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THE
ELEMENTS
OF
MATERIA MEDICA;

COMPREHENDING
THE NATURAL HISTORY, PREPARATION, PROPERTIES,
COMPOSITION, EFFECTS, AND USES
OF
MEDICINES.

PART II.

CONTAINING
THE VEGETABLE AND ANIMAL MATERIA MEDICA.

BY
JONATHAN PEREIRA, F.R.S. & L.S.

MEMBER OF THE ROYAL COLLEGE OF SURGEONS;
FELLOW OF THE ROYAL MEDICAL AND CHIRURGICAL SOCIETY;
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LECTURER IN THE MEDICAL SCHOOL OF THE LONDON HOSPITAL.

LONDON:
LONGMAN, ORME, BROWN, GREEN, AND LONGMANS.

1840.

LETTER NO. 10

TO THE HONORABLE SENATE OF THE UNITED STATES

IN SENATE, JANUARY 18, 1871.

REPORT OF THE

COMMISSIONERS OF THE LAND OFFICE

IN RESPONSE TO A RESOLUTION PASSED BY THE SENATE

ON JANUARY 18, 1870.

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ACTINOMYKOSIS :

A NEW INFECTIOUS DISEASE OF ANIMALS AND MANKIND.*

BY GEORGE FLEMING, F.R.C.V.S.,

Army Veterinary Inspector.

THE progress of pathological research is continually demonstrating the mighty part played by microscopic vegetable organisms in the production of disease in plants and animals, generally leading to their destruction, and with more or less rapidity. The feeblest and smallest, as well as the largest and most powerful, are alike exposed to the ravages of these invading, relentless foes, whose attack is all the more destructive because it nearly *can* always cannot be detected at its onset; and their extreme *rarely* minuteness and tenuity, as well as their insidious and obscure manner of operating, are also so many barriers to timely recognition and protective measures against their assaults.

The immense destruction caused by minute parasitic fungi upon cereal and other useful plants, is only too often experienced by agriculturists and others. The mildew of the wheat, for instance, arises from the attack of a small fungus—the *Puccinia graminis*. When this little pest becomes multiplied to a great extent, it gives rise to most serious consequences. The disease called "Smut," attacking the flower of the wheat, is the produce of a minute parasite—the *Uredo segetum*; while the "Bunt," or disease involving the seed itself, is caused by another parasitic microscopical fungus—the *Uredo foetida*—which, as soon as it

* A portion of this paper was read, and morbid specimens, drawings, and microscopical preparations exhibited, at the meeting of the Southern Counties Veterinary Medical Association, on October 30th, 1882.

enters the grain, completely fills it, and replaces the flour by a black, disgusting, fetid powder, consisting of minute balls, four millions of which may exist in a single grain. The disease which attacks rye and other grain, called "Ergot" or "Cock's-spur," is produced by a like minute fungus—the *Spermædia clavus*; that attacking the potato—the *Botrytis infestus*; that destroying the different species of *Allium*, as the onion—*Botrytis destructor*; and many other destroying fungi, whose existence in plants can only be realised by their ravages, and their presence by means of the microscope, are known to those who have made them a special study.

The lowest, as well as the highest animals, are similarly the victims of these almost impalpable organisms. There is not a creature, probably, which may not afford scope for their baneful action. The disease called "Muscardine," in the silkworm, is produced by the "balsoma" or *Botrytis Bassiana*, and several species of caterpillars are affected in the same way; indeed, some of these fungi of caterpillars completely transform the bodies of these into their own substance. Then we have the fungi which grow upon or within the bodies of man and wild and domesticated animals, and cause troublesome, very often serious, and only too frequently fatal disorders. The wonderful revelations which have been made by means of the microscope, lead us to believe that those diseases which are included in the group designated "zymotic," owe their production to vegetable germs; and other maladies not comprised in this class have already been discovered to be due to these microphytes—for instance, Anthrax, Tuberculosis, Swine-plague, Rabies, Fowl-cholera, Leprosy, etc.

Yearly the list of diseases evidently due to *Microbes*, or "germs"—as they are commonly designated—is added to; and whether these germs consist of simple forms, such as special *Micrococci* or *Bacilli*, or more complex organisms, yet by culture and inoculation-experiments their part in the pathogenesis of certain maladies can be no longer doubted.

Whether these fungi invade plants or animals—whether they attack the simplest or the most complex organisations—the tendency of their action is always the same—degeneration and disintegration.

The object of this paper is to bring to notice another addition to the list of microphytes which prove to be veritable scourges to animals, and are productive of loss to the community.

For the last two years, the pages of the VETERINARY JOURNAL have been more or less occupied with the descriptions and discussion of a disease chiefly affecting bovine animals, more particularly those of a juvenile age, and which has been by the majority of writers designated "Tubercular Stomatitis," evidently from the character of the lesions and its chiefly affecting the mouth; while by a few it has received other designations, and its tubercular nature has been denied.

The same malady has received some attention at other times among veterinary surgeons in this country, but nothing has been published as to its pathology.*

Though it is probable that two or more diseases have been included in this discussion, yet with regard to that which received the before-mentioned designation, there were some veterinary surgeons—myself included—who, for several reasons, were inclined to doubt its being allied to, or identical with, Tuberculosis; and as the question was one of some importance, from a sanitary and pathological point of view, an attempt was made to decide it by appealing to those practitioners who had the opportunity, to forward specimens of the disease to the Brown Institution for examination.

Several members of the profession obligingly complied with the request; but the only specimen which arrived in a satisfactory condition was the tongue of a steer forwarded in May last, by Mr. James, M.R.C.V.S., Thornbury, Gloucestershire. The animal from which the organ had been obtained was, as Mr. James subsequently informed me, one of five affected with this so-called Tubercular Stomatitis, the others having been successfully

* There are a few notes on what may have been this malady, by Professor Axe, in the *Veterinarian* for 1877, pp. 605, 759, but they are merely quotations, and throw no light whatever on the disease. Up to the present time, the views entertained with regard to it are fairly represented in the opinion of the late Professor of Cattle Pathology at the Royal Veterinary College, who, in the course of some remarks on what would appear to have been a case of this affection, and which was designated "Schirrus Tongue," states that "the causes of Schirrus are obscure, but they are evidently of a constitutional nature, as the disease is generally insidious in its attack, gradual in its development, and fatal in its consequences."

submitted to surgical treatment. The steer had not received much attention—the tongue having only been dressed a few times—as it was a two-year old animal, and the owner thought he would rather have it slaughtered before it lost condition.

The tongue was in good preservation when it reached the Brown Institution, and when I saw it an examination had been made of it by Dr. Roy, director of, and Mr. Garside, M.R.C.V.S., then veterinary surgeon to, that valuable establishment. The appearance of the organ was somewhat curious and very unusual, and it was evident—almost at a glance—that it was affected with something very different to Tuberculosis. In the first place, it appeared to be considerably increased in size, and in texture it was very dense; indeed, the term rigid might have been appropriately applied to it. A transverse section through its middle third exhibited the muscular tissue pale in colour, its fibres indistinct, and looking as if undergoing degeneration; while interspersed closely throughout the entire mass were myriads of small, light yellow, dense nodules, rather firm in consistence, for the most part perfectly distinct from each other, and varying in size from the dimensions of a pin's head to that of a millet seed or filbert. Here and there two or more of these nodules had evidently coalesced to form larger masses, and the section already mentioned had been made through a somewhat extensive patch, which looked as if in process of softening, and the tissues immediately surrounding it were ulcerating. This softening mass, which was somewhat caseous, might have been mistaken for tuberculous deposit; but to those who are familiar with the lesions of Tuberculosis, it would have been scarcely possible to make such a mistake in this instance, after a careful inspection of sections in different parts of the organ.

Mr. Garside had made the following notes with regard to it :

“The tongue weighed eleven pounds (5994 grammes). About seven inches from the tip it becomes suddenly enlarged. The enlargement extends to the fauces, and is hard and firm to the touch, resembling cartilage in consistence. Length 8 inches, depth 5 inches. The surface shows variously-sized ulcerations, not very deep, and looking as if punched out. In some parts the mucous membrane is purple in colour, mottled by the

presence of still darker spots, which look like blood extravasations. The thickening does not feel nodular, but uniform; and it is evident that the mucous membrane is thickened by infiltration of the submucous tissue. On making a longitudinal section of the enlargement, it is seen to be pale in colour, inclining to a yellowish-red. Scattered throughout are a number of nodules, varying in size from that of a pin's head to a hazel nut. Some are isolated, others in groups of two and three. They project above the cut surface. They are white in colour, and their margins are generally well-defined. In some instances they are surrounded by a capsule of connective tissue. Although present throughout the whole of the section, they are far more numerous towards the surface of the tongue, being contained within a zone of an inch and a-half from the surface. They are of all shapes, but the smaller ones are mostly round. The nodules are also contained in the submucous tissues.

"In addition to these projecting nodules, are a number of variously-sized white patches, generally streaky, which look like hypertrophied intermuscular connective tissue. The nodules are also scattered throughout the muscular tissue. On the under surface of the tip of the tongue, there is seen through the mucous membrane a patch made up of yellowish nodules."

Mr. Garside's microscopical examination of the nodules at first led him to consider them crystals—a mistake easily made.

If the disease affecting this tongue was not Tuberculosis, then the question arose, What was it? Mr. James, who had sent the specimen, had in his communications to the *VETERINARY JOURNAL*, spoken of it as a somewhat common, and certainly a very serious malady in his district, among calves and young bovine stock, though adult animals did not escape its ravages. It was, therefore, of great moment to discover its nature.

As I have already said, Mr. Garside, from the density of the nodules, at first thought they were crystals, and calcareous in composition, and accordingly tested them with acids, but he concluded they were not composed of lime salts.

With much care, and after the exercise of a considerable amount of patience, it was subsequently found by Dr. Roy and Mr. Garside that the nodules were found to offer a definite

structure under the microscope, and when the higher magnifying powers of the instrument were employed, the presence of a peculiar minute fungus was detected, the mycelium developing, or being arranged in, a novel manner, each nodule being mainly constituted by a cluster or conglomeration of fungi or fungus elements, differing in arrangement and appearance from anything hitherto noted among entophytes infesting animals.

This was recognised as the *Actinomyces*, a fungus which has been discovered in certain morbid conditions of mankind and animals in Germany and Italy.

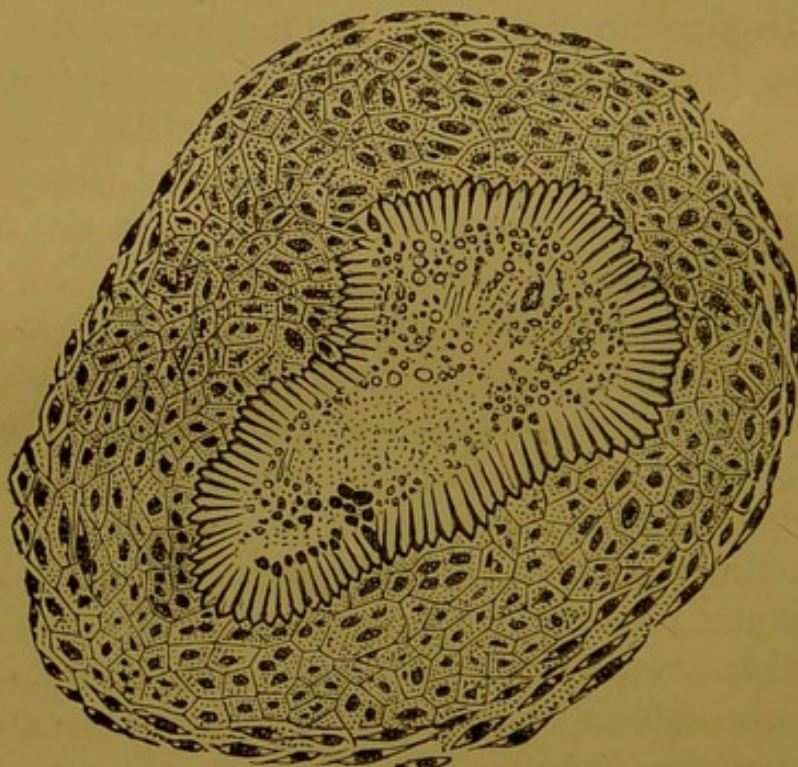


FIG. 1.—A cluster of *Actinomyces* tufts in the centre of a stratum of cells.
From a nodule in the cow's tongue.

It now dawned upon me that we had to do with a particular disease, the pathology of which has only been elucidated within a few years, and which is referred to in the *VETERINARY JOURNAL* for January (p. 60, *Sarcoma in Oxen*) and April (p. 256, *A New Vegetable Parasite causing Disease in Cattle*), 1879.

