE PARASITIC GROWTHS:—1, SCLEROTIA; 2, MALACOTIA

I. *The Sclerotia (Melanoid variety): general description.*—These hard, black particles are in appearance the most characteristic elements of the disease. Commonly their size ($\frac{1}{20}$ to $\frac{1}{3}$ inch diameter), is not larger than the head of a pin, but they occur of all intermediate dimensions up to that of a pistol-bullet; or by blending of several particles, the masses may attain an even much larger volume. Their surface-colour is intensely black, or very deep brown; and the consistence firm, sometimes even hard; at other times friable or comparable with that of rotten wood. Their exterior surface is bossed, mammillated or tuberculated, so as to present a mulberry-like aspect when viewed with a lens; the form of these particles varies according to size; the larger being more or less spheroidal, and the smaller ones rather resembling botryoidal, often flattened, fragments, which have become free by detachment from the peripheral layer, or rind, of the larger particles. It hence appears that the more perfect individuals are those which attain a certain volume—probably not less than $\frac{1}{8}$ inch, but commonly much larger; and that the lesser fragments which abound in the fluid discharged from the openings in the diseased foot are, in reality, the numerous fruit-bearing segments detached and passing onward to their destination outside the body. Obviously the larger masses above referred to could not, on account of their dimensions, travel in a similar manner along the efferent canals; they, therefore, remain in their loculi, and probably continue to germinate for years.

The general structure of these several bodies entirely bears out the inferences just mentioned:—thus, the larger typical masses (which have been roughly likened to minute “truffles”) are found to present on section a rich, deep brown colour to some extent contrasting with the thin, jet-black peripheral portion or rind, and the cut surface is also marked by a radiated aspect, indicative of the course of the numerous fasciculi which compose the bulk of the particle. These branching filaments radiate from the centre to the circumference, in a very regular manner; they are closely aggregated, frequently divide or give off lateral branches, and sometimes blend with neighbouring fasciculi; they appear somewhat knotted in contour, and are cylindrical in form. Their peripheral extremities, and in some cases the lateral branches, bear one or more deep-tinted, terminal, globular, and very firm expansions, the varying size and projection of which give the

irregular aspect of the exterior before alluded to. The diameter of these fasciculi was found in one specimen to range from $\frac{1}{400}$ inch to $\frac{1}{150}$ inch; and the dark globular dilations situated at their extremities are frequently $\frac{1}{20}$ inch, or more, in diameter.

Such is the general structure of those sclerotoid masses which are softer in consistence, and disposed to tear or break up in the radiating directions already mentioned.

In other cases, the whole mass throughout is more friable, and appears to be made up of the beaded fibres named below, so closely aggregated as to convey the impression that it is entirely built up of elongated cells regularly apposed. Sclerotia of this form are seldom large, and they appear to be of equal consistence throughout.

The *smaller particles*, besides being of firmer consistence and darker tint, are also of more uniform structure; they clearly correspond to the detached tips of the branching fasciculi, and the place of detachment may commonly, by aid of a lens, be seen in the form of a broken pedicle, on their under surface.

Minute structure.—Microscopic examination throws much light upon the character of these bodies, and upon their mutual relation. By this means it is at once apparent that all the dark-coloured particles are of true *vegetable* nature; and this discovery forms the basis of my subsequent comments.

In detail, it is found that the black, friable *rind* of the larger sclerotia, and as well the *main portion* of the minuter detached fragments, is composed of clear, orange-tinted and ovoid, or angular cells, closely arranged so as to form a compact structure, and having the dimensions of $\frac{1}{4000}$ inch to $\frac{1}{1500}$ inch. On further inspection it appears that these cells have arisen by a process of budding, commonly proceeding in right lines; and in some instances, when probably active growth is going on, the putting forth of new cells and beaded fibres is very clearly indeed indicated. For full description see Plate IX.

Besides this perfectly characteristic structure, I find that there exist imbedded within the compact mass of smaller cells just described, numerous *larger vesicular bodies* (seemingly comparable to gemmules or sporangia), whose relation to the cells is not very evident, although they doubtless arise at the extremities of the compressed beaded fibres by gemmation and expansion. These very marked bodies may attain the size of $\frac{1}{800}$ inch in diameter; their form is spheroidal or ovoid; their colour a deep orange tint, and their walls commonly very thick: their contents vary, being generally granular or grumous, either uniform or obscurely segmented, and either darker or lighter in tint than the cell-wall; several varieties in this last respect, especially amongst the smaller black particles, have been noticed, and most are described below, as well as shown in the figures (Plate IX). I suppose these varying appearances to be due to the stages of partial development at which my observations were made; spores were never seen within the vesicles, but not unfrequently bulging of their wall or even the offshoot of a beaded fibre; and occasionally indications of a rupture of their parietes were perceptible. The structures in question, are not, in my opinion, like the ova of ordinary parasites; and this remark is made because the affirmative supposition has been ventured. See Section III, Chapter II, page 46.

Respecting the paler, reddish-brown, fibre-like, *central part* of the larger sclerotia, it is composed of slender, pale, flattened, and branching fibres, whose diameter varies from $\frac{1}{6000}$ inch to $\frac{1}{3000}$ inch, and in which no other structure is apparent than a finely granular, homogeneous material, without distinction of liminary membrane and contents.

These pale yellow fibres are arranged in bundles, which compose the fasciculi above described, and which in their course and blending sometimes resemble in appearance and disposition the elastic tissue found in the middle coats of arteries. Intermixed with them may be found numerous granules, and a few large, beaded fibres, the septa of which are sometimes absent, as if these fibres were passing into the homogeneous state. The relation of these two forms is doubtless close, and it may be inferred that the flat, non-beaded fibres represent an imperfectly developed *mycelium*, centrally placed, and of compact growth.

On this assumption the beaded, cellular fibres and the similarly constituted peripheral structures described above, would correspond to irregularly developed or aborted organs of *fructification*, bearing in their midst stunted *sporangia*, or reproductive *gemmules*. (See the following Chapter, page 86).

The influence of ordinary reagents upon these black particles above described is but slight. Acetic acid and the alkalis have but little effect, nor has ether more. The addition of iodine does not produce a blue colour; but there is sometimes noticed the deep brown tint which is distinctive of cellulose, and this was remarked in my earliest specimen. The long persistence of organized structure in these sclerotoid bodies, is as well marked as their indifference to all reagents, except those of a destructive character; and both these features are, I may add, more evident in vegetable than in common animal bodies.

I have here to mention that frequently there may be found amongst the *smaller* sclerotia, where lodged within their containing canals, some minuter fragments of a less dark colour and softer consistence, which on careful examination are ascertained to be ordinary black particles undergoing, as it would seem, a partial growth and development after their separation, but still during detention within the diseased foot. Such is the interpretation I put on the appearances represented in Plate IX, fig. 6 c; hence I conclude that the clear, colourless cells there shown are newly formed from the pre-existing brown cells, and that under favorable circumstances they would grow into a mycelium, which it is conceivable might prove to be that of the *Chionyphe*. Prolonged observation under various conditions would settle this point, but after many attempts I have not succeeded in directly tracing further this stage of growth *in situ*; happily, however, cultivation of the sclerotia in artificial soil has led to fuller elucidation of the subject.

I append, for illustration, my original notes descriptive of the structure of the black particles, and of the tissues forming part of the parasitic growth in the foot.

Memoranda of *microscopic examination* of the Sclerotoid particles characteristic of the first or Melanotic variety of *Mycetoma*.

1. Specimen from Scinde (*vide* page 4).

a. Took a black particle having lighter-coloured tubercules, from the interior of a canal. The light parts are composed of small ($\frac{1}{1000}$ in. diam.), clear, thin-walled cells; but besides there are some of larger size having yellow-tinted, thick walls, and colourless, finely granular contents. Other vesicles were seen whose walls and contents were both coloured, and occasionally the latter most deeply so.

b. Took a very minute particle of black colour from a canal; it did not look like a mere stain, but rather like a broken-off fragment and was not adherent; it had the same structure, and there were indications that the first stage of the large white cell was expansion and blanching of the brown one.

c. Took a *stain* from the lining membrane in immediate contact with a large black particle; it showed also a minute perfect black particle; + Ac + ether; there are in some parts indications of *mycelium* or fibrous

network, but in this larger tubes (?) or fibres are seen, some $\frac{1}{1000}$ in. diam., or even much wider; they seem to be tubes containing clear, brown particles, and are certainly not blood-vessels. In some positions quite separate from the other mass, may be seen small groups of clear brown cells ($\frac{1}{1000}$ — $\frac{1}{1300}$ in. diam.), some of which were thick-walled and very dark-tinted. The mycelium in some places is very distinct, being formed of large clear fibres, ramifying in an extensive manner.

2. Specimen from Bhooj (*vide* page 8).

a. Took a brownish, transparent speck along with the lining membrane, from the interior of the foot. It is composed of clear, globular (?) cells, probably of various size: on coarse dissection found no new appearances, but saw that the lining membrane is thrown into broad folds, and into long villous processes, on the surface of which the brown specks and masses are attached; it sometimes seems that they are situated in the substance of the folds, and they may then form flattened fragments of considerable breadth and woody consistence. Many of these masses appeared firmly adherent to the membrane, and that not by mere cohesion, but as if originally placed within its layers.

b. Took another small fragment in which a well-marked fibrous *mycelium*, and a cluster of globular cells ($\frac{1}{4000}$ to $\frac{1}{3000}$ in. diam.) were seen: this cluster had a globular form and was composed of globular cells of the above size; it was placed at a slight distance from the mycelium, and might have arisen from it.

c. Another fragment with a whitish tubercle on it; this appeared to be composed of fungus-structure, and was not fat.

d. Another larger coloured particle; it is the same at an early stage (?): saw something like a speck in it ($\frac{1}{2000}$ in. diam.), viz. a bright-coloured, thin-walled cell.

e. Several other particles were taken, which seemed to show that the light-coloured part is only fibrous tissue.

f. Took a little bit of brownish matter adherent to the sides of a canal, along with a portion of the membrane itself; + acetic acid. There appeared to be a complete mycelium and organs of fructification.

g. Small, light-coloured particles found amongst the black ones in the canals; 1, of a brownish colour, is composed of clear, brown cells; 2, of a lighter tint and soft consistence, seems to be formed of nucleated epithelium, in which some yellow spores (?) were seen.

h. Yellowish spots seen in the membrane are composed of coloured cells ($\frac{1}{1300}$ in. long diam.) which have no distinct wall or clear contents, but appear to be homogeneous; of various sizes and in clusters of an irregular form; acetic acid and ether have no effect on them: they resemble the spores (?) mentioned in the last paragraph.

i. Several soft, oval or globular white masses may be seen in the midst of the black accumulations; these have an appearance not unlike the particles of the pale variety of *Mycetoma*, but on minute examination are found to be composed of a tissue like the lining membrane of the canal, filled up with some small, brown points in which the new black fungus-particle is developed: there are fibres forming a mycelium, and a large cellular mass in which the cells appear to be arranged in a radiating manner.

j. A fragment of the lining membrane of a cavity in which large particles are lodged, has in it minute brown spots, which can be isolated and then examined along with a portion of the membrane: without the addition of any reagent the brown specks appear to be diffused, and not very defined or made up of any distinct structure; but one had a radiated appearance, no cells having been seen. After the addition of acetic acid to one of these spots, three ovoid, clear, coloured bodies were seen, which disappeared on ether being added, and nothing satisfactory could afterwards be seen.

k. Several small fragments were taken and subjected to the action of ether and acetic acid: the particles were then seen to have a well-defined round edge, to be of a deep black colour and perfectly opaque. Amongst them was a body having very slender walls with peculiar bulgings in it, indications of a large granular or grumous nucleus, and a general mahogany tint: other smaller very dark-coloured bodies were also seen.

l. The little brownish masses appear to be made up of cells exceedingly clear, arranged in a radiating manner, and not all of the same kind: the larger are round or oval and transparent, they contain little or no colouring matter, while the others which compose most of the mass seem to be the seat of the colour and are not easily separated from each other, so that their form is not readily seen.

3. Specimen from Bombay (*vide* page 5).

a. Took from the interior of a mass not adherent to the lining membrane, a particle having a light extremity:

+ acetic acid, + ether: this is found to arise from the presence of numerous, very large, clear, thin-walled cells, of spherical or sometimes compressed form; intermixed with these are the small, brown cells, brick-shaped, and smaller in size, which alone form the brown particles themselves. At that end of the specimen where the light colour is present, there have three colourless cells accumulated: they seem at times to give off beaded filaments and to be in a state of active growth: intermixed are a few of the bright yellow cells of smaller size; it is difficult to say what the true relation is of the two—the large white cells may arise from the exterior of the brown mass? this appears evident because there is no germ of them seen; or are the brown cells a further development of the large white ones? this is not likely from the appearance of things; are they distinct sexes? it is possible; or are both organs of fructification? this, too, is possible, as the colourless cells do certainly give off beaded filaments.

b. Took a fragment of the soft kind with the brownish specks in it; it seems to be largely composed of fat; + ether, the brown parts remain and are formed of brown cells; the margin shows numerous colourless cell-processes such as were seen to arise from the clear cells above described.

c. Found a light-coloured particle similar in size and form to the small brown ones, but translucent and of yellowish tint: it was taken from an aperture in the sole of the foot. It is composed of cells and fibres in active formation and development, and very much resembling the lighter parts of some black particles; both kinds of cells exist, namely the large white, and a few of the brown: and there are also numerous cell-fibres with dilated ends.

d. Took another fragment of darker colour and firmer consistence; it was composed entirely of cells of the two kinds with numerous fibres. The brown cells are of a rounded form and acquire a thick cell-wall: both clear fibres and clear cells exist, and it would seem sometimes that the clear fibres give rise to the brown cells, for there are, in their interior, found bright granules which by growth might form the round cells, or such of them as are here seen to be placed in the midst of the beaded fibres or at their tips: dimensions of these coloured cells $\frac{1}{1000}$ to $\frac{1}{2000}$ in. The luxury of the sprouting is wonderful. There was here sufficient evidence to show that the small black particles do undergo a change from dark to light colour without much alteration in size or form; but very large black particles were not seen to be so altered.

e. A small black particle taken from an aperture in the sole of the foot: it is made up of small brown cells intermixed with which are numerous large clear cells, often seen to be sprouting into small delicate fibres; these are frequently very fine and were never seen to arise from the brown cells, but on the contrary the coloured cells seem to arise, sometimes at least, from the end of the clear fibres, and they may be observed to be arranged in a radiating manner around the larger colourless vesicles.

f. A small fragment found in the canals of very light, pale, brown colour and barely visible to the naked eye. It was not attached: it consisted entirely of large vesicles, some brown, some white, but all clear and irregularly intermixed: on breaking up this mass it is found that all the brown cells consist of colouring matter contained in colourless walls, or collected with a kind of nucleus, or in other cases this nucleus may become free, possibly by accident. This colouring matter is found in small as well as in large cells: there are besides numerous white cells of the usual appearance. See Plate IX, fig. 6, *b*, *c*, for illustration of these remarks.

Memoranda of *microscopic examinations* of (*a*) the lining membrane of the canals and loculi; (*b*) soft tissues in which the fungus-particles are imbedded; and (*c*) the tissues of the foot immediately investing the new growth.

1. Specimen from the J. J. Hospital, Bombay; case previously described as No. 4, page 5.

a. The glairy substance in which the black particles are imbedded is composed of—1. Pus-cells. 2. Large granule-cells. 3. Separate, minute granules. 4. A few red blood-corpuscles. I have no detailed description of the "granules" just named.

b. The opaque, yellow, friable walls of the tubes and cavities, presented no peculiar composition of parts; the colour appeared to be due to the aggregation of fat-granules.

c. The gelatiniform substance in the immediate neighbourhood of the tubes presented traces of muscular fibres, granules, &c.

2. Specimen from Kutch; case described as No. 2, page 4.

a. The black masses are inclosed in a capsule of soft, fibrous (slimy) consistence, which adapts itself to the inequalities of the surrounding surfaces and is but loosely adherent. This membrane was found to consist

of—1. Homogeneous fibrillæ like the simple membranes of coagulated fibrine. 2. Myriads of cells and free nuclei—probably purulent. 3. Tubes filled with cells or nuclei: of these no detailed account was preserved—an omission I much regret, and the rough sketch which remains is too imperfect for reproduction: it represents a straight tube with thin walls, and measuring about $\frac{1}{1000}$ in. in diameter.

Varieties of Sclerotoid Particles.—I am disposed to lay stress on a form observed in a diseased foot sent from Bellary (*vide* p. 6), because of the evidence it affords of a process of fatty (?) change occurring in the ordinary Sclerotia, the result of which is the partial or complete loss of fungus-structure, so that were an observer to meet with such a specimen as that now referred to, he might, unless he were pre-informed from other sources, justly conclude that nothing really like the well-known simple vegetable cell-forms had ever existed in the individual particles he was scrutinising. There was, however, in my view, sufficient sign and trace to render undoubted, the true nature of the masses in question (*vide* fig. 7, Plate IX), and to warrant the application, by way of analogy, of the main facts of this very interesting example of Mycetoma, to the elucidation of other obscurer forms of the disease.

Minute structure of the fungoid particles: in by far the majority of specimens examined the cellular structure has become almost obliterated; a radiating, fibrous disposition, is, however, clearly apparent in the larger particles, and we may see even separate, delicate, clear fibres (*vide* fig. 7 b, Plate IX); I note that at the peripheral terminations of these fibres, no distinct, cellular structure was to be seen, but conclude that the fibres just referred to, represent the central parts of the more normal, black sclerotia. Examination of the smaller fragments did not reveal more evidence of cellular structure. All the particles are so brittle that they break up in almost any direction, more generally, however, in the radiating; and when this altered consistence is compared with the marked toughness of ordinary sclerotia, it becomes evident that a kind of degeneration has occurred in this instance. Prolonged digestion in ordinary sulphuric ether, has no effect on the particles beyond that of abstracting a small quantity of colouring matter, and their pinkish, dark brown or mahogany tint was not materially changed by this reagent. The whole case furnishes clear evidence that the melanotic sclerotia of Mycetoma may undergo an entire change of structure, without losing such characters as mere form and size: under what conditions such change occurs is not, however, yet known, but the fact is both valuable and impressive. It is also noteworthy that the other accompanying specimen from Bellary was, as well, peculiar, in that the pale, soft particles, although in other respects similar to the common, had likewise a very dark colour; so that it would appear as if in the circumstances attending the growth of the fungus in both these instances from Bellary there had been an influence at work, under which the two kinds of Mycetoma exhibited characters pointing to a common origin. What was that influence, *e. g.* whether of locality, season, or race, &c., is unknown to me.

II. *The Malacotia (Ochroid variety of Mycetoma).*—In some parts of India, these more frequently than the above-named forms come under the notice of the surgeon, but so far as I am able to ascertain, only one kind had been distinguished prior to the publication of my researches in 1860; that form is, however, the most common, and, as it stands alone, perhaps as singular as any other. I now refer to the structures earliest discriminated and figured by my late colleague, Dr G. R. Ballingall, in the year 1855; the same are also described by Dr G. Bidie, of the Madras Medical Service, under date 1862; and they have subsequently been frequently made the subject of discussion, as may be seen in the Bibliography appended to this Memoir.

The several sub-varieties, whose relation to each other will be afterwards considered, may be described in the order in which they presented themselves to me. It is by no

means improbable that other similar, perhaps intermediate, sub-forms or phases may be early detected, now that attention is drawn to this subject.

In the instances under consideration, the parasitic or fungoid elements assume the character of pink, light-brown, yellowish or pale buff particles, of minute size and soft consistence: their number is immense; and their prevalence universal in the affected foot.

The first kind seen, perhaps the rarest, but certainly very characteristic, seems to furnish a clue to the correct interpretation of other forms; it may be described as follows:

a. Separate or non-blended, brownish-tinted particles, size from $\frac{1}{150}$ to $\frac{1}{40}$ in. diam., being so minute that they are only just visible to the unaided eye; very numerous.

When highly magnified, found to have a mammillated exterior, from which, and as well from the torn surface, may be seen projecting in a somewhat radiating direction, beaded fibres of cellular structure, very minute in size, but distinct and unmistakable in character: these beaded tubules resembled those described in the first specimen of the melanotic variety of Mycetoma, except only that they were paler in colour and somewhat smaller in dimensions (see Plate X, fig. 1). Some were of equal diameter throughout, but most of them terminated in an oval expanded cell; occasionally they were indented, as it were, on one side: most of the cellules were clear and bright, some were granular, and rarely pointed and granular cells were seen. The smaller filaments were exceedingly delicate, granular, and sometimes beaded. Apparently the whole structure throughout is composed of such cellular elements. These latter retain their character for a long period; thus, nine months afterwards, I found the same structure still very distinct in a part preserved in diluted alcohol, and then noted that potassic solution seems to render the particles friable and liable to break up into sections of a radiated sphere, whose centre was not to be made out; sulphuric acid merely dissolved them; and so late as fifteen months after amputation of the foot, the fungus-structure was still apparent, although the beaded filaments appeared to be shrivelled. These facts are of interest with reference to the validity of observations made in England, upon specimens forwarded from India.

The "*slimy*" tissue found to line the cavities in the diseased foot, and imbedded in which were the particles or granules described above, appeared to be comprised of numerous filaments forming a kind of network, with much granular matter, granular cells, and oil in globules. The filaments seemed in many instances, at least, to be hollow and to contain in their interior granular cells, their walls being formed of something like white fibrous tissue, or overlapped cells. I have given a sketch of the appearances which were noted in the perfectly fresh specimen, in Plate X, fig. 1 *d.*

After being some time in spirits, this tissue had changed its appearance, for the cavities then contained only a scanty tissue, in aspect like to adipose, and a few loose white granules were found in their walls, the resemblance being now very similar to what is observed in other specimens; both tissue and granules just mentioned contained numerous fungi, and on minute examination the former was found to be made up of fibrous and adipose tissue, and the latter of granule-cells like those of exudation; much fatty matter was mixed with both, and it seemed to particularly abound in the fungus-fragments.

In this case the fungus-particles were decidedly larger, than usually are the common bacteroid-masses; and in one instance I noticed a dwindling down, as it were, of them, leaving an opaque central part, and the external substance presenting some indications of an incipient crystalline fringe: see Plate X, fig. 1 *f.*

Having before referred to the contents of the discharge from the openings in the foot, a figure is added (Plate X, 1 *e*), and I would specially note that many of the branching filaments proceeding from the budding cells within, were of extremely minute size.

b. The foot from Madura described at page 9 is, like the last, as yet unique of its kind.¹ The new material was of a general pinkish hue, owing to the dissemination of minute particles, barely visible to the unaided eye

¹ Mr Jayakar, from Ahmedabad, writes that he had seen an instance of this pink variety of Mycetoma in an adult woman, whose left foot was amputated three

inches below the tubercle of the tibia. There was a history of local injury, as is usually the case, in Mr Jayakar's opinion.—'Ind. Med. Gaz.,' August, 1871.

and of bright pink colour: the tint of the tissues themselves was rather more yellowish. The particles were tolerably uniformly scattered, but sometimes were in small clusters. Under a low magnifying power they appeared as round, ovoid, quadrate, dumb-bell-shaped, double or even quadruple-shaped bodies: the variety of form seemingly indicated multiplication by duplicate fission. Under a higher power some of the particles were seen to be of a yellowish hue: further investigation of their structures was attended with difficulties. Separate or aggregate, they had commonly no cell-wall, though occasionally there were seen some indications of one; no nucleus or internal differentiation of structure was detected. Under favorable circumstances, or where the splitting into two or four took place, one might see an appearance within, described in my notes as comparable to "the termination of minute fungus-fibres, or it might be that the interior was filled with small, oval or roundish cells, which are held together by a clear material, and may escape by rupture; the first supposition is the most likely." I now understand that the appearances thus described would be better compared with those peculiar to the 'Bacteria-colonies' of late investigators. For full description see that of Plate X, fig. 2.

The pink particles varied in size from $\frac{1}{50}$ to $\frac{1}{100}$ in. in diameter.

The slimy substance in which they were imbedded was also tinted, was loaded with fat; and had only an obscurely fibrous structure.

Examined at a later period, many of the particles were found to have become of a lighter colour, *i. e.* yellowish or brownish; and it then became evident, that these little bodies very closely resembled the granules characteristic of the commoner species of this ochroid variety of Mycetoma, as afterwards described. This observation is of value, as indicating a fundamental similarity of nature in both structures.

It may be added that there was found in a cavity near the toes, freely opening on the skin, a large quantity of *débris* consisting of oily matter, epithelial scales, and even more than one *globe épidermique*; also small dark masses which readily tore up, and in all probability were only altered hairs in which the pigment had collected into separate granules. Future observers will not be misled by these irregular black fragments; nor, I may remark, by altered blood-clots. In some of the smaller cavities of the bones, opaque, white masses might be seen, having sometimes a mulberry-like aspect: these are found to present numerous oil-globules, bundles of spiculae, and in the interior some of the pink-coloured particles seen elsewhere; the spiculae do not radiate from them very clearly, nor are they so abundant as usual. The numerous oil-globules of very varying size, and so tinted as to impart the general hue, are readily dissolved by ether: but the characteristic particles are themselves little amenable to the influence of ordinary re-agents. The coincidence here, as in ordinary cases, of much fatty matter and even of crystals, is indirect evidence of the common nature of all these fungus-particles.

c. I now come to the *Malacotia* proper, as may be termed the comparatively well-known, pale-buff or yellowish, and soft masses or granules, which have been variously described and several times figured. Though small in size, they may be readily distinguished by the unaided eye, and have been roughly likened to the ova of fishes (fish-roe), mustard seed, poppy seed, &c., their consistence being at the same time termed "cheesy," &c. All these commonly visible masses are in reality *aggregations* of the ultimate particles, or elements, whose varying number determines their apparent size: the larger masses may attain $\frac{1}{4}$ in. in diameter, and they have a lobulated or mulberry-like aspect; the smaller granules are hardly detectable by unaided vision; and the ultimate particles could not thus be seen. The mass of particles is held together by means of the fatty crystalline envelope which each individual possesses; and its dimensions seem to be matter of accident, or determined probably by the calibre of its containing cavity or tube. Before issuing in the semi-purulent discharge from the sinuses in the affected foot, the masses break up into the small granules which can ordinarily be obtained from the apertures, or fluid exuding. The actual number of individuals has been immense, in all specimens carefully examined by me.

A detailed description of the little granular masses, or *roe-like particles*, is hardly required; I have said that they are commonly visible in the discharge from the sinuses of the foot. Examined with a lens they look like little white mulberries, or highly tuberculated particles: while under a higher power they are seen to be mere congeries or aggregations of smaller elements, whose internal arrangement, however, has not, to me, been clearly methodical, although such disposition may really exist; and around each smaller body is the fatty envelope which here acts as cement. The varying number and projection of these ultimate elements, impart the granular or tuberculated appearance spoken of, and as well determine the size.

This *ultimate element* is, in all cases, a more or less spheroidal particle, around which has formed a regular

and complete investment of colourless crystalline spiculæ; and these two structures may be separately described.

First, the *central body* (malacotium) is a definite structure of rather constant form and size, usually separate, but occasionally conjoined to one or two others. When separate, its diameter commonly varies from $\frac{1}{150}$ to $\frac{5}{500}$ in.; its form is spheroid or ovoid, and its surface smooth or slightly mammillated; the colour is pale yellow, orange or buff; and the consistence always soft, though when fresh not without a certain degree of elasticity or firmness. It has been described as a "cell," but not accurately so, being really a mass of minute aggregated, refracting granules; of a form seemingly rounded, and held together by an intermediate gelatinoid material. It is true that in some instances an appearance is seen of a cell-wall, or rather limiting membrane, having, indeed, more than one homogeneous layer, but as I have, under the most favorable circumstances, more frequently than not failed to verify the presence of such a structure, it seems most probable that the appearance is either delusive or due to secondary causes. When aggregated, the dimensions of the group vary according to the number of clustered particles. It is not certain that these ever exist in the same multiple clusters so evident in the variety from Madura last described, nor am I sure that the individuals are ever blended otherwise than in a mechanical manner; there is, however, the positive observation embodied in fig. 3 *b*, Plate X (*see* description), which demonstrates that the particles may present characters indicative of construction, or a mode of cohesion, essentially corresponding to that noticed in the Madura specimen last described.

I may add that in another instance, namely that recorded at page 6 (from Bellary), some of the particles were even more clearly disposed to break up by conchoidal fracture, into regular and equal segments; and a division into four quarters was once very distinct, the appearance being identical with fig. 2 *c*, Plate X. This instance, too, of the disease merits special notice, not only from the great ravages inflicted by the parasitic growth, but from the variety of tint presented by the separate particles, some being pink, others brown, and others pale yellowish; occasionally indeed they were of very dark, rich brown colour, but always had they the fatty crystalline fringe: so that in this particular specimen, as in the one which accompanied it (*see* page 7) was evidence of characters intermediate between forms which, otherwise, must have been regarded as distinct; nay, as far as relates to colour, here was the same dark, mahogany tint occurring in examples of both of the two chief varieties of Mycetoma; and the fact may possibly underlie a connection of more intimate nature. The minute structure of the dark soft particles, I may add, appeared to be the same as others of a paler tint; their size and general form were not unusual: and there was sometimes the appearance of a wall around them. I noticed also in this case, the co-existence of coloured, ovoid or globular bodies of considerable size, *i. e.* from $\frac{1}{10}$ in. diam. downwards, not before seen, and indicative perhaps of transitional stages in the development of the particles. "Caustic soda destroys the structure and partly dissolves the crystalline fringe, and other slowly dissolves the latter also; but the brown particles themselves remain unaffected under the influence of these re-agents." (*Author's notes.*)

Reverting now to the more frequent Malacotioid bodies, I shall insert in this place only what I have myself observed on various occasions. To comment on the several other descriptions which have been made public, would not be practicable here; and, on the whole, there is such a considerable agreement in opinion as to the appearances actually seen, that further details of this kind are unnecessary: it is when the interpretation of these peculiar structures is considered, that differences of opinion mostly arise. I shall in a subsequent chapter discuss the question of the nature of these particles, by the aid of facts brought to light only in very recent days; and would here refer to the illustrations contained in Plate X, figs. 3, *a to f*.

