
MISSOURI

Agricultural College Experiment Station,

BULLETIN No. 12.

BLACK-LEG,

—BY—

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BLACK LEG.

Gaseous Charbon, Symptomatic Anthrax, Bacterian Anthrax.

INTRODUCTION.

This malady causes the death of many thousand calves and young cattle yearly in our state, and it would be difficult to estimate the total annual loss in America. From all accounts, however, it seems that there is not a state in the union free from it. One can scarcely read an agricultural paper without finding something about it. In Missouri, every monthly report to the Board of Agriculture, coming from farmers in every quarter of the state, furnish ample evidence of its extensive devastation and the powerless condition in which farmers and stockmen find themselves. In the hope of rendering some service to the state, we undertook the study of that disease, as far as our time permitted, (having underway, besides the regular official sanitary work, a programme to follow concerning investigations in Texas fever, the results of which have just been published in bulletin No. 11.)

We did not intend to publish anything now, but we yield to the farmers' demand for information.

Unlike Texas fever, which was misunderstood everywhere, we found in Black-Leg a malady fairly well understood, and hence to attain our object it was not necessary to lay a plan of investigation entirely original.

The extensive experiments and researches of Arloing, Cornevin, Thomas, Chauvan, and others in France have furnished us much material for comparative study, and finding that the disease in question is identical in Europe and America, we quote considerably from the above named authorities for the benefit of our people. As will be shown in this bulletin, we owe much to these scientists for their grand achievements, for to them, besides

being indebted for the many scientific problems which they have solved, we owe the process of vaccination against Black-Leg, which to-day saves millions of dollars to France, Switzerland and other European Countries, and would save our stock raisers on an equal basis if they would only put the discovery in practice.

NATURE, CAUSE, SYMPTOMS AND LESIONS.

Black-Leg is a disease due to parasitic bacteria (or germs) which exist in certain localities, particularly low lands and luxurious grasses, and which when in the body of young cattle, grow principally in the connective tissue (between the skin and flesh) and in the muscles, causing the appearance of dark, bloody, gaseous tumors.

The adult germ is of the rod form with roundish extremities. See Fig. I. The parasite gains access in the body with the food by the alimentary canal. They penetrate from the bowels, like the absorbed nourishment, in various parts of the body, but localize chiefly under the skin in the loose connective tissue about the shoulders, hips, etc., where they find soils fit for their growth and reproduction. It is a disease of cattle almost exclusively, and like other germ diseases, the susceptible animal, and particularly the well fed young calves, are simply the fields in which the parasites develop, generate and thus cause disturbance in the system.

The disease is not transmitted by contact but is inoculable directly, as will be seen further.

The *nature* of this disease then is: A *specific, infectious* malady, contracted by young cattle on infectious grounds and other infectious places, and the essential cause is a germ.

As to the symptoms and lesions I shall mention only the characteristic ones, which are fever, lameness, and local swellings or black muscular tumors with formation of gas therein. The ordinary observer may notice the last named symptoms and lesions only.

As a rule the proprietor is surprised one morning, to find among his herd of cattle, his best, fattest calf, or yearling or two-year old dead. The body is already swelled to enormous proportions and there seems no clue to the cause of such rapid destruction. On examination he finds on the body a local place more enlarged than the rest, and in cutting into it the flesh is found dark and even black as tar. The hand passed over the skin covering this enlargement, causes a crackling or crepitating noise much as the crumpling of paper in the hand; the knife causes a screeching sound in passing through the mass. These peculiar sounds are due to the gas generated by the germs growing in the tissues. Exposed to the air a little while, the dark and apparently bruised flesh regains its natural red color more or less, but not its natural *condition* in full.

In the tissues so abnormal at the time, may be found the germs of Black-Leg.

Perhaps that for a couple of days there will be no more trouble, and the proprietor then will feel secure, but on the other hand as he watches, he may notice a subject more or less lame, in a fore leg or in a hind leg and soon dullness will be appreciable.