Mr. James has quite recently, at my earnest solicitation, forwarded three additional specimens of the disease—portions of two heads, and a tongue. I shall notice the former first, as they are the most interesting and important, and give the clinical history of the cases, for which I am also indebted to Mr. James.

The specimens were two bovines—a steer and a heifer—each about a year and a-half old. The heifer was first attacked about three months before. The symptoms were: swelling of the upper lip and nose, and the appearance of a “red place” about two or three inches from the anterior nares—this place resembling a *boil* on the human skin. Some dressing was sent, and this was applied two or three times a-week. Mr. James did not see the animal again for two or three weeks, when he was requested to inspect it again, as it was very much worse. He found the upper lip much more tumefied and very hard, and the disease extending up the nasal chambers, the little masses or “tubercles” being very characteristic. On his next visit he observed that the disorder had been checked, and it was kept in this condition for about a month. It then began to extend again, and all efforts to overcome it were fruitless. Dressings appeared to have no effect on it, and there was great difficulty experienced in properly syringing the nasal cavities. From this time the malady continued to gain ground, the growths developing so rapidly as almost to fill the nostrils. The animal was greatly distressed in breathing, throwing up its nose, and snorting and roaring in its efforts to respire. It was destroyed. Neither mouth or tongue was involved in this case.

A few weeks after the heifer became affected, the farmer requested Mr. James to see a steer as quickly as possible, as it had the same disease, and he was afraid his other stock would be involved, particularly the milch cows, in the “distemper.” On examination, Mr. James discovered the roof of the mouth to be the seat of the malady, the greater part of it being “abraded.” The nose did not appear to be implicated then, nor for some time afterwards. The disease yielded to treatment, and rapid progress was made towards recovery. But soon it attacked the upper lip and nose, precisely as in the other case, though not so seriously. This animal was killed at the same time as the heifer, the owner being afraid his cows would catch it.

These animals, with several more, had been sent away from the home farm to graze on some poor undrained land. The specimens, when they arrived in London, were found to have been much mutilated by the butcher. The nasal bones

had been removed from one head, and only the superior maxilla, pre-maxilla, turbinated, ethmoid, and palatine bones remained. The mucous membrane lining the nasal fossæ and covering the turbinated bones, was studded by various-sized, light-yellow, isolated little masses, like warts or small raspberries in outline. During life these nodular-looking bodies must have greatly obstructed the breathing. The only portions of the other head sent for inspection were the nose and the upper lip. The latter was much thickened and indurated, and small shot-like masses could be felt through the mucous membrane lining it.

The tongue specimen was from a two-year old steer. The anterior part of the organ, to an extent of five or six inches, was extremely indurated, and numbers of the yellow nodules, small in size, were scattered through the submucous and muscular tissues. This case was a very mild one of the disease.

A microscopical examination of the nodules from the mucous membrane of the nose, by Mr. Batt, M.R.C.V.S., of the Brown Institution, revealed the existence of myriads of the vegetable organism designated *Actinomyces*, each nodule or mass being made up of a number of smaller nodules, these individually containing nests of felted fungi. Each cluster of the *Actinomyces* had the characteristic daisy-like outline and radiating lines springing from a somewhat dark centre, which will be hereafter alluded to, and which was such a marked feature in the specimens found in the first-described tongue.

These specimens, then, exhibited the same characteristic fungus elements and pathological features as the tongue, and leave no doubt whatever as to the nature of the malady which is reported to be so widely prevalent in Gloucestershire, and, from report, in other parts of England, as well as in Scotland and Ireland, and prove its non-identity with Tuberculosis.

The great importance and interest which attaches to this disease, have, therefore, induced me to bring it to the notice of the veterinary and medical professions in this country, as its nature has not hitherto been suspected, though by various names it has probably been known as a destructive disorder among cattle and other animals from time immemorial; and though its presence has not hitherto been signalled in our own species in these

islands, yet that it may not unfrequently occur there is every reason to believe, when we now know how prevalent it is among our cattle, and that cases affecting mankind have been recorded in Continental medical literature.

HISTORY.

As already stated, so far as the pathology of this malady is concerned, it is a new disease, as until its histological characters were discovered, we were in ignorance of its nature. For a very long period, and especially in Germany, it had been observed that the ox tribe was affected with a certain disease, or diseases, of the bones and soft tissues of the head, which received various popular names by agriculturists and dairy people, whose cattle were so frequently victims to it. In Germany the disease of the bones was known as "Ladendruck," "Ladengeschwulst," "Dicker backen," "Krebsbacken," "Bäkel," "Kimbeule," "Kiefergeschwulst," "Knochenkrebs," "Knockenwurm," "Winddorn," etc.; while when the tongue or other soft tissues in the mouth were specially involved, the terms "Holzzunge" (wooden tongue), "Hohlgeschwulste," "Schlundbeulen," "Wurm," etc., were applied.

Among veterinarians in Germany, the disease of the bones was looked upon as Osteosarcoma, Spina Ventosa, bone Tuberculosis, Osteoporosis, Hyperostosis, etc., while the tongue affection was supposed to be Tuberculosis, chronic interstitial Glossitis, tongue degeneration, Sarcomatosis, etc., the affection in other soft tissues being considered either as lymphomatous, fibromatous, scrofulous, or scrofulo-tuberculous.

In Italy, where the disease appears to be very prevalent, especially in the plains of Ferrara and in the Maremme of Tuscany, it was popularly considered to be a kind of Glanders and Farcy of bovines, sometimes looked upon as tuberculous, and when affecting the tongue was named the *Mal del rospo* (*rospo*—toad), *Trutta* (thrush), or Tuberculosis of the tongue.

In this country, as already remarked, the disease undoubtedly exists, and in all probability widely and frequently; though its pathology has not hitherto been ascertained. Under the designation of Scrofula, Tuberculosis, Tubercular Stomatitis, Miliary Tubercle, Schirrus tongue, Glossitis, Osteosarcoma, Osteoporosis, and many other names, there is every reason to think that this

disease has been included in the descriptions of these various affections.

In 1877, Bollinger* drew attention to a disease of cattle which, he asserted, was not unfrequent among them, and which consisted in a kind of new-formation tumour, that appeared on the upper or lower jaw, in the alveoli of the molar teeth, or sprang from the spongy tissue of the bones, displaced the teeth, and in growing invaded and destroyed the healthy tissues,—bones, muscles, mucous membrane and skin, appearing externally, or in the mouth or palatine sinus. The bones, when macerated, looked like pumice-stone, modified through central osteoporosis and external hyperostosis. After some time the round, conglomerate, luxuriant growths generally became puriform or ichorous, and ulcerated, producing abscesses and fistulæ, and sometimes increased to the size of a child's head. The progress of the disease was gradual, and interfered with mastication when it had advanced to a certain stage; this led to emaciation, and to prevent loss from this cause the owners of the cattle generally had them destroyed before this stage was reached. In examining fresh tumours, Bollinger discovered (in three cases) amongst the dense connective tissue, conglomerate masses or nodules of various sizes, from that of a walnut to a hen's egg, of soft consistence, pale yellow colour, and moist appearance, which on section showed a turbid, whitish-yellow puriform contents; or the nodules were of a spongy texture, in the fine stroma of which were numerous spaces about the dimensions of a hemp-seed, containing a dull-yellow, thick, or cheesy-like substance. In scraping a section of an old or young nodule, this substance was easily removed. Microscopically, the tumours appeared to be composed for the greater part of old or embryo granulation tissue, which had a kind of sarcomatous structure, while the cheesy substance consisted of pus-corpuscles, granulation and granular cells, as well as fatty granular *detritus*; in addition, the latter contained innumerable, various-sized bodies, which were opaque, of a faint yellow tint, often somewhat mulberry-shaped in outline, and here and there encrusted with lime salts. This was recognised as a real fungus, but at first

* References will be found at the end of this paper, when treating of the literature of the subject.

no pathological importance was attached to its presence, and the disease was simply named "jaw-osteosarcoma."

Besides this noteworthy form, which appeared to have its origin in the invasion of the alveoli by the fungus, the tongue of the ox presented another form, proper to itself. Imbedded in the parenchyma of the organ, Bollinger found a greater or lesser number of nodular-looking bodies, the majority of which were as large as a millet or hemp-seed, and some as big as a cherry or walnut; many stood prominently from the surface of the mucous membrane. When fresh, they were mostly white or greyish-white, diaphanous, moist-looking, very soon becoming turbid or undergoing puriform softening, and vacating their connective tissue capsule. When these nodules were on the upper surface of the tongue, destruction of the mucous membrane, erosion, ulceration, and cicatrization took place; while in the parenchyma of the tongue, a secondary interstitial Glossitis became developed, when there was partial atrophy of the muscular fasciculi, and a marked enlargement and wood-like induration of the organ.

The disease, when in the jaws, was not uncommon in old cattle, developing itself in a few weeks, and was nearly always incurable; the animals would survive for a month, or even a year, until the difficulty of eating, because of the diseased jaw or enlarged tongue, produced emaciation and debility, and the animal was slaughtered. In the nodules of the tongue, as in the jaw, the microscopical fungus was constantly present.* That the tongue disease was not rare, was evidenced by the fact that in one year Bollinger had no fewer than six specimens sent to him from various parts of Bavaria; while in five preparations he had in spirit, he found the fungus. He not only discovered this fungus in the centre of the nodules, but also in the sub-maxillary lymphatic glands of the tongue, as well as in the tracheal lymphatic glands. He found these glands greatly enlarged, and studded with grey and dull-yellowish spongy nodules, in the interior of which he found immense numbers of the fungus. The fungus was likewise discovered in a series of new-formation tumours which cows are very liable to, in the

* These organisms had been observed for several years (1870) by Professor Hahn, of the Munich Veterinary School, but he had not attached sufficient importance to them.

pharynx and larynx, as well as in the mucous membrane of the stomach. In the two former situations, these tumours appear as polypi and submucous new formations, and these had received such names as Lymphoma, Throat-tumour, Fibroma, Tuberculosis, Scrofula, etc.* In all these tumours (ten of which he had preserved in spirits of wine), the section was always more or less of a spongy character, and when the puriform or cheesy matter contained in the numerous small interspaces of their structure was examined microscopically, enormous quantities of the same endophyte were found as had been discovered in the jaw tumours and the so-called "Wooden-tongue."

Besides all these, in the tumours of cattle which the German farmers and dairymen named "Throat-boils" (*Schlundbeulen*), and which appear in the vicinity of the parotid gland, larynx, and pharynx, and apparently have some relationship to the jaw tumours, the same nodules and organisms are found; they may be derived from the lymphatic glands in their neighbourhood. In a case of supposed Fibroid in the second compartment of a cow's stomach, the tumour being about the size of a man's fist and of a spongy nature, the fungus was found by Bollinger; as well as at the base of a gastric ulcer which was mistakenly supposed to be of a tuberculous character.

In fixing upon this endophyte as the cause of the disease, through its destructive nature, and its tendency to produce new-formation growths (in this respect resembling the *Chionophye Carteri*, which causes the "Madura-foot" of the natives of India), Bollinger makes some remarks on the fungus, which had been carefully studied by the professor of botany at the Munich Veterinary School, Dr. Harz, who obtained it from fresh specimens. The fungus found in the tumours from cattle, form globular drussy tufts, from 0,11 millimetre in diameter. The majority of these tufts are aggregated in mulberry-shaped masses of from 0,5 to 1 millimetre in diameter, and appear to the unaided eye as very minute dull-white granules. Very frequently the tufts are somewhat calcareous, and then it is difficult to make out their composition; it is the same when they have

* Bollinger notes that in some parts of North Germany, five per cent. of the cattle are affected with these throat tumours.

become altered by lying for some time in alcohol. By a slight pressure made upon it, the fungus tuft is considerably altered in appearance, and mostly assumes the shape of a spheroidal segment, wherein some of the organisms can be distinctly traced throughout. The latter commence at the pointed end of the mass, with a somewhat cone-shaped base-cell, which may possibly represent the non-apparent mycelium, and which bears a large number of short-stalked hyphens. The end of the hyphen shows the Gonidiæ, which are, like the hyphen itself, polymorphous, and of an oval, globular, or elongated form. From the expanded end of the Gonidiæ are developed a number of young shoots or sprigs, and from each Gonidium arises an individual; so that a number of Gonidiæ together give rise to a mulberry-shaped colony; and this is the usual form in which the clusters of fungi appear, though sometimes here and there are found apparently stunted or abortive groups.