When examined in the freshest state, that is, immediately on being taken from the living foot and divested of their fringe, these particles have been repeatedly seen by me to present a finely dotted appearance at their edges, with a darker granular shade towards their centre: always there seemed to be a uniform matrix of jelly-like or gelatinous material, which is translucent, homogeneous, rather firm, decidedly elastic, and having a distinct contour—although no limiting membrane was ever seen in the fresh specimens. Imbedded in this matrix were found very minute granules, of rounded or elongated shape; separate or arranged in rows; or even showing indications of a filamentous form; highly refractile; commonly disposed in a manner seemingly irregular, but occasionally presenting signs of a radiating disposition in the interior. These compact central bodies, which are clearly the essential part of the entire malacotioid particle, long preserve their physical characters; and finding no great apparent alteration in them after long exposure to the action of dilute alcohol, I have again, in England, submitted them to close scrutiny, with the following results:—Examined with a magnifying power of 600 diameters, their ultimate structure still preserved the same appearance, namely, that of minute granules imbedded in a gelatinous material. When the optical power was increased to 1500 diameters or more (Gundlach's immersion lens of

$\frac{1}{2}$ in.), the structure was still that of a clear matrix in which are imbedded minute, refractile granules whose minute dimensions seem difficult to precisely determine; discrimination of parts was, however, not so clear as before, and some of my figures in Plate X, though as accurate as possible, cannot be regarded as so satisfactory as if they had been taken from views of perfectly fresh specimens. Only a finely granular protoplasmic-mass was apparent.

As to the influence of re-agents upon these malacotoid particles, I note that it is singularly slight. Acetic acid does not act upon them as upon ordinary fibrin or albuminous material, nor does liquor potassæ or other alkaline solution. In one fresh specimen I noticed that the addition of iodine solution renders them of a deep orange tint; but no blue tinge was apparent in them or their crystalline fringe: on the addition of dilute sulphuric acid, they are not dissolved, but rather rendered somewhat opaque; no distinction of internal structure being noticed: on ether being added, the fringe is totally dissolved, but the particles are not rendered clear, their structure remains of a finely granular appearance, and it is seemingly uniform throughout. "The defined edge formerly seen has not been seen in this case (described at page 10)." In another instance (page 9) I noted that the addition of dilute nitric acid causes the rays, or fringe, to dissolve, and in their place globules of oil appear; no effect upon the central bodies, beyond rendering them lighter and clearer. Again, in a perfectly fresh specimen, I note that acetic acid has no effect upon the particles, beyond clearing their surroundings: ether does not act very freely upon the crystalline fringe, and not at all upon the *malacotia* themselves; nor does liquor potassæ, or liquor ammoniæ, quickly destroy the former. Carmine does not tinge either fringe or central body. The iodine test for starch does not indicate the presence of the latter substance.¹

This indifference of these pale soft particles to chemical influence, is to me strong evidence of their vegetable, rather than animal, nature; and the occasional absence of amyloid material, &c., is no objection whatever to the conclusion which is here drawn.

Before concluding my description of these pale, soft particles, I should allude to the peculiarities which were noticed in a specimen received from Bhooj, and described above, at page 10. Here the crystalline fringe was furnished with a secondary finer fringe resembling rows of *cilia*, and the detached fragments had sometimes the appearance of ciliated epithelium from the respiratory tract: all were readily dissolved by ether. But more to be noticed is the circumstance, that in the interior of the particles might be seen nuclear or spore-like bodies: thus, for example, taking a fragment from the interior of the foot, I found a great many particles having this appearance: the average size of the rounded bodies in their interior was $\frac{1}{25000}$ in.; their colour a light orange-brown, contrasting distinctly with the matrix: form generally rounded; size not very regular: they are highly refractile: structure apparently granular; no distinct wall. Previously, I had determined these dark, globular bodies to be oil-globules, partly because they were seen to run together, and from the interior of the particle itself oil-globules could be forced out by pressure: I found, too, that when ether could be brought to act upon them they were dissolved; and notwithstanding that a different interpretation was possible, I still incline to the same opinion. It was from one of such particles that I subsequently observed, after cultivation in rice, the growth of the red mould (*Chionyphe*), and this circumstance, I am bound to add, rather supports the view of these interior bodies being spores,² although there was here probably a simple coincidence. The conjunction of abundant fatty crystals in the fringe and of oil-globules in the interior, pointed to unusual excess of fatty matter, or possibly to superabundance of one oleaginous principle only.

Referring, in the next place, to the *crystalline envelope* which surrounds each single particle on its exposed surface, and therefore forms a complete investment in all cases, I would observe that this feature, however characteristic it has been regarded, is more striking than important. From the first, I concluded that these clear, homogeneous, colourless, more or less symmetrical rays, needles or spiculæ, are but *crystals of the more solid fatty principles*; nor does the variety of form which they may assume militate against this view. Thus, while their common shape is that of an elongated, flattened, or sub-angular cone, the base of which rests directly upon the central body itself, and whose apex is directed outwards in a radial direction from the centre of the same body, it is yet not unusual to find other more complicated forms due to the super-imposition of secondary or even tertiary crystals, which may impart a stellate, ciliated or feathered aspect to an originally simpler spicule; a description

¹ I have sometimes, however, seen the cellulose reaction (Second Memoir, 1861); and Dr Bidie (loc. cit.) states that he occasionally noticed a blue tinge on the use of this test.

² See the 'Intellectual Observer,' November, 1862,

p. 254, where these particles are described as consisting of "one or more large mother-cells filled with a mass of daughter-cells," these latter are the apparent nuclear or spore-like bodies, which I regard as only oil-globules.

of each of these varieties (most of which are figured in Plate X) is not here required, as their common characters are sufficiently evident.

That the fringe or envelope now under notice is really of inorganic nature might have been inferred from its homogeneous and translucent appearance, and from its position showing no organic connection with the fungoid particle; also from the decisive action of pure ether, especially when warmed, which steadily dissolves the spiculæ. I have in a perfectly fresh specimen noticed a tendency in the crystals to bend, run together and blend into large globules or drops, such as was of itself characteristic of an inorganic substance. It should be mentioned, however, that the action of ether may be tardy, as well as that of liquor potassæ, liquor sodæ, and liq. ammoniæ, at ordinary temperatures. Carmine does not tinge these crystals, nor do they furnish any blue tinge with iodine. Acetic acid has no effect upon them: nitric acid causes their disappearance. In chemical composition these appendages are formed of stearin, with which margarin may be intermixed: and this opinion is founded on both the physical character of the crystalline rays and on the commonly tardy action of ether upon them. When the needles show a decided tendency to droop into curves and have many oil-globules intermingled, and particularly if the solvent action of ether be quickly apparent, it is probable that margarin and olein are present, in addition to stearin. In preparations long kept in diluted alcohol I have noticed abundant plates of cholesterin amongst the other structures, and regard the circumstance as noteworthy. The general question, however, as to the exact chemical nature of these well-marked crystalline structures, is not so important as some other points; and I will only observe that there exist, so far as I know, no strict analogues to them in other diseased conditions. The fringes in question may be present when the osseous tissues are not at the same time affected; and they occur at an early stage of the parasitic growth, when the disease may be said to be only commencing its course. This last fact is quite worthy of notice, but its interpretation is at present not easy: only I will say that the fatty appendages were altogether absent in the first instance of the ochroid form of Mycetoma, which came under my notice. The dimensions attained by the conical, single-branched or ciliated fringe-elements vary; commonly in length they are equal, or nearly equal, to the diameter of the fungoid particles themselves ($\frac{1}{300}$ to $\frac{1}{100}$ in.), and in greatest breadth they may measure $\frac{1}{10}$ to $\frac{1}{2}$ of their length. Invariably their size is larger than, as their form is different from, the free fat-crystals which may usually be found to co-exist with them, and which it may be supposed are of purer chemical composition. The circumstance I have just mentioned, would also appear to indicate that these pathological crystalline forms owe their special characters to their connection with the fungus-particles; but in what manner the latter may contribute to the formation of their very characteristic crystalline envelopé, does not appear. However, free fat-crystals of spicular form and oil-globules in abundance, frequently co-exist with the particles, and this association is noteworthy as indicative of a common source or origin. I have above remarked upon the presence of oil-globules in the interior of the fungoid bodies; and this feature, besides pointing to a fatty degeneration, also indicates another source than the tissues of the foot, of fatty crystalline principles. Not unusually, I may add, are granule-cells, or pus-corpuscles, found, with but few contemporaneous signs of inflammation; and I have observed well-marked myeloid cells intermixed with all these matters.

As regards their real significance, I have supposed that the formation of the crystalline fringes indicated a quiescent state, perhaps death and degeneration, of the fungus-particles upon which they appear. They are not, assuredly, invariable attendants on the pathological elements of Mycetoma, for they were not found in either my second case, or in the Madura specimen; and I infer that, though common, they are not an essential feature of the parasitic growth. Any foreign body may serve as a nucleus of crystallization for the fatty principles, when these super-abound or become free; and such body is not necessarily of extinct life. The fact, indeed, remains, that fungus-particles showing signs of activity, were not attired with these fringes in question; and future observations must determine the precise connection *in time* of the two structures above discriminated. On the other hand, I have observed the pink mould springing out of a pale soft particle, which had a perfect fatty fringe; and this was proof positive that the particle had not undergone changes entirely destructive of life, or of the inclosed germs which it might serve to protect for a time.

The inference to which present knowledge seems to point is, that these malacotioid bodies are an unusual—perhaps abnormal—form of structure pertaining to the organisms which seem to connect the fungi and bacteria-groups; and that their crystalline fringe is merely an appendage, due to the circumstance of their development amidst animal textures rich in oil, or the elements of fat.

Lastly, with regard to the nature of the *glairy substance* in which these growths are imbedded, and to the characters of the *membrane which forms the parietes* of their containing channels and loculi, I would refer to the following observations:

1. The membrane which forms the walls of the canals (of a yellowish opaque tint) is apparently homogeneous or striated, and studded with innumerable fatty granules, and the membrane lining the cavities in the bones had a similar structure. (Case recorded at page 10.)

2. Quite recently, I have re-examined a preserved specimen of this variety of Mycetoma, and have but little to add, for the substance of the limiting membrane seems to be composed entirely of fibrous tissue, somewhat resembling that belonging to thin membranes or aponeuroses; elastic fibres and nuclei are, however, wanting; and the clear branching flattened fibres are arranged in layers, not much interwoven. Free granular cells, and from them commencing fibres may sometimes be seen, especially in the substance of the membrane; and the opaque yellow tint of the latter appeared to be due to the presence of oily matter. Further observations were not satisfactory in this long-preserved fragment, and as yet I am unable to state whether or not a mycelium external to the particle is to be admitted or denied, because the negative evidence is not very strong. No spores or incipient particles were seen; but it is known that they are present on the exterior of this membrane, in some instances at least. I have elsewhere compared this investment to the outermost walls of an Hydatid cyst, or to the outer integument of the great parent Filaria; and further observation may determine this relation to be something more than imaginary. The investment, or limiting membrane in question, possesses the same structural characters in all varieties of Mycetoma; its disposition, however, is not always that of a smooth lining or envelope, but, on the contrary, it may form folds, long villous processes (*see* Bhooj specimen, p. 70), or even follicles or secondary loculi, in which the fungus-particles are lodged (*see* Plate VII, fig. 1, and description).

CHAPTER II

COMMENCEMENT (A); AND MODE OF GROWTH (B), OF THE ENTOPHYTES

A. *Commencement and earliest visible traces.*—Externally, as has been said, no characteristic signs of Mycetoma are to be seen until the peculiar vesiculoid or soft swellings, and consecutive openings whence issue the fungus-particles, make their appearance on some part of the foot previously, or not, the seat of swelling. But within the tissues of the affected member there are commonly visible, on close scrutiny of a section of amputated parts, certain signs of the new growths in the form of *pinkish-coloured streaks*, situated in the true skin and extending inwards, vertically or obliquely, to the extent of a few lines, towards the subjacent connective tissues. These streaks or stains may be detected either close to the apertures of the vehicular tunnels, in which are lodged the ripened fruit-products, or at some distance from such openings; and the first-named feature is a noteworthy one, because it has seemed to me that if the pink streaks indicate the first stage of growth, after introduction of germ or spore, their proximity to these apertures of exit would point to the occurrence of a re-inoculation, or auto-inoculation, by means of the reproductive particles recently extruded from their *nidus* in the foot; nor, indeed, would the fact of the coloured streaks in question being placed at a short distance from the openings, militate against this notion, especially when it is remembered that the latter may be found on the back of the foot, as well as in the sole. On the other hand, it might be suggested that the conjoined location of streak and cavity filled with developed growth,

would rather show that the primary inoculations having simultaneously happened at several approximated spots, in only a few instances had growth proceeded to maturity. My own opinion inclines to the view of auto-inoculation.

The tinted streaks now mentioned are seldom more than a line in breadth, and often much narrower; their length may reach to several lines, and they may be seen to branch or divide into several bands, which are finally lost in the fibrous or adipose tissue around. It is obvious from their position that their existence could not be ascertained on inspection of the foot from the outside only. Reference should be made to Plate X, fig. 6.

The following extracts from my notes, of microscopic examination of these coloured spots, will serve to describe their structure; and, by inference, their probable character:

a. The foot from Scinde: *Melanoid* variety; see page 4. After removal of the cuticle from the sole of the foot numerous pinkish spots are seen; and on cutting through the cutis over them, I found beneath each spot a deposit of pink, red, or orange-brown colour, in the form of streaks, longitudinal or radiating, and imbedded in the sub-corial tissue. This deposit is composed of minute, bright-tinted and clear globules measuring $\frac{1}{3000}$ to $\frac{1}{2000}$ in. diam., a few others being larger and of a deeper tint; sometimes it is apparently in tubes which branch or stretch out (see Plate X, fig. 6 a), the appearance being often such as one might suppose would ensue, if the sweat-ducts were filled with red granules, but the accumulations are oftener clearly outside the tubes. Occasionally the coloured globules were arranged in spherical groups or masses which measured about $\frac{1}{300}$ in. diam. Since over these pink spots no aperture in the cuticle was seen (having possibly, however, escaped notice), it is not unlikely that the spores, if the coloured globules are to be regarded as such, have entered, *ab extra*, through a natural orifice, e. g. of a sweat-duct; and this event, from their comparative size, is perfectly feasible.

Other like spots were subsequently examined, + acetic acid + ether; and then it was observed "that the red colour is owing to oblong or rounded clusters of bright-orange granules, the diameter of the former being rather more than $\frac{1}{1000}$ in., and the latter no larger than about $\frac{1}{2000}$ in.; in addition to these, numerous, large, deep-tinted corpuscles were seen; also pale, globular corpuscles (not unlike those of blood), and as well fungus-filaments and elongated cells forming these filaments."¹

Once more—"took a piece of skin from the sole; + acetic acid:—Again were found the separate and aggregated tinted-granules: a globular collection was found to measure at least $\frac{1}{300}$ in. diam.; it is of clear, slightly yellow colour, and regular form; it is composed of individual globules having the dimensions of $\frac{1}{1000}$ to $\frac{1}{2000}$ in., and each of which is surrounded by an envelope of jelly-like material, but all being commonly blended, it seems as if the globules were imbedded in a mucoid substance." I note that these structures "are very delicate, but that they are readily seen." "In the interior of these on similar masses the red corpuscles appear which I once called 'spores'; they have a deep, clear, orange tint, possess no distinct wall, and, when small, measure in diameter $\frac{1}{3000}$ in., but are sometimes as large as $\frac{1}{2000}$ in.; they occur in clusters: other bodies of smaller dimensions, colourless, clear, very numerous and disposed in rows or clusters," were also noticed. On another occasion the spherical aggregates which were found, rather resembled those first noticed, the individual globules being in close apposition.

To similar effect is the result of examination of the specimen from Bhooj (page 4), also of the *Melanoid* variety of Mycetoma; thus I note—

" . . . close to one of the openings on the dorsum of the affected foot a reddish streak was seen on the sectional surface, leading down into the sub-cutaneous tissue; this when microscopically examined, is found to be crammed with bright yellow globules; some very minute, others larger, all clear; and there are besides, several much larger, deep-tinted corpuscles like those found in the foot from Scinde. . . ." Feb. 28, 1860.

¹ Here, I may remark, the appearances seem to point to immigration and transition of structures from the blood into the tissues: at the time these observations in

India were made (1862), attention had not been drawn to such occurrence, so much as it has of late times.

An additional observation may be given here:—In the foot-disease described at page 5, I found—

“Numerous small apertures in the sole, close to each other and mixed with red stains: from them the canals do not run long or deep, but always contain black particles, even close to the surface, of a perfect kind and unmixed. They are placed close together, and often communicate. These places on the sole seem to show the manner in which the disease begins, before it spreads upwards, and they also seem to show that (local) infection takes place consentaneously at several points.”

b. I now turn to examples of the *Ochroid* variety of the disease; again transcribing the original notes.

“In a specimen received from Bhoj (page 9), there is precisely the same appearance of pink spots and streaks in the skin of the sole, situated in the neighbourhood of sinuses, and very numerous: they present, too, a similar structure to that above described.” Amongst the contents of a narrow canal situated near the root of the toes—a locality selected because of its being on the outskirts, as it were, of the main growth—I found spherical bodies of appearance identical with those described above as occurring in the pink stains of the Melanoid variety: thus it is noted—“mixed with the soft particles, fat-crystals and *débris*, was seen a globular mass measuring in diameter $\frac{1}{300}$ in., and consisting of a delicate, granular, mucous substance in which are imbedded countless numbers of minute, bright globules, sometimes single, sometimes double, or even quadruple; of a clear yellow tint and not arranged in any particular manner; the size of the individual globules seemed to range between $\frac{1}{30000}$ in. and $\frac{1}{20000}$ in.” For full description see Plate X, fig. 7.

Another of these globose aggregations is thus described—“it is smaller than the above ($\frac{1}{300}$ in. diam.), but presents the same general appearance only the sub-division of the constituent globules had not proceeded so far.” In the same specimen I found appearances indicative, as I think, of the development of the pale, soft particles so characteristic of Mycetoma, from structures similar at least to those now described: this point will be afterwards considered.

c. There remains to mention some observations of similar, if not identical, corpuscular bodies, whose presence was detected, not in the integument, but in other tissues in the immediate neighbourhood of the developed, perhaps still progressing, growth within the foot.

First, in the specimen of the black fungus disease described at page 5, I noticed some time after operation, a reddish substance found alongside a *tendon* in its sheath: “it consisted of spores, as seen in the skin:” amongst other corpuscles besides numerous, coloured, spherical granules, sometimes aggregated, was seen a globular vesicle ($\frac{1}{500}$ in. diam.) of pale colour having a distinct wall and contents seemingly of finely granular or grumous consistence (Plate X, fig. 9). Next, in the specimen of the pale variety of Mycetoma described at page 10, at an examination made directly after amputation of the limb, I note—“section of the tissues in the immediate neighbourhood of the advancing disease; muscles, ligament, skin. The *muscles* seem to have generally undergone some fatty degeneration; a large amount of fatty matter, in the form of granules and drops, also between the fibres: occasionally an orange-coloured particle is seen, but these have no determinate form or size: not much else is to be seen in the case of the *ligaments*; in the *skin*, the fatty matter is less abundant, and the coloured particles more so, being also arranged in lines not unlike the pink-coloured streaks before described, which were not apparent in this specimen. Some were seen in close contact with sweat-ducts but not to all appearance within them. Sometimes radii (fatty crystals) were seen amongst the muscular fibres among the fatty deposit, and quite unconnected with any fungus-particle.” A figure is given, which is reproduced in Plate X, fig. 8.

d. I have observed, as others have also, that the skin covering the foot in Mycetoma is frequently marked by pale spots: these, as I suppose, are commonly of the nature of cicatrices, that is, they are due to removal, in various ways, of the whole depth of the cuticle and adjoining layers of cutis: such spots were observed in the case last referred to and the following note was made, also immediately after operation:

Section of the skin through one of the circular pale spots—the continuity of surface was unbroken; the corium beneath seems more vascular than elsewhere, but nothing abnormal amongst the textures was detected

by the microscope. Some hypertrophy of the subcutaneous tissues exists. Very little more was seen, I may add, in the specimen of incipient fungus described at page 11; except, of course, the concurrence of parasitic elements.

Summary.—The appearances above described, I have always supposed to be indicative of the earlier, visible stage of growth within the tissues, of the parasitic entophytes which are the immediate cause of disease in Mycetoma. It is true that the pink streaks, &c., were not always noticed, but they might have been overlooked, or not sufficiently searched for; and it is, of course, possible that the auto-inoculation of the foot to which I have attributed their presence, may not at the time of observation have occurred, for this self-reproduction is not a persistent or inevitable phenomenon of the disease. The question would rather be, do these pink streaks really indicate the spots where, subsequent to inoculation, growth of *Chionyphe* has begun; and are they the precursors of the perforating, fruit-laden tunnels which subsequently ramify through every tissue of the foot? Now the only kind of evidence which could settle these points would consist of experiments expressly made to ascertain if the peculiar contents of these stains, streaks, &c., would grow by artificial cultivation outside the body into the parent form of plant; and such evidence is yet wanting. Still there remain the morphological observations which I have recorded; and it is on them, briefly, that my opinion rests.

I should here again refer to the constant presence of ovoid or globular, clear, deep-tinted corpuscles, of tolerable size, among the "glæogenous" masses contained in the pink stains, &c., and also found free (*vide* Plate X, fig. 6). They were supposed by me to gradually disappear as the particles approached full growth, and to have no evident relation to the "spurious nuclei" sometimes noticed within the latter; presuming that these false nuclei are really such, I have still no valid reason for changing opinion, and cannot better tell what becomes of these characteristic corpuscles. Some other remarks respecting them will be found in the last chapter.

B. *Mode of growth of the Entophytes.*—Having now specified the facts which I possess bearing on the subject of the commencement of Mycetoma, I proceed to offer such a connected account, as may best serve to bring these and similar data into their true, relative position in time.

On the most cursory examination of the peculiar characters of this disease, it becomes obvious that one must start with the assumption, that "spores" or "germs" are, in some way, introduced beneath the skin of the affected member. As to the *mode* in which this is possible, it is sufficient to repeat that there are natural openings in the integument, particularly abundant in the sole and palm (where probably the disease oftenest begins), through which such reproductive elements, in the form of *Conidia*, *Amæboid cells* or *Bacteria*, might readily enter. Simple comparative measurements sufficiently show the

¹ Having submitted to Mr Berkeley, for inspection, some of the figures shown in Plate X, fig. 7, I was favoured with the following reply:—"I see no reason why what you have drawn should not be a peculiar development of the Fungus. You know what strange transformations crystals undergo when formed in colloid substances, and the spores or conidia of fungi put on as strange disguises. There are one or two cases in ascigerous fungi after the fashion of those which you draw. The most striking case is that of *Spheria barbata*, B.

(*Melanospora barbata*, Dur. and Mont.), which is unfortunately so rare that there is scarcely more than a single perithecium. There are cases enough where the division is transverse and not crucial, as in the case just mentioned." In all my conceptions, however, respecting the structures in question, I have since noting them, had in mind the illustrations to Mr Lankester's paper, quoted below, because here are seen representatives amongst Bacteria-forms, of most or all of the bodies which I detected within the diseased foot in India.

possibility of such event, and the motile powers possessed by the last-named bodies would aid in this result. But it is also obvious that, besides the openings of the sudoriparous glands (or, as well, hair-follicles and sebaceous glands, in other parts than those named above), any small artificial orifice, as puncture or abrasion, would serve for passage equally well; and, in fact, not uncommonly patients attribute this disease to the prick of an Acacia-thorn, &c. The soil of both field and lane in India, so invariably swarms with decaying vegetable matter, and this at certain seasons in a moist condition, that one can only wonder that the bare-footed native, does not far oftener become affected with the fungus-disease.

In general terms it may be said, that the spores or germs of *Chionyphe*, however introduced, become developed amid the tissues, away from light, but plentifully supplied with oxygen, nitrogen, and other food; and also favoured by moisture and a constant high temperature. An early stage of their growth is doubtless presented by the pink-coloured streaks in the skin, &c., which were above described; but the precise relation of the contents of these streaks, to the different forms of mature particles already discriminated, is as yet only to be explained upon hypothesis, or, at best, by analogy; and the same may be said respecting the origin from spore or germ, of the pink streaks themselves. As discussion of these points will be reserved for a note, supplementary to the last chapter, I will here only remark that, according to the opinions of competent observers,¹ from the spore of a fungus may directly proceed bacterioid bodies, and that as a normal process; whence it may be said that, from the spore of *Chionyphe* accidentally thrust into the skin of the human foot, there is formed by growth in this new nidus, not ordinary mycelium and sporangium, but in ways already demonstrated for other instances, a *micrococcus*-mass or *zoogloea*-form, such as is actually found within the pink-stains above described. Subsequently, it is to be presumed that the ordinary cellular fungus-structure appears, and the black *sclerotia*; which may be regarded as possessing in themselves, such elements of growth and continued reproduction, within the body, as they are well known to possess outside, and under normal conditions. It is the particular stage of growth at which inoculation from *Chionyphe* takes place, that seems to determine the pathological result, namely, of scleroid or of malakoid particle: and from all that I know, in one and the same locality in India, nay, in the same village, one person shall have the melanoid, and one the ochroid, form of fungus-disease of the foot. Or both forms shall be the same, of which two instances have come to my knowledge. Could future observation detect the attendant conditions upon which these variations depend, how much light would be thrown upon this interesting subject! That fixed conditions exist, we may be sure; and it is that our future groping after truth may not be wholly distracted, that I now venture to put forth theoretical suggestions in this place.

Respecting the commoner *Ochroid* variety of *Mycetoma*, it is not, on any theory, easy

¹ Hallier, Huxley, Fruh. Lüders, Lister, &c.: the last-named author in the 'Quarterly Journal of Microscopical Science,' October, 1873, has described as one mode of development of hyphomycetous fungus, the spores (conidia) shooting out sprouts of exquisite delicacy, which break up into Bacteria; and the figures given of this *Dematium fuscisporum* (Auct.), show its spores to have the thick, dark-coloured walls, and a mode of

sprouting very much like the gemmules, or imperfect sporangia belonging to the sclerotial form of *Chionyphe* C., as witnessed in the human foot. I have before said that delicate filaments have been seen to proceed from more than one variety of malacotioid particle; but though their destination could not be traced, the circumstance may be mentioned as suggestive. (Vide Plates X and XI, figs. 1c and 2.)

to conceive in what form, the rudiments of its characteristic particles commonly exist outside the body, or enter the human foot. True, on Hallier's hypotheses (to be afterwards referred to), their germs may at some time be veritable fungus-spores; but more likely is the notion, that their immediate predecessors belong to the Schizo-myceta of De Bary. Thus, there is the fact that their minute structure appears to be very similar indeed to that of such bodies as the Micrococcus-colonies of Hallier, or the Bacteria-colonies of Klebs;¹ and still more to that of such compact bodies as proceed from the species of "Bacterium," whose growth was watched by Mr E. R. Lankester, and which I have by the kindness of the observer, been enabled to directly compare with the pale particles of Mycetoma. The globose, deep-tinted and fine-grained masses to which I refer, are not fully described in Mr Lankester's paper,² having been noticed by him at a date

¹ 'Archiv für Experimentelle Pathologie und Pharmakologie,' pt. 6, 1st h., 1873; in an article entitled "Contributions to Knowledge respecting Micrococci," where the results of artificial cultivation of Microc. septic. and Diphtheritis-masses, are given in much detail; and it is shown that there are produced rounded masses, having a yellow colour, such as present a very considerable likeness to the structures characteristic of the Indian foot-disease. There are obvious objections to this comparison being pursued further, in the absence of specific information respecting the origin and development of the last-named bodies; but as all facts bearing upon this subject are of interest, I have appended a brief abstract of Klebs' experiments. I note that here the zoogloea stage was not apparent; that the original Bacteria were motionless; and that in various particulars this pathological species differed in developmental phase from the normal; and I add that this variation is of itself significant with respect to Mycetoma.

Summary of the appearances observed, in experiment, during the development of *Microsporon septicum*:—

1. Proliferation starts from rod-shaped, motionless particles (Bacteria), which probably divide only lengthwise; and there result isolated, crossed or radiated clusters of Bacteria.

2. Subdivision rapidly proceeding, the individual particles disappear, and there arises a granular mass, which at first possesses a pointed form, then under quick growth gives rise to spheroidal bodies . . . such globular bodies either separate from the chief mass, or may arise from detached germs.