On close inspection and hand examination the crepitation, if not the swelling, will be detected. From this moment it will not be long as a rule that the enlargement will be marked, and probably death will have gathered the patient, for very few escape, even with the best treatment, when once the germs have caused much disturbance in the organs. In opening the body the intestines will be found more or less reddened, congested and thickened. The liver and spleen, which in essential Charbon (or Anthrax), and in Texas fever are gorged and softened, offer *little* if any change, although they contain the germs. The disease runs its course in a few hours to a few days. It is not uncommon to see demise within twenty-four hours of the appearance of the first external signs. Consequently medicinal treatment is scarcely practicable

even if there were any remedies capable of positive service as curative agent. We have therefore to institute such practice among our herds as will prevent the occurrence of the plague just as people take means to avoid small-pox and the like. It is only on the line of prevention that we can fight maladies *not* amenable to curative treatment, and even these had better be guarded against and prevented.

THE GERM OF SYMPTOMATIC ANTHRAX.

The microscopic parasite that causes the lesions and phenomenon known as a whole under the common term of Black-Leg, is in the adult state in the tissues, a short rod with rounded extremities. On blood serum, nutritive gelatine, and vegetable albumen artificially prepared, it forms filaments composed of rods and other forms more or less spherical. The germs may be found in the bloody effusion that form the characteristic tumor of Black-Leg, in the tissues of that swelling, the liver, spleen, kidneys, lymphatic glands, and the lungs. It propagates itself by fission and by spore formation, i. e. by the rods breaking off into shorter ones and by formation of seeds. See the illustrations and their explanations on the last page.

INOCULABILITY OF BLACK-LEG.

The many opinions that have been formed concerning the cause of this affection, principally by those who have suffered through it, are so numerous and varied that it would be idle to attempt to disabuse the minds in error, by exposing the fallacies of each theory. Desiring only to give facts, the truth pure and simple, I herewith present evidence as to the causative agent.

One is apt to consider such obscure maladies as Black-Leg as more or less impenetrable mysteries, and yet a few well directed researches and experiments, in these days of scientific progress, are often sufficient to elucidate the most obscure point or question. Black-Leg, however, has been much studied in Europe. Indeed the veterinarians already mentioned (of the Veterinary School of

Lyons) have long and patiently experimented (to the great good of the whole world). They have shown, beyond all doubt, that it is specific and transmissible. Their inoculations from cattle to cattle, cattle to sheep, and to rabbits are conclusive. And yet with all that, most of people on this continent have doubted to this day. Perhaps we are to blame for that, for our stockmen and farmers have not been informed widely as was done in Europe, at government expense.

In order to lay the matter clearly before the masses we made a few experiments. First, we too inoculated cattle from cattle, then sheep from cattle, rabbits from cattle and rabbits from rabbits, and though some writers have denied until now the transmissibility of the disease by inoculation, we have repeatedly succeeded in accomplishing it with serious or deadly results.

My first inoculations were made early in 1887, when filtered, fresh and unmodified fluid of a crushed piece of flesh from a Black-Leg tumor was inoculated to four rabbits with fatal effects in two, and in one heifer with the effect of causing a characteristic tumor and lameness.

In examining the lesions of each sick inoculated animal, they presented the specific appearances of Black-Leg, and the microscope revealed the true germs that produce it.

These limited experiments were certainly in line with the published reports of the French investigators.

Later the same year, I caused the practice of inoculation of *unmitigated* fluid from a liver, with the production of the characteristic tumor with fatal results in two calves five and seven months old respectively. This only confirmed former conclusions.

These spasmodic experiments could not be made of immediate practical use. Without assistance I had to travel officially almost constantly, and methodical laboratory work was almost entirely out of the question.

Late in 1889 however, we had occasion to test again the transmission of Black-Leg and protective inoculation with a *modified* virus.

The following short table gives the results of some of our latest inoculations practiced with very strong virus taken fresh from typical tumors, or from livers or lymph glands of diseased subjects.

