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SPECIAL REPORT

ON

DISEASES OF CATTLE.

BY

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For printing, binding, and distribution of the publications entitled "Diseases of the Horse" and "Diseases of Cattle," $200,000: *Provided*, That said publications shall be deposited one-third in the folding room of the Senate and two-thirds in the folding room of the House of Representatives, and said documents shall be distributed by Members of the Senate and House of Representatives.

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SPECIAL REPORT

ON

DISEASES OF CATTLE.

ADMINISTRATION OF MEDICINES.

By Leonard Pearson, B. S., V. M. D.

Medicines may be administered to cattle in many ways. The channel and method of administration depend on whether a general or local effect is desired, the condition of the animal, and the nature of the medicine that is to be given. The easiest method, and therefore the most common, is to give ordinary remedies by the mouth with the food, with drink, or separately. There are, however, some conditions in which medicines administered in this way will not act promptly enough, or wherein a desired effect of the medicine on a distant part of the body is wholly lacking unless it is applied in some other way.

The various methods of administering medicines to cattle will be considered below.

By the mouth.—The simplest way to give medicines by the mouth is to mix them with the food or water. This can be done when the medicine is in the form of a powder or fluid, if but a small quantity is to be given, if it does not have a taste that is disagreeable to the animal and is not so irritant as to injure the lining membranes of the mouth and throat.

The usual method of administering bulky or unpalatable doses is to mix them with a fluid vehicle, such as water, milk, molasses, or broth, and give from a bottle. A dose given in this way is known as a "drench." In administering a drench the head of the animal should be elevated a little by an assistant. This is best accomplished when standing on the left side of the cow's head and by grasping the nose with the thumb and fingers of the right hand inserted in the nostrils; with the left hand beneath the chin the head is further raised and supported. If the animal is unruly, it may be tied in a stall or placed in a stanchion. The medicine can now be poured into the mouth by inserting the neck of the bottle between the lips on the right side. Care must be taken to avoid getting the bottle between the back teeth.

The mouth of the bottle should be inserted as far as the middle of the tongue and the contents poured slowly. If the cow coughs, the head must at once be lowered to permit the fluid to escape from the larynx. If medicine is given during coughing, some of the dose may pass down the windpipe to the lungs and cause a severe or a fatal pneumonia. This is especially to be guarded against when the throat is partly paralyzed or insensitive, as in parturient paresis (milk fever). In this disease it has often happened that drenches have been poured into the lungs, thus killing the cow.

The quantity of fluid to be given in a drench depends upon the effect desired and the nature of the medicine. In impactions of the stomach very large quantities of fluid may be given—as much as a gallon or several gallons at a time. Usually, however, it is not customary or desirable to give more than from 1 to 2 quarts at a dose, and not more than a pint unless it is necessary on account of the irritant quality of the drug that has to be shielded with a large quantity of the vehicle.

Soluble medicines should be completely dissolved before they are given; insoluble ones should be finely divided by powdering or by shaking, and should be well agitated and mixed immediately before they are given. In the latter case a menstruum with considerable body, such as molasses or flaxseed tea or milk, will help to hold solids or oils in suspension until swallowed.

Balls are large pills adapted for the larger animals. Powders or gums are sometimes mixed with an adhesive substance and rolled into balls for the purpose of convenience of administration. Balls are not used so much and are not so well adapted to the medication of cattle as of horses. The process of solution is slower in the paunch of a cow than in the stomach of a horse; if the cow is so sick as to have stopped ruminating, a ball may get covered up and lost in the mass of material in the paunch and so lie for days, producing no effect whatever.

Capsules are shells or envelopes made of soluble gelatin in which powders or liquids may be inclosed. Capsules and balls are administered by being placed on the tongue well back in the mouth while the tongue is drawn forward and the mouth is held open by a block of wood between the back teeth. The ball should be dropped, the tongue released, and the block removed as nearly simultaneously as possible, so that the backward carriage of the tongue will throw the ball into the throat and lead to its being swallowed. In introducing the ball care must be taken to avoid having the hand cut or crushed. After a little experience it is possible to do away with the block of wood.

By the stomach.—Medicines are introduced directly into the first stomach by the use of an esophageal tube or through the cannula of a trocar passed into the paunch through the side. This method is used in the treatment of diseases of digestion.

By the rectum.—Medicines are usually administered by the rectum for the purpose of controlling the bowels and for the treatment of local diseases. Sometimes, however, medicines that have a general effect are given in this way when, for any reason, it is not possible or convenient to give them through the mouth. Only drugs that are readily absorbed should be given per rectum for a general effect and in somewhat larger dose or more frequently than when given by the mouth. Such stimulants as ether, alcohol, or the aromatic spirits of ammonia, diluted with from four to six times their bulk of warm water, may be used in this way.

Rectal injections, or enemata, are used in the treatment of constipation. If it is the purpose of the injection to soften hardened fecal masses, the water should be comfortably warm and may have a little clean soap in it. If it is the purpose of the injection to stimulate sluggish bowels to contraction, the water may be cold.

In giving rectal injections a rectal syringe may be used, or, better, a piece of one-half to three-quarter inch rubber hose 5 feet long with a tin funnel attached to one end. The hose is soaped or oiled and introduced slowly and gently into the rectum 2 or 3 feet. The fluid is then slowly poured into the funnel and allowed to gravitate into the rectum. The same apparatus may be used for feeding by the rectum.

By the vagina.—Medicines are inserted into the vagina, and through the vagina into the womb, in a manner similar to that of rectal administration. Most of the medication made use of in this way is for the local treatment of these organs. Following calving, during outbreaks of abortion, and in an infectious disease of the vagina, such injections become necessary.

By the udder.—Injections into the udder are now regularly made in the treatment of parturient paresis (milk fever). For this purpose a 1 per cent solution of iodid of potassium is commonly employed, although some other solutions and oxygen gas are also used. In making this injection so many precautions are necessary in relation to the sterilization of the apparatus and the teats and skin that this work should be left to a skilled veterinarian. The introduction of even a minute quantity of infectious dirt may cause the loss of the udder. For making this injection one may use one of the prepared sets of apparatus or a milking tube and funnel connected by a piece of small rubber hose. The apparatus should be boiled and kept wrapped in a clean towel until needed. The udder and teats and the hands of the operator must be well disinfected, and the solution must be freshly made with recently boiled water kept in a sterile bottle. The udder should be emptied of milk before the injection is made. After all these precautions have been observed the milking tube may be inserted and through it one-half pint of solution introduced by gravity air pressure or by syringe. There is practically no danger in this mode of treatment if it is properly carried out.

Injections into the udder are sometimes made in the treatment of garget, but so far with indifferent success.

By the nostrils.—An animal may be caused to inhale medicine in the form of gas or vapor or to snuff up a fine powder. Sometimes. for the purpose of local treatment, fluids are injected into the nose. A medicine inhaled may have either a local or a general effect.

Medicated steam, carrying the volatile products of compound cresol solution, carbolic acid, balsam of Peru, compound tincture of benzoin, tincture of iodin, etc., may be liberated beneath the nostrils of a cow so that she must inhale these soothing vapors; but such treatment is not so common for cattle as for horses. In producing general anesthesia, or insensibility to pain, the vapor of chloroform or ether is administered by the nostrils. As a preliminary to this it is necessary to cast and confine the animal. Great care is necessary to avoid complete stoppage of the heart or breathing.

By the trachea.—Medicines are injected into the trachea, or windpipe, in the treatment of some forms of diseases of the lungs, and especially in that form of bronchitis or pneumonia that is caused by lungworms. For this injection a large hypodermic syringe, fitted with a very thick, strong needle, is used. The needle is to be inserted about the middle of the neck and between the cartilaginous rings of the trachea.

By the skin.—Although a number of drugs, notably mercury, are so readily absorbed by the skin of cattle as to render poisoning easy, medicines are not given in this way for their general or constitutional but only for their local effect.

Diseases of the skin and superficial parasites are treated or destroyed by applications in the forms of washes, ointments, dips, and powders. Liniments and lotions are applied to the skin for the relief of some near-lying part, such as a muscle, tendon, or joint. Blisters are applied to the skin for the purpose of obtaining the effect of counterirritation upon a neighboring region or organ. Cold water may be applied to the skin to reduce the temperature and to diminish congestion or inflammation in a superficial area or to reduce the temperature of the whole body. High fever and heat strokes are treated in this way.

By the tissue beneath the skin.—Hypodermic or subcutaneous injections are often made for the purpose of introducing a drug, reagent, or vaccine directly into the connecting tissue beneath the skin. Introduced in this way, the substance is quickly absorbed, none of it is lost, and its whole effect is obtained, often within a few minutes.

There are numerous precautions necessary in making a subcutaneous injection, most of which have to do with cleansing and sterilization. It is also important to select a proper site for the injection, so that blood vessels, joints, and superficial nerves, organs, or cavities may all be avoided. With due regard for the necessary precautions, there is practically no danger in such an injection, but it should be attempted only by those who are able to carry it through in a surgically clean way. Only certain drugs can be given subcutaneously, and dosage must be accurately graduated.

By the veins.—Certain medicines act most promptly and surely when introduced directly into the blood by injecting them into a vein, usually the jugular. Some vaccines and antitoxins are administered in this way. Intravenous injection should be practiced only by experienced veterinarians.

DISEASES OF THE DIGESTIVE ORGANS.

By A. J. Murray, M. R. C. V. S.

[Revised by R. W. Hickman, V. M. D.]

CHARACTER OF FEEDS AND FEEDING.

Diseases of the digestive organs are very common among cattle, and may often be traced to defects in feeding. The first three stomachs of the larger ruminants hold the feed for a long time, during which period it is subjected to macerating, mixing, and straining processes in preparation for entrance into the fourth or true stomach. The straining is accomplished through the medium of the manyplies or book, while the paunch, or rumen, with its adjunct, the waterbag, is concerned in the macerating, kneading, and mixing, as well as in regurgitation for rumination or the chewing of the cud. The action of the first three stomachs is merely preparatory to digestion. Thus it would seem that as a result of their complex anatomical and functional arrangement the feed of the ox, when of good quality and wholesome, is in the most favorable condition possible for the digestive process when it reaches the fourth stomach, where true digestion first takes place. The location and arrangement of the stomachs are shown in Plates I and II.

If the feed is of improper character, or is so given that it can not be cared for by the animal in a normal way, false fermentations arise, causing indigestion, and possibly, later, organic disease. In feeding cattle there are a number of important considerations apart from the economy of the ration, and some of these are noted below.

Feeds must not be damaged by exposure to the weather, by frost, by molds, or by deleterious fermentations.

Damaged feeds retard or prevent digestion, and sometimes they contain or cause to be generated substances that irritate the digestive tract, or are distinctly poisonous to the animal. For example, hay that was rained on severely during curing has not only lost a part of its nutritive value through a washing-out process, but what remains is not so readily available as in good hay. Roots that have been frozen are likely to irritate and injure the digestive tract. Grass eaten with frost on it may cause severe indigestion. All moldy feeds are not injurious, for some molds appear to have no influence on the process of digestion, but those of other species may not only retard digestion and cause local injury to the digestive organs, but may cause general poisoning of a severe and fatal type.

The following molds have been shown (Dammann) to be dangerous in respect to the production of the morbid conditions enumerated:

Tilletia caries grows chiefly in wheat and may be found with the grain, thus appearing in the bran or meal. It causes paralysis of the throat and spinal cord and irritation of the digestive tract. The rusts, such as *Puccinia graminis*, *P. straminis*, *P. Coronata*, and *P. arundinacea*, cause colic and diarrhea, and in some cases partial paralysis of the throat. The rusts that occur on clovers, beans, and peas cause very severe irritation of the lining membrane of the mouth and throat, resulting sometimes in gangrene of this tissue.

Polydesmus exitans grows on the leaves of rape and turnips, appearing in early summer. This fungus is very irritating to the mouths and feet of cattle, causing severe inflammation and the formation of a false membrane. In some instances this condition has been mistaken for foot-and-mouth disease, but it can be differentiated by the absence of the blister that is characteristic of that disease and by the further fact that it is nontransmissible.

Polytrincium trifolii, which grows on clover, causing it to become black, causes severe irritation of the stomach and intestines of cattle feeding upon it.

Feeds must not contain too large a proportion of woody fiber or of indigestible substances. If the dry matter ingested or the bulk of the feed is very great on account of the small proportion of digestible matter, it is impossible for the great mass to be moistened properly with and attacked by the digestive juices. In consequence of this, abnormal fermentations arise, causing indigestion and irritation of the digestive organs. On the other hand, a ration too concentrated, and especially too rich in protein, is not suitable, because, after a meal, the animal must have a certain feeling of fullness in order to be comfortable and quiet, and the digestive organs require a relatively large volume of contents to fill them to the point where secretion is properly stimulated and their activity is most efficient. If too much protein is in the ration there is a waste of expensive feed, and the tendency is for the animal to become thin. It is evident that a cow can not thrive on concentrated feeds alone, even though these contain in assimilable form all the nutritive materials needed for perfect support. It is because bulk is necessary that the standard of about 25 pounds of dry matter per cow per day has been reached by experimenters. There is no objection to feeding grain or meal separately to a cow, provided enough bulky feed is fed at another time in the day to keep the digestive tract sufficiently distended.

In changing the ration, and especially in making radical changes, as at the beginning and the end of the pasturing season, the change should be made gradually, so that the digestive organs may accommodate themselves to it. After the digestive organs and juices have from long practice become adjusted to the digestion of a certain feed, which is then suddenly withheld and another of quite different character and properties is substituted, the second feed is not well digested; it may even irritate the digestive canal. It is often observed that cattle lose from 25 to 100 pounds when turned on pasture from dry stable feed. This loss can readily be prevented by not shocking the digestive organs by a sudden change of diet.

Regularity in feeding has much to do with the utilization of the ration, and gross irregularity may cause indigestion and serious disease.

Water for live stock should be as free from contamination and as nearly pure as that used for household purposes. When practicable it is well to warm the water in the winter to about 50° F. and allow cattle to drink often.

DISEASES OF THE MOUTH.

WOUNDS AND CONTUSIONS OF THE LIPS, AND SNAKE BITE.

The lips may become inflamed from contusions, which are sometimes produced by a blow from the horns of another animal, or, in the case of working oxen, by a blow from the driver. While cattle are grazing, more especially when they are in woods, they may be bitten in the lips by insects or serpents.

Symptoms.—As a result of a contusion the lips become thick and swollen, and if treatment is neglected the swelling may become hard and indurated, or an abscess may form. This condition renders it difficult for the animal to get food into its mouth, on account of the lips having lost their natural flexibility. In such cases an ox will use his tongue more in the prehension of food to make up for the incapacity of the lips. In cases of snake bite the swelling is soft or puffy and its limits are not well defined.

Treatment.—When we have to deal with a bruise, the affected part should be bathed with hot water two or three times daily. In recent cases no other treatment will be required, but if the swelling is not recent and has become hard or indurated, then the swollen part should be treated each day by painting it with tincture of iodin. In snake bite a straight incision penetrating into the flesh or muscle should be made across the center of the swelling and in the direction of the long axis of the face. After this has been done a small wad of cotton batting should be pressed against the wounds until the bleeding has almost stopped. Afterwards the following lotion may be applied to the wounds several times a day: Permanganate of potassium, half a dram; distilled water, 1 pint. As snake bites are usually attended with considerable depression, which may terminate in stupor, it is advisable to give a stimulant. One ounce of aromatic spirits of ammonia mixed with a pint of water should be given, and the dose should be repeated in half an hour if the animal is sinking into a stupefied and unconscious condition. The repetition of the dose must depend on the symptoms which the animal shows. It must be borne in mind that the object of treatment is to ward off the stupor, which is one of the results of snake bite. The swelling from an insect bite should be bathed with ammonia water as soon as noticed and then treated with frequent applications of hot water.

SALIVATION.

Salivation is a symptom of some general or local disorder. It may be a symptom of a general disease, such as rabies or foot-and-mouth disease, or it may be a purely local trouble, as when copious secretion of the salivary glands is produced by the eating of irritating plants, such as wild mustard. When saliva is observed to dribble from the mouth, that part should be carefully examined by introducing into the mouth an instrument like a balling iron, or, if one is not at hand, by grasping the tongue and partially withdrawing it from the mouth, and by placing a block of wood between the back teeth, while all parts of the mouth are exposed to a good light, so that the presence of any foreign substance may be detected. The cause is sometimes found to be a short piece of wood becoming fixed on the palate, its two ends resting on the upper molar teeth of each side; or it may be a needle, thorn, or splinter of wood embedded in the tongue. Sometimes a sharp piece of tin or other metal may become partially embedded in the inner surface of the cheek. Hay occasionally possesses some quality, usually dependent upon its having heated in the mow or having become moldy, which produces salivation. Second-crop clover and some irritant weeds in the pasture or forage may cause salivation. Cattle rubbed with mercurial ointment may swallow enough mercury in licking themselves to bring about the same result. (See "Mercury poisoning," p. 57.) Such cases, of course, arise from the constitutional action of mercury, and, on account of the common habit which the animals have of licking themselves, indicate the danger of using such preparation externally. Mercury is also readily absorbed through the skin, and as cattle are very susceptible to its action it is thus easy for them to be poisoned by it even without licking it from the surface. Cases of mercurial poisoning sometimes follow disinfection of cattle stables with the usual 1 to 1,000 solution of mercuric chlorid.

Treatment.—If salivation depends on the irritation and inflammation set up by the ingestion of acrid plants, or forage possessing some peculiar stimulating property, the feed must be changed, and a lotion composed of an ounce of powdered alum dissolved in a quart of water may be syringed into the mouth twice a day, using half a pint of the solution each time. If, however, the salivation is due to the presence of a thorn, splinter of wood, or any other foreign substance embedded in the cheek or tongue, the offending object should be removed and the mouth washed occasionally with a weak solution (2 per cent) of carbolic acid and tepid water. When salivation is produced by mercurial poisoning or by foot-and-mouth disease, the treatment appropriate to those general conditions of the system, as well as the local treatment should be applied. (For information about foot-and-mouth disease see p. 383.)

IRREGULARITIES OF THE TEETH.

Irregularities of the teeth may be occasioned by the unequal wearing of some of the teeth or by some of the incisors being broken, which may happen when cattle are pastured on sandy or gravelly soil. The molar teeth may also show irregular wear from similar causes, or from a disease or malformation of the jaw. Their edges may become sharp, or it may happen that a molar tooth has been accidentally fractured. It may also occur that a supernumerary tooth has developed in an unusual position, and that it interferes with the natural and regular mastication of the feed.

Treatment.—The mouth may be examined by grasping the animal's tongue with one hand and partially withdrawing it from the mouth, so as to expose the incisor and molar teeth to inspection. When it is desired, however, to examine the molar teeth with the fingers, so as to obtain a better idea of their condition, an instrument like the balling iron which is used for the horse should be introduced into the mouth, so as to separate the jaws and keep them apart while the examination is being made. Any sharp edges of the molars must be removed by the tooth rasp, such as is used for horses. Any supernumerary tooth which interferes with mastication or any tooth which is fractured or loose should be extracted. In performing such operations it is desirable to throw, or cast, the animal, and to have its head held securely, so as to enable the operator to do what is necessary without difficulty.

CARIES OR DECAY OF THE TEETH.

The presence of caries may be suspected if the mouth exhales a bad odor and if the animal during mastication occasionally stops as if it were in pain. The existence of caries in a molar tooth may be ascertained by examining the mouth in the manner already described. If one of the molars is found to be carious, it should be extracted. When the crown of the tooth has been destroyed and only the stump or root is left, extraction is impracticable. In case the animal has special value the root stumps may be removed by a veterinarian by the operation of trephining; otherwise, it is best to sell the animal to the butcher.

ACTINOMYCOSIS OF THE JAWBONES (BIG JAW OR LUMPY JAW).

[See Actinomycosis, p. 440.]

INFLAMMATION OF MUCOUS MEMBRANE OF MOUTH (STOMATITIS).

The membrane of the mouth may become inflamed by eating some irritating substance or plant, or little vesicles may form in the mouths of calves when they are affected with indigestion, constituting what is termed aphtha.

Symptoms.—The saliva dribbles from the mouth, and when the mouth is examined the surface of the tongue and other parts appear red and inflamed. When young animals are affected with the form of disease termed aphtha, small red elevations are observed on the tongue and other parts of the mouth, having little white points on their centers, which consist of the epithelium of the mucous membrane raised into vesicles. These white patches are succeeded by ulcerated surfaces, which are caused by the shedding of the white patches of epithelium.

Treatment.—When there is merely a reddened and inflamed condition of the mucous membrane of the mouth, it will suffice to syringe it out several times a day with 4 ounces of the following solution: Alum, 1 ounce; water, 2 pints. When the edges of the tongue and other parts of the mouth are studded with ulcers, they should be painted over once a day with the following solution until the affected surface is healed: Permanganate of potassium, 20 grains; water, 1 ounce. When indigestion is associated with an ulcerated condition of the mouth, separate treatment is required.

ULCERATIVE STOMATITIS (OR ULCERS IN THE MOUTHS OF YOUNG CALVES).

[See Necrotic stomatitis, p. 464.]

MYCOTIC STOMATITIS (SORE MOUTH).

[See p. 532.]

INDURATION OF THE TONGUE (ACTINOMYCOSIS).

[See Actinomycosis, p. 440.]

DISEASES OF THE PHARYNX AND GULLET.

PHARYNGITIS (SORE THROAT).

Pharyngitis is an inflammation of the mucous membrane lining the pharynx. It is frequently associated with inflammatory diseases of the respiratory tract, such as laryngitis and bronchitis or pleurisy.

Symptoms.—The muzzle is dry and the saliva dribbles from the corners of the mouth; the animal swallows with difficulty or not at all, and holds its neck in a stiff, straight position, moving it as little as possible. The eyelids are half closed, the white of the eye is bloodshot, and the animal occasionally grinds its teeth. After masticating the feed the animal drops it out of its mouth as if to avoid the pain of swallowing, and also evinces pain when pressure is applied externally on the pharynx and tries to prevent the pressure from being applied.

Causes.—Pharyngitis may be produced by a sudden cooling of the surface of the body, as when cattle are exposed to a cold wind or a cold rain; or by swallowing irritant substances.

Treatment.—The throat should be syringed three times a day with an ounce of the following solution: Nitrate of silver, 1½ drams; distilled water, 1 pint. Bland and soothing drinks, such as linseed tea or oatmeal and water should occasionally be offered. Diet should consist of soft food, such as bran mashes with a little linseed meal mixed in them. Dry hay and fodder should not be given. Fresh, green grass or sound ensilage may be fed in small quantities. The upper part of the throat and the space between the jaws should be well rubbed once a day with the following liniment: Liquor ammonia fortior, 4 ounces; oil of turpentine, 4 ounces; olive oil, 4 ounces; mix. When evidence of blistering appears the application of the liniment should be stopped and the skin anointed with vaseline. Under the treatment described above the inflammation of the throat will gradually subside and the animal will be able to swallow as usual in five or six days. We need hardly say that during its treatment the sick animal should be kept in a comfortable stable.

PAROTITIS.

Inflammation of the parotid gland may arise from the inflammation extending to it when an ox is affected with pharyngitis or laryngitis, or the inflammation may commence in the salivary ducts and may depend on some influence the nature of which is unknown. Parotitis sometimes arises from a blow or contusion severe enough to set up inflammation in the structure of the gland. Tuberculosis and actinomycosis may infrequently be characterized by the lodgment of their parasitic causes in the parotid glands, in which case parotitis may be a symptom of either of these diseases.

Symptoms.—There is an elongated, painful swelling, beginning at the base of the ear and passing downward along the posterior margin of the lower jaw. The swelling is sometimes limited to one side, and when both are swollen it is generally larger on one side than on the other. The secretion of saliva is increased, the appetite is poor, the neck is stiff, so that it is painful to raise the head, and feed is swallowed with difficulty. In many cases the swelling of the glands, when submitted to proper treatment, disappears in a comparatively short time. In other cases, however, they remain enlarged, even after the animal recovers its appetite. In tuberculosis, lymphatic glands beneath the parotid glands are sometimes enlarged, thus causing the appearance of enlarged parotid glands.

Treatment.—A warm bran poltice, made by mixing bran with a hot 2 per cent compound cresol solution in water, should be applied on the swollen gland and kept in place by means of a bandage. Whenever the poultice has cooled it should be replaced by a new one. This treatment should be continued until the pain is less and the swelling is reduced or until there is evidence of pus formation, which may be ascertained by examining the surface of the gland with the fingers; and when, on pressing any part of the surface, it is found to fluctuate or "give," then we may conclude that there is a collection of pus at that place. It is well not to open the abscess until the fluctuation is well marked, as at this stage the pus or matter is near the surface and there is less trouble in healing the wound than if the pus is deep seated. The abscess should be opened with a clean, sharp knife. The poulticing should then be continued for two or three days, but the form of the poultice should be changed, by replacing the bran with absorbent cotton and pouring the compound cresol solution on the cotton. At all times the wound should be kept clean and the cavity injected once or twice daily with a solution of 1 dram of carbolic acid in 8 ounces of water. Under this treatment the pus may cease and the wound heal without complications. Saliva may issue from the orifice and result in the formation of a salivary fistula. This requires operative treatment by a qualified veterinarian. When poulticing fails to reduce the swelling or produce softening, the inflamed area may be rubbed once daily with camphorated oil, compound iodin ointment, or painted twice daily with Lugol's solution of iodin. The diet should be as recommended under Pharyngitis (p. 17).

PHARYNGEAL POLYPI.

Tumors form not infrequently in the pharynx, and may give rise to a train of symptoms varying according to their size and location. The tumor may be so situated that by shifting its position a little it may partially obstruct the posterior nares (nostrils), when, of course, it will render nasal breathing very noisy and labored. In another situation its partial displacement may impede the entrance of air into the larynx. In almost any part of the pharynx, but especially near the entrance of the gullet, tumors interfere with the act of swallowing. As they are frequently attached to the wall of the pharynx by a pedicel or stalk, it will be seen that they may readily be displaced in different directions so as to produce the symptoms before described. Enlarged postpharyngeal lymphatic glands are not rare in tuberculosis, and by pressing upon the wall of the pharynx and restricting the lumen of this organ they cause difficulty in both breathing and swallowing. Such enlarged glands may be differentiated from tumors by passing the hand into the cow's throat after the jaws are separated by a suitable speculum or gag.

Treatment.—The method of treatment in such cases is to separate the animal's jaws with an instrument termed a gag, and then, after drawing the tongue partially forward, to pass the hand into the pharynx and to twist the tumor gently from its attachment. One veterinarian who has had considerable practice in treating this form of disease scrapes through the attachment of the tumor gradually with his thumb nail. When the attachment is too strong to be severed in this way an instrument like a thimble, but possessing a sharp edge at the end, may be used to effect the same purpose, or the base of the tumor may be severed by the use of a crushing instrument known as an écraseur.

CHOKING.

Choking usually happens from attempting to swallow too large an object, such as a turnip, potato, beet, apple, or pear, though in rare cases it may occur from bran, chaff, or some other finely divided feed lodging in and filling up a portion of the gullet. This latter form of the accident is most likely to occur in animals that are greedy feeders.

Symptoms.—The symptoms vary somewhat according to the part of the gullet or throat in which the obstruction is. In most cases there is a discharge of saliva from the mouth; the animal coughs frequently, and when it drinks the water is soon ejected. The cow stops eating and stands back from the trough, the expression is troubled, breathing is accelerated, and oftentimes there is bloating as a result of the retention of gas in the paunch. These symptoms, however, are not always present, for if the obstacle does not completely close the throat or gullet, gas and water may pass, thus ameliorating the discomfort. If the obstruction is in the neck portion of the gullet, it may be felt as a lump in the left jugular gutter.

Treatment.—If the object is in the throat, it is advisable to put a gag in the animal's mouth, and, while the head is in a horizontal direction by two assistants, to pass the hand into the pharynx, grasp the foreign body, and withdraw it gradually and steadily. When the substance is lodged in the upper part of the gullet, pressure should be made by an assistant in an upward direction against the object while the operator passes his hand into the pharynx, and if the assistant can not by pressure dislodge the substance from the gullet, the operator may by passing his middle finger above and partly behind the substance gradually slide it into the pharynx and then withdraw it by the mouth.

The presence of an obstructing substance in the cervical (neck) portion of the gullet may be ascertained by passing the hand along the left side of the neck, when a hard and painless swelling will be found to indicate the presence of the foreign body. In such cases we must endeavor by gentle and persevering pressure with the thumb and next two fingers to slide the obstructing substance gradually upward to the pharynx. To facilitate this it is well to give the animal a half pint of raw linseed or olive oil before the manipulations described are commenced. When the substance has been brought into or nearly into the pharynx, then the mouth gag should be used, the tongue drawn partially forward with the left hand, and the right should be passed backward into the pharynx to withdraw the obstruction.

When bran or chaff causes the trouble it is best to give a small quantity of oil to lubricate the walls of the gullet, and then by gentle and persevering pressure, to endeavor to separate and divide the mass and to work it downward toward the stomach. This will be assisted by pouring small quantities of oil and water down the animal's throat. It is not advisable to use the probang to push down any soft material, such as oats or chaff, as this generally condenses and renders firmer the obstructing substance by pressing its particles or elements together, so that it forms a solid, resisting mass which can not be moved.

In some cases the foreign body, either because it is in the chest portion of the esophagus, and so beyond reach, or because too firmly seated, can not be dislodged from the neck by pressing and manipulating that part externally. In such event we must resort to the use of the probang. (Pl. III, figs. 2 and 3.) A probang is a flexible instrument and adapts itself to the natural curvature of the gullet, and if used cautiously there is not much risk of injury. Before passing the probang, a gag which has an aperture at each end, from which straps pass to be buckled at the back of the head below the horns, is introduced into the mouth. (Pl. III, fig. 4.) The probang should then be oiled, and, the head and neck being held in a straight line by two assistants, the tongue must be partly drawn out of the mouth, the probang cautiously passed along the roof of the mouth into the pharynx and thence into the gullet, through which it is passed down. If resistance is met, gentle and continuous pressure must be used, under the influence of which the object will generally in a short time pass into the stomach. One must be careful not to pass the probang into the larynx and thence into the windpipe, as an animal may readily be killed in this way. This accident is indicated by efforts to cough and by violently disturbed breathing. If such symptoms arise the probang must be withdrawn at once. To avoid a wrong passage, the end of the tube should be pressed very slowly through the throat until its presence in the esophagus is assured. After it is once in the esophagus care is still necessary, because the walls of this tube may easily be torn.

Some writers have advised that when the obstruction is lodged in the cervical (neck) portion of the gullet it should be struck with a mallet, to crush it and thus alter its shape, so that it may easily slip down into the stomach. If the obstructing substance is hard, this will be a dangerous operation, but if soft—as in the case of a ripe pear, for example—this procedure may be safely adopted.

In all cases, if pressure applied on the neck fails to move the obstruction and the probang also fails to move it, it may be divided by a subcutaneous operation, or the gullet may be opened and the obstructing substance removed through the wound. In such cases the assistance of a veterinarian or a surgeon must be obtained.

WOUNDS AND INJURIES OF THE GULLET.

Sometimes the walls of the gullet may be more or less lacerated or abraded by the rash and too forcible use of the probang, and the animal consequently swallows with pain and difficulty. In such cases dry feed must be withheld for five or six days, so as to allow the injured parts to heal, and the diet must be limited to linseed tea, hay tea, and thin oatmeal gruel and molasses. The same kind of diet must be fed after the operation of cutting into the gullet has been performed.

Sometimes the gullet is ruptured and lacerated to such an extent that treatment of any kind is hopeless. This has been known to occur when the handle of a pitchfork or buggy whip has been pushed down a cow's throat to remove an obstruction. When such treatment has been applied it is best to slaughter the animal without delay, as the flesh may be utilized so long as there is no fever or general disease, and remedial treatment would be hopeless. In this connection it may be mentioned that whatever substitute may be used for a probang, which sometimes is not at hand, it should be flexible and should possess a smooth surface. A piece of new rope, with the end closely wrapped and waxed and then oiled, or a piece of thin garden hose, or a well-wrapped twisted wire may be used in emergencies.

DISEASES OF THE STOMACHS.

ACUTE TYMPANITES (HOVEN, OR BLOATING).

Tympanites is a distention of the rumen or paunch with gases of fermentation, and is manifested outwardly by swelling in the region of the left flank.

Causes.—Tympanites may be caused by any kind of feed which produces indigestion. When cattle are first turned into young clover they eat so greedily of it that tympanites frequently results. Turnips, potatoes, cabbage, or the discarded pulp from sugar-beet factories may also cause it. Middlings and corn meal also frequently give rise to it.

Care is necessary in turning animals into fields of clover or stubble fields in which there is a strong growth of volunteer grain. It is always better to keep them from such pasturage while it is wet with dew, and they should be taken out when they have eaten a moderate quantity. When cattle are fed upon pulp from sugar beets, germinated malt, etc., they should be fed in moderate amounts until they have become accustomed to it, as any of these feeds may give rise to severe bloating.

An excessive quantity of any of the before-mentioned feeds may bring on this disorder, or it may not be caused by excess, but to eating too hastily. Sometimes the quality of the feed is at fault. Grass or clover when wet by dew or rain frequently disorders digestion and brings on tympanites; frozen roots or pastures covered with hoar frost should also be regarded as dangerous. When feed has been eaten too hastily, or when it is cold and wet, the digestive process is imperfectly performed, and the feed contained in the paunch ferments, during which process large quantities of gas are formed. The same result may follow when a cow is choked, as the obstruction in the gullet prevents the eructation or passing up of gas from the stomach, so that the gas continues to accumulate until tympanites results.

Symptoms.—The swelling of the left flank is very characteristic, as in well-marked cases the flank at its upper part rises above the level of the backbone, and when struck with the tips of the fingers emits a drum-like sound. The animal has an anxious expression, moves uneasily, and is evidently distressed. If relief is not obtained in time, it breathes with difficulty, reels in walking or in standing, and in a short time falls and dies from suffocation. The distention of the stomach may become so great as to prevent the animal from breathing, and in some instances the case may be complicated by rupture of the stomach.

Treatment.—If the case is not extreme, it may be sufficient to drive the animal at a walk for a quarter or half an hour; or cold water by the bucketful may be thrown against the cow's sides. In some cases the following simple treatment is successful: A rope or a twisted straw band is coated with pine tar, wagon grease, or other unsavory substance and is placed in the cow's mouth as a bit, being secured by tying behind the horns. The efforts of the animal to dislodge this object result in movements of the tongue, jaws, and throat that stimulate the secretion of saliva and swallowing, thus opening the esophagus, which permits the exit of gas and at the same time peristalsis is stimulated reflexly.

In urgent cases the gas must be allowed to escape without delay, and this is best accomplished by the use of the trocar. The trocar is a sharp-pointed instrument incased in a cannula or sheath, which leaves the sharp point of the trocar free. (See Pl. III, figs. *5a* and *5b*.) In selecting the point for using the trocar a spot on the left side equally distant from the last rib, the hip bone, and the transverse processes of the lumbar vertebræ must be chosen. Here an incision about three-fourths of an inch long should be made with a knife through the skin, and then the sharp point of the trocar, being directed downward, inward, and slightly forward, is thrust into the paunch. (Pl. I.) The cannula or sheath of the trocar should be left in the paunch so long as any gas continues to issue from it. If the cannula is removed while gas is still forming in the paunch and the left flank becomes considerably swollen, it may be necessary to insert it again. It is well, accordingly, to observe the cannula closely, and if gas is found to be issuing from it it should not be removed. When gas issues from it in considerable quantities the sound accompanying its escape renders the exact condition obvious. It is occasionally necessary to keep the cannula in the stomach for several hours. When this is necessary a piece of stout cord should be passed round the neck of the cannula immediately below the projecting rim and then be passed round the animal's body and tied in a secure knot, and a careful attendant must remain with the cow during the entire period that the instrument is in place. The rim surrounding the mouth of the cannula should be in contact with the skin. Whenever the person in charge of the cow is convinced that gas has ceased to issue from the cannula the instrument should be removed.

The trocar is to be used only in extreme or urgent cases, though everyone who has had experience in treating indigestion in cattle realizes that he has saved the lives of many animals by its prompt application.

When the tympanitic animal is not distressed and the swelling of the flank is not great, or when the most distressing condition has been removed by the use of the trocar, it is best to use internal medicine. Two ounces of aromatic spirits of ammonia should be given every half hour in a quart of cold water; or half an ounce of chlorid of lime may be dissolved in a pint of tepid water and the dose repeated every half hour until the bloating has subsided; or 1 ounce of creolin in 2 quarts of tepid water may be given at one dose or carefully injected through the cannula directly into the paunch to stop fermentation and the consequent formation of gas. It is generally necessary to give a moderate dose of purgative medicine after bloating has subsided, as animals frequently show symptoms of constipation after attacks of indigestion. For this purpose 1 pound of Glauber's salt may be used.