3. A difference in their contents next appears: some of the globules clearly being transformed in Bacteria-colonies; while others, smaller and less numerous, acquire a homogeneous, dull-lustred and yellow-tinted appearance. The most striking property of these "yellow bodies" is their approach in character to amoeboid cells, and the occurrence of slow but distinct contractile movements in them. . . .

4. The fourth stage consists of the passage of both kinds of bodies into a homogeneous mass, in which neither pigment-corpuscles nor Bacteria-colonies are apparent. This process is attended with the detachment of adult Bacteria from the edge of the latter, and their gradual, though interrupted, approach to the yellow bodies, with which they blend. . . .

5. From this last-formed plasma-layer may with re-

newed development arise just as from the first introduced germs.

The particles figured by Klebs, in Taf. IV, fig. 10 a (yellow Micrococcus-colonies), most of all, perhaps, resemble the "Malacotia" of Mycetoma; but I do not intend to pursue this topic into details, which as yet would be quite hypothetical.

² 'Quarterly Journal of Microscopical Science,' Oct., 1873; "On a Peach-coloured Bacterium—*Bacterium rubescens*," p. 8. This species was incidentally found in the summer, and lived till the autumn: it occurred in jars of putrescent water, and is described as spreading similarly to *Chionophle* in the Bombay specimens. The "globose aggregates" are figured as themselves joining, whence result particles large enough to be visible as specks to the unaided eye; some are as much as $\frac{1}{300}$ in. or more in diameter, and when persisting for more than one year, they have a very dark deeply stained appearance; on account, too, of the minute size of the plastids (granules) forming them "are, at first view, with a quarter-inch objective, hardly to be recognised as similar in nature to the paler masses of larger homogeneous bacteroids." This observation is singularly applicable. I note, to the pathological growth, in which too, as I interpret, the subdivision of ultimate particles has proceeded so far as to leave only a finely granular structure. Mr Lankester's species lived under water; light was not necessary to its growth; artificial cultivation had not been successful; on drying the elements assumed a brownish tint, "and this will tend to modify the aspects of old crusts;" active movements were not seen in the commoner forms of this species of Bacterium, and, indeed, only once out of many varieties of shape, &c. Mr Lankester observes, "the series of forms which I have found in the growth of *Bact. rub.* leads me to suppose—what has appeared probable to other persons in regard to the Bacteria generally—that the natural species of these plants are within proper limits 'protean.'" And other remarks might be quoted, but it will be sufficient to have indicated the direction of research which seems most likely to lead to fuller acquaintance with the subject in hand.

It is, I may add, satisfactory to myself to have at last found the type of structure to which may, to all appearance, correctly be referred these hitherto anomalous bodies found in the human disease. As is well known, no perfectly satisfactory interpretation of this character

subsequent to that communication; and being the result, it is supposed, of further continuous subdivision of the coloured particles contained in the "globose, glæogenous aggregates," which form so striking a feature in the development of this *Bacterium rubescens*. Probably, therefore, these more compact masses represent the terminal stage in the growth of the plant; and they may ultimately break up into Bacteria-like particles, from which a similar course of development again begins. This instance is perhaps more strictly comparable than the first-named, because it refers to a normal example fully detailed, and presenting stages of growth with which not a little of what is observed in the fungus-disease, may be afterwards found to correspond. Once for all, I would state that the presence of a *Bacterium*, whether moving or motionless, in connection with the early (or perhaps any) stage of Mycetoma, has not been demonstrated. It is therefore on hypothesis alone that I am now proceeding; the argument being that the peculiar Zooglæa-forms detected in the pink-stains, presuppose the existence of Bacteria, whose isolated existence might well indeed escape notice, under the circumstances of our pathological inquiries. The possible exception above noted, is the observation of Oscillatoria (?) or delicate-jointed filaments, seen in connection with a fresh-removed particle (Plate XI, fig. 2). In short, the first-known trace of the entophytic growth, occurs under a form seemingly referable to a Bacterioid origin.

To what faculty is to be attributed the penetrating power evidently possessed by the human parasite, is difficult to imagine, in the absence of all powers of movement in the various kinds of growth already distinguished; yet I note that the species of *Bacterium* (or *Micrococcus*) to which for comparison reference is here made, were also motionless. The parent fungus itself—*Chionyphe*—displays, so far as I know, no tendency to burrow; and this last circumstance would point to the need of artificial aid in inoculation, unless this event commonly happens at a stage of growth, when motile germs exist.

Not a few features of the fungus-disease become intelligible on the view proposed: thus the glairy, slough-like tissue or matrix in which the new growth is imbedded,¹ may be ascribed to the action of the parasite upon the normal textures; and, I think, the rapid, painless progress of the tumour, unattended with much irritation, is, to some extent, due to the living agency to which is owing, the origin of the swelling.

has hitherto been put forward, and I have since my late return to England, failed to get any real enlightenment. I may add here that it was only by a sort of accident that my attention was directed to the writings above quoted, and it arose as follows:—While in Norway, for the purpose of studying "Leprosy," Dr G. A. Hansen, of Bergen, a most competent observer, pointed out the possible origin of certain morbid elements of that disease in the growth of Bacteria, at the same time referring to Klebs' article—the grounds of this conception being not without foundation in the fact that active Bacteria may be seen in fresh cells directly removed from the living leprosy subject—and it was thus that I noticed the similarity, which on subsequent inquiry has now become, for me, a real one.

¹ I formerly (First Memoir, 1860) stated my impression that the fungoid particles pertaining to the Ochroid (and possibly also to the Melanoid) variety of the disease, "will eventually be found to belong to that order of Fungi (called by Payer *Myxospora*) in which the spores arise in the midst of a mucilaginous substance repre-

senting the *mycelium*, and having no very distinct organization. The fleshy, glairy, slough-like tissue found in the case of the woman in the Madura specimen (and probably in all others of the kind when fresh), may represent the little organized mycelium. The spores are said by Tulasne to arise by nuclei in this mass; they are often brown or black, and in some species are grouped in six or eight, so as to resemble compound spores. One of Payer's figures (*Thecaphora deformans*) might represent the chief characters of these spores. This order of fungi, according to the author named, includes most of the entophytal fungi, and is represented by the bunt, or smut, of our cereals, or by the ergot of rye, &c." It is in deference to the opinion of Mr Berkeley, that I have desisted from urging more these early views of the character of the infecting fungus of man, in India; but it still appears to me that they should not be lost sight of in future deliberations, if only because the natural, or normal, history of these lowly organisms is still open to much elucidation.

Commencing at some points upon the surface, the entophytic growth proceeds towards the deeper parts, and the whole mass of the foot may so be traversed; and as well adjoining parts of the leg itself: then, sooner or later, the growth tends towards the free surface of the skin, and by irritation of the deeper layer of the cutis, vesicles are caused, such as arise by the corresponding approach of the Guinea-worm on its way outwards; their rupture produces, and leaves, the peculiar apertures above described, and here escape the matured products of plant-growth. The soft, elevated swellings of the skin, or abscesses, so-called, may be regarded, perhaps, as but exaggerated vesicles; and they have the same relation to the deeper-seated processes. These latter are attended with some irritation of the tissues, which leads in those of the integument, to firm œdema and even hypertrophy, which may be considerable; the muscles in the course of the branching, fruit-bearing tunnels are necessarily destroyed, and they are also wasted by disuse: the ligaments and tendons longer persist, these and the fibrous aponeuroses, probably to some extent influence the direction of growth, but this does not appear of the bones, which frequently suffer to a large extent, and sometimes, I have thought, by preference: in all the last-named tissues, the attendant vascular irritation is slight, and not to be compared with that due to ordinary foreign bodies, or the more heterogeneous morbid products. The structure of the tubes, tunnels, or cavities in which are lodged the growing fungi has been already described.

I have, too, remarked that inoculations of the foot may be single or numerous, direct or consecutive; but in all cases, may here add, it occurs only at the surface as a fresh starting-point, for I never remarked any growth amongst the tissues which was wholly detached, or which could not, with due care, be traced to be in direct continuity with other formations, or with the skin itself; every one of the masses being thus put into communication with the free surface or exterior of the body.

It is certain that a period of incubation must intervene, between inoculation and return to the surface, of the spreading growths; should the germs pass deeply inwards, such period of hidden development and extension may be prolonged; yet in no instance could it be certainly defined, because the date of effective inoculation—the first essential factor of reckoning—was wanting. The point is one of interest, but is not elucidated by experiment or observations made on growth outside the body: that there is, besides, a seasonal period of exacerbation in growth, may be surmised, but this is not yet certainly known. The parent-fungus (*Chionyphe Carteri*) grows only at one season (as will afterwards be demonstrated); and, as I have above said, the habit may not be altogether lost in its pathological phases. The Guinea-worm parasite periodically appears.

The present observations apply to both varieties of Mycetoma, and, so far as I am aware, no essential differences exist between these as regards the general characters under consideration.

Respecting the successive stages of growth of the entophytes of Mycetoma I have little to say, in the absence of more complete observations than those above recorded. It is, however, a very singular circumstance that I seldom succeeded in detecting fungoid particles, of any kind, presenting signs indicative of successive stages of growth. Thus the smaller *black* particles were the same in structure as the larger, or if changed, the differing portion was clearly a further development, rather than a preceding stage, of the sclerotoid body. I here refer to the observations recorded at page 69, and illustrated

in Plate IX, fig. 6. And as regards the *pale*, soft particles, I cannot from positive knowledge state the precise manner in which they are formed, having never detected other than obscure signs of the preliminary stages of development, or phases prior to their termination in the production of the almost structureless globules already described; and yet such stages must occur, on any hypothesis of their origin. So much as is known, I shall presently state in full.

I have, however, mentioned isolated observations on the structure of the *investing membrane* of these growths, which should be here referred to, because it is *à priori* not unlikely, that there might be found the *nidus* whence they sprang; and it was soon after making these researches, that I attempted to describe the growth of the *sclerotoid* particles as follows (2nd Memoir, 1861):—"The large brown spores by germination produce the mycelium from which the brown cells forming the mass of the fungus arise; amongst these the large colourless cells are developed, some of which sprout at once into fibres terminating either in other colourless cells, or in small brown ones, the increase of the mass being thus provided for; others are probably converted into the large spores.¹ Adopting this view, the smaller fungus-particles are detached growths either once adherent to the sides of the canal or constituting the outer layer or rind of the larger masses. These latter comprise the entire growth, their central part being composed of the radiating fibrous mycelium, and their cortical part of the organs of fructification. Accordingly we may suppose that growth commences in the walls of the canals to which the spores become attached, or perhaps in the formation of the large particles they sprout unattached: in whatever mode it takes place the process is most active, for no more striking, almost wonderful, sight can be seen, than the canals and cavities forming the bulk of a Mycetomatous growth of the Melanoid variety, when they are crammed with glistening, jet-black particles passing on their way to the exterior of the body."

I now (but very briefly in this place) advert to the mode of growth of the *pale*, soft particles, above termed Malacotizæ. It has already been intimated that nothing certain is known touching their origin or even true character: still an opinion has been proffered,

¹ "If we bring a vegetating Mycelium of the *Mucor mucedo* into a medium which contains the necessary nourishment for it, but is enclosed from the free air, the formation of sporangia takes place very sparingly or not at all, but the formation of *gemmules* is very abundant. Single interstitial pieces of the twigs or even whole systems of branches, are over-filled with a rich greasy protoplasm; the short pieces and ends are bounded by partitions which form particular, often tun-like or globular cells, while the longer ones are changed through the formation of cross partitions into chains of similar cells; the latter often attain by degrees strong thick walls, and their greasy contents often forms itself into innumerable drops of a very regular globular shape, and of equal size. Similar appearances show themselves after the sowing of spores, which are capable of germinating in the medium already described (*i. e.* a solution of sugar), from which the air is excluded. Either short germinating utricles shoot forth, which soon form themselves into rows of *gemmules*, or the spores swell to large round bladders filled with protoplasm, and shoot forth on various parts of their surface innumerable pro-

tuberances, which fixing themselves with a narrow basis, soon become round vesiculate cells, and on which the same sprouts which caused their production are repeated—formations which remind us of the fungus of fermentation which we will describe further on, and which will be called globular yeast. Among all the known forms of *gemmules*, we find a variety which are intermediary; all of which show, when brought into a normal condition of development, the same proportion and the same germination as those we first described these *gemmules*, *brooding cells*, resemble such vegetable buds and sprouts of foliaceous plants as remain capable of development, after the organs of vegetation are dead, in order to grow under suitable circumstances to new vegetating plants; as, for example, the bulbs of onions, &c." Quoted from 'Quarterly German Magazine,' Berlin and London, 1872, No. 2, p. 39. "On Mildew and Fermentation," by A. de Bary—(an English translation, not always quite intelligible); with reference to the large thick-walled and often deep-tinted cellular bodies termed "spores" in the text, but probably of the nature of the "gemmules" here described.

and not inconsistent with this, is the earlier view which I took, as thus expressed in my Second Memoir (1861):—"I am still inclined to view these pale, soft bodies as having originally had a distinct cellular structure, and having subsequently undergone degeneration: in favour of this opinion, is the actual occurrence of particles similar in appearance, position, &c., which unmistakably possessed such a structure; and besides, in this instance, some of them were seen passing through the degenerative stage, traces of a solid fatty fringe being visible around their exterior" (see Plate X, fig. 1*f*). Reference is here made to a single specimen, respecting the general value of which I am more than ever disposed to insist. On the assumption that Bacterium (or Micrococcus) forms, are intimately and even essentially connected with the fungi proper, it can be understood that the little bodies which were found in the foot of the woman whose case is described at page 8, had passed into a certain stage of development while within the foot, in succession to the glæogenous, colony, or more compact phase; and from them it was ascertained that *Chionyphe* might spring, outside the body.

In these same particles, whose general size exceeds that of the *Malacotia* proper, I noticed appearances which seemed to show how the crystalline envelope might arise, out of the fungus-substance itself.

CHAPTER III

REVERSION TO NORMAL TYPE, BOTH SPONTANEOUS AND INDUCED. THE ADVENT OF CHIONYPHE UPON THE FUNGUS-PARTICLES OF MYCETOMA

Having now considered the first appearance, and possible mode of growth, of the parasitic entophytes within the human body, I pass on to describe what occurs, when these pathological products are allowed to germinate outside the foot, under circumstances both natural (as they may be termed), and artificial; the result in either case being identical, namely, that both the commoner kinds of fungus-particles *revert* to a parent-species, which is the same for both of them.

I will first narrate the facts at my disposal.

1. *Spontaneous development of Chionyphe Carteri*

(a) The foot appertaining to the case of the woman described at page 8, which was amputated in November, 1859, was placed in water to be macerated, and the bottle with its contents put aside. In May, 1861, the specimen was found to be partly covered with a crimson-coloured mould which had made its appearance some time previously, decomposition of the tissues having but slowly proceeded. When observed, that portion of the specimen remaining uncovered by water was on its surface most deeply coloured, but other parts also, and even the sides of the bottle, to some extent, had a colour like that of fresh blood. The new growth occurs, I have noted, in spots of various sizes, from a mere point to a patch having a diameter of half an inch: its superficial surface (containing the organs of fructification) is of a deep purple-lake colour, is irregularly lobulated, and when examined with a lens, is found to have scattered over it numerous light-coloured and spherical bodies, which impart an appearance comparable to the fungiform papillæ seen on the tongue of a healthy person. The thickness of the patches varies from about $\frac{1}{10}$ to $\frac{1}{8}$ inch: in the latter case their consistence is distinctly

fibrous, and they tear readily in vertical direction: superficially, is a flocculent, crimson layer, in which are the spherical bodies (vesicular fruit); next follows a pale tough material, having a somewhat flocculent, and irregularly lobulated appearance, and forming about one fourth of the thickness of the whole mass, the chief bulk of which has, however, a buff tint becoming tinged with red above; and the lowest stratum is thin, with a lighter tint than the rest. The edge of the patches was generally indistinct, but in the thickest part it was crenated.

The minute structure of the crimson mould is figured and described in Plate XI, fig. 1 *a* to *g*. Respecting the tissues of the specimen, it was seen that the *cuticle* of the toes and sole of the foot, and the exposed surface of the section, exhibited the deepest colour, which much resembled that of a clot of blood: the *cutis* beneath is also of a deep red tinge, but this seems to be due only to staining of the part, and the adipose and other tissues lying immediately beneath the divided surface of the section are similarly stained red. On minute examination it was found that the deep red stain extended through the *cutis*, but was lost in the subjacent lax tissue; it was of uniform tint; the *papillæ* of the corium were not altered in form or definition, they were tinged as the rest: no fungus-elements seemed to be present in their substance; the whole became clearer on the addition of acetic acid, but the red tinge was here very evident still, and no spores, &c., could be anywhere detected, though searched for with care: vessels and nerves, as usual, were seen in the *papillæ*. The *cuticle* was entire; its epithelial scales were stained yellow, and intermixed were spores and nucleated cells; besides were seen a few filaments which were delicate, branching, and occurring in clusters. It is apparent that this new pink mould is strictly limited in its growth and extension to the surface of the specimen, and nowhere does it show a tendency to penetrate the normal textures of the foot, or to assume the form of globular masses.

(*b*) Another specimen of the pale, soft variety of the disease received from Bhoj in June, 1862,¹ had been put into a bottle with some fresh spirit, and the bottle being tied over with paper, was put aside until the month of August. The spirit had then partly evaporated, and a part of the specimen was thus left uncovered; this was observed to have acquired a reddish tinge, and soon after there appeared a thick layer of crimson mould similar to that before seen, and this was speedily covered by a close, white, flocculent layer. The new growth is confined, I noted, to the surface along which it is spreading, over bone, flesh, and skin; it maintains no definite or invariable connection with the pale, soft particles, but seems to spring up occasionally in isolated spots. A thin layer scraped off the skin shows flattened cells of the epidermis covered with the growth, which consists of large, branching filaments, irregularly septate, and containing numerous oil-globules of various sizes; appended to some of the lateral branches are spore-capsules of small size and light colour, the contents of which are not very distinct; some appear to have thick walls; terminal dilatations of the filaments are seen which may be supposed to be incipient capsules. The red tint is owing to colouring matter generally diffused. No spores are visible. The white velvety layer is composed of filaments like the above, with very few sporangia: in one or two places, groups of reddish masses, composed of refractive, round or oval bodies, were seen, which had something the appearance of an accumulation of spores, but may have been a collection of oil-globules escaped from the end of broken tubes, since neither their form nor size were regular. In the deeper placed part of the red growth, the spore-capsules were very plentiful, and even filled with fully formed spores of regular oval form; the colouring matter was here, too, not limited to certain structures only. A sketch of this pink mould was made, but as it exactly resembles that in Plate XI, fig. 1, which was taken from the last-described specimen, it need not be here introduced. I subsequently, also, examined this new growth (Nov., 1862), and found in addition to some still persistent structures whose import is unknown to me, a globular body, or cyst, containing a coloured and a colourless vesicle, together with numerous small globules, the whole resembling an imperfectly developed sporangium with its spore-like globules as well as peculiar vesicles, and being evidently comparable to

¹ The foot arrived on June 26th, and was temporarily put aside. I have no note of its minute examination, but of the nature of the specimen there was no doubt whatever. The following is the history of the case:—Harkha, a Hindoo cultivator, aged 30, native and resident of a village in Wagur, has disease of the right foot; says that nine years ago he was hurt on the sole of his right foot by a small stone; this was followed by some swelling and hardening, which slowly began to increase by extending inwards. A year after this, another swelling made its appearance on the outer side

of the foot; both tumours began slowly to increase, and in about four years they became painful and burst, one after the other, febrile symptoms being attendant. The matter discharged from the openings was thin, and it contained white granules resembling mustard seeds. After this the swellings continued to gradually increase; now and then becoming painful, bursting and discharging particles as above described. It is thus that the tumefactions have attained their present size. (Notes of Mr S. Hemraz.)

similar bodies found in the pink stains in the skin of other specimens: no indication of a stalk was perceived. *Vide* Plate X, fig. 7.

That the red mould described above, was identically the same in both instances is undoubted, and there are other common features which merit notice; thus, the new growth appeared only at a certain time of the year, which, for Bombay, may be regarded (other facts being corroborative) as the close of the hot season and setting in of the rains, or from April to July or August; its duration is then a limited one, and it seemed to die out gradually. Many details respecting this mould may have yet to be ascertained, but that it originated in the pale, soft particles characteristic of one form of Mycetoma, is an inference of the greatest probability; for although it would have been impossible to demonstrate this, in the instances under notice, yet there is the negative fact that upon no other morbid specimens, or other kinds of soil, except those mentioned, did the pink mould make its appearance; and the evidence from experiment, as detailed below, is sufficiently confirmatory. The *Chionyphe* (for such it is) was limited in its growth, to the surface of the substratum upon which it thrived, extending, however, to neighbouring surfaces, where air and light were equally abundant: no approach to the characters of the peculiar particles found in the affected feet, was anywhere noticed; but this is a circumstance which might have been anticipated, because the red mould results from the normal mode of development of a parent form, which gives rise to these particles only under the abnormal conditions of growth obtaining amid the textures of the human foot.

It should be noticed that in both of the instances above recorded, the spontaneous development of the pink mould took its origin from the more common, pale variety of Mycetoma; and it may be added that in one case the liquid medium was water, and in the other diluted alcohol. The locality in which both the bottles were placed, was the dissecting-room at Grant College, Bombay; and close by were numerous other "specimens" in similar bottles, in which, however, this mould did not at any time appear.

There is wonderfully little similarity in appearance, and general characters, I may here remark, between the luxuriant pink mould above described, and the light-tinted, thin and scant growth, which is described and figured by Thienemann as belonging to the other known forms of *Chionyphe*, occurring in Europe, upon melting snow, at the close of winter; but the identification of this new tropical species must yet, for the present, at least, be regarded as valid.

2. *Artificial development of Chionyphe Carteri.*

Notices of the following experiments have been preserved:—

(a) On the day of amputation (Oct. 3, 1859) some black particles taken from a foot were placed in *cotton soil*,¹ moistened with animal juices and enclosed in a stoppered bottle, which was left unopened for two years and

¹ This early experiment was made with a view of testing a prevalent opinion that the disease known as "Madura Foot," &c., was more prevalent on *cotton soil* than elsewhere (*see* *antè*, p. 39). In September, 1860, I received some cotton soil from Madura (kindly sent by Dr Wilson), which was found to be of a dark colour and tolerably uniform, granular consistence; it was composed of black friable mould intermixed with small particles of quartz, which have sometimes a reddish tinge. No more is to be seen by aid of a lens except minute radicles imbedded in the humus. This soil was moistened and kept at a tolerably uniform temperature: afterwards some yellow, slimy masses were observed,

and later still fungus-filaments; but no particular description was preserved of either, as the parent mould of Mycetoma was not known at this time. Experiments with negative results may be looked for if made at a season of the year when the normal development of *Chionyphe* does not occur. I afterwards examined a similar specimen of cotton soil from Guntoor (also in the Madras Presidency) with equally negative results. Future experiments may have to be more intelligently conducted than were these; yet as *Chionyphe C.* prevails in other media than cotton soil, search and trial should not be limited to scrutiny of the latter.

nine months, *i. e.* until July, 30, 1862, when it was found that a thin reddish film had appeared on the still moist surface, like that noticed on the surface of salt-pans in the marshes near Bombay. This film, I note, is made up of minute red particles, just visible to the unaided eye, which present on further examination coloured cells with a narrow, colourless wall, identical, I suppose, with the cells of *Palmella*. The fungus-particles had undergone some slight change, and in the drawings which I have preserved are delineated some orange-coloured bodies which had appeared within them; but as the nature of these structures was not obvious, I have not reproduced the figures: it is in my notes that the addition of *iodine* did not produce a blue tint in either black particle or orange spore-like bodies.

(b) Some black particles were at the same time (Oct., 1859) placed in rice-paste, moistened and corked up: all remained unchanged till July, 1862, when on opening the bottle and removing its contents into an open glass-cell, a *red mould* speedily made its appearance and spread luxuriantly: it had not, however, a clear connection with the fungus-particles, but seemed to spring up independently of them upon the rice, wherever this was exposed to the air. Such is the statement in my notes, yet I now think that there existed the connection here not detected.

(c) Experiments made with the same black particles placed in water only, did not yield any results of moment: they were made at a later date, *viz.* August to September.

(d) Black particles were taken directly from the foot amputated at Bombay on Sept. 26, 1861, and placed in some moist ground rice; and others were put in water: in both instances they remained unchanged during the following few months; but under date April 3, 1862, I note that a reddish tinge has for some time been observed in the rice-starch, which all this time has been kept moist, and the colour is now very distinct, being of a bright crimson hue in some places; it has exactly the same appearance as that observed in the red mould of the bottled specimens. In one or two cases the starch was allowed to dry up, and a white mould has appeared in them. The black particles have remained unchanged, to all appearance; and these red stains do not surround them, but may spring up unconnectedly. On taking out a black particle, it was found to be covered with the rice rather closely; but this latter could be removed, leaving the former unchanged. Examination with the microscope shows, too, that the particles had undergone no change, or perhaps their constituent cells were rather withered or wasted. Closely invested by paste in which the new *Mucor* luxuriantly grows, it appears sometimes as if its filaments sprang from the black particle; but this was not unmistakably sure, as the appearance was always explicable on the assumption of bits of the rice, and *mucor*, still remaining adherent. The filaments of the new growth measure $\frac{1}{3000}$ — $\frac{1}{3000}$ in. diam.: capitula are seen of all sizes at the ends of the filaments . . . some are filled with minute, crimson granules, giving a colour to the mass, but the *Mucor* is abundant when the colour is not evident to the eye. Portions of the cuticle of the seeds of the rice are also to be seen, of a yellowish tinge, which may aid in producing the general colour: raw rice was used. Supposing this *Mucor* to give rise to spores having the properties of *Asaba*, or supposing the spores of this pathological Fungus to give rise to such motile organisms, it can readily be explained why the red colour should appear at widely separate points.

At the time the above was written, I was not aware of the real connection of the pink mould with the fungus-particles of *Mycetoma*; but I prefer to alteration, allowing my notes to remain in their original state.

(e) On August 29, 1862, the following experiments were made in elucidation of the view at that time become apparent, of such real connection:—

Aug. 29.—1. Put into some rice-paste fragments of the black fungus (1861).

2. Put rice-paste only.

3. Put into a larger glass-cell another fragment of the black fungus which had been kept dry in a box since 1859.

Sept. 18.—Examined:

1. Only result is growth of a brownish mould.

2. No result.

3. No result.

Sept. 24.—Again examined :

1. No result.
2. Has now dried up without the growth of any mould : there is a suspicious reddish tinge in one part.
3. Covered with a pink growth, which has all the appearance of the *red mould*; it has grown equally and spread everywhere, but at its commencement had no more apparent connection with the unaltered black masses, than in other cases.

(f) In July of the same year other experiments were made with fresh particles taken from the foot amputated in 1861; they had clearly sprouted in some instances, and I have preserved some rough figures; but as it happened that the specimens were lost, I need not make further remark here.

In all the above-described experiments, the Sclerotoid particles characteristic of the Melanoid variety of Mycetoma were made use of. I have recorded all the facts at my disposal, in order that an impartial opinion may be formed as to the connection of the pink mould with these morbid bodies. In my own view, the positive data outweigh the negative, because the conditions adverse to reversion to the normal type are more likely to prevail than are favorable conditions, under the circumstances of the experiments quoted. Should doubt yet remain, I would refer to the emphatic testimony of the Rev. M. J. Berkeley and Mr H. J. Carter, mentioned in the Appendix; and as to future trials, would draw attention to the necessity of observing seasonal conditions. The dormant vitality of the black particles (sclerotia) is persistent, as I have just shown, for at least three years.

Respecting experiments made with the pale, soft fungoid particles (malacotia) of the ordinary variety of Mycetoma, I had not in Bombay more than one favorable opportunity of pursuing the subject. I now refer to the case of the young man described at page 10, and the following notes were made at the time (1862):—

(g) Next day (August 10), took another ochroid particle; saw again on the edges some very delicate filaments, too small (under the magnifying power of $\frac{1}{4}$ -in. obj.) to be measured, branching and curved: looking like strings of *Oscillatoria* (so I note), but not moving, and seen before, *i. e.* immediately after amputation. They are not like the fine crystalline fringe, which generally assumes a straight parallel or radiating disposition. In Plate XI, fig. 2, are the illustrations. My notes continue: these delicate filaments were more abundant on the second day than the first; they persist after the addition of the strongest re-agents, and their true nature was not at the time apparent to me. I now think they may have been *leptothrix*-filaments proceeding from the particles.

(h) Experiment. Put some of the pale, soft particles taken from the same foot into a little boiled rice (1); others on moistened sand (2); also placed some plain rice for comparison (3). Date August 10, 1862, being the day after amputation of the limb. On the 20th, I note the plain rice is covered with mould of buff and green colour; no appearance of the red mould. That rice in which the particles were put, has just a trace of yellow tinge, but no alteration is noticed in these bodies. On the 25th it is remarked that No. 1 has for the last day or two shown a *red tint*, and that there is now a distinct growth of this colour; further, in examining one of the particles having a reddish tint, the origin of the new growth seems to be clearly traced to it. See fig. 3, Plate XI. On August 29th No. 2 had shown no change, and No. 3 had wholly decayed: further note of their appearance was therefore discontinued. At this date, it is now observed that the pink mould in No. 1 had ceased to spread, and that other moulds were appearing.