TABLE OF SOME INOCULATIONS OF BLACK LEG IN 1890.

Date of INOCULATION 1890.....	Case and Mark.	Average temperature within 5 days*....	Result and Remarks.
Jan. 28	Roan heifer.	103° F.	Produced crepitation & severe lameness for some days; reco'd.
" "	One sheep.	103 1-5	{ Severe pain and enlargement with crepitation at point of inoculation ; lameness quite pronounced; recovered.
" 31	Heifer No. 4 in stable.	103 1-2	{ Virus apparently weak, but caused characteristic swelling of blackleg; recovered.
" "	Sheep in shed.	.....	Very lame; characteristic tumor of Black Leg in the thigh.
" "	Rabbit in cage No. 10.	.....	Crepitation of side at point of inoculation; recovered.
Feb. 2	Heifer at Paquin's house.	105	Characteristic tumor at shoulder; died of true Black Leg.
" 13	Small calf in lot.	102 4-5	Other signs than fever accidentally omitted in the record book.
" "	Sheep.	.....	Typical case of Black Leg. Found dying and killed purposely.
April 1	Rabbit, marked in left ear.	.....	Died of Black Leg on the 4th of April.
" 20	Sheep.	.....	{ Had been inoculated once before and recovered. Showed no illness this time.

In all cases in which death occurred or in which the inoculated subjects were killed purposely, the germs of Black Leg were found in abundance in the loose tissues between the muscles and their fibres, in the liver, spleen and other organs. It is from one of these cases that germs were procured for Fig. 1 in the illustrated page of this bulletin.

*The average normal temperature of cattle is between 100 deg. and 101 deg. F.

PREVENTIVE AND CURATIVE TREATMENTS.

As mentioned, the truly rational treatment of Black-Leg is one calculated to prevent it, but, of course, it will break out here and there unexpectedly, in new places where the germs exist unknown to the people, in spite of any and all precautions unless it be inoculation. Therefore it does become necessary to attempt to limit outbreaks after their appearance, if one is so unfortunate as to be a sufferer thereby.

The first thing to do in a case of Black-Leg is to *remove at once from the place* where the malady started, all the stock showing *no sign* of the disease and *leave the sick ones there*. Place the apparently well ones on higher and dryer lands if possible, or in a yard, or open well ventilated stable, and feed them dry fodder for a week or so and give them plenty of good, clear water—not filthy, stagnant pond or pool water.

During that period if you can procure Black-Leg *vaccine* properly prepared, inoculate every subject twice, i. e. at six or eight days interval, and then nearly all, if not absolutely all, will be in a position to resist the germs of Black-Leg, no matter where exposed, and where they may find them.*

On the belief that only the fattest and best conditioned calves or young cattle become affected, it has been suggested that a treatment calculated to impoverish the system would in a measure prevent Black-Leg. It is partly on this basis that a change of pasture to a poorer one is recommended, and partly because by such practice the animals may be excluded from infectious soil. But on the same principle of impoverishment, the use of setons, or so-called rowels, has been prescribed. It causes copious suppuration and thereby a drain is established on the vital elements of the body. This, by the way, may not sound scientific enough for some of the standing authorities; nevertheless, there is some reason in it, and seemingly, some good results from such practices are not exceptional.

* Any man of ordinary intelligence can safely practice this vaccination or inoculation. All that is necessary is good virus and a hypodermic syringe. P. P.

A seton is inserted in the following manner: With the left hand pull a flap of skin of the dewlap (or brisket) down as far as possible, then with a sharp knife make a hole through the skin, i. e. from one side until the point of the blade appears on the opposite side of the flap, then insert a two or three inch wide tape or a good sized string in the incision. When a seton is in place it bears the same relation to the skin that a thread passed through a fold of cloth bears to that fold. Knots are made at each end, or the ends are so tied together as to prevent the string from pulling out. A little liquor ammonia or corrosive sublimate on the string or tape will increase suppuration. The seton should be pulled to and fro once or twice a week at least.