The fungus, in fact, is allied in many respects to the common green mould (*Penicillium glaucum*) which grows on jam, paste, damp leather, etc., and is therefore very far from being one of the lowest of the group to which it belongs. The individual plant, in reality, consists of a conical mass of branched filaments springing from a single cell, and bearing on their short terminal branchlets the spores or *Conidia*, by which the mould is produced.

From the radiating structure of this micro-entophyte, and its being found at first in the ox tribe, it was named *Actinomyces* (ἄκτις, a ray, μύκης, a mushroom or fungus) *bovis*. This, Bollinger asserted, was the first instance in which a fungus belonging to the class of moulds had been found in the interior of animal tissues, such as the bones. The designation of Actinomykosis (mykosis—μύκης, a fungus) was given to the disease, following the example of previous pathologists—such as Alibert, who applied the term mykosis to the affection in mankind known as *Frambæsia* (the *Molluscum contagiosum*, for instance, due to a vegetable parasite, and which he designated *Mycosis fungoides*).

Zippelius of Obernburg (Lower Franconia) informed Bollinger that, in the course of ten years, he had noted not fewer than 254 cases of Lymphoma in the vicinity of the larynx and pharynx, in addition to 157 cases of jaw tumours in cattle: and Bollinger

was of opinion that the majority of the first, and probably all of the second, were due to this fungus. Zippelius had also seen both forms of the disease in goats and swine, though much seldomer than in cattle. Veterinary literature also contained a number of cases of these tumours in goats and oxen; and Bollinger suspected that they would likewise be found to exist in sheep and other animals.

In other parts of Franconia, Professor Franck has found the tumours in the region of the throat so common, that among cattle owners, whenever an animal began to lose condition, it was said to have a "growth" (*gewächs*) in its throat. Even while Bollinger was writing his paper on the disease, he received a tumour from a veterinary surgeon in Pfalz, which was as large as a fist, and which he had removed from the pharynx of a two-year old bull.

For some time previously the animal could not eat, appeared to suffer great pain, coughed, and so rapidly lost condition that it had to be slaughtered. In the pharyngeal cavity this tumour was found just above the larynx. It was spongy in texture, and in the meshes of the fibrous framework was a puriform fluid containing the characteristic fungus in immense quantity. The spongy character of this granulation-tumour was so marked, that the unaided eye might have discovered its mykotic origin.

Bollinger's observations attracted much attention on the Continent, and as I have already stated, I gave a brief abstract of them in the VETERINARY JOURNAL for 1879 (Vol. VIII. p. 256), with the view of discovering whether the disease had been noticed in this country.

Their publication in Italy elicited the fact that Professor Rivolta, of the Turin Veterinary School, had already published a paper in the VETERINARY JOURNAL of that city, so long ago as 1868, on a sarcomato-fibrous tumour on the lower jaw of an ox; and after that date, in 1875, Professor Perroncito, of the Turin Veterinary School, had an article in the "Enciclopedia Agraria Italiana," on "The Osteosarcomata of the upper or lower jaws of cattle," in which he describes, among other microscopical objects found in the round and giant-cell sarcomata, cryptogamic bodies in conglomerations, which were made more distinctly visible by treating them with dilute hydrochloric acid, which dissolved the

lime salts surrounding them. According to Israel, Langenbeck, the famous German surgeon, had, years previously, described and delineated the fungus, which he found in the pus from a deep-seated vertebral abscess in a man in the hospital at Kiel; but some doubt is thrown upon the correctness of this statement.

In 1875, Rivolta undoubtedly described the structure of the nodules very accurately, and pointed out that the vegetable organisms were not crystals, but minute fungi, which were not soluble in water, alcohol, solutions of potass, or sulphuric or hydrochloric acids, etc.; the nodules were, in fact, discoid tufts (*cespugli discoidi*), composed of branching rods; these tufts were of unequal volume, and the nodules were the size of a poppy-seed.

In 1878, Siedamgrotzky, of the Dresden Veterinary School, furnished conclusive evidence of the correctness of Bollinger's descriptions and conclusions. In multiple sarcomata from the mucous-membrane of the pharynx of oxen, as well as a tumour from the lower jaw of a cow, obtained fresh, he found the *Actinomyces* described by Bollinger; but he was unsuccessful in cultivating it, or inoculating animals with it. In the same year, Israel published a case of what he designated "Chronic Pyæmia," occurring in man, in which the fungus was found, and its identity with that of the bovine species was subsequently established.

After this date, several German and Italian veterinarians record observations, all more or less interesting; while sixteen cases are reported by medical men in Germany. These I shall again refer to. In the meantime I will briefly sketch the symptoms of the disease, and mention the different situations and animals in which it has hitherto been observed.

Actinomykosis of the Tongue.

I have already stated that in this country, when the disease is present in the tongue, it is supposed to be Schirrus, Induration, Glossitis, Tuberculosis, Cancer, etc.* Doubtless, all these morbid

* For instance, in Steel's "Diseases of the Ox" (p. 234), in treating of Cancer of the tongue, it is stated: "In this disease the organ is the seat of small nodules of carcinomatous deposit, which more or less replace the proper substance of the organ, and some of them bulge beneath the mucous membrane of the dorsum. Some undergo softening, and the submaxillary and parotid lymphatic glands are generally involved through absorption of cancerous matter. This disease progresses slowly, and materially interferes

states may exist without the presence of the *Actinomyces*, but I think I may be pardoned, from the specimens forwarded from Gloucestershire and the cases reported, if I ascribe the majority of the instances which occur of disease in the tongue to this microphyte. In South Germany, where interstitial Glossitis or Induration is very frequently reported, nearly all those examined have proved to be cases of Actinomykosis. I have no doubt whatever that it is the same in this country. Take, for instance, the description given by Captain Russell, F.R.C.V.S., and we shall find Actinomykosis of the tongue graphically delineated.

He writes, when treating of Induration of the tongue in the ox—a disease very common in his practice in Lincolnshire: “I have observed that the disease commences with small patches of a yellow colour, associated with thickening of the mucous membrane, sometimes on the dorsal surface, sometimes on the tip, and at others underneath the tongue, or on one or other of its sides. This thickening, in the course of a short time, breaks up into a number of small pimple-like excrescences, which soon become confluent. As the disease spreads, a cheesy deposit is thrown off, leaving a very red and angry-looking surface. Subsequently, the organ becomes hard and swollen, and eventually hangs from the mouth perfectly useless. The animal quickly loses the power of prehension and deglutition, and if not destroyed usually succumbs to inanition. I do not find that either constitutional or local treatment is of any avail. Four years ago my attention was called to several cases, and this season I have seen as many as twenty. The progress of the malady is generally slow, the increase in size of the tongue being gradual; but as it progresses movement of the organ is diminished, and mastication is performed with corresponding difficulty. There are rarely any indications of severe inflammation noted, and this fact should differentiate the disease from Glossitis, as should also the absence of the acute pain which marks the latter. Discoloration may be present here and there; indeed, this usually precedes ulceration.”

with the development of the animal. It is incurable, and the flesh of cattle thus affected is not good meat, though always consumed. . . . Some authorities consider this disease scrofulous rather than a form of Carcinoma.”

These are the chief symptoms when the tongue is the seat of the disease. The pimple-like excrescences are often only the size of a pin's head or a millet-seed, but they are more frequently larger—from the size of a cherry to that of a walnut, or even greater. The inflammation (if any is present) and interstitial induration appear to proceed from the surface towards the centre, and the growth of the nodules takes place rapidly; and this is evidently proven from the circumstance attending their reappearance when they have been removed by operation. Mr. James has noticed this speedy reproduction, as in a letter to me he writes: "I am of opinion that most of the nodules or tubercles found in the substance of the tongue come to the surface at some time or other. For when treating such a tongue (as the one he first sent), we find sometimes that we have succeeded in curing the ulcers on the surface, but the next day or two we see a regular crop of ulcers and nodules on the surface again, and the poor animal protruding its tongue several inches from the mouth."

The appearance of the tongue, then, is characteristic of the affection, whether inspected while the animal is alive, or examined after death.

In the great majority of cases, there are perceived a more or less considerable number of prominences, on the dorsum most frequently, on one or both sides of the tongue, or over the whole of its surface; these look like nodules or tubercles, sometimes like warty excrescences flattened on the top, and vary in size from a millet-seed, a hemp-seed, or a pea, to that of a walnut; they may be single or in clusters. The tongue is enlarged, indurated, "lumpy," often more or less extensively ulcerated in one or more places; there is very considerable hypertrophy of the submucous and interstitial connective tissue; atrophy or degeneration, more or less marked, of the muscular tissue; and the peculiar yellowish-white round nodules disseminated singly, or in masses throughout, each containing a cluster, or at least a tuft of the *Actinomyces*. The gums, cheeks, palate or jaws may also be involved.

In addition to the description given of that first sent by Mr James, as well as the second specimen, I will select

that offered by Professor Putz,* veterinary teacher at the University of Halle, though many others might be given.

In February, 1882, Veterinary-Surgeon Enke sent to the clinic of the school, the tongue of a newly-slaughtered cow, which, for a long time—at least six months—had eaten very little. An examination of this tongue was carefully made, and it presented the following appearances :—Its posterior part was greatly swollen, and the dorsum extremely elevated ; its anterior portion appeared to be normal. About three inches behind the tip were a number of irregular, sharply-defined, warty-looking elevations, which were scattered over the entire upper surface of the organ backwards. They were in size from that of a linseed to a hen's egg, the largest having broken through the mucous membrane, while the smaller ones could be felt as little irregular masses beneath it. The former resembled large, oval, and very much flattened warts, deprived of their epithelium. Their colour was pale-yellow, and their consistence soft and elastic. The largest of these was on the right side of the tongue, and was flat ; it measured $4\frac{1}{2}$ centimetres long, 3 centimetres broad, and $2\frac{1}{2}$ centimetres high. Besides this growth, there were on the same side, towards the under part of the tongue, a great many nodules the size of a linseed, which could be felt beneath the mucous membrane. Large and small tumours of a similar character were found on the left side of the tongue. Above, on the arch of the dorsum, three large, well-defined cicatrices could be felt in the mucous membrane ; these had a red appearance, and on their upper surface small irregularities could be felt rising, as it were, from the connective tissue beneath. The central cicatrix was in the middle of the tongue, between the circumvallate papillæ ; the others were on each side, towards the margin of the tongue, the left being the largest—12·90 centimetres long, and 5·90 centimetres broad. In making a longitudinal section through the tongue, the tissues offered great resistance to the knife, and the cut surface exhibited an immense number of greyish and yellowish-white opaque nodules, imbedded in patches in the pale-red muscular tissue, many of them projecting

* Die Seuchen und Herdekrankheiten Unserer Hausthiere, Abtheilung 2, seite 599.

beyond the level ; their size was between that of a linseed and a florin. The largest of these patches was somewhat oval in form, and penetrated, in a stellate fashion, deeply into the tongue-substance, as if following the course of the muscular fibres. The upper surface of the section was moderately moist, and studded with a number of millet-sized yellow nodules. The apex of the tongue was the only part of the organ free from these bodies. The weight of the fresh tongue was 2,430 grammes (5 lbs. 7 oz.). All the other parts of the cow, according to Enke, were healthy. Microscopical examination of the new formations or nodules proved them to be composed of masses or tufts of the *Actinomyces*, between the tufts being an abundance of lime salts. The tissue of the tumours had a kind of sarcomatous appearance, but there could be no doubt whatever as to the nature of the disease.