The animal should be fed carefully upon easily digested food for several days after the bloating has subsided, so that all fermenting matter may pass out of the stomach.

CHRONIC TYMPANITES.

Cattle, especially those that have been kept in the stable all winter, are liable to suffer from chronic tympanites. In this form they bloat up after feeding, but seldom swell so much as to cause any alarm. The chronic form of indigestion may also follow an acute attack like that previously described. This is also a symptom of tuberculosis when the lymphatic glands lying between the lungs are so enlarged as to press upon and partly occlude the esophagus. It may develop in calves as a result of the formation of hair balls in the stomach.

Treatment.—Treatment should be preceded by a moderate dose of purgative medicine: 1 pound of sulphate of magnesia (Epsom salt) or sulphate of soda (Glauber's salt), half an ounce of powdered Barbados aloes, 1 ounce of powdered ginger, 1 pint of molasses. The salts and aloes should be dissolved by stirring for a few minutes in 2 quarts of lukewarm water, then the molasses should be added, and after all the ingredients have been stirred together for about 10 minutes the dose should be administered. After the operation of the purgative it is generally necessary to give some tonic and antacid preparation to promote digestion, which is imperfectly performed in such cases. The following may be used: Powdered gentian, 3 ounces; powdered bicarbonate of potash, 3 ounces; powdered ginger, 3 ounces; powdered capsicum, 1 ounce. Mix and divide into 12 powders, one of which should be given three times a day before feeding, shaken up with a pint and a half of water. It is also advantageous in such cases to give two heaped teaspoonsfuls of wood charcoal, mixed with the animal's feed three times a day. The animal should also go out during the day, as want of exercise favors the continuance of this form of indigestion. If the dung is hard, the constipation should be overcome by feeding a little flaxseed twice daily or by giving a handful of Glauber's salt in the feed once or twice daily, as may be necessary. Roots, silage, and other succulent feeds are useful in this connection. If tuberculosis is suspected as the cause of chronic bloating, a skilled veterinarian should make a diagnosis, using the tuberculin test if necessary. Until it is settled that the cow has not tuberculosis, she should be kept apart from the other members of the herd.

DISTENTION OF RUMEN OR PAUNCH WITH FEED.

This form of indigestion is caused by the animal gorging itself with feed, and arises more from the animal's voracious appetite than from any defect in the quality of the feed supplied to it. The condition is, however, more severe if the feed consumed is especially concentrated or difficult of digestion. In cases of this kind there is comparatively no great formation of gas, and the gas which is formed is diffused through the stomach instead of accumulating in a layer in its upper part. On pressing the flank with the closed fist the indent of the hand remains for a short time in the flank, as if the rumen were filled with a soft, doughy mass.

This form of indigestion should be treated by stimulants, such as aromatic spirits of ammonia.

If the formation of gas is not great and the distention with solid material is somewhat limited, the animal may be drenched through a piece of ordinary garden hose, one end inserted in the mouth, and the other end fitted with a funnel, giving 1½ pounds of Epsom salt or Glauber's salt dissolved in 2 gallons of water, at a single dose. Immediately after this treatment the left side of the animal, extending below the median line of the abdomen, should be powerfully kneaded with the fist, so that the impacted food mass will be broken, allowing the water to separate it into small portions which can be carried downward for the process of digestion. But if the treatment fails and the impacted or overloaded condition of the rumen continues, it may become necessary to make an incision with a sharp, long-bladed knife in the left flank, commencing at the point where it is usual to puncture the stomach of an ox, and prolong the incision in a downward direction until it is long enough to admit the hand. When the point of the knife is thrust into the flank and the blade cuts downward, the wall of the stomach, the muscle, and the skin should all be cut through at the same time. Two assistants should hold the edges of the wound together so as to prevent any food from slipping between the flank and the wall of the stomach, and then the operator should remove two-third of the contents of the rumen. This having been done, the edges of the wound should be sponged with a little carbolized warm water, and, the lips of the wound in the rumen being turned inward, they should be brought together with catgut stitches. The wound penetrating the muscle and the skin may then be brought together by silk stitches, which should pass through the entire thickness of the muscle and should be about 1 inch apart. The wound should afterwards be dressed once a day with a lotion and the animal covered with a tight linen sheet, to protect the wound from insects and dirt. The lotion to be used in such case is made up as follows: Sulphate of zinc, 1 dram; carbolic acid, 2 drams; glycerin, 2 ounces; water, 14 ounces; mix. It is clear that this operation requires special skill and it should be attempted only by those who are competent.

IMAGINARY DISEASES (HOLLOW HORN; LOSS OF CUD; WOLF IN THE TAIL).

It would appear quite in place here, in connection with the diseases of the stomach and bowels of cattle, to consider the three old fallacies or superstitions known by the above names, since these names, whenever and wherever used, seem to be invariably applied to some form of digestive derangement or disease having its origin in the stomach and bowels.

Hollow horn.—In the first place it should be noted that the horns of all animals of the ox tribe are hollow. The horn cores are elongations of the frontal bones of the skull, and the frontal sinuses, which are the larger of the air spaces of the head, are prolonged into the horn cores. When a cow is sick, if the horns are hot it is an evidence of fever; if they are cold it indicates impaired circulation of the blood; but these manifestations of sickness are to be regarded as symptoms of some constitutional disorder and do not in themselves require treatment. The treatment should be applied to the disease which causes the abnormal temperature of the horns. The usual treatment for the supposed hollow horn, which consists in boring the horns with a gimlet and pouring turpentine into the openings thus made, is not only useless and cruel, but is liable to set up an acute inflammation and result in an abscess of the sinus.

Loss of cud.—The so-called loss of cud is simply a cessation of rumination, frequently one of the first indications of some form of disease, since ruminants stop chewing the cud when they feel sick. Loss of cud is a symptom of a great many diseases, and when it is detected it should lead the observer to try to discover other symptoms upon which to base a correct opinion as to the nature of the disease from which the animal suffers. No local treatment is required.

Wolf in the tail.—This term also seems to be vaguely applied to various disturbances of the digestive function, or to some disease which is in reality in the stomach or bowels.

VOMITING.

Vomiting is not to be confounded with rumination, though some writers have advanced the opinion that it is merely a disordered and irregular rumination. It is not of common occurrence in cattle.

Symptoms.—Animals which vomit are frequently in poor condition. After having eaten tranquilly for some time the animal suddenly becomes uneasy, arches the back, stretches the neck and head, and then suddenly ejects 10 to 12 pounds of the contents of the rumen.

After having done this the uneasiness subsides and in a short time the animal resumes eating as if nothing had happened.

Cause.—The cause of this disordered state of the digestive system in cattle is usually obscure, but has in some cases been traced to a partial closure of the opening into the second stomach or to a distention of the esophagus. It has been found to occur when there was cancerous disease of the fourth stomach, and experimentally it has been shown that a suspension of digestion or great derangement of this stomach produces considerable nervous disorder of the rumen and sometimes vomiting or attempts to vomit.

Treatment.—Easily digested feed and plenty of water should be given. Fear and excitement, chasing, or hurrying animals after they have eaten heartily are liable to bring on this result. In order to overcome irritation which may produce vomiting the following draft should be given: Hydrate of chloral, half an ounce; water, 1 pint. The dose must be repeated when the condition of the animal seems to require it. As a rule, treatment is not successful.

DEPRAVED APPETITE (PICA).

Cattle suffering from this disease have a capricious and variable appetite as regards their ordinary feed but evince a strong desire to lick and eat substances for which healthy cattle show no inclination. Alkaline and saline-tasting substances are especially attractive to cattle having a depraved appetite and they frequently lick lime, earth, coal, gravel, and even the dung of other cattle. Cows in calf and young cattle are especially liable to develop these symptoms. Animals affected in this way lose condition, their coat is staring, gait slow, and small vesicles containing yellow liquid form under the tongue; the milk given by such cows is thin and watery. Such animals become restless and uneasy, as is indicated by frequent bellowing. The disease may last for months, the animal ultimately dying emaciated and exhausted. Depraved appetite frequently precedes the condition in which the bones of cattle become brittle and fracture easily, which is known as osteomalacia.

Cause.—From the fact that this disease is largely one of regions, it is generally believed that some condition of the soil and water and of the local vegetation is responsible for it. It is more prevalent some years than others, and is most common in old countries, where the soil is more or less depleted. Cattle pastured on low, swampy land become predisposed to it. It occasionally happens, however, that one individual in a herd suffers though all are fed alike; in such cases the disease must arise from the affected animal's imperfect assimilation of the nutritive elements of the feed which is supplied to it.

Treatment.—The aim in such cases must be to improve the process of digestion and to supply the animal with a sufficiency of sound and wholesome feed. The following should be given to the cow three times a day, a heaping tablespoonful constituting a dose: Carbonate of iron, 4 ounces; finely ground bone or "bone flour," 1 pound; powdered gentian, 4 ounces; common salt, 8 ounces; powdered fenugreek, 4 ounces; mix. In addition to this, 3 tablespoonfuls of powdered charcoal may be mixed with the feed three times a day, and a piece of rock salt should be placed where the animal can lick it at will. German veterinarians have had brilliant results from the treatment of this disease with subcutaneous injections of apomorphin in doses of 1½ to 5 grains for three or four days.

HAIR CONCRETIONS.

Hair concretions, or hair balls, result from the habit which some cattle have of licking themselves or other animals. As a result the hairs which are swallowed are carried around by the contractions of the stomach and gradually assume the form of a small pellet or ball. This increases in size as fresh quantities of hair are introduced into the stomach and adhere to the surface of the ball. These balls are found most frequently in the reticulum or second stomach (Pl. II, B), though sometimes in the rumen. In calves hair balls are generally found in the fourth stomach. There are no certain symptoms by which we can determine the presence of hair balls in the stomach, and therefore no treatment can be recommended for such cases. In making post-mortem examinations of cattle we have sometimes found the walls of the reticulum transfixed with nails or pieces of wire, and yet the animal had not shown any symptoms of indigestion, but had died from maladies not involving the second stomach.

INDIGESTION (DYSPEPSIA, OR GASTROINTESTINAL CATARRH).

Tympanites, already described, is a form of indigestion in which the chief symptom and most threatening condition is the collection of gas in the paunch. This symptom does not always accompany indigestion, so it is well here to consider other forms under a separate head. If indigestion is long continued, the irritant abnormal products developed cause catarrh of the stomach and intestines—gastrointestinal catarrh. On the other hand, however, irritant substances ingested may cause gastrointestinal catarrh, which, in turn, will cause indigestion; hence, it results that these several conditions are usually found existing together.

Causes.—Irritant feed, damaged feed, overloading of the stomach, or sudden changes of diet may cause this disease. Want of exercise predisposes to it, or feed which is coarse and indigestible may after a time produce it. Feed which possesses astringent properties and tends to check secretion may also act as an exciting cause. Feed in excessive quantity may lead to disorder of digestion and to this disease. It is very likely to appear toward the end of protracted seasons of drought; therefore a deficiency of water must be regarded as one of the conditions which favor its development.

Symptoms.—Diminished appetite, rumination irregular, tongue coated, mouth slimy, dung passed apparently not well digested and smelling bad, dullness, and fullness of the flanks. The disease may in some cases assume a chronic character, and in addition to the foregoing symptoms slight bloating or tympanites of the left flank may be observed; the animal breathes with effort and each respiration may be accompanied with a grunt, the ears and horns are alternately hot and cold, rumination ceases, the usual rumbling sound in the stomach is not audible, the passage of dung is almost entirely suspended, and the animal passes only a little mucus occasionally. Sometimes there is alternating constipation and diarrhea. There is low fever in many cases.

The disease continues a few days or a week in the mild cases, while the severe cases may last several weeks. In the latter form the emaciation and loss of strength may be very great. There is no appetite, no rumination, nor peristalsis. The mouth is hot and sticky, the eyes have receded in their sockets, and milk secretion has ceased. In such cases the outlook for recovery is unfavorable. The patient falls away in flesh and becomes weaker, as is shown by the fact that one frequently finds it lying down.

On examining animals which have died of this disease it is found that the lining membrane of the fourth stomach and the intestines, particularly the small intestine, is red, swollen, streaked with deeper red or bluish lines, or spotted. The lining of the first three stomachs is more or less softened, and may easily be peeled off. The third stomach (psalter) contains dry feed in hard masses closely adherent to its walls.

In some cases the brain appears to become disordered, probably from the pain and weakness and from the absorption of toxins generated in the digestive canal. In such cases there is weakness and an unsteady gait, the animal does not appear to take notice of and will consequently run against obstacles; after a time it falls and gives up to violent and disordered movements. This delirious condition is succeeded by coma or stupor, and death ensues.

Treatment.—Small quantities of roots, sweet silage, or selected grass or hay should be offered several times daily. Very little feed should be allowed. Aromatic and demulcent drafts may be given to produce a soothing effect on the mucous lining of the stomachs and to promote digestion. Two ounces of camomile flowers should be boiled for 20 minutes in a quart of water and the infusion on cooling should be given to the affected animal. This may be repeated three or four times a day. When constipation is present the following purgative may be administered: One pound of Glauber's salt dissolved in a quart of linseed tea and a pint of molasses. After this purgative has acted, if there is a lack of appetite and the animal does not ruminate regularly, the powder mentioned in remarks on the treatment of chronic tympanites may be given according to directions. The diet must be rather laxative and of an easily digestible character after an attack of this form of indigestion. Feed should be given in moderate quantities, as excess by overtaxing the digestive functions may bring on a relapse. Ice-cold water should be avoided.

INDIGESTION FROM DRINKING COLD WATER (COLIC).

This disorder is produced by drinking copiously of cold water, which arrests digestion and produces cramp of the fourth stomach, probably of the other stomachs, and also of the bowels.

Causes.—It is not customary for the ox to drink much water at once. In fact, he usually drinks slowly and as if he were merely tasting the water, letting some fall out at the corners of his mouth at every mouthful. It would therefore seem to be contrary to the habits of the ox to drink copiously; but we find that during hot weather, when he has been working and is consequently very thirsty, if he drinks a large quantity of cold water he may be immediately taken with a very severe colic. Cows which are fed largely on dry hay drink copiously, like the working ox, and become affected in precisely the same manner. In such cases they are seized with a chill or fit of trembling before the cramps come on.

Symptoms.—There is some distension of the abdomen, but no accumulation of gas. As the distension and pain occur immediately after the animal has drunk the water, there can be no doubt as to the exciting cause.

Treatment.—Walk the animal about for 10 minutes before administering medicine, and this allows time for a portion of the contents of the stomach to pass into the bowel, and renders it safer to give medicine. In many cases the walking exercise and the diarrhea bring about a spontaneous cure of this disorder, but as in some instances the cramps and pains of the stomachs persist, one may give 1 ounce of sulphuric ether and 1 ounce of tincture of opium, shaken up with a pint of warm water, and repeat the dose in half an hour if the animal is not relieved. In an emergency when the medicine is not to be had, a tablespoonful of powdered ginger may be administered in a pint of warm water.

INDIGESTION IN CALVES (GASTROINTESTINAL CATARRH, DIARRHEA, OR SCOUR).

Calves are subject to a form of diarrhea to which the foregoing designations have been applied.

Causes.—Calves that suck their dams are not frequently affected with this disease, though it may be occasioned by their sucking at long intervals and thus overloading the stomach and bringing on indigestion, or from improper feeding of the dam on soft, watery, or damaged feeds. Suckling the calf at irregular times may also cause it. Exposure to damp and cold is a potent predisposing cause. Calves separated from their dams and fed considerable quantities of cold milk at long intervals are liable to contract this form of indigestion. Calves fed on artificial feed, used as a substitute for milk, frequently contract it. Damaged feed, sour or rotten milk, milk from dirty cans, skim milk from a dirty creamery skim-milk vat, skim milk hauled warm, exposed to the sun and fed from unclean buckets may all cause this disease.

Symptoms.—The calf is depressed; appetite is poor; sometimes there is fever; the extremities are cold. The dung becomes gradually softer and lighter in color until it is cream colored and little thicker than milk. It has a most offensive odor and may contain clumps of curd. Later it contains mucus and gas bubbles. It sticks to the hair of the tail and buttocks, causing the hair to drop off and the skin to become irritated. There may be pain on passing dung and also abdominal or colicky pain. The calf stands about with the back arched and belly contracted. There may be tympanites. Great weakness ensues in severe cases, and without prompt and successful treatment death soon follows.

Treatment.—Remove the cause. Give appropriate feed of best quality in small quantities. Make sure that the cow furnishing the milk is healthy and is properly fed. Clean all milk vessels. Clean and disinfect the stalls. For the diarrhea give two raw eggs or a cup of strong coffee. If the case is severe, give 1 ounce of castor oil with a teaspoonful of creolin and 20 grains of subnitrate of bismuth. Repeat the bismuth and creolin with flaxseed tea every four hours. Tannopin may be used in doses of 15 to 30 grains.

Calves artificially fed on whole or skim milk should receive only such milk as is sweet and has been handled in a sanitary manner. Milk should always be warmed to the temperature of the body before feeding. When calves artificially milk-fed develop diarrhea, the use of the following treatment has given excellent results in many cases: Immediately after milking, or the separation of the skim milk from the cream, formalin in the proportion of 1 to 4,000 should be added to the milk which is used for feeding; this may be closely approximated by adding four drops of formalin to each quart of milk. This medicated milk should be fed to the calf in the usual quantity. When the diarrhea is not controlled in three or four days by this treatment, the additional use of some of the agents recommended above may assist in a recovery.

INFECTIOUS DIARRHEA; WHITE SCOUR.

[See chapter on Diseases of young calves, p. 247.]

GASTROENTERITIS.

This consists of an inflammation of the walls of the stomachs and of the bowel.

Gastroenteritis, or inflammation of the walls of the stomachs and intestines, follows upon irritations more severe or longer continued than those that produce gastrointestinal catarrh.

Causes.—Severe indigestion may be followed by gastroenteritis, or it may be caused by swallowing irritant poisons, such as arsenic or corrosive sublimate or irritant plants. Exposure to cold or inclement weather may produce the disease, especially in debilitated animals or animals fed improperly. It is asserted that if cattle feed on vegetation infested with some kinds of caterpillars this disease may result.

Symptoms.—Dullness; drooping of the ears; dryness of the muzzle; dry skin; staring coat; loins morbidly sensitive to pressure; fullness of the left flank, which is caused by the distention of the fourth stomach by gas. The pulse is small, the gait is feeble and staggering; each step taken is accompanied with a grunt, and this symptom is especially marked if the animal walks in a downward direction. There is loss of appetite, and rumination is suspended. The passages at first are few in number, hard, and are sometimes coated with mucus or with blood. Later a severe diarrhea sets in, when the passages contain mucus and blood and have an offensive odor. There is evidence of colicky pain, and the abdomen is sensitive to pressure. Pain may be continuous. There is fever and acceleration of pulse rate and respirations. Mental depression and even insensibility occur before death. The disease is always severe and often fatal.

Post-mortem appearances.—The mucous membrane of the fourth stomach has a well-marked red color and sometimes presents ulcerations. The wall is thickened and softened, and similar conditions are found in the walls of the intestines. The red discoloration extends in spots or large areas quite through the wall, showing on the outside.

Treatment.—Very small quantities of carefully selected feed must be given and the appetite must not be forced. Protect the animal well from cold and dampness. Internally, give linseed tea, boiled milk, boiled oatmeal gruel, or rice water. These protectives may carry the medicine. Tannopin in doses of 30 to 60 grains is good.

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Subnitrate of bismuth in doses of 1 to 2 drams may be given. Pulverized opium may be used, if the diarrhea is severe, in 1 to 2 dram doses. If the bowel movements are not free, one may give from a pint to a quart of castor or raw linseed oil.

TRAUMATIC INFLAMMATION OF THE STOMACH.

This disease results from the presence of a foreign body. This condition is not rare in cattle, because these animals have the habit of swallowing their feed without careful chewing, and so nails, screws, hairpins, ends of wire, and other metal objects may be swallowed unconsciously. Such objects gravitate to the second stomach, where they may be caught in the folds of the lining mucous membrane, and in some instances the wall of this organ is perforated. From this accident, chronic indigestion results. The symptoms, more or less characteristic, are pain when getting up or lying down; grunting and pain upon sudden motion, especially downhill; coughing; pain on pressure over the second stomach, which lies immediately above the cartilaginous prolongation of the sternum. If the presence of such a foreign body is recognized, it may be removed by a difficult surgical operation, or, as is usually most economical, the animal may be killed for beef, if there is no fever.

DISEASES OF THE BOWELS.

DIARRHEA AND DYSENTERY.

[See also Gastrointestinal catarrh, p. 32.]

The word "dysentery," as it is commonly used in relation to the diseases of animals, signifies a severe form of diarrhea.

Causes.—Diarrhea is a symptom of irritation of the intestines, resulting in increased secretion or increased muscular contractions, or both. The irritation is sometimes the result of chilling from exposure, improper feeding, irritant feeds, indigestion, organic diseases of the intestines, or parasites.

Symptoms.—Passages from the bowels are frequent, at first consisting of thin dung, but as the disease continues they become watery and offensive smelling, and may be even streaked with blood. At first the animal shows no constitutional disturbance, but later it becomes weak and may exhibit evidence of abdominal pain by looking around to the side, drawing the feet together, lying down, or moving restlessly. Sometimes this malady is accompanied with fever, great depression, loss of strength, rapid loss of flesh, and it may terminate in death.

Treatment.—When the disease depends on irritating properties of the feed which has been supplied to the animal, it is advisable to give a mild purgative, such as a pint of castor or linseed oil. When the secretions of the bowels are irritating, an ounce of carbonate of magnesia and half an ounce of tincture of opium should be shaken up in a quart of linseed tea and given to the animal three times a day until the passages present a natural appearance. When there is debility, want of appetite, no fever, but a continuance of the watery discharges from the bowels, then an astringent may be given. For such cases the following is serviceable: Tannic acid, 1 ounce; powdered gentian, 2 ounces; mix and divide into 12 powders, one powder to be given three times a day until the passages present a natural appearance. Each powder may be mixed with a pint and a half of water. Tannopin is a new remedy that is most useful in such cases. The dose is from 30 grains to 2 drams. Useful household remedies are raw eggs, strong coffee, parched rye flour, or decoction of oak bark. In all cases the food must be given sparingly, and it should be carefully selected to insure good quality. Complete rest in a box stall is desirable. When diarrhea is a symptom of a malady characterized by the presence of a blood poison, the treatment appropriate to such disease must be applied.

SIMPLE ENTERITIS.

[See Gastroenteritis, p. 33.]

CROUPOUS ENTERITIS.

Under certain conditions, severe irritation of the digestive canal may, in cattle, cause a form of inflammation of the intestines (enteritis) that is characterized by the formation of a false membrane upon the surface of the lining membrane of the intestines, particularly the large ones.

Symptoms.—There is fever, depression, loss of appetite, diarrhea, and in the fecal masses shreds of leathery false membrane may be found. These shreds are sometimes mistaken for parasites or for portions of the wall of the intestine.

Treatment.—Give a pound of Glauber's salt, followed by bicarbonate of soda in doses of 2 ounces four times daily.

ENTERITIS (OBSTRUCTION RESULTING FROM INVAGINATION, OR INTUSSUSCEPTION, TWISTING, AND KNOTTING OF THE BOWELS).

Inflammation may arise from a knot forming on some part of the small intestine from the portion of the bowel becoming twisted on itself, or from one part of the bowel slipping into another, which is termed invagination. This form of enteritis occurs occasionally in animals of the bovine species.

Causes.—The small intestine, which in the ox rests on the right side of the rumen, is, from the position which it occupies, predisposed to this accident. It has been ascertained that animals which have shown symptoms of this malady have trotted. galloped. or made other violent exertions in coming from drinking, or that they have been chased by dogs or by animals of their own species while at pasture. The accident is most likely to occur among cattle on very hilly pastures. The danger of jumping or running is greatest when the rumen is distended with food.

Symptoms.—This form of enteritis or obstruction is manifested by severe colicky pains: the ox scrapes and strikes the ground with his front and hind feet alternately; keeps lying down and getting up again; he keeps his tail constantly raised and turns his nose frequently to his right flank; he is frequently bloated, or tympanitic, on that side. He refuses feed and does not ruminate, and for some hours suffers severe pains. At first he frequently passes thin dung, and also urinates frequently, but passes only a little urine at a time. On the second day the pains have become less acute; the animal remains lying down; moans occasionally; his pulse is small and quick; he still refuses feed and does not ruminate. At this stage he does not pass any dung, though sometimes a small quantity of bloody mucus may be passed. The animal passes very little urine. This condition may continue for a considerable time, as cattle so affected may live for 15 or even 20 days.

Post-mortem appearance.—At death the bowels are found to be misplaced or obstructed, as mentioned above, and inflamed, the inflammation always originating at the point where the intestine has been invaginated, twisted, or knotted. Sometimes the part is gangrenous, the compression of the blood vessels preventing circulation, and thus causing the death of the tissues.

Treatment.—Purgatives, anodynes, and other remedies are of no service in such cases, and bleeding also fails to produce any benefit. Indeed, it is usually true that in such cases treatment is useless. Some cases are recorded in which an incision has been made in the flank, so as to enable the operator to restore the intestine to its normal position or to remove the kink.

CONSTIPATION.

Constipation is to be regarded rather as a symptom of disease or of faults in feeding than as a disease in itself. It occurs in almost all general fevers unless the bowels are involved in local disease, in obstructions of all kinds, from feeding on dry, bulky feed, etc. In order to remove the constipation the treatment must be applied to remove the causes which give rise to it. Calves sometimes suffer from constipation immediately after birth when the meconium that accumulates in the bowels before birth is not passed. In such cases, give a rectal injection of warm water and an ounce of castor oil shaken up with an ounce of new milk. The mother's milk is the best food to prevent constipation in the new-born calf, as it contains a large amount of fatty matter which renders it laxative in its effects.

It is usually better to treat habitual constipation by a change of diet than by medicine. Flaxseed is a good feed laxative. If the constipation has lasted long, repeated small doses of purgatives are better than a single large dose.

INTESTINAL WORMS.

[See chapter on "The animal parasites of cattle," p. 502.]

RUPTURES (VENTRAL HERNIA).

Ventral hernia, or rupture, is an escape of some one of the abdominal organs through a rupture in the abdominal muscles, the skin remaining intact. The rumen, the small intestine, or part of the large intestine, and the fourth stomach are the parts which usually form a ventral hernia in bovine animals.

Causes.—Hernia is frequently produced by blows of the horns, kicks, and falls. In old cows hernia may sometimes occur without any direct injury.

Hernia of the rumen.—Hernia of the rumen is generally situated on the left side of the abdomen, on account of the situation of the rumen. In exceptional cases it may take place on the right side, and in such cases it also generally happens that some folds of the intestine pass into the hernial sac. Hernias have been classified into simple or complicated, recent or old, traumatic (from mechanical injury) or spontaneous.

In recent traumatic hernia there is swelling on the left side of the lower part of the abdomen. The swelling is greatest in the cases of hernia which are situated on the lower part of the abdomen. Unless an examination is made immediately after the injury has been inflicted it is difficult, and sometimes impossible, to ascertain the exact extent of the rupture, owing to the swelling which subsequently takes place. Frequently there is no loss of appetite, fever, or other general symptoms attending the injury. From the twelfth to the fifteenth day the swelling has generally subsided to such an extent that it is possible by an examination to determine the extent of the rupture.

In old cows what is termed spontaneous hernia may sometimes take place without any direct injury. The occurrence of this form of hernia is explained by the increase in the size of the abdomen, which takes place in an advanced stage of pregnancy, causing a thinning and stretching of the muscular fibers, which at last may rupture, or give way. Such hernias frequently occur about the end of the period of gestation, and in some instances have contained the right sac of the rumen, the omentum, the small and large intestines, a portion of the liver, and the pregnant uterus.

In old hernias the swelling is soft and elastic, and if they have not contracted adhesions to the sides of the laceration, they can be made to disappear by pressure carefully applied. Sometimes this accident is complicated by a rupture of the rumen, constituting a complicated hernia. If a portion of the contents of the rumen escape into the abdomen, the case will be aggravated by the occurrence of peritonitis.

Hernia of the bowel.—When the intestines (Pl. III, fig. 6) form the contents of the hernia, it will be situated at the right side of the abdomen. In an intestinal hernia the swelling is usually not painful, of a doughy consistence or elastic, according as the intestine does or does not contain alimentary matter. This swelling can generally be made to disappear by pressure, and when it has been reduced one can easily recognize the direction and extent of the hernial opening. Hernias of the bowel which are situated at the upper and right side of the abdomen are usually formed by the small intestine. They are less easily reduced than a hernia in a lower situation, but when reduction has been effected they are less readily reproduced than those occurring lower. In hernias of the small intestine, adhesion of the protruding parts to the walls of the opening, or strangulation, are complications which sometimes take place. If adhesion has taken place the hernia can not be reduced by pressure, and when strangulation has occurred the animal shows symptoms of pain—is restless, turns its nose to the painful part, and shows those symptoms which are usually collectively designated under the term colic. If relief is not afforded, the animal will die.

Hernia of the rennet, or fourth stomach.—This disease occasionally occurs in calves and is usually caused by a blow from a cow's horn on the right flank of the calf. After such an accident a swelling forms on the right flank near the last rib. This swelling may be neither hot nor painful, even at first, and is soft to the touch. It can be made to disappear by careful pressure, when the sides of the aperture through which it has passed can be felt. The application of pressure so as to cause the disappearance of the hernia is best made immediately after the occurrence of the accident, or when the edema which accompanies the swelling has disappeared.

Treatment.—When a hernia is reducible—that is, can be pushed back into the abdomen—then, if it is of recent occurrence, it is advisable to maintain the natural position of the parts by bandaging and to allow the walls of the laceration to grow together. The bowels should be kept reasonably empty by avoiding the use of bulky feed, and the animal must be kept quiet.

The following method of bandaging is recommended by Bouley:

First prepare a bandage (must be of strong material), about 10 yards long and between 3 and 4 inches broad, and a flexible and solid piece of pasteboard adapted in size to the surface of the hernia. The protruding organ must then be replaced in the abdomen and maintained in that position during the application of the bandage. This being done, a layer of melted pitch and turpentine is quickly spread on the skin covering the seat of the hernia, so as to extend somewhat beyond that space. This adhesive layer is then covered with a layer of fine tow, then a new layer of pitch and turpentine is spread on the tow, and the piece of pasteboard is applied on the layer of pitch, its outer surface being covered with the same preparation. Lastly, the bandage, adhering to the piece of pasteboard, to the skin, and to the different turns which it makes around the body, is carefully applied so as to form an immovable, rigid, and solid bandage, which will retain the hernia long enough for the wound in the abdominal walls to heal permanently.

If the hernia is old and small it may be treated by injecting a strong solution of common salt about the edges of the tear. This causes swelling and inflammation, which, respectively, forces the protruded organ back and closes the opening. There is some risk attached to this method of treatment.

In small, old, ventral hernias the method of compressing and sloughing off the skin has been used successfully. If the hernia is large a radical operation will be necessary, and this is also true when the symptoms indicate that a hernia is strangulated. This operation is performed by cutting down on the hernia, restoring the organ to the abdominal cavity, and then closing the wound with two sets of stitches; the inner stitches, in the muscular wall, should be made with catgut and the outer stitches, in the skin, may be made with silk or silver wire. The strictest surgical cleanliness must be observed. Bleeding vessels should be tied. Then a compress composed of ten or twelve folds of cloth must be placed smoothly over the seat of injury and a bandage applied around the body, the two ends being fastened at the back. In the smaller kinds of hernia, nitric acid may sometimes be applied with success. This treatment should not be applied until the swelling and inflammation attending the appearance of the hernia have subsided; then, the contents of the hernia having been returned, the surface of skin corresponding to it is sponged over with a solution composed of 1 part of nitric acid to 2 of water. This treatment acts by exciting considerable inflammation, which has the effect of causing swelling, and thus frequently closing the hernial opening and preventing the contents of the sac from returning. A second application should not be made until the inflammation excited by the first has subsided. In what is termed spontaneous hernia it is useless to apply any kind of treatment.

Umbilical hernia.—The umbilicus, or navel, is the aperture through which the blood vessels pass from the mother to the fetus, and naturally the sides of this aperture ought to adhere or unite after birth. In very young animals, and sometimes in newborn calves, this aperture in the abdominal muscles remains open and a part of the bowel or a portion of the mesentery may slip through the opening, constituting what is called umbilical hernia. The wall of the sac is formed by the skin, which is covered on the inner surface by a layer of cellular tissue, and within this there is sometimes, but not always, a layer of peritoneum. The contents of the hernia may be formed by a part of the bowel, by a portion of the peritoneum, or may contain portions of both peritoneum and bowel. When the sac contains only the peritoneum it has a doughy feel, but when it is formed by a portion of the bowel it is more elastic on pressue.

Causes.—In the new-born animal the opening of the navel is generally large, and may sometimes give way to the pressure of the bowel on account of the weak and relaxed condition of the abdominal muscles. This defective and abnormal condition of the umbilicus is frequently hereditary. It may be occasioned by roughly pulling away the umbilical cord; through kicks or blows on the belly; through any severe straining by which the sides of the navel are stretched apart. We may mention in this connection that it is best in new-born calves to tie the umbilical cord tightly about 2 inches from the navel, and then to leave it alone, when in most cases it will drop off in a few days, leaving the navel closed.

Treatment.—It is well to bear in mind that many, and especially the smaller, umbilical hernias heal spontaneously; that is, nature effects a cure. As the animal gets older the abdominal muscles get stronger and possess more power of resistance to pressure, the bowels become larger and do not pass so readily through a small opening, so that from a combination of causes there is a gradual growing together or adhesion of the sides of the navel. In cases of umbilical hernia in which there are no indications that a spontaneous cure will take place, the calf should be laid on its back; immediately on this being done the hernia will often disappear into the abdomen. If it does not, its reduction may be brought about by gentle handling, endeavoring, if need be, to empty the organs forming the hernia before returning them into the abdomen. After the hernia has been returned, the hair should be clipped from the skin covering it and a compress composed of 10 or 12 folds of linen or cotton should be applied, first smearing the skin with pitch and then a bandage about 3 inches wide should be passed round the body so as to retain the compress in position. The lower part of the compress should be smeared with pitch, and also those portions of the bandage which pass over it, so as to keep it solid and prevent it from shifting. In some cases it will be found that the contents of the sac can not be returned into the abdomen, and this generally arises from the fact that some part of the contents of the sac has grown to or become adherent to the edges of the umbilical opening. In such a case the skin must be carefully laid open in the long direction, the adhesions of the protruding organs carefully separated from the umbilicus, and after the protruding parts have been returned into the abdomen, the sides of the umbilicus must be freshened if necessary by paring, and then the edges of the opening brought together by catgut stitches; the wound in the skin must then also be brought together by stitches. The wound must be carefully dressed every day and a bandage passed round the body so as to cover and protect the part operated on.

In small hernias nitric acid has been used successfully in the same manner as has been described in the treatment of ventral hernia. Sulphuric acid has also been used for a similar purpose, diluting it to the extent of 1 part of acid to 3 or 5 of water. In thin-skinned animals the weaker preparations ought to be preferred, and caution must be exercised in using such preparations so as not to destroy the tissues on which they are applied.

Another method of treatment is, after the contents of the sac have been returned into the abdomen, to tie a piece of strong waxed cord round the pendulous portion which formed the outer covering of the hernia. The string is apt to slacken after two or three days, when a new piece of cord should be applied above the first one. The constriction of the skin sets up inflammation, which generally extends to the umbilicus and causes the edges to adhere together, and by the time the portion of skin below the ligature has lost its vitality and dropped off, the umbilicus is closed and there is no danger of the abdominal organs protruding through it. This is what takes place when this method has a favorable result, though if the umbilicus does not become adherent and the skin sloughs, the bowels will protrude through the opening.

GUT-TIE (PERITONEAL HERNIA).—In peritoneal hernia of the ox a loop or knuckle of intestine enters from the abdomen into a rent in that part of the peritoneum which is situated at the margin of the hip bone or it passes under the remains of the spermatic cord, the end of which may be grown fast to the inner inguinal ring. The onward pressure of the bowel, as well as the occasional turning of the latter round the spermatic cord, is the cause of the cord exercising considerable pressure on the bowel, which occasions irritation, obstructs the passage of excrement, and excites inflammation, which terminates in gangrene and death.