As to medicinal treatments, experiments with mercurial preparations, carbolic acid, mineral acids, iron and copper preparations, sulphurated agents, and various antiseptics have failed. I have tried also several "sure cures" and specifics (?) recommended, for the purpose of satisfying the demands of the people, and the claims of the manufacturers, but I have failed with all. Pure salt and sulphur, limewater, etc., etc., are, so far as our experience goes, of little if any value as curative medicines. We shall experiment this year with a line of new and untried drugs.

Yet there are cases in which it is desirable to attempt a cure even though chances are much against success. This is particularly true in very valuable animals found ill at an early hour, or in slow, dragging cases. In these I have found the following treatment the most beneficial of all that I have tried, though it is seldom indeed that recovery occurs with even that.

* Place the animal in a lot, yard, or stable, empty the bowels, and activate all the secretions, particularly the urine, in order to favor the expulsion of the poisonous germs and of their products from the body. To attain this object give 10 grains to 3 drams of calomel mixed in a little oil, say 12 ounces of raw linseed oil or

* This for cattle five months to two years old,

castor oil, every three or four hours; and three times a day add 10 gr. to 1 dram of powdered nux vomica to this dose. Give early (and occasionally) thereafter, injections of quarts, and indeed gallons, of warm water in the bowels; follow these medicines in 48 hours with 1-4 to 1 pound of epsom salts if the bowels are not already loose. The kidneys may be activated by the use of pulverized nitrate of potash at about teaspoonful doses 4 times a day. This may be mixed with the above oil emulsion. These combinations of oil, calomel, powdered nux vomica and nitrate of potash are not very scientific, but they are safe enough and they avoid the trouble of frequent dosing, and prevent the worrying of the subjects. Besides that may be given quinine at dram doses, or antipyrine in half these quantities three or four times daily. These are good to counteract the fever. Antipyrine is exceedingly costly however.

The remedy for the evil is preventive inoculation early. See special article further on this point. If this were practiced by every farmer, almost every animal so protected would resist.

BLACK-LEG AND CHARBON.

DIFFERENTIATION. (See Figs. 1 and 2.)

As we occasionally have Charbon in this state* and as people unacquainted with veterinary sciences may occasionally confound the two diseases, it is perhaps well to explain the most marked differences.

In the first place, Black-Leg, in the natural course of things is a disease of *young cattle* I may say exclusively, although it may be *inoculated* to sheep, rabbits, etc.; it is due to a germ described by Chauvau, of France and named *Bacterium Chauveii*. Other names for Black-Leg are Symptomatic Anthrax, Quarter-ill, Emphysematous or Gaseous Anthrax.

* We have not charbon in Missouri any thing like the states of Mississippi, Louisiana and California. It is unfortunate for the people, that in those states, the difference between Charbon and Black Leg have not been laid clearly before them, and have been confounded.

‡A scientific term for the germ of Black-Leg is Clostridium.

Charbon, is a disease of horses, mules, cattle, sheep, etc. etc., and even man. It is due to a germ named *Bacillus Anthracis* which differs radically from the germ of Black-Leg in its preference in vegetation, etc. Charbon is referred to sometimes, simply as Anthrax or as Essential Anthrax, and in man as Malignant Pustule.

In Black-Leg the *most characteristic* and striking signs are the pronounced gaseous black tumors about the shoulders or hips, limbs, neck, back, etc. etc. The *liver* and *spleen*, with the exception of a discoloration which is often the result of changes after death are about *unchanged* in their volume and consistency.

In Charbon these *pronounced gaseous tumors*, are absent, although there are *occasionally* enlargements about the tongue, or throat, particularly when the disease occurs in the horse specie. They are nothing to be mistaken for the true Black-Leg tumors, even if such did appear regularly in Charbon in cattle, which is not the case. The *liver*, *spleen*, (and some other organs) are *changed* in *volume* and *consistency*; they are gorged with dark, thick blood, just the reverse of livers and spleens in Black-Leg.