*Actinomykosis of the Bones of the Jaws.**

I have already given Bollinger's description of the disease, as

* Gamgee (Dairy Stock) undoubtedly alludes to this affection, though he was unaware of its pathology. He writes : " In young cattle there is a somewhat frequent disease termed by some veterinary surgeons ' Osteo-sarcoma,' ' Spina-Ventosa,' and other inappropriate names. The only term I can give it is fibro-plastic degeneration of bone. There is no recognised cause of the disease. It occurs most readily from two to five or six years of age, and affects steers in preference to bulls ; the lower jaw is most frequently seized in the vicinity of the second or third molar teeth. Sometimes the upper jaw is implicated....At a spot on the side of the face corresponding to the roots of the third or fourth grinder, above or below, a small, hot, circumscribed swelling occurs. The animal experiences no inconvenience from it, except when the part is struck or pressed upon. The tumour, however, grows and pain increases. In some cases the growth is rapid, and in a few months the disease has invaded the larger part of one-half of the upper or lower jaw, and gives rise to severe symptoms, which arise chiefly from disturbed mastication, pain, and often from various cruel methods of treating the disease. The teeth become loose in their sockets, may be affected by caries, and drop out. Anacker says, that sometimes a fistula opens into the mouth. . . . It is evidently a morbid condition of the bony structure. On dissecting the skin off the tumour, we find it covered with tough, fibrous tissue arranged in layers. The fibrous element diminishes towards the deeper parts of the growth, where at various parts *yellow accumulations of a friable, cellular, or granular matter are enclosed in solid cavities*, surrounded by bony plates, or a tough gristly tissue. M. Collignon, veterinary inspector of the slaughter-house of Montmartre (Paris), has observed the disease three times in 300 oxen, and those he found affected came from the marshy plains of La Rochelle. In the plains of Ferrara, and in the Maremme of Tuscany, the disease is very frequent. Low-bred animals are most subject to it, and its origin is usually attributed to a blow."

it affects the bones of the jaws. Not unfrequently we have the tongue and jaw, or jaws, affected simultaneously or consecutively—generally the latter. The tumour which forms on or in the bone is apparently of a sarcomatous or fibro-sarcomatous character, according as the Actinomykosis is periosteal or myeloid. It often commences in the alveoli of the jaw, and thence extends into the mouth and the cancellated tissue of the bone, and is accompanied by abscesses and fistulæ. In this situation it has been observed in the ox, pig, goat, and dog.

Only one instance has been recorded in the dog—that by Professor Vachetta, of the Veterinary School at Pisa, and which was published this year under the heading of “Macrocellular Osteo-condro-sarcoma, with Actinomykosis.” About two months before the Professor saw the dog, a swelling appeared, without any assignable cause, on the posterior half of the right branch of the lower jaw, and rapidly increased in volume. In about twenty days the tense skin became ulcerated, mastication was difficult, and the animal was then brought to the clinic of the school. The ulceration of the skin was now somewhat extensive, and in the centre of this was a small hole, into which a probe could only be introduced two or three millimetres. The tumour was hard as a stone at the margin of the dental alveoli, but became softer towards the lower border of the jaw. With the exception of the ulceration, the skin was otherwise healthy in the neighbourhood. The tumour was not hot, neither did pressure upon it cause pain, but difficulty was evidently experienced in moving the jaw. The mouth was kept half open, and a little saliva flowed from it; the tongue was healthy, and nothing amiss was noticed on the left side or roof of the cavity. The fourth and fifth molars of the right side were pushed upwards by the growth of the tumour, and were a little separated from the adjoining teeth. The mucous membrane of the mouth was healthy, and the gums were not separated from the teeth. There was no swelling in the intermaxillary space, nor towards the neck. The jaw could be moved passively. The disease was diagnosed as Osteo-sarcoma, probably complicated with myeloplaxy.

In view of the rapid growth of the tumour, and the local and general condition of the animal, as well as the improbability of

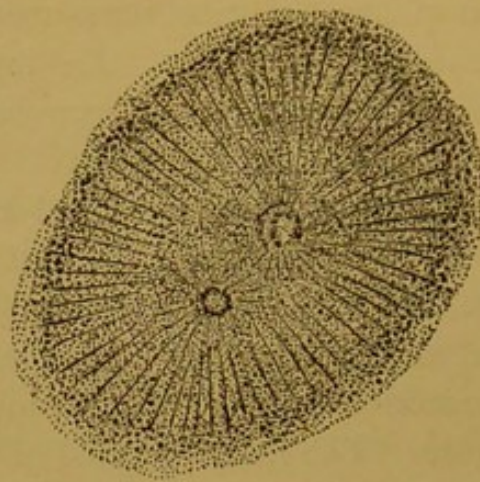
palliative, surgical, or pharmaceutical measures being of any avail, resection of the diseased portion of the jaw was made, and though for some time the prospects of recovery were favourable, yet the dog ultimately succumbed rapidly.

The major portion of the tumour was hard and fibrous, and had a reddish-yellow tint at the inferior part, whitish elsewhere. At the lower curvature the neoplasm became suddenly and regularly lobulated, the connective tissue forming the interlobular spaces being continuous with that composing the envelope of the tumour as a whole. The inferior third of the section showed multitudes of yellow points, irregularly disseminated throughout; there were none in the upper part. The tumour and its fibrous envelope were very slightly vascular. When examined microscopically, the most important feature noted was the presence of numerous disseminated *Actinomyces*, especially towards the inferior part; they were only casually met with in the upper portion, while deeper in the tumour they were very definite in outline, and enclosed in a kind of nucleus composed of apparently dead tissue. Many of these radiate fungi did not show the slightest trace of calcification, others were completely invaded by lime salts, and the nodules enclosing them had to be treated with hydrochloric or nitric acid before their contour could be well defined. The fungus appeared in two rather different forms, or rather aspects, which probably depended upon its stage of growth. Cut in the direction of the sarcomatous tissue, intermediate to the necrobiotic focus, there were observed very numerous small discs composed of fineradiating filaments, one portion of which terminated in a rather dark punctiform dilatation (Fig 2). These



FIG. 2.—Young *Actinomyces* Disc.

were more abundant in the peripheral tissue of the tumour, which appeared to contain the younger specimens, and of which there were only a few varieties. There was a more adult form, very often two discs together (Fig. 3), in which the radiating

FIG. 3.—Double Discs of Adult *Actinomyces*.

filaments, starting from the central discs, were not so slender as in the other example, were of various lengths, and the punctiform dilatations at the end were also larger and more numerous. These dilatations, which may be considered conidia in process of maturation, were found in some preparations so developed as to look like true spores, and by their number and minute size they might readily become the active agents of dissemination, far and near, of the micromycetes in the tissues. The other form of *Actinomyces* was composed of a central irregular, or round disc, light-yellow or olive-tinted, and granular, from which proceeded rays much larger than in the preceding forms. In some of the specimens these rays were approximately equal in length, and altogether the *Actinomyces* did not look unlike the flower

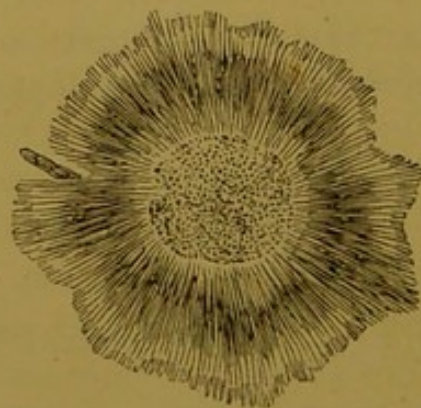


FIG. 4.—Marguerite-shaped Disc.

Marguerite (Fig. 4). In other instances, the length of the single filaments varied remarkably: while some of these projected only

a short distance from the central disc, others extended in a direct or flexuous manner right into the surrounding necrobiotic elements. When by pressure the *Actinomyces* could be separated from each other into single filaments, and these were highly magnified, they were found to be flexible rods, each terminating in a lance-like bulging, or in an angular, single, bifurcated, or trifurcated extremity with a rounded apice. When yet more highly magnified, there was seen in the centre of each filament a fine axial line, either entire, broken, or in points or dots.

Vachetta terminates his observations by remarking that though the canine species has hitherto shown itself refractory to experimental inoculation, yet this instance proves that it may suffer from the accidental disease; that the fungus may present slight variations in form, not only in the different species of creatures in which it has been found (man, ox, pig, horse, and dog), but also in individuals and in the different neoplasmata, as is shown by the representations given of it under these circumstances. He was doubtful as to the channel by which it found its way into the tissues—whether by an excoriation, ulceration, or fissure in the gums, or (which seemed more probable) rather by an ulcer or fistulous opening at the lower margin of the jaw.

Subsequent to the date of Bollinger's published observations, Johne had examined thirteen of these cases of myeloid Actinomykosis of the jaws (presumably of cattle); ten of these were fresh specimens, and three were old specimens preserved in spirit. Eleven were of the lower jaw, one of the upper jaw, and only one of both jaws. All had evidently a central origin (*centralen ursprung*), though in some cases the disease may have commenced in the periosteal tissue. He describes cases of myeloid Actinomykosis belonging to the former, and periosteal Actinomykosis denoting the latter. He also mentions a case of Fibrosarcoma of the lower jaw of an ox, in which the tumour was the size of two fists, round, fungous, and fibrous, and which arose from the alveolar periosteum of the middle incisors; it lay beneath the mucous membrane, and produced great thickening of the lip; another instance of fibrous tumour of the gum, apparently of new formation, the size of a hen's egg, which grew from the periosteum at the interior aspect of the junction of the two por-

tions of the lower jaw, at the lower half of the alveolar border. The stroma of the tumour was three millimetres thick, and the mass, like that of the last tumour, contained "nests" (*nester*) of *Actinomyces*. He likewise alludes to an apparently fibro-sarcomatous tumour on the margin of the gum of the lower jaw of a pig : a tumour about the size of a pigeon's egg, involving the tongue, and springing directly from the periosteum on the upper surface of both branches of the jaw. In the more dense fibrous tissue, less in the spongy stroma, were many conglomerations of nodules the size of a millet-seed, containing the *Actinomyces* in clusters, many of which were calcified.

Actinomykosis of the Fauces.

The disease generally appears in this region in the form of submucous new formations, or polypi, which have been classed with the Lymphomata or Lympho-sarcomata. They are round, fungous, or spongy tumours, covered by apparently normal mucous membrane. There are sometimes several in this situation. They present the same features, histologically, as the nodules in the tongue. Hitherto they have only been found in the ox. Johne describes one of these polypi obtained from the fauces of an ox, as about the size of a fist, round, fungous, and soft, covered by normal mucous membrane, rising from the right side of the cavity, a short distance behind the tonsil. On section, it showed five isolated, round, and generally fine spongy nodules, the size of a walnut. All of these contained conglomerated masses of the fungus.

The symptoms are generally difficulty in deglutition, and even in respiration, with cough, when the tumour is near the laryngeal opening. These tumours may also be the indirect cause of Broncho-pneumonia, through their diverting the food into the air-passages.

As has been said, tumours and abscesses are rather common in this cavity in the ox tribe.

Actinomykosis of the Nasal Chambers.

The only cases on record, so far as I can ascertain, are those described by Mr. James, and referred to at the commencement of this paper.

Actinomykosis of the Larynx.

Similar tumours to those observed in the fauces, are found in the region of the epiglottis and larynx. They are spongy in structure, and the characteristic nodules and *Actinomyces* tufts are contained in the fibrous meshes of their structure. In the region of the larynx, these formations cause more or less disturbance and difficulty in respiration.

Actinomykosis of the Œsophagus.

A most interesting instance of the disease in the œsophagus is described by Siedamgrotzky, who obtained the specimen fresh, and carefully examined it. The mucous membrane of the tube was covered with hundreds of small, flattened, sub-epithelial nodules, from one to four millimetres in diameter, mostly collected in groups, in each of which, in a bright light, a small yellow centre could be distinguished by the naked eye. In some places the small tumours had become confluent to form irregular, compact masses, about twenty millimetres long, of a pale-red tint, and in which the yellowish-red centres or kernels were visible. Some of the tumours stood out from the mucous membrane like pins' heads. In the middle of the œsophagus was a similarly-shaped polypus, from eight to nine millimetres in diameter, four millimetres high, and four millimetres in diameter at its base on the mucous membrane. The tissue of these masses was yellowish-red, soft, and filled with numbers of nodules containing the *Actinomyces*.*

Actinomykosis of the Stomach and Intestinal Canal.

Two specimens of the disease in the stomach and intestines are described by Johne. In the second compartment of the stomach of an ox was found a round, flat tumour, the size of a fist, attached to its surface, and covered by normal mucous membrane. Its interior was soft, more or less spongy, and

* An analogous instance, but the real nature of which was not suspected, is given in the *Edinburgh Veterinary Review* (vol. iv., p. 235), under the heading, "Degeneration of the Mucous Membrane of the Œsophagus." The membrane was studded with what were described as warty growths, some of them of great size.

contained numerous small masses of nodules, consisting of conglomerations of the *Actinomyces*.

Bollinger alludes to what was described as a tuberculous ulcer in the rumen of a cow, but which he is of opinion was a case of Actinomykosis.

Perroncito has described a sarcoma of the intestines and stomach, in which the fungus was found.

Actinomykosis of the Udder.