As to the value of the observation that the red mould (*Chionyphe Carteri*, Berk.) could be traced directly to the central body of the fungoid particle, those acquainted with the delicacy of these investigations, may differ in opinion: I record the appearances only. If, however, the conjoined series of fact now related, be regarded as conclusively establishing the connection of the *red mould* with each variety of the *fungus-particles*—and such is the interpretation of data, similar and not more precise, which is maintained

by very competent and independent observers—then a most interesting feature in the natural history of *Mycetoma*, will have been elicited; and one which, inasmuch as it furnishes a clue useful towards search for the parasite in its native soil, may, as well, be regarded as possessing some practical import.

I am free to own that, at first, I did not appreciate the significance of this new, tinted growth; but afterwards, on learning the opinion of Mr Berkeley, that the "peculiar mould is, it can scarcely be doubted, the perfect condition of the species;" and on repeating some of the earlier experiments with the results now stated above, I do not hesitate to express my conviction that the normal and the pathological growths are essentially related to each other. This topic will, however, be more suitably discussed in Chapter IV; and to proceed, the *addendum* below will serve to supply other details completing this part of my subject: it contains notices of the place in classification to which the new mould is to be referred, and, as well, the terms of Berkeley's identification. A certain amount of repetition is unavoidable, but in the present instance, this circumstance hardly affects the value of independent, confirmatory testimony.

Addendum.

The following are the original remarks of the Rev. M. J. Berkeley ('Intell. Obs.,' Nov., 1862, p. 250: see Appendix), which appear to express the grounds upon which that eminent naturalist proposed the identification of the Pink Mould above described. "The fungus resembles closely the genus *Mucor*, but there is no columella in the sporangium—a character which accords with *Chionyphe* rather than with *Mucor*. Indeed I do not see a single character in which it differs generically from *Chionyphe*, although the two recorded species occur only under snow. It is very possible, however, that the proper habitat of our fungus may be upon damp soil. It consists (as noticed in experiment) of a thin filamentous stratum spreading in every direction over the paste, so as to form little slightly raised patches. The threads, which are about 1-5400 of an inch in diameter, are more or less branched, and contain masses of grumous matter which give them an articulated appearance. These masses pass from a bright yellow into red. Short lateral branches from the mycelium give rise to a globose sporangium, which at first contains a single nucleus, but as it grows exhibits different phases of cell-formation, and finally gives rise to short sub-fusiform spores, each of which contains a nucleus or oil-globule at either extremity. The sporangia, which attain sometimes a diameter of 1-400 of an inch, like the mycelium, change from yellow to red, but some apparently are colourless. The spores when ejected germinate very rapidly, giving rise to fresh threads, which are at first perfectly straight. Some of the threads of the mycelium, and probably the younger, are distinctly articulated, and in this case there is uniformly a nucleus or oil-globule at the upper extremity of each articulation, near to the dissepiment. The sporangia are sometimes covered with a network of threads, the exact origin of which is at present obscure, but the same appearance occurs in *Mucor stolonifer*, Corda, which often accompanies our *Chionyphe* in the paste.

The species may be characterised as *CHIONYPHE CARTERI*; *hyphasmate ex albo flavo-rubroque; sporangiis demum coccineis; sporis breviter fusiformibus.*"

According to this definition the parent mould, or normal form, of the formidable Eastern entophyte, whose history and ravages I have endeavoured to describe, would occupy a place in the current classifications of the day which may be thus expressed:—

I. Class	<i>Fungi.</i>
II. Order	<i>Physomyces, Berk.</i>
III. Sub-order.	
	(Family)	<i>Mucorini, Fr.</i>
IV. Genus	<i>Chionyphe, Thien.</i>
V. Species	<i>Carteri, Berk.</i>

Respecting the illustrations which are appended to this Memoir, it may seem to some readers that my figures do not altogether correspond to Berkeley's definition and description; yet they were strictly copied from nature. For my own satisfaction I forwarded to that gentleman the drawings of the pink mould, which are

reproduced in Plate XI, figs. 1 a—g, and was favoured with the following reply:—"I think it (this new growth) is undoubtedly *Chionyphe Carteri*. In *Ascophora elegans* you have two different forms of vesicular fruit on the same stem; and I know of no limits to the variation of fructification (including conidia) in the same species. Many moulds are undoubtedly mere states of higher Fungi, but such Fungi as *Mucor* and *Ascophora*, if forms, are probably forms of *Saprolegnia*. This latter notion may be worth consideration, as the fungus-disease might possibly be induced from spores of *Saprolegnia* in stagnant pools." (Letter dated June 28, 1873.)

As thus defined, *Chionyphe C.* has not yet been found apart from connection with the pathological products, or in what may be termed its natural habitat; but, as Berkeley observed, this circumstance need excite no surprise, as so little attention has hitherto been paid to the minute fungi of India, and further observations will doubtless demonstrate immediate connection of some of the latter, with this disease.

It has been above shown that, while still retaining every essential character, 'Mycetoma' occurs in widely distant regions of the peninsula, and therefore under very varying conditions of soil, vegetation, and degree of moisture: and this circumstance is, for me, indication that either *Chionyphe* is a very wide-spread plant, or, as is not unlikely, the species is a 'protean' one, and capable of existing in forms which do not readily attract the eye, so much as does the remarkably deep-tinted and luxuriant mould, which is produced under conditions already ascertained.

Lastly, I have, for further elucidation, extracted from the originals, and summarised, the following particulars respecting *Chionyphe*:—This genus included, until now, only plants growing upon melting snow. The first notice of it is contained in an article published in the "Nova Acta physico-medica Academiæ Cesariæ Leopoldino-Carolinæ naturæ curiosum," tom. xix, Breslau et Bonn, 1839, and entitled "Über ein neues geschlecht von schneepflanzen *Chionyphe Schneegewebe*, von Dr L. Thienemann." The genus is therein stated to contain three species, namely, one found in Iceland and two in continental Europe: it is described thus:—*Fila libera, articulata, hyalina, dichotoma, dense sibi implicata, in nive superficie crescentia, apice sporis valde intumescente, sicco statu capitulum formante. Hoc genus Algis confervoideis Ag. adnumerandum* I add a few other details:—All the species hitherto known, grew upon melting snow towards the end of the winter season, and doubtless sometimes the plants arise in connection with the dung of animals, &c., but at other times, they seem to spring up spontaneously: they grow quickly, and spread more or less over the snow in the form of a thin film, which soon after is dissipated. Thienemann supposed it likely that the plants imparting a red colour to snow belong to this genus, but the latter does not include other known colouring plants, and totally differs from *Protococcus*. The spore-capsules are either green or brownish-green, or brownish-red; and the mycelium is of a pale green tint. The appearance of *C. densa* (which might be regarded as coming nearest to the Indian species) is, I note, that of minute brownish or reddish dots, on a thin, flat web of light brown hue. The common mode of development is thus indicated by Thienemann:—The globular spores become elongated and divide; they assume a greenish tint; the process of division (which is accompanied by an active movement amongst the granular contents of the cells) continues for a time, and finally the terminal cells expand into vesicles; the molecules which these vesicles contain, enlarge and form smaller vesicles, which fill the primary capsule; when mature, the capitulum in two of the spores acquires a deep brown or reddish colour.

What other phenomena may be seen in the development of Indian species may be learnt from the more recent observations of Berkeley and Carter, as quoted in the Appendix: I have nothing of my own to add on this point.

Note.—Respecting moulds which may appear in connection with *Mycetoma*, the following memoranda may be added from my note-book. A specimen of the first variety of the disease amputated at the J. J. Hospital in September, 1861, had been then placed in spirit, and latterly became only partly covered with the preservative fluid, when (February, 1862) it was noted that for some time previously, several kinds of mould had appeared on the cut surface only, of the specimen, and of these the following varieties were specified:—1. A globular black mass with a mammillated or convoluted surface and measuring about half an inch in diameter. 2. Several similar masses of a white colour. 3. A smaller flocculent white semi-spherical mass. 4. A small flattened yellow bag: all these were hollow, and con-

tained a fluid in the interior. 5. An irregular flattened mass of yellow colour, covering a space of two or three square inches and slightly raised; it was formed of soft fibres running mostly in one direction, and having amidst them cups in which is contained a smooth globular head. Outlines of all these forms have been kept, but need not be here reproduced. In addition, a great part of the surface was covered with a white mouldy film; but further minute examination was not made, nor the direct connection traced of any of the above with the black fungus-particles of *Mycetoma*. This specimen was put, like others, in the dissecting-room at the Grant College: and the season of the year was, it will be noticed, later than that at which the pink mould appears.

CHAPTER IV

RELATIONS, AND CO-RELATION WITH CHIONYPHE, OF THE VARIOUS KINDS OF FUNGUS-PARTICLES
HITHERTO NOTICED IN MYCETOMA.

This subject is yet involved in obscurity, for independently of the fact that due attention has hardly been paid towards detecting other forms, and intermediate stages, of growth of these bodies—whence results a dearth of materials suitable for its settlement—there are the difficulties resulting from the numerous modifications of character, which simple and transitory organisms like the lower Fungi, are capable of undergoing, under various conditions, chiefly concerned with their nourishment.

a. Relation of the two kinds of *darker-coloured* particles.—I now refer especially to the specimen of Foot-disease received from Bellary, and described at page 6, as compared with ordinary examples of Sclerotoid growth: and here it will be seen that the dark particles, while retaining their form and size, had assumed a lighter tint—pink or dark brown,—and a softer—caseous—consistence; both of which features, while differing from the common, are, it may be noted, approximations towards the physical characters belonging to the second variety of the disease. But more particularly was to be observed, the absence of a true fungus-structure in these mahogany-coloured bodies; although their form and general characters were such, as to render it highly probable that their ultimate construction, would be similar to that of the ordinary black particles. The change which they had undergone, was a transformation into a material not unlike, in some respects, to that which composes the pale, soft particles, but it had not, so far as my inquiries show, the same finely granular appearance: yet whatever view be taken of these examples, one must admit, that here was an instance of fundamental change of structure, which seemed to point to intermediate stages, elsewhere not apparent. I would recommend that the two cases be again perused. The foot itself is similarly affected in both of them.

b. Relation of the several kinds of the soft, *paler forms* of fungus-particles.—I had in my first Memoir drawn attention to several features which these had in common; thus, 1, as regards *size*, in Case No. 1 the particles varied in diameter from $\frac{1}{40}$ to $\frac{1}{130}$ in.: in the Madura specimen (Case No. 2), from $\frac{1}{60}$ to $\frac{1}{130}$ in.: in the Bellary specimen No. 2 (page 7), $\frac{1}{43}$ to $\frac{1}{87}$ in.: here is evidenced a tolerable uniformity not unworthy of notice. When, however, one examines the more frequent kinds of pale, soft particles, their dimensions are found to be in general below the above, thus in some of the old College specimens I found them to be $\frac{1}{150}$ to $\frac{1}{300}$ in.; and in my Satara specimens, $\frac{1}{250}$ to $\frac{1}{300}$ in. in diameter. It is not easy to understand the reason of this difference, except on the supposition that these latter are, in reality, but segments of the larger particles represented by the specimens first mentioned; and there are indications enough that such may be the case, in their several forms and composition. Not seldom—perhaps commonly—the ordinary particles exhibit marks of, and a tendency to, conchoidal fracture; and the same feature was observed in both Madura and Bellary specimens above referred to.

2. The general *form* of all is the same, and while it is apparently unusual to observe the segmentation, which was so marked in the pink-coloured Madura specimens; still, as I have said, there is a tendency to break up in a definite manner, which would show a regularity of construction hardly to be looked for, from a mere aggregation of individuals.

3. The *colour* passes by gradations from light buff to yellowish, pink, brown and dark mahogany tint: the last-named finding its counter-type in the specimen which accompanied it from Bellary, although this rather appertained, as regards size and form, to the variety of the disease here termed Melanoid. Both Bellary specimens contained bodies of the same general colour, but otherwise differing.

4. As regards *minute structure*, however, this is not the same in all these malacotioid bodies. It is essentially the same, in the great majority of specimens which I have examined; but in one—at present unique—so clear and decided was the cellular structure of a true fungus apparent, that I have long been of opinion this instance presented the key to all the others, whose appearance has seemed inexplicable, except on the supposition that their original structure was the same as in this specimen in question, but had undergone a change, consequently, I once thought, upon their death and degeneration. Other observers, indeed, have not yet ratified this discovery of a real fungus-structure in the Malacotia; but the observation remains of positive value.

5. As more general characters, indicating a connection between these several varieties of growths, may be mentioned their similarity in *number* and *general disposition*, in the affected member of the body; and the foot itself, in all cases presents a very similar *pathognomonic appearance*. Such features as these have, indeed, but a restricted value as regards the point in question, because a variety of causes not specifically, or even generically, identical, may produce a common series of effects: yet, whether or not it be admitted that the various kinds of fungus-particles which I have described, are (as I think) essentially related to each other, no question need arise as to their all being living growths of a vegetable nature; and hence none, as to their causing in the human foot a uniform sequence of pathological phenomena. I may add that, hitherto, no observer in India has, to my knowledge, expressed opinions pointing to the existence of fundamental differences, in the general character of the pale form of Mycetoma under notice.

c. Relation of the Melanoid and Ochroid varieties of Mycetoma.—Observations bearing on this subject are not very numerous, and in the absence—which is sufficiently remarkable—of specimens and examples, indicating intermediate stages or forms in the development of the parasitic growths, the available facts are, for the most part, of indirect application.

It might be said on first inspection of two well-marked examples of these pathological varieties, that there was absolutely no connection between them, except as regards such a general similarity of appearance as might, indeed, result from an influence only generically the same in both; and, I confess, the assertion would have seemed sufficiently plausible to myself at one time, as it may now to those, who have not been at the trouble to peruse the entire series of facts already recorded above. There is really no likeness between the jet-black, glistening, hard particles of most characteristic aspect, which may be seen to crowd the spaces in which they are lodged, on the one hand; and, on the other, the pale, dull, soft particles, equally numerous and similarly placed indeed, but far less striking to the eye and sense of touch. Yet, as I have before intimated, considerations of

this sort, respecting mere appearance or other morphological character, are here apt to be fallacious, or, at best, are but plausibly founded; and the whole history of the parasitic growths of both kinds must be known, before a comparison of their nature or relation can properly be attempted. I do not pretend that, as yet, such complete information has been collected; but submit that sufficient is already known, to direct the line of inquiry and to point out deficiencies to be made good. The following remarks bear me out:—1. The two forms in question, are occasionally connected by the common presence of a true, vegetable, fungus-structure. 2. Particles belonging to the black variety may present physical characters approximating to the paler sort, *i. e.* may become lighter in colour, softer in consistence, and may lose their fungus-structure. On the other hand, the pale variety may present a very dark mahogany tint. 3. The parasitical affection, in both cases, is the same in character, *e. g.* the diseased foot, or hand, is, in either case, of similar size, equal duration, similarly distributed in the sexes, and in localities; and as regards the host, results are the same. 4. Both affections seem to commence in a similar way; that is to say, in specimens of each variety have been found, certain pink-coloured streaks in the skin, the contents of which are clearly not strictly pathological, but have all the semblance of vegetable structure belonging to incipient, and early stage, of lowly plant growth. I had long since (second Memoir, 1861) pointed out how the ordinary pale, soft particles might arise from the structures contained in these coloured streaks, and despite the absence of better-grounded assumption respecting the sclerotioid form, there still remains the strong inference, that if these marks or streaks do show the first beginnings of the parasitic growths, and do present the same characters on both varieties of the disease, then these latter are closely, or even vitally, related to each other. 5. Their chief bond of connection, however, may by some be referred to the circumstance, that the particles of each kind may spontaneously, and by artificial cultivation, (the difference of these conditions being merely incidental), give rise to a completely normal form of Mould; which, by all analogy, should be regarded as their common parent-form, whence both arise, and to which, after a cycle of wholly different transformations, both may at last revert.

b. The last point under the present heading, namely, the Relation of both kinds of fungus-particles to *Chionyphe Carteri*, Berk., need be only briefly referred to here, for after the observations detailed in the first pages of Chap. III, I need but add my opinion that the fact has been sufficiently established, at least for temporary acceptance, that all the entophytic growths of *Mycetoma*, under favorable circumstance, revert to a common specific form, which has been (perhaps provisionally also) distinguished as above. The last link in the chain is, indeed, as yet wanting, for this *Chionyphe* (which, oddly enough, seems to belong to a Borean-genus) has not been found to occur naturally in the Indian Peninsula; but this defect in our knowledge may obviously be owing to want of due search; and it is no greater than that still attending the incompletely-traced natural history of the *Filaria*-disease, which for a much longer period of time has engaged attention in the East.

CHAPTER V

NATURE OF THE FOREIGN BODIES PATHOGNOMONIC OF MYCETOMA

a. FACTS b. HYPOTHESIS

The present account of this affection would be defective, without some remarks on the subject of the above heading, which is one interesting alike to the surgeon and the naturalist. I should therefore attempt to treat it at some length, did I think that the facts at my disposal are sufficiently numerous, or clear, to remove all doubt respecting the nature of these characteristic bodies; but, owing to both poverty of data and the unsettled state of knowledge, such is not the case; and, reserving speculations for a *note*, I can now do little more, than sum up the intimations already given in previous chapters.

Be it remarked, that question does not here arise, as to the relation of these new growths with the essential features of disease, for that subject is perfectly distinct; and it has been above decided that an entophyte, under more forms than one, is the immediate cause of all the symptoms of Mycetoma.

As another preliminary observation, I would repeat that having in India, under favorable conditions, and with a magnifying power of over 300 diameters, repeatedly scrutinised the structures in question; and having, in England, also re-examined some preserved specimens with higher powers, the result has been neither more nor less than what is here recorded. I do not suppose these preserved specimens to have materially changed, since amputation of the foot was performed.

1. *Facts*.—Respecting the *hard, black*, rounded or botryoidal particles, whose size varies considerably, having determined their structure to be wholly cellular, or filamentocellular, I regard them as essentially corresponding in nature, to the so-called *Sclerotia* of common moulds. This opinion is grounded on the following particulars:—their general character; their structure (centre and mid); their position and evident destination (as indicated in the progress of the disease); their observed tendency to germinate, even within the foot, in certain instances, or possibly at certain seasons; and lastly, the fact that at prescribed periods of the year (namely, the spring in Europe and early rains in India), from such particles may spring a normal fungus, capable of development outside the body. The earlier chapters of this Memoir must be referred to, and the note below,¹

¹ Referring to the growth of a common mildew—*Botrytis cinerea*—it is remarked “that its Mycelium often gives rise to the organs or bodies termed *Sclerotia*, which are a thick bulbous tissue formed of Mycelium-filaments at first colourless, the sclerotium, which is imbedded within the vegetable tissues and is of very visible size, acquires a brown or black colour from its outer layers of cells becoming round, and finally forming a black rind, which separates it from the neighbouring tissue the sclerotium then becomes loose and may be detached it is a perennial organ, designed to begin a new state of vegetation after a state of apparent quietude and may be compared

to a bulb or the perennial roots of an under-shoot. The usual time for the development of the *Sclerotia* is late in the autumn, after the fall of the vine leaves in which they are often found they can lie dry for a whole year without losing their power of development. This latter commences when the sclerotium is brought into contact with damp ground, during the usual temperature of our warmer seasons. . . . Only such vegetable tissues as possess some measure of a massive and solid texture like many leaves, pumpkins, thick stalks, &c., can be the seat of these bodies, which do not form on very delicate and deciduous parts. . . .” A. de Bary, “On Mildew and Fermentation,” in the

in elucidation of the analogy which is here offered, as the best-known interpretation of the phenomena under consideration; and on the adoption of this view, it would become necessary to regard the hard, black particles belonging to the Melanoid variety of Mycetoma, as the *Sclerotia* of the fungus known as *Chionyphe Carteri*, Berk.¹

I again observe, as a very noteworthy fact, that the proper fungus-structure of these sclerotoid particles may be lost by reason of a change—seemingly a degeneration—which yet does not destroy size or form, but is attended with a paler tint and a softer consistence. The full import of this fact is not yet apparent, *i. e.* it cannot be positively stated, whether the change in question is a normal stage, or merely a superadded phenomenon: but the bearing of the observation is so obviously to confirm my opinions, that I here express it in tabular form.

Connection of the varieties of Mycetoma.

Common form = 1. Black particles (true fungi) = Pale particles (true fungi) 1 = Case at page 8.

Bellary foot = 2. Dark particles (no cell-structure) = Pale particles (no cell-structure) 2 = Common form.

Next, adverting to the *pale, soft* particles (*Malacotia*), characteristic of the Ochroid variety of Mycetoma, I must insist upon distinctions amongst them, which are, as it seems to me, of great significance.

There is, first, the instance as yet unique, but possibly only rare, and of itself seemingly a typical case (page 8). Distinguished by no peculiar clinical history or local sign, the diseased foot yet contained particles which in general size, colour, and consistence, were like the commoner kind, but which in structure were pre-eminently distinguished by possessing a plain, simple cellular composition resembling that *e. g.* of *Oidium*.² No free conidia, or spore-like bodies were seen, but this circumstance has only a negative force; and as there was no trace of the ordinary crystalline envelope to the pale particles, by which they are commonly aggregated into masses comparable to the ova of fishes, poppy-seeds, &c., I regarded them as being still in a state of active individual growth. This instance happened to me immediately after the discovery of the black fungus; and, partly hence, has left a strong impression behind. Does it not, indeed, furnish a key to the comprehension of other ochroid forms, and is it not an obvious band of connection between the melanoid and ochroid varieties of the disease? When the *Sclerotia* germinate, they lose their dark colour, and at first assume a simple cellular structure: more is not known by

¹ 'Quarterly German Magazine,' 1872, No. 2, p. 23—25 (London, Williams and Norgate). The above illustration, it may be objected, is taken from a group of Fungi (the Hyphomycetes) which does not embrace the generic forms of *Mucor* or *Chionyphe*; yet be it remarked that *Botrytis* belongs to a family (the Mucedini) of acro-sporous fungi, which corresponds to the family Mucedini of theca-sporous fungi, including both the moulds just named; in fact, the *Mucor* family itself is by some referred to the hyphomycetes or acro-spori; and these circumstances are here mentioned, as showing that modified forms of growth, like the sclerotoid, are not necessarily limited to groups artificially arranged.

² See second and third Memoirs (Bombay, 1861 and 1862) for the earliest references to this interpretation, which has received the sanction of Mr Berkeley himself, who writes to me (June, 1873): "I consider the large fun-

gous masses sclerotoid forms of *Chionyphe*." The term *sclerotium*, is that of a spurious and discarded genus, which included a number of fungoid structures, all now regarded as consisting of the mycelium in an imperfect state; as I have above adopted the word in a plural form expressive of individuals, and not of groups, it may be as well to add that this has been done to avoid periphrasis.

² One might here remark, that Hallier finds springing from his *Micrococcus*-colonies, *Torula*-like fungi, and that afterwards germinating cysts appear; both of which phenomena would serve to explain the connection of these two, pale fungus-particles with the commoner, pale finely granular *Malacotia*, if it be permissible to assume an identity of their nature, at some earlier or later stage of growth.

actual observation, except that the red mould (*C. C.*) may appear, and the same mould did grow luxuriantly upon the rare pathological specimen, presenting these undoubted fungus-particles. Lastly, on the hypothesis mentioned below, it is possible to understand the correlations of these growths with the others.

The second remarkable case is that from Madura recorded at page 9. There was, apparently, no reason to suppose that this instance was an exceptional one; yet the like does not seem to have been noticed before. Here the new growth was in the form of small, pink particles, in resemblance comparable to the grains of red or Cayenne pepper, or to a red dust scattered amidst the diseased tissues: but when more minutely examined these bodies are found to be either globular, ovoid, bi-partite or even quadrate in form, as if undergoing regular segmentation. Clusters of such particles may be found, but no trace of crystalline envelope to any of them. The larger ones show a tendency to crack or break up into segments, which are not without an aspect of regularity; and the exposed interior is then seen to be colourless, or nearly so, with a distinct semblance of minutely granular structure. There were no signs of origin, or intermediate stages of formation of these particles, and hence from their structure and general appearance only, can a conception be formed of their nature. Respecting this point I have failed to obtain assistance from even experienced observers.¹ My notes show that the bright pink colour was evanescent; and that on its change to a yellowish tint, some of the particles then resembled the ordinary ochroid variety referred to below. This aptitude to fade is, be it said, noticed in the globular, pink-tinted bodies which appear in the final stages of growth of *Bacterium rubescens*; and, on the whole, one might not without reason compare the particles in question with these last-named, normal bodies. As the fatty crystalline fringe was wanting, I supposed that no degeneration of structure had commenced in the pathological pink particles: their artificial cultivation was, unfortunately, not attempted.

I now come to the consideration of structures which are, perhaps, of most frequent occurrence; but which do not, in any given locality, happen to the exclusion of either black or pink-tinted forms.

Having already described these very characteristic, *pale, soft* particles, I here note that their real nature has been a puzzle to all observers from Professors Queckett and Ballingall (1854) to the Rev. Mr Berkeley and Professor Cohn,² at the present moment.

¹ I have again had recourse to the valued opinion of Berkeley, who observes "the fat-globules tinged with pink and fat crystals are sufficiently clear, but what are the bright red bodies sometimes quaternate? The question is whether these are fungi at all? May they not be abnormal development of cellular tissue? At any rate I know of nothing in Fungi like them. The nearest approach is *Sarcina* which I could never get to germinate; and the fungal nature of which is doubtful." "The minute pink bodies in your drawing (see Plate X, fig. 2) remind one of that peculiar state of some moulds which occurs in decaying vegetable substances, and which Stevens seems to have traced to a higher form of development in 'Annals of Nat. Hist.'" In the xx vol., 1857, of the 'Annals,' I find Mr H. O. Stephens describes a *Sarcina ossium*, occurring upon the calcined bones of oxen, forming part of the cargo of a vessel laden with bones and hides, from South America; the growth having

here a cinnabar or orange-red colour, and assuming the form of patches or dots, which consist of numerous quadrangular cells a little rounded at the angles, and united in fours or groups of fours; but very minute in size ($\frac{1}{1000}$ — $\frac{3}{1000}$ in.). A white fungus occurs simultaneously with these patches, but is said to be distinct from them. No new light appears hence; and I am the more disposed to regard these coloured *Malacotia*, as having immediate Bacteria-relations, although now existing only as masses of almost structureless protoplasm.

² By the kindness of Dr B. Sanderson some of these pale, soft, roe-like particles (*Malacotia*) characteristic of the second or Ochroid variety of *Mycetoma*, have quite recently been submitted for opinion to Professor F. Cohn of Breslau, who writes as follows:—"I have examined Dr Carter's preparation, but have not as yet come to any decided conclusion as to its nature. I find in the roe-like masses oval, sharply defined bodies, which

My own conception is, admittedly, a hypothetical one; but I am still disposed to hold, with modifications, the view advanced in my earliest Memoirs, namely, that in these instances of the Ochroid variety of Mycetoma, "the fungus has undergone some change, *e. g.* died and degenerated: this seems not unlikely, for . . . there are indications of the original structure to be detected when carefully looked for . . . the crystalline coat possibly indicates the death of the fungus." (1860). The actual occurrence of particles similar in physical characters and position, which really possessed an undoubted fungus-structure, was, however, the chief foundation of this view; and subsequent experience, wherein it was proved that *Chionyphe* may spring from these, as from other varieties of particles, has strongly confirmed the general accuracy of my original impression. Further inquiry since my late temporary return to England, has led to an expansion of these ideas; and I am now inclined to regard the bodies in question, as essentially masses of Protoplasm, and identical with the Micrococcus-, or Bacteria-colonies well known to microscopists. Long preservation in diluted alcohol does not, seemingly, produce any essential change in these particles, which I have recently re-examined with some care, directly comparing them with the only analogous structures known to me—namely, samples of the terminal developmental forms of *Bacteria rubescens*, Lankester, which were kindly given me by the discoverer: and though differences enough were perceptible during this scrutiny, yet the similarity of ultimate structure, seemed to be undoubted. Since the bacteria-masses are not dead or degenerated clusters, it may be assumed that neither are so the morbid fungus-particles; and evidence of their vitality is forthcoming in the fact, that they have been seen to give rise to, or revert to the parent species—*Chionyphe*.

In the last place, and as regards all those structural masses in which no more is

exhibit perhaps an opening; I don't know their nature. I am, however, certain that they have no vegetable structure, and can scarcely be *sclerotia*—nor can I suppose them to be formed of bacteria. The culture experiments I have made on paste according to Carter's plan, have been without result. The drawing in Carter's paper (a figure of the Pink Mould, from the 'Transactions of the Pathol. Soc. of London,' 1873) resembles a Mucor: as, however, Berkeley has made a new species of it (*Chionyphe Carteri*) it must be supposed that it possesses characters not expressed either in the drawing or description. A connection of the fungus with the fish roe-like bodies, appears to me not to be deducible from anything that I have observed. The red colour is striking: according to the description it must resemble that of *Monas prodigiosa*, which I have been lately observing on milk. I intend to place the material before one of our most reliable observers, who is familiar with entozoa, and with pathological histology; in the hope that he may have more to say as to its nature than a Mycologist." Such is additional negative testimony, which may, by some, be regarded as excluding the views expressed in the text; nevertheless, and without blind prejudice, these opinions must, I think, remain till disproved by affirmative proof.