Both maladies are preventable by vaccination—Black Leg by *one* method, discovered and extensively practiced in Europe by Arloing, Thomas and Cornevin;—Charbon by *another* method discovered and extensively practiced by Pasteur and his agents.* Indeed, to the man of science there seems to be more analogy between Charbon and Septicemia than between Charbon and Black-Leg, and the ordinary observer, is more apt to be confused when noticing the post mortem appearances of Charbon and Texas fever which present lesions much alike in the liver and spleen.

*Both kinds of vaccinations are practiced in this country—the virus being prepared by the principle of the discoverers, but by processes by which the germs may be applied safely by anyone, and preserved for an indefinite period.

VACCINE AND VACCINATION.

(*Protective Virus.*)

There is no more mystery or secret about Black-Leg vaccine than there is about Small-pox vaccine. It simply consists of the germ of the disease so weakened by heat or other processes as to cause fever sufficiently high, but not enough to sicken much, stunt or kill, just as vaccinia is, according to authorities, the germ of horse-pox or cow-pox, which is naturally such as to cause, when inoculated to man, only a mild fever and pustule. But by both inoculations the maladies that they are intended to prevent respectively are in reality guarded against for years.

The germs are obtained from swellings of cases of Black-Leg, are properly weakened by heat at 80 deg. and 85 deg. C., and then worked into convenient form and inoculated twice, each dose about a week apart. The germs heated the most are the weakest and consequently inoculated first, the others are inoculated last. The operation is practiced with an ordinary hypodermic syringe in the tail in the smooth, hairless portion underneath, from four to six inches from the body. Inoculation anywhere else, particularly where the skin is loose on the body, may occasionally cause local characteristic swellings of Black-Leg, that are detrimental and dangerous to the animal.

The vaccine matter may be made into tablets.

If inoculation is practiced during an outbreak, only the animals showing no signs of the disease should be operated on, right after removing them from whence the disease started. On farms where Black-Leg occurs more or less regularly the most rational and successful way is to inoculate young, say at five or six months of age. The death rate need not be feared much thereafter from Black-Leg among the protected stock, if good vaccine was used.

The following quotations show some of the tests abroad:

“Mr. Strebel, in the *Canton of Fribourg*, Switzerland, in the spring of 1886, inoculated with *modified* Black Leg virus 1275 young cattle and left unvaccinated 1829 heads. They were on different more or less infectious grounds. Black-Leg had previously made victims on some of the same pastures. The result was that only one of the vaccinated lot died of the disease, whilst 71 of the unvaccinated succumbed. In the districts of *Gruyere* and *Singine* 160 vaccinated and 433 not vaccinated young cattle were placed *together* on infectious pastures. Among the 160 vaccinated beasts only one was attacked by Black-Leg; among the 433 unvaccinated 20 died from it.”

This is only a modest illustration of hundreds of tests in which thousands of cattle were tried.

I give data of some years back, purposely to show the success of protective inoculation from the beginning. The results now are much better still.

The following presents some of our own field tests in 1889:

PROTECTIVE INOCULATION OF BLACK LEG. (Vaccination.)

Date of 1st inoculation.	Date of 2d inoculation.	Number of cattle.	Condition of herd before inoculation.....	Condition of herd after inoculation. Results and remarks.
1889				
Oct. 8.	Oct. 16.	16	{ Outbreak of Black Leg among young stock; several dead, one sick.	{ Stock left on grounds supposed infectious; none died except the one that had the disease when vaccinated. The cases have since the freedom of all the infectious grounds and remain healthy where they before perished. Not a death after inoculation and the stock roams where death by Black-Leg caused devastation before. There was no Black-Leg among these cattle, they are on grounds where in the years previous the disease caused ravages; cattle remain healthy. Not one death after first vaccination even, and though since the two operations, the animals have been allowed all freedom on infectious soils, not a case occurred.
Oct. 25.	Nov. 3.	17	{ Outbreak of Black Leg among herd. Two deaths.	
Nov. 10.	Nov. 17.	10	{ Cattle healthy, but were on grounds presumably infectious.	
Dec. 16.	Dec. 28.	39	{ Outbreak of Black Leg. Three or four deaths.	