Johne has described two instances, and Ponfick one, of the disease occurring in the udder. Two were in swine, and one was due to experimental inoculation. In Johne's cases—accidental and experimental—the disease appeared as a diffused fibroma. In the accidental case, the udder was enormously enlarged, and weighed nearly sixteen pounds; it was hard, indefinite in mass, and on section appeared to be, from its white colour, a cellular fibro-sarcomatous growth, in which the gland structure was limited to a few small masses in the midst of the new formation. The teats were partly normal, partly effaced by retraction into the tumour, and partly gangrenous and fissured. In the mass of the tumour were found a small number of well-defined nodules, from the size of a hazel-nut to that of a fist. The smallest of these contained a greyish-yellow or reddish mass, resembling brain tissue, with yellowish coloured nuclei interspersed throughout. In the centre of the largest the matter appeared to be undergoing caseous degeneration, and in some of the interspaces was a greenish-yellow, thick, puriform fluid. The milk cistern was markedly altered. In places it was smaller and larger, and near the centre of the tumour it was flask or flagon-shaped, its outline being sharply defined, and the dilatations being filled with the typical spongy tumour mass.

In the case produced by inoculation, reference to which will be made hereafter, the most interesting fact is that the *Actinomyces* was introduced into the gland by its milk duct, and that the inflammation set up in the mucous membrane, which was at first adventitious, became interstitial—affecting the intra-acinous connective tissue, and producing intensive development of the glandular parenchyma, with, finally, extreme hypertrophy of all the connective tissue.

Ponfick had sent to him the udder of a sow which had been affected with Erysipelas (*Rothlauf*), but there was such an unusual disappearance of the proper gland tissue, and altogether the lesions were so different to those brought about by that malady, that the existence of another disease was suspected.

In the middle of the largest half of a round swelling involving the entire mass of the mamma, and which was double the size of a child's head, were noticed a great number of soft, round nodules, fixed here and there in the lardaceous-looking substance of the tumour. This felt so peculiarly elastic, and was at the same time so compact, that on pressure on the surface it seemed as if the fluctuation was due to some deep-seated gelatinous fluid. This was enclosed in a white, dense, inelastic tissue, on the inner surface of which were some detached portions of the gland proper, and which formed, with the thickened and indurated cutis, a continuous kind of rind. The entire mass gave the impression that the parts had been affected with diffuse inflammation, which had produced extreme induration of the skin and the subcutaneous and gland tissues. But what was peculiar, was the presence in the homogeneous mass of a considerable number—more than a dozen—of sharply-defined nodules, from the size of a cherry-stone to that of a walnut, imbedded in a spongy, flesh-like gelatinous matrix, and studded with yellowish spots, islets, and small cavities. These cavities contained a greyish-yellow fluid, in which a number of white bodies, the size of millet-seed, were suspended.

Microscopically, no trace of the gland structure was found in the dense connective tissue. The yellow, flesh-like substance of the solid portion had a general resemblance to polymorphous round-cell tissue, with very few vessels, while lying in groups, in concentric strata of increasing dimensions, were small white nodules. Throughout these, and in the fluid portion, were found immense numbers of the *Actinomyces*, many of them surrounded by a calcareous envelope. These felt like particles of sand.

Actinomykosis of the Lungs.

Actinomykosis of the lung of cattle had not been observed until Professor Pflug, Veterinary Professor in the University of

Giessen, published an instance in 1882. Indeed, there were only four cases of lung Actinomykosis recorded previous to this—two occurring in the human species, and two produced in calves by experimental inoculation—all recorded by Ponfick.

Pflug's case is very interesting, and is as follows:—

A cow about five years old, appeared to be dull, did not eat as usual, and frequently coughed. For two days before the arrival of the veterinary surgeon, the appetite had almost gone, and the respirations and cough were so frequent that the owner thought the animal was suffering from inflammation of the lungs. The veterinary surgeon found the cow apathetic, nostrils widely dilated, and staggering about in the stall; the dyspnœa was great, and the breathing most laborious. Percussion on each side of the chest yielded a dull sound, while auscultation detected an indefinite respiratory murmur, a bronchial rattle, and increased expiration. The pulse was proportionately strong, and the internal temperature 40.9° Cent. On a second visit all the symptoms were increased, and as they bore a strong resemblance to those of Contagious Pleuro-pneumonia—then prevalent in the district—he had the animal slaughtered. On examination, only the lungs were found to be diseased, being studded with miliary tubercles, and as this condition was very unusual, the parts were forwarded to Pflug.

The lungs were fully distended with air, and firm, but elastic; for the most part they were anæmic and generally white, only small portions being hyperæmic. The pleura was normal, but there appeared throughout very many miliary tubercles the size of a pin's head, which formed so many slight prominences on the membrane, and caused it to feel granular. The lungs did not sink in water, even when incised. The cut surface had a fine porous, or pumice-stone appearance; and no serum, but only a small quantity of blood, could be squeezed from it on pressure. The inter-alveolar and interlobular lung tissue appeared to be slightly thickened and porous, and this, together with the emphysematous condition of the alveoli, gave the lung its strongly-elastic consistency. On the cut surface were seen numberless minute tubercles, very granular, in size about that of a millet-seed, or a little larger. In the hyperæmic patches the tubercles were

very conspicuous. In none of these nodules was there a yellow centre or softening, and to the unaided eye they looked very little different externally, or in consistency, from the ordinary crude grey tubercle which is developed into the yellow tubercle.

Thousands of these tubercles were observed throughout the lung, in the middle of the respiratory tissue, near the bronchi and blood-vessels, and in the vicinity of the lobular tissue.

On microscopical examination, in the lung substance were found an immense number of tubercles, so small that they escaped the naked eye. These were generally round, on the cut surface discoid, and when two were confluent, biscuit-shaped, or distorted, jagged, or gibbous.

The round or somewhat oval-shaped tubercles (Figs. 5, 6)

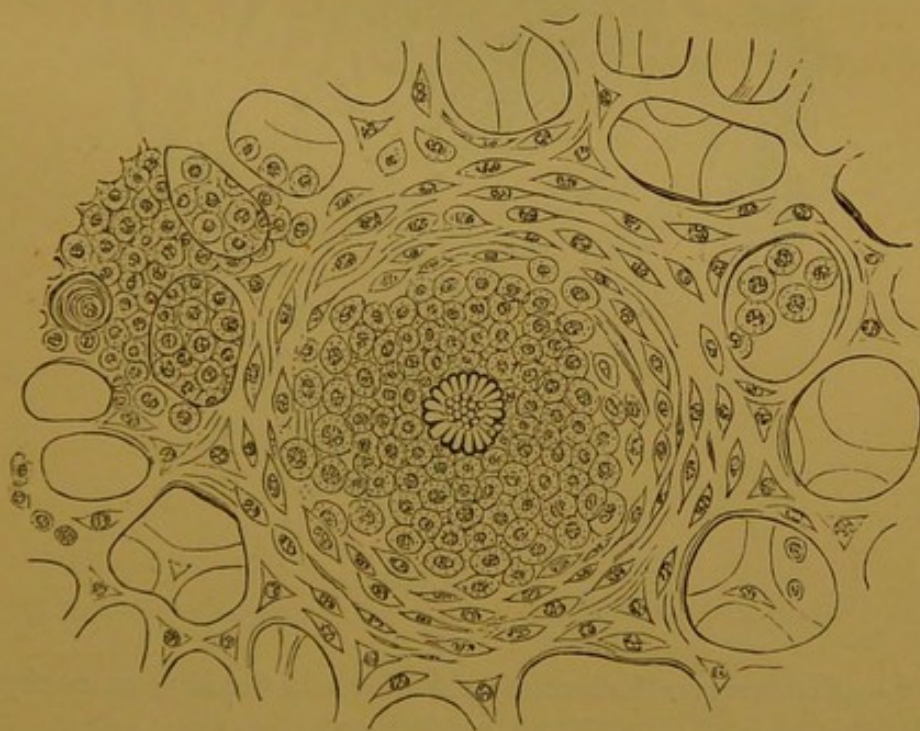


FIG. 5.—A Lung Tubercle or Nodule with an *Actinomyces* Tuft in the centre. From cow's lung.

were generally about 0·45 mm., seldomer 0·30 ; 0·27, or 0·20 mm. in diameter,* and contained either a dark-tinted nucleus, or a spongy structure, with perhaps a dark nucleus in its midst.

* A very large tubercle gave the following dimensions : Total diameter, 1·00 mm. ; thickness of fibrous portion, 0·20 ; the middle cell portion enclosing the fungus, 0·60 ; *Actinomyces* tufts, 0·15.

This dark nucleus proved to be the most interesting discovery in the diseased lung. It was a round, globular, rarely a slightly oval body, with a diameter of from 0·04 to 0·05 millimetres. Under a low power its contour was sharp and distinct, and it had a yellowish-green tint, with a markedly radiating structure. With a higher magnifying power, the contour was no longer sharp and circular, but notched or indented irregularly, and the radiating lines were found to be minute club-shaped particles,

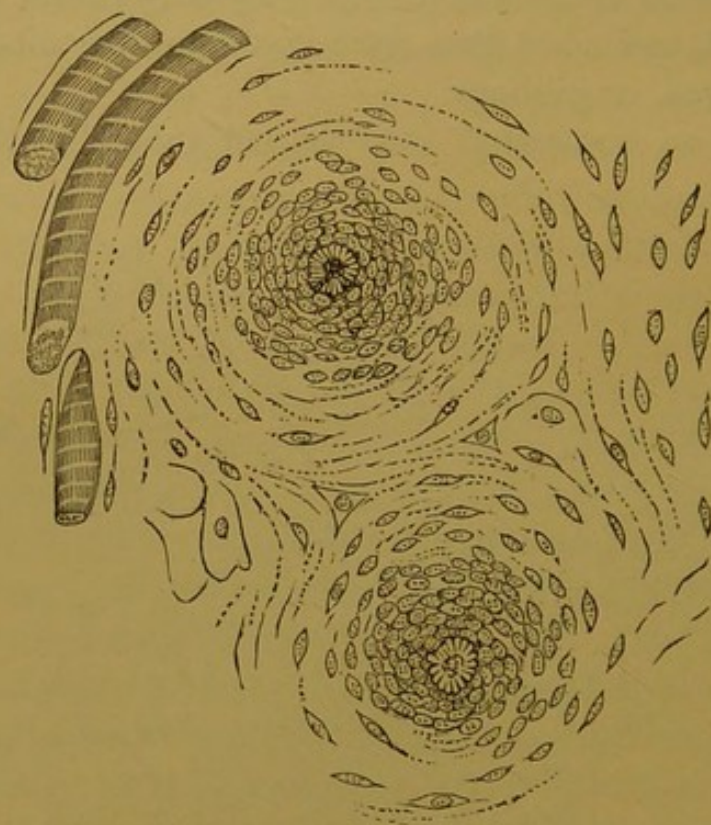


FIG. 6.—*Actinomyces* Tubercles or Nodules in the lung parenchyma.
From cow's lung.

the smaller extremity being at the centre and the wider part toward the periphery of the mass. Still more highly magnified, there were distinctly observed in these radiating parts, particularly towards the centre, exceedingly minute, structureless granules of a light yellowish-green tint, refrangent, of a diameter between 0·008 to 0·01 mm. (Figs. 5, 7).

In some of the tubercles it was very difficult to discover this radiating nucleus ; it was so small and delicate that it had to be

looked for with the greatest care and patience, and was often composed of only a small number of the club-shaped radiating portions—from four to six, or only three, starting from a point in the centre.

In each tubercle, around the fungus, and forming a medium stratum, was a large mass of cells, about 0.25 mm. in diameter. These cells were round or slightly polygonal, and lying close to each other (Figs. 5, 6, 7). There were also

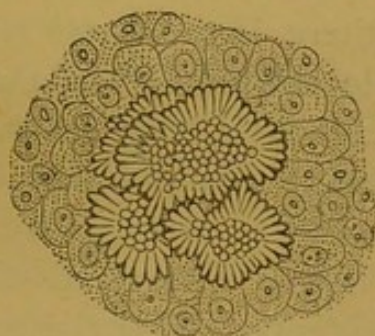


FIG. 7.—An *Actinomyces* Cluster surrounded by a number of large cells. From a cow's lung.



FIG. 8.—*Actinomyces* Sphere, with a supposed central foramen.

spindle-shaped and other cells. The cells of the middle stratum were composed of faintly granular protoplasm, with a large nucleus, which was stained a deep blue by hæmatoxylin. The external stratum was fibrous, the fibres being concentric around the cells; it formed the limit of the tubercle, isolating it more or less from the normal inter-alveolar tissue. There were other tubercles, as before mentioned, in which the fungus was so fine and small as to be difficult to detect.

In the anæmic portion of the lung, vesicular emphysema was

well-marked, while in the hyperæmic portion there was no emphysema.