Mr Berkeley in a communication to me dated so far back as July, 1861, thus states the result of his examination of specimens which I had sent to him. . . . "I find cheesy bodies consisting of a mass of irregular, minutely granular bodies, like those of some of the

minute Algae figured by Kützing, as for example in *Micrrohaloa firma*. It did not arrive, however, in as good condition as the other specimen. . . ." In a subsequent, printed article, similar remarks are made, and I presume that no more definite structure was detected by this distinguished observer himself.

In the Appendix are references to the views of several eminent medical men who, at different times, have also examined these particles; and I may here quote from some of them. In 1864 Mr Hulke and Dr Bristowe, after scrutiny with $\frac{1}{2}$ in. object-glass, did not detect other appearances in the particles than were visible under lower powers, and no certain traces of fungus-structure: in 1870 Mr Hogg and Dr Moxon closely examined the same bodies, and concluded that they did not resemble altered fungi but rather masses of coagulated fibrine. Dr D. Cunningham and Mr T. Lewis (Bengal) and Dr Goodhart (London) have also paid attention to the same structures, without being able to detect any, or clear, signs of their fungus-nature.

On the other hand, in Berkeley's article ('Intellectual Observer,' 1862) are given some figures from Mr H. J. Carter's sketches, with the remark that the foundation of these pale particles consists of "one or more large mother-cells filled with a mass of daughter-cells:" this view has been above referred to; but on the whole I cannot confirm the statement thus advanced and illustrated. See Plate X, fig. 3, for my own interpretation.

apparent, than fine granules disseminated through a translucent matrix, and which, therefore, have just been compared to aggregations of Bacteria-growth, one might ask if such masses do not strictly correspond in nature, properties or even development, with the Sclerotia of Fungi proper; that is, may they not represent a stage or mode of growth which has for its object a similar intent, namely, the temporary but sufficient enclosure, in simple and least exposed form, of the general and specific qualities of the organisms concerned; the final purpose being that reached in higher modes of life, by bud or ovum. It is partly from a conviction that the pale, soft particles of the Ochroid form of Mycetoma, are, essentially, of a nature corresponding to the highly contrasted black, hard bodies, that I have ventured to propose a new name for them bearing some indication of this similarity—*Malacotium* being correlated with *Sclerotium*.

That the structures in question, belong to the category of "giant-cells" of pathologists, is a supposition which I have not thought it necessary to at length discuss, in this place.

2. *Theses and an hypothesis.*—One of the chief objections to the adoption of my views as to the real cause of the Indian foot-disease, is the circumstance that, very frequently, the characteristic particles do not show any trace whatever of a fungus-structure, as commonly understood; and it is, therefore, inferred that since the vegetable parasite is sometimes absent, such entophytic growth cannot be regarded as the essential cause of the malady. The validity of this objection might be questioned on general considerations alone, as I have before attempted to show: for some special morphological structures are invariably present, and these if not obviously fungoid, are yet so very peculiar as to have hitherto puzzled almost every observer. I repeat, too, that in one form of Mycetoma a very decided fungus is always found; and in the other form (to which exceptions belong), an unmistakable fungus has, as well, been found: also, I remark that in both forms, the incipient growth is the same, and contains structures comparable to glæogenous Bacteria or Micrococci: lastly, I add that each kind of fungus-particle has been seen to give rise to one common normal mould—viz. a species of *Chionyphe*.

It is needless for me to re-state the grounds, upon which it is held that the malacotioid bodies (respecting which here is most question) are not only of vegetable character, but are comparable in their nature to known products of Bacteria development; and I proceed on the assumption that this view is a tenable one.

The inquiry now arises whether or not, elsewhere, have been elicited any series of facts demonstrating not only that Fungi may, under different conditions, assume very different forms; but that between any of these latter, and the still lowlier organisms included in the Schizo-mycetous group of De Bary, a true relationship does or may exist. I am aware that eminent observers do not agree with the associated views, whose most prominent advocate is perhaps Hallier of Vienna; but, without intending to take side in this matter, I shall briefly point to the theory which best serves (as I think) to connect the version of facts already proffered in this Memoir.

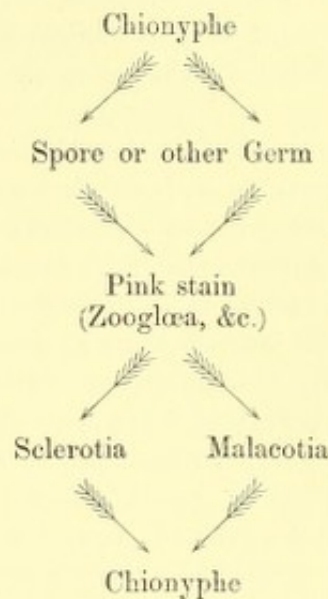
Dogmatically stated, the fundamental observations arrange themselves thus:—

1. The parasitic growth always commences and proceeds, in the same manner.
2. Its earliest visible traces exist in the form of spherical collections, identical with the so-called Zooglæa-masses (Bacteria forms).
3. Subsequent development varies:—

- a.* A simple cellular fungus appears, which produces the Sclerotia.
b. Spheroidal, fine-grained masses remain, which are the Malacotia.

4. Both these last-named products contain germs of *Chionyphe*.

Having thus, by a synthetical process, arrived at the common parent-form of the human entophyte; it remains to ascertain how, in upward course of development, this mould may, by inference and analogy, be supposed to grow into the pathological or pseudo-normal structures so often referred to. And in the view (however modified in details) that Bacteria may be derived from bodies dissimilar to themselves, and specially from Fungi, it seems to me tenable to arrange in a diagram the several phases of development, as follows:—



The lower cycle of metamorphoses is that applying to the instance of disease in the human body; wherein obtain the abnormal conditions under which alone, it is supposed, that erratic growth proceeds; and this only for a time, and in degree, not subversive of every common feature, or prohibitive of reversion to the original form. To what extent the transformations now indicated are strictly non-natural, may be debated; but there seems here no real destruction of either form or property. What circumstance, too, it is, which determines that from the contents of the pink stains, there shall in one case be developed Sclerotia, and in another instance (occurring at the same locality) the very dissimilar Malacotia, is as yet unknown; but probably it is connected with the parasite, and not with the host. Thus, the form of infection would seem more influential than the nutritive quality of the substratum; but whether or not the former be spore or mere protoplasm, and the latter skin or fat (*e. g.*), there is clearly a primary determination which results in such wide divergence of growth, that amongst many peculiarities of *Mycetoma*, hardly one has impressed me more, than this total dissevering of physical characters presented by the entophytic elements, while all surroundings are identical. Surely these fundamental features, alone, indicate no remote community of origin, prior or sequent.

Finally, the attempt to illustrate the pathological phenomena, by reference to numerous analogous instances of a normal character, might, indeed, be interesting, and to some

extent even useful; but in the absence of sufficient facts and of better-founded notions than yet exist, I will only remark that nothing has been here advanced which is contrary to ascertained precedent; that on no other hypothesis known to me, can the history and phenomena of Mycetoma be so well understood; and that, at all events, future observers have, hence, a definite line of inquiry indicated for their use. Whether or not the observations now concluded, shall serve as confirmation of certain pre-existing views, above intimated, I leave for others to determine;¹ yet, to my own mind, the asserted intimate relationship of Fungi and Bacteria seems, hereby, to acquire additional proof.

¹ I find in the 'Medical Reports to the Privy Council,' vol. ix, 1866, p. 518, the following statement of Dr Buchanan.—"Mr Berkeley also draws my attention to the resemblance of Hallier's spore-cysts to some of those which were represented by himself in 'Journ. Linn. Soc.' 1864, as belonging to the fructification of *Chionyphe Carteri*." See, too, above Plate XI, fig. 2; and description. It is there shown that in one instance the pale, soft particles were seen to give off very delicate filaments looking like strings of *Oscillatoria* (so it is expressed in my notes, 1862), but not moving. I can hardly help now supposing that these filaments were of the same character as those of the *Micrococcus leptothrix*, which is described by Hallier as resulting from artificial cultivation of Cholera-matter, in ammonium tartrate and paste.

I need not quote the statements and experiments of Fröh Lüdgers, Huxley, &c., or quite recently of Lister, with respect to the opinions above applied; and a more detailed reference to Hallier's views I have purposely omitted in this place. I do not suppose that the resemblance just mentioned by Buchanan was intended as subject for comment. The only circumstance in which the Cholera-fungus and *Chionyphe*, could be said to accord, is in their wide distribution over India; yet in Lower Bengal where cholera abounds, Mycetoma seems to be comparatively very rare. As regards the connection of cholera-matter and the black blight of rice, this is a debated point, which, on the view that the fungus-disease

is related to smut of grain, is worthy of notice in future researches. I will here add a memorandum of other epidemic plant-pests:—in Malwa and along the Nerbudda, a blight of linseed and wheat is apt to recur at intervals of 20—24 years, and accompanying easterly winds. It is at first of a light, beautiful, orange colour, and found chiefly upon the ulsee (linseed), which it does not seem much to injure, but about the end of February the fungi ripen and shed their seeds rapidly; these are taken up by the wind and carried over the corn-fields. . . . I have seen the air tinted of an orange colour for many days by these seeds . . . and only when the wind is east is the wheat affected. . . . Stalks and leaves become first of an orange colour, but this changes to deep brown; all that part of the stalk that is exposed seems as if it had been pricked with needles and had exuded blood from every puncture . . . every pore it is said may contain from 20 to 40 of these plants, and each plant may shed 100 seeds, so that in the warm weather of March when wheat is attaining maturity, these plants ripen and shed their seeds in a week. . . . It is worthy of remark that hardly anything suffered but the wheat. . . . Col. Sleeman's 'Rambles of an Indian Official,' 1844, vol. i, p. 250. With respect, however, to this and the like notions, touching the connection of Mycetoma with local or temporary phenomena, I am reminded that this affection is found to be very wide-spread, and is not yet known to occur only in certain years, or cycles of time.

A P P E N D I X

BIBLIOGRAPHY OF MYCETOMA; ARRANGED IN CHRONOLOGICAL ORDER, AND COMPRISING THE ARTICLES TO WHICH REFERENCE IS MADE, IN THE TEXT AND NOTES

It is at least thirty years ago, so far as I could ascertain,¹ that surgeons in India first remarked in their official reports and in separate communications, an affection of the foot, which it was not possible to refer to any of the better known diseases entered in current nosological tables; one or other of which complaints, however, it was generally stated to resemble.

1842. It would appear that one of the earliest notices of 'Mycetoma' is that by an officer in the Madras Medical Service, which is mentioned by Dr J. Colebrook, then Zillah Surgeon, Madura, in his 'Dispensary Report for 1848.' This gentleman states that his predecessor, Dr Gill, in a similar document dated A.D. 1842, gave a short but graphic account of the foot-disease; and he quotes the following extract:—"When the leg has been amputated, the foot has been found to be one mass of disease of a fibro-cartilaginous nature, with entire destruction of the joints, cartilages, and ligaments; it has neither shape nor feature, and is covered with large fungoid excrescences discharging an offensive, ichorous fluid."

1844. In the 'Departmental Report of the Public Dispensary at Bellary, for 1844,' Garrison-Surgeon Godfrey has furnished a more detailed account. After stating that many patients with ulcers and sinuses in the lower extremities are seen, Mr Godfrey proceeds to distinguish certain cases, hitherto returned as "*ulcus grave*;" in which the foot is so affected as to necessitate amputation. Two carefully described instances present all the characteristics, in my opinion of the fungus-disease: Mr Godfrey, considering them as "dissimilar in several respects" from any disease he had been able to find recorded in books, and also in various particulars from Elephantiasis, yet looking upon them as being apparently a local tubercular affection, then proposed to designate the disease "*morbus tuberculosis pedis*;" and this name it has retained in Madras. Godfrey had seen three other instances; and he considered that the successful result of amputation may tend to show the advantage of removing tubercular structure as early as possible, not only from the foot, but perhaps from any parts of the body, where an operation would be practicable; and it is further surmised that but for the operation, the

¹ I have not even attempted to trace, the earlier history of this curious and serious local disease, but may here mention, that amongst the old and established Hindoo medical works is noticed, as one of the slighter affections of the extremities, an intractable complaint which has been thus referred to:—"Should the sole of the foot be injured by some external cause, as by a thorn or the like, much pain and a hard indolent swelling like the stone of plums forms, accompanied with a considerable discharge: it is cured with difficulty"

treatment:—"remove the swelling by a knife, and apply to the part a mixture of warm oil mixed with burnt sulphate of copper, &c." (Dr Wise's 'History of Oriental Medicine,' 1867, vol. ii, p. 365, &c.). Meagre as is this description, its application to Mycetoma may be fairly suggested; and the proposed method of treatment is almost that, of late recommended by surgeons of our own times, as likely to be efficient in early stages of the foot-disease.

system in these cases might have become contaminated. In his Report for 1845, two other successful cases are recorded by Mr Godfrey, and of one of them it is stated that the amputated foot contained a considerable black deposit, much resembling fragments of coal; but, says the operator, "at present I consider it is an accidental product in, but not forming part of, this peculiar disease of the foot;" he looked upon this deposit as melanotic, and as showing that melanosis may be quite black in man. It appears to me highly probable that this black substance (which was contained in a cyst the size of a small walnut), was identical with the entophytic growth I have above described; and I would observe that this is the first occasion in which it has been specially mentioned—the black variety of *Mycetoma* being, it would seem, rather uncommon in Southern India, as compared with the pale, soft variety ordinarily associated with the term "Madura foot." That the disease is the same in Madura and in Bellary, I have sufficient grounds for believing, in the identity of specimens sent to me from both districts. Mr Godfrey shortly afterwards published in the 'Lancet' (under date May 30th, 1846) an account of these cases as illustrative of a "disease of the foot not hitherto described;" and it may be added, that the worm-eaten and roughened appearance of the bones, was also noticed by this author.

1846. No doubt, the fungus-disease has long been known in the Bombay Presidency, although on account of its comparative infrequency, not, it would appear, so early noticed. On a cursory examination, however, of the Records of the Jamssetjee Jejeebhoy Hospital, Bombay, I find under date February, 1846, a case described by Dr Morehead as "*Hypertrophy of one foot, with diseased metatarsal bones;*" the patient, a man aged 40, and suffering for seven years, had come from Kattiawar, a district where the fungus-disease is common; and there is no doubt in my mind, after reading the full account of this case, that the instance was one of *Mycetoma*.

Already the endemic character of the affection had become known; the term "Madura foot" being commonly used in some parts of Southern India. Colebrook, who furnished me with this statement, also gave it as his opinion that the disease is of "scrofulous origin;" but I have reason to suppose that he has now (1860) a different impression.

Respecting the discrimination of "*Mycetoma*" in the other Presidencies of India, besides Madras and Bombay, I have found no records until of comparatively recent date, which will be presently referred to; and those chiefly for the North-West Provinces. There is, indeed, a case narrated in the 'Indian Annals,' vol. ii, p. 706, which may have been an instance of the first or black variety of the disease; dark granular matter, or black gritty particles, being found amongst the bones and in the sinuses: it is true that even after a microscopic examination, it was presumed that these particles consisted of dried blood only, but one may suppose that the fungus-structure had here escaped detection. Two cases of scrofulous disease of the foot are recorded in the same journal ('Annals,' vol. vi, p. 643), the first of which appears to have presented, in external appearance, many similarities to cases of this disease; but it is now admitted, that *Mycetoma* is not by any means frequent in Bengal proper.

1855. I come, at length, to one of the most important accounts of this affection hitherto published. It is a paper by my late colleague, Dr G. R. Ballingall, Professor of Surgery in the Grant College, Bombay, which is contained in the 2nd vol. (new series, 1855) of the 'Transactions of the Medical and Physical Society of Bombay,' and is entitled "*An account of a tumour affecting the foot.*" Here is presented the earliest notice, so far as I am aware, of the microscopic peculiarities of fungus-particles belonging to the pale variety of *Mycetoma*. A concise description of the external characters of the affection, as seen in Bombay, with a reference to the peculiar discharge from the sinuses, is followed by one of the interior, or sectional, surface: the pulpy granular substance found in the internal parts, and occasionally in the discharge, is then microscopically examined, and ascertained to be composed of "large, granular cells," circular or oval in form, and generally surrounded with transparent fringes, consisting of large irregular spiculæ; radiating groups of spiculæ without any distinct cell in the centre, and numerous oil-globules, may also be detected. The nature of these bodies could not be made out; they were, however, considered to be organized structures, and the disease to be essentially "of a parasitic nature;" the new growth taking the place of the normal bony structure, which is probably removed by absorption. Other remarks follow, and illustrations are appended. It is thus evident, that Dr Ballingall was led by his sagacity to distinguish this tumour-like affection of the foot, as one unlike that of a simple scrofulous affection, and also to detect the prominent peculiarities of the new growth or formation: indeed, not much that may be detected by simple inspection, has since been added to these trustworthy observations. No reference is made to that variety of the disease, in which the more striking *black* fungus is found; and I may say, that until

the case occurred which I shall presently describe (1859), no other appears to have been noticed at the Jamsetjee Jejeebhoy Hospital in Bombay, notwithstanding the comparative frequency of this form in several districts included under the Bombay Presidency.

I have examined the preserved specimens in the Museum of the Grant College, Bombay; and can confirm most of Dr Ballingall's statements. As was shown above, in the text, the true nature of the peculiar bodies, is probably as follows:—the large granular "cell" is the remains of an altered fungus; the spiculæ and the radiating groups of crystals are of a fatty nature, the abundance of oil-globules also indicating the presence of these oleaginous principles. A congeries of the fungus-particles and crystals forms the soft yellowish granules ("tubercles") found in the discharge, and, on after-examination, in the sinuses and cavities of the diseased parts. It is not, in my opinion, to be wondered at that even Professor Quekett should not have been able to detect the real nature of the large granular "cells;" as, at this stage, their characteristic structure is lost. The fungi having undergone transformation, become the nucleus of crystallization, their own structure also probably furnishing fatty crystalline principles; for like proteinous animal matter, the nitrogenous material of these fungi, seems to be capable of fatty degeneration.

1858. In a subsequent volume of the same 'Transactions' (vol. v, new series, 1858, p. 230) several "*Cases of diseased foot*" are recorded by Sub-Assistant Surgeon Bazonji Rustonji, when in medical charge of the Dispensary at Bhooj, the capital of the Kutch Province; they relate to a disease peculiar to certain parts of the Bombay Presidency, &c., and being the most fully and carefully recorded instances of the fungus-disease, published prior to the above date, they are well deserving of perusal by all interested in this subject. The cases are eight in number; subsequently, Mr. Bazonji Rustonji has forwarded others to Bombay, and he had even at that time, seen four or five more, so that the frequency of this affection in Kutch, &c., may be considered well established. I have myself since received undoubted specimens from the same localities, including one very characteristic of the black variety of fungus growth, from Mr Sudaseo Hemraj; who was formerly Sub-Assistant Surgeon, and subsequently medical attendant to the Court of the Rao of Kutch. Most of the instances here referred to, belong to the second variety of Mycetoma, the small soft, yellowish granules being present; but the writer briefly distinguishes another form in which the granular deposit is absent, and a substance "dark in colour, and soft and thick in consistence" is substituted. He supplies us with a summary of the symptoms, pathology, and morbid anatomy; which is very creditable to his care and discernment. Practically, the disease is regarded as a species of caries peculiar to India: the connection with *phthisis pulmonalis* is disallowed, and I think correctly; the nature of the deposit is considered scrofulous or allied to it. I have already had occasion to refer to these interesting cases.

1859-60. Perhaps the most complete account of this foot-affection is, however, to be found in the 'Indian Annals' No. XII, dated for July, 1859, but not published until April 10, 1860; and not received in Bombay until upwards of two months after the communication, which forms the basis of the present Memoir, had been read before the Medical and Surgical Society of Bombay (March, 1860), and a brief summary of it printed and locally distributed.

Mr E. W. Eyre, Deputy Inspector-General in the Madras Medical Service, the author of the article referred to, entitles it an "*Account of a peculiar disease (tubercular) of the foot,*" thus endorsing the opinion of Godfrey, his predecessor at Bellary. Mr Eyre had himself seen eighteen cases, and introduces an analysis of many others from Gunttoor and Cuddapa, which are also districts in the Madras Presidency where 'Mycetoma' endemically prevails: he refers to Godfrey's opinions, and then treats of the malady under five heads:—1. The *external characters*, briefly describing them, and adding a coloured illustration, which—however inferior to the original drawing, as I am informed by Dr. Eyre, it is—is yet quite characteristic. 2. The *previous history* and natural course of the disease; the absence of constitutional taint, and ordinary termination by diarrhœa (as with other exhausting affections) are noted, amongst other features. 3. The *morbid anatomy*: the author states that although various appearances may be seen in different cases, yet they only indicate different stages of the same process; "in every foot examined were numerous minute tubercles, resembling fish-roe, lying beneath the muscles and extending from the bones to beneath the skin; and nodules of the same, often black in colour." A minute account of the dissection of two specimens is added; for want of a clue to the actual nature of the disease, all bare descriptions may be obscure, yet in that here given by Assistant-Surgeon F. Day are, I think, to be recognised all the main features of the fungus-disease. 4. The question is then asked, *what is the disease?* The author is evidently inclined to look upon the affection as of a strumous nature, and quotes cases from

English authors which appear to resemble his, and were decidedly of that character: yet it is distinctly stated that no diathesis or hereditary taint is present in these Indian cases. Through Mr Eyre's great civility, I am enabled to state that the disease is not, in his opinion, of a true tubercular nature; he remarks to me, in a private communication, that he gave it a doubtful appellation, when he termed it 'tubercular.' The conclusions of such an experienced observer are of great importance, in considering this part of the subject; I wish therefore to be somewhat particular in freeing the word "tubercular," from a meaning it might be very readily supposed to bear. Were the little roe-like granules really scrofulous deposits, the term would of course be applicable; but then we should most probably, find them associated with the well-known diathesis, and other local signs; as this is not the case, and as the particles so characteristic of the affection are something quite different from tubercles, properly so called, the employment of the word in question is not strictly appropriate. 5. The *results of treatment*: on this point the author's facts and statements must be regarded as authoritative. Amputation is the only cure; it is a radical cure: no instance of return of the disease after complete removal, appears to have been recorded; and the risk of operation is much below the average. Others remarks follow, and the author thus concludes—"The utility of the Civil Dispensaries receives an additional testimony from this one disease. The natural cause of it being fatal, sixty lives have been saved in this and the Guntoor districts, by the surgical means afforded at the Dispensaries." I am glad to find, that so far as the medical history, and other features of the disease, are concerned, the conclusions I had come to coincide with those enunciated by Dr Eyre; whose experience and wide sphere of observation, have rendered him an authority on these points. The real nature of the affection under consideration, however, is, I am myself convinced, now first brought to light; the result of careful and prolonged observation, leaving hardly a doubt on my mind, in this part of the subject.

1860. In point of time, now comes the sixth volume of the 'Transactions of the Medical and Physical Society of Bombay,' new series, 1860, which contains my article entitled "*On a new and striking form of fungus-disease, principally affecting the foot and prevailing endemically in many parts of India:*" since the present Memoir is largely based upon the materials therein contained, or referred to, it is not necessary to add in this place a summary of the above communication, which first conveyed a correct view of some forms, at least, of the affection afterwards named by me "Mycetoma;" nor need I, at length, refer again to Memoranda in continuation of the above, published in vols. vii (1860) and viii (1862) of the same 'Transactions,' because their contents, also, are incorporated in the present work. I therefore pass on to information made known subsequently to the above date, viz. 1860, by observers in India, and by referees in England.

PUNJAB, 1860. The earliest evidence of the prevalence of the fungus-disease in the Punjaub is contained in a short but valuable article by Mr Peter A. Minas, Grad. Med. Coll. Bengal, and Sub-Assistant Surgeon at Sirsah, which is published in the 'Indian Annals,' No. XIII, p. 316, 1860, and is entitled "*Observations on Keereenagrah (tuberculous disease) of the Foot.*" The following is a brief summary of contents:—the meaning of the above vernacular term ("worm"-disease) is explained: the characteristic symptom of the affection, is stated to be the presence and constant discharge of small particles, either soft, or black and hard; there are numerous fistulous openings in the part affected: the disease commences by a hard and tender swelling which gradually enlarges; it is usually first seen in the sole of the foot. The disease has been seen in the hand. Cause unknown; but attributed to an injury in most cases. Locality—prevails to a limited extent in the district around Sirsah, but patients come from Bicaner, Bhuwulpore and Hissar (adjoining districts, native states and parts of Rajputana). As Mr Minas furnishes more numerous statistics at a subsequent date, notice of those contained in the present communication may be here omitted; and I will only observe, in confirmation of my remarks on the necessity of complete removal of the disease by operation, that an instance of partial amputation is mentioned, one toe only being removed, with the result that subsequently amputation of the leg was required. Other clear and useful observations of Mr Minas, have been above referred to.

PUNJAB, 1861. In the succeeding number of 'Indian Annals' (No. XIV, date Sept., 1861) Dr. J. E. T. Aitchison, Civil Surgeon, Jhelum (in the Punjaub, near to the confines of Kashmir), records five cases of "*Godfrey and Eyre's tubercular disease of the foot:*" of these one is that of an adult woman, whose wrist was affected, but not, as I think, with the fungus-disease; two other patients were also females, and in these, as well as in the two males, the foot was the affected part. Dr Aitchinson looks upon thickening of the skin; dull pains felt only when the foot is moved; the early appearance of sinuses not leading to bone, as characterising this affection. On the other hand, scrofulous maladies are, according to him, distinguished by acute pains on movement, a constant gnawing pain, often worse at night, also deep-seated and frequently sympathetic, or

referred to another joint; sinuses, too, appear late and lead to the joint. I should suppose that these cases were mostly examples of the pale, soft variety of Mycetoma.

1861. About this time, probably, was published the following work, with which I am acquainted only through an elaborate review, contained in the 'Madras Quarterly Journal of Medical Science,' April, 1862, p. 331, &c.:—"Leçon du Dégénération endémique des os du pied, par le Dr A. Collas, second médecin en chef de la Marine Impériale, &c. &c. Pondichéry, 1861." The author of this "Lecture," which is highly commended for its general tone, had seen the foot-disease, and describes in full three cases of it, but much of his material was evidently derived from English authors: though quoting Eyre, &c., he does not seem to have been aware of the views advocated in the Bombay researches. The reasons for giving this disease, which has already received so many names, that of "Endemic Degeneration" are simply that the author considers the names previously given to be unsatisfactory . . . by it I mean (it is stated) the localization in one foot of a benign diathesis, which develops itself in a marked manner more frequently in men than in women, and is characterised by the production of a particular element, which, occupying the place of the bones of the foot, ends by inducing their destruction. I have given it the name to prejudice nothing of its nature . . . It is impossible that this malady can be anything else than a tumour of which the pathological element is made up of "myeloplaxes," produced by a diathesis *sui generis*, and by hypergenesis, *i. e.* in a proportion much exceeding that encountered in the substance of the bones in a normal state . . . the tumour is a "myeloplaxoma." . . . Dr Collas also describes what he saw in microscopical examinations of the new material . . . "a great number of little bodies of blackish or reddish-brown colour, having an irregular triangular form, which in the clearer parts seem to be formed of small cells, transparent, and unaffected by water, acetic acid, sulphuric ether, sulphuric acid . . . there are besides small, rounded, nucleated cells which ammonia appeared to render more distinct, but which I have not yet sufficiently studied . . ." Dr Collas also enters into wider details respecting the characters of Mycetoma; and as to the treatment of the malady, he observes, that at first he freely tried tonic remedies, according to the idea that he had to deal with a scrofulous affection, but these had not the least effect here, while the same had never been inefficacious in caries . . . Amputation of the diseased member remains, then, the only sure remedy.

I have had occasion to make use in the text of one or two statements made by Dr Collas, and will here only remark, that his opinion of the nature of this peculiar disease is not confirmed by my inquiries; but it is true, that amongst young subjects, 'myeloid cells,' with their multiple nuclei, may be found amid the diseased growth, and my note-book contains sketches of a very characteristic instance (page 10): the true import of this occurrence, however, could not then be mistaken for other than a probable coincidence. Respecting the minute structures described by Dr Collas, so far as may be judged from the review, which is my sole source of information, I detect some resemblance to my own results; but nothing essential, I think, to support the view specially advocated by the author himself.