The rent in the peritoneum is situated at the upper and front part of the pelvis, nearer to the sacrum than the pubes.

Causes.—Among the causes of peritoneal hernia considerable importance is attached to a method of castration which is practiced in certain districts, viz, the tearing or rupturing of the spermatic cord by main force instead of dividing it at a proper distance above the testicle in a surgical manner. After this violent and rough method of operating, the cord retracts into the abdomen and its stump becomes adherent to some part of the peritoneum, or it may wind around the bowel and then the stump becomes adherent, so that strangulation of the bowel results. The rough dragging on the cord may also cause a tear in the peritoneum, the result of which need not be described. The severe exertion of ascending hills and mountains, drawing heavy loads, or the straining which oxen undergo while fighting each other may also give rise to peritoneal hernia.

Symptoms.—The ox suddenly becomes very restless, stamps with his feet, moves backward and forward, hurriedly lies down, rises, moves his tail uneasily, and kicks at his belly with the foot of the affected side. The pain evinced may diminish but soon returns again. In the early stage there are frequent passages of dung, but after the lapse of 18 or 24 hours this ceases, the bowel apparently being emptied to the point of strangulation, and the passages now consist only of a little mucus mixed with blood. When injections are given at this time the water passes out of the bowel without even being colored. The animal lies down on the side where the hernia exists and stretches out his hind feet in a backward direction. These two particular symptoms serve to distinguish this affection from enteritis and invagination of the bowel. As time passes the animal becomes quieter, but this cessation of pain may indicate that gangrene of the bowel has set in, and may, therefore, under certain circumstances, be considered a precursor of death. Gangrene may take place in from four to six days, when perforation of the bowel may occur and death result in a short time.

Treatment.—In the first place the ox should be examined by passing the oiled hand and arm into the rectum; the hand should be passed along the margin of the pelvis, beginning at the sacrum and continuing downward toward the inguinal ring, when a soft, painful swelling will be felt, which may vary from the size of an apple to that of the two fists. This swelling will be felt to be tightly compressed by the spermatic cord. It very rarely happens that there is any similar swelling on the left side, though in such cases it is best to make a thorough examination. The bowel has sometimes been released from its position by driving the ox down a hill; by causing him to jump from a height of 2 feet to the ground; the expedient of trotting him also has been resorted to with the hope that the jolting movement might bring about a release of the bowel. If the simple expedients mentioned have been tried and failed, then the hand being passed into the rectum should be pressed gently on the swelling in an upward and forward direction, so as to endeavor to push the imprisoned portion of the bowel back into the abdomen. While this is being done the ox's hind feet should stand on higher ground than the front, so as to favor the slipping out of the bowel by its own weight, and at the same time an assistant should squeeze the animal's loins, so as to cause it to bend downward and so relax the band formed by the spermatic cord. If the imprisoned portion of gut is freed, which may be ascertained by the disappearance of the swelling, the usual sounds produced by the bowels moving in the abdomen will be heard, and in a few hours the feces and urine will be passed as usual. If the means mentioned fail to release the imprisoned portion of the gut, then an incision about 4 inches long must be made in the right flank in a downward direction, the hand introduced into the abdomen, the situation and condition of swelling exactly ascertained, and then a probe-pointed knife inserted between the imprisoned bowel and band compressing it, and turned outward against the band, the latter being then cautiously divided and the imprisoned gut allowed to escape, or, if necessary, the bowel should be drawn gently from its position into the abdomen. The wound in the flank must be brought together in the same way as in the case of the wound made in operating for impaction of the rumen.

WOUNDS OF THE ABDOMEN.

A wound of the abdomen may merely penetrate the skin; but as such cases are not attended with much danger, nor their treatment with much difficulty, we will consider here merely those wounds which penetrate the entire thickness of the abdominal walls and expose to a greater or less extent the organs contained in that cavity.

Causes.—Such accidents may be occasioned by falling on fragments of broken glass or other sharp objects. A blow from the horn of another animal may penetrate the abdomen. Exposure and protrusion of some of the abdominal organs may also be occasioned by the incautious use of caustics in the treatment of umbilical or ventral hernia. The parts which generally escape through an abdominal wound are the small intestine and floating colon.

Symptoms.—When the abdominal wound is small, the bowel exposed presents the appearance of a small round tumor, but in a few moments a loop of intestine may emerge from the opening. The animal then shows symptoms of severe pain by pawing with his feet, which has the effect of accelerating the passage of new loops of intestine through the wound, so that the mass which they form may even touch the ground. The pain becomes so great that the ox now not only paws but lies down and rolls, thus tearing and crushing his bowels. In such cases it is best to slaughter the animal at once; but in the case of a valuable animal in which tearing and crushing of the bowels has not taken place the bowels should be washed with freshly boiled water reduced to the temperature of the body and returned and the wounds in the muscle and skin brought together in a manner somewhat similar to that described in speaking of ventral hernia.

DISEASES OF THE LIVER AND SPLEEN.

JAUNDICE (THE YELLOWS, OR CONGESTION OF THE LIVER).

When jaundice exists, there is a yellow appearance of the white of the eyes and of the mucous membrane of the mouth. A similar aspect of the skin may also be observed in animals which are either partly or altogether covered with white hair. Jaundice is then merely a symptom of disease and ought to direct attention to ascertaining, if possible, the cause or causes which have given rise to it. A swollen condition of the mucous membrane of that part of the bowel called the duodenum may produce jaundice, as that mechanically closes the orifice of the biliary duct. In constipation there is an inactive or torpid condition of the bowel, and the bile which passes into the intestine may be absorbed and cause the yellow staining of jaundice. Jaundice is one of the symptoms of Texas fever. It may also arise from the presence of parasites or gallstones in the ducts, forming a mechanical obstruction to the onward flow of bile. The conditions under which jaundice most commonly calls for treatment are when cattle have been highly fed and kept in a state of inactivity. At such time there is an excess of nutritive elements carried into the blood, which is associated with increased fullness of the portal vein and hepatic artery. When continued high feeding has produced this congested state of the liver, the functions of that organ become disordered, so that a considerable portion of the bile, instead of being excreted and passing into the intestine, is absorbed by the hepatic veins.

The structure of the liver is shown in Plate IV.

Symptoms.—This disease, although rare, occurs most frequently among stall-fed cattle. Pressure along the margin of the short ribs on the right side produces pain; the appetite is poor and the animal shows hardly any inclination to drink; the mucous membranes of the eye and mouth are yellow, the urine has a yellow or brown appearance, the animal lies down much and moves with reluctance, moans occasionally, and has a tottering gait. The ears and horns are alternately hot and cold; in cows the secretion of milk is much diminished, and that which is secreted has a bitter taste; sometimes the animal has a dry, painful cough and presents a dull, stupefied appearance.

Treatment.—In such cases it is advisable to produce a free action of the bowels, so as to remove the usually congested condition of the portal vein and liver. For this purpose the administration of the following dose is recommended: Sulphate of soda, 16 ounces; molasses, 1 pint; warm water, 1 quart. The sulphate of soda is dissolved by stirring it up in tepid water. Following this the animal should have a heaping tablespoonful of artificial Carlsbad salt in the feed three times daily. This treatment may be assisted by giving occasional injections of warm water and soap. The diet should be laxative and moderate in quantity and may consist of coarse bran mash, pulped roots, grass in the season, and hay in moderate quantity.

HEPATITIS (INFLAMMATION OF THE LIVER).

Hepatitis is an inflammation of the liver and usually occurs as a complication of some infectious disease. It may also occur as a complication of gastrointestinal catarrh or in hot weather from overheating or damaged (putrid or fermented) feeds.

Symptoms.—The symptoms are sometimes obscure and their real significance is frequently overlooked. The most prominent symptoms are yellowness of the white of the eye and of the membrane lining the mouth; the appetite is poor, the body presents an emaciated appearance, the feces are light colored, while the urine is likely to be unusually dark; there is thirst, and pain is caused by pressing over the liver. The gait is weak and the animal lies down more than usual, and while doing so frequently rests its head on the side of its chest.

Treatment.—Give a purge of Glauber's salt and after it has operated give artificial Carlsbad salts in each feed, as advised under "Jaundice." Give green feed and plenty of water. Oil of turpentine should be rubbed in well once a day over the region of the liver. The skin on which it should be applied extends from the false ribs on the right side to 6 inches in front of the last one, and from the backbone to 12 inches on the right side of it.

FLUKE DISEASE.

[See chapter on "The animal parasites of cattle," p. 502.]

SPLENITIS (INFLAMMATION OF THE SPLEEN).

This disease occurs almost solely as a result of the existence of some infectious disease, and the symptoms caused by it merge with the symptoms of the accompanying causative disease. The spleen is seriously involved and becomes enlarged and soft in Texas fever, anthrax, and blood poisoning.

DISEASES OF THE PERITONEUM.

PERITONITIS.

Peritonitis consists of an inflammation of the peritoneum, which is the thin, delicate membrane that lines the abdomen and covers the abdominal organs.

Causes.—Wounds are the usual cause in cattle. The wound may be of the abdominal wall or of the intestines, stomach, or uterus; or inflammation may extend from one of the organs of the abdominal cavity to the peritoneum; so this disease may complicate enteritis or inflamed womb. A sharp metal body may perforate the second stomach and allow the gastric contents to escape, irritating the peritoneum. This disease may follow castration or operation for hernia.

Symptoms.—A continuous or occasional shivering; the animal lies down, but appears uneasy; it frequently turns its head toward its belly and lows plaintively; pressure on the flanks produces pain; has no appetite; muzzle is dry and no rumination; while standing, its legs are placed well under its body; pulse small and hard. The evacuations from the bowels are dry and hard. If this disease is complicated by the presence of inflammation of the bowels, the pain is more severe and the animal is more restless. The skin is cold and dry in the early stage of this disease, but in a more advanced stage this condition may be succeeded by heat of the skin and quick breathing. The fits of trembling, uneasiness, small and hard pulse, and tension of the left flank are symptoms the presence of which would enable one to reach the conclusion that peritonitis exists.

Post-mortem appearance.—The membrane lining the abdomen and covering the surface of the bowels is reddened to a greater or less extent, and there is usually considerable serous, or watery, fluid collected in the abdomen.

Treatment.—When we have to do with the form of peritonitis resulting from an injury, as when the horn of another animal has been thrust through the abdominal walls, this lesion must be treated in accordance with directions before given, but the general treatment must be similar to that which follows. Peritonitis resulting from castration or from parturient fever must also be treated in connection with the special conditions which give rise to it, as the general treatment of this disease must be modified to some extent by the exciting cause.

The aim must be to discover and remove the cause. The cause must be treated according to its nature. Harms strongly recommends borax in the treatment of peritonitis. He gives 6 ounces in the first 24 hours, divided into three doses, and afterwards he gives 6 drams three times daily. Opium in doses of 2 to 3 drams may be given. To bring on evacuations of the bowels it is better to give rectal injections than to administer purges. The strength may be sustained by coffee or camphor.

The body should be warmly clothed, and it is advisable, when practicable, to have a blanket which has been wrung out of hot water placed over the abdomen, then covered by several dry blankets, which are maintained in position by straps or ropes passing round the body. The wet blanket must be changed as it cools—the object of treatment being to warm the surface of the body and to determine as much blood to the skin as possible. The diet should consist of laxative food and drinks, such as linseed tea. If peritonitis assumes chronic form the diet should be nutritious, such as selected clover hay, linseed cake, grass, etc., and iodid of potassium should be given three times a day in gram doses dissolved in a pint of water.

DROPSY OF THE ABDOMEN (ASCITES).

In this disease there is a serous, or watery, effusion in the cavity of the abdomen.

Causes.—When old animals are fed on innutritious feed or when reduced by disease, they become anemic; in other words, their blood becomes impoverished and dropsy may follow. An innutritious and insufficient diet produces the same effect in young animals. It is one of the results of peritonitis, and may also arise from acute or chronic inflammation of the liver, such as is of common occurrence when flukes are present in the liver in large numbers. Heart disease and chronic lung disease may be followed by ascites. It is sometimes, in calves, a symptom of infestation with worms.

Symptoms.—A gradual increase in the size of the abdomen at its lower part, while the flanks becomes hollow; pallor of the mucous membrane of the mouth and eye; weak and sluggish gait; want of appetite, and irregularity in ruminating. On percussion or tapping the surface of the abdomen with the fingers, a dull sound is produced. If the hand and arm are oiled and passed into the rectum as far as possible, on moving the hand from one side to the other the fluctuation caused by the presence of fluid in the abdomen may be felt.

Treatment.—If possible the cause must be discovered and removed. The diet should be nutritious, and in those cases in which we have merely to deal with anemia (the bloodless state) arising from insufficient diet, the use of tonics and diuretics, at the same time keeping the skin warm, may bring about a gradual absorption of the fluid contained in the abdomen. One of the following powders may be mixed with the animal's feed three times a day; or, if there is any uncertainty as to its being taken in that way, it should be mixed with sirup, so as to form a paste, and smeared well back on the animal's tongue with a flat wooden spoon: Carbonate of iron, 3 ounces; powdered gentian, 3 ounces; powdered nitrate of potassium, 3 ounces; mix and divide into 12 powders. The administration of purgatives which promote a watery discharge from the mucous surface of the bowels also tends, by diminishing the serum of the blood, to bring about absorption and a gradual removal of the fluid contained in the abdomen. Large doses should not be given, but moderate ones should be administered morning and night, so as to produce a laxative effect on the bowels for several days. To attain this end the following may be used: Sulphate of soda, 8 ounces; powdered ginger, half an ounce; to be mixed in 2 quarts of tepid water and given at one dose.

DISEASES OF THE DIGESTIVE ORGANS.

DESCRIPTION OF PLATES.

PLATE I. Position of the first stomach (rumen or paunch) on the left side. The area inclosed by heavy dotted lines represents the rumen; the elongated, shaded organ is the spleen resting upon it. The skin and muscles have been removed from the ribs to show the position of the lungs and their relation to the paunch.

PLATE II. Stomach of ruminants.

Fig. 1. Stomach of a full-grown sheep, $\frac{1}{5}$ natural size (after Thanhoffer, from R. Meade Smith's Physiology of Domestic Animals): *a*, rumen, or first stomach; *b*, reticulum, or second stomach; *c*, omasum, or third stomach; *d*, abomasum, or fourth stomach; *e*, esophagus, or gullet, opening into the first and second stomachs; *f*, opening of fourth stomach into small intestine; *g*, opening of second stomach into third; *h*, opening of third stomach into fourth.

The lines indicate the course of the food in the stomachs. The incompletely masticated food passes down the esophagus, or gullet, into the first and second stomachs, in which a churning motion is kept up, carrying the food from side to side and from stomach to stomach. From the first stomach regurgitation takes place; that is, the food is returned through the gullet to the mouth to be more thoroughly chewed, and this constitutes what is known as "chewing the cud." From the second stomach the food passes into the third, and from the third into the fourth, or true, stomach, and from there into the intestines.

Fig. 2. Stomach of ox (after Colin, from R. Meade Smith's Physiology of Domestic Animals): *a*, rumen; *b*, reticulum; *c*, omasum; *d*, abomasum; *e*, esophagus; *f*, opening of fourth stomach into small intestine.

Fürstenberg calculated that in an ox of 1,400 pounds weight the capacity of the stomach is as follows:

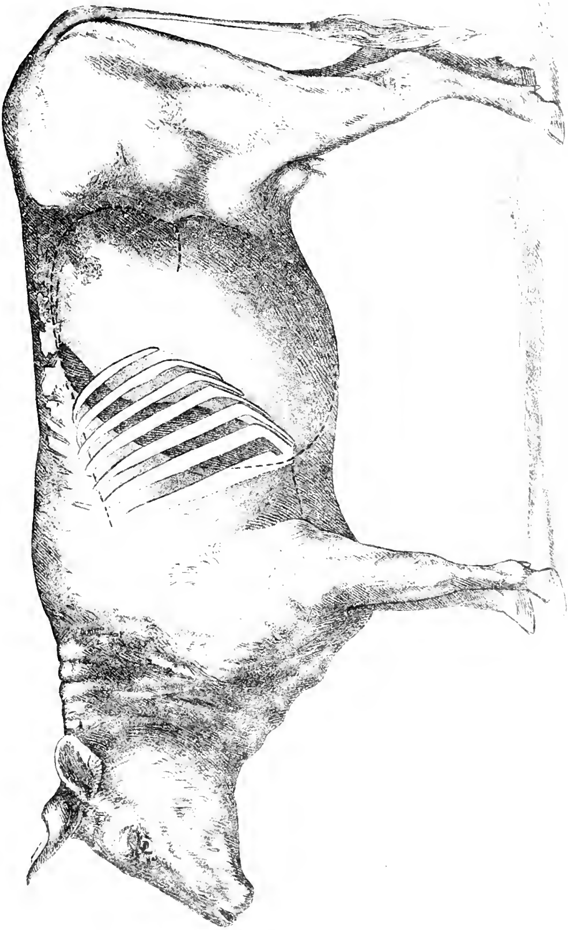
	Per cent.
Rumen, 149.25 quarts, liquid measure	62.4
Reticulum, 23.77 quarts	10
Omasum, 36.98 quarts	15
Abomasum, 29.05 quarts	12.6

According to Colon—

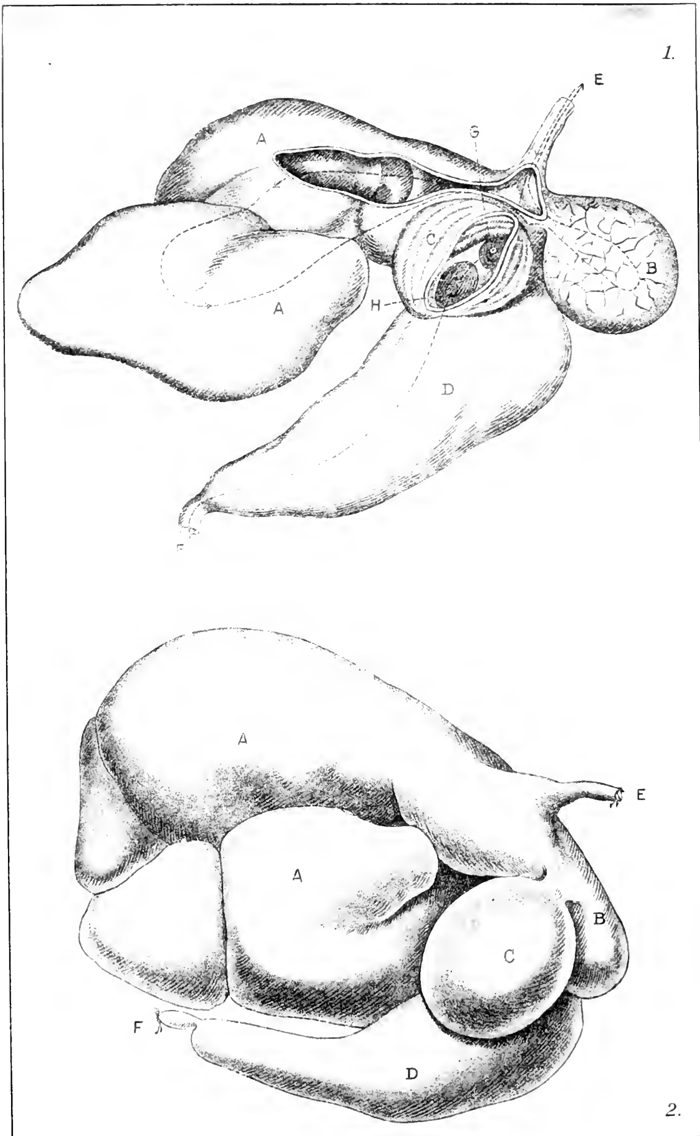
	Quarts.
The capacity of a beef's stomach is	266.81
Small intestine	69.74
Cecum	9.51
Colon and rectum	25.58

PLATE III. Instruments used in treating diseases of digestive organs.

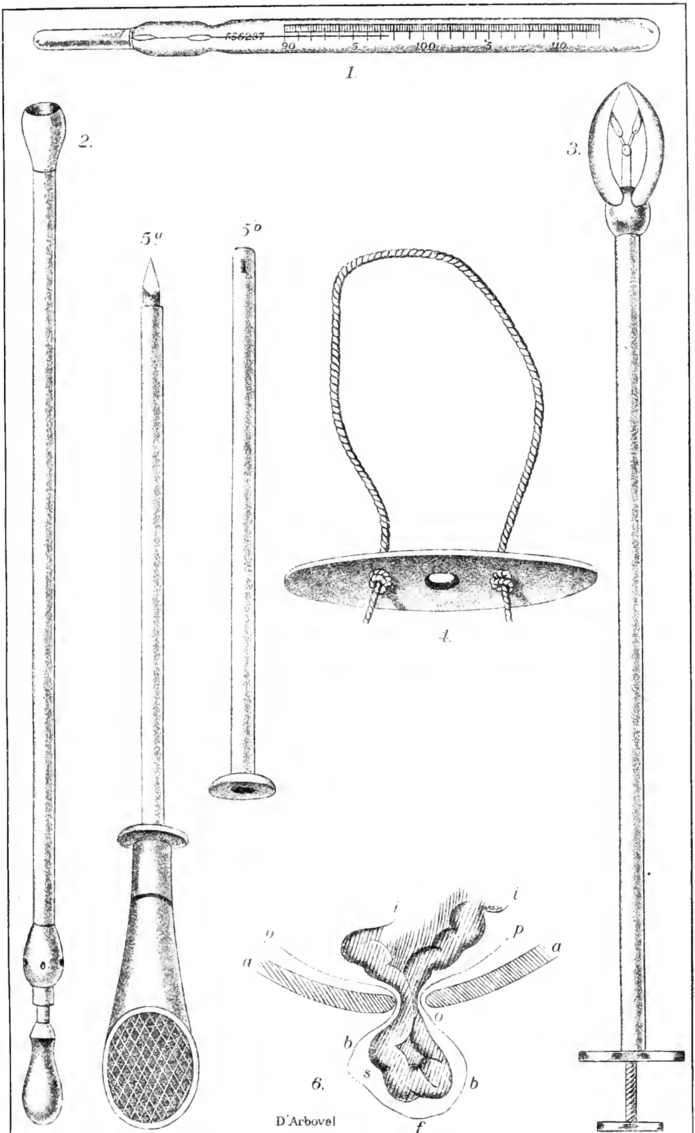
Fig. 1. Clinical thermometer, $\frac{4}{5}$ natural size. This is used to determine the temperature of the animal body. The thermometer is passed into the rectum after having been moistened with a little saliva from the mouth, or after having had a little oil or lard rubbed upon it to facilitate its passage. There it is allowed to remain two or three minutes, then with-



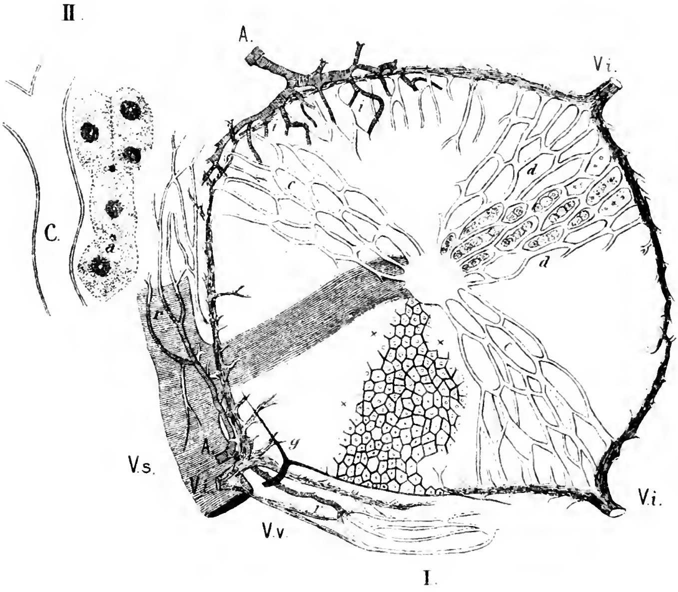
SHOWING THE POSITION OF THE RUMEN.



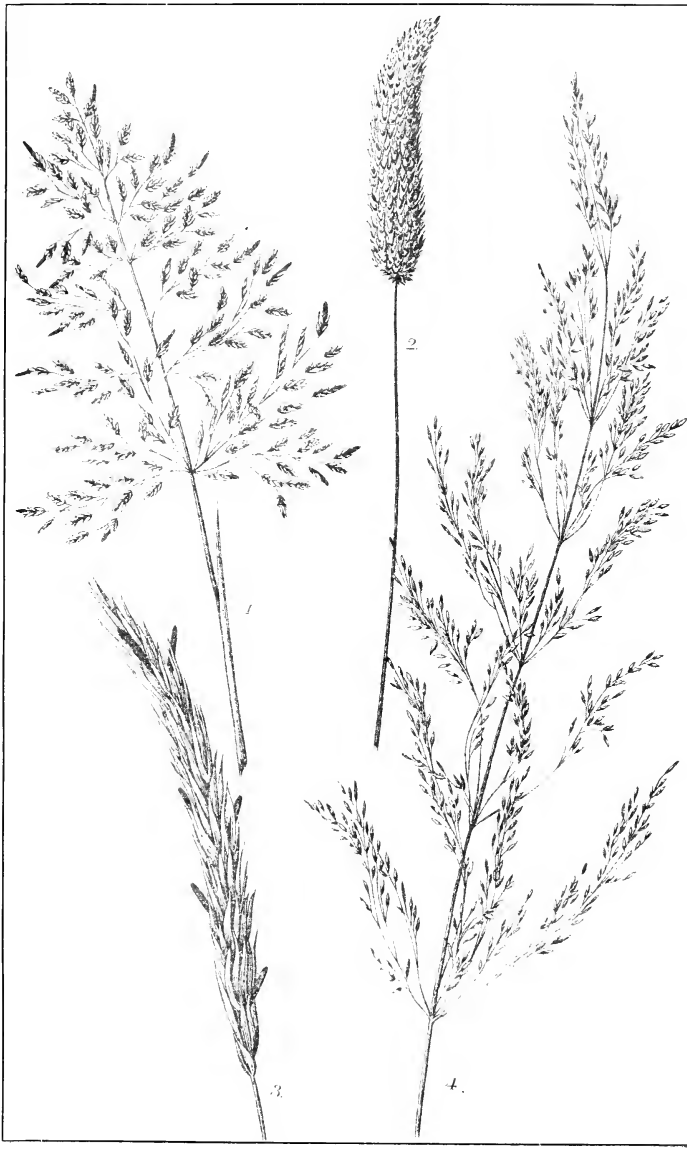
STOMACH OF RUMINANTS.



INSTRUMENTS USED IN TREATING DISEASES OF DIGESTIVE ORGANS.



MICROSCOPIC ANATOMY OF THE LIVER.



ERGOT IN HAY.

Marx, from nature.

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ERGOTISM.

PLATE III.—Instruments used in treating diseases of digestive organs—Contd.
drawn, and the temperature read as in any ordinary thermometer. The clinical thermometer is made self-registering; that is, the mercury in the stem remains at the height to which it was forced by the heat of the body until it is shaken back into the bulb by taking hold of the upper portion of the instrument and giving it a short, sharp swing. The normal temperature of cattle varies from 100° to 103° F. In young animals it is somewhat higher than in old. The thermometer is a very useful instrument and frequently is the means by which disease is detected before the appearance of any external sign.

Fig. 2. Simple probang, used to dislodge foreign bodies, like apples, potatoes, eggs, etc., which have become fastened or stuck in the esophagus or gullet.

Fig. 3. Grasping or forceps probang. This instrument, also intended to remove obstructions from the gullet, has a spring forceps at one end in the place of the cup-like arrangement at the end of the simple probang. The forceps are closed while the probang is being introduced; their blades are regulated by a screw in the handle of the instrument. This probang is used to grasp and withdraw an article which may have lodged in the gullet and can not be forced into the stomach by use of the simple probang.

Fig. 4. Wooden gag, used when the probang is to be passed. The gag is a piece of wood which fits in the animal's mouth; a cord passes over the head to hold it in place. The central opening in the wood is intended for the passage of the probang.

Figs. *5a* and *5b*. Trocar and cannula; *5a* shows the trocar covered by the cannula; *5b*, the cannula from which the trocar has been withdrawn. This instrument is used when the rumen or first stomach becomes distended with gas. The trocar covered by the cannula is forced into the rumen, the trocar withdrawn, and the cannula allowed to remain until the gas has escaped.

Fig. 6. Section at right angles through the abdominal wall, showing a hernia or rupture. (Taken from D'Arborval. Dictionnaire de Médecine, de Chirurgie de Hygiene): *a a*, The abdominal muscles cut across; *o*, opening in the abdominal wall permitting the intestines *i i* to pass through and outward between the abdominal wall and the skin; *p p*, peritoneum, or membrane lining the abdominal cavity, carried through the opening *o* by the loop of intestine and forming the sac S, the outer walls of which are marked *b f b*.

PLATE IV. Microscopic anatomy of the liver. The liver is composed of innumerable small lobules, from $\frac{1}{20}$ to $\frac{1}{10}$ inch in diameter. The lobules are held together by a small amount of fibrous tissue, in which the bile ducts and larger blood vessels are lodged.

Fig. 1 illustrates the structure of a lobule; *v v*, interlobular veins or the veins between the lobules. These are branches of the portal vein, which carries blood from the stomach and intestines to the liver; *c c*, capillaries, or very fine blood vessels, extending as a very fine network between the groups of liver cells from the interlobular vein to the center of the lobule and emptying there into the intralobular vein to the center of the lobule; *v c*, intralobular vein, or the vein within the lobule. This vessel passes out of the lobule and there becomes the sublobular vein; *v s*, sublobular vein. This joins other similar veins and helps to form the hepatic vein, through which the blood leaves

PLATE IV. Microscopic anatomy of the liver—Continued.

the liver; *d d*, the position of the liver cells between the meshes of the capillaries; *A A*, branches of the hepatic artery to the interlobular connective tissue and the walls of the large veins and large bile ducts. These branches are seen at *r r* and form the vena vascularis; *v v*, vena vascularis; *i i*, branches of the hepatic artery entering the substance of the lobule and connecting with capillaries from the interlobular vein. The use of the hepatic artery is to nourish the liver, while the other vessels carry blood to be modified by the liver cells in certain important directions; *g*, branches of the bile ducts, carrying bile from the various lobules into the gall bladder and into the intestines; *x x*, intralobular bile capillaries between the liver cells. These form a network of very minute tubes surrounding each ultimate cell, which receives the bile as it is formed by the liver cells and carried outward as described.

Fig. 2. Isolated liver cells: *c*, blood capillary; *a*, fine bile capillary channel.

PLATE V. Ergot in hay: 1, bluegrass; 2, timothy; 3, wild rye; 4, redtop. Ergot is a fungus which may affect any member of the grass family. The spore of the fungus, by some means brought in contact with the undeveloped seed of the grass, grows, obliterates the seed, and practically takes its place. When hay affected with ergot is fed to animals it is productive of a characteristic and serious affection or poisoning known as ergotism.

PLATE VI. Ergotism, or the effects of ergot. The lower part of the limb of a cow, showing the loss of skin and flesh in a narrow ring around the pastern bone and the exposure of the bone itself.

POISONS AND POISONING.

By V. T. Atkinson, V. S.

[Revised by C. Dwight Marsh, Ph. D.]

DEFINITION OF A POISON.

To define clearly the meaning of the word "poison" is somewhat difficult. Even in law the word has never been defined, and when a definition is attempted we are apt to include either too much or too little. The following definition given by Husemann is perhaps the best: "Poisons are those substances, inorganic or organic, existing in the organism or introduced from the outside, produced artificially or formed as natural products, which, through their chemical nature, under definite conditions, so affect some organ of a living organism that the health or well-being of the organism is temporarily or chronically injured." The common conception of a poison is any substance which, in small quantity, will destroy life, except such as act by purely mechanical means, as, for example, powdered glass.

Some substances that are not usually looked upon as poisons may destroy life if given in large doses, such as common salt. Other substances which are perfectly harmless when taken into the body in the usual way are poisons if injected into the circulation, such as distilled water, milk, or glycerin. Living organisms are not "chemical substances," and are not considered in this connection.

SOURCES OF POISONING.

Poisoning may come from many causes, among the chief of which are the following:

(1) *Errors in medication.*—By using the wrong substance or too large dose an animal may be poisoned.

(2) *The exposure of poisons used for horticultural, technical, or other legitimate purposes.*—Poisons used for spraying plants, disinfecting, poisoning vermin, dipping cattle or sheep, painting, smelting, dyeing, or other purposes may be so handled as to come within the reach of animals.

(3) *Damaged food.*—Food that has undergone putrefaction or certain kinds of fermentation or heating, may have become poisonous, producing forage poisoning, meat poisoning, cheese poisoning, etc.

(4) *Poisonous plants in the pasture or forage.*

(5) *The bite or sting of a poisonous insect or the bite of an animal.*

(6) *Malicious poisoning.*

THE ACTION OF POISONS.

The action of poisons may be either local, and exerted directly on the tissues with which they come in contact, or remote, acting through the circulation or the nervous system; or both local and remote action may be exerted by the same drug. Poisons which act locally generally either destroy by corrosion the tissues with which they come in contact or by inhalation set up acute inflammation. When any corrosive agent is taken into the stomach in poisonous quantities, a group of symptoms is developed which is common to all. The tissues with which the agent comes in contact are destroyed, sloughing and acute inflammation of the surrounding structures take place; intense pain in the abdomen and death ensue. In a like manner, but with less rapidity, the same result is reached if the agent used be not of a sufficiently corrosive nature to destroy the tissues, but sufficiently irritating to set up acute inflammation of the mucous membrane of the digestive tract. If the poison exerts a remote influence alone, the action is quite different, little or no local effect being produced upon the digestive organs.

To produce an effect on some part of the body distant from the channel of entrance, a poison must have been absorbed and carried in the blood to the central nervous system or other region involved. The poisonous effect of any substance is modified by the quantity used; by its chemical combinations; by the part of the animal structure with which it comes in contact; by the physical condition of the subject; and also by the rapidity with which the poison is excreted. As an illustration, opium may be given with safety in much larger doses to an animal suffering from acute pain than to one free from pain, and to an adult animal with greater safety than to a young one. The rapidity with which the poison is absorbed, owing to the part of the body with which it is brought in contact, is also an important factor. So marked is this quality that some agents which have the power of destroying life with almost absolute certainty when introduced beneath the skin, may be taken into the stomach without causing inconvenience, as curara, the arrow poisons, or the venomous secretion of snakes. Other agents in chemical combination may tend to intensify, lessen, or wholly neutralize the poisonous effect. For example, arsenic in itself has well-marked poisonous properties, but when brought in contact with dialyzed iron it forms an insoluble compound and becomes innocuous. Idiosyncrasies are not so noticeable in cattle practice as in practice among human beings, but the uncertainty with which some drugs exert their influence would lead us to believe that well-marked differences in susceptibility exist. Even in some cases a tolerance for poison is engendered, so that in a herd of animals equally exposed injurious or fatal effects do not appear with uniformity. For example, among cattle that are compelled to drink water holding in solution a salt of lead the effects of the poisoning will be found varying all the way from fatality to imperceptibility.

GENERAL SYMPTOMS OF POISONING.

It is not always easy to differentiate between poisoning and some disease. Indeed, examination during the life of the animal is sometimes wholly inadequate to the formation of an opinion as to whether the case is one of poisoning or, if it is, as to what the poison may be. A chemical and physical examination after the death of the animal may be necessary to clear up the doubt. On the other hand, the symptoms may be of such a nature as to point unmistakably to poisoning with a certain agent. In general, the following classes of symptoms may be regarded as indicative of poisoning: Sudden onset of the disease without visible cause, a number of animals being similarly affected at once, with severe gastrointestinal disorder or derangement of the nervous system, or both; sudden alteration of heart action in relation to frequency, force, or rhythm; local irritation, dyspnea, or change in the urine or urination.

After death, lesions of the greatest variety may be found, and it is necessary for one to be skilled in anatomy and pathology in order to determine their significance. Oftentimes the stomach and intestines are red, have thick walls, and contain blood. This signifies a severe irritant, such as arsenic or corrosive sublimate. Other alterations sometimes found are inflammation of the kidneys or bladder, points of hemorrhage in various organs, changes in the blood, congestion of the lungs, and certain microscopic changes.

GENERAL TREATMENT.