An important question arises with regard to the seat of these *Actinomyces* tufts in the lungs. Are they located in the parenchyma of the lung, the alveoli, or in the lymph or blood-channels, and there give rise to the *Actinomyces* tubercles? It would appear that the tubercles containing the fungus are found in the parenchyma, rather than the alveoli. In the intermuscular connective tissue of the tongue they are nearly always located, and it appears to be the same with regard to the lungs. In both nodules or tubercles there is the same structure—an external fibrous capsule, a middle stratum of cells, and the fungus in the centre; the only difference is, that in the tongue the fungus mass is drusey, in the lungs it is globular.

Professor Marchand, in examining very many microscopical preparations of these lungs, discovered the *Actinomyces* tufts in the finest bronchi, evidently giving rise to a cellular exudation. Thus strengthening the supposition that the fungus finds entrance through the respiratory passages.

Actinomykosis of the Skin, and Submucous and Intermuscular Connective Tissue.

Tumours which have, by some, been supposed to be of a scrofulous nature, and have received various names, such as "Cysto-sarcoma," "Lympho-sarcoma," "Hedgehog Throat" in Germany (and not improbably the so-called "wens" in Lincolnshire and elsewhere in this country), are somewhat common in cattle, rarer in other animals. Their chief seat is in the vicinity of the neck and head, towards the parotideal region. Several instances are recorded of similar tumours in other parts of the body, more or less voluminous, and which have, like those in the region of the head, been found to present the characters, and contain the microphyte, which distinguish Actinomykosis.

Perroncito describes a tumour removed from the anterior part of the neck of a three-year-old ox. This tumour had a wide, undefined base, and weighed nearly three pounds. On section,

it was found to be composed of shining connective tissue, encapsulating a sarcomatous mass, which contained small masses of the *Actinomyces*.

Johne alludes to an instance of Actinomykoma on the right cheek of a young cow. It was isolated, the size of a hen's egg, fungiform, and apparently sarcomatous; the skin over it was ulcerated. A test-section removed from it during the life of the animal, was found to contain granulation nodules within which were the *Actinomycetes*. Six months after this section was made, the tumour had disappeared, and there was only at the posterior border of the jaw, between this and the parotid gland, a small, spindle-shaped, characteristic *Actinomyces* tumour, and in the loose connective tissue between the upper and lower buccal glands were more yellow nodules, the size of a pea, each containing the fungus. The interesting feature in this case is the disappearance of the tumour without surgical treatment, it having only been dressed with Sulph. Cupri pulv. after the section had been made.

Another instance Johne met with in a two-year-old heifer, which had a round, fungoid, flesh-like tumour, about two inches in diameter, on the right cheek, near the angle of the mouth; it appeared to grow by an ill-defined pedicle from the muscles. The corresponding part of the buccal mucous membrane appeared to be healthy. On the surface of the growth were seen the characteristic yellow nodules, which proved it to be an Actinomykosis tumour. On removal, it was discovered to arise from the intermuscular tissue in the vicinity of the submucous connective tissue. The wound healed by primary intention.

Veterinary surgeon Eckert, of Walthalben, had sent to Johne, amongst other specimens, a round, dense tumour, about three inches in diameter, which had been removed from the sub-cutis, immediately over the masseter muscle, at the angle of the lower jaw. At the upper part of the tumour, at an earlier period, was a small fistulous opening, from which a whitish-yellow pus flowed, but which, having ceased, the opening healed, and the swelling became somewhat less prominent. Shortly before this period, he saw a similar tumour, slightly larger, which, like the other, was attached by strong connective tissue to the struc-

tures beneath. On examination, both tumours were found to be real *Actinomykomata* ; they were the size of, or bigger than large walnuts, spongy in texture, and full of the fungus tufts enclosed in a capsule of thick connective tissue arising from between the sub-cutis and the inter-muscular connective tissue.

Rabe relates the case of a cow, which had a number of pale, greyish-red tumours, round or somewhat bean-shaped, and of various sizes, on the left side of the face. The largest, about the size of a hen's-egg, was situated at the outer margin of the nostril, where the cutis joins the mucous membrane, and was surrounded by a number of smaller and very small tumours. There were eleven others, varying in size from that of a hazel-nut to a plum, in the masseteric region ; these were more or less apart, but between them were smaller ones, and here and there a marked cordiform kind of swelling—not unlike the inflamed lymphatics of Farcy. The majority of the tumours lay immediately beneath the skin or the fascia of the facial muscles ; the surface was smooth, and each tumour seemed to be isolated from its fellows. Over some of them the cutis had become ulcerated, and they appeared on their upper surface moist, red, and fungoid.

On section of these tumours, there were observed a great number, particularly towards their periphery, of dull-yellow nodules the size of a pin's head, in the neighbourhood of which the tissue was soft, spongy, and moist. On microscopical examination, each of these yellow, submiliary granules was found to contain the *Actinomyces* tufts in abundance, and in their immediate vicinity a great quantity of pus-corpuscles and young connective-tissue cells, with very turbid protoplasm, and other characteristic appearances.

ACTINOMYKOSIS IN MAN.

In mankind, so far as I am aware, only sixteen cases of the disease have as yet been recorded, Dr. Ponfick having observed no fewer than five. All the cases published hitherto have occurred, I believe, in Germany. They are tabulated as follows by Johne :—

NO.	OBSERVER.	DIAGNOSIS.
1	Israël	Chronic Pyæmia. Death. ¹
2	Do.	Inflammatory Tumefaction of the alveolar processes of lower jaw, with deep-seated Abscess. Recovery. ²
3	Do.	Subperiosteal abscess at the margin of the lower jaw, coincident with Caries of the third molar. Recovery. ³
4	Do.	Chronic Pyæmia. Death. ⁴
5	Ponfick....	Prævertebral Abscess, with Caries of the vertebræ. Death. ⁵
6	Do.	A similar case, and fatal termination. ⁶
7	Do.	Abscess after extraction of an upper molar tooth, immobility of the jaw through Cicatrization, Fistulæ in the temporal muscle and upper part of the neck. Death. ⁷
8	Do.	Prævertebral Abscess, opening into the jugular vein, Metastatic Tumour in the heart, Actinomykotic Peri- and Myo-carditis. Death.
9	Do.	Ulceration of the jaw and Abscess. Partial resection. Recovery. ⁹
10 } 11 } 12 }	Rosenbach .	Actinomykosis Tumefactions, with deep-seated Abscess. Recovery. ¹⁰
13 }		
14	Kracke	Particulars not known.
15	Esmarch ..	Particulars not known.
16	Weigert ..	Peripleuritis.

¹ Virchow's Archiv, Bd. 74, s. 15. ² *Ibid*, Bd. 74, s. 37. ³ *Ibid*, Bd. 74, s. 41. ⁴ *Ibid*, Bd. 78, s. 421. ⁵ Breslauer ärztlicher Zeitschrift, 1879, s. 116. ⁶ *Ibid*, 1879, s. 117. ⁷ *Ibid*, 1880, s. 151. ⁸ *Ibid*, 1880, s. 151. ⁹ Mittheil. v. d. Naturf.-Vers. zu Danzig. Berlin Klinik Wochenschrift, 1880, s. 42. ¹⁰ Centralblatt für Chirurgie, 1880, s. 225.

I cannot do more here than briefly refer to some of these cases, to show their relationship to those occurring among animals.

Professor Ponfick's original case was that of a powerfully-built man, aged forty-five, who had suffered from the sequelæ of Pleurisy on the left side for a year and eight months. After death, there was found an extensive prævertebral phlegmonous inflammation in the posterior mediastinum, with a parapleuritic abscess-cavity extending both to the right and left, at the level of the seventh, eighth, and ninth intercostal spaces; with this cavity there communicated a complex system of sinuses, extending through the substance of the longissimus dorsi, the scapular muscles, and the subcutaneous tissues of the whole back. The

sulphur-yellow fungus-bodies were found upon or between the granulations of these sinuses and in their substance, as well as in the sero-purulent discharge ; they were also found in a cavity of the size of a cherry, which occupied the centre of a hepatised area of the left lung (lower lobe), as well as in the exudation that filled some of the neighbouring alveoli. The second case was that of a woman aged sixty-one, admitted with an abscess of the lower part of the abdominal wall ; she subsequently developed another abscess of the left iliac fossa, without recurring symptoms of peritonitis, and died from exhaustion. After death, caries (with prævertebral collection of pus) of the three lower lumbar and first sacral vertebræ, abscesses in both iliac fossæ, and perityphlitic adhesions, were found. The yellow fungus-bodies were discovered in the pus of the prævertebral abscess. The third case was that of a woman, aged forty-five, who had suffered an injury of the right thumb three years before, with swelling of the arm, which did not subside, but extended to the neck and back, and was accompanied by progressive weakness. The necropsy revealed extensive sinuses on the left side of the neck and in the prævertebral tissue, a knob-like excrescence of new growth extending into the lumen of the internal jugular vein, a tumour, of the size of an apple, growing into the right auricle and ventricle, with corresponding whitish centres in the ventricular substance, and gelatinous nodules in the spleen and in the occipital lobe of the right cerebral hemisphere. In this remarkable case, the fungus-bodies were found in the sinuses of the neck, in the substance of the sarcoma-like growth of the jugular vein, in the tumour of the right auricle and ventricle, and elsewhere. In the fourth case, the illness began fourteen months before death, following the extraction of an upper molar tooth ; it consisted of swelling in the region of the right maxillary joint, tumefaction of the face, and subsequently of the neck ; successive outbreaks of abscesses and sinuses in these regions. Death occurred from extreme exhaustion. The yellow fungus bodies were frequently obtained in this case from the sinuses during life. The record of the case is too elaborate to be given, even in outline ; but it may be mentioned that there was, besides the extensive sinuses and granulation-centres of the face and

neck, a prævertebral abscess extending from the basilar process of the occiput to the fourth dorsal vertebra, with osteophytic growths from all the bones, together with caries of both occipito-atlantal joints and of the right atlanto-axial. In the fifth case—a boy—the first indication of illness was a year before death, when he had symptoms of Pleurisy; nine months later, there was a new and much more severe affection of the same side, with general dropsy, progressive swelling in the lower part of the back, and evacuation of pus from a cavity opposite the eleventh left rib. *Post mortem*, a large prævertebral cavity was found on the left side, partly retropleural at the level of the eighth, ninth, and tenth ribs, and partly retroperitoneal at the level of the last two ribs and the left kidney; also several perforations of the diaphragm. There were numerous centres of Actinomykosis in the muscles of the back, in the intercostals, and in the left psoas muscle; also in the muscular substance of the left ventricle, and in the upper end of the spleen.

In Rosenbach's cases, the disease commenced in the neighbourhood of the jaws, and appeared to be in some way dependent upon carious teeth, involving the dental alveoli. Ponfick and Israel had remarked on this tendency of the disease to originate in the teeth or their sockets. This local affection is not unfrequently followed by metastatic abscess in the liver, spleen, intestine, and muscles. Death seems to result from Chronic Pyæmia, or from exhaustion, as a consequence of protracted and pernicious suppuration. In mankind the tendency of the disease is to the formation of abscesses and suppurations; in bovines, to tumours and small nodules.

In all the detailed reported cases occurring in man, there have been found, in the pus of the abscesses, immense quantities of small nodules, the majority being the size of a pin's head, sulphur-yellow in tint, and generally soft and tallowy in consistence. These are agglomerations of the *Actinomyces*.

The Actinomyces.

The botanical character of the *Actinomyces* does not seem to be yet clearly established. Harz, who first studied its morpho-

logy and biology, was inclined to consider it as belonging to the class of moulds (such as the *Penicillium glaucum*), but Karsten thought it should be included among the *Coniomycetes*, as the "rust" and "smut" of cereals and grasses, and therefore belonging to the *Ustilaginæ*. So long ago as 1870, Professor Hahn, of the Munich Veterinary School, had discovered in a case of "Wooden Tongue" (*Holzunge*) characteristic organised bodies, which looked like a kind of brush-shaped mould. When Bollinger drew attention to the disease in 1877, and to the presence of these fungi, Harz made a special investigation of them, and from their eccentric radiating structure gave them the name of *Actinomyces*. As has been already shown, the fungus is contained in nodules which are often soft or puriform, and forms a pale-yellow, brownish, or greenish-yellow, globular tuft, which, under a low microscopical power, offers a radiating arrangement of its substance, from the centre towards the periphery, reminding one somewhat of the crystals of certain fat acids. The larger of the tufts, which generally are composed of two or more mulberry-shaped masses, often appear to the naked eye as very small, millet-sized bodies. When properly prepared and highly magnified, if the nodules were embedded in tissues, they are observed to be composed of a kind of fibrous capsule; within this a layer of cells, for the most part of a lymphoid character; nearer the centre are larger cells, like ordinary epitheloid cells; and in the centre the *Actinomyces* clusters.* Iodine, anilin, and picric acid give these a characteristic reaction, the cell-membrane generally offering a cellulose reaction. Alcohol, æther, acids, and alkalis have no immediate effect upon the fungus tufts, and this distinguishes them from such bodies as fat crystals. By pressure, the globular tufts can be broken up into numerous kind of wedge-shaped pieces of various sizes, from 0.010 to 0.050 millimetres in length, and the majority are about equal in breadth towards the end. Each piece is composed of a great number of individuals, every one of which is somewhat conical, from 0.0005 to 0.0020 millimetres

* A good method of showing the *Actinomyces* is to cut sections, and stain them singly with Spiller's purple, or doubly with it and diluted soluble blue. To demonstrate the separate parts of the nodule, a small portion may be teased out in glycerine.

broad, about 0·0045 millimetres long, representing the mycelium, from which begins a central base-cell or basidium. From this arises a two to nine-stalked hyphen, from 0·0005 to 0·002 mm. in diameter, and at the extremity of the stalks or sterigmata are the conidia.