Next follow extracts from a very interesting paper entitled—

1862. "Notes on the possibility of the Embryos of the Guinea-worm and so-called 'Fungus-disease,' respectively, entering the human body through the sudorific ducts. By H. J. Carter, F.R.S." (From the 'Annals of Natural History,' 3rd ser., vol. ix, 1862, p. 442.) Respecting the Filaria-disease, the author observes that since young Filaria may be seen to enter and lodge in apertures existing on the surface of large fungi, and not exceeding $\frac{1}{1000}$ in. in diameter, there is no difficulty in conceiving them to enter and pass along the sudorific ducts, whose calibre may be estimated at $\frac{1}{1000}$ in. He then remarks, with reference to the Fungus-disease, that it "may also in an embryo state, that is, in the form of a zoospore, like an *Amœba*, enter the body through one of the sudorific ducts; for microscopic examination of fresh, young, and favorable specimens of this undoubted fungus (the melanoid variety is here referred to, H.V.C.)" has led me to infer that it is most nearly allied to the Mucoridae, *e. g.* *Mucor stolonifer*, Ehr., which . . . is most probably propagated in this way. This *Mucor* is closely allied to *Achlya*; and closely allied to *Achlya*, again, are the 'water-fungi' (*Pythium*) which grow in and out through the cells of all Algæ. . . . Lastly, all these are allied to the great fungus family of the *Myxogastres*, for which now the name of 'Myxozoa' has been proposed by M. Al. de Bary, partly on account of their embryos, or propagation-germs, being locomotive, that is, polymorphic cells (minute *Amœbae*) provided with one or two cilia, so that they can swim with the latter when in water, or creep about by means of their polymorphic moto-plastic cells on wet surfaces Now *Mucor*, *Achlya*, *Pythium*, and the *Myxogastres*, all being allied to each other by the mode of propagation (that is by minute *Amœbas* or moto-plastic cells), we are not wanting in Fungi which produce embryonal forms that, if any of them chose to enter the human body, have

the power under the conditions and circumstances above mentioned, to do so as easily through the sudorific ducts (or even directly, through the skin itself, for they have wonderful penetrating power) as an embryonal *Filaria*." Mr Carter afterwards observes, "I would also add my opinion, that the black fungus of the human body is a monster-form, from its sporangia, or large cells, apparently identical with sporangia, never to my knowledge, containing anything but an amorphous albuminous mass (abortive state of sporidia, which is chiefly the seat of the black colouring matter, and ultimately becomes resinous or fatty?), and thus that this fungus is no more capable of putting forth a true embryo which can propagate the species from one human body to another, or even out of the body, than the Guinea-worm; and that the natural habitat of the species is therefore, like that of the Guinea-worm, out of the body."

MADRAS, 1862. In the 'Madras Quarterly Journal of Medical Science' for April, 1862, Dr G. Bidie, Mysore Farm, narrates his experience at Guntoor under the title "Notes on *morbus pedis entophyticus*." The author refers to my pamphlet containing the original article published in the 'Bombay Transactions,' but states that his own views were independently arrived at; gives a general view of the prevalence, &c., of the disease; its symptoms as divided into stages, and its morbid anatomy: he describes and figures the granules and peculiar bodies, with their fringes; considers that the latter are part of the growth, and states that the bodies have a tough envelope containing a firm gelatinous substance. Dr Bidie fancies he detected traces of starch, and concludes from this, and from the history of the bodies, that the latter are entophytes; thinks they may belong to the division *Athrosporei*, and very likely to the tribe *Oidei*; and finally proposes the above name. Some other information is added respecting the cases witnessed: amputation is regarded as the cure, and hardly a dangerous one, since no death had occurred at Guntoor in thirty operations. The illustrations appended to this paper are sufficiently characteristic; and there is one figure which, though at present to myself obscure in its significance, should be especially noticed. I refer to the drawing corresponding to the following statement by the author:—the roe-like particles may also contain "numerous branching, transparent, delicate filaments: the granules (malacotia, H.V.C.) containing filaments are most common in cases of very long duration, or in old cases far up the leg, where the affection may be said to be recent." Dr Bidie's figure hardly conveys the idea of a *mycelium*-structure, but the discovery of such structure would be very significant, and in future inquiries this observation should be borne in mind. No mention is made here of the more striking variety of *Mycetoma*, in which are present black particles, of undoubted vegetable character; but this memoir is yet of some corroborative value, as regards the ochroid variety of the fungus-disease.

The next memoir of importance with which I am acquainted, is one termed "*The Fungus-Foot of India*," by its author, the Rev. M. J. Berkeley, M.A., F.L.S., which is printed in the 'Intellectual Observer,' No. X Nov., 1862. Confessedly adapted to non-medical readers, this article is yet of much interest and importance, as it could not fail to be, coming from the pen of so accomplished an observer. Mr Berkeley refers to my own researches, and states that notes and sketches made by Mr H. J. Carter have been also placed at his disposal: reference is made to the black fungus-particles, and to the pink mould which springs from them under artificial cultivation, and which is now characterised as *Chionyphe Carteri*, with the definition given in the text. Next is mentioned the pale, soft variety of the disease, and of it two figures are given: afterwards the Madura Foot is referred to; it is one of my specimens described above, in which pink particles were noticed; and, lastly, the author offers some general remarks of value, but not requiring repetition in this place. There are numerous illustrations to this article, some of which would convey a different impression to my own figures; and as the author has also not always made clear, the authority for some of his descriptions, it may be as well for me to state that I am not responsible for any of the statements, except as they may be taken directly from the papers which I sent to England, immediately after they were published in Bombay (1860-62). The author's determination of the genus of the parent fungus of *Mycetoma*, it is not necessary for me to discuss at present.

Mr Berkeley subsequently continued his observations; and since these refer to points of considerable scientific interest, I have made large extracts from their record in the 'Linnean Society's Journal,' which are here subjoined.

1865. Observations on a peculiar Mode of Fructification in *Chionyphe Carteri*, Berk. By the Rev. M. J. Berkeley F.L.S., from the 'Journal of the Linnean Society,' n.s., vol. viii, 1865, p. 139. The author states that having received from Mr H. J. Carter specimens of the above named mould "in such a condition that it was hoped I might be able to raise a crop in the following spring upon rice-paste . . . it was the more desirable to do this as the *Chionyphe*, as seen by Mr Carter, exhibited more than one form of fructification, in one of

which a multitude of globose spores were formed within the terminal cyst; in another, if not an earlier stage of the same thing, a few secondary cysts were produced within the mother-cyst; while in a third, instead of globose spores, there were myriads of more minute uniform bodies. These secondary cysts, it should be observed, are unlike anything observed in *Chionophye* or *Mucor*, though approaching certain appearances in *Saprolegnia* and its allies. The resemblance, however, to these plants did not stop here, for in certain cysts lateral branchlets formed a reticulated mass over the surface, reminding me strongly of the antheridia in *Saprolegnia monoica*, Pringsheim, or of the supposed antheridia figured by Hofmeister in Truffles. Those who are familiar with the various modes of fructification of Fungi, and more especially if they have studied the *Saprolegnia*, will not be surprised at these anomalies, or at the additional proofs afforded by them of the affinity which really exists between the *Mucarini* and *Saprolegnia*. . . . therefore it was matter of some interest to watch, if possible, the development of the *Chionophye*. As soon, then, as the weather was sufficiently warm in the spring of 1863, minute fragments of my specimens were placed upon thick rice-paste, and each was covered with a bell-glass to prevent any accession of fresh spores from without. Unfortunately, however, our native moulds rapidly made their appearance in great abundance, and it was only after they had arrived at perfection that the pink patches of the *Chionophye* became conspicuous, and these were so intermixed with the strangers that it was very difficult to follow out their development; added to which the rice-paste seemed to be so exhausted by the first-formed moulds, that the vegetation of the *Chionophye* ceased before the greater part of the fruit was perfected. As far, however, as my observations go, they confirm Mr Carter's remarks. There were two kinds of Hyphasma, the one consisting of irregular-branched and anastomosing, sparingly jointed threads, which seemed to give rise to the Mucorioid fruit; the other of straight Conservoid threads (which appear to be identical with those figured by Mr Carter), in whose articulations there was a minute nucleus at the upper part, while in the terminal articulation there were sometimes two, though I am not able to verify this minute character. There were the same cysts of the second order in some of the mother cysts, and there were spores germinating *in situ*, though these appeared to me elliptic rather than globose. A most curious matter, in addition, was exhibited by the straight threads, which points to another curious analogy with certain Algae. The portion of the protoplasm or contents of the cells in which Mr Carter observed the nucleus above mentioned to be immersed, soon separated from the rest, first presenting a cask-shaped mass, surrounded or not with a distinct membrane, and then becoming elliptic or sub-globose. A large nucleus was observed in many of these masses, but these appeared to be frequently replaced by an indefinite number of smaller bodies. After a time a little papilla is formed on one side exactly as in the fructifying joints of *Zygnema*, which gradually bulges out, the mass soon conforming itself more or less to its enlarged walls. In a single case only, I witnessed the junction with another thread, and then the form of the intermediate cyst was extremely irregular, and its cavity filled with large spores. In some threads, however, a different state of things appeared, sometimes in the centre, sometimes at the apex, but whether in either case corresponding with a twin nucleus I am unable to say. However this may be, instead of one cyst, two appeared, a conjugation probably taking place between the two within the threads as in some *Zygnemata*, and the upper forming it should seem ultimately the perfect cyst. No one cyst, however, came to perfection. In some cases the lower cyst seemed to be entirely absorbed, while in others it was permanently connected with the upper by a distinct neck. In one instance I saw one of the straight threads forked, and producing two terminal cysts. From the circumstances before mentioned, it was impossible for me to follow out each point with the requisite precision the conjugation of the threads seems to resemble more closely that of *Zygnema* than the well-known analogous phenomenon in the genus *Syzygites*."

I regret that Mr Berkeley's figures could not be here reproduced, and further reference is therefore to be made to the original essay; I would, however, observe that a similar, if not identical, mode of production of the 'cysts' above referred to from Hyphasmic threads, may be observed amongst the small black fungus-particles during their residence in the canals within the tissues of the foot; see description of fig. 6, Plate IX; but no signs of germination through a conjugating process was remarked in these circumstances, sufficient time for full germination here, too, not having elapsed.

Following on Mr Berkeley's article thus so largely quoted, is a brief communication from Mr H. J. Carter on the structure of the same fungus, in its normal and its abnormal form. There are admirable figures, of which all I need say is, that the drawing of the morbid fungus-form (melanoid variety) differs not materially from my own fig. 6, Plate IX; while that of the fully developed *Chionophye* is like mine in figs. 1*d-f*, Plate XI, with the important addition that the sporangia, or spore-cysts, are shown to be covered with a network of small filaments "which seem to spring from the same filament on which the sporangium is borne." Mr Carter

observes of this network—"what its office may be I cannot say, unless it be connected with impregnation, after the manner pointed out by Pringsheim in *Saprolegnia*, &c.," thus taking a similar view to that suggested by Mr Berkeley. I have myself no new facts to add, and to a not-long distant future, one may look for a full comprehension of the position and growth of this new mould. Mr Carter also remarks that he could not get the *Chionyphe* to grow on paste after the spring and beginning of summer, and he therefore infers that this is the time in which it fructifies: a conclusion, I may add, quite supporting the results of experiment in India. 'The Transactions of the Medical and Physical Society of Bombay,' No. IX, new series, for the year 1869, contains a portion of the above remarks by Mr. Berkeley, which were read to the Society, at the time they were received by me in Bombay.

1868. In this place, may be mentioned the valuable statistical information accumulated by Mr P. A. Minas, Honorary Assistant-Surgeon in the Bengal Establishment, &c., and detailed in the 'Indian Annals,' No. XXIV, July, 1868. The cases were seen in the Punjaub, Rajputana, and some adjoining states: they number 37, of whom 32 were males, 5 females: the average age of the *former* was 31 yrs., duration of disease when first seen 5 yrs. 2 mos.: youngest male patient was 12 yrs. old, the oldest 60 yrs.: shortest duration of disease 2 mos., the longest 26 yrs.: amongst *females*, the average age was 35 yrs., the youngest 20 yrs., the oldest 45 yrs.: average duration of disease when seen 3 yrs. 9 mos., shortest duration 10 mos., and the longest 7 yrs. As regards occupation there were 20 agriculturists, 4 beggars, &c. The right foot was affected 18 times, the left foot 9 times; single toes of the corresponding feet were implicated, 2 and 5 times respectively: the left leg was affected once, the right hand twice. Once the diseased foot weighed as much as 10 lbs. 8½ oz. Amputation was performed 26 times with success; of 11 cases otherwise treated, 6 were relieved, 4 cured, and 1 died. It would seem that all the above cases belonged to the first, or black variety of Mycetoma. Those seen in the earlier stages, had the disease upon some part of the sole of the foot; in many even of the older cases, one toe alone was affected. In both the hand cases, the disease began on the palmar surface. Mr Minas's previous experience has been already mentioned.

I may here introduce a reference to the notices of this disease, which have hitherto appeared in the 'Indian Medical Gazette' (Calcutta). In vol. ii (1867) is an excellent article by Dr Eddowes on treatment at an early stage by removal of the growth; and another by Dr W. J. Moore; in vols. iii and iv, are cases narrated by Mr Minas, which have for the most part been already referred to; in vol. vi are brief notices of cases in Goojerat, by Mr Jayakur, of the Bombay Medical Service; and in vol. viii is an interesting communication from Dr Moore, with references to other operators; and as well a case (melanoid variety) narrated by Dr Downie, which is noteworthy from its containing a memorandum from Dr D. Cunningham, to the effect that the black particles examined did not present any clear trace of fungus-structure, a result which is unusual.

1869. 'Transactions of the Medical and Physical Society of Bombay,' No. IX, New Series, for the year 1869; Appendix, p. xxxii, "On a somewhat unusual proceeding in Surgery after amputation for 'Mycetoma,' under the care of Doctors Miller and McDowall, reported by Assistant-Surgeon C. McDowall." This is a case occurring in a young man "presenting outwardly nothing unusual:" the foot was the size of a large pumpkin: flap amputation was performed below the knee; the patient's health had been carefully prepared for some days before. There was obstinate bleeding from the medullary cavity of the tibia: amputation was performed at the lower third of the thigh: bleeding was again copious, even from the veins everywhere; the medullary cavity of the femur had to be plugged with a cork, and the plan was quite successful in checking the hæmorrhage. The patient recovered. It is remarked that Dr Lord, Civil Surgeon of Poona, had to amputate twice in consequence of bleeding, in a similar case; and the authors are of opinion that in Mycetoma there is an unusual likelihood of bleeding. Those members of the Society who were present at the meeting when this interesting paper was read seem, however, to have demurred to the last statement; and it is stated that out of upwards of twenty cases of fungus-disease of the foot operated on at the J. J. Hospital, Bombay, no instance of unusual hæmorrhage had ever occurred.

The same volume of the 'Transactions' contains notes and a figure of a case of Mycetoma which refer to the same instance as that recorded in the text at page 10 (Case 5). Vol. ix also contains the note by the Rev. M. J. Berkeley, F.L.S., "On a peculiar mode of fructification in *Chionyphe Carteri*," which is quoted above in this Appendix.

No. X of the 'Transactions,' for the year 1870, has "Notes on Mycetoma, with cases, by T. Holmsted,

Esq., Civil Surgeon, Hyderabad" (Siud); and this interesting communication I became aware of, only after the greater part of the text was printed. The author observes that he has seen "twelve cases; in ten, one foot alone was affected—sometimes right, sometimes left; in two cases, the disease had also been spreading up the leg. Once I think I saw the hand affected; the subject of it promised to enter the hospital, but never showed himself again. In one case, the subject was a female; this was an incipient case, and had the appearance of a fibro-cystic tumour surrounding the base of the great toe, but containing the ordinary products of fungus-disease. Another incipient case was a young man who had the disease in the dorsum of the left foot, the skin of which was raised, hardened and had an unhealthy look; a probe on being passed, touched something like dead bone. Two years previously he had run a thorn into the foot . . . the thickened tissue was dissected off, and passing into one of the extensor tendons was found a thorn, of irregular shape and nearly one inch in length; the part not appearing healthy was touched with carbolic acid, and he made a good recovery" . . . The author is inclined to think that the disease is a form of melanosis—because of "the microscopical examination" (revealing to him only "minute vesicles of $\frac{1}{3000}$ to $\frac{1}{2000}$ in. with one dark spot in their walls," and exhibiting active molecular movements); "because the disease commences in the skin, and perhaps amongst the cells of the rete mucosum; and because I can never detect any fungus." . . . A case of amputation at the thigh for disease of the knee of long standing is mentioned: "on examining the diseased part, I found what I then thought to be melanosis of the head of the tibia and tissues around. I now think it must have been a case of Mycetoma; I had not then seen a genuine case of this disease:" . . . the flap operation was preferred, and acupuncture adopted for preventing bleeding: wire sutures were used for the flaps, and carbolic acid applied to the wound. Mr Holmsted employed one form only of acupressure—"that by which the artery is compressed by a long needle projecting out of the wound or skin;" and though not dissatisfied with it, expresses the opinion that for general use, the ligature seems best, the risk of secondary hæmorrhage being less.

Observations made in England may be fitly preceded by a notice of the "Scheme for obtaining a better knowledge of the endemic skin diseases of India," prepared by Drs Tilbury Fox and Farquhar; for although Mycetoma is not to be included amongst skin affections proper, yet a useful and suggestive summary of certain characters of this disease has been herein introduced: date of the document 1872.

The succeeding paragraphs appertain to records of the examination of specimens, transmitted at various times from India to members of the Pathological Society of London. The several volumes of 'Transactions' containing these records are here named:—

In vol. xv, 1864, are notes and drawings of a case of the commoner, pale, soft variety of the disease, which were sent by me from Satura, a locality in the Deccan plain of Western India: as the instance is also referred to in the text, I will only remark in this place that the members of the special Committee appointed to examine this specimen, viz. Mr Hulke, F.R.S., and Dr Bristowe, report having examined the pale "particles" with a power of $\frac{1}{2}$ in. and having failed to recognise a structure in them comparable to that of a fungus. Of course, I may add, this is ordinary experience; yet, obviously, the negation is of but negative force.

In vol. xxi, 1870, are recorded the results of another special examination by Mr Jabez Hogg and Dr Moxon, of a second specimen of Mycetoma (pale, soft variety): the roe-like bodies were found to present no trace of structure; the authors regard them not as altered fungi, but as rather resembling masses of coagulated fibrine: they are of opinion that the development of these bodies should if possible be traced, their structure being now sufficiently well known: they observe respecting the membrane lining the canals and cavities enclosing the roe-like bodies that it offers no apparent structure except fibrils and defaced nuclei. The Committee are disposed to doubt the fungus nature of this variety of Mycetoma.

In vol. xxii, 1871, data of a more positive character are recorded: a specimen from Guntoor (in the Madras Presidency) was presented by Dr Tilbury Fox, and referred to the very competent observer Dr Bristowe. It is noted that the cavities and canals in the diseased portion of the foot are filled with masses of a nearly black, dense, dry, friable substance; fragments taken from the surface of these masses had a botryoidal character; taken from the centre, they were fibrous in texture and the colour in the interior was

paler and redder: the masses looked like 'truffles,' but also like dried blood. As seen with a low power, there were indications of branching filaments; with a higher power these were resolved into flat fibres: figures are given: the fungus-tubules are described, and the large thick-walled cells; the illustrations of these parts are clear and decided; nothing new is made out, but the confirmation of my observations on this variety of Mycetoma is in the main sufficiently apparent. At the close of his Report, the writer adds—'I venture to remark, however, that the black masses seem to be as truly a fungus, as do masses of truffle; and not merely inspissated secretions, which have become invaded by the growth of fungus. But I must add, on the other hand, that I failed to detect any traces, whatever, of fungus, in the diseased foot previously exhibited by Dr Tilbury Fox—a foot which, but for the absence of the black masses, appeared to be diseased in precisely the same way as the foot to which this report alludes.' In elucidation of this last remark of Dr Bristowe, it will be sufficient for me to here observe, that the specimen just mentioned as one not presenting any trace of the black fungus, was a specimen of 'ochroid variety of Mycetoma,' where the curious bodies termed in this Memoir—*malacotia*—are alone present. It has been my object to show that these, too, are of vegetable nature, and, probably, of fungus-origin.

In Dr Bristowe's article, it is stated that Dr Thudichum had submitted the truffle-like material to spectroscopic examination, and 'found that it did not present the absorption bands of any form of hæmatine. A small quantity of the grumous black matter was submitted to chemical examination. From its appearance, it might have been mistaken for dried and altered blood, or hæmatine; but it proved to be insoluble in all re-agents, whether dilute or concentrated, including caustic potash and oil of vitriol. On combustion, it left a small quantity of ash, which contained a little iron oxide, but much less than it would have contained, if the matter had been altered blood. I am, therefore, inclined to believe that the matter is not condensed blood, nor approximately derived from it or from hæmatine; but that it is of a different nature.' These observations bear directly upon the idea which has been broached in India, that the black fungus-particles may be only blood-clot; such idea again seems untenable, from the side of chemistry.

In vol. xxiii, 1872, is a notice by Mr Jabez Hogg of a specimen from Rajcote (in the Bombay Presidency), which appears to have been one of the second or ochroid variety of Mycetoma, and but a partially removed tumour. I own that I cannot understand the character of the disease in this instance, and it would almost appear as if there had been some accidental admixture of a mould. Mr Hogg doubts if a fungus is the essential cause of Mycetoma; and has in other publications expressed the same opinion.

In vol. xxiv, 1873, will be found some remarks by myself, on the pink mould which I had long since observed to arise in connection with specimens of Mycetoma, of both varieties; and a coloured figure is given of this growth, which is the *Chionyphe Carteri* of Berkeley.

1873. One of the latest observations on this subject which has been made known, is contained in the work of Dr Fayrer entitled 'Chemical and Pathological Observations in India,' London, 1873, p. 637. An instance of the "so-called Madura Foot" is described, which is noteworthy as having occurred in Lower Bengal, where the affection does not seem to have been hitherto noticed: the case is a characteristic one of the second variety of Mycetoma, and besides being fully recorded, is of interest from the appended and illustrated remarks on the structure of the new growth, by two very able observers, viz. Dr T. Lewis of the British Medical Service, and Dr. Goodhart, of the Royal College of Surgeons, London, &c. It is nothing new to record the negative results of microscopic scrutiny, but I may observe, first, that probably the failure to induce artificial germination of the fungus-particles (as I regard them) recorded by Dr Lewis, may be explained by the late season of the year when the experiments were made; and, secondly, neither of these two gentlemen named have offered an opinion, or pointed out an analogy to other morbid products, respecting these peculiar bodies, so that in short the results do not contradict my own observations so much as they fall short, as others have, of those positive data.

In order to render this brief summary of contemporaneous opinions as complete as possible, I may add a reference to the work of Mr Hancock on the 'Operative Surgery of the Foot and Ankle-joint,' dated London, 1873, in which, under the headings of "Perforating Ulcer" (p. 37,) and "Tubercular Disease of the Foot," (p. 75,) will be found various, but as I think hardly discriminating, remarks on both Mycetoma and

another affection of a totally different character. It is difficult to perceive clearly the writer's meaning, but enough is advanced to indicate that the disease termed by Nélaton, in 1852, 'Une Affection singulière des os du pied' cannot be the same as the fungus-disease of India, the alternative conclusion being the unlikely one, that close, clinical and microscopic observations had not been exercised by surgeons in Europe: indeed, from the narrative here given, it would appear that Nélaton's disease, or the perforating ulcer of the foot, is an affection of constitutional, perhaps strumous, origin, and attended with progressive caries and necrosis of the phalangeal, metatarsal or other bones, &c., of the foot.¹ I have had no practical acquaintance with this last-named complaint; but may trust that after the publication of the present volume, no difficulty will be experienced in adequately discriminating 'Mycetoma,' and so avoiding any confusion of diagnosis.

¹ Since the above was written, I have heard it stated on good authority, that the perforating ulcer of the foot is] probably a form, or relic, of Leprosy; and the sug-

gestion I regard as both valuable and sound, for, read in this light, Nélaton's cases become, to one acquainted with this last disease, by no means unintelligible.

The first part of the paper discusses the general theory of the subject. It is divided into two main sections: the first section deals with the general theory, and the second section deals with the special theory. The general theory is based on the principle of least action, which states that the path taken by a particle is the one that minimizes the action. This principle is derived from the principle of stationary action, which states that the action is stationary with respect to variations of the path. The special theory is based on the principle of relativity, which states that the laws of physics are the same in all inertial frames of reference. This principle is derived from the principle of the constancy of the speed of light, which states that the speed of light is the same in all inertial frames of reference.

The second part of the paper discusses the application of the theory to the case of a particle moving in a magnetic field. It is divided into two main sections: the first section deals with the general theory, and the second section deals with the special theory. The general theory is based on the principle of least action, which states that the path taken by a particle is the one that minimizes the action. This principle is derived from the principle of stationary action, which states that the action is stationary with respect to variations of the path. The special theory is based on the principle of relativity, which states that the laws of physics are the same in all inertial frames of reference. This principle is derived from the principle of the constancy of the speed of light, which states that the speed of light is the same in all inertial frames of reference.

PLATE I

Vertical section of a foot affected with the Melanotic or black variety of Mycetoma. See Case 1, page 3.—
This was the first example seen; and the dark fungus-masses belonging to it are figured in Plate IX. Sketched immediately after amputation.

The new growth is in the form of black particles or masses, which are located in both hard and soft parts; being inclosed in a capsule and, as well, commonly imbedded in a gelatinous or fleshy material.

* * * * The sclerotioid growths in different parts of the foot.

- a. Lower end of the *tibia*, in which are imbedded two globular masses, surrounded by a thin membrane; a few small, detached particles are scattered about.
- b. The *astragalus*, upon which, too, masses of growth have slightly encroached.
- c. The *os calcis*, which is largely occupied by the foreign bodies in question.

There is less general tumefaction than usual of the foot, in this instance; the disease being thus presented in an uncomplicated form.



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VERTICAL SECTION OF A FOOT SHOWING THE MELANOID OR BLACK VARIETY OF MYCETOMA. See the case at Page 3.

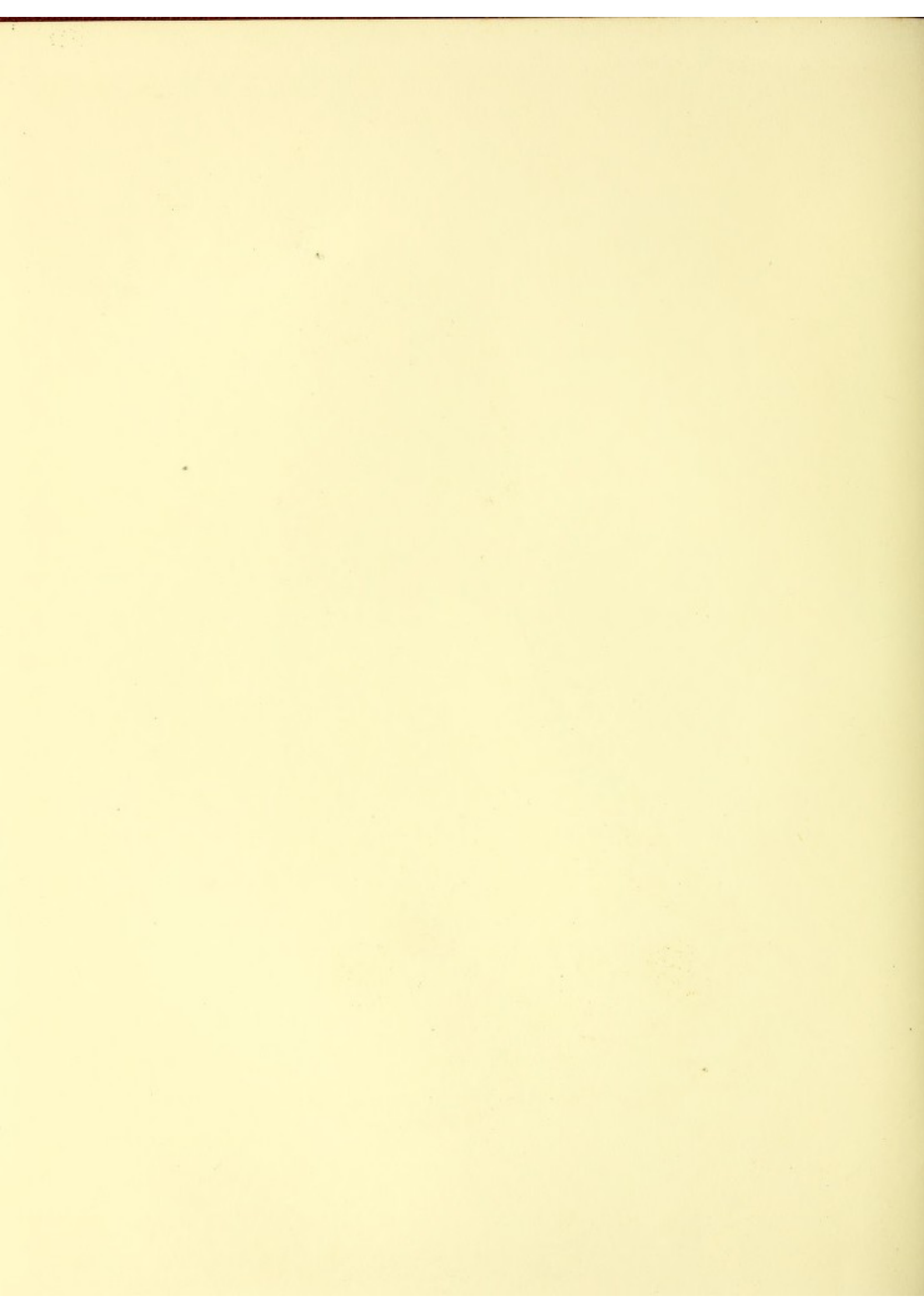


PLATE II

MYCETOMA: *var.* MELANOTICA

FIG. 1.—*External appearance of the foot* described at page 4, Case No. 2.—The specimen had been preserved in dilute alcohol, but there are still evident the small, pouting orifices from which the black particles issue. The globular form of the whole foot—the Mycetoma—is tolerably well marked. Light patches in the skin are seen, which are not essentially related to the fungus-disease itself. The tarsus seems to be chiefly affected. At *, a white bristle placed in one of the openings above mentioned.