The treatment of animals suffering from poison must vary according to the nature of the toxic agent. There are a few general plans of action, however, which should be followed so far as possible. In man and in some of the smaller animals it is possible to eliminate unabsorbed poison by the use of the stomach pump or by causing vomiting. These proceedings are impracticable in cattle. It is well, therefore, in many cases to endeavor to expel the unabsorbed poison by emptying the digestive tract, so far as may be, with a nonirritating purge. Castor oil in doses of 1 pint to 2 quarts is adapted to this purpose. If the poison is known to be nonirritant—as a narcotic plant—from 10 to 20 drops of croton oil may be given with a quart of castor oil. When poisons are somewhat prolonged in their effect, Epsom salt in doses of 1 pound can be given advantageously. To protect the mucous membrane from the action of strong irritants, one may give flaxseed tea, barley water, the whites of eggs, milk, butter, olive oil, or fresh lard. Chemical antidotes may sometimes be used for special poisons, as advised below. In general, if an acid has been taken it may be neutralized with an alkali, such as chalk, magnesia, bicarbonate of soda (baking soda), ammonia (diluted), or soap. If the poison is an alkali, such as caustic soda or potash (lye), or ammonia, an acid, such as diluted (1 per cent) sulphuric acid or vinegar, may be administered. Special treatments and antidotes are considered below.

A poisonous agent may be so gradually introduced into the system as to slowly develop the power of resistance against its own action. In other cases where the poison is introduced slowly the poisonous action becomes accumulative, and, although there is no increase in the quantity taken, violent symptoms are suddenly developed, as if the whole amount, the consumption of which may have extended over a considerable period, had been given in one dose. Other agents, poisonous in their nature, tend to deteriorate some of the important organs, and, interfering with their natural functions, are productive of conditions of ill health which, although not necessarily fatal, are important. Such might properly be called chronic poisons. Poisons of themselves dangerous when administered in large doses are used medicinally for curative purposes, and a very large percentage of the pharmaceutical preparations used in the practice of medicine if given in excessive quantities may produce serious results. In the administration of medicines, therefore, care should be exercised not only that the animal is not poisoned by the administration of an excessive dose but that injury is not done by continued treatment with medicines the administration of which is not called for.

MINERAL POISONS.

ARSENIC POISONING.

Of the common irritant and corrosive poisons, arsenic, especially one of its compounds (Paris green), is likely to be the most dangerous to our class of patients. The common practice of using Paris green and other compounds of arsenic as insecticides for the destruction of potato beetle and other insect enemies of the farmer and fruit grower has had the effect of introducing it into almost all farming establishments. White arsenic is also a principal ingredient in some popular dipping preparations, and poisoning from this source occasionally takes place when, after dipping, animals are allowed to run in a yard in which there is loose fodder. The drippings from the animals falling on the fodder render it poisonous and dangerous to animal life if eaten. Familiarity with its use has in many instances tended to breed contempt for its potency as a poison. Rat poisons often contain arsenic. The excessive use of arsenic as a tonic, or of "condition powders" containing arsenic, has been the means of poisoning many animals. This is the common poison used by malicious persons with criminal intent. The poison may also be absorbed through wounds or through the skin if used as a dip or bath.

If a large dose is given, at once acute poisoning is produced; if repeated small doses are given, chronic poisoning may result. The poisonous dose for an ox is from 3 drams to 1 ounce.

Symptoms.—The symptoms of acute poisoning first appear as those of colic; the animal is restless, stamping with the feet, lying down and getting up. There is tenderness on pressure over the abdomen. The acute symptoms increase; in a few hours violent diarrhea is developed; in many cases blood and shreds of detached mucous membrane are mixed with the evacuations. There is irregular and feeble pulse and respiration, and death is likely to supervene between the eighteenth hour and the third day. If the latter period is passed, there is a reasonable hope of recovery.

In chronic poisoning the symptoms are similar to those of chronic gastrointestinal catarrh, with indigestion, diarrhea, and general weakness and loss of condition.

Treatment.—The antidote for arsenic is a solution of hydrated oxid of iron in water. It should be prepared fresh by mixing a solution of sulphate of iron, made by dissolving 4 ounces of sulphate of iron in one-half pint water, with a suspension of 1 ounce of magnesia in one-half pint water. This quantity is sufficient for one dose for a cow and may be repeated in an hour, if much arsenic was taken. A solution of calcined magnesia or powdered iron or iron filings or iron scale from a blacksmith's forge may be given in the absence of other remedies. Powdered sulphur is of some value as an antidote. One must also administer protectives, such as linseed tea, barley water whites of eggs, etc.

LEAD POISONING.

Lead poisoning of cattle sometimes comes from their having licked freshly painted surfaces and thus swallowed compounds containing white lead. In several instances cattle have been poisoned by silage from a silo painted inside with lead paint shortly before filling. Sometimes cattle eat dried paint scrapings with apparent relish and are poisoned. Cattle grazing on rifle ranges have been poisoned by lead from the bullets. Sugar of lead has been administered by mistake for Glauber's salt. Lead poisoning may be acute or chronic. The fatal dose of sugar of lead is from 1 to 4 ounces. Water drawn from lead pipes or held in a lead-lined tank may cause poisoning.

Symptoms.—The symptoms are generally dullness, lying down with the head turned toward the flank, colic, rumbling in the abdomen, loss of control of the limbs when walking, twitching, champing of the jaws, moving in a circle, convulsions, delirium, violent bellowing, followed by stupor and death. The symptoms generally extend over considerable time but may end in death after 24 hours.

Chronic lead poisoning occasionally occurs in districts where lead mining is the principal industry. The waste products of the mine thrown into streams contaminate the water supply, so that the mineral is taken into the system gradually, and a very small per cent of any of the salts taken into the system in this way is pernicious. Water which contains any salt of lead to the extent of more than one-tenth of a grain to the gallon is unfit to drink. Such water when used continually is likely to produce colic from the resulting intestinal irritation, and in aggravated cases paralysis more or less severe is likely to be developed. A blue line on the margin of the gums, the last symptom, is regarded as diagnostic and its presence as conclusive evidence of the nature of the disorder.

Treatment.—The treatment should first be directed toward removing the cause. A large dose of purgative medicine should be given, and the brain symptoms be relieved by giving bromid of potassium in half-ounce doses every 4 or 5 hours and by the application of cold water to the head. Dilute sulphuric acid in half-ounce doses should be given with the purgative medicine. In this case sulphate of magnesia (Epsom salt) is the best purgative, and it may be given in doses of from 1 to 2 pounds dissolved in warm water. After the acute symptoms have abated, iodid of potassium may be given, in doses of 2 drams each, three times a day for a week.

No treatment is likely to be of avail until the cause is removed.

COPPER POISONING.

The soluble salts of copper, though used as a tonic in the medicinal treatment of cattle, are poisonous when taken in large quantities. Like lead and arsenic, they have an irritant effect upon the mucous membrane with which they come in contact in a concentrated form. Cattle are not very likely to be poisoned from this cause unless through carelessness. Sulphate of copper, commonly called blue vitriol, is occasionally used for disinfecting and cleansing stables, where it might inadvertently be mixed with the feed. It is also used largely for making the Bordeaux mixture used in spraying fruit trees. The general symptoms produced are those of intestinal irritation, short breathing, stamping, and tender abdomen.

Treatment.—Give powdered iron, or iron reduced by hydrogen, or calcined magnesia. Sulphur may be used. This should be followed by a liberal supply of demulcents, linseed infusion, boiled starch, whites of eggs, etc.

ZINC POISONING.

Several of the soluble salts of zinc are irritant poisons. The chlorid and sulphate are those in most common use. In animals which have power to vomit they are emetic in their action. In others, when retained in the stomach, they set up more or less irritation of the mucous membrane and abdominal pain, producing symptoms already described in the action of other poisons which produce the same result.

Treatment.—The treatment should be the same as for copper poisoning.

PHOSPHORUS POISONING.

Only one of the forms of phosphorus in common use—the ordinary yellow—is poisonous. Phosphorus in this form is used for the destruction of rats and mice and other vermin, and has been largely used in the manufacture of matches.

Symptoms.—The symptoms are loss of appetite, colic, diarrhea, irritation of the mouth and throat, and paralysis of the throat. There is also weakness, difficult breathing, and rapid pulse. The course of the poisoning is usually rapid, terminating in either recovery or death within three days. The toxic dose for cattle is from 5 to 30 grains. If taken in large quantities the excreta are occasionally noticed to be luminous when examined in the dark.

Treatment.—Turpentine is given in an emulsion with flaxseed tea in a single dose of from 2 to 8 ounces. Permanganate of potassium may be given in a one-fourth of 1 per cent solution. Stimulants, such as alcohol and ether, should be administered. Oils and milk must not be given.

MERCURY POISONING.

Mercury poisoning is not rare in cattle from the fact that these animals have a special susceptibility to the action of this substance. Antiseptic washes or injections containing the bichlorid of mercury (corrosive sublimate) must be used on cattle with great care. Mercurial disinfecting solutions or salves must be used cautiously. Calomel can not be given freely to cattle.

Symptoms.—The symptoms are salivation, sore mouth, indigestion, diarrhea, skin eruption, paralysis of local groups of muscles, and nephritis.

Treatment.—The treatment consists in administering sulphur in large doses (2 to 4 ounces) or iron powder. Both make insoluble compounds with mercury. Follow with the whites of eggs mixed with water and with linseed tea. If the case does not terminate promptly, give iodid of potash in 1-dram doses twice daily.

POISONING BY ACIDS.

Mineral acids.—The mineral acids—nitric, sulphuric, hydrochloric, etc.—when used in a concentrated form destroy the animal tissues with which they come in contact, and in this respect differ from most of the poisons previously described. When taken into the stomach the mucous membrane of the mouth, pharynx, esophagus, and stomach is apt to be more or less completely destroyed. If taken in large quantities death is likely to result so speedily that nothing can be done to relieve the patient, and even if time is allowed and the action of the acid can be arrested it can not be done until considerable and, perhaps, irreparable damage has been done. The mucous membrane with which the acid has come in contact in the esophagus may be destroyed by its corrosive action and carried away, leaving the muscular tissues exposed. The raw surface heals irregularly, the cicatrice contracting causes stricture, and an animal so injured is likely to die of starvation. In the stomach even greater damage is likely to be done. The peristaltic action of the esophagus carries the irritant along quickly, but here it remains quiet in contact with one surface, destroying it. It is likely to perforate the organ and, coming in contact with the abdominal lining or other organs of digestion, soon sets up a condition that is beyond repair. In a less concentrated form, when this is not sufficiently strong to be corrosive, it exerts an irritant effect. In this form it may not do much harm unless taken in considerable quantity. When thus the mucous membrane of the stomach and intestines becomes inflamed· pain and diarrhea are likely to result.

Treatment.—Any of the alkalies may be used as an antidote. Most convenient of these are chalk, baking soda, marble dust, magnesia, lime, soap, or plaster from a wall. Mucilaginous drinks should be given in large quantities.

Vegetable acids.—Oxalic acid in particular is corrosive in its action when taken in concentrated solution, losing its corrosive effect and becoming irritant when more dilute. It also exerts a specific effect on the heart, frequently causing death from syncope. Taken in the form either of the crystals or solution it is likely to cause death in a very short time. Failure of heart action and the attendant small pulse, weakness, staggering, and convulsions are the more noticeable symptoms. Acetic acid is irritant to the gastro-intestinal tract, and may cause sudden paralysis of the heart.

Treatment.—The action of the acid should be counteracted by the use of alkalies, as advised above, by limewater or lime or plaster given promptly, by protectives to the digestive tract, and by stimulants.

POISONING BY ALKALIES.

The carbonates of potash and soda and the alkalies themselves in concentrated form cause symptoms of intestinal irritation similar to those produced by mineral acids. Ammonia, caustic soda, and caustic potash (lye) are those to which animals are most exposed. The degree of their caustic irritant effects depends on their degree of concentration. When they reach the stomach the symptoms are nearly as well marked as in the case of the acids. The irritation is even more noticeable, and purgation is likely to be a more prominent symptom. If death is not caused soon, the irritation of the gastro-intestinal tract and malnutrition will last for a long time.

Treatment.—Treatment consists in neutralizing the alkali by an acid, such as dilute sulphuric acid (1 per cent) or strong vinegar. The administration of such an antidote and its action must be carefully watched during administration. In the chemical change which takes place when the acid and alkali are combined, carbonic-acid gas is liberated, which may be to an extent sufficient to cause considerable distention of the abdomen, and even to produce asphyxia from pressure forward on the diaphragm. Should this danger present itself, it may be averted by opening the flank, permitting the gas to escape. (See "Acute tympanites, or Bloating," p. 22.) Flaxseed or slippery-elm decoction must be given to sooth the inflamed mucous surface. Opium may be used to allay pain.

COAL-OIL POISONING.

Coal oil is sometimes administered empirically as a treatment for intestinal parasites. If given in large doses it produces poisonous effects, which are likely to be manifested some time after the administration. It acts as an irritant to the digestive tract, causing dribbling of ropy saliva from the mouth, diarrhea, tenesmus, and loss of appetite, with increased temperature and cold extremities. Visible mucous membranes are injected, pupils of the eyes are contracted, and there is a watery discharge from the eyes and nostrils. Remotely it exerts a depressing influence on the functions of the brain and slight coma, and occasionally convulsions, from which the animal is easily aroused. The kidneys also suffer. The urine is dark colored and has the characteristic odor of coal oil. Death may result from gastroenteritis or convulsions.

Treatment.—The patient's strength should be fostered by the frequent administration of mild stimulants, of which aromatic spirits of ammonia is perhaps the best. The animal should be encouraged to eat soft feed and given mucilaginous drinks.

Crude coal oil is sometimes applied to the skin to kill parasites. If too much is used, especially in hot weather, great weakness and depression may be caused and in some cases death may result.

CARBOLIC-ACID POISONING.

Although one of the most valuable antiseptic remedies, carbolic acid in a concentrated form, when taken internally or used over a large surface externally, is likely to produce poisonous effects. It causes whitening, shrinking, and numbness of the structures with which it comes in contact, and, besides its irritant effect, exerts a powerful influence on the nervous system. Being readily absorbed, it produces its effect whether swallowed, injected into the rectum, inhaled, or applied to wounds, or even to a large tract of unbroken skin. Used extensively as a dressing, it may produce nausea, dizziness, and smoky or blackish colored urine. The last symptom is nearly always noticeable where the poisonous effect is produced. In more concentrated form, or used in larger quantities, convulsions, followed by fatal coma, are likely to take place. Even in smaller quantities, dullness, trembling, and disinclination for food often continue for several days. In a tolerably concentrated solution it coagulates albumen and acts as an astringent.

Treatment.—As an antidote internally, a solution of sulphate of soda or sulphate of magnesia (Glauber's or Epsom salt) may be given. The white of egg is also useful. Stimulants may be given if needed. When the poisoning occurs through too extensive applications to wounds or the skin, as in treatment of mange, cold water should be freely applied so as to wash off any of the acid that may still remain unabsorbed. As a surgical dressing a 3 per cent solution is strong enough for ordinary purposes. Water will not hold more than 5 per cent in permanent solution. No preparation stronger than the saturated solution should be used medicinally under any circumstances.

SALTPETER POISONING.

Both nitrate of soda and nitrate of potassium are poisonous to cattle. These substances are used for manure and for preserving meats. They may be administered in a drench by error in place of Glauber's salt, or they may be exposed within reach of cattle and thus be eaten. The toxic dose depends upon the condition of fullness of the stomach. If in solution and given on an empty stomach, as little as 3 ounces of saltpeter (nitrate of potassium) may be fatal to a cow. More of the Chile saltpeter (nitrate of soda) is required to cause serious trouble.

Symptoms.—Severe gastroenteritis, colic, tympanites, diarrhea, excessive urination, weakness, trembling, convulsions, collapse.

Treatment.—Same as for poisoning by common salt.

POISONING BY COMMON SALT.

A few pounds (3 to 5) of common salt will produce well-marked signs of poisoning in cattle. So much salt as this will not be taken by cattle except under unusual conditions. If the feed is poor in salt, and if no salt has been given for a long time, an intense "salt hunger" may occur that may lead an animal to eat a poisonous quantity, or an overdose of salt may be given by error as a drench. In order to prevent overeating of salt, it is doubtless better in salting cattle to use rock salt rather than that in more or less finely divided form.

Herring and mackerel brine and pork pickle are also poisonous, and are especially dangerous for hogs. In these substances there are, in addition to salt, certain products extracted from the fish or meat which undergo change and add to the toxicity of the solution. Sometimes saltpeter is present in such brines.

Symptoms.—The symptoms are great thirst, abdominal pain, diarrhea, poor appetite, redness and dryness of the mouth, increased urination, paralysis of the hind legs, weak pulse, general paralysis, coma, and death in from six to eight hours.

Treatment.—Allow as much warm water as the animal will drink; give protectives, such as linseed tea, etc. Linseed or olive oil may be given. To keep up the heart action give ether, alcohol, camphor, digitalis, or coffee. To allay pain, give opium.

VEGETABLE POISONS.

Vegetable poisons may be divided into two classes—those that are likely to be administered to the animal as medicine, and such as may be taken in the feed, either in the shape of poisonous plants or as plants or feeds of vegetable origin that have been damaged by fungi or by bacteria which have produced fermentation or putrefaction.

VEGETABLE POISONS USED AS MEDICINE.

OPIUM (MORPHIN, LAUDANUM) POISONING.

Opium and its alkaloid, morphia, are so commonly used in the practice of medicine that the poisonous result of an overdose is not uncommon. The common preparations are gum opium, the inspissated juice of the poppy; powdered opium, made from the gum; tincture of opium, commonly called laudanum; and the alkaloid or active principle, morphia. Laudanum has about one-eighth the strength of the gum or powder. Morphia is present in good opium to the extent of about 10 per cent. In medicine it is a most useful agent in allaying pain. It first produces a stimulating action, which is followed by drowsiness, a disposition to sleep or complete anesthesia, depending on the quantity of the drug used. In poisonous doses a state of exhilaration is well marked at first. This is particularly noticeable in cattle and in horses. The animal becomes much excited, and this stage does not pass into insensibility unless an enormous dose has been given. If the dose is large enough, a second stage sometimes supervenes, in which the symptoms are those of congestion of the brain. The visible membranes have a bluish tint (cyanotic) from interference with the air supply. The breathing is slow, labored, and later stertorous; the pupils of the eyes are very much contracted; the skin dry and warm. Gas accumulates in the stomach, so that tympanites is a prominent symptom. The patient may be aroused by great noise or the infliction of sharp pain, when the breathing becomes more natural. A lapse into the comatose condition takes place when the excitement ceases. Later, there is perfect coma and the patient can no longer be aroused from the insensible condition. The contraction of the pupil becomes more marked, the breathing intermittent and slower, there is perspiration, the pulse more feeble and rapid, till death takes place. Poisoning of cattle with opium or its products rarely goes beyond the stage of excitement, because the quantity of the drug required for the later effects is so great. Seventy-five grains of morphia administered subcutaneously has sufficed merely to excite for 12 hours.

Treatment.—Give strong coffee, 1 to 4 quarts, aromatic spirits of ammonia or carbonate of ammonia. Atropia is the physiological antidote.

STRYCHNIN POISONING.

Strychnin is a very concentrated poison and produces its effect very quickly, usually only a few minutes being necessary if given in sufficient dose and in such a way that it will be at once absorbed. When employed as a medicine, as a rule, minimum doses should be used, as cattle are quite susceptible to its effects and may be killed by the maximum doses given in the common manuals of veterinary medicine. The first noticeable symptom is evidence of unrest or mental excitement; at the same time the muscles over the shoulder and croup may be seen to quiver or twitch, and later there occurs a more or less well-marked convulsion; the head is jerked back, the back arched and leg extended, the eyes drawn. The spasm continues for only a few minutes, when it relaxes and another occurs in a short time. The return is hastened by excitement and in a short time again disappears, continuing to disappear and reappear until death results. As the poisonous effect advances the intervals between the spasms become shorter and less marked and the spasms more severe until the animal dies in violent struggles.

Treatment.—The best method is to put the patient under the influence of chloral, chloroform, or ether, and keep it there continuously until the effect of the poison has passed off. Alcohol may be given in large doses.

ACONITE POISONING.

In recent years tincture of aconite has become a popular stable remedy. If an animal is ailing, aconite is given whether indicated or not. Fortunately the dose used is generally small, and for this reason the damage done is much less than it would otherwise be. Aconite is one of the most deadly poisons known. It produces paralysis of motion and sensation, depresses the heart's action, and causes death by paralysis of respiration. In large doses it causes profuse salivation, champing of the jaws, and attempts at swallowing. If not sufficient to cause death, there is impaired appetite with more or less nausea for some time after. In poisonous doses it causes the animal to tremble violently, to lose power to support itself, and brings on slight convulsions, with perspiration. The pulse is depressed, irregular, and afterwards intermittent.

Treatment.—The chemical antidote is tannic acid, which forms an insoluble compound with the aconitin. The depressing effect on the heart should be counterated by the use of ammonia, digitalis, alcohol, camphor, or other diffusible stimulants, which have a physiological effect opposite to aconite.

POISONOUS PLANTS.

An important group of poisons may be classed under this head. In most cases it is poison naturally belonging in the plant; in other cases the poisonous principle is developed in what would otherwise be harmless plants as a plant disease, or as a fermentation or putrefaction due to bacterial growth and observed in forage, grain, or meal that has become heated, damaged, or "spoilt."

The subject of poisonous plants is an important one and is of especial interest to those using the western stock ranges, for it is probable that there is no other single cause producing so many fatalities. In this article only a few of the more important plants are treated in a brief way, for an extended treatise would be necessary if the subject were to be handled adequately. Further information should be sought in the more elaborate publications. Many of the American poisonous plants have been treated in bulletins issued by the United States Department of Agriculture.

Treatment for plant poisoning.—Remedies given by the mouth in most cases fail to give relief to cattle affected by poisonous plants. The material of the poisonous plants in the first stomach is not very largely affected by a remedy given as a drench. If any beneficial result is effected, it must be on the material which has already passed into the fourth stomach, so that to get any real antidotal result the remedy must be given repeatedly in order to meet the alkaloid poisons as they are passing through the fourth stomach. While certain substances like tannic acid and potassium permanganate are the logical antidotes for plant poisons, in practical application they are very disappointing in the treatment of ruminant animals. Reliance must be mainly on prevention and upon such remedies as will increase elimination. A laxative or purgative is always helpful, and for this purpose Epsom salt may be given in pound doses, or linseed oil in doses of 1 or 2 pints. In some few cases special remedies can be given as is indicated below.

It is well to bear in mind that cattle while grazing freely in good pasture are not likely to eat poisonous plants to any extent. If these same plants are gathered and thrown in a pile, the animals, through a kind of pernicious curiosity, may eat them with disastrous results. This has frequently happened when freshly cut branches of cherry, yew, oleander, and other plants have been thrown where dairy cattle could get at them.

OAKS.

The foliage of oaks is a valuable constituent of the forage on many ranges and pastures. It has been shown, however, that when this is eaten without some admixture of other food, cattle frequently sicken and die. Many cases of the poisoning of cattle by acorns have been reported in England and Germany, and there have been some complaints in the United States. Harmful results from eating acorns do not seem likely to occur except as they are eaten in considerable quantities.

Symptoms.—The symptoms of oak poisoning are constipation, mucus and blood in the feces, emaciation, and edema. The symptoms of acorn poisoning are much the same.

Treatment.—Change of pasture or an addition of other food material.

HORSE CHESTNUT—BUCKEYE.

All the species of *Æsculus*, popularly known as horse chestnut or buckeye, are considered poisonous. The bark, leaves, and fruit are injurious. It is said that if the fruit is boiled or roasted and washed out it becomes harmless and even is a desirable addition to the feed of cattle. The Indians in time of scarcity of food have used the fruit after preparing it in this way. The buckeyes are said to have a specific effect in producing abortion in cattle and goats.

DEATH CAMAS (SPECIES OF ZYGADENUS).

The death-camas plants, which are commonly known in the Pacific States as "lobelia," are especially destructive of sheep, but cattle sometimes eat them and are poisoned. Cases of cattle poisoning are not likely to result fatally.

Symptoms.—The symptoms are salivation, nausea accompanied by vomiting, great weakness, and lowered temperature.

Treatment.—There is no effective treatment for death-camas poisoning.

FLY POISON (CHROSPERMA MUSCÆTORIUM).

This plant, which is closely related to the death-camas plants, is sometimes known as "stagger grass" and causes a considerable loss in the Southern States. It grows earlier than the grasses, and on this account is more likely to be eaten. Like death camas, it produces pronounced nausea, resulting in vomiting and weakness, and in cases which recover the effects may continue for several days. Apparently the injurious effects are more common in the case of cattle than in other domestic animals. There is no known way of treating these animals, though doubtless purgatives would be beneficial.

YEW (TAXUS BACCATA).

The European yew has long been known as a very poisonous plant. It is cultivated in America, and while cases of poisoning have not been common, it is well to recognize its dangerous character. A comparatively small dose is poisonous and ordinarily acts with great rapidity. It causes respiratory paralysis and the animal dies in convulsions.

LAUREL.

The laurels, including the broad-leafed laurel, *Kalmia latifolia*, the narrow-leafed laurel, *Kalmia angustifolia*, the rhododendrons, and other closely related plants are poisonous and cause considerable losses. It is dangerous to let cattle graze where these plants are abundant at times when other forage is scarce. The symptoms are salivation, nausea and vomiting, spasms, dizziness, stupor, and death.

FERN.

The common brake or bracken fern, *Pteris aquilina*, has been considered responsible for the poisoning of many horses and cattle. Many cases have been reported in England and Germany, and some well-authenticated cases in the United States. Very little has been learned experimentally of fern poisoning, but there seems to be little question that it has been the cause of many deaths. The symptoms

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are said to be temperature higher than normal, loss of appetite, bloody discharges from mouth, nose, and bowels, and great depression followed by coma and death. Some authors say that the urine is colored by blood. It is thought by some that the disease known as "red water" in the northwestern United States and Canada is caused by eating ferns.

SORGHUM POISONING.

Under certain conditions sorghum contains enough hydrocyanic acid to make it exceedingly dangerous to cattle. These cases of poisoning most commonly occur when cattle are pastured upon the young plant or upon a field where the crop has been cut and is making a second growth. Conditions of drought make the sorghum especially dangerous. There is some reason to think that the frosted second growth is particularly rich in hydrocyanic acid. The cases of poisoning occur when animals are grazed upon the plant, but not from the harvested crop or from silage. If cattle are grazed on sorghum or sorghum stubble they should at first be under constant observation and should be removed as soon as any signs of illness appear. Similar precautions should be used in grazing kafir.

CORNSTALK DISEASE.

Considerable losses of cattle have occurred when they were turned upon cornfields in the fall. Deaths come very suddenly and there is no opportunity to apply remedies. It has been thought that these fatalities, like those from sorghum, were caused by hydrocyanic acid, but there is good reason to think that this is not true, and at the present time there is no accepted explanation of this disease, although there seems to be no doubt that it is connected in some way with the condition of the corn. Whether a given field is poisonous or not can only be determined by experiment, and the wise farmer will keep his cattle under close observation when they are first turned into a cornfield.

WATER HEMLOCK (CICUTA).

This plant, growing in wet places by ditches and along creeks, is the most poisonous of North American plants. The root is the poisonous part, and cattle generally get it when it is plowed up or washed out by high water. Sometimes they pull it up, for the plant occasionally grows out into ditches so that the whole plant will be taken in grazing. The most marked symptoms of Cicuta poisoning are the violent convulsions, which remind one of the effect of strychnin.

Treatment.—Little can be done in the way of treatment. The logical thing is to attempt to control the convulsions by means of morphia, but in view of the fact that the stomach can not be emptied, the prognosis is not good, and most cases die.

LARKSPURS.

The larkspurs are a source of heavy loss to cattle owners in the higher ranges of the West. There are a number of species, growing at altitudes from 4,000 feet to timber line, and all are poisonous. A few cases of poisoning by larkspurs have been reported in the eastern United States, but most of the losses are confined to the West, both because larkspurs grow there in greater profusion and because cattle are grazed in that region on the open ranges. The losses are confined to cattle, for sheep and horses can graze on larkspur with no resulting harm. Most of the larkspur losses occur in the spring and early summer, as the plants lose their toxicity after maturing.

Symptoms.—Larkspur poisoning is accompanied by a definite line of symptoms. In range animals the first symptom noted is generally the sudden falling of the animal and consequent inability to rise. After a while it may rise, only to fall again. This may happen repeatedly. In severe cases the animal lies prone and exhibits nausea, accompanied by vomiting. It dies of respiratory paralysis, death many times being hastened by the asphyxia following the vomiting.

Treatment.—The animal, if found down, should be turned so that its head is uphill in order to relieve the lungs. Many cases will recover with no further treatment. Nearly all cases will recover if a hypodermic injection is given immediately of physostigmin salicylate 1 grain, pilocarpin hydrochlorid 2 grains, strychnin sulphate $\frac{1}{2}$ grain.

LOCO.

The loco plants have caused especially heavy losses of cattle, horses, and sheep. They grow in the semiarid regions of the West and sometimes in great luxuriance. The best known are the "blue loco," the "woolly loco" or "purple loco," and the "white loco" or "rattleweed." The blue loco is common in parts of New Mexico, Arizona, and Utah. It affects both horses and cattle. The purple loco, *Astragalus mollissimus*, is common in Texas and the adjoining States and extends north as far as Nebraska and Colorado. It is especially destructive to horses. The white loco, *Oxytropis lamberti*, is still more widely distributed, being found in the plains region from Alaska to Mexico and west of the Rocky Mountains to central Utah. The white loco is much more important than the purple loco, for it affects not only horses but cattle and sheep. These plants belong to the pea family, and there are a number of other species of this family that are loco plants and produce the same symptoms.

Symptoms.—Loco poisoning is a chronic condition and symptoms are shown only after somewhat prolonged feeding. The condition is one of cumulative poisoning, and animals sometimes decline very rapidly after the first symptoms appear. In many cases animals acquire a habit of eating loco and prefer it to any other feed. The poison affects the central nervous system. There is a lack of muscular coordination and the animal performs very erratic movements. In the later stages the animal becomes emaciated and eventually dies of starvation.

Treatment.—Locoed animals are badly constipated, and it is important that this condition should be remedied at the start. Any purgative can be used, but Epsom salt has been found especially effective. If locoed animals can be turned into a field of alfalfa, a large proportion of them will recover with no further treatment. Recovery may be aided by giving cattle, hypodermically, daily doses of three-twentieths to four-twentieths of a grain of strychnin. By this treatment cattle can be cured and put in condition for market.

WHITE SNAKEROOT (EUPATORIUM URTICÆFOLIUM).

White snakeroot, frequently known as "rich weed," is a plant growing in great abundance in some of the eastern and central regions of the United States. It is particularly abundant in parts of Ohio, Indiana, and Illinois, and in western North Carolina. It is responsible for most, if not all, of the cases of a disease which is commonly known as "milk sickness."

Symptoms.—The animals are constipated, sometimes have bloody feces, become weak, and exhibit muscular trembling. This trembling is very characteristic, so that the disease is sometimes known as "the trembles."

Remedy.—There are no remedies which will work very efficiently. It is desirable to give the animals purgatives like Epsom salt and, of course, to remove them from fields where this plant is abundant.

RAYLESS GOLDENROD (ISOCOMA WRIGHTII).

The rayless goldenrod is a plant growing in especial abundance in parts of the Pecos Valley in New Mexico and Arizona, and there produces a disease so much like that produced in the East by white snakeroot that it is sometimes called milk sickness. More generally this disease goes under the name of "alkali disease." The plant has produced heavy losses in the regions where it grows abundantly.

Symptoms.—The symptoms are much like those produced by the white snakeroot. The animals are constipated, sometimes have bloody feces, become weak, and exhibit muscular trembling. There is good reason to think, too, that the milk of cows eating this plant is more or less injurious.

Treatment.—A purgative like Epsom salt will aid an animal in recovering, but most important is to remove the cattle from pastures where the plant is abundant and give them an abundance of good forage. Under such conditions they are almost certain to recover.

MILKWEEDS.

Many of the milkweeds have long been known to have more or less poisonous properties. Within the last few years it has been discovered that certain of the milkweeds going under the popular name of whorled milkweeds are especially toxic. There are at least four species of whorled milkweeds, but two of them are particularly important from the standpoint of people handling livestock. One, known scientifically as *Asclepias galioides*, is harmful in Colorado, Utah, Arizona, and New Mexico, while another, known as *Asclepias mexicana*, has produced losses, especially in California and Nevada. These whorled milkweeds are distasteful to all animals and are eaten only when the stock is closely confined to pastures where there is little else in the way of forage.

Symptoms.—The most prominent symptoms are weakness, producing staggering, and this is followed in acute cases by violent spasms.

Treatment.—There is no treatment which will effectively antidote the effect of the poison. In practically all cases, however, poisoning may be avoided if care is taken to prevent animals from being closely confined where this plant is abundant, as they never eat the plant by choice.

CHERRY.

In the leaves of the cherries more or less hydrocyanic acid is produced, and when these leaves are eaten in any considerable quantity cases of poisoning are likely to arise. It is popularly supposed that these cases arise from eating wilted cherry leaves, but there is every reason to think that the fresh leaves will produce the same results. These cases are easily prevented, because no harm results from eating a small quantity of the leaves, and if the fact is recognized that poisoning may result from eating a large quantity, it is not difficult to care for the animals so as to prevent poisoning.

ERGOTISM.

The poisonous effects of ergot (Pls. V, VI) appear chiefly in the winter and spring of the year and among cattle. It is developed among grasses grown on rich soil in hot, damp seasons. Rye seems more liable to ergot than any of our other crops. Of the grasses which enter into the composition of hay, bluegrass is the most likely to become affected. Ergot may also affect redtop, oats, grasses, and grains. On the plant the fungus manifests itself on the seeds, where it is easily recognized when the hay is examined in the mow. The ergotized seeds are several times larger than the natural seeds—hard, black, and generally curved in shape.

The effect of the protracted use of ergot in the feed is pretty well understood to be that of producing a degeneration and obstruction of the smaller arterial branches. The result is to shut off the blood supply to the distal parts of the body, where the circulation is weakest, and thus to produce a mummification or dry gangrene of the extremities, as the ears, tail, feet, etc. Cattle seem to be more susceptible than other animals to the influence of ergot, possibly on account of the slowness of the heart's action. When the effect of the poison has become sufficient to entirely arrest the circulation in any part, the structures soon die. The disorder manifests itself as lameness in one or more limbs; swelling about the ankle which may result in only a small slough or the loss of a toe, but it may circumscribe the limb at any point below the knee or hock by an indented ring, below which the tissues become dead. The indentation soon changes to a crack, which extends completely around the limb, forming the line of separation between the dead and living structures. The crack deepens till the parts below drop off without loss of blood, and frequently with very little pus. Ergot may cause serious irritation of the digestive tract; or by acting upon the nervous system it may cause lethargy or paralysis. It also operates to cause contraction of the uterus, and may thus cause abortion.

Treatment.—Regarding the treatment, change of feed and local antiseptics are, of course, indicated. The former may be useful as a preventive, but when the symptoms have appeared the animal is necessarily so completely saturated that recovery is likely to be tedious. Tannin may be given internally in doses of one-half dram twice daily for a few days to neutralize the unabsorbed alkaloids of the ergot. At the same time give castor oil. To dilate the blood vessels give chloral hydrate. Bathe the affected parts with hot water. If sloughing has gone far, amputation must be resorted to.

OTHER POISONOUS FUNGI.

Many other fungi poison herbivora. In some instances, however, where fungi are blamed for causing disease their presence on the feedstuff or herbage is but coincidental with some other and more potent disease-producing factor. For example, if the conditions are favorable to the growth of fungi they are also favorable to the growth of bacteria, and bacteria may produce poisons in feeds. In general it may be said that any feed that is moldy, musty, or putrid is possibly dangerous. Silage, properly cured, does not belong to this class, because the curing of silage is not a bacterial process. But spoiled silage and silage matted with mold is dangerous and should not be fed.

POISONING BY ANIMAL PRODUCTS.

SNAKE BITES.

The poison contained in the tooth glands of certain venomous reptiles, particularly some of the snakes, which is injected into or under the skin of an animal bitten by the reptile, is a very powerful agent. It is likely to produce a serious local irritation, and in the case of the more poisonous snakes serious constitutional disturbances, even to causing death, which it may do in either of two ways: First, when very strong, by exerting a narcotic influence similar to that of some of the powerful poisons, checking heart action. Second, by diffused inflammation of the areolar tissue, gangrene, and extensive sloughing.