Johne and Vachetta point out that the periphery of the *Actinomyces* tuft is not always so symmetrical as Harz has represented, and my own observations confirm this remark. When closely examined, many of the club-shaped cells towards the periphery will be found standing out prominently from the others, and measuring about 0·0019 mm. broad to 0·0740 mm. long (Fig. 9, *a*; Fig. 10, *aa*).

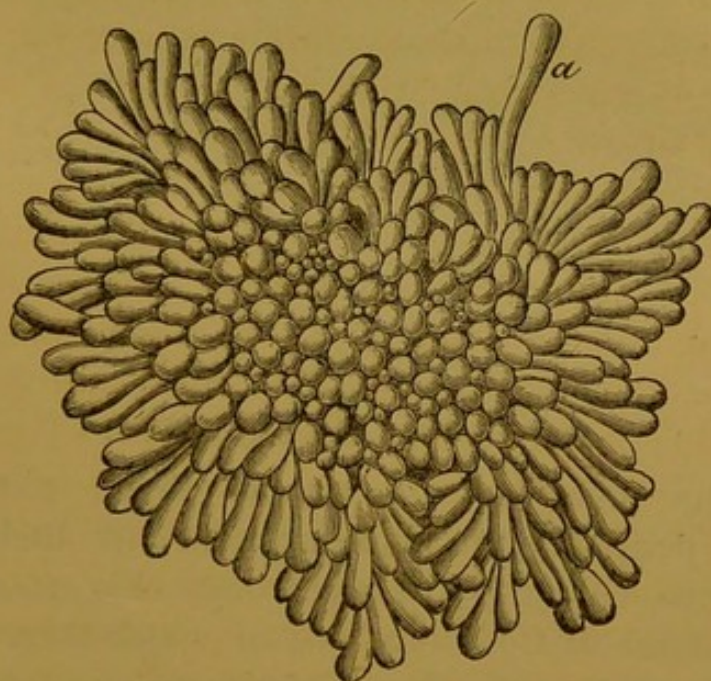


FIG. 9.—Unsymmetrical *Actinomyces* Tuft.

Here and there are some fine, pale, faintly shining, single mycelium threads springing from the depths of the tuft, and appearing beyond its margin (Fig. 10 *b*). Another tuft, or portion of one, mainly consists of such mycelium or hyphen-threads (as in Fig. 10 *b*). Very exceptionally, there are seen at the peripheral end of these fine threads, a delicate pear-shaped expansion (Fig. 10 *c*); and among them are larger pear or club-shaped cells, often crowded together (Fig 10 *d*); while not unfrequently are noticed isolated, and generally small tufts, which

appear to be composed only of the very finest mycelia, and which Harz looked upon as aborted forms, but which Johnne considers young growths. Within the zone of the tuft (as in Fig. 9), and especially towards the centre, are not only the upper surfaces or ends of the larger club-shaped cells visible, but also small shining corpuscles, which resemble micrococci (Fig. 10 *e*). In the centre of the tuft, in addition, are extremely fine, but not

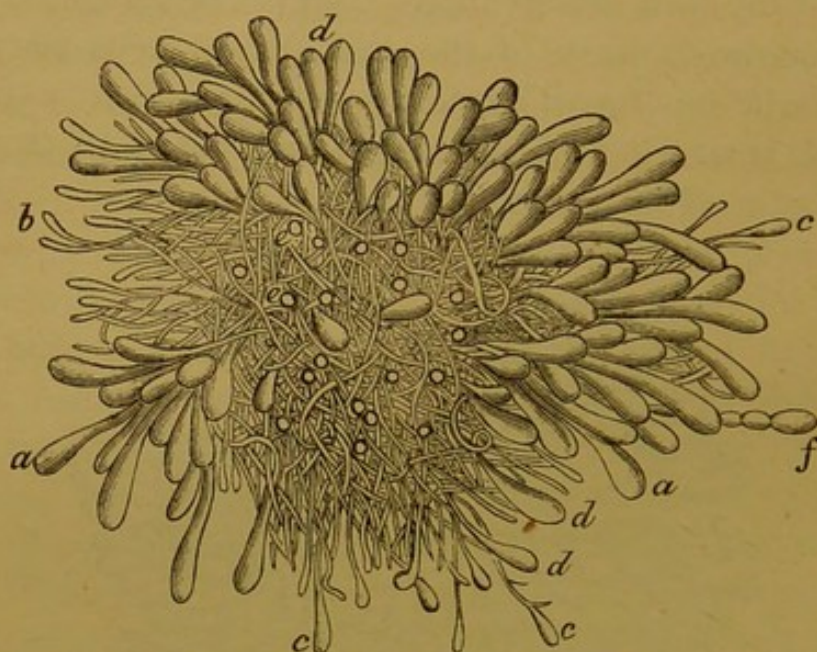


FIG. 10.—An *Actinomyces* Tuft.

very numerous mycelia; and beyond these, passing direct towards the periphery, are many mycelia with their extremity expanding into a long pear-shaped body (Fig. 10 *c*), which has received the name of Conidium, and of which there is generally only one for each thread. In breaking up or pressing the tuft the conidia are very easily detached in the shape of conical or pyriform bodies, with in many instances the narrow end much elongated. The mycelium is irregularly branched, two or more conidia growing from each by means of their narrow extremity, something like a bunch of grapes (Fig. 11).



FIG. 11.—Mycelium and Conidia of the *Actinomyces*.

The various forms the conidia may assume are shown by Johne, Ponfick, Harz, and Israel ; but the most diverse opinions are entertained as to the development and growth of the fungus itself.

It is probable that when the fungus-tufts become calcified, as they are often found to be, their growth has ceased, and they can no longer fructify.

Culture experiments have hitherto not been very successful, so that we are still in the dark as to the process of, or length of time necessary for, development. Clinical observation and experimental inoculation, however, would go to prove that spon-

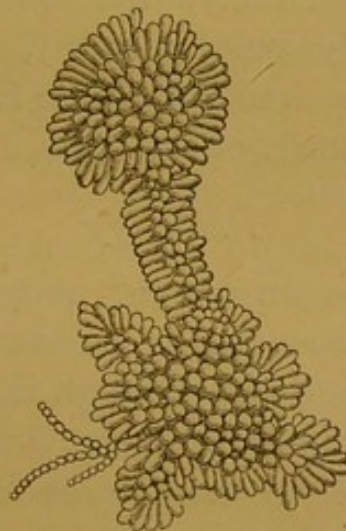


FIG. 12.—Fragment of barley, with clusters of Conidia of the *Actinomyces*.

taneous or accidental Actinomykotic tumours take longer to grow than those which are experimentally produced.

Israel was of opinion that the mycelium of the fungus, obtaining access to the tonsils of mankind and there producing germs or spores, gave rise to Actinomykosis ; and Johne believes he found corroborative evidence of this in making a careful examination of the tonsils in the section of a pig's head. Externally, these appeared quite healthy, and on pressing some of the glandulæ only the ordinary turbid mucus fluid they usually contain was expelled ; but from others there was expressed a yellow, thick, grumous matter, something like pus, and which on examination by means of the microscope was found to have a very great number of *Actinomyces* tufts of various sizes and in different stages of

development, some of them even calcareous. A section of the amygdaloid cavity showed that it was much dilated, and its lymphoid tissue normal, as a rule; only in some preparations of the part did this tissue appear infiltrated with small cells. In some of the glandulæ were small, delicate, but rigid vegetable particles, which were for the most part fragments of corn or barley husk; and on close inspection there were perceived, either on the surface of these particles or clustered on the beard of the barley, with few exceptions, crowds of pear-shaped hyphenless conidia (Fig. 12) which in form, size, etc., differed in no respect from those found in the Actinomykosis nodules.

Johne subsequently examined the tonsils of twenty-four pigs which were apparently quite healthy, and with only two exceptions found them free from these fungi. He could never discover them in the tonsils of cattle.

Pathology.

There can scarcely be any doubt as to the etiology of Actinomykosis. The *Actinomyces* is constantly found in new formations of a special kind, and through its irritating and disintegrating influence it not only produces these formations, but sets up destructive processes in the tissues in which it may locate itself; and sooner or later, unless it loses its power or is removed from them, it causes their death. An *Actinomyces* tumour must, therefore, be looked upon as what German pathologists designate an "infection tumour," and Actinomykosis as an infectious disease.

As has been said, the tumours offer certain distinctive characters, and all tumours possessing these characters contain the fungus. Externally these growths, be they large or small, present various appearances; but they are generally round, lobular, or fungiform in shape, smooth on the surface, and soft in consistency, like the polypi-sarcomata, or somewhat hard, like the fibro-sarcomata or fibromata. In colour they also vary—the latter being of a greyish-white, or light-yellow tint; the former are darker, less vascular, and often stained by blood extravasations. Studding the surface, and particularly in the softer variety, are generally seen a multitude of small, very

yellow nodules, whose presence is really a diagnostic feature. On section, the typical character of the Actinomykoma is best displayed. Imbedded in the fibrous stroma of the growth are noticed the various-sized nodules, more or less numerous, small and isolated, or in confluent rounded masses the size of a hazel or walnut, grey or yellow in colour, of a cheesy softness, and in the very smallest of them are a number of minute particles or centres, sulphur-yellow in tint, which are the clusters of the *Actinomyces*. If one of the cheesy masses is submitted to pressure or teased out, these particles—which resemble *Lycopodium* seeds—are slightly separated from the matter around them.

The majority of these are soft, something like tallow; others may be gritty to the touch, when they are impregnated with lime salts. Whether occurring in animals or man, these peculiar particles must always be considered diagnostic of the disease, even without the aid of the microscope.

When the nodules are removed from the connective-tissue stroma, this is found to be cavernous in its structure, from the large number of small cavities they occupied—another characteristic feature of the tumour.

I have already alluded to the histological characters of the nodules.

As to the manner in which, and channel by which, the fungus invades the tissues, there is no satisfactory evidence. It is, however, extremely probable that it enters, in the form of spores, through a wound, abrasion, fissure, or even by means of the delicate mucous follicles of the membrane lining the lips, mouth, pharynx and nostrils—in fact, any part of the digestive or respiratory canal. It has been shown that it may exist harmlessly in large numbers in the tonsilar glands of the pig, probably waiting for a casual abrasion or removal of the epithelium, in order that it may rapidly develop in the tissues beneath.

This injury may be inflicted in many ways, and very likely by the food upon which the animals most liable to the disease are fed. I am informed by a practitioner in Lincolnshire, that the malady is most frequent after cattle have been fed on straw, barley, and chaff; and this may not only injure the

mouth, but serve also as the vehicle for transmission of the fungus—straw being so often mouldy, and infested with vegetable parasites of various kinds.

The species of animal invaded by the *Actinomyces* appears to have much influence on the pathological results. In man the tendency is to suppurative processes and metastatic abscesses; while in animals it is to new-formation tumours, and induration or degeneration of tissues—be they hard or soft; the extension of the fungus being progressive by means of its spores, which are disseminated, localise themselves, fructify, and produce the characteristic changes in their surroundings. These spores may find their way into the œsophagus, stomach, and intestines, or into the bronchi and lungs, and there fructify.

That the disease is transmissible from one animal to another, there is now no reason to doubt, as the fact has been experimentally demonstrated by Johne and Ponfick. The experiments of these and others had previously failed, probably because the inoculation material was too old and had undergone change.