FIG. 2.—*Sectional appearance of the foot* described at page 5, Case No. 4.—Sketched immediately after operation. Here the tumefaction was considerable: the bulk of the growth occupies the centre of the foot, and the ankle and heel are free from disease; the tarsus, in front, and chiefly the metatarsus, are implicated and mostly destroyed. The new growth also occupies both sole and dorsum of the foot; and while itself forming a large part of the entire tumour, has besides excited considerable swelling in the soft parts around. This super-added tumefaction is of an œdematous or elephantoid character. The tendons are spared; and sections of two or three may be seen in the cut surface: the articulations of the foot are not especially affected. At *a*, and elsewhere, are seemingly isolated portions of the new growth; these were, however, probably connected with the main body. At *b*, is the largest or densest collection of *sclerotia*; all masses are capsulated; and their yellow-tinted, friable envelope is seen around them. At *c*, are sections of numerous canals filled with a gelatinous substance, imbedded in which are the black particles; the appearance being sometimes that of cysts laid open. At *, a bristle is passed into one of the openings of the surface, to show its connection with deep-seated masses of the growth.

Fig 1



Fig 2

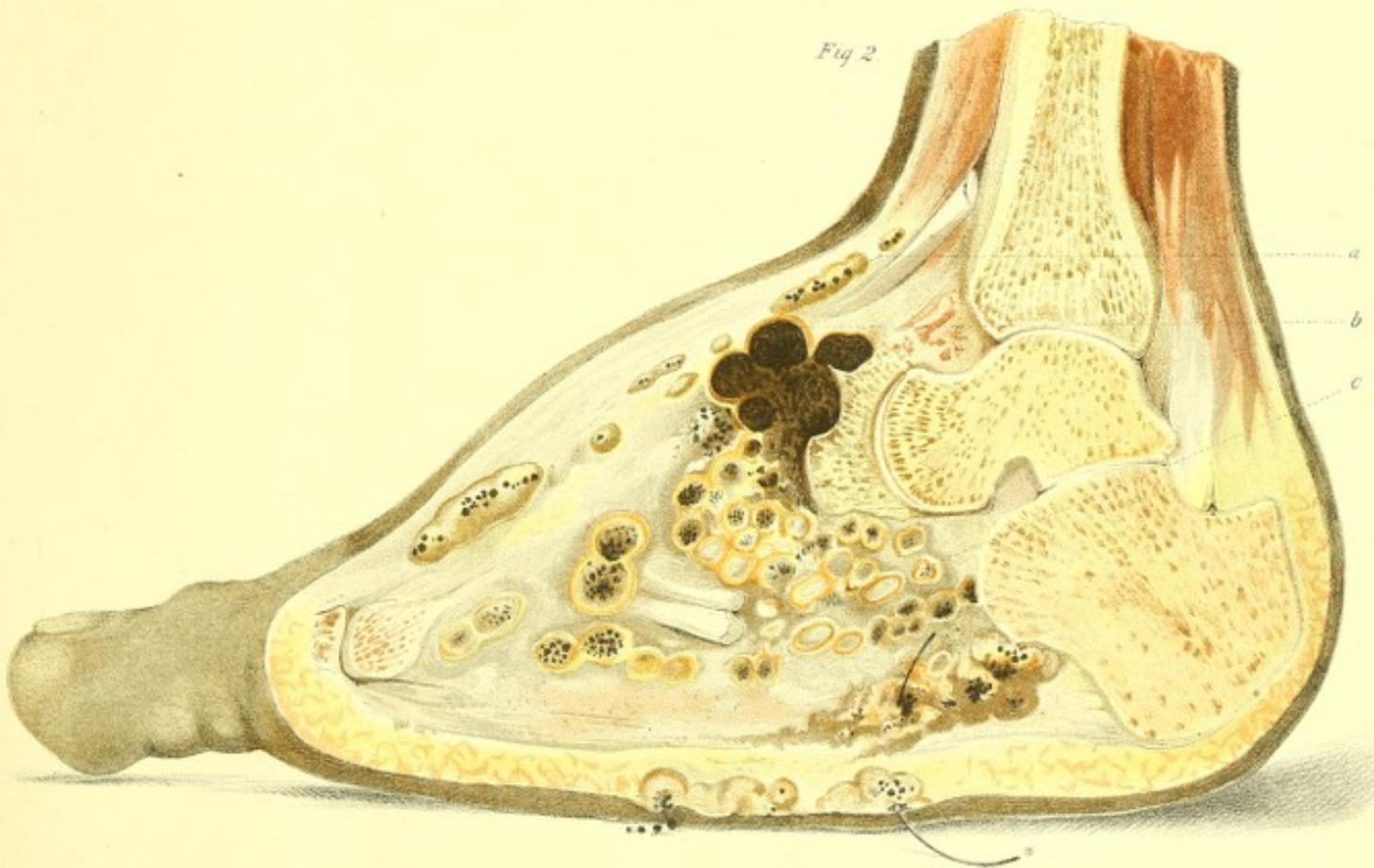


PLATE III

MYCETOMA OF THE HAND: BLACK VARIETY

FIG. 1.—View of the third finger, right hand, in the case described as No. 8, at page 6. Sketched from a specimen preserved in spirit. The new growth, and the openings leading to it, are situated chiefly on the palmar aspect: the amount of swelling is not great, and the finger alone seems to have been implicated.

FIG. 2.—An entire hand, with part of forearm, seen in the anterior aspect. The former is considerably swollen; the two outer fingers are most affected, and laterally displaced: the palm is also largely implicated, and the ball of the thumb. There are apparent cicatrices near the wrist, but the growth has spread above this joint, to the extent of two or three inches. The index and middle finger, and most of the thumb, seem to have escaped destruction. The case is alluded to at page 6.



Fig. 1.

Fig. 2.

PLATE IV

MYCETOMA OF THE FOOT: OCHROID OR PALE VARIETY. Case 1, page 8

FIG. 1.—External aspect of the foot, drawn immediately after operation. The large, pale, soft swellings which are seen at **, are outgrowths of the masses within. There is not much general swelling of the foot, and the parts in front are unaffected.

FIG. 2.—Sectional view of the same specimen, sketched at the same time. The new growth is seen to consist of a greenish-tinted, gelatinous material, which is accumulated in various parts ***, encroaching on the *tibia*, *a*, the *astragalus*, *b*, *os calcis*, *c*, and as well as other tarsal bones in front, *d*. In the medullary cavity of the tibia are seen two small, pale cavities, which look as if they had once been the seat of the growth. Some of the tendons are seen to be cut across at *e, e*; there is no special disease of the articulations: the front part of the foot is free from implication.

Fig. 1



Fig. 2

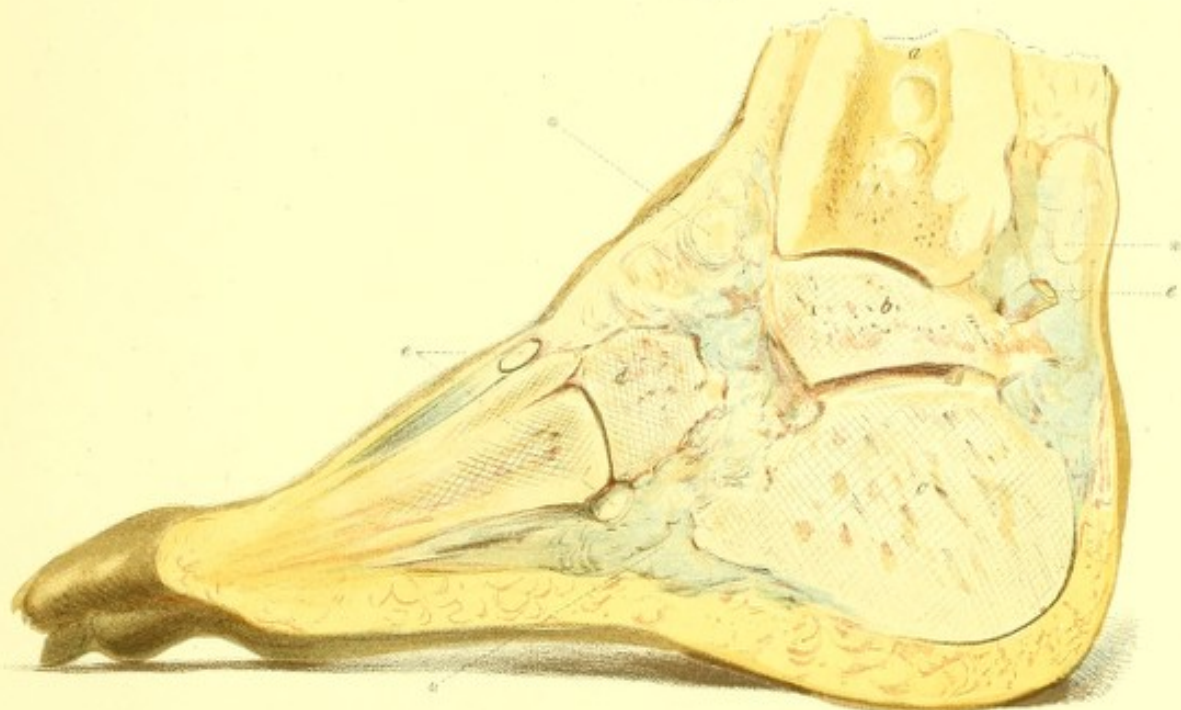


PLATE V

MYCETOMA OF THE FOOT: PALE VARIETY. Case 4, page 10

This illustration, taken from the life, previous to operation, shows a common aspect of tumours of this kind, when of moderate size. The swelling was here remarkable in being limited to the inner side of the foot. Dark and light spots on the skin are seen, which are mostly due to pigmentary alterations; and there are the usual, small openings from which the pale, soft fungus-particles emerge in abundance. That portion of the foot not implicated in the growth was apparently healthy.



PLATE VI

MYCETOMA OF THE FOOT: PALE VARIETY. Case 5, page 10

The tumour is unusually large: it involves chiefly the fore part of the foot, and does not extend above the ankle-joint. There are everywhere the usual pale, soft swellings, and at the inner ankle, the peculiar apertures of this disease. The toes are seen to be partly involved, and the outer toe is widely separated from the rest by means of the new growth. There are notable pigmentary changes in the skin, but the parts of the foot not directly implicated seem to be unchanged or only wasted. The patient was in a very reduced state of health.



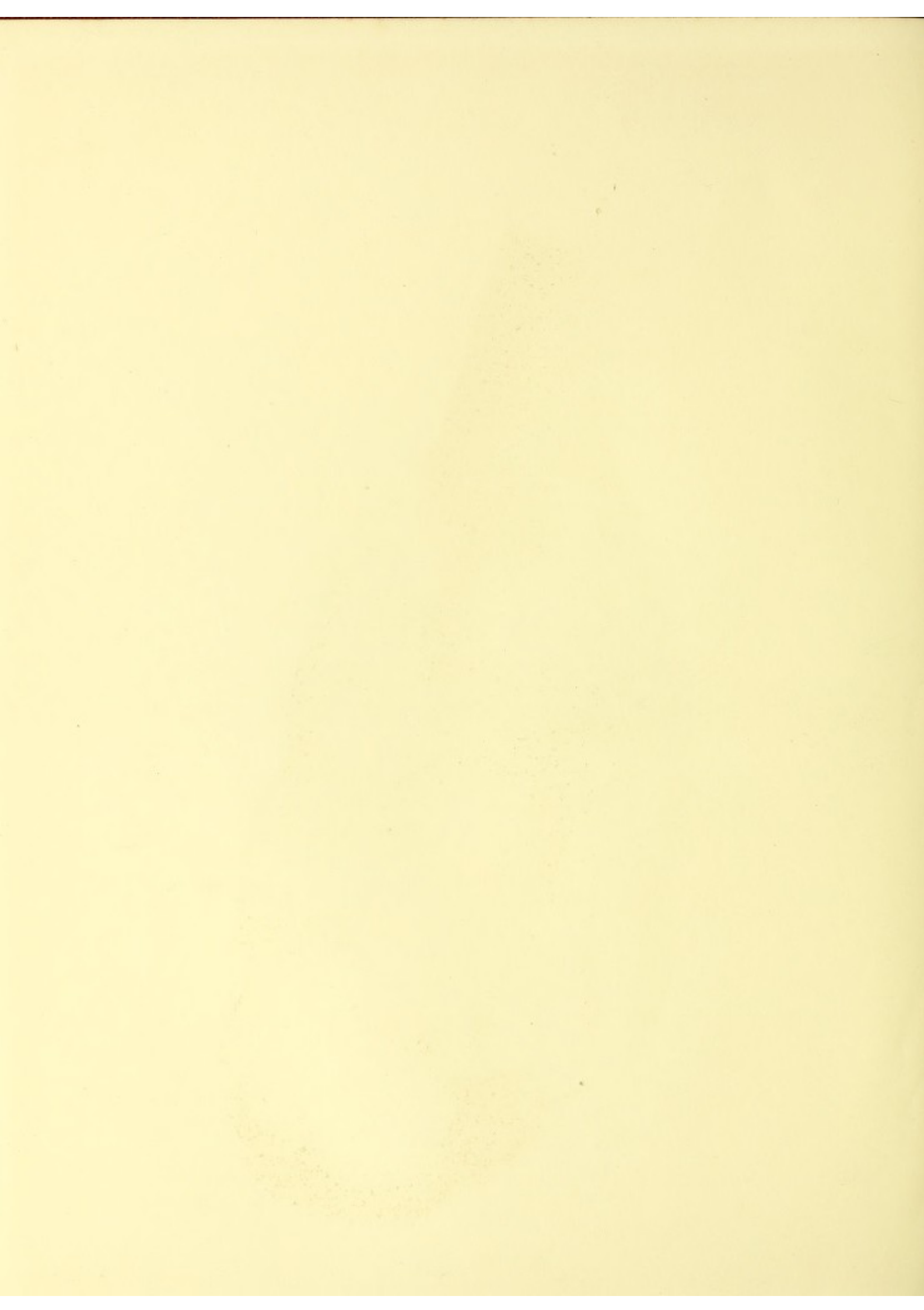


PLATE VII

FIG. 1.—Section of a part of the foot shown in Plate VI: natural size; appearance after long preservation in spirit (*vide* Prep. 302 C, Pathological Museum, R. Coll. Surg. London). There is much thickening of the soft tissues: the muscular fibres are not distinct; the bones are unchanged: the toes are displaced, from their tendons being pressed upon. There are seen several, apparently isolated portions of the growth; the largest at *a*, where the chambers or cavities lodging the pale, soft particles are particularly distinct: at *b* are sections of canals leading from these cavities to the surface of the foot. *c* is a cavity of unusual size, and having in its thick walls numerous follicles, in which are to be seen the fungus-particles, and which impart a honey-combed appearance to its inner aspect. *d* are small cavities, of diameter intermediate between that of the chamber and canal; in them, too, may be seen the fungus-masses, which generally break up into smaller fragments as they pass on their way outwards. At * is a metatarsal bone.

There is here to be noticed the yellow- or orange-tinted walls of both canal and cavities, altered somewhat in colour from action of the spirit—whence, too, the marked hollow appearance of the cavities, their gelatinous contents having shrunk away. A bristle is passed into one of the lower openings.

FIG. 2.—A view of the outer, convex surface of the small tumour which is described at page 11 (Case 7): natural size; after preservation in spirit. It shows the characteristic aspect of the openings in the cutaneous surface; namely, that of circular or oval depressions, deepest at the centre, where is the aperture giving exit to the particles. The growth was here at an early stage. A large patch of pale discoloration occupies part of the surface: some of the cuticle had desquamated.

FIG. 3.—Section through one of the circular apertures of fig. 2. *a*, epidermis; *b*, derma or cutis; *c*, sub-cutaneous tissue: fungus-particles were found at some distance down into this part. Magnified view.

FIG. 4.—A portion of the foot from Madura, described as Case 2, at page 9: nearly natural size. The new growth is the pink-tinted, fleshy mass here shown (*a, a*), which permeates the soft tissues, and excavates the bones (* * *), reaching the surface at *c, c*; and where divided in its course presenting the aspect of canals, as at *b, b*. The general tint is partly due to the presence of pink granules (fungus-particles), some of which are seen, separately, at *d*. The specimen had been preserved in spirit, before it was sawn in two and the drawing made. The pink particles are again figured in Plate X.

Fig. 1.

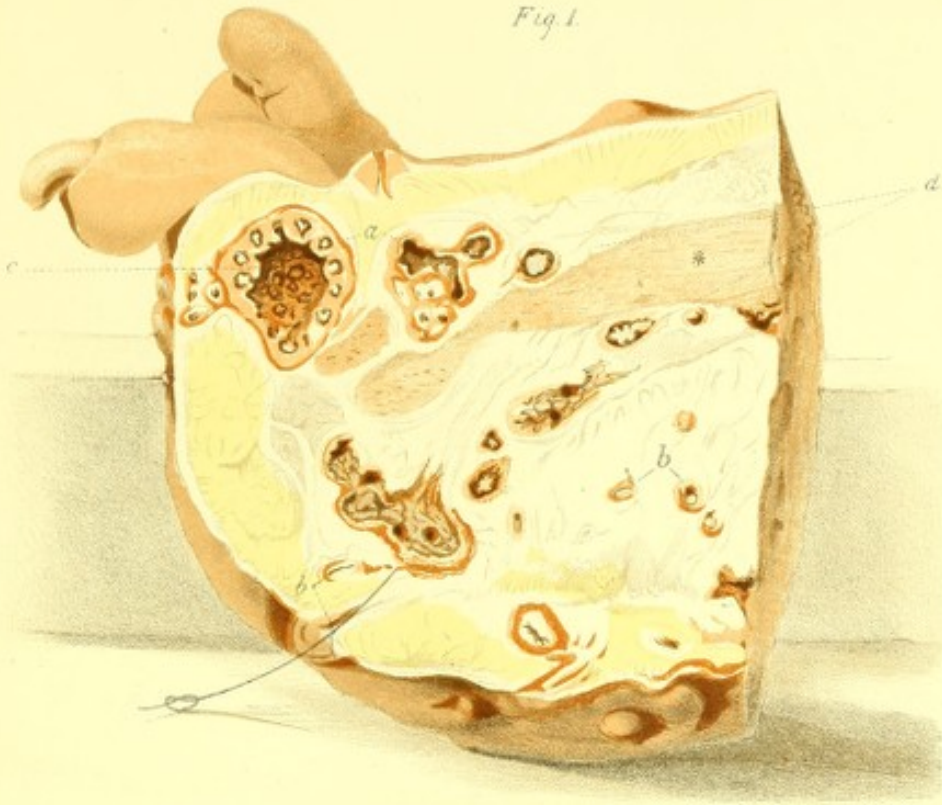


Fig. 3.

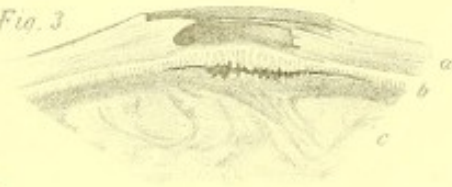


Fig. 2.



Fig. 4.



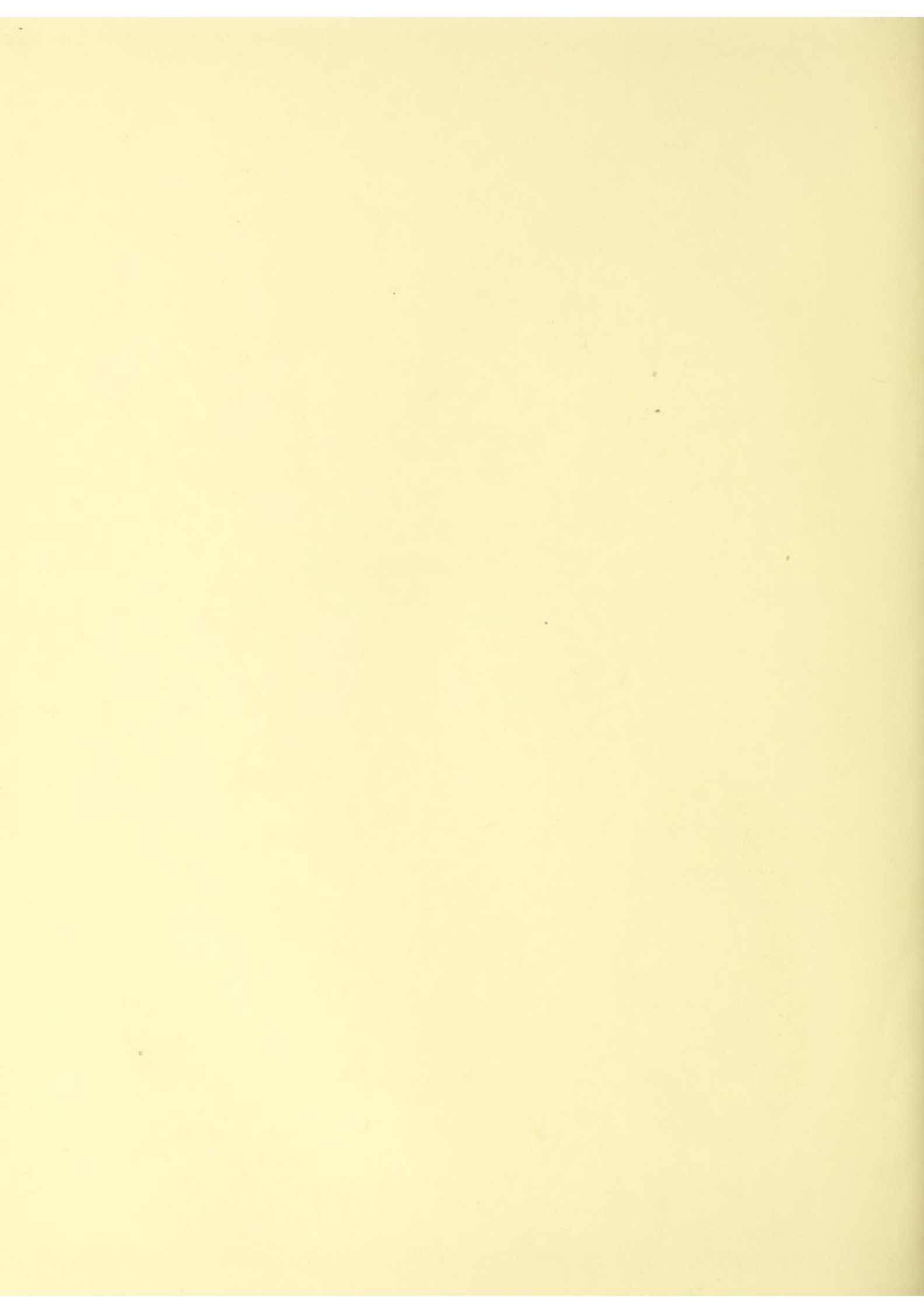


PLATE VIII

FIG. 1.—*The bones in Mycetoma of the foot.*—At *a, a, a*, are the characteristic, spheroidal holes, tunnels, or excavations, which are produced by, and serve to lodge, the masses of new growth. It will be seen that the osseous tissue is riddled by these passages or loculi, and that with the exception of some roughening, thickening, and a few spiculæ—all the result of simple irritation caused by the presence of foreign bodies—there is no abnormal change in the bones themselves. The joints are entirely unaffected. The figure is the one alluded to in Chap. III, Sect. I, page 20.

FIG. 2.—*Mode of invasion of the growth in Mycetoma.*—An ideal section of the foot. At *a, a, a*, are cavities containing the black particles, and interspersed throughout the foot: they are lodged in the spherical excavations of both hard and soft parts above described. *b, b, b*, are canals in the tissues, leading from these cavities to the surface of the foot: they frequently communicate, and are lined by a continuous membrane; they are the channels along which the fungus-particles pass on their way to the exterior. A soft, gelatinous, or fleshy material is also contained within them, and is present also in the cavities when these are not filled with fungi; so that the appearances here of hollow passages, is only partially correct; the lumen of the channels is always filled, or else their walls are in contact. *c, c, c*, Apertures on the surface where the canals terminate: they are often very numerous, and frequently in them may be found impacted the fungus-particles. *d, d, d*, Pink-coloured stains or streaks in the skin, which are, for the most part, situated near to the apertures just mentioned, and are supposed to be owing to fresh inoculation of the foot at these spots, whence new extension of the growth proceeds. I have not attempted to show in this diagram the orange-tinted, and probably growing, coat or envelope of the new growth, which invests all the cavities and channels; but in Plate II, fig. 2, and Plate VII, fig. 1, it may be readily seen. At * * are two canals, &c., traced out of an actual specimen (that from Sind, described above at page 5), and serving, with other data, as examples for imitation in the larger figure below them. In the dilatations of the canals will be seen some of the black particles and those arranged in groups of four, or as if multiplying by outgrowth.

The above particulars refer immediately to the melanotic variety of Mycetoma, but it is believed that *mutatis mutandis*, this figure would correctly represent the disposition of the parasitic growth in the other variety of the affection.

Fig. 1.

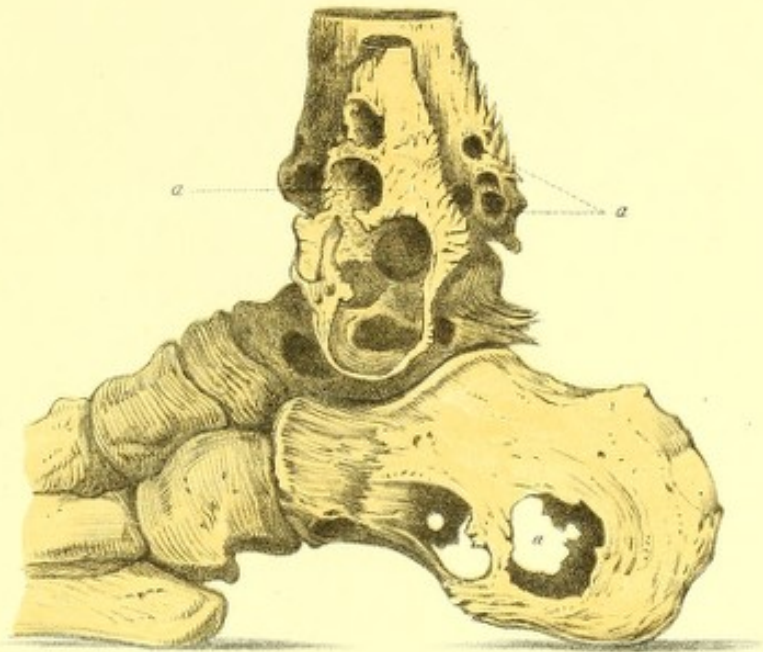


Fig. 2.



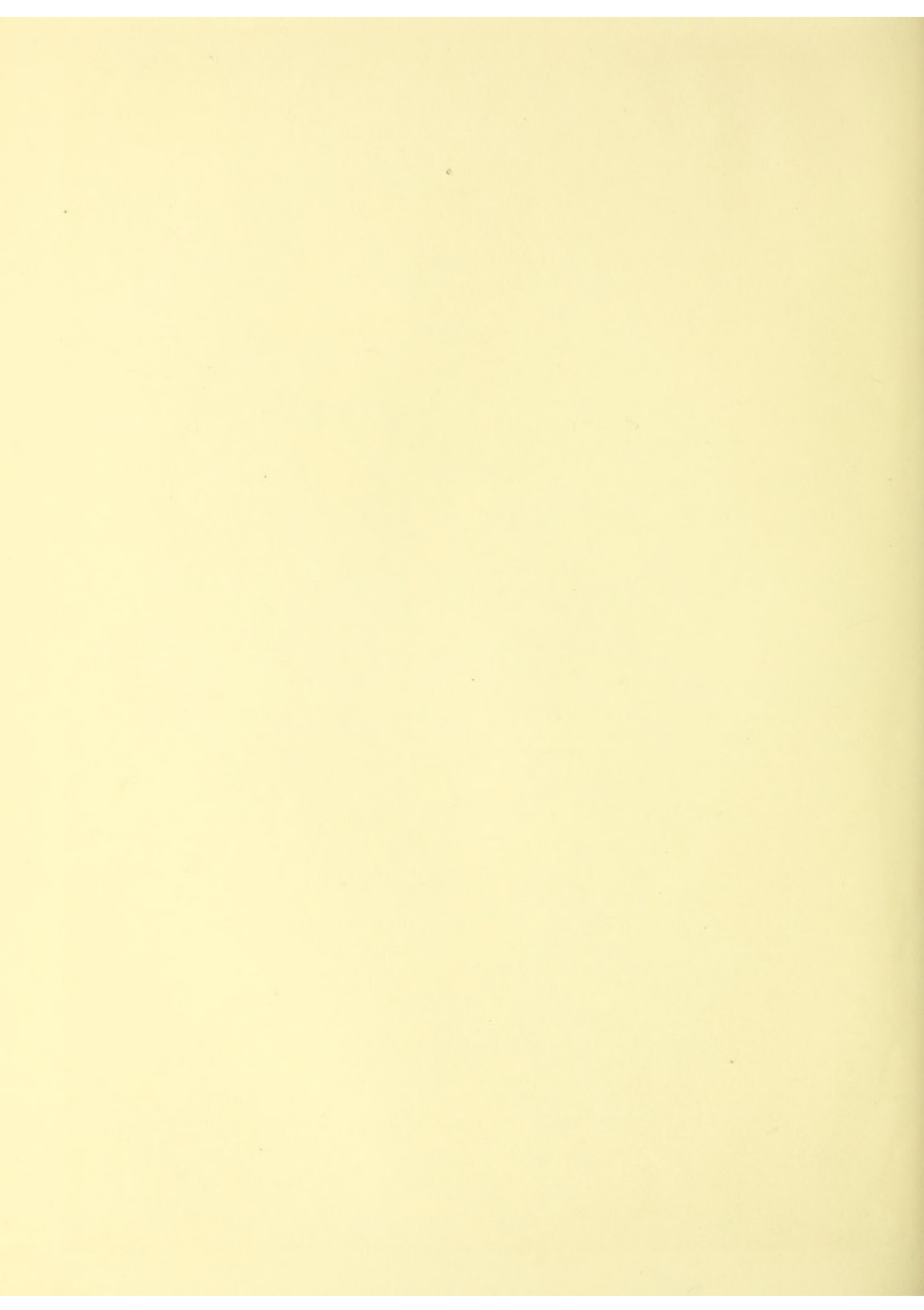


PLATE IX

Structure of the *Sclerotia* belonging to the Melanotic variety of Mycetoma. For full description see Sect. V, Chap. I, page 67.