Symptoms.—The symptoms of snake bite are a local swelling caused by an intense local inflammation, pricks showing where the fangs penetrated, depression, weakness, feeble pulse, difficult breathing, bluish discoloration of the visible mucous membranes, stupor, or convulsions. If the poison is not powerful or plentiful enough to produce death, it is, at any rate, likely to cause severe local abscesses or sloughs.

Treatment.—The treatment may be divided into local and general. Locally every effort should be made to prevent absorption of the poison. If discovered at once the bitten part had better be excised. If that is impracticable and a ligature can be applied, as in the case of a bite to one of the limbs, no time should be lost in applying it above the injury. It should be made sufficiently tight to so far as possible arrest circulation in the bitten part. The wound should be freely incised, so that it will bleed freely, and the poison should be extracted by cupping, or pressed out by squeezing with the fingers. Permanganate of potassium in 5 per cent solution should be applied to and injected into the wound. The depressing effect of the poison on the general system should be counteracted by hypodermic injections of strychnin, or by liberal drenching with stimulants, such as coffee, digitalis, or the aromatic spirits or carbonate of ammonia. In animal practice the alcoholic stimulants and local treatment above described are likely to meet with best success. A special antitoxin for use in treating snake bite is now prepared and may be had from the leading druggists. It is quite effective if used promptly.

WASP AND BEE STINGS.

Wasps and bees secrete a poisonous substance which they are able to insert through the skin of an animal by the aid of their sharp stings. This poison is a severe local irritant and may even cause local gangrene. It also has a depressing effect upon the central nervous system and destroys the red-blood corpuscles. To produce these general effects it must be introduced in very large quantities, as when an animal is stung by a swarm of bees or wasps.

Treatment.—The treatment is to wash the parts with diluted ammonia or permanganate of potassium solution and to give stimulants internally. If there is so much swelling about the head and nostrils as to interfere with breathing, tracheotomy may be necessary.

POISONING WITH SPANISH FLY.

Spanish fly, in the form of powdered cantharides, may be given in an overdose, or when applied as a blister to too large a surface of skin enough may be absorbed to poison. If given by the mouth, it causes severe irritation of the gastrointestinal tract, shown by salivation, sore throat, colic, bloody diarrhea, etc. It also produces, whether given by the mouth or absorbed through the skin, irritation of the urinary tract, as shown by frequent and painful urination. If death results, it is due to respiratory paralysis.

Treatment.—Give protectives and the white of egg, with opium. Do not give oils or alcohol.

DISEASES OF THE HEART, BLOOD VESSELS, AND LYMPHATICS.

By W. H. HARBAUGH, V. S.

[Revised by Leonard Pearson, B. S., V. M. D.]

THE CIRCULATORY SYSTEM.

In cattle, as in human beings, the heart, blood vessels, and lymphatics may be described as the circulatory apparatus.

The heart is in the thoracic cavity (chest). It is conical in form, with the base or large part uppermost, while the apex, or point, rests just above the sternum (breastbone). It is situated between the right and left lungs, the apex inclining to the left, and owing to this the heart beats are best felt on the left side of the chest, behind the elbow. The heart may be considered as a hollow muscle, containing four compartments, two on each side. The upper compartments are called auricles and the lower ones ventricles. The right auricle and ventricle are completely separated from the left auricle and ventricle by a thick septum or wall, so that there is no communication between the right and left sides of the organ.

At the bottom of each auricle is the auriculo-ventricular opening, each provided with a valve to close it when the heart contracts to force the blood into the arteries. In the interval between the contractions these valves hang down into the ventricles.

The muscular tissue of the heart belongs to that class known as involuntary, because its action is not controlled by the will.

The cavities of the heart are lined by a serous membrane, called the endocardium, which may be considered as a continuation of the veins and the arteries, forming their internal lining. The walls of the ventricles are thicker than those of the auricles, and the walls of the left ventricle are much thicker than those of the right.

The heart is enveloped by a fibrous sac (or bag), called the pericardium, which assumes much of the general shape of the outer surface of the heart.

The action of the heart is similar to that of a pump and its function is to keep the blood in circulation. The auricles may be considered as the reservoirs or receivers of the blood and the ventricles as the pump chambers. During the interval between contractions, the heart being in momentary repose, the blood pours into the auricles from the veins: the auriculo-ventricular orifices being widely open, the ventricles also receive blood; the auricles contract and the ventricles are filled; contraction of the ventricles follows; the auriculo-ventricular valves are forced up by the pressure of the blood and close the auriculo-ventricular openings and prevent the return of blood into the auricles; the contraction of the ventricles forces the blood from the right ventricle into the lungs through the pulmonary artery and its branches, and from the left ventricle into the aorta, thence through the arteries to all parts of the body. After the contraction of the ventricles the heart is again in momentary repose and is being filled with blood, while the valves in the aorta and pulmonary artery close to prevent the return of blood into the ventricles. (See Pl. VII.)

The average weight of the heart of an ox is said to be from 3½ to 5 pounds; but, of course, owing to the many breeds and sizes of cattle, it must vary in different animals.

The vessels that convey the blood from the heart to all parts of the body are called arteries; those which return the blood to the heart are called veins. The arteries divide and subdivide (like the branches of a tree), become smaller and smaller, and ultimately ramify into every part of the body. Between the ultimate ramifications of the arteries and the beginning of the veins there is an intermediate system of very minute vessels called capillaries, which connect the arterial with the venous system of the circulation. The walls of the arteries are possessed of a certain amount of rigidity, sufficient to keep the tubes open when they are empty.

The blood leaves the left ventricle through a single vessel, the common aorta, consisting of the anterior and posterior aortas, which give off the large arteries.

The veins take the blood from the capillaries in all parts of the body. They begin in very small tubes, which unite to become larger in size and less in number as they approach the heart.

In its course an artery is usually accompanied with a vein and in many situations with a nerve. The more important arteries are placed deep within the body; when they are superficial, however, they are generally found where least exposed to injury, as, for example, on the inner side of the legs. Arteries are less numerous than veins, and their total capacity is much less than that of the veins A great number of veins are in the tissue immediately beneath the skin and do not generally accompany arteries.

The blood, throughout its course in the heart, arteries, capillaries, and veins, is inclosed within these vessels. Except where the large lymphatics empty into the venous blood, there is no opening into the course of the blood.

All the arteries except the pulmonary and its branches carry bright-red blood, and all the veins, except the pulmonary veins, carry dark-red blood. The impure dark-red blood is collected from the capillary vessels and carried to the right auricle by the veins; it passes down into the right ventricle, and thence into the pulmonary artery and through its branches to the capillaries of the lungs, where the carbonic-acid gas and other impurities are given up to the air in the air cells of the lungs (through the thin walls between the capillaries and the air cells), and where it also absorbs from the air the oxygen gas necessary to sustain life. This gas changes it to the bright-red, pure blood. It passes from the capillaries to the branches of the pulmonary veins, which convey it to the left auricle of the heart; it then passes through the auriculo-ventricular opening into the left ventricle, the contraction of which forces it through the common aorta into the posterior and anterior aortas, and through all the arteries of the body into the capillaries, where it parts with its oxygen and nutritive elements and where it absorbs carbonic-acid gas and becomes dark colored. (See theoretical diagram of the circulation, Pl. VII.)

The branches of certain arteries in different parts unite again after subdividing. This reuniting is called anastomosing, and assures a quota of blood to a part if one of the anastomosing arteries should be tied in case of hemorrhage, or should be destroyed by accident or operation.

THE BLOOD.

The various kinds of food, after being digested in the alimentary canal, are absorbed and carried into the blood by the lymphatics, and by the blood to the places where nutrition is required. The blood takes from all parts of the body all that is no longer required, and carries it to the different organs through which it is eliminated from the body. It contains within itself all the elements which nourish the body.

The blood may be considered as a fluid holding in solution certain inorganic elements and having certain bodies suspended in it. To facilitate description, the blood may be considered as made up of the corpuscles and the liquor sanguinis. The corpuscles are of two kinds, the red and the white, the red being the more numerous. The color of the blood is caused by the coloring matter in the red corpuscles, which are the oxygen carriers. Both kinds are very minute bodies, which require the aid of the microscope to recognize them. The liquor sanguinis is composed of water containing in solution salts, albumen, and the elements of fibrin.

The lymphatics, or absorbents, are the vessels which carry the lymph and chyle in the blood. They begin as capillaries in all parts of the body, gradually uniting to form larger trunks. Placed along the course of the lymphatic vessels are glands, in some situations collected into groups; for example, in the groin. These glands are often involved in inflammation arising from the absorption of deleterious matter.

Absorption is the function of the lymphatics. The liquor sanguinis passes from the blood capillaries to supply nutrition to the tissues. All of the liquor sanguinis that is not required is absorbed by the lymphatic vessels and conveyed back to the blood by the lymphatic ducts. The lymphatics which proceed from the intestines convey the chyle into the blood during digestion. As a rule, the lymphatic vessels follow the course of the veins. All the absorbent vessels convey their contents to the thoracic duct and right great lymphatic vein, which empty into the anterior vena cava, where the lymph and chyle mix with the venous blood, and thus maintain the supply of nutritive elements in the blood.

THE PULSE.

As fully explained, the heart pumps the blood throughout the arterial system. The arteries are always full and each contraction of the ventricle pumps more blood into them; this distends their elastic walls and sends along them a wave which gradually becomes less perceptible as it nears the very small arteries. This wave constitutes the pulse, and is lost before the capillaries are reached. The sensation or impression given to the finger when placed upon the artery shows the force exerted by the heart and some important facts concerning the condition of the circulation. In adult cattle the average number of pulsations in a minute is from 50 to 60. The pulse is faster than normal after exercise, excitement, on hot days, from pain, and as a result of fullness of the stomach. In old animals it is slower than in the young and in males slightly slower than in females. In fevers and inflammations and in local diseases of the heart the pulse rate is increased. If the rate is greater than 100 or 110 to the minute the outlook for recovery is not good.

Other variations of the pulse are known as infrequent pulse, which means that the number of pulsations in a given time is less than normal. The irregular or the intermittent pulse is when the pulsations do not follow in regular order. The large pulse and the small pulse refer to the volume of the pulse, which may be larger or smaller than usual. The strong pulse and the feeble pulse refer to the strength or weakness of the pulsation. The pulse is said to be hard when the vessel feels hard and incompressible, the soft pulse being the opposite. By dicrotic pulse is meant that kind of pulsation which makes each beat seem double, and therefore it is generally called the double pulse.

The venous or "jugular pulse" is the pulsation so frequently observed in the jugular vein of cattle and is particularly noticeable while they are ruminating—"chewing the cud." It is not always associated with disease, but may be a symptom of some disease of the heart; in such cases the jugular pulse is continuous.

The place selected for feeling the pulse in cattle is where the submaxillary artery winds around the lower jawbones, just at the lower edge of the flat muscle on the side of the cheek; or, if the cow is lying down, the metacarpal artery on the back part of the fore fetlock is very convenient for the purpose.

THE EXAMINATION OF THE HEART.

Corresponding to the beats of the heart two sounds are emitted which are of a definite type in healthy animals. The first is produced by the contraction of the heart and the flow of blood out of it; the second is caused by the rebound of blood in the aorta and the closure of the valves that prevent it from flowing backward into the heart, whence it came. The first sound is the longer and louder of the two, though of low pitch. The second sound is sharper and shorter, and is not always easy to hear. There is a brief interval between them.

To distinguish these sounds, the ear is placed against the left side of the chest, a little above the point where the elbow rests when the animal is standing in a natural position, and about opposite the sixth rib. Both heart sounds are reduced in intensity when the animal is weak or when the heart is forced away from the chest wall by collections of fluid or by tubercular or other growths. Nonrhythmical heart sound is often caused by pericarditis or by disease of the valves. It may also be attributable to overfilling of the heart upon the right side, as occurs in severe congestion of the lungs and in some febrile diseases.

In pericarditis, sounds like scraping, rubbing, or splashing may be heard, entirely apart from the two normal sounds above described.

The impulse of the heart, as felt by placing the hand against the chest, is of some consequence in reaching a conclusion in respect to disease of the heart; but it must be remembered that the impulse may be very much increased by diseases other than those of the heart, as, for example, inflammation of various organs, severe pains, etc. The impulse may be increased also (when disease does not exist) by work, exercise, fright, or any cause of excitement, or, in general, by anything that causes acceleration of the pulse.

The impulse of the heart may be felt and the sounds may be heard fairly well in lean cattle, but in fat ones it is difficult and often impossible to detect either impulse or sound with any degree of satisfaction.

PALPITATION.

When the impulse of the heart is excessive—that is, when it beats more or less tumultuously—the familiar expression "palpitation of the heart" is applied; by many it is called "thumps." The hand or ear placed against the chest easily detects the unnatural beating. In some cases it is so violent that the motion may be seen at a distance. Palpitation is but a symptom, and in many instances not connected with disease of the structure of the heart or its membranes. A badly frightened animal may have palpitation. When it comes on suddenly and soon passes away, it depends on some cause other than diseases of the heart; when it is gradually manifested, however, and becomes constant, although more pronounced at one time than another, heart disease may be suspected, especially if other symptoms of heart disease are present.

INJURY TO THE HEART BY FOREIGN BODIES.

Cattle are addicted to the habit of chewing and swallowing many objects not intended as articles of food. Every veterinarian of experience has met with instances to remind him of this, and it is well known to butchers. Among the great variety of things that have thus found their way into the stomachs of cattle the following have been noticed: Finger rings, knitting needles, old shoes, table knives, wood, pieces of leather, pieces of wire, buttons, hairpins, brushes, nails, coins, etc. The more sharply pointed objects sometimes penetrate the wall of the stomach, in some cases causing gastric irritation enough to produce indigestion, gradually work their way through the diaphragm toward the heart, pierce the pericardium (bag inclosing the heart), wound the heart, and thus prove fatal to the animal. Cases are recorded in which the foreign body has actually worked its way into one of the cavities of the heart. Instances are known, however, in which the object took a different course, and finally worked its way toward the surface and was extracted from the wall of the chest. While it is possible that the foreign body may pierce the wall at different parts of the alimentary canal, as it frequently does that of the rumen (paunch), it is thought that in most cases it passes through the wall of the reticulum (smaller honeycombed compartment, or second stomach) and is drawn toward the heart by the suctionlike action of the chest. Post-mortem examinations have demonstrated the course it pursued, as adhesions and other results of the inflammation it caused were plainly to be seen. All manner of symptoms may precede those showing involvement of the heart, depending upon the location of the foreign body and the extent of inflammation caused by it. Severe indigestion may occur; stiffness and difficulty in moving about owing to the prods of the sharp body following muscular contraction; pain on pressure over the front, lower, or right side of the abdomen; coughing and difficult, quick breathing. In most cases the foreign body does not penetrate to the heart, nor even to the pericardium.

Symptoms.—The symptoms are as follows: The animal is disinclined to move actively, the step is restricted and cautious, sudden motion causes grunting, the attitude is constrained, the feet are drawn somewhat together, the back is arched, the face has an anxious expression. If the disease is of several days' standing, there is likely to be soft swelling (edema) beneath the neck, in the dewlap, and under the chest, between the fore legs. Breathing is short and difficult; it may clearly be painful. The pulse is rapid, 80 to 120 per minute. The muscles quiver as though the animal were cold. Rumination and appetite are depressed or checked. The dung is hard, and to void it appears to cause pain. These symptoms usually develop gradually, and, of course, they vary considerably in different animals, depending upon the size and location of the foreign body and the irritation it causes.

As a matter of course, in such cases treatment is useless, but when it is possible to diagnose correctly the animal could be turned over to the butcher before the flesh becomes unfit for use; that is, before there is more than a little suppuration and before there is fever. Knowing that cattle are prone to swallow such objects, ordinary care may be taken in keeping their surroundings as free of them as possible.

PERICARDITIS.

Inflammation of the pericardium (heart bag) is often associated with pneumonia and pleurisy, rheumatism, and other constitutional diseases, or with an injury. It also occurs as an independent affection, owing to causes similar to those of other chest affections, as exposure to cold or dampness and changes of the weather.

Symptoms.—It may be ushered in with a chill, followed by fever, of more or less severity; the animal stands still and dull, with head hanging low, and anxiety expressed in its countenance. The pulse may be large, perhaps hard; there is also a venous pulse. The hand against the chest will feel the beating of the heart, which is often irregular, sometimes violent, and in other instances weak, depending in part upon the quantity of fluid that has transuded into the pericardial sac. The legs are cold, the breathing quickened and usually abdominal; if the left side of the chest is pressed on or struck, the animal evinces pain. There may be spasms of the muscles in the region of the breast, neck, or hind legs. After a variable time swelling may also appear in the legs and under the chest and brisket.

In those animals in which the heart sounds may be heard somewhat distinctly, the ear applied against the chest will detect a to-and-fro friction sound, corresponding to the beats of the heart. This sound is produced by the rubbing of the internal surface of the heart bag against the external surface of the heart. During the first stages of the inflammation these surfaces are dry, and the rubbing of one against the other during the contraction and relaxation of the heart produces this sound. The dry stage is followed by the exudation of fluid into the heart sac, and the friction is not heard until the fluid is absorbed sufficiently to allow the surfaces to come in contact again. But during the time the friction sound is lost a sound which has been called a "churning noise" may take its place.

The friction sound of pericarditis can not be mistaken for the friction sound of pleurisy if the examination is a careful one, because in the heart affection the sound is made in connection with the heart beats, while in the pleuritic affection the sound is synchronous with each respiration or breath of air taken in and expelled from the lungs.

Treatment.—When pericarditis is complicated with rheumatism or other diseases the latter must be treated as directed in the description of them. The animal must be kept in a quiet, comfortable place, where it will be free from excitement. Warm clothing should be applied to the body, and the legs should be hand-rubbed until the circulation in them is reestablished, and then they should be snugly bandaged. The food should be nutritive and in moderate quantity. Bleeding should not be performed unless the case is in the hands of an expert.

At the beginning give as a purgative Epsom salt—1 pound to an average-sized cow—dissolved in about a quart of warm water and administered as a drench. When there is much pain 2 ounces of laudanum, diluted with a pint of water, may be given every three hours until the animal is better. Do not give the laudanum unless demanded by the severity of the pain, as it tends to constipate. Give one-half ounce of nitrate of potassium (saltpeter), dissolved in drinking water, four or five times a day. After the attack has abated mustard mixed with water may be rubbed well over the left side of the chest to stimulate the absorption of the fluid within the pericardium. The other medicines may be discontinued and the following administered: Sulphate of iron, 2 ounces; powdered gentian, 6 ounces; mix and make 8 powders. Give one powder every day at noon, mixed with feed, if the animal will eat it, or shaken up with water in a bottle as a drench. Also the following: Iodid of potassium, 2 ounces; nitrate of potassium, 8 ounces; mix and make 16 powders. Give one in drinking water or in drench every morning and evening. The last two prescriptions may be continued for several weeks if necessary.

In extreme cases tapping the pericardium with a trocar and cannula to draw off the fluid is resorted to, but the operation requires exact anatomical knowledge.

After death from pericarditis there is always more or less fluid found in the pericardium; the surfaces are rough and covered with a yellow-colored exudate. There are also in many cases adhesions to a greater or less extent between the heart and pericardium.

MYOCARDITIS.

Inflammation of the muscular structure of the heart occurs in limited, circumscribed areas, as evidenced by post-mortem examination, and it is probably always somewhat involved in connection with pericarditis and endocarditis. It may readily be inferred that if the whole organ were inflamed death would ensue immediately. Usually myocarditis results from the preexistence of blood poisoning or of some infectious febrile disease.

Symptoms.—The chief symptoms are those of heart weakness. The heart beat is fast, weak, and often irregular. Respiration is difficult and rapid. There is great general weakness and depression. Death comes suddenly.

Treatment.—Treatment consists in supporting the animal by the use of stimulants, such as ammonia, coffee, digitalis, camphor, etc. Complete quiet must be provided, and the general care should be as in pericarditis.

ENDOCARDITIS.

When the membrane which lines the cavities of the heart—the endocardium—suffers inflammation, the disease is called endocarditis. The cause is another disease, during which substances that irritate the lining of the heart are produced and admitted into the circulation. These substances are usually living organisms, or it is possible that in some cases they are chemical irritants. Endocarditis occurs as a complication of or sequel to pneumonia, blood poisoning, inflammation of the womb, rheumatism, or severe wounds or abscesses. The symptoms are much the same as those of pericarditis, and it is difficult to discriminate between the two affections. There is a jugular pulse, the legs may become dropsical, and there is a tendency to faint if the head is elevated suddenly. The bellowslike sound is more distinct than it is in pericarditis. It is the most fatal of heart diseases, because of the liability of the formation of clots, which may adhere to the valves, change in the structure of the valves, and often a complication with an abnormal condition of the blood.

Clots may be formed in the heart, and, being carried to other parts, prove fatal by interrupting the circulation in some vital organ.

Treatment similar to that advised for myocarditis may be followed in this disease.

VALVES OF THE HEART.

The valves are subject to abnormal growths and structural changes in chronic endocarditis or as a result of acute endocarditis. Sometimes valves are torn by sudden, extreme muscular effort or a congenital abnormality. Cases are also reported in which they have been found ruptured.

Symptoms.—The general symptoms are those of heart weakness, accompanied with edema and congestion of the lungs.

Treatment.—Relief is sometimes afforded, but usually only temporarily, by the use of stimulants, especially digitalis.

RUPTURE OF THE HEART.

Sudden effort, blows, or disease may lead to rupture of the heart of the ox. The first cause does not operate so often in cattle as in horses. Tuberculosis or ulceration from other causes, such as a foreign body, is the most common source of this accident. Rupture is shown by sudden fainting, followed very shortly by death.

HYPERTROPHY AND DILATATION OF THE HEART.

This is an enlargement of the heart, and may consist of the thickening of the walls alone, or at the same time the cavities may be either enlarged or diminished. Dilatation of the cavities has been noticed as existing independently of thickened walls. In hypertrophy the sounds of the heart are loud and pronounced, may be heard on both sides of the chest distinctly, and palpitation occurs to a greater or less extent. Fortunately both conditions are very rare in cattle.

ATROPHY.

Atrophy is the technical term for wasting of the muscular tissue. Atrophy of the heart is very rare among cattle, and is usually a result of other diseases.

FATTY DEGENERATION OF THE HEART.

This condition of the heart is met with in some very fat cattle, but it must be understood that the accumulation of fat around the heart is not referred to by this designation. In fatty degeneration the elements of the muscular tissue are replaced by fatty or oily granules. The muscle becomes weak, the heart contractions are insufficient, and heart weakness is shown by general weakness, shortness of breath, and weak, rapid pulse.

CYANOSIS.

Owing to the most prominent symptoms, cyanosis is also called "blue disease," and is seen occasionally in new-born calves. It is recognized by the blue color of the mucous membrane (easily seen by looking within the mouth and nostrils), the coldness of the surface of the body, and rapid, labored breathing. It is caused by non-closure of the foramen ovale, connecting the right with the left side of the heart, and the consequent mixing of the venous with the arterial blood. Calves so affected live but a short time.

MISPLACEMENT OF THE HEART.

Cases are recorded in which the heart has been found out of its natural position, sometimes even outside the chest. This is a congenital condition for which there is no remedy. A heifer calf with the heart entirely outside the thoracic cavity and beneath the skin in the lower part of the neck was kept for two years at the veterinary hospital of the University of Pennsylvania, during which time it grew to be a well-developed cow.

WOUNDS OF ARTERIES AND VEINS.

When a blood vessel is opened a glance will tell whether it is an artery or a vein by simply remembering that bright-red blood comes from arteries and dark-red from veins. When a vein or a very small artery is severed the blood flows from the vessel in a continuous and even stream, but when one of the larger arteries is severed the blood comes in intermitting jets or spurts corresponding to the beats of the heart. It is well to call attention to the fact that the dark-red blood which flows or oozes from a wound soon becomes bright red, because it gives up its carbonic-acid gas to the air, and absorbs oxygen gas from the air, which is exactly the change it undergoes in the capillaries of the lungs.

The general treatment of wounds will be found in another section; here it is necessary only to refer briefly to some of the most practical methods used to arrest hemorrhages, as instances occur in which an animal may lose much strength from the loss of blood, or even bleed to death unless action is prompt.

BLEEDING (HEMORRHAGE).

The severity of a hemorrhage depends upon the size of the vessel from which the blood escapes, though it may be stated that it is more serious when arteries are severed. If the wound in an artery is in the direction of its length, the blood escapes more freely than if the vessel is completely severed, because in the latter instance the severed ends retract, curl in, and may aid very much in arresting the flow. When the blood merely oozes from the wound, and even when it flows in a small stream, the forming of the clot arrests the hemorrhage in a comparatively short time.

Slight hemorrhages may be checked by the continuous application of cold water, ice, or snow, to the wound, as cold causes contraction of the small vessels. Water from a hose may be thrown on a wound, or dashed on it from the hand or a cup, or folds of cotton cloths may be held on it and kept wet. Ice or snow may be held against the wound, or they may be put into a bag and conveniently secured in position.

Hot water of an average temperature of 115° to 120° F. injected into the vagina or womb is often efficient in arresting hemorrhages from those organs. Tow, raw cotton, lint, or sponges may be forced into a wound and held or bound there with bandages. This is an excellent method of checking the flow of blood until the arrival of an expert. If the flow persists, these articles may be saturated with tincture of iron, but it is not advisable to use it unless necessary, as it is a caustic and retards healing by causing a slough. In cases of necessity, the articles may be saturated with vinegar, or tannic acid or alum dissolved in water may be used instead. Whatever article is used should be left in the wound sufficiently long to make sure that its removal will not be followed by a renewal of the hemorrhage. Sometimes it must remain there one or two days.

An iron heated white and then pressed on the bleeding vessel for three or four seconds is occasionally used. It should not be applied longer, or else the charred tissue will come away with the iron and thus defeat the purpose of its application.

Compression may be applied in different ways, but only the most convenient will be mentioned. To many wounds bandages may easily be applied. The bandages may be made of linen, muslin, etc., sufficiently wide and long, according to the nature of the wound and the region to be bandaged. Bed sheets torn in strips the full length make excellent bandages for this purpose. Cotton batting, tow, or a piece of sponge may be placed on the wound and firmly bound there with the bandages.

Many cases require ligating, which is almost entirely confined to arteries. A ligature is a piece of thread or string tied around the vessel. Veins are not ligated unless very large (and even then only when other means are not available) on account of the danger of causing phlebitis, or inflammation of a vein. The ligature is tied around the end of the artery, but in some instances this is difficult and it is necessary to include some of the adjacent tissue, although care should be taken not to include a nerve. To apply a ligature, it is necessary to have artery forceps (tweezers or small pincers may suffice) by which to draw out the artery in order to tie the string around it. To grasp the vessel it may be necessary to sponge the blood from the wound so that the end will be exposed. In case the end of the bleeding artery has retracted, a sharp-pointed hook, called a tenaculum, is used to draw it out far enough to tie. The ligature should be drawn tightly, so that the middle and internal coats will be cut through.

Another method of checking hemorrhage is called torsion. It consists in catching the end of the bleeding vessel, drawing it out a little, and then twisting it around a few times with the forceps, which lacerates the internal coats so that a check is effected. This is very effectual in small vessels, and is to be preferred to ligatures, because it leaves no foreign body in the wound. A needle or pin may be stuck through the edges of the wound and a string passed around between the free ends and the skin (Pl. XXVII, fig. 10), or it may be passed around in the form of a figure 8, as is often done in the operation of bleeding from the jugular vein.

ANEURISM.

A circumscribed dilatation of an artery, constituting a tumor which pulsates synchronously with the beats of the heart, is called aneurism. It is caused by disease and rupture of one or two of the arterial coats. The true aneurism communicates with the interior of the artery and contains coagulated blood. It is so deeply seated in cattle that treatment is out of the question. Such abnormalities are ascribable to severe exertion, to old age, to fatty or calcareous degeneration, or to parasites in the blood vessels. Death is sudden when caused by the rupture of an aneurism of a large artery, owing to internal hemorrhage. Sometimes spontaneous recovery occurs. As a rule no symptoms are caused in cattle by the presence of deep-seated aneurisms, and their presence is not known until after death.

A false aneurism results from blood escaping from a wounded artery into the adjacent tissue, where it clots, and the wound, remaining open in the artery, causes pulsation in the tumor.

THROMBOSIS (OBSTRUCTION) OF THE ARTERIES.

Arteries become obstructed as a result of wounds and other injuries to them, as those caused by the formation of an abscess or the extension of inflammation from surrounding structures to the coats of an artery. Arteries are also obstructed by the breaking off of particles of a plug or clot, partly obstructing the aorta or other large artery. These small pieces (emboli) are floated to an artery that is too small to permit them to pass and are there securely held, producing obstruction. These obstructions are shown by loss of power in the muscles supplied by the obstructed artery and by excitation of the heart and by respiration after exercise. The loss of power may not come into evidence until after exercise.

Symptoms.—While standing still or when walking slowly the animal may appear to be normal, but after more active exercise a group of muscles, a leg, or both hind legs, may be handled with difficulty, causing lameness, and later there is practically a local paralysis. These symptoms disappear with rest. In some cases the collateral circulation develops in time, so that the parts receive sufficient blood and the symptoms disappear.

INFLAMMATION OF VEINS (PHLEBITIS).

When bleeding is performed without proper care or with an unclean lancet, inflammation of the vein may result, or it may be caused by the animal rubbing the wound against some object. When inflammation follows the operation, the coats of the vein become so much enlarged that the vessel may be felt hard and knotted beneath the skin, and pressure produces pain. A thin, watery discharge, tinged with blood, issues from the wound. The blood becomes coagulated in the vessel. In inflammation of the jugular the coagulation extends from the wound upward to the first large branch. Abscesses may form along the course of the vein. The inflammation is followed by obliteration of that part in which coagulation exists. This is of small import, as cattle have an accessory jugular vein which gradually enlarges and accommodates itself to the increased quantity of blood it must carry.

Treatment.—The treatment for inflammation of the vein is to clip the hair from along the course of the affected vessel and apply a blister, the cerate of cantharides. Abscesses should be opened as soon as they form, because there is a possibility of the pus getting into the circulation.

In the operation of bleeding the instruments should be clean and free from rust. If the skin is not sufficiently opened, or when closing the wound the skin is drawn out too much, blood may accumulate in the tissue, and if it does it should be removed by pressing absorbent cotton or a sponge on the part. Care should also be used in opening the vein, so that the instrument may not pass entirely through both sides of the vein and open the artery beneath it.

DISEASES OF THE HEART, BLOOD VESSELS, AND LYMPHATICS.

DESCRIPTION OF PLATE.

PLATE VII:

Diagram illustrating the circulation of the blood. The arrows indicate the direction in which the blood flows. The valves of the heart, situated between the right auricle and ventricle, and left auricle and ventricle, and between the ventricles and large arteries, are represented by curved lines. These valves are intended to prevent the flow of blood in a direction contrary to that indicated by the arrows

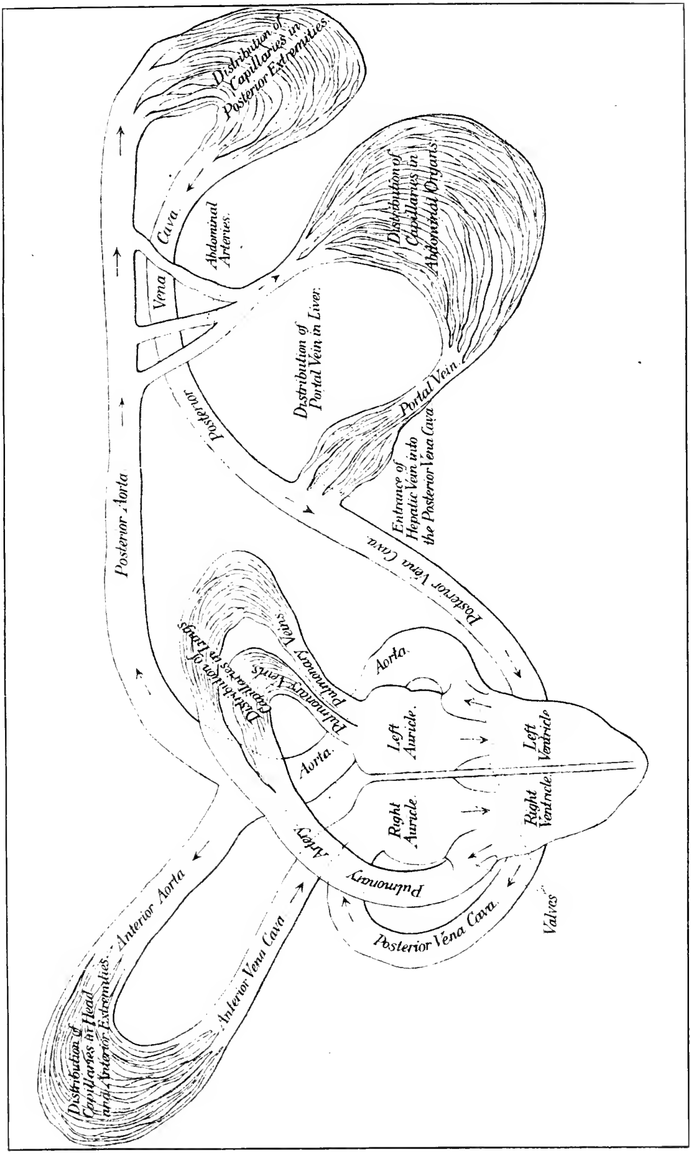


DIAGRAM OF THE CIRCULATION OF THE BLOOD.

NONCONTAGIOUS DISEASES OF THE ORGANS OF RESPIRATION.

By William Herbert Lowe, D. V. S.

DIAGNOSIS.

In the determination of disease in the human being the physician, in making his diagnosis, is aided by both subjective and objective symptoms, but the veterinary physician, in a very large majority of cases, is obliged to rely almost solely upon objective symptoms, and perhaps in no class of diseases is this more true than in the exploration of those under consideration. This condition of affairs has a strong tendency to develop observation and discernment in the veterinarian, and not infrequently do we find that the successful veterinary practitioner is a very accurate diagnostician. In order to make a differential diagnosis, however, it is not only necessary to know the structure and functions of the organs in health, but to adopt a rigid system of details of examination, without which successful results can not be reached.

History.—The history of a case should always be ascertained so far as possible. The information obtained is sometimes unsatisfactory and not to be depended upon, but even when this is the case it is advisable to weigh the evidence from every point of view.

In connection with the history of every case it is always of primary importance to ascertain the cause of illness. A knowledge of the origin and development of a disease is important, both in making a diagnosis and in formulating the treatment. Exposure to cold and dampness is frequently the exciting cause of affections of the organs of respiration.

The experienced practitioner is always sure to ascertain whether the particular animal he is called on to attend is the only one in the stable or on the premises that is similarly affected. If several animals are similarly affected, the disease may have a common cause, which may or may not be of an infectious nature.

Another thing that the experienced practitioner ascertains is what previous treatment, if any, the animal has had. Medicine given in excessive doses sometimes produces symptoms resembling those of disease.

The hygienic and sanitary conditions must always be considered in connection with the cause as well as the treatment of disease.

Much of the disease which occurs in large dairies and elsewhere could be prevented if owners and those in charge of animals had proper regard for the fundamental laws of animal hygiene and modern sanitation. Disregard for these laws is the cause of most of the diseases under consideration in this chapter.

Attitude and general condition.—The feeling of pain in animals suffering from serious affections of the organs of respiration is expressed to the close observer in no uncertain language—by their flinching when the painful part is touched; by the care with which they move or lie down; by walking or standing to "favor" the part; by the general attitude and expression of the eye; by the distress and suffering apparent in the face; and by other evidences.

The general physical condition and attitude of the sick animal tell the careful observer much that aids him in making a diagnosis and prognosis. Cows suffering from affections of the organs of respiration usually assume a position or attitude that is characteristic, well known to experienced stockmen, as well as to veterinarians. When an animal has a fever or is suffering from an inflammation, the skin is one of the first parts to undergo a change that is apparent to the average observer, for it soon loses its elasticity and tone, and the hair becomes dry and staring.

From the general condition or state of nutrition one is able to judge the effect that the disease has already had upon the animal and to estimate the strength remaining available for its restoration to health; from the degree of emaciation one can approximate the length of time the animal has been ill. The age and breed of the animal, as well as its constitution and temperament, are among the things that have to be taken into account in making a diagnosis and in overcoming the disease.

The mucous membrane.—The mucous membrane should in all cases be examined. It can be readily seen by everting the eyelids or by an inspection of the lining membrane of the nostrils.