Johne subsequently employed quite fresh material, and was successful in three out of four experiments—the animals being two calves, a cow, and a foal. The latter remained unaffected. The calves were inoculated subcutaneously behind the lower jaw, and elsewhere, and a small quantity of the same material, which was derived from a tumour on a living cow, was also introduced into the peritoneal cavity. In one case death took place forty days after inoculation; the calf having lost its appetite, became emaciated and debilitated, and then succumbed. At the seat of inoculation, as well as in the abdomen, Actinomykosis was markedly developed. In the second case, death took place 114 days after inoculation, and the results were found to be as marked as in the other instance.

The third case was a pregnant cow, which gave only a small quantity of milk. This animal was inoculated through the milk-duct of the teat. The inoculation was in a few days followed by inflammatory œdema, which soon became developed into phlegmonous Mastitis. Without any treatment the inflammation subsided, but there remained a small hard swelling, which increased so much that in three months the quarter of the gland was double its

normal size, and felt like a hard fibroma. No milk was secreted. The cow was killed 133 days after inoculation, and in the udder were discovered all the signs of Actinomykosis : diffuse fibroma, with, in various parts, multiple spongy fibro-sarcomata, the interspaces of which contained the characteristic nodules or "granulation tissue," enclosing the fungus.

Ponfick did not succeed in inoculating dogs or rabbits. He endeavoured to produce the disease in cattle, by feeding them with infective material in the form of fresh nodules, but the results were negative. By subcutaneous inoculation and intravenous injection, however, he was completely successful, and the lesions of the former were similar to those in Johne's cases. Injection of the material into the jugular vein produced, in the course of two or three months, typical new formations in the lungs. The details of these experiments are very interesting, and I regret I cannot transcribe them here. But they conclusively prove that the artificial production of the disease does not alter in any way its characters.

There is no record of any instances which might tend to show that the disease may be accidentally transmitted ; though the fact that it is inoculable leads us to suppose that it may be conveyed from one animal to another, from one man to another, or from animals to man, and *vice versa*.

Ponfick relates the case of a woman, thirty-four years of age, who was attacked by the disease, and who had been for several years employed as a servant, in which position she was frequently among sick cattle, and these were affected with what the veterinary surgeon who attended them called "wurm"—the popular name in Germany for the malady under consideration. This is the only case of probable transmission recorded.

Now, however, that attention is likely to be directed to the disease by veterinarians and surgeons, we may be able to note its accidental transmission from diseased to healthy animals, and to mankind.

Prognosis.

The prognosis must depend not only upon the locality or anatomical seat of the disease, but also upon the extent to which it has developed itself. When an important organ is involved,

and that extensively, or when the disease is but slightly advanced but is beyond reach, then the prognosis must be unfavourable. When it is accessible, and has not caused serious alteration, and when it can be removed or palliated within a certain time, then it must be pronounced favourable. Sometimes spontaneous recovery takes place, probably owing to the fungus losing its vitality, through diminished nutritive supply from retraction of the connective tissue stroma, and its becoming encapsuled in lime salts.

Treatment.

The treatment of Actinomykosis belongs exclusively to the domain of surgery, and its object must be the extirpation or destruction of the microphyte. This is only possible when it is accessible to the hand, surgical instruments, or destructive agents—as caustics. Tumours situated on the jaws or face can be removed by cutting instruments, but it must be for the veterinary surgeon to determine as to whether operation will be profitable, from a pecuniary point of view. It must be remembered that resection of the jaws, which is generally a desirable and successful operation in man, is not to be recommended in the case of animals, for obvious utilitarian reasons. If it is decided that treatment be resorted to in the case of these and other easily-accessible Actino-mykomatous tumours, they should be removed according to surgical principles, and the wounds dressed with agents which will be likely to destroy any spores of the fungus which may chance to remain ; or the attempt may be made to destroy the fungus by injecting these agents in a fluid state into the centre of the mass. Johne speaks favourably of the action of sulphate of copper in destroying the fungus.

With regard to Actinomykosis of the tongue, success in treatment must depend upon the condition of the organ, *i.e.*, the extent to which it is invaded by the fungus. When this is near the surface it is easily destroyed by caustics, as Carbolic Acid (1 to 25 of water), Tinct. ferri perchlorid., or Liq. ferri perchlorid. fort., diluted with only two parts of water. The latter agent has been very successfully employed by Mr. James, who states with regard to it, "Only at the commencement of treatment is it necessary to dress every day ; after a week, once in two or

three days may be sufficient, but I leave that to the discretion of the practitioner, who will be guided by the appearance of the tongue and the progress the case is making; also to further dilute the dressing if necessary. . . . I always order some extra nutritive food, and I find after two or three dressings there will be a great improvement in the animal's feeding; the tongue will be hardened, and the abnormal sensitiveness destroyed."* A cure cannot be effected in a very short space of time, and patience is necessary to carry out the treatment effectively. When the organ is extensively involved, and treatment is nevertheless determined upon, it is advisable to make more or less deep incisions in the indurated portions, and apply the caustic agent to these, so as to reach the deeper-seated fungus nodules. Excision of a portion of the tongue may even be advantageously resorted to, if the animal is to be fed on soft food, with the intention of its being consigned to the butcher.

When the Actinomykomata are situated in the mouth or pharynx, they may be removed by the knife, *écraseur*, or even the fingers alone, the gag being employed to protect the hand and render the operation easier. Meyer, a veterinary surgeon at Neuhaus, in Germany, has, in the course of twelve years' practice, operated in more than 300 cases of pharyngeal tumours, or so-called Lymphomata. He only employed his hand, passing it into the pharynx, seizing the growth, and removing it by twisting, tearing, and scraping with the finger nail. I am informed that Mr. Wyer, M.R.C.V.S., of Donington, Lincolnshire (where such tumours are frequent), has also been very successful in this operation. He had the animal thrown down, inserted a mouth dilator between the jaws, which were maintained as wide apart as possible; then, with a short-bladed knife he made a vertical incision through the soft palate, to allow more room for the introduction of his hand into the pharynx, in order to tear away the tumours. The hæmorrhage was never serious, and the only danger was the tumefaction which ensued in a few instances.

In some cases, either before or after operation, tracheotomy may be necessary to ensure success.

* The VETERINARY JOURNAL, Vol. xiv., p. 12.

The Sanitary Importance of Actinomykosis.

The sanitary importance of this disease is so far evident. It is proved that the microphyte which induces it, or which constitutes it, can be successfully transplanted from a diseased to a healthy animal, and produce all the serious and characteristic lesions which mark the natural malady. If artificial, or rather experimental, transmission can be easily and successfully accomplished, there can scarcely be any reason to deny the possibility of accidental transmission ; and though at present there is no direct evidence of this having taken place, either in man or beast, yet this absence of proof may be owing to our ignorance of the nature of the disease, and consequent inability to trace or ascribe its origin to infection.

Now that we are acquainted with its pathology, and especially its etiology, and are in a position to be able to diagnose it in man and animals, we shall doubtless rapidly acquire new facts with regard to it. In the meantime, it is well to bear in mind the important fact—for which we are once more entirely indebted to experimental pathology—that the spores of this fungus, alike destructive to man and beast, may invade the body by a trifling scratch or wound, and there set up such changes as to ultimately cause death. Many such cases may have entered our hospitals and come under the observation of the surgeons, without their true nature being suspected. For, as I have already said, no instance—so far as I am aware—has been recorded as occurring in man in this country, Germany alone furnishing all the cases hitherto recorded ; and yet there is only too much evidence to show that it widely prevails among our cattle (probably also among our other domesticated animals), and therefore, those who go about such diseased creatures must be exposed to accidental transplantation of the *Actinomyces*.

ADDENDUM.

Since the foregoing paper was written, M. Kaufmann, assistant-teacher of physiology in the Lyons Veterinary School, has published some investigations he has made with regard to the infectiveness of the fungus, *Aspergillus glaucus*, and as the results of his researches have an important bearing on the subject of micro-pathology, and especially on this of Actinomykosis, I think it will not be amiss to refer to them here.

The microbes and bacterides, it is now fully established, are not the only microscopic agents capable of exercising a pernicious influence on the health of animals and mankind, as other vegetable organisms, and particularly the spores of certain "moulds," possess the same property; and it was to more fully establish this point that Kaufmann undertook his task. In the note which embodies his remarks and conclusions, and which is given in the *Archives Vétérinaires* for Nov. 25th, 1882 (p. 861), he reviews the state of the question up to the moment when he began his experiments: pointing out that in 1869, Grohe and Block produced fatal infection in rabbits, by injecting into their veins the spores of two of the commonest moulds, the *Pencilium glaucum* and *Aspergillus glaucus*. These results, however, were doubted by Cohnheim and Grawitz, who vainly attempted to reproduce them in 1874-75. But at a later period, in 1880, the last of these experimenters succeeded in producing infection with cultivated spores adapted to an alkaline medium.

The experiments which Kaufmann undertook, under the direction of Chauveau, had reference to the *Aspergillus glaucus*, and the results he obtained prove that the spores of this cryptogam are infective without any previous adaptation. The following is the *résumé* he gives of one of his experiments, those which were

afterwards instituted in modifying the circumstances, having corroborated the conclusions arrived at from this one :—

“On May 12th, 1880, on damp bread I sowed the spores of *Aspergillus glaucus* procured from the surface of a dried solution of gum Arabic. This cultivation, placed in a water-bath kept at a temperature of 35° Cent., furnished numerous spores in about forty-eight hours. In order to obtain spores in abundance, I made a new cultivation on bread reduced to broth, with an acid reaction, using for this purpose the spores obtained by the preceding cultivation. This second crop, like the first, furnished spores in abundance in about forty-eight hours. I left these cultivations in the bath until May 19th, and on the evening of that day I put a quantity of spores of the second generation in water enough to make it look slightly turbid. Into the jugular vein of a rabbit (No. 1) I injected one centilitre of this fluid ; and into another rabbit (No. 2) two centilitres. During the night of the 23rd-24th, rabbit No. 1 died ; while rabbit No. 2 was very ill, turning its head towards the side and foaming at the mouth : it died during the night of the 24th-25th. At the autopsy there were found in both rabbits the typical lesions of infection by moulds, such as Grawitz had described. The kidneys were highly congested in places, and on their surface were a multitude of white nodular points. On section from the periphery towards the hilum, it was noted that each white point on the surface was prolonged towards the medullary surface by a white line. Examined microscopically, in all these nodules the mycelium was found to be felted and already undergoing destruction. In rabbit No. 1 the mycelium tubes were yet perfectly recognisable ; they were felted and partitioned, and in every respect similar to those figured by Grawitz. In rabbit No. 2, the one that lived a day longer, the mycelia had almost completely disappeared. Some fragments were noticeable which were easily broken up.

“In the liver there were also numerous white points, which contained fragments of mycelia in process of destruction. The lungs showed a small number of white nodules, but no mycelium tubes could be discovered in them, only granules which were doubtless the product of disintegration of the mycelia under the influence of the inflammation its presence provoked in

the lung tissue. Similar white points to these were also found beneath the pericardium and in the walls of the stomach.

"In these two rabbits, the spores of *Aspergillus glaucus*, cultivated on bread which had an acid reaction, produced a mortal infection exactly similar to that which Grohe and Block obtained, and also like that induced by Grawitz, with their malignant varieties previously adapted to the character of the blood by gradual cultivations.

"The spores which I injected into the rabbits did not undergo any process of adaptation to enable them to live in the blood; nevertheless, they germinated and vegetated in the organism. Previous adaptation is therefore needless in order to render the spores of *Aspergillus glaucus* infective."

Kaufmann alludes to the experimental results published by Koch and his assistants, Loeffler and Gaffky, and which are analogous to those obtained by himself. These German investigators believed they had discovered the cause of Grawitz's non-success. Finally, he arrives at the following conclusions:—

1. The *Aspergillus glaucus* grown on bread may produce fatal infection in the rabbit, even in an extremely small dose, 1/10th of a milligramme. Subsequently it was found that 0.05 milligramme of spores was sufficient to kill large rabbits.

2. That its previous adaptation to a liquid and alkaline medium, and to a temperature of 39° Cent. is not requisite to confer infectious properties.

3. That if this adaptation exercises any influence, it can only be accessory and very slight.

4. That the spores exposed to the temperature of the air during nearly six months preserve all their infective activity.

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PHYSIOLOGY & METAPHYSICS IN RELATION TO MIND

The author of this work is a student of the science of physiology, and has endeavored to present a systematic and comprehensive view of the subject, as it relates to the mind. The work is divided into two parts, the first of which is devoted to a description of the organs and functions of the human body, and the second to a discussion of the principles of physiology as they apply to the mind.

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