FIG. 1.—Black particles, of natural size and appearance when perfectly fresh: taken from the foot of the man whose case is described at page 3; it was the first example seen of the disease. (*Vide* Plate I.) The large spheroidal mass in the middle of the row was taken from a cavity in the *tibia*, and it is shown in section also. A few of the small particles are introduced. In instances subsequently observed, the form and size of these bodies were even greater and more irregular.

FIG. 2.—View of the smaller black particles, when seen by aid of a lens. There is shown their flattened, botryoidal shape, and the appearance of a stalk upon the under surface.

FIG. 3.—View of the cut surface of a large particle (*Sclerotium*), when seen by aid of a lens. There is shown the dark, tuberculated rind, and the radiated construction of the interior, due to the presence of fasciculi or bundles; which, proceeding from the centre, branch and unite as they pass outward, finally terminating on the exterior in a black and expanded knob. These terminal dilatations are supposed to be the fruit-bearing segments, and being harder and more friable in consistence than the branches which bear them, they become detached, and thus form the free black particles of smaller size, so abundantly met with in the foot. Taken from the larger mass shown in fig. 1.

FIG. 4.—Minute structure of the *Sclerotia*, as displayed with a power of 2—300 diameters. *a*. The compact, cellular construction of the black, firm, peripheral part of the larger particles; it is that, too, of the main portion of the smaller particles. There is seen imbedded one of the *sporangia* described in the text, and a general radiated arrangement of the cells is apparent. *b*. The free edge of the same. Here is shown luxuriant cell-growth, by gemmation and extension. *c*. Another illustration of the same. One of the growing filaments (to the left) presents a characteristic appearance in the position of the 'nucleus' in each cell, and such as was subsequently noticed in *Chionyphe* when artificially cultivated. (*See* Mr. Berkeley's article in the 'Appendix.') *d*. Structure of the interior part of the larger black masses: here are seen chiefly minute, flat, pale, homogeneous filaments; very closely arranged, and often blending. Beaded fibres co-exist. The tint of these ultimate structural elements appears very light, in comparison with that of the mass which they form.

FIG. 5.—Section of the periphery or rind, at its junction with the common enveloping membrane. The rounded form of the dark-coloured tip, and the radiating disposition of its component cells, are indicated. The membrane itself, which is derived from the tissues of the foot, is seen to be perfectly separate, at least in most part; of striated and obscurely fibrous structure, and studded with numerous globules, which were supposed to be formed of oily matter. Acetic acid has been added, in order to render the animal structure more distinct. $\times 250$ diameters.

FIG. 6.—Minute structure of 'a small brown fragment from the interior of a canal.' Here is seen what I hold to be the sprouting, *in situ*, of a small black particle, the clear colourless cells being derived from the pre-existing brown ones, and possibly giving rise to the like in turn. There is also shown, imbedded in the mass of cells, a number of the expanded vesicles, which I have compared to *gemmules* or *sporangia*. The diameter of the component cells is about $\frac{1}{3000}$ in., of the vesicles $\frac{1}{1000}$ in. There is here evidence of great activity of growth.

a, a, a. Isolated vesicles representing *gemmules* or *sporangia*, which have been taken from various specimens of the melanotic variety of Mycetoma. The variety of appearances, as regards both cell-wall and contents, is remarkable. It is probable that the true character of these organs is obscured, through their abnormal conditions of growth, but the terms just mentioned seem to indicate the differences that exist. Certainly, some of the vesicles at once sprout into beaded filaments or tubes; whilst others show grumous contents, apparently undergoing sub-division, and possess thick walls, as if they were an aborted condition of spore-vesicles.

b, b. Isolated groups of cells which were observed, during attempts to trace the connection between the dark-coloured and the colourless cells. (*See* pages 69—71.) Occasionally, it seemed as if the latter were produced from the former; whilst at other times, the order of formation appeared to be the reverse.

c. A remarkable group of cells, both pale and coloured. The large vesicle filled with finely granular contents is marked in my notes as a doubtful transitional form: it may possibly have relation to lower forms of vegetable life, as of the *Bacteria*, which seem to be connected with the fungus of Mycetoma. $\times 250$ diameters.

FIG. 7.—*a*. Magnified view of two dark brown fungus-particles, taken from the Bellary specimen described at pp. 6 and 72. There is evidently a close similarity in general characters to the ordinary black particles, as shown in fig. 2; and there is seen a striated and radiated appearance in the interior of these bodies which is comparable to that commonly existing, as indicated in fig. 3. Two bundles of fat-crystals are shown, beneath these coloured particles, with which they were found.

b. The minute structure of these bodies. There is a distinct arrangement of filaments, but the vegetable or cellular beaded nature of the latter was not evident. It is supposed that these particles were *Sclerotia*, which had undergone a degenerative change, and had lost their primitive cellular composition. A comparison of their present structure is, however, possible, with that shown at fig. 4, *d*, as belonging to the ordinary black particle.

PLATE IX.

Fig. 1.



Fig. 2.



Fig. 4.



a



b



c



d

Fig. 5.

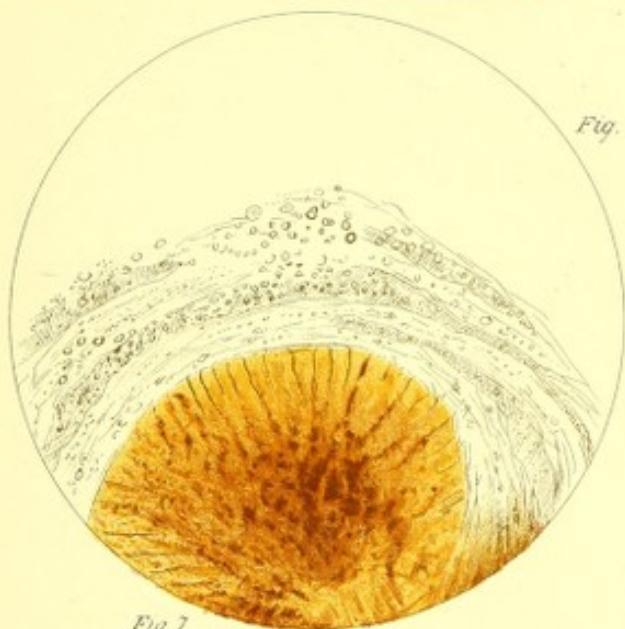


Fig. 3.



Fig. 7.



b

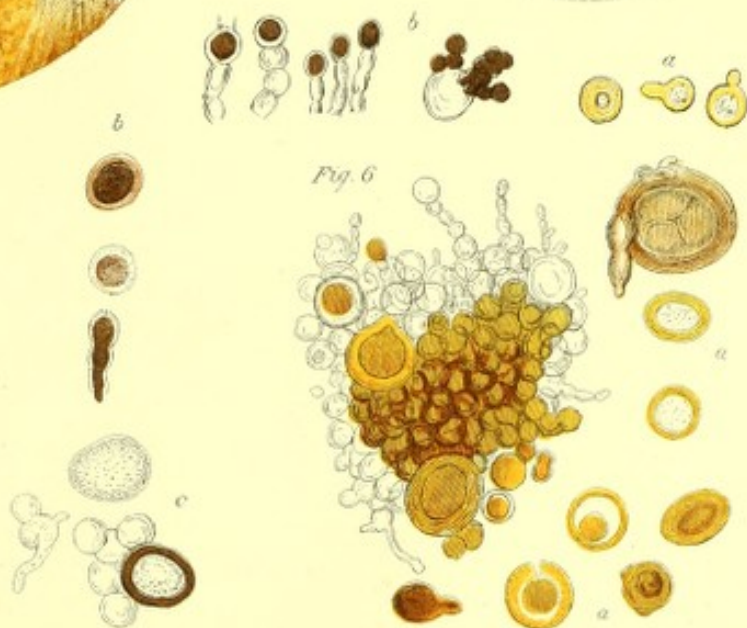


Fig. 6.

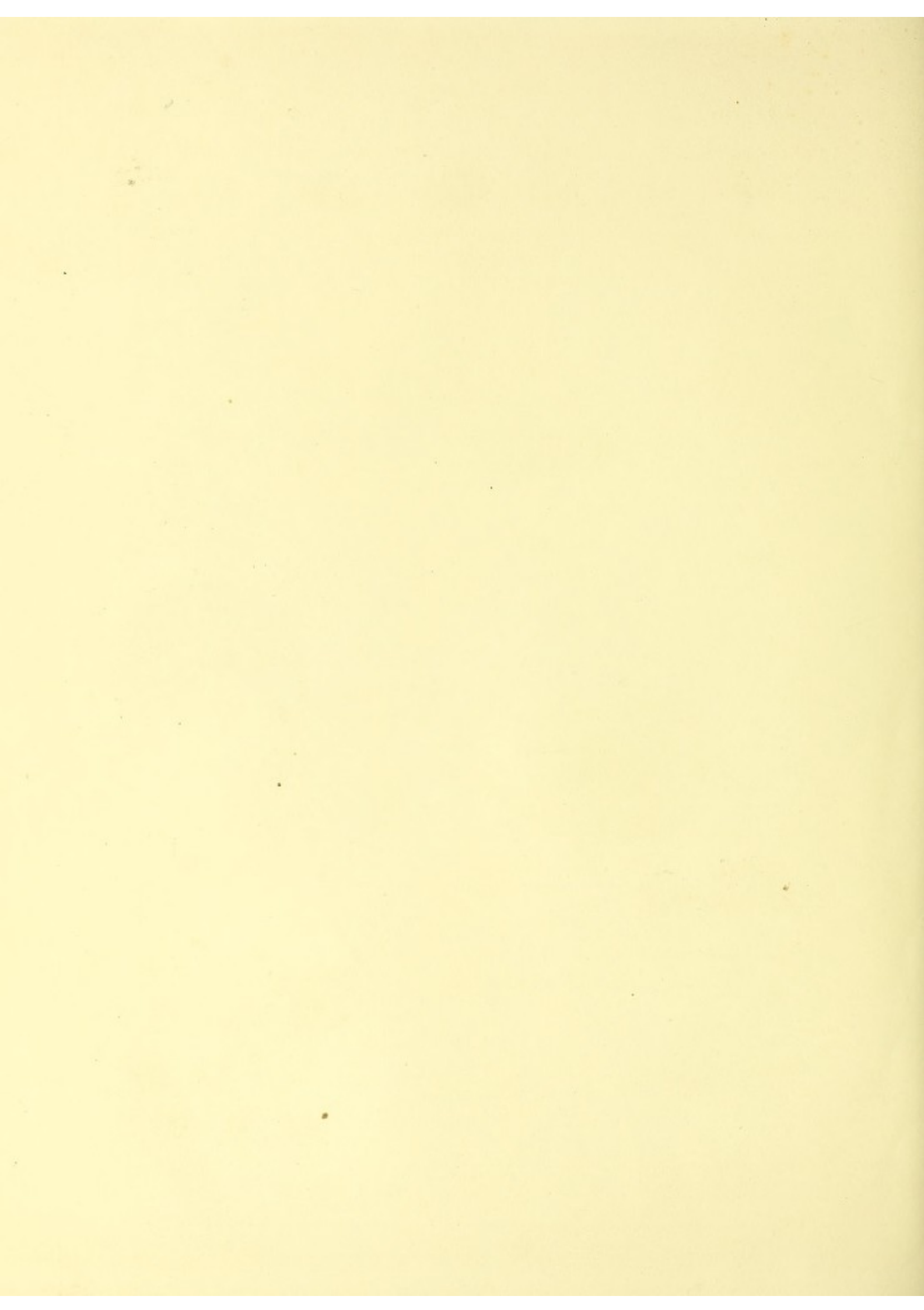


PLATE X

Illustrations of the minute structure of the fungus-particles (*Malacotia*), belonging to the pale (*Ochroid*) variety of *Mycetoma*.

FIG. 1.—The true fungus-elements found in the case of the woman described at page 8; for description see page 73.

- a. Natural size of the particles.
- b. Particles as seen magnified by aid of a lens; their normal colour, and their tuberculated exterior are here shown.
- c. An entire smaller particle, as seen with $\frac{1}{2}$ -inch objective. Its true cellular character is apparent.
- d. Free surface of the same, as seen under a higher power ($\times 250$ diameters). The luxuriant growth and multiplication of the component cells is clearly seen; no other structures but these exist. Some of the beaded filaments have a dilated extremity, but sporangia had not formed; nor were conidia seen to be detached. At the lower part of the circle is shown the structure of the filaments described in the text, at page 73, as being present in the gelatinous matrix holding the fungus-particles, in the foot. The relation of these filaments to the particles was not made out.
- e. Contents of the fluid discharged from openings in the foot. Besides pus-cells, blood-corpuscles, and granule-masses, there were seen the small collections of fungus-growth shown in the figure. Sometimes the beaded fibres were large and distinct; at others, smaller filaments were seen, shown to the right and below. $\times 300$ diameters.
- f. One of some particles, occasionally detected. They were opaque in parts corresponding to the nucleus or centre, and to certain rays passing off in a radiating manner. It seemed to me that the dark globular centre corresponded to the body of an ordinary *malacotium*; whilst the incipient rays would form its crystalline envelope; and that there was here a transition from these distinctly cellular bodies, to the more obscure ones, which are commonly found.

FIG. 2.—The pink particles found in the specimen from Madura. See page 9.

- a. Natural size and appearance of the particles.
- b. Particles as seen with a power of 200 diameters. Their varying size, form, and construction are here shown. For description, see page 74.
- c. A particle of different colour. It had burst open in the manner shown; and the finely-granular interior was then seen; the same appearance was present in other specimens.
- d. Globules of oil, of varying sizes; they partake of the pink hue, and give rise to the general tint.
- e. Collections of fat-crystals.
- f. A globe *épidermique* found amongst the pink particles; there were, besides, several masses of epithelial scales, of great delicacy.

FIG. 3.—Fungus-particles (*malacotia*) of the kind commonly met with. For full descriptions, see page 74.

- a. Natural size and appearance of these bodies.
- b. A small collection of them, still in apposition, and retaining part of their crystalline fringe. The larger, compact aggregations, which have been compared to the 'ova of fishes,' to 'poppy-seeds,' &c., have a similar general arrangement of the particles and fringes. Taken from a perfectly fresh specimen just removed from the foot. $\times 200$ diameters.
- c. An ideal particle, but founded on fact. In the centre is the essential element—the *malacotium*—of globular form and tinted hue; and surrounding it, on all sides, is the crystalline envelope, which is regarded as being composed of the more solid fat-principles. At * is one of these fatty corpuscles of a complicated character.
- d. One of the particles taken from the Bhoj specimen, described at page 9, and here represented as showing certain peculiarities. The interior of the compressed mass is seen to contain several ovoid bodies, which had a certain resemblance to spores, or secondary cells, but which were, probably, globules of oil; and the crystalline envelope was here of more complicated construction than usual. $\times 250$ diameters. See page 76.
- e. The appearance of a 'malacotium,' as viewed with a power of 700 diameters. The specimen had been preserved in dilute alcohol.
- f. A portion of the same, more highly magnified.

FIG. 4.—Structure of the membrane investing the black particles and lining the canals; as seen in the specimen from Bhoj, described at page 4. There are—1, a fibrillated structure; 2, myriads of cells or nuclei; 3, tubes filled with cells or nuclei; but these latter are not shown in the original figure.

FIG. 5.—Structures found adherent to, or imbedded in the above membrane. It would seem as if the growth of a mycelium had commenced in this instance; see page 70. $\times 200$ diameters.

FIG. 6.—The structure and arrangement of the 'pink stains,' which are supposed to indicate an incipient stage of growth of the fungus-particles. See page 78.

a. From the skin of the said specimen (melanoid variety, Case 3, page 4). The appearance is as if some natural tubes or ducts had become filled with coloured granules; an isolated, spheroidal group is seen, the individual particles forming which had a diameter of $\frac{1}{20000}$ — $\frac{1}{20000}$ in.

b. Other pink stains in the skin. Collections of coloured granules are seen, which are probably 'zooglæa-forms' appertaining to the early stage of the parasitic growth.

c. From the same foot. Here are various structures, described in the text, which seem to indicate stages in the development of the fungus-particles.

FIG. 7.—Other like structures from a specimen of the Ochroid variety of *Mycetoma*; that, namely, from Bhoj. See page 80.

- a. Bodies found free, in a section made near the toes.
- b. Another 'zooglæa-mass' from the same part.
- c. A still larger similar collection.

FIG. 8.—Bodies seen in the substance of the skin, in a perfectly fresh specimen of the pale variety of *Mycetoma*, (Case 4, page 10) + acetic acid + glycerine. Some of them were seen in close contact with the sweat-ducts, but not, to all appearance, within them. They were arranged in streaks, not unlike those seen elsewhere.

FIG. 9.—Bodies taken from the same specimen; they were found alongside a tendon, in its sheath.

FIG. 10.—Structures seen near the aperture of a canal (Bhoj specimen, second variety). They seem to indicate the mode of origin of the soft, pale particles; commencing at the right hand and proceeding towards the left, the gradual transition of forms may be seen, which intervene between bodies like those found in the skin, and the mature *malacotium*.

Fig. 1. a

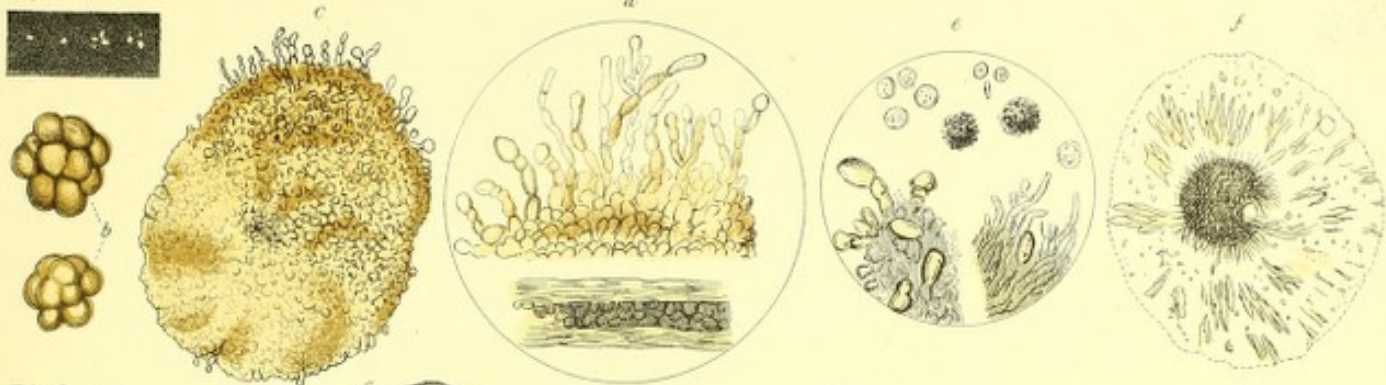


Fig. 2. a

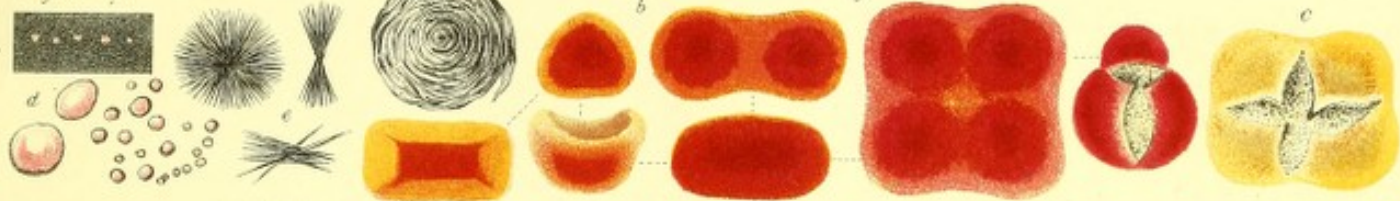


Fig. 3.

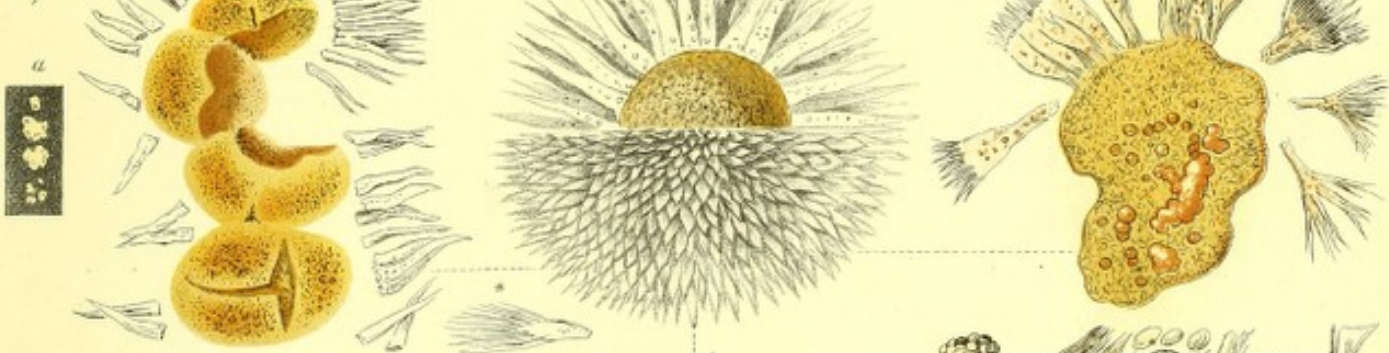


Fig. 4.

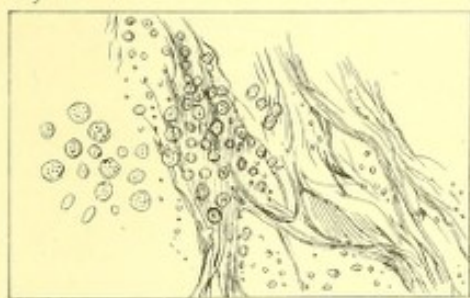


Fig. 5.



Fig. 10.



Fig. 8.



Fig. 9.

PLATE XI

SPONTANEOUS AND ARTIFICIAL DEVELOPMENT OF CHIONYPHE CARTERI, Berk.

FIG. 1.—Appearance and structure of the crimson mould as it occurred spontaneously upon a specimen of *Mycetoma*. See page 87.

- a. Natural appearance of the red mould, at its free surface.
- b. The same surface seen through a lens, showing its finely tuberculated aspect.
- c. Vertical section of the thicker part of the growth: natural size.

d. Constituent parts of the deep-tinted, flocculent superficies of the new growth $\times 200$ diameters. Here are seen *spore-capsules* of spherical shape, and of varying size; some are coloured, the others colourless; and stages in the growth of both forms seem to be represented in vesicles either tinted or clear, also here present. Dimensions of the larger coloured sporangia $\frac{1}{1000}$ in.: of the larger, colourless ones, $\frac{1}{1000}$ in. The vesicles vary in size. One of the sporangia having burst, a number of *spores* are set free; these are of oval form, and measure $\frac{1}{1000}$ by $\frac{1}{1000}$ in. The *mycelium-fibres* are also of different appearance: the more delicate colourless ones are no larger than $\frac{1}{1000}$ to $\frac{1}{1000}$ in. diam.; the coloured, and jointed ones, measure $\frac{1}{1000}$ in. Stages in the formation of these fibres are also seen. There are numerous granules and some irregular masses of pigment.

e. Structure of the great mass of the growth: friable, buff-coloured, and tearing longitudinally (like the stalk of a mushroom). Here the *vesicular fruit* is seen in its normal stalked position: there is apparently no *columnella* projecting into the capsule. Stages in the development of the sporangia are seen. There is no sign of fructification by conidia-bearers. The *mycelium-fibres* are shown in different states of growth and size: one of them presents the beaded appearance with a particle, or nucleus, near to the joint, which was observed in the *sclerotia* (Plate IX, fig. c), and has been more particularly described by Berkeley.

f. Structure of the subjacent, pale, tough material; also friable, however, and readily tearing up in all directions. It consists of *mycelium-fibres* of varying appearance, of free globules, of sprouting spores, and of pigment masses.

g. A diagram of the foot upon which the new mould appeared, to show the appearance, position, &c., of the latter. At * is the spot whence the specimen of the growth above described was taken. The foot is that of the woman whose case is described at page 8.

FIG. 2.—View of the appearances presented by one of the pale fungus-particles, taken from the foot of the young man whose case is described at page 10. Water only has been added. $\times 200$ diameters. To show certain very delicate filaments, too small to be measured, branching and curved, and looking like strings of oscillatoria, but not moving and seen immediately after amputation. They are not like the fine crystalline fringe, which generally assumes a straight, parallel, or radiated disposition. Some were free, and others appeared to be connected with the animal cells. As these filaments were more abundant on the second day than the first, it may be supposed that they are the result of decay: they persist after the addition of the strongest re-agents. (Author's notes).

* The *malacotium*, whence these new growths proceeded. See text, page 91.

FIG. 3.—Sketch from my note-book of *Chionyphe Carteri*, as it seemed to arise out of the interior of a malacotiid particle,* which had been sown in rice. The experiment is described at page 91. Growth has proceeded so far that vesicles were appearing at the ends of the mycelium-fibres: the pink tint was obvious.

I would repeat that the 'red mould' has here been called 'Chionyphe,' not altogether from the characters shown in my early illustrations; but, as well, from Berkeley's identification, based upon specimens he had himself examined. There is no doubt, however, that these figures accord with such identification, so far as they are illustrative of a specific form; and for other pictorial details, recourse should be had to the sources mentioned in the 'Appendix,' page 110.

Fig. 1.



Fig. 2.

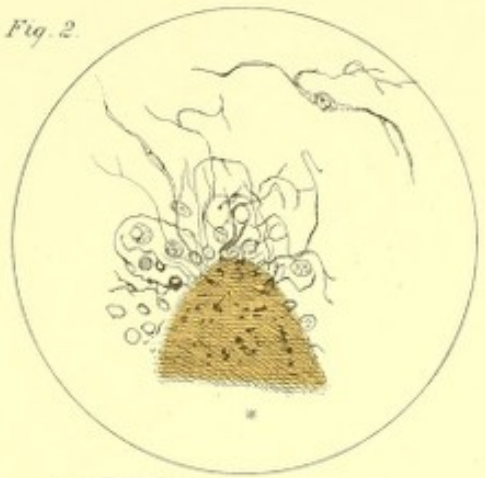
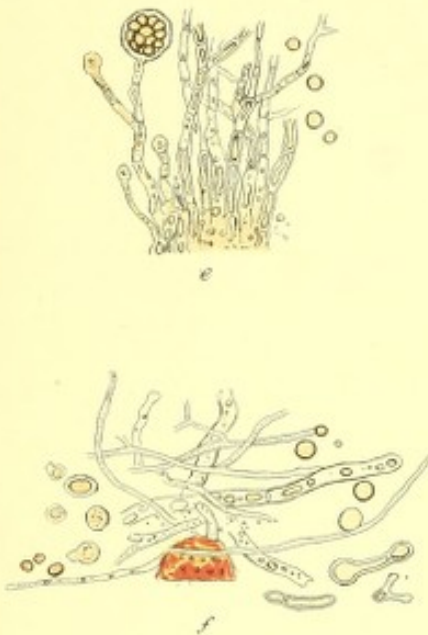
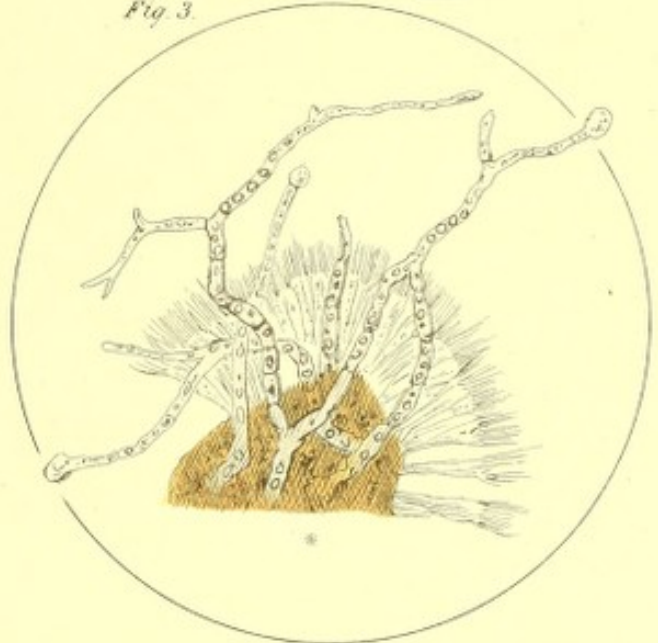


Fig. 3.



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