Thus of 82 head vaccinated at different dates in different localities where the disease actually existed and on grounds which had furnished the virus and had caused death, only one died and that one was actually suffering from Black-Leg when inoculated.

IMMUNITY AGAINST BLACK LEG.

The principle by which this disease is prevented by inoculation or vaccination is not more clearly understood than it is in other affections so prevented. The foreign experiments and studies, confirmed by ours, point to the fact that calves that contract the disease never again become seriously ill from it, and that those inoculated purposely likewise remain free from it thereafter. This may explain why, as Arloing has thought, the young stock *particularly* succumb from it, and adult cattle do not suffer; it is probably because these *did* suffer from a mild attack *when young* and thereby they became proof. It has been pretty well established that old cattle in good condition, that have never grazed or been exposed outside where there is liability to receive the germs of Black-Leg, can be inoculated almost as well as young cattle, because they never had become proof by a natural case, mild or serious. On this proposition, we are still experimenting with a view to render the prevention of Black-Leg as cheap as possible. It is now practicable by any one.

The intelligent farmer and stockman may apply it himself.

Very respectfully,

PAUL PAQUIN.

State Veterinarian's Office,
Pathological Laboratory,
Columbia, Mo.
April 25, 1890.

NOTE.—The State Veterinarian of Missouri has no authority of law to manufacture vaccine at state expense. The Paquin Vaccine Laboratory is a private institution under the management of Mr. D. D. Moss, chemist, with which I have no more to do at present than to inspect the vaccine and see that the people get proper material. It was given my name for which I feel honored—by those financially concerned. It is the only institution on the continent manufacturing (different) vaccines to prevent both charbon and black-leg.

P. PAQUIN.

EXPLANATION OF FIGURES.

FIRST PAGE OF ILLUSTRATIONS.—Figures 1 and 2 are intended to show the differences between the germs of Black Leg (or symptomatic anthrax) and the germs of Charbon, (or essential anthrax.)

Figure 1, Black Leg germs from a calf's muscles, magnified 1000 times. 1 shows a spore (or seed) of the germ; 2 spore developing into an adult form; 3 an adult germ or form with a spore at one extremity; 4 blood corpuscle.

Figure "2". Charbon (or true anthrax) germs magnified 1000 times. 1, 1 represents the germ (or bacillus) of anthrax with several fine spores within; 2 represents a blood corpuscle; 3 a germ before the formation of spores within.

SECOND PAGE OF ILLUSTRATIONS.—Figures 2, 3, 4, 5 and 6 from Arloing, Cornevin & Thomas' work on Symptomatic Anthrax, Paris, France, 1887.

Figures 2 and 3 represent spores, adult germs magnified about 700 times, together with fragments of muscle (see Nos. 5 and 6 in fig. 3), plate is from Serosity in affected muscular tissue.

Figure 4 presents blood corpuscles and developing spores.

Figures 5 and 6, affected muscular tissue, exudation of lymph between the muscle fibres (which are colored pink) and a few germs floating therein.

THE GERM OF BLACK LEG.