Paleness of the mucous membrane indicates weak circulation or poor blood and may result from disease, hemorrhage, or from inappropriate feed.

In healthy animals increased redness of the mucous membrane occurs from pain, excitement, or severe exertion, and in such instances is always transitory. In certain pathological conditions, such as fevers and inflammation, this condition of the mucous membrane will also be found. The increased redness of the mucous membrane lasts during the duration of the fever or inflammation.

A dusky or blue mucous membrane indicates that the blood is imperfectly oxidized and contains an excess of carbon dioxid, and is seen in serious diseases of the respiratory tract, such as pneumonia, and in heart failure.

The secretions.—The secretions may be diminished, increased, or perverted. In the early stage of an inflammation of a secretory organ its secretion is diminished. In the early stage of pleurisy the serous membrane is dry, and as the disease advances the membrane becomes unnaturally moist. The products of secretion are sometimes greatly changed in character from the secretion in health, becoming excessively irritant and yielding evidence of chemical and other alterations in the character of the secretion.

Cough.—Cough depends upon a reflex nervous action and may be primary when the irritation exists in the lungs or air passages, or secondary when caused by irritation of the stomach, intestines, or other parts having nervous communications with the respiratory apparatus. A cough is said to be dry, moist, harsh, hollow, difficult, paroxysmal, suppressed, sympathetic, etc., according to its character. It is a very important symptom, often being diagnostic in diseases of the respiratory organs, but this is a subject, however, which can be more satisfactorily treated in connection with the special diseases of the organs in question.

Respiration.—In making an examination of an animal observe the depth, frequency, quickness, facility, and the nature of the respiratory movements. They may be quick or slow, frequent or infrequent, deep or imperfect, labored, unequal, irregular, etc., each of which indications has its significance to the experienced veterinarian.

Sleep, rumination, pregnancy in cows, etc., modify the respiratory movements even in health. Respiration consists of two acts—inspiration and expiration. The function of respiration is to take in oxygen from the atmospheric air, which is essential for the maintenance of life, and to exhale the deleterious gas known as "carbon dioxid."

The frequency of the respiratory movements is determined by observing the motions of the nostrils or of the flanks. The normal rate of respiration for a healthy animal of the bovine species is from 15 to 18 times a minute. The extent of the respiratory system renders it liable to become affected by contiguity to many parts and its nervous connections are very important.

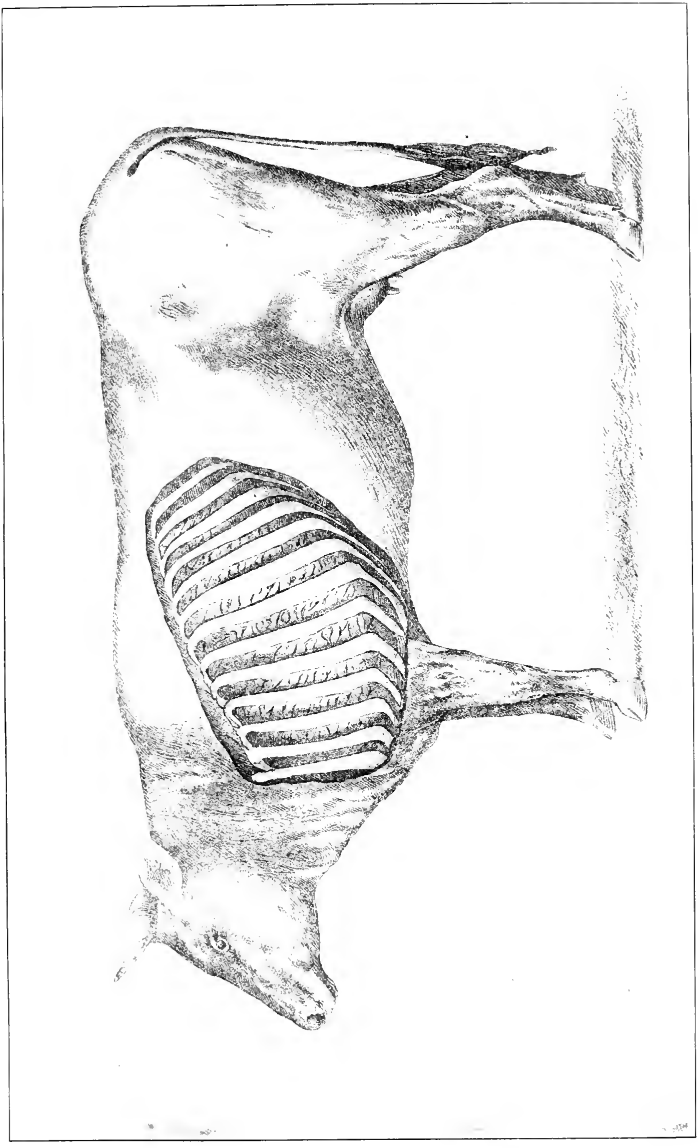
Rapid, irregular, or difficult breathing is known as dyspnea, and in all such cases the animal has difficulty in obtaining as much oxygen as it requires. Among the conditions that give rise to dyspnea may be mentioned restricted area of active lung tissue, owing to the filling of portions of the lungs with inflammatory exudate, as in pneumonia; painful movements of the chest, as in rheumatism or pleurisy; fluid in the chest cavity, as in hydrothorax; adhesions between the lungs and chest walls; compression of the lungs or loss of elasticity; excess of carbon dioxid in the blood; weakness of the respiratory passages; tumors of the nose and paralysis of the throat; swellings of the throat; foreign bodies and constriction of the air passages leading to the lungs; fevers, etc.

As already stated, it is only the careful and constant examination of animals in health that will enable one properly to appreciate abnormal conditions. One must become familiar with the frequency and character of the pulse and of the respirations and know the temperature of the animal in health, before changes in abnormal conditions can be properly appreciated.

Temperature.—The temperature should be taken in all cases of sickness. Experienced practitioners can approximate the patient's temperature with remarkable accuracy, but I strongly recommend the use of the self-registering clinical thermometer, which is a most valuable instrument in diagnosing diseases. (See Pl. III, fig. 1.) It is advisable to get a tested instrument, as some thermometers in the market are inaccurate and misleading. The proper place to insert the thermometer is in the rectum, where the instrument should be rested against the walls of the cavity for about three minutes. The normal temperature of the bovine is 101° to 102° F., which is higher than that of the horse. A cow breathes faster, her heart beats faster, and her internal temperature is higher than that of the horse. Ordinary physiological influences—such as exercise, digestion, etc.—give rise to slight variations of internal temperature; but if the temperature rises two or three degrees above the normal some diseased condition is indicated.

Pulse.—The pulse in a grown animal of the bovine species in a state of good health beats from 45 to 55 times a minute. Exercise, fright, fear, excitement, overfeeding, pregnancy, and other conditions aside from disease may affect the frequency and character of the pulse. It assumes various characters according to its rapidity of beat, frequency of occurrence, resistance to pressure, regularity, and perceptibility. Thus we have the quick or slow, frequent or infrequent, hard or soft, full or imperceptible, large or small pulse, the character of each of which may be determined from its name; also that known as the intermittent, either regular or irregular. We may have a dicrotic, or double, pulse; a thready pulse, which is extremely small and scarcely perceptible; the venous, or jugular, pulse; the "running down" pulse, and so on. (See p. 76.)

In cattle the pulse is conveniently felt over the submaxillary artery where it winds around the lower jawbone, just at the lower edge of the flat muscle on the side of the cheek. If the cow is lying down the pulse may be taken from the metacarpal artery on the back part of the fore fetlock. The pulsations can be felt from any superficial artery, but in order to ascertain the peculiarities it is necessary to select an artery that may be pressed against a bone. There is a



Position of the Lung.

marked difference in the normal or physiological pulse of the horse and that of the cow, that of the horse being full and rather tense, while in the cow it is soft and rolling. The pulse is faster in young or old cattle than it is in those of middle age.

Auscultation.—Auscultation and percussion are the chief methods used to determine the various pathological changes that occur in the respiratory organs. Auscultation is the act of listening, and may be either mediate or immediate. Mediate auscultation is accomplished by aid of an instrument known as the stethoscope, one extremity of which is applied to the ear and the other to the chest of the animal. In immediate auscultation the ear is aplied directly to the part. Immediate auscultation will answer in a large majority of cases. Ausculation is resorted to in cardiac and certain abdominal diseases, but it is mainly employed for determining the condition of the lungs and air passages. Animals can not give the various phases of respiration, as can the patients of the human practitioner. The organs themselves are less accessible than in man, owing to the greater bulk of tissue surrounding them and the pectoral position of the fore extremities, all of which render it more difficult in determining pathological conditions. (See Pl. VIII.)

The air going in and out of the lungs makes a certain soft, rustling sound, known as the vesicular murmur, which can be heard distinctly in a healthy state of the animal, especially upon inspiration. Exercise accelerates the rate of respiration and intensifies this sound. The vesicular murmur is heard only where the lung contains air and its function is active. The vesicular murmur is weakened as inflammatory infiltration takes place and when the lungs are compressed by fluids in the thoracic cavity, and disappears when the lung becomes solidified in pneumonia or the chest cavity filled with fluid as in hydrothorax. The bronchial murmur is a harsh, blowing sound, heard in normal conditions by applying the ear over the lower part of the trachea, and may be heard to a limited extent in the anterior portions of the lungs after severe exercise. The bronchial murmur when heard over other portions of the lungs generally signifies that the lung tissue has become more or less solidified or that fluid has collected in the chest cavity.

Other sounds, known as mucous râles, are heard in the lungs in pneumonia after the solidified parts begin to break down at the end of the disease and in bronchitis where there is an excess of secretion, as well as in other conditions. Mucous râles are of a gargling or bubbling nature. They are caused by air rushing through tubes containing secretions or pus. They are said to be large or small as they are distinct or indistinct, depending upon the quantity of fluid that is present and the size of the tubes in which the sound is produced.

According to their character they are divided into dry and moist. The friction sound is produced by the rubbing together of roughened surfaces and is characteristic of pleurisy.

Percussion.—Percussion is that mode of examination by which we elicit sounds by striking or tapping over the part. It may be direct or indirect. If the middle finger of the left hand is placed firmly on the chest and smartly tapped or struck with the ends of the first three fingers of the right hand, the sound will be noticed to be more resonant and clear than when the same procedure is practiced on a solid part of the body. This is because the lungs are not solid, but are always, in health, well expanded with air. In certain pulmonary diseases, however, as in pneumonia, they fill up and become solid, when percussion produces a dull sound, like that on any other solid part of the animal. When fluid has collected in the lower part of the chest cavity the sound will also be dull on percussion. Where there is an excess of air in the chest cavity, as in emphysema or in pneumothorax, the percussion sound becomes abnormally loud and clear. By practice on healthy animals the character and boundaries of the sounds can be so well determined that any variation from them will be readily detected, and will sometimes disclose the presence of a diseased condition when nothing else will.

Percussion is sometimes practiced with the aid of a special percussion hammer and an object known as a pleximeter to strike upon. A percussion hammer is made of rubber or has a rubber tip, so that when the pleximeter, which is placed against the side of the animal, is struck the impact will not be accompanied with a noise. A percussion hammer and pleximeter may be purchased from any veterinary instrument maker.

CATARRH (COLD IN THE HEAD).

Nasal catarrh is an inflammation of the mucous membranes of the nostrils and upper air passages. Simple catarrh is not a serious disease in itself, but if neglected is liable to be complicated with laryngitis, bronchitis, pneumonia, plurisy, or other serious and sometimes fatal diseases of the respiratory organs. Catarrh is a common disease among cattle. It is often caused by sudden exposure to wet and cold after they have been accustomed to shelter. It may arise from inhalation of irritating gases. It is also sometimes produced by certain specific atmospheric conditions, and may assume an enzoötic form. It is very debilitating, and requires prompt and judicious treatment.

Symptoms.—Redness of the mucous membranes of the nose and redness and watering of the eyes are symptoms of nasal catarrh. The mucous membrane first becomes dry; afterwards a watery discharge appears, and later, in severe cases, the discharge becomes mucopurulent. In mild cases there is little or no fever, but in severe ones it may run high. The animal becomes dull, languid, and is not inclined to move about, and the appetite may become impaired; there is also variable temperature of the horns and ears. If in a cow giving milk the secretion diminishes, the mucus from the eyes and nose becomes thicker and yellower. Afterwards, as the symptoms increase in severity, the discharge becomes mucopurulent.

Treatment.—The animal should be housed in a well-ventilated place, with good hygienic surroundings. In cold and damp weather it should be kept warm with blanketing, and, in severe cases, hot, medicated inhalations given. If the fever is high, it may be reduced by giving nitrate of potassium, from 1 to 2 ounces, in the drinking water, three times daily. Diffusible stimulants are beneficial in most cases. Too much importance can not be attached to good nursing. There is no necessity to resort to the old system of bleeding, purging, or the use of powerful sedatives.

EPISTAXIS (BLEEDING FROM THE NOSE).

Bleeding from the nostrils is rather rare in cattle. It may arise from any one of a variety of causes, but usually results from disease or injury to the mucous membranes or to violent exertions in coughing and sneezing. It is seldom serious. It generally occurs in drops from one nostril only, accompanied with sneezing, and without frothing. Bleeding from the lungs comes from both nostrils, is bright red, frothy, and accompanied with a cough.

Treatment.—In many cases the bleeding will cease spontaneously and all that is necessary is to keep the animal quiet and bathe the head and nostrils with cold water. The cause of the bleeding should be learned and governed accordingly in the treatment. In severe and exceptional cases, when the hemorrhage is persistent and long continued, the animal's head should be tied to a high rack or beam and cold water or ice applied, or recourse to styptic injections taken. If the hemorrhage is profuse and persistent, either a drench composed of 1½ drams of acetate of lead dissolved in a pint of water or 1½ drams of gallic acid dissolved in a pint of water should be given.

LARYNGITIS (SORE THROAT).

An inflammation of the mucous membrane lining the larynx is known as laryngitis. It may be either a primary or a secondary disease, complicated or uncomplicated. In the majority of cases it is attributable to some form of exposure, a sudden change from warm to cold surroundings, or exposure to cold storms. It may also result from inhaling irritating gases or from external violence. In an acute attack of laryngitis there is an elevation of temperature, pain on pressure over the region of the larynx, violent paroxysms of coughing, difficult and noisy respiration. The nostrils are dilated, the nose extended, and the animal has a frightened expression. There is marked difficulty in swallowing.

Treatment.—Treatment consists of fomentations and hot applications over the throat. Stimulating liniments, mustard mixed with cold water and well rubbed in with a stiff brush, or other forms of counterirritation may be applied in severe cases. Hot inhalations should be frequently resorted to, and often afford much relief to the suffering animal. In this disease medicines should be given so far as possible in the form of electuaries (soft solid) on account of the difficulty of deglutition. Large drafts of medicines have a tendency to produce violent spells of coughing, and in this way retard recovery. The subjoined formula for an electuary will be found to answer the purpose in ordinary cases: Chlorate of potassium, pulverized, 8 ounces; fluid extract of belladonna, 2 ounces; powdered opium, 1 ounce; powdered licorice root, 8 ounces; sirup, sufficient quantity; mix. Place a small tablespoonful of the mixture frequently on the tongue or back teeth. Or the following may be used instead: Aloes, powdered opium, and gum camphor in equal parts; mix. Rub an ounce on the molar teeth every four or five hours. The bowels should be kept open and the diet should be such as the patient can easily swallow. Warm, sloppy mashes, boiled oatmeal gruel, linseed tea, and the like are the most suitable substances. If suffocation be threatened during the course of the disease, tracheotomy should be performed without delay. The details of the operation are fully described under the head of "Surgical operations." (See p. 289.)

When the disease assumes a chronic form, strong counterirritation is indicated. A cantharides blister may be applied, or the following ointment used: Biniodid of mercury 1 part, lard 6 parts; mix. In some cases it will be found necessary to repeat the application.

BRONCHITIS.

Bronchitis is an inflammation of the mucous membrane of the bronchial tubes. When a primary disease, it is generally the result of what is commonly known as "catching cold." It may be secondary to or complicated with many of the diseases of the respiratory system. It may also be caused by breathing irritating gases, or by the introduction of foreign bodies into the bronchial tubes, which sometimes results from injudicious and careless drenching when the larynx is temporarily relaxed. It may be acute or chronic, and is divided, according to the seat of the inflammation, into bronchitis proper when the large tubes are affected, or capillary bronchitis when the trouble is in the smaller ones.

Symptoms.—Loss of appetite, elevation of temperature, generally 104° or 105° F. The inspiration is incomplete, short, and painful, and the expiration is prolonged. The pulse is increased in frequency and is hard. A characteristic, painful cough is present, but it is paroxysmal and incomplete. Auscultation and percussion greatly aid us in a diagnosis. A normal sound is given on percussion. On auscultation, in the early stages, rhonchus râles are detected if the larger tubes are affected, and sibilant râles if the smaller ones are affected. Later mucous râles are noted, and sometimes all sounds in certain parts are absent, owing to the plugging up of the tubes. This plugging, if extensive enough, is sometimes the cause of death, or death may result from extension of the disease to the lungs or pleura.

Treatment.—The animal should be placed in a light, well-ventilated box, and the bowels kept in a soft condition by enemas, etc. Violent purgatives should not be used. The body should be kept warm by blanketing. In the early stages a draft composed as follows should be given three times daily: Extract of belladonna, 2 drams; solution of acetate of ammonium, 4 fluid ounces; water, one-half pint. In the later stage of the disease the following formula may be substituted and given twice daily: Carbonate of ammonium, 3 drams; liquor hydrochlorate of strychnin, 2 fluid drams; spirits of nitrous ether, 1 fluid ounce; water, one-half pint.

In some cases the following is preferable to either of the above, and may be given in a pint of linseed tea every four hours: Spirits of nitrous ether, 1½ ounces; aromatic spirits of ammonia, 2 ounces; powdered camphor, 2 drams. The feed should be light and nutritious.

Bronchitis is liable to become chronic if not properly treated in the earliest stage. In this case remedial treatment is of little value.

PLEURISY.

Pleurisy is an inflammation of the serous membrane lining the chest cavity and enveloping the lungs. It is somewhat rare as an independent disease, but it often complicates pneumonia; indeed, it is often caused by the same germ that causes pneumonia—pneumococcus. It may arise from exposure to cold or wet or from external violence, and is usually present in some degree in cases in which the ribs have been fractured with or without a penetrated wound.

Symptoms.—In the first stage there is great pain aggravated by movement, and the animal is usually stiff as though foundered, the pulse is quick and hard, the breathing abdominal, the chest being fixed so far as possible, the inspiration short and jerky, the expiration longer. The pain is caused by the friction of the dry, inflamed pleural surfaces of the lung and chest on each other. At this stage the ear detects a dry friction murmur, resembling somewhat the sound made by rubbing two pieces of sole leather together. Pressure between the ribs gives pain and usually causes the animal to flinch and grunt. The muzzle is hot and dry, the mouth slimy, and the secretions scanty. After a day or two the severity of the symptoms is much lessened, the temperature, which during the first days may have been as high as 106° F., falls to 103° or 104°, the pain decreases, the stiffness disappears, and the patient eats a little. The pulse softens, but remains quicker than normal. Now, day by day the patient loses a little strength, the friction sound disappears as the exudation moistens the pleural surfaces; percussion now shows a horizontal line of dullness, which day by day rises higher in the chest, the respiration grows more frequent and labored, the countenance is anxious and haggard, the eyes sink somewhat in their sockets, and in unfavorable cases death occurs during the second or third week, from either asphyxia or heart failure.

In pleurisy, as in pneumonia, the elbows are usually turned outward. Care must be taken to differentiate pleurisy from traumatic pericarditis (which see). In the latter condition the area of dullness of the heart is much increased, and usually a splashing sound is heard at each beat of the heart. Another diagnostic symptom of value is that in traumatic pericarditis respiration is painful, not difficult, and the respiratory rate is very much increased on movement. In both conditions a considerable swelling of the dewlap may be noticed in the later stages.

Treatment.—Give the same general care as recommended in bronchitis or pneumonia. In the early stages give a febrifuge to reduce the fever, as directed for pneumonia. For relief of the cough give electuary formula, which will be found in the treatment of laryngitis. The bowels must be kept relaxed and the kidneys secreting freely. In the stage of effusion the following should be given three times daily: Digitalis tincture, 1 ounce; iodid of potassium, 30 to 60 grains; mix. Apply strong counterirritant to chest and put seton in dewlap. (See "Setoning," p. 293.) If collapse of the lung is threatened, a surgical operation, termed paracentesis thoracis, is sometimes performed; this consists in puncturing the chest cavity and drawing off a part of the fluid. The instruments used are a small trocar and cannula, which are introduced between the eighth and ninth ribs. The skin should be drawn forward so that the external wound may not correspond to the puncture of the chest, to prevent the entrance of air. Only a portion of the fluid should be removed. The animal gets immediate relief, but it is generally only temporary, as the fluid has a tendency to accumulate again.

PNEUMONIA.

Pneumonia is an inflammation of the lung substance, and is divided into three forms, viz, croupous, catarrhal, and interstitial. These various forms, however, can be differentiated only by the expert, and it is therefore deemed necessary for the purpose of the present work to treat the subject under the general head of pneumonia.

The causes of pneumonia in general are the same as those of the various other inflammatory diseases of the respiratory tract. The germ is known as a pneumococcus. The disease mostly follows congestion of the lungs, but may in rare cases have a parasitic origin.

Symptoms.—In the first stage, that of congestion, the disease is usually ushered in by a chill, although this may not always be observed by the attendant. This is followed by an elevation of temperature, usually 105° to 106° F., or it may be even higher. The respirations are quick and shallow; the nostrils are dilated; the pulse is full and hard. Cough may or may not appear in this stage. The nose is hot and dry; the tongue sometimes protrudes and is slimy; the coat is staring, and the skin dry and harsh. The urine is usually diminished in quantity, high colored, and the bowels constipated. The animal stands with the forelegs wide apart to facilitate respiration. On auscultation crepitation will be observed over the portion of the lung affected. The sounds elicited on percussion are practically normal in this stage.

In the second stage the temperature generally drops one or two degrees, and respiration is performed with much difficulty. The cough is frequent and painful. The animal still stands with the forelegs wide apart and the elbows turned outward. If it assumes the recumbent position it rests on the sternum. All secretions are more or less suspended, particularly the milk in cows. The animal has a haggard appearance, and the pulse becomes small and wiry at this period. The extremities are hot and cold alternately; the crepitation which was present in the first stage is now absent, and no sound on auscultation is heard, unless it is a slight wheezing or whistling noise. On percussion dullness over the diseased lung is manifested, indicating consolidation. The lung has now assumed a characteristic liverlike appearance.

In the third stage, if the disease is to terminate favorably, the cough becomes loose, the animal improves, the appetite returns, and the symptoms above detailed rapidly subside; if, on the other hand, resolution is not progressing, the lung substance degenerates, becomes clogged up, and ceases to function. In fatal cases the breath has a peculiar, fetid, cadaverous odor, and is taken in short gasps; the horns, ears, and extremities become cold and clammy, and the pulse is imperceptible. On auscultation, when suppuration is taking place and the lung structure is breaking down, a bubbling or gurgling crepitation, caused by the passage of air through pus, is heard.

Treatment.—Good hygienic surroundings and good nursing are essential in connection with the medical treatment. The probability of recovery depends largely on the extent of the lung tissue involved, as well as on the intensity of the inflammatory process. In the early stage, when the fever is high, febrifuges should be given. If the pulse be strong and full, aconite (Fleming's tincture, 1 to 2 drams, every four or five hours) may be given for a short time, but should be discontinued as soon as the fever begins to abate. Aconite is a valuable drug in the hands of the intelligent practitioner, but my experience leads me to believe that not infrequently animals are lost by its injudicious use, for in many febrile conditions it is positively contraindicated, owing to its action upon the heart. In a plethoric animal, with a strong, bounding pulse, bleeding may be resorted to instead of administering aconite. If the bowels are constipated, calomel, 1 to 3 drams, which acts as a cathartic and a febrifuge, is advisable. In the second stage diffusible stimulants are required, viz: Spirits of nitrous ether, 2 ounces; aromatic spirits of ammonia, 1 ounce; mix, and give in gruel three times daily. In some cases carbonate of ammonia, 2 to 5 drams, has been found beneficial. Most practitioners apply counterirritants, such as mustard plasters, turpentine, and ammonia liniment, or cantharides.

EMPHYSEMA (HEAVES).

Emphysema is a rupture of the minute air vesicles of the lung substance, and may be either interlobular or vesicular. There is an extreme interference with respiration, inspiration being short and expiration prolonged. It is a nonfebrile condition, in which the appetite is not decreased and the milk secretion is kept up. It may be caused by an attack of asthma or may result from chronic bronchitis. The disease can be diagnosed by the marked interference with respiration. The animal, as a rule, is emaciated, has a staring coat, and is hidebound. If percussion is resorted to, the animal's chest will give a tympanic, drumlike sound. The normal resonant sound is exaggerated.

Treatment.—The disease is incurable, and only a palliative form of treatment can be carried out. The destruction of the animal is often advisable, from a humane as well as from a financial point of view.

PULMONARY CONGESTION.

Cattle that are overdriven or overworked are liable to pulmonary congestion in an acute form, and sometimes to pulmonary apoplexy. In such cases they should be allowed to rest, and if the weather is hot, they should be put in a shady place. Give stimulants internally, unload the venous side of the heart by bleeding, and apply stimulating applications to the legs, and bandage.

HEMOPTYSIS.

Hemoptysis is a term used to signify bleeding from the lungs. The trouble may result from a previous congestion of the lungs or from a breaking down of the lung substance, or from specific disorders.

Bleeding from the lungs comes from both nostrils and from the mouth. The blood is bright red, frothy, and accompanied with a cough, the flow being somewhat profuse and intermingled with mucus. It may cease of its own accord. Internally hemostatics are indicated, and locally over the sides cold applications have a tendency to check the hemorrhage. A drench of $1\frac{1}{2}$ drams of gallic acid dissolved in a pint of water should be given.

ABSCESS OF THE LUNG.

Abscesses of the lung sometimes form during the course of or subsequent to tuberculosis or other diseases. An animal affected with abscess of the lung usually has a protracted, feeble cough and a general appearance of emaciation and anemia. The pulse is feeble and the breath foul. An offensive discharge from the lungs frequently occurs. Percussion and auscultation aid in making a diagnosis in this condition. The appetite is poor. Such animals go from bad to worse, and their prompt destruction would, as a rule, be to the interest of the owner.

HYDROTHORAX.

Hydrothorax, or dropsy of the chest, is not a disease in itself, but is simply a condition in which an effusion takes place in the chest cavity, and is the result or effect of some disease, mostly pleurisy. It can be easily diagnosed by physical signs. A loss of the respiratory murmur will be noticed on auscultation, and on percussion dullness or flatness on a line as high as the effusion has taken place. When a large amount of effusion is present, tapping with the trocar and cannula is generally resorted to. The proper method of performing this operation will be found under the head of "Pleurisy."

PNEUMOTHORAX.

An accumulation of gas in the pleural sac is known as pneumothorax. The presence of air may result from either an injury of the lung or a wound communicating from the exterior. The indications for treatment are to remove any foreign body that may have penetrated, to exclude the further entrance of the air into the cavity by the closure of the external opening, and to employ antiseptics and adhesive dressings. The air already in the cavity will in most cases be absorbed.

VERMINOUS BRONCHITIS.

This is a disease that sometimes attacks young cattle when pastured in low-lying meadows near rivers subject to flood. It is caused by a small worm, *Strongylus micrurus*, which lodges in large numbers in the trachea and bronchial tubes, giving rise to considerable irritation of the air passages and inflammation. Sometimes the strongyles lodge in large numbers in the windpipe, forming themselves into a ball, and thus choke the animal to death.

Symptoms.—It is liable to attack a number of animals at once, and the weakest are the first to give way. The animal has a remarkably forcible cough, distressing, and of a special hacking and paroxysmal character. A stringy mucus is sometimes expelled during the spells of coughing. This mucus contains the *Strongylus micrurus*, which can be detected, or their ova observed, under a low power of the microscope. The attack has a subacute character and is very exhausting. The parasites, by becoming entwined in balls, seriously impede respiration, which is always remarkably labored in this disease.

Treatment.—The affected calves should be placed in a dry stable, protected from dampness, and subjected to fumigations of sulphurous anhydrid or chlorin gas. The liberation of chlorin gas is brought about by the action of sulphuric acid, either on a mixture of chlorid of sodium and black oxid of manganese or on bleaching powder. Sulphurous anhydrid may be procured by burning sulphur. Some practitioners prescribe small doses of spirits of turpentine in linseed oil. The system requires good support, and the diet should therefore be liberal and nutritious. Equal parts of sulphate of iron, gentian, and ginger make an excellent tonic.

Prevention.—Avoid pastures notorious for generating verminous bronchitis.

PLEURODYNIA.

Pleurodynia is a term applied to rheumatism of the intercostal muscles, the apparent symptoms being very similar to those of pleurisy. The animal is stiff, is not inclined to turn around, and the ribs are kept in a fixed state as much as possible. Pleurodynia may be distinguished from pleurisy by the coexistence of rheumatism in other parts and by the comparative absence of fever, cough, the friction sound, and the effusion into the chest. The treatment for this affection is the same as that for rheumatism affecting other parts.

DISEASES OF THE NERVOUS SYSTEM.

By W. H. Harbaugh, V. S.

[Revised by John R. Mohler, V. M. D.]

THE NERVOUS SYSTEM.

The nervous system is the distinguishing feature of animal life. Without it there can be no intelligence, no instinct, no sensibility, no perception; in fact, existence would be nothing more than vegetable life.

The senses—touch, taste, sight, hearing, smell—all depend on the nervous system. Motion depends on it. A muscle can not contract without receiving the stimulus from the nervous system. For example, if a nerve passing from a nerve center to a muscle is severed, the particular muscle that is supplied by the cut nerve is paralyzed.

The nervous system is often studied in two divisions—the cerebrospinal division and the sympathetic division.

The cerebrospinal division consists of the brain and spinal cord, nerves, and ganglia. The nerves of this division convey the impulses of motion and sensation and supply all parts which are under the control of the will. For example, the voluntary muscular tissue includes all the muscles which act as the will directs. Another example: If anything comes in contact with any part of the skin, the impression is immediately perceived. All the special senses belong to this division.

The sympathetic division consists of nerves and ganglia. The muscular tissue, which acts independently of the will—as, for example, the stomach, intestines, womb, blood vessels, ducts, etc.—is called involuntary muscular tissue, and receives nervous stimulus from the sympathetic division.

The brain, spinal cord, and the ganglia are the central organs of the nervous system. The nerves conduct the nervous influence. The nerves terminate differently according to their function. The terminations are called end organs. The terminal end organs in the skin and other parts endowed with sensation receive the impressions, which are conveyed to the brain, where they are appreciated. They are so sensitive that the most gentle zephyr is perceived. They are so abundant that the point of the finest needle can not pierce the skin without coming in contact with them, and the sensation of pain is instantly conveyed to the brain. The terminal end organs of the nerves that supply the muscles are different, as they give the impulse which is conveyed by the motor nerves to the elements which constitute the muscle, and this impulse is the excitation which causes the muscle to contract. The terminal end organs of the special senses of taste, smell, etc., receive their special impressions, and their respective nerves carry the impressions to the brain.

There are two divisions of nerves, the afferent and efferent.

The afferent nerves are those which convey the impression to the nerve centers. All the sensory nerves belong to this division.

The efferent nerves are those which convey the nervous impulse outward from the nerve centers, and they are further classified according to the function of their respective centers. For example: Motor fibers carry the impulse from the nerve center to a muscle to cause contraction. Vasomotor fibers carry the impulse to the muscular tissue in the blood vessels, which regulates their caliber. The secretory fibers convey the impulse to the cells of the glands and excite the activity of the gland, and its particular product is secreted or evolved, as, for instance, milk in the mammary gland. Inhibitory fibers control or inhibit the action of the organ to which they are distributed, as, for instance, the heart.

Nerve centers may be considered as a collection or group of nerve cells. Both the cerebrospinal and the sympathetic divisions have nerve centers. The centers derive their special names from their functions. The brain is the great center of the nervous system, as it is the center of intelligence and perception. The centers of all the special senses, as well as the centers of various functions, are located in different parts of the brain. Nerve centers also exist in the spinal cord and in connection with the sympathetic system.

A nerve is a cord consisting of a certain number of fibers of nerve tissue, inclosed in a sheath of connective tissue. Nerves divide and subdivide, sending off branches, which ramify in all parts of the body, and, as they near their terminations, they contain but one or two fibers.

The brain and spinal cord are contained within a bony canal, which forms a protective covering for them.

The spinal cord, or spinal marrow, lodged within the spinal canal, or hollow of the backbone, is continuous with the brain anteriorly, and terminates in a point in the sacrum (that part of the spinal column which immediately precedes the tail). The spinal cord gives off branches at each of the spaces between the segments of the backbone. These branches form nerve trunks which carry both sensory and motor impressions and impulses. The spinal cord is a grand nerve trunk to carry messages to or from the brain and to and from the reflex centers contained within itself.

The brain is contained within the cavity of the skull and is continuous with the spinal cord; there is nothing to mark the place where one leaves off and the other begins. The brain is the seat of reason and intelligence. Voluntary effort originates from the brain. Coordination, or harmony of movement, is controlled by the rear portion of the brain, known as the cerebellum.

The meninges are the membranes, three in number, which envelop the brain and spinal cord, and separate them from the bones which form the walls of the cranial cavity and spinal canal.

The sympathetic, also called the ganglionic, division of the nervous system consists of two chains of ganglia, reaching from the head to the tail, situated beneath the spinal column, one on either side. The presence of the ganglia or enlargements on the cords give them their chainlike appearance.

The sympathetic nerves are closely connected with the cerebrospinal nerves, but are not under the control of the will.

INFLAMMATION OF THE BRAIN AND ITS MEMBRANES (STAGGERS).

Inflammation of the brain is technically termed encephalitis and of its membranes cerebral-meningitis, but as both conditions usually occur together, and since it is practically impossible to distinguish one from the other by the symptoms shown by the diseased animal, they may as well be considered together here as varieties of the same disease. Staggers, coma, frenzy, etc., are terms that are sometimes applied to this disease in its different forms or stages.

Causes.—Severe blows on the head with a hard object, or the head coming violently in contact with the ground or other hard substance in a fall, may be followed by encephalitis. Irritation caused by tumors in the brain may produce inflammation. Feed containing deleterious matters—for example, ergot (see Pl. V) and other fungi which contain a narcotic principle—is the most frequent cause of this affection, and hence it is often called "grass staggers" and "stomach staggers." Highly nitrogenous feeds are blamed for causing this disease. Parasites, mineral and narcotic poisons, hot weather, and severe exertion or excessive excitement may cause this condition. Inflammation of the brain may occur as a complication of some infectious disease or may follow some forms of indigestion. In many localities certain plants have the reputation of causing staggers.

Symptoms.—The symptoms vary much, but a careful observer will detect a trouble connected with the nervous system without much uncertainty. The first signs may be those of frenzy, but generally at the start the animal is dull and sleepy, with little or no inclination to move about; the head may be pressed against the wall or fence and the legs kept moving, as if the animal were endeavoring to walk through the obstruction: the body, especially the hind part, may be leaned against the side of the stall or stable, as if for support. The bowels are constipated: the urine, when passed, is small in quantity and darker in color than natural. There may be trembling and even spasms of muscles in different parts. In the dull stage the animal may breathe less frequently than is natural, and each breath may be accompanied with a snoring-like sound. The pulse may be large and less frequent than normal. If suddenly aroused from the drowsy state, the animal appears startled and stares wildly. When moving about it may stagger, the hind quarters swaying from side to side.

If delirium ensues, the cow is commonly said to be mad. She may bellow, stamp her feet, run about wildly, grate the teeth, froth at the mouth. If she is confined in the stable, she rears and plunges; the convulsions are so violent in many instances that it is really dangerous for one to attempt to render aid. The body may be covered with perspiration. She may fall; the muscles twitch and jerk; often the head is raised and then dashed against the ground until blood issues from the nose and mouth; the eyes may be bloodshot and sightless; the limbs stiff and outstretched, or they may be kicked about recklessly; the head may be drawn back and the tail drawn up; the urine may be squirted out in spurts; often the "washer" (membrane nictitans) is forced over the eye. When the convulsions cease they may be followed by a period of quiet unconsciousness (coma) which is more or less prolonged, when the animal may gradually regain consciousness, get up on its feet, and perhaps quietly partake of food, if there be any within reach, while at other times it arises with much difficulty and staggers blindly about the stall or field.

It must be remembered that all the foregoing symptoms are not always seen in the same case. In those cases usually designated "sleepy staggers" the general symptoms of drowsiness are presented, while in other cases the symptoms of frenzy cause the affection to be called "mad staggers." In other cases there are symptoms of paralysis, swaying of the hind quarters, inability to rise, etc., and sometimes these symptoms of paralysis are the most striking manifestations and continue until death. Acute cases are accompanied by fever.

It is well to remark that when the disease follows injuries to the head the symptoms may not be manifested until two or three days (or longer) after the accident.

Treatment.—Recoveries are rare in spite of careful attention. To be of any service whatever the treatment must be prompt and begin with the disease. In the early stage, when the pulse is large, most cases will admit of bleeding. Eight or 9 quarts of blood should be taken from the jugular vein. This should be followed immediately by a purgative, the following for a cow of average size: Epsom salt, 24 ounces; pulverized gamboge, one-half ounce; croton oil, 20 drops; warm water, 3 quarts; mix all together and give at once as a drench.

About 2 quarts of warm water or warm soapsuds should be injected with a syringe into the rectum every three or four hours. It is best to keep the animal in a quiet, sheltered place, where it will be free from noise or other cause of excitement. All the cold water the animal will drink should be allowed, but feed must be withheld, except bran slops occasionally in small quantities, or grass, if in season, which may be cut and carried fresh to the patient.

The skull must be examined, and if sign of injury is found, appropriate surgical treatment should be given.

During the convulsions all possible efforts should be made to prevent the animal injuring itself. The head should be held down on the ground and straw kept under it. Cold water may be continuously poured on the head, or bags filled with ice broken in small pieces may be applied to the head. Different authors recommend different remedies to allay the convulsions, but for two reasons it will be found extremely difficult to administer medicines during the convulsions: (1) While the animal is unconscious the power to swallow is lost, and therefore the medicine is more liable to go down the windpipe to the lungs than it is to go to the paunch; (2) the convulsions are often so violent that it would be utterly useless to attempt to drench the animal; and furthermore it must be borne in mind that during this stage the functions of digestion and absorption are suspended, and as a consequence the medicine (provided it finds its way to the paunch) is likely to remain there unabsorbed and therefore useless.

A blistering compound, composed of mustard, 1 ounce; pulverized cantharides, one-half ounce; hot water, 4 ounces, well mixed together, may be rubbed in over the loins, along the spine, and back of the head on each side of the neck. This is occasionally attended with beneficial effect, and especially so in those cases when paralysis is present.

If the purgative acts and the animal shows signs of improvement in the course of two or three days, 2 drams of iodid of potassium may be given every night and morning, dissolved in a half bucketful of drinking water, if the animal will drink it, or it may be dissolved in a half pint of water and given as a drench. Great care must be observed in regard to the food, which should be nutritive, but not coarse, and at first in small quantities, gradually increased as the patient improves. After some progress is made toward recovery 1½ drams of pulverized nux vomica may be given twice a day, added to the iodid of potassium drench. This should be administered so long as a staggering gait continues.

In those rare cases when recovery takes place it is only partial as a rule, as there is generally a sequel which remains, such as partial paralysis. However, this is but a slight drawback in cattle, because when it is seen to persist the medicine should be stopped and the animal fattened for butchering.

Post-mortem examinations discover congestion of the brain and its membranes. In those cases which have exhibited much paralysis of the hind legs before death the cord may be congested in the lumbar region (loins). When the disease has been caused by injury to the head, the congestion and extravasated blood may be found inside of the cavity in the location corresponding to the place where the injury was inflicted externally. In some cases pus is also discovered. It remains to be said that in all animals that have died from this affection the lungs are found very much congested. This may lead the superficial observer to suppose that the disease was a lung affection, but in fact it is only a natural consequence when death ensues from brain disease.

APOPLEXY.

That form of congestion of the brain known as parturient apoplexy, or parturient paresis, which is so frequently associated with the period of calving is described in another part of this work. (See "Milk fever," p. 226.)

Cerebral apoplexy, not connected with parturition, is a rare disease among cattle. However, it may be due to degeneration and consequent rupture of a blood vessel in the brain.

The attack is sudden, the animal in most cases falling as if it had received a blow on the head. It may stagger and reel some time before going down. After falling, there are convulsive movements of the legs or the animal sinks into insensibility. There may be remissions in the severity of the symptoms, but the pressure from the continued escape of blood soon causes death. Rest, quiet, friction to the legs and surface, frequent turning of the animal and cold to the head are to be practiced, if treatment is attempted.

CONGESTION OF THE BRAIN.

There is a form of congestive apoplexy affecting cattle which are in a plethoric condition. The congestion, or overfilling with blood, causes pressure on the brain substance and disorganizes its function. It occurs mostly in hot weather. In this disease the symptoms are somewhat similar to those exhibited when the animal has encephalitis, but the onset is more sudden, the duration is shorter, and there is less fever. There may be frenzy or coma, or alternations one with the other. The intelligence is diminished, staring eyes, bracing with the legs, pressing against the stall partition or manger, red mucous membranes. This condition usually terminates in recovery.

In such cases bleeding should be resorted to immediately, and when the power of swallowing is not lost purgatives should be administered. Cold applications to the head and the general treatment recommended for encephalitis are indicated.

CONCUSSION OF THE BRAIN.

Severe blows on the head, striking the head against some hard object while running, or falling on the head may cause concussion of the brain. The injury may fracture bones of the cranium and produce compression of the brain.

Symptoms and treatment.—The symptoms and the treatment that is indicated differ very little from what has been said under congestion of the brain and under encephalitis. In some cases it may be necessary to operate to remove a piece of bone that is pressing on the brain or to remove a clot of blood under the area which received the blow.

EPILEPSY.

This affection is characterized by the occurrence of sudden convulsions. The animal may appear to be in a fair state of health usually, but at any time, in the stable or in the field, it may have a convulsion in which it will fall and lose consciousness. Epilepsy must not be confounded with vertigo—the fainting which is an effect of heart troubles.

The exact cause of epilepsy in the majority of cases is unknown. Post-mortem examinations in many instances have failed to discover any lesion in connection with the brain or nervous system, while in other instances disease of the brain has been found in the form of thickening of the membranes, abscesses, and tumors, and in some cases the affection has been manifested in connection with a diseased condition of the blood. The cause has also been traced to reflex irritation, due to teething, worms, and chronic indigestion.

Treatment.—When the affection is due to the last-named causes treatment may be successful if the cause is removed. If there are symptoms of worms or of indigestion, follow the general treatment advised for those troubles under their proper heads. If due to irritation caused by teething, the inflamed gums must be lanced. Examination of the mouth often develops the fact that one of the temporary teeth causes much irritation by remaining unshed, and thereby interfering with the growth of a permanent tooth. The offending tooth should be extracted. When the cause of epilepsy can not be discovered, it must be confessed that there is no prospect of a cure. However, some benefit may be expected from the occasional administration of a purgative dose of medicine. A pound of Epsom salt dissolved in a quart of warm water, for a cow of average size, may be given as a drench once or twice a month. In addition to the purgative, 4 drams of bromid of potassium, dissolved in the drinking water, three times a day, has proved very beneficial in some cases.

SUNSTROKE (PROSTRATION FROM HEAT).

Owing to the fact that cattle are seldom put to work at which they would have to undergo severe exertion, especially in collars, they are not frequently prostrated by the extreme heat of the summer months. When at pasture they select the coolest places in the shade of trees, in water, etc., when the heat becomes oppressive, and thereby avoid, as much as possible, the effects of it.

It does happen, however, that cattle that have been kept up for the purpose of fattening, when driven some distance in very hot weather, are sometimes prostrated, but it must be remembered that it is not really necessary for the animal to be exposed to the rays of the sun, as those confined in hot, close places may suffer. This often happens in shipping, when they are crowded together in cars.

Symptoms.—The premonitory signs are those of exhaustion—dullness, panting, frothing at the mouth, tongue hanging out, irregular gait, uneasiness, palpitation—when, if the circumstances which tend to the prostration are not mitigated, the animal staggers or sways from side to side, falls, struggles for a while, and then gradually becomes quiet, or the struggles may continue, with repeated but ineffectual efforts to regain a standing position. In serious cases the attack may be very sudden, unconsciousness occurring without continued or distressing premonitory symptoms.

Treatment.—At first, when not very serious, removal to a quiet, sheltered place, with a few days on a reduced diet, is all that need be done. When the animal has fallen, apply cold water or ice to the head; rub the body and limbs with cloths or wisps of straw and continue the rubbing for a considerable time. If the power of swallowing is not lost (which may be ascertained by pouring a little cold water into the mouth), give 3 drams of stronger liquor ammonia, diluted with a quart of cold water. Be very careful in drenching the animal when lying down. Repeat the drench in a half hour and an hour after the first one has been given. Instead of the ammonia, a drench composed of 3 ounces of spirits of nitrous ether in a pint of water may be given, if more convenient, but the ammonia drench is preferable. If unconsciousness continues, so that a drench can not be administered, the same quantity of ammonia and water may be injected with a syringe into the rectum. The popular aqua ammonia, commonly called "hartshorn," will do as well as the stronger liquor ammonia, but as it is weaker than the latter the dose for a cow is about 1½ ounces, which should be diluted with a quart of water before it is given to the animal, either as a drench or an enema. When ammonia can not be obtained, an ounce of tincture of digitalis may be given.

As soon as the animal is able to rise it should be assisted and moved to the nearest shelter. All the cold water it will drink should be allowed. The ammonia or spirits of nitrous ether drench should be administered every three hours so long as there is much failure of strength. The diet should be limited for several days—bran slops and a little grass. When signs of returning strength are presented, 12 ounces of Epsom salt dissolved in a quart of warm water may be given in those cases which have been down and unconscious, but do not give it while much weakness remains, which may be for several days after the attack. The flesh of an animal that is suffering from heat stroke should not be prepared for use as food. On account of the fever with which the animal suffers, the flesh contains toxins that may render it poisonous to the consumer.

INJURIES TO THE SPINAL CORD.

The spinal cord is liable to concussion from blows and falls, and paralysis, to a greater or less extent, may be the result. Fracture, with displacement of the bones (vertebræ) which form the spinal column, by compressing the spinal cord, produces paralysis, which varies in its effect according to the part of the cord that is compressed. If the fracture is above the middle of the neck, death soon follows, as communication between the brain and diaphragm (the essential muscle of inspiration) is stopped. When the fracture is farther down in the neck, posterior to the origin of the phrenic nerve, the breathing continues, but there is paralysis in all parts posterior to the fracture, including the fore and hind legs. When the fracture is in the region of the loins the hind legs are paralyzed, but the fore legs are not. If the fracture is in the sacrum (the division of the spinal column between the loins and the tail), the tail alone is paralyzed.

As a matter of course, when the back is broken there is no remedy; the animal should be killed at once.

PARALYSIS.

Paralysis, or loss of motion in a part, may be due to a lesion of the brain, of the spinal cord, or of a nerve. It may also be caused by reflex irritation. When the paralysis affects both sides of the body, posterior to a point, it is further designated by the name paraplegia. When one side of the body (a lateral half) is paralyzed, the term hemiplegia is applied to the affection. When paralysis is caused by a lesion of a nerve, the paralysis is confined to the particular part supplied by the affected nerve.

As already pointed out, paralysis may be due to concussion of the spine, fracture of a bone of the spinal column with consequent compression of the spinal cord, concussion of the brain, or compression of the brain. An injury to one side of the brain may produce paralysis of the same side of the head and of the opposite side of the body (hemiplegia). Paralysis may occur in connection with parturient apoplexy, lead poisoning, ergotism, etc.

CONGESTION OF THE SPINAL CORD.

Paraplegia, or paralysis of the rear part of the body, is the dominant symptom in congestion or inflammation of the spinal cord. The cause is not known, but the disease is probably due to chilling. It is thought by some that some toxic influence (poison) may be responsible for its development.

Symptoms.—The symptoms usually appear suddenly and consist in inability to stand. Sometimes this is preceded by a period of excitement. The animal usually lies quietly, but sometimes it groans and tosses its head about in a way that indicates pain. Cows heavy with calf are sometimes affected with a form of paraplegia, which usually attacks them from about a month to a few days before calving. Apparently they are in good health in every respect except the inability to stand up on account of the paralysis of the hind quarters. This form is generally attributed to feeding on feeds containing insufficient protein and ash. It is most likely to occur in cows that are weak and thin. With good care and feed recovery usually occurs.

Treatment.—The animal must be given a soft, dry bed under shelter and in a quiet, airy place. It is well to apply mustard along the spine. The action of the mustard may be intensified by rubbing the skin with ammonia or turpentine. Internally give a purge of Glauber's salt. Nux vomica or strychnia (1 to 2 grain doses) may be given. Turn the cow two to four times daily and rub the legs well each time.

There are instances when cows will persist in lying down (in spite of all efforts that are made to compel them to stand up), when it can not really be said that they are paralyzed. They have sensation in all parts; they can move all their feet; they can change their position; and in fact every function seems to be normally performed, but they obstinately refuse to rise or even make an effort to do so. Cases of this kind have been killed, as it was an utter impossibility to get the animal on its feet. However, there are instances when a cow, after refusing to rise when all other means had been tried, quickly jumped to her feet and showed fright upon the appearance of a dog or other terrifying object.

RABIES (HYDROPHOBIA).

[See discussion of this disease in chapter on "Infectious diseases," p. 358.]

LIGHTNING STROKE (ASPHYXIA ELECTRICA).

When an animal is struck by lightning the shock is instantaneously expended on the nervous system, and as a rule death occurs immediately; but when the shock is not fatal animation is suspended to a greater or less extent, as evidenced by prostration, unconsciousness, and paralysis.

Symptoms.—When not fatal, the symptoms vary much, according to the severity of the shock. The animal usually falls, as from an apoplectic attack, and, as a matter of course, the symptoms are such as are generally manifested in connection with concussion of the brain. The muscular system may be completely relaxed; the legs limber; the muscles flabby and soft to the touch; or there may be convulsions, spasms, and twitching of the muscles. The breathing is generally labored, irregular, or interrupted, and slower than normal. In most instances the electrical fluid leaves its mark by singeing the hair, or by inflicting wounds, burns, or blisters.

Treatment.—So long as the beating of the heart is perceptible the endeavor to resuscitate the animal should be continued. Dash cold water over the head and body; rub the body and legs; smartly whip the body with wet towels or switches. Mustard, mixed with water, should be well rubbed over the legs and back of the head on each side of the neck. Inject into the rectum 4 drams of stronger liquor ammonia, or 1½ ounces of hartshorn diluted with a quart of warm water. Cautiously hold an uncorked bottle of hartshorn to the nostrils, so that some of it is inhaled, but care should be taken that too much is not suddenly inhaled. If the animal is unconscious, hypodermic injections of stimulants are indicated, such as 6 drams of camphorated oil in one dose, subcutaneously, or 20 grains of caffein or ½ grain of strychnin, also subcutaneously.

When the animal revives sufficiently to be able to swallow, 4 drams of the stronger liquor ammonia, diluted with a quart of cold water, should be given as a drench, and the dose should be repeated in an hour. One and one-half ounces of ordinary hartshorn may be used instead of the stronger liquor ammonia, but, like the latter, it should be diluted with a quart or more of water, and even then care should be exercised in drenching.

In cases where the shock has not caused complete insensibility recovery may be hastened by the ammonia and water drench, or 4 ounces of brandy diluted with a quart of water, or 8 ounces of whisky diluted with a quart of water. These doses may be given every three or four hours if necessary. After recovery from the more serious symptoms 2 drams of sulphate of quinin should be given twice a day until health is restored. If any paralysis remains 1½ drams of pulverized nux vomica should be given twice a day with the quinin.

The foregoing treatment is also applicable when the electrical shock is given by telephone, electric car, or electric-light wires, etc. The wounds, burns, or blisters should be treated according to the antiseptic method of treating wounds.

TUMORS IN THE BRAIN, ETC.

Tumors of different kinds have been found within the cranial cavity, and in many cases there have been no well-marked symptoms exhibited during the life of the animal to lead one to suspect their existence. Cases are recorded where bony tumors have been found in the brain of cattle that died suddenly, but during life no signs of disease were manifested. Post-mortem examinations have disclosed tubercles in the membranes of the brain. (See "Tuberculosis," p. 407.) Abscesses, usually the result of inflammation of the brain, have been found post-mortem. For the description of hydrocephalus, or dropsy of the brain, of calves the reader is referred to the section on parturition. (See "Water in the head," p. 179.)

Chorea, constant twitching and irregular spasmodic movements of the muscles, has been noticed in connection with or as a sequel to other affections, as, for example, parturient apoplexy.

Various diseases, the description of which will be found in other sections of this work, affect the nervous system to a greater or less extent—for example, ergotism, lead poisoning, uremia, parturient apoplexy, colic, and other affections associated with cramps, or spasms, etc. Disease of the ovaries or of the spinal cord, by reflex irritation, may cause estromania (see "Excess of venereal desire," p. 148, constant desire for the bull).

DISEASES OF THE URINARY ORGANS.

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Of the materials that have served their purpose in building up the animal body or in sustaining the body temperature, and that are now to be thrown out as waste, the greater part is expelled from the system through the lungs and the kidneys, but the agents that pass out by either of these two channels differ in the main from those passing by the other. Thus from the lungs in the form of dioxid of carbon—the same gas that comes from burning of coal or oil—there escapes most of the waste material resulting from the destruction in the system of fats, sugars, starch, and such other foods as are wanting in the element nitrogen, and do not form fibrous tissues, but go mainly to support animal heat or maintain functional activity. From the kidneys, on the other hand, are thrown out the waste products resulting from the destruction of the foods and tissues containing nitrogen—of, for instance, albumin, fibrin, gluten, casein, gelatin, woody tissue, etc. While much of the waste material containing nitrogen leaves the body by the bowels, this is virtually only such of the albuminoid food as has failed to be fully digested and absorbed; this has never formed a true constituent part of the body itself or of the blood, but is so much waste food, like that which has come to the table and again carried away unused. If the albuminoid food element has entered the blood, whether or not it has been built up into a constituent part of the structure of the body, its waste products, which contain nitrogen, are in the main expelled through the kidneys, so that the latter become the principal channels for the expulsion of all nitrogen-containing waste.

It would be an error, however, to infer that all nitrogenous food, when once digested and absorbed into the blood, must necessarily leave the system in the urine. On the contrary, in the young and growing animal, all increase of the fibrous structures of the body is gained through the building up of those flesh-forming constituents into their substance; in the pregnant animal the growth of the offspring and its envelopes has a similar origin, and in the dairy cow the casein or curd of the milk is a means of constant elimination of these nitrogen-containing agents. Thus, in the breeding cow and, above all, in the milking cow, the womb or udder carries on a work in one sense equivalent to that otherwise performed by the kidneys.

Not only are these organs alike channels for the excretion of albuminous products, but they are also related to each other structurally and by nervous sympathy, so that suffering in the one is liable to induce some measure of disorder in the other.

As in the case of other mammals, this nitrogenous waste matter is mainly present in the urine of cattle in the form of urea, but also, to some extent, as hippuric acid, a derivative of vegetable food which, in the herbivora, replaces the uric acid found in the urine of man and carnivora. Uric acid is, however, found in the urine of sucking calves which have practically an animal diet, and it may also appear in the adult in case of absolute, prolonged starvation, and in diseases attended with complete loss of appetite and rapid wasting of the body. In such cases the animal lives on its own substance, and the product is that of the wasting flesh.

The other products containing nitrogen are present in only small quantities and need not be specially referred to. The urine of cattle contains much less of carbonates than that of the horse, and effervesces less on the addition of an acid. As the carbonates form a large proportion of the solid deposits (gravel, stone) from the horse's urine, the ox may thus be held less liable, yet even in the ox the carbonates become abundant or scanty, according to the nature of the feed, and therefore gravel, formed by carbonate of lime, is not infrequent in cattle. When fed on beets, clover hay, or bean straw carbonates are present in large quantities, these aliments being rich in organic acids and alkaline carbonates; whereas upon oat straw, barley straw, and, above all, wheat straw, they are in small amount. In calves fed on milk alone no carbonates are found in the urine.

Phosphates, usually in combination with lime, are, as a rule, present only in traces in the urine of cattle; however, on a dietary of wheat, bran, or other aliment rich in phosphates, these may be present in large amount, so that they render the liquid cloudy or are deposited in solid crystals. The liquid is rendered transparent by nitric acid.

The cow's urine, on a diet of hay and potatoes, contained:

	Parts.
Urea	18.5
Potassic hippurate	16.5
Alkaline lactates	17.2
Potassium bicarbonate	16.1
Magnesium carbonate	4.7
Lime carbonate	0.6
Potassium sulphate	3.6
Common salt	1.5
Silica	Trace
Phosphates	0.0
Water and undetermined substances	921.3
Total	1,000.0

The following table after Tereg[1] gives the different conditions of the urine, and especially the amount of urea and hippuric acid under different rations. The subjects were two oxen, weighing, respectively, 1,260 pounds and 1,060 pounds:

Feed per day (pounds).	Water.	Urine passed.	Density.	Solids in urine.	Hippuric acid.	Urea.	Nitrogen in hippuric acid and urea.	Total nitrogen.	Urea per day.	Hippuric acid per week.
		Lbs.	*Lbs.*		*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*Ozs.*	*Ozs.*
16.90 wheat straw, and 1.30 bean meal	46.46	7.40	1,036	8.41	2.66	1.33	0.83	0.94	1.63	3.23
14.70 oat straw, and 2.30 bean meal	61.10	15.26	1,039	6.93	2.09	0.84	0.55	0.49	2.2	5.3
10.4 wheat straw, 10.4 clover hay, 0.6 bean meal, and 2.6 starch	71.76	12.36	1,043	8.05	0.95	1.85	0.93	0.94	3.83	1.96
10.4 wheat straw, 10.4 clover hay, 2.7 bean meal, 1.4 starch, and 0.8 sugar	80.54	12.46	1,044	8.29	8.07	2.41	1.19	1.11	5.8	2.1
10.4 wheat straw, 10.4 clover hay, 5 bean meal, and 0.8 sugar	78.96	17.62	1,043	8.41	0.74	3.12	1.45	1.24	9.17	2.17
10 wheat straw, 10 clover hay, 6.4 bean meal, 1.7 starch, 4 sugar, and 0.4 rape oil	110.12	25.86	1,038	7.00	0.31	2.49	1.19	1.25	10.9	1.33
10 wheat straw, 10 clover hay, 9.4 bean meal, 3.1 sugar, and 0.4 rape oil	101.80	27.04	1,037	7.14	0.20	2.95	1.39	1.58	13.3	0.9
10 wheat straw, 10 clover hay, 11.7 bean meal, 2.8 starch, and 0.5 rape oil	119.00	23.20	1,038	7.74	0.21	4.06	1.91	1.69	15.4	0.8
17.86 bean straw, and 1.6 bean meal	54.84	12.60	1,043	7.06	0.40	2.53	1.21	1.15	5.3	0.83
14.88 bean straw	55.76	16.34	1,036	5.45	0.11	1.41	0.67	0.64	3.83	0.3
16.90 meadow hay	36.26	15.14	1,042	7.91	1.30	1.73	0.91	0.92	4.37	3.3

The varying quantity of urea (from 1.6 to 15.4 ounces) is most suggestive as to the action of the more or less nitrogenous feed and the resulting concentration of the urine and blood. Hippuric acid, on the other hand, is most abundant when the animal is fed on hay and straw.

The specific gravity of the urine of cattle varies from 1,030 to 1,060 in health, water being 1,000. It is transparent, with a yellowish tinge, and has a characteristic, musky smell. The chemical reaction is alkaline, turning red litmus paper blue. The quantity passed in twenty-four hours varies greatly, increasing not only with the water drunk, but with the albuminoids taken in with the feed and the urea produced. If a solution of urea is injected into the veins the secretion of urine is greatly augmented. Similarly the excess of salts like carbonate of potash in the feed, or of sugar, increases the action of the kidneys. Only about 20 per cent of the water swallowed escapes in

[1] Encyklop. der Thierheilk., Vol. IV, p. 208.

the urine, the remaining 80 per cent passing mostly from the lungs, and to a slight extent by the bowels. The skin of the ox does not perspire so readily nor so freely as that of the horse; hence the kidneys and lungs are called upon for extra work. The influence of an excess of water in the feed is most remarkable in swill-fed distillery cattle, which urinate profusely and frequently, yet thrive and fatten rapidly.

Among the other conditions that increase the flow of urine is overfilling of (internal pressure in) the blood vessels of the kidneys; hence the contraction of the blood vessels of the skin by cold drives the blood inward, tends to dilate the blood vessels of the kidneys, and to increase the secretion of urine. Nervous disorders, such as excitement, fear, congestions, or structural injuries to the back part of the base of the brain, have a similar result, hence, doubtless, the action of certain fungi growing in musty hay or oats in producing profuse flow of urine, whereas other forms of musty fodder cause stupor, delirium, or paralysis. Bacteria and their products are mainly expelled by the kidneys, and become sources of local infection, irritation, and disease.

The quantity of urine passed daily by an ox on dry feeding averages 7 to 12 pints, but this may be increased enormously on a watery diet.

The mutual influence of the kidneys and other important organs tends to explain the way in which disease in one part supervenes on preexisting disorder in another. The introduction of albuminoids in excess into the blood means the formation of an excess of urea, and a more profuse secretion of urine, of a higher specific gravity, and with a greater tendency to deposit its solid constituents, as gravel, in the kidneys or bladder. A torpid action of the liver, leaving the albuminoids in transition forms, less soluble than the urea into which they should have been changed, favors the onset of rheumatism or of nervous disorder, the deposit of such albuminoid products in the kidneys, the formation of a deep-brown or reddish urine, and congestion of the kidneys. Any abnormal activity of the liver in the production of sugar—more than can be burned up in the circulation—overstimulates the kidneys and produces increased flow of a heavy urine with a sweetish taste. This increased production of sugar may be primarily due to disease of the brain, which, in its turn, determines the disorder of the liver. Disease of the right side of the heart or of the lungs, by obstructing the onward flow of blood from the veins, increases the blood pressure in the kidneys and produces disorder and excessive secretion. Inactivity of the kidneys determines an increase in the blood of waste products, which become irritating to different parts, producing skin eruptions, itching, dropsies, and nervous disorders. Sprains of the loins produce bleeding from the kidneys and disease of the spinal cord, and sometimes determine albuminous or milky looking urine.

The kidney of the ox (Pl. IX, fig. 1) is a compound organ made up of 15 to 25 separate lobules like so many separate kidneys, but all pouring their secretion into one common pouch (pelvis) situated in an excavation in the center of the lower surface. While the ox is the only domesticated quadruped which maintains this divided condition of the kidney after birth, this condition is common to all while at an early stage of development in the womb. The cluster of lobules making up a single kidney forms an ovoid mass flattened from above downward, and extending from the last rib backward beneath the loins and to one side of the solid chain of the backbone. The right is more firmly attached to the loins and extends farther backward than the left. Deeply covered in a mass of suet, each kidney has a strong outer, white, fibrous covering, and inside this two successive layers of kidney substance, of which the outer is that in which the urine is mainly separated from the blood and poured into the fine, microscopic urinary ducts. (Pl. X, fig. 1) These latter, together with blood vessels, lymph vessels, and nerves, make up the second, or internal, layer. The outer layer is mainly composed of minute globular clusters of microscopic, intercommunicating blood vessels (Malpighian bodies), each of which is furnished with a fibrous capsule that is nothing else than the dilated commencement of a urine tube. These practically microscopic tubes follow at first a winding course through the outer layer (Ferrein's tubes), then form a long loop (doubling on itself) in the inner layer (Henle's loop), and finally pass back through the inner layer (Bellini's tubes) to open through a conical process into the common pouch (pelvis) on the lower surface of the organ. (Pl. X, figs. 1, 2, 3.)

The tube that conveys the urine from the kidney to the bladder is like a white, round cord, about the size of a goose quill, prolonged from the pouch on the lower surface of the kidney backward beneath the loins, then inward, supported by a fold of thin membrane, to open into the bladder just in front of its neck. The canal passes first through the middle (muscular) coat of the bladder, and then advances perceptibly between that and the internal (mucous) coat, through which it finally opens. By this arrangement in overfilling the bladder this opening is closed like a valve by the pressure of the urine, and the return of liquid to the kidney is prevented. The bladder (Pl. IX, fig. 2) is a dilatable, egg-shaped pouch, closed behind by a strong ring of muscular fibers encircling its neck, and enveloped by looped, muscular fibers extending on all sides around its body and closed anterior end. Stimulated by the presence of urine, these last contract and expel contents through the neck into the urethra. This last is the tube leading backward along the floor of the pelvic bones and downward through the penis. In the bull this canal of the urethra is remarkable for its small caliber and for the S-shaped bend which it describes in the space between the thighs and just above the scrotum. This bend is attributable to the fact that the retractor muscles are attached to the penis at this point, and in withdrawing that organ within its sheath they double it upon itself. The small size of the canal and this S-shaped bend are serious obstacles to the passing of a catheter to draw the urine, yet by extending the penis out of its sheath the bend is effaced, and a small, gum-elastic catheter, not more than one-fourth of an inch in diameter, may with care be passed into the bladder. In the cow the urethra is very short, opening in the median line on the floor of the vulva about 4 inches in front of its external orifice. Even in her, however, the passing of a catheter is a matter of no little difficulty, the opening of the urethra being very narrow and encircled by the projecting membranous and rigid margins, and on each side of the opening is a blind pouch (canal of Gärtner) into which the catheter will almost invariably find its way. In both male and female, therefore, the passing of a catheter is an operation which demands special skill.

General symptoms of urinary disorders.—These are not so prominent in cattle as in horses, yet they are of a similar kind. There is a stiff or straddling gait with the hind legs and some difficulty in turning or in lying down and rising, the act causing a groan. The frequent passage of urine in driblets, its continuous escape in drops, the sudden arrest of the flow when in full stream, the rhythmic contraction of the muscles under the anus without any flow resulting, the swelling of the sheath, the collection of hard, gritty masses on the hair surrounding the orifice of the sheath, the occurrence of dropsies in the limbs under the chest or belly, or in either of these cavities, and finally the appearance of nervous stupor, may indicate serious disorder of the urinary organs. The condition of the urine passed may likewise lead to suspicion. It may be white, from crystallized carbonate of lime; brown, red, or even black, from the presence of blood or blood-coloring matter; yellow, from biliary coloring matter; frothy, from contained albumin; cloudy, from phosphates; glairy, from pus; it may also show gritty masses from gravel. In many cases of urinary disorder in the ox, however, the symptoms are by no means prominent, and unless special examination is made of the loins, the bladder, and the urine the true nature of the malady may be overlooked.

DIURESIS (POLYURIA, DIABETES INSIPIDUS, EXCESSIVE SECRETION OF URINE).

A secretion of urine in excess of the normal amount may be looked on as disease, even if the result does not lead to immediate loss of condition. Cattle fed on distillery swill are striking examples of such excess caused by the enormous consumption of a liquid feed, which nourishes and fattens in spite of the diuresis; the condition is unwholesome, and cattle that have passed four or five months in a swill stable have fatty livers and kidneys, and never again do well on ordinary feed. Diuresis may further occur from increase of blood pressure in the kidneys (diseases of the heart or lungs which hinder the onward passage of the blood, the eating of digitalis, English broom, the contraction of the blood vessels on the surface of the body in cold weather, etc.); also from acrid or diuretic plants taken with the feed (dandelion, burdock, colchicum, digitalis, savin, resinous shoots, etc.); from excess of sugar in the feed (beets, turnips, ripe sorghum); also from the use of frozen feed (frosted turnip tops and other vegetables), and from the growths of certain molds in fodder (musty hay, mow-burnt hay, moldy oats, moldy bread, etc.). Finally, alkaline waters and alkaline incrustations on the soil may be active causes. In some of these cases the result is beneficial rather than injurious, as when cattle affected with gravel in the kidneys are entirely freed from this condition by a run at grass, or by an exclusive diet of roots or swill. In other cases, however, the health and condition suffer, and even inflammation of the kidneys may occur.

Treatment.—The treatment is mainly in the change of diet to a more solid aliment destitute of the special, offensive ingredient. Boiled flaxseed is often the best diet or addition to the wholesome dry food, and, by way of medicine, doses of 2 drams each of sulphate of iron and iodid of potassium may be given twice daily. In obstinate cases 2 drams ergot of rye or of catechu may be added.

BLOODY URINE (RED WATER, MOOR ILL, WOOD ILL, HEMATURIA, HEMAGLOBINURIA).

This is a common affection among cattle in certain localities, above all on damp, undrained lands and under a backward agriculture. It is simply bloody urine or hematuria when the blood is found in clots, or when under the microscope the blood globules can be detected as distinctly rounded, flattened disks. It is smoky urine—hemaglobinuria—when neither such distinct clots nor blood disks can be found, but merely a general browning, reddening, or blackening of the urine by the presence of dissolved, blood-coloring matter. The bloody urine is the more direct result of structural disease of the kidneys or urinary passages (inflammation, stone, gravel, tumors, hydatids, kidney worms, sprains of the loins), while the stained urine (hemaglobinuria) is usually the result of some general or more distinct disorder in which the globules are destroyed in the circulating blood and the coloring matter dissolved in and diffused through the whole mass of the blood and of the urine secreted from it. As in the two forms, blood and the elements of blood escape into the urine, albumin is always present, so that there is albuminuria with blood-coloring matter superadded. If from stone or gravel, gritty particles are usually passed, and may be detected in the bottom of a dish in which the liquid is caught. If from fracture or severe sprain of the loins, it is liable to be associated not only with some loss of control of the hind limbs and with staggering behind but also with a more or less perfect paralysis of the tail. The bloodstained urine without red globules results from specific diseases—Texas fever (Pl. XLVII, fig. 3), anthrax, spirillosis, and from eating irritant plants (broom, savin, mercury, hellebore, ranunculus, convolvulus, colchicum, oak shoots, ash privet, hazel, hornbeam, and other astringent, acrid, or resinous plants, etc.). The Maybug or Spanish fly taken with the feed or spread over a great extent of skin as a blister has a similar action. Frosted turnips or other roots will bring on the affection in some subjects. Among conditions which act by the direct destruction of the globules in the circulating blood may be named an excess of water in that fluid; the use of water from soils rich in decomposing vegetable matter and containing alkaline salts, particularly nitrites; and the presence in the water and feed of the ptomaines of bacteria growth; hence the prevalence of "red water" in marshy districts and on clayey and other impervious soils, and the occurrence of bloody urine in the advanced stages of several contagious diseases. Some mineral poisons—such as iodin, arsenic, and phosphorus taken to excess—may cause hematuria, and finally the symptoms may be merely the result of a constitutional predisposition of the individual or family to bleeding. In some predisposed subjects, exposure of the body to cold or wet will cause the affection.

The specific symptom of bloody or smoky water is a very patent one. It may or may not be associated with fever, with the presence or absence of abdominal tenderness on pressure, with a very frothy state of the milk or even a reddish tinge, with or without marked paleness of the mucous membranes, and general weakness. When direct injury to the kidneys is the immediate cause of the disease the urine will be passed often, in small quantity at a time, and with much straining. When there is bloodlessness (a watery blood) from insufficient nourishment, fever is absent and the red water is at first the only symptom. When the active cause has been irritant plants, abdominal tenderness, colics, and other signs of bowel inflammation are marked features.

Treatment.—Treatment varies according as the cause has been a direct irritant operating on a subject in vigorous health or a microbian poison acting on an animal deficient in blood and vigor. In the first form of red water a smart purgative (1 pound to 1½ pounds Glauber's salt) will clear away the irritants from the bowels and allay the coexistent high fever. It will also serve to divert to the bowels much of the irritant products already absorbed into the blood and will thus protect the kidneys. In many such cases a liberal supply of wholesome, easily digestible feed will be all the additional treatment required. In this connection demulcent feed (boiled flaxseed, wheat bran) is especially good. If much blood has been lost, bitters (gentian, one-half ounce) and iron (sulphate of iron, 2 drams) should be given for a week.

For cases in which excess of diuretic plants has been taken, it may be well to replace the salts by 1 to 2 pints of olive oil, adding 1 ounce of laudanum and 2 drams of gum camphor; also to apply fomentations or a fresh sheepskin over the loins. Buttermilk or vinegar, one-half pint, or sulphuric acid, 60 drops in a pint of water, may also be used frequently as injections. In cases caused by sprained or fractured loins, inflamed kidneys, stone or gravel, the treatment will be as for the particular disease in question.