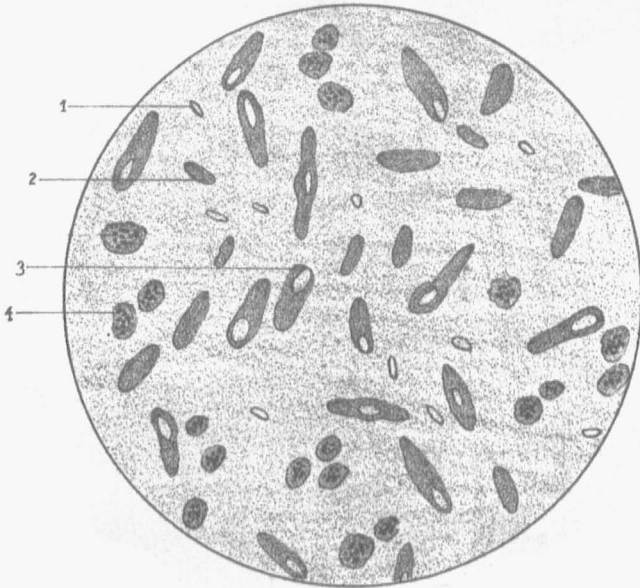


Fig. 1 X 1000.

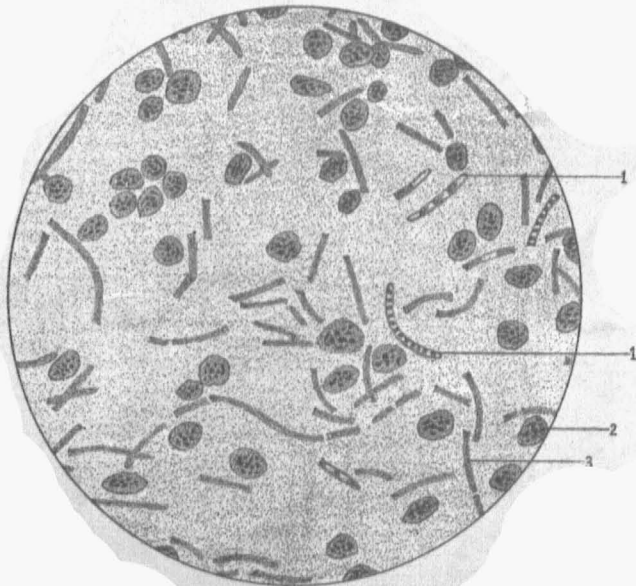


Fig. 2 X 1000.

THE GERM OF BLACK LEG.

Fig. 2.

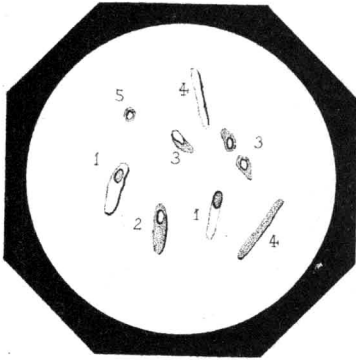


Fig. 3.

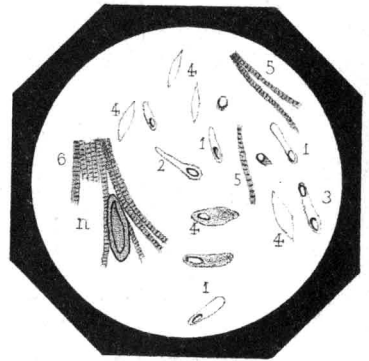


Fig. 4.

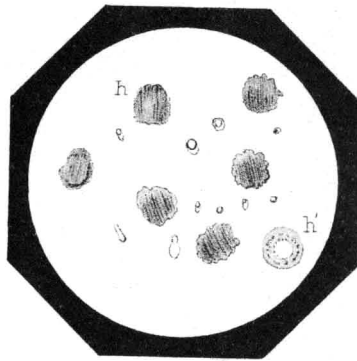


Fig. 5.

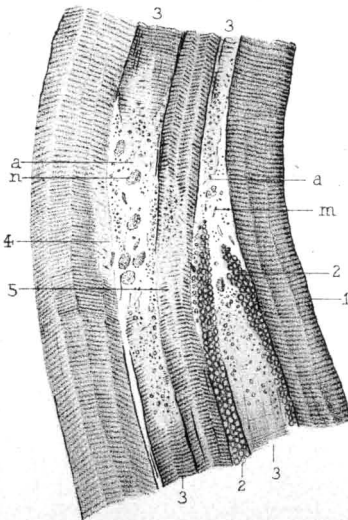


Fig. 6.