In hematuria from anemia (watery blood), whether from insufficient or badly adjusted rations or from the poisonous products of fermentations in impervious or marshy soils, the treatment must be essentially tonic and stimulating. Rich, abundant, and easily digestible feed must be furnished. The different grains (oats, barley, wheat, bran, rye) and seeds (rape, linseed, cotton seed) are especially called for and may be given either ground or boiled. As a bitter, sulphate of quinin, one-half dram, and tincture of chlorid of iron, 2 drams, may be given in a pint of water thrice a day. In some cases 1 or 2 teaspoonfuls of oil of turpentine twice daily in milk will act favorably.

In this anemic variety prevention is the great need. The drainage and cultivation of the dangerous soils is the main object. Until this can be accomplished young and newly purchased cattle not yet inured to the poisons must be kept from the dangerous fields and turned on only those which are already drained naturally or artificially. Further, they should have an abundant ration in which the local product of grass, hay, etc., is supplemented by grain or other seeds. Another point to be guarded against is the supply of water that has drained from marshes or impervious soils, rich in organic matter, as such water is charged with nitrites, ptomaines, etc., which directly conduce to the disorder. Fence out from all such waters and supply from living springs or deep wells only.

ALBUMIN IN THE URINE (ALBUMINURIA).

In bloody urine albumin is always present as an important constituent of the blood, and in congested and inflamed kidneys it is present as a part of the inflammatory exudate. Apart from these, albumin in the urine represents in different cases a variety of diseased conditions of the kidneys or of distant organs. Among the additional causes of albuminuria may be named: (1) An excess of albumin in the blood (after easy calving with little loss of blood and before the secretion of milk has been established, or in cases of sudden suppression of the secretion of milk); (2) under increase of blood pressure (after deep drinking, after doses of digitalis or broom, after transfusion of blood from one animal to another, or in disease of the heart or lungs causing obstruction to the flow of blood from the veins); (3) after cutting (or disease) of the motor nerves of the vessels going to the kidneys, causing congestion of these organs; (4) violent exertion, hence long drives; the same happens with violent, muscular spasms, as from strychnia poisoning, lockjaw, epilepsy, and convulsions; (5) in most fevers and extensive inflammations of important organs, like the lungs or liver, the escape of the albumin being variously attributed to the high temperature of the body and disorder of the nerves, and to resulting congestion and disorder of the secreting cells of the kidneys; (6) in burns and some other congested states of the skin; (7) under the action of certain poisons (strong acids, phosphorous, arsenic, Spanish flies, carbolic acid, and those inducing bloody urine); (8) in certain conditions of weakness or congestion of the secreting cells of the kidneys, so that they allow this element of the blood to escape; (9) when the feed is entirely wanting in common salt, albumin may appear in the urine temporarily after a full meal containing an excess of albumin. It can also be produced experimentally by puncturing the back part of the base of the brain (the floor of the fourth ventricle close to the point the injury to which causes sugary urine). In abscess, tumor, or inflammation of the bladder, ureter, or urethra the urine is albuminous.

It follows, therefore, that albumin in the urine does not indicate the existence of any one specific disease, and except when from weakness or loss of function of the kidney cells, it must be looked on as an attendant on another disease, the true nature of which we must try to find out. These affections we must exclude one by one until we are left to assume the noninflammatory disorder of the secreting cells of the kidney. It is especially important to exclude inflammation of the kidney, and to do this may require a microscopic examination of the sediment of the urine and the demonstration of the entire absence of casts of the uriniferous tubes. (See "Nephritis," p. 123.)

To detect albumin in the urine, the suspected and frothy liquid must be rendered sour by adding a few drops of nitric acid and then boiled in a test tube. If a solid precipitate forms, then a few more drops of nitric acid should be added, and if the liquid does not clear it up it is albumin. A precipitate thrown down by boiling and redissolved by nitric acid is probably phosphate of lime.

Treatment.—Treatment is usually directed to the disease on which it is dependent. In the absence of any other recognizable disease, mucilaginous drinks of boiled flaxseed, slippery elm, or gum may be given, tannic acid, one-half dram twice daily, and fomentations or even mustard poultices over the loins. When the disease is chronic and there is no attendant fever (elevation of temperature), tonics (hydrochloric acid, 6 drops in a pint of water; phosphate of iron, 2 drams, or sulphate of quinin, 2 drams, repeated twice daily) may be used. In all cases the patient should be kept carefully from cold and wet, a warm, dry shed, or in warm weather a dry, sunny yard or pasture being especially desirable.

SUGAR IN URINE (DIABETES MELLITUS).

This is a frequent condition of the urine in parturition fever, but as a specific disease, associated with deranged liver or brain, it is practically unknown in cattle. As a mere attendant on another disease it demands no special notice here.

INFLAMMATION OF THE KIDNEYS (NEPHRITIS).

This has been divided according as it affects the different parts of the kidneys, as: (1) Its fibrous covering (perinephritis); (2) the secreting tissue of its outer portion (parenchymatous); (3) the connective tissue (interstitial); (4) the lining membrane of its ducts (catarrhal); and (5) its pelvis or sac receiving the urine (pyelitis). It has also been distinguished according to the changes that take place in the kidney, especially as seen after death, according to the quantity of albumin in the urine, and according as the affection is acute or chronic. For the purpose of this work it will be convenient to consider these as one inflammatory disease, making a distinction merely between the acute and the chronic or of long standing.

The *causes* are in the main like those causing bloody urine, such as irritant and diuretic plants, Spanish flies applied as a blister or otherwise, exposure to cold and wet, the presence of stone or gravel in the kidneys, injuries to the back or loins, as by riding one another, the drinking of alkaline or selenitic water, the use of putrid, stagnant water, of that containing bacteria and their products, the consumption of musty fodder, etc. (See "Hematuria," p. 119.)

The length of the loins in cattle predisposes these parts to mechanical injury, and in the lean and especially in the thin, working ox the kidney is very liable to suffer. In the absence of an abundance of loose, connective tissue and of fat, the kidneys lie in close contact with the muscles of the loins, and any injury to them may tend to stretch the kidney and its vessels, or to cause its inflammation by direct extension of the disease from the injured muscle to the adjacent kidney. Thus, under unusually heavy draft, under slips or falls on slippery ground, under sudden unexpected drooping or twisting of the loins from missteps or from the feet sinking into holes, under the loading and jarring of the loins when animals ride one another in cases of "heat," the kidneys are subject to injury and inflammation. A hard run, as when chased by a dog, may be the occasion of such an attack. A fodder rich in nitrogenous or flesh-forming elements (beans, peas, vetches (*Vicia sativa*), and other leguminous plants) has been charged with irritating the kidneys through the excess of urea, hippuric acid, and allied products eliminated through these organs and the tendency to the formation of gravel. It seems, however, that these feeds are most dangerous when partially ripened and yet not fully matured, a stage of growth at which they are liable to contain ingredients irritating to the stomach and poisonous to the brain, as seen in their inducing so-called "stomach staggers." Even in the poisoning by the seeds of ripened but only partially cured rye grass (*Lolium perenne*), and darnel (*Lolium temulentum*), the kidneys are found violently congested with black blood; also, in the indigestions that result from the eating of partially ripened corn or millet some congestion of the kidneys is an attendant phenomenon.

Cruzel says that the disease as occurring locally is usually not alone from the acrid and resinous plants charged with inducing hematuria, but also from stinking camomile (*Anthemis cotula*) and field poppy when used in the fresh, succulent condition; also from the great prevalence of dead caterpillars on the pasture, or from dead Spanish flies in the stagnant pools of water. The fresh plants are believed to be injurious only by reason of a volatile oil which is dissipated in drying. In the case of the stagnant water it may be questioned whether the chemical products of the contained ferments (bacteria) are not more frequently the cause of the evil than the alleged Spanish flies, though the latter are hurtful enough when present.

Inflammation of the kidneys may further be a form or an extension of a specific contagious disease, such as erysipelas, rinderpest, septicemia, or even of poisoning by the spores of fungi. Rivolta reports the case of a cow with spots of local congestion and blood staining in the kidney, the affected parts being loaded with bacteria. Unfortunately he neither cultivated the bacteria nor inoculated them, and thus the case stands without positive demonstration that they were the cause of disease.

In certain cases the *symptoms* of nephritis are very manifest, and in others so hidden that the existence of the affection can be certainly recognized only by a microscopic examination of the urine. In violent cases there is high fever, increase of the body temperature to 103° F. and upward; hurried breathing, with a catching inspiration;

accelerated pulse; dry, hot muzzle; burning of the roots of the horns and ears; loss of appetite; suspended rumination; and indications of extreme sensitiveness in the loins. The patient stands with back arched and hind legs extended backward and outward, and passes water frequently, in driblets, of a high color and specific gravity, containing albumin and microscopic casts. (Pl. XI, fig. 5). When made to move, the patient does so with hesitation and groaning, especially if turned in a narrow circle; when pinched on the flank just beneath the lateral bony processes of the loins, especially on that side on which the disease predominates, it flinches and groans. If the examination is made with oiled hand introduced through the last gut (rectum), the pressure upward on the kidneys gives rise to great pain and to efforts to escape by moving away and by active contractions of the rectum for the expulsion of the hand. Sometimes there is a distinct swelling over the loins or quarter on one or both sides. In uncastrated males the testicle on the affected side is drawn up, or is alternately raised and dropped. In all there is a liability to tremors of the thigh on the side affected.

In some severe cases colicky pains are as violent as in the worst forms of indigestion and spasms of the bowels. The animal frequently shifts from one hind foot to the other, stamps, kicks at the belly, frequently looks anxiously at its flank, moans plaintively, lies down and quickly gets up again, grinds its teeth, twists its tail, and keeps the back habitually arched and rigid and the hind feet advanced under the belly. The bowels may be costive and the feces glistening with a coat of mucus, or they may be loose and irritable, and the paunch or even the bowels may become distended with gas (bloating) as the result of indigestion and fermentation. In some animals, male and female alike, the rigid, arched condition of the back will give way to such undulating movements as are sometimes seen in the act of coition.

The disease does not always appear in its full severity; for a day, or even two, however, there may be merely loss of appetite, impaired rumination, a disposition to remain lying down, yet when the patient is raised it manifests suffering by anxiously looking at the flanks, shifting or stamping of the hind feet, shaking of the tail, and attempts to urinate, which are either fruitless or lead to the discharge of a small quantity of high-colored or perhaps bloody urine.

In some recent slight cases, and in many chronic ones, these symptoms may be absent or unobserved, and an examination of the urine is necessary to reach a safe conclusion. The urine may contain blood, or it may be cloudy from contained albumin, which coagulates on heating with nitric acid (see "Albuminuria," p. 121); it may be slightly glairy from pus, or gritty particles may be detected in it. In seeking for casts of the uriniferous tubes, a drop may be taken with a fine tube from the bottom of the liquid after standing, and examined under a power magnifying 50 diameters. If the fine, cylindroid filaments are seen they may then be examined with a power of 200 or 250 diameters. (Pl. XI, fig. 5.) The appearance of the casts gives some clue to the condition of the kidneys. If made up of large, rounded or slightly columnar cells, with a single nucleus in each cell (epithelial), they imply comparatively slight and recent disease of the kidney tubes, the detachment of the epithelium being like what is seen in any inflamed mucous surface. If made up largely of the small, disk-shaped and nonnucleated red blood globules, they imply escape of blood, and usually a recent injury or congestion of the kidney—it may be from sprains, blows, or the ingestion of acrid or diuretic poisons. If the casts are made of a clear, waxy, homogeneous substance (hyaline), without any admixture of opaque particles, they imply an inflammation of longer standing, in which the inflamed kidney tubules have been already stripped of their cellular (epithelial) lining. If the casts are rendered opaque by the presence of minute, spherical granular cells, like white blood globules, it betokens active suppuration of the kidney tubes. In other cases the casts are rendered opaque by entangled earthy granules (carbonate of lime), or crystals of some other urinary salts. In still other cases the casts entangle clear, refrangent globules of oil or fat, which may imply fatty degeneration of the kidneys or injury to the spinal cord. The presence of free pus giving a glairy, flocculent appearance to the urine is suggestive of inflammation of the urinary pouch at the commencement of the excretory duct (pelvis of kidney) (Pl. IX, fig. 1), especially if complicated with gritty particles of earthy salts. This condition is known as pyelitis. In the chronic cases swelling of the legs or along the lower surface of chest or abdomen, or within these respective cavities, is a common symptom. So, also, stupor or coma, or even convulsions, may supervene from the poisonous action of urea and other waste or morbid products retained in the blood.

Treatment.—In the treatment of acute nephritis the first consideration is the removal of the cause. Acrid or diuretic plants in the feed must be removed, and what of this kind is present in the stomach or bowels may be cleared away by a moderate dose of castor or olive oil; extensive surfaces of inflammation that have been blistered by Spanish flies must be washed clean with soapsuds; sprains of the back or loins must be treated by soothing fomentations or poultices or by a fresh sheepskin with its fleshy side applied on the loins, and the patient must be kept in a narrow stall in which it can not turn even its head. The patient must be kept in a warm, dry building, so that the skin may be kept active rather than the kidneys. Warm blanketing is equally important, or even mustard poultices over the loins will be useful. Blisters of Spanish flies, turpentine, or other agent which may be absorbed and irritate the kidneys must be avoided. The active fever may be checked by 15 drops tincture of aconite every four hours or by one-third ounce of acetanilid. If pain is very acute, 1 ounce of laudanum or 2 drams of solid extract of belladonna will serve to relieve. When the severity of the disease has passed, a course of tonics (quinin, 2 drams, or gentian powder, 4 drams, daily) may be given. Diuretics, too, may be given cautiously at this advanced stage to relieve dropsy and give tone to the kidneys and general system (oil of turpentine, 2 teaspoonfuls; bicarbonate of soda, 1 teaspoonful, repeated twice a day). Pure water is essential, and it should not be given chilled; warm drinks are preferable.

In the chronic forms of kidney inflammation the same protection against cold and similar general treatment are demanded. Tonics, however, are important to improve the general health (phosphate of iron, 2 drams; powdered nux vomica, 20 grains; powdered gentian root, 4 drams, daily). In some instances the mineral acids (nitric acid, 60 drops, or nitrohydrochloric acid, 60 drops, daily) may be used with the bitters. Mustard applied to the loins in the form of a thin pulp made with water and covered for an hour with paper or other impervious envelope, or water hotter than the hand can bear, or cupping, may be resorted to as a counterirritant. In cupping, shave the loins, smear them with lard, then take a narrow-mouthed glass, expand the air within by smearing its interior with a few drops of alcohol, setting it on fire and instantly pressing the mouth of the vessel to the oiled portion of the skin. As the air within the vessel cools it contracts, tending to form a partial vacuum, and the skin, charged with blood, is strongly drawn up within it. Several of these being applied at once, a strong derivation from the affected kidneys is obtained. In no case of inflamed or irritable kidney should Spanish flies or oil of turpentine be used upon the skin.

PARASITES OF THE KIDNEY.

As the kidney is the usual channel by which the bacteria leave the system, this organ is liable to be implicated when microphytes exist in the blood, and congestions and blood extravasions are produced. In anthrax. southern cattle fever (Texas fever), and other such affections bloody urine is the consequence. Of the larger parasites attacking the kidney may be specially named the cystic form of the echinococcus tapeworm of the dog, the cystic form of the unarmed or beef tapeworm of man, the diving bladderworm—the cystic form of the marginate tapeworm of the dog, and the giant strongyle—the largest of the roundworms. These give rise to general symptoms of kidney disease, but the true source of the trouble is likely to be detected only if the heads or hooklets of the tapeworm or the eggs of the roundworm are found on microscopical examination of the urine.

TUMORS OF THE KIDNEY (HYPERTROPHY OR ATROPHY).

The kidney may be the seat of cancerous or simple tumors, and it may be unnaturally enlarged or reduced in size, but though there may be signs of urinary disorder the true nature of the disease is seldom manifest until after death. The passing of blood and of large multi-nucleated cells in the urine (to be detected under the microscope) may betray the existence of an ulcerated cancer of the kidney. The presence of cancerous enlargement of (superficial) lymphatic glands may further assist and confirm the decision.

RETENTION OF URINE.

Inability to pass urine may come from any one of three conditions—first, spasm of the neck of the bladder; second, paralysis of the body of the bladder; third, obstruction of the channel of outlet by a stone (calculus) (see Pl. XI) or other obstacle.

In *spasm of the neck of the bladder* the male animal may stand with the tail slightly raised and making rhythmical contractions of the muscle beneath the anus (accelerator urinæ) (see Pl. IX, fig. 2), but without passing a drop of liquid. In the female the hind legs are extended, widely parted, and the back is arched as if to urinate, but the effort is vain. If the oiled hand is introduced into the rectum or vagina in the early stages of the affection, the bladder may be felt beneath partially filled, but not overdistended with liquid, and its neck or mouth firm and rigid. In the more advanced stages of the affection the organ is felt as a great, tense, elastic bag, extending forward into the abdomen. In this condition the overdistended muscular coat of the bladder has lost its power of contraction, so that true paralysis has set in, the muscle closing the mouth of the sac alone retaining its contractile power.

In *paralysis of the body of the bladder* attention is rarely drawn to the urinary disorder until the bladder has been distended to full repletion and is almost ready to give way by rupture and to allow the escape of the contained liquid into the abdomen. Overdistention is the most common cause of the paralysis, yet it may occur from inflammation of the muscular wall of the bladder, or even from injury to the terminal part of the spinal marrow. In this last condition, however, the tail is liable to be powerless, and the neck of the bladder may also be paralyzed, so that the urine dribbles away continuously.

Causes.—Among the causes of spasm of the neck of the bladder may be named the lodgment of small stones or gravel, the feeding on irritant diuretics (see "Bloody urine," p. 119, or "Nephritis," p. 123), the enforced retention of urine while at work or during a painful or difficult parturition. The irritation attendant on inflammation of the mucous membrane of the bladder may be a further cause of spasms of the neck, as may also be inflammation of the channel (urethra) back of the neck. Extensive applications of Spanish flies to the skin, the abuse of diuretics, and the occurrence of indigestion and spasms of the bowels are further causes. So long as spasmodic colic is unrelieved, retention of water from spasm of the neck of the bladder usually persists.

Treatment.—Treatment depends largely on the cause. In indigestion the irritant contents of the bowels must be got rid of by laxatives and injections of warm water; Spanish-fly blisters must be washed from the surface: a prolonged and too active exertion must be intermitted. The spasm may be relaxed by injecting one-half ounce of solid extract of belladonna in water into the rectum or by a solution of tobacco. Chloroform or ether may be given by inhalation, or chloral hydrate (1 ounce) may be given in water by the mouth. Fomentations of warm water may be made over the loins and between the thighs, and the oiled hand inserted into the rectum may press moderately on the anterior part of the bladder, which can be felt as an elastic fluctuating bag of an oval shape just beneath.

All other measures failing, the liquid must be drawn off through a tube (catheter). This is, however, exceedingly difficult, alike in male and female, and we can not expect an amateur to succeed in accomplishing it. In the cow the opening into the bladder is found in the median line of the floor of the generative entrance, about 4 inches in front of the external opening, but it is flanked on either side by a blind pouch, into which the catheter will pass, in ninety-nine cases out of a hundred, in the hands of any but the most skilled operator. In the bull or steer the penis, when retracted into its sheath, is bent upon itself like the letter **S**, just above the scrotum and testicles (see Pl. IX, fig. 2), and unless this bend is effaced by extending the organ forward out of its sheath it is quite impossible to pass a catheter beyond this point. When, however, by the presentation of a female, the animal can be tempted to protrude the penis, so that it can be seized and extended, or when it can be manipulated forward out of the sheath, it becomes possible to pass a catheter of small caliber (one-third inch or under) onward into the bladder. Youatt advised laying open the sheath so as to reach and extend the penis, and others have advocated opening the uretha in the space between the thighs or just beneath the anus, but such formidable operations are beyond the stock owner. The incision of the narrow uretha through the great thickness of muscular and erectile bleeding tissue just beneath the anus is especially an operation of extreme delicacy and difficulty. Drawing the liquid through the tube of an aspirator is another possible resort for the professional man. The delicate needle of the aspirator is inserted in such cases through the floor of the vagina and upper wall of the bladder in the female, or through the floor of the rectum (last gut) and roof of the bladder in the male, or finally through the lower and back part of the abdominal wall, just in front of the bones of the pelvis (pubic bones), thence through the lower and anterior part of the bladder near its blind anterior end. After relief has been obtained the administration of belladonna in 2-dram doses daily for several days will tend to prevent a recurrence of the retention.

When the body of the bladder has become benumbed or paralyzed by overdistention, we may seek to restore its tone by doses of one-half a dram of powdered nux vomica repeated daily, and by mustard plaster applied over the loins, on the back part of the belly inferiorly, or between the thighs. Small doses (2 drams) of balsam of copaiba are sometimes useful in imparting tone to the partly paralyzed organ.

INCONTINENCE OF URINE (PALSY OF THE NECK OF THE BLADDER).

This may occur from disease or injury to the posterior part of the spinal cord or from broken back, and in these cases the tail, and perhaps the hind limbs, are liable to be paralyzed. In this case the urine dribbles away constantly, and the oiled hand in the vagina or rectum will feel the half-filled and flaccid bladder beneath and may easily empty it by pressure.

Treatment.—Treatment is only successful when the cause of the trouble can be remedied. After these (sprains of the back, etc.) have recovered, blisters (mustard) on the loins, the lower part of the abdomen, or between the thighs may be resorted to with success. Two drams of copaiba or of solid extract of belladonna or 2 grains Spanish flies daily may serve to restore the lost tone. These failing, the use of electric currents may still prove successful.

URINARY CALCULI (STONE OR GRAVEL).

Stone or gravel consists of hard bodies mainly made up of the solid earthy constituents of the urine which have crystallized out of that liquid at some part of the urinary passage, and have remained as small particles (gravel), or have concreted into large masses (stone, calculus). (See Pl. XI, figs. 1, 2, 3.) In cattle it is no uncommon thing to find them distending the practically microscopic tubes in the red substance of the kidney, having been deposited from the urine in the solid form almost as soon as that liquid has been separated from the blood. These stones appear as white objects on the red ground formed by cutting sections of the kidney, and are essentially products of the dry feed of winter, and are most common in working oxen, which are called upon to exhale more water from the lungs and skin than are the slop-fed and inactive cows. Little water being introduced into the body with the feed and considerable being expelled with the breath and perspiration in connection with the active life, the urine becomes small in amount, but having to carry out all waste material from the tissues and the tissue-forming feed it becomes so charged with solids that it is ready to deposit them on the slightest disturbance. If, therefore, a little of the water of such concentrated urine is reabsorbed at any point of the urinary passages the remainder is no longer able to hold the solids in solution, and they are at once precipitated in the solid form as gravel or commencing stone. In cattle, on the other hand, which are kept at pasture in summer, or which are fed liberally on roots, potatoes, pumpkins, apples, or ensilage in winter, this concentrated condition of the urine is not induced, and under such circumstances, therefore, the formation of stone is practically unknown. Nothing more need be said to show the controlling influence of dry feeding in producing gravel and of a watery ration in preventing it. Calculus in cattle is essentially a disease of winter and of such cattle as are denied succulent feed and are confined to dry fodder as their exclusive ration. While there are exceptions, they are so rare that they do not invalidate this general rule. It is true that stone in the kidney or bladder is often found in the summer or in animals feeding at the time on a more or less succulent ration, yet such masses usually date back to a former period when the animals were restricted to a dry ration.

In this connection is should be noted that a great drain of water from the system by any other channel than the kidneys predisposes to the production of gravel or stone. In case of profuse diarrhea, for example, or of excessive secretion of milk, there is a corresponding diminution of the water of the blood, and as the whole quantity of the blood is thus decreased and as the urine secreted is largely influenced by the fullness of the blood vessels and the pressure exerted upon their walls from within, it follows that with this decrease of the mass of the blood and the lessening of its pressure outward there will be a corresponding decrease of urine. The waste of the tissues, however, goes on as before, and if the waste matter is passed out through the kidneys it must be in a more concentrated solution, and the more concentrated the urine the greater the danger that the solids will be deposited as small crystals or calculi.

Again, the concentrated condition of the urine which predisposes to such deposits is favored by the quantity of lime salts that may be present in the water drunk by the animal. Water that contains 20 or 30 grains of carbonate or sulphate of lime to the gallon must contribute a large addition of solids to the blood and urine as compared with soft waters from which lime is absent. In this connection it is a remarkable fact that stone and gravel in the domesticated herbivora are notoriously prevalent on many limestone soils, as on the limestone formations of central and western New York, Pennsylvania, Ohio, and Michigan: on the calcareous formations of Norfolk, Suffolk, Derbyshire, Shropshire, and Gloucestershire, in England; in Landes in France, and around Munich in Bavaria. It does not follow that the abundance of lime in the water and fodder is the main cause of the calculi, as other poisons which are operative in the same districts in causing goiter in both man and animal probably contribute to the trouble, yet the excess of earthy salts in the drinking water can hardly fail to add to the saturation of both blood and urine, and thereby to favor the preciptation of the urinary solids from their state of solution.

The known results of feeding cattle a generous or forcing ration in which phosphate of lime is present to excess adds additional force to the view just advanced. In the writer's experience, the Second Duke of Oneida, a magnificent product of his world-famed family, died as the result of a too liberal allowance of wheat bran, fed with the view of still further improving the bone and general form of the Duchess strain of Shorthorns. Lithotomy was performed and a number of stones removed from the bladder and urethra, but the patient succumbed to an inflammation of the bowels, induced by the violent purgatives given before the writer arrived, under the mistaken idea that the straining had been caused by intestinal impaction. In this case not only the Second Duke of Oneida, but the other males of the herd as well, had the tufts of hairs at the outlet of the sheath encased in hard, cylindroid sheaths of urinary salts, precipitated from the liquid as it ran over them. The tufts were in reality resolved into a series of hard, rollerlike bodies, more or less constricted at intervals, as if beaded.

When it is stated that the ash of the whole grain of wheat is but 3 per cent, while the ash of wheat bran is 7.3 per cent, and that in the case of the former 46.38 per cent of the ash is phosphoric acid, and in that of the latter 50 per cent, it can easily be understood how a too liberal use of wheat bran should prove dangerous if fed dry. The following table shows the relative proportion of ash and phosphoric acid in wheat bran and in some common farm seeds:

Ash and phosphoric acid in bran and some common farm seeds.

Kind of grain.	Ash.	Phosphoric acid in ash.	Phosphoric acid in the entire feed.
	Per cent.	*Per cent.*	*Per cent.*
Wheat bran	7.3	50	3.65
Wheat, grain	3	46.38	1.3914
Oats, grain	2.50	26.5	.6625
Barley, grain	3.10	39.6	1.2276
Bean, grain	3.10	31.9	.9864
Peas, grain	2.75	34.8	.957
Tare, grain	3	36.2	1.086
Indian corn, grain	1.5	....	....
Rye, grain	1.6	39.9	.6384

Wheat bran, it will be observed, contains three times as much phosphoric acid as is found in any of the other grains, and four times as much as oats, beans, peas, or rye; so that if fed in excess it will readily overcharge the urine with phosphates.

There is another point to be considered, however, in estimating this danger. Wheat bran contains a far greater quantity of albuminoids and other nitrogen-containing constituents than the common grains (these being made up mainly of starch, which contains no nitrogen); and, all nitrogen-bearing products contained in the blood and tissues being expelled from the body mainly through the kidneys in the form of urea and (in cattle) hippuric acid, it follows that the excess of urea formed when such feed is consumed must load the urine with solids and bring it constantly nearer to the point of saturation, when such solids (or the least soluble of them) must be deposited.

The following table will show the relative amounts of the nitrogen-bearing products in wheat bran and some of our common grains:

Nitrogenous matter in wheat bran and some common farm grains.

Kind of grain.	Albuminoids (nitrogenous).	Woody fiber (nitrogenous.)	Total nitrogenous-bearing constituents.
	Per cent.	*Per cent.*	*Per cent.*
Wheat bran	16.1	8	24.1
Wheat, grain	12.5	1.8	14.3
Barley, grain	12.4	2.7	15.1
Oats, grain	11.8	9.5	21.3
Rye, grain	10.6	1.7	12.3
Indian corn	10.1	1.7	11.8

It will be observed that, with the exception of oats, none of the grains contain more than two-thirds of the nitrogenous material present in the wheat bran, while in the case of rye and maize there is practically but one-half. Even in the case of oats the albuminoids, which are the more digestible principles, and therefore those that are the most easily and speedily converted into urea, are present only to the amount of two-thirds of that which exists in the wheat bran. With such an excess of ash, of phosphates, and of nitrogenous (urea-forming) constituents in wheat bran, its tendency to favor the formation of calculi is fully explained. It must not, however, be inferred that wheat bran is not a valuable feedstuff. The inference is only that it should be fed with an abundance of water, as a sloppy mash, or in combination with an abundance of roots, potatoes, pumpkins, or other succulent aliment.

In this connection the presence of magnesia in the feed or water must be named as favoring calculous formations in the urinary passages. The explanation is that while the phosphate of magnesia thrown out in the urine is soluble in water, the compound phosphate of ammonia and magnesia is insoluble, and, accordingly, if at any time ammonia is introduced into urine containing the phosphate of magnesia there is instantly formed the ammonio-magnesium phosphate, which is as promptly deposited in the solid form. The common source of ammonia in such cases is from decomposition of the urea in fermenting urine. In order to produce this a ferment is necessary, however, and therefore, as an additional prerequisite, the presence of bacteria, or fungi, in the urine is essential. These ferments may make their way from without along the urinary passage (urethra), and their propagation in the bladder is greatly favored by the prolonged retention of urine, as in case of spasm of the neck of the bladder or obstruction by an already existing stone. Another mode of entrance of the ferment is an unclean catheter used to draw the urine. Still another is the elimination through the kidneys of the bacteria of infectious diseases, or of such as, without producing a general infection, yet determine fermentation in the urine. The precipitation is favored not only by the production of ammonia, but also by the formation of viscid (colloid) products of fermentation. In this sense bacteria are most important factors in causing gritty deposits in the urine.

Another insoluble salt which enters largely into the composition of many urinary calculi of the ox is carbonate of lime. This is derived mainly from the lime in the feed and water and from the carbon dioxid formed by the oxidation of the organic acids in the fodder. These organic acids, being composed of carbon, hydrogen, and oxygen (without nitrogen), are resolved by the addition of oxygen into carbon dioxid (CO_2) and water (H_2O). The carbon dioxid unites with the lime in the blood to form carbonate of lime, and in this state passes into the urine. Now, carbonate of lime is soluble in water containing free or uncombined carbon dioxid, but is precipitated whenever the latter is withdrawn. It is only necessary, therefore, to have in the urine sufficient lime or other available base to unite with all the free carbon dioxid in order to bring about the precipitation of the dissolved carbonate of lime in the solid, crystallized form; hence it is that, of all sediments in the urine of herbivora, this is the most frequent and usually the most abundant.

A less common constituent of urinary calculi is the insoluble oxalate of lime. In this case the lime is derived as before from the feed or water, or both, while the oxalic acid is a product of the oxidation of organic acids of the feed, less oxygen having been used than in the formation of carbon dioxid. The final product of the complete oxidation of these acids is carbon dioxid, but when less oxygen is furnished, owing to some disease of the lungs or a disease of the nerve centers, which lessens the activity of the breathing, then oxalic acid may be produced. If this oxalic acid comes into contact with lime, it is instantly precipitated as crystals of oxalate of lime.

Another inorganic substance at times found in urinary calculi is silica (SiO_2). This contributes largely to giving stiffness to the stems of growing plants, and in most of our cereals and grasses makes up a large proportion of the ashes of the burned plant. It is found in the soluble form in combination as silicate of potash, but at times is displaced by oxalic or other acid and then appears as gritty, sandy particles in the stem. This gritty, insoluble silica is especially noticeable among the horsetails (*Equisetæceæ*), bamboos, and sedges. The per cent of silica in the ash of several common fodder plants is given below:

Silica in ash of various fodder plants.

Ash of—	Silica.	Ash of—	Silica.
	Per cent.		*Per cent.*
Wheat straw	67.6	Rye-grass hay	64.57
Oats and husk	38.6	Wheat chaff	81.2
Oat straw	35.4	Oat chaff	59.9
Barley straw	73.1	Barley awn	70.7
Rye straw	64.4		

It is only soluble silica that is taken up into the system, and it is in this form (usually as silicate of potash or soda) that it enters the urine, but all that is wanted to precipitate it in crystalline form as a gritty sand is the presence of oxalic or other acid having a stronger affinity for its base (potash or soda).

Other conditions, however, enter largely into the causation of stone, or gravel. A high density of urine resulting from a highly saturated condition is often present for a length of time without any precipitation of solid materials. Urea and carbonates may be present in excess, the feed may be given dry, and drinking water may be deficient in quantity without any deposition of stone or gravel. In such cases, the presence of noncrystalline organic matter in the urine becomes an exciting cause. Rainey and Ord have shown experimentally that colloid (noncrystallizable) bodies like mucus, epithelial cells, albumin, pus, blood, hyaline casts of the kidney tubes, etc., not only determine the precipitation of crystallizable salts from a strong solution, but they determine the precipitation in the form of globular masses, or minute spheres, which, by further similar accessions, become stones, or calculi, of various sizes. The salts that are deposited by mere chemical reaction without the intervention of colloids appear in the form of sharply defined angular crystals, and hence the rough, jagged crystals of oxalate of lime or ammonia-magnesium phosphate. Heat intensifies the action of the colloids in causing precipitation of the dissolved salts, so that the temperatures of the kidneys and bladder constitute favorable conditions. Colloids that are undergoing decomposition are also specially powerful, so that the presence of bacteria or fungi causing fermentation is an important factor.

In looking, therefore, for the immediate causes of urinary calculi we must accord a high place to all those conditions which determine the presence of excess of mucus, albumin, pus, blood, kidney casts, blood-coloring matter, etc., in the urine. A catarrhal inflammation of the pelvis of the kidney, of the ureter, or of the bladder, generating excess of mucus or pus; inflammation of the kidneys, causing the discharge of blood, albumin, or hyaline casts into the urinary passages; inflammation of the liver, lungs, or other distant organ, resulting in the escape of albumin in the urine; disorders of the liver or of the blood-forming functions, resulting in hematuria or hemoglobinuria; sprains or other injuries to the back, or disease of the spinal marrow, which cause the escape of blood with the urine; the presence in the bladder of a bacterial ferment, which determines the decomposition of the mucus and urea, the evolution of ammonia and the consequent destruction of the protecting cellular (epithelia) lining of the bladder, or the irritation caused by the presence of an already formed calculus, may produce the colloid or uncrystallizable body that proves so effective in the precipitation of stone or gravel. It has long been known that calculi almost invariably form around any foreign body introduced into the kidney or bladder, and I have seen a large, calculous mass surrounding a splinter of an arrow that had penetrated and broken off in the body of a deer. The explanation is now satisfactory—the foreign body carries in with it bacteria, which act as ferments upon the urine and mucus in addition to the mechanical injury caused by its presence. If such a body has been introduced through the solid tissues, there is, in addition, the presence of the blood and lymph derived from the wounded structures.

CLASSIFICATION OF URINARY CALCULI.

Urinary calculi are most conveniently divided according to the locality in which they are found. Thus we find first renal calculi, formed in the kidney (Pl. XI, fig. 1), and which for cattle must be again divided into calculi of the uriniferous tubes and calculi of the pelvis. The second class are named ureteral calculi because they are found in the duct leading from the kidney to the bladder (ureter). The third class are the vesical calculi, from the bladder or vesicle in which they are found. The fourth class are the urethral calculi, and are found in the duct leading outward from the bladder through the penis (urethra). The fifth and last class are the preputial calculi, since they are found within the sheath of the penis (prepuce).

Calculi may also be classed according to their chemical composition and this has the advantage of suggesting the special cause of each as found in the feed, water, soil, or general conditions of health. This classification affords no guide to their location or symptoms, as calculi of the same chemical composition may be formed at any part of the urinary passages, as those formed in the kidney may pass on through all the various passages outward, unless it is found at any point of their progress that they have grown so large that the passage will not admit them. The following are among the concretions found in the various parts:

(1) *Coralline calculi.*—These are of a dull-white color and irregular surface, like coral. They are made up of hard and resistant layers evenly deposited around a central nucleus. (Pl. XI, fig. 3.) Their specific gravity is 1,760, water being 1,000, and they contain 74 per cent of carbonate of lime with some carbonate of magnesia, organic matter, and a trace of carbonate of iron. Yellowish-white, smooth, round calculi of the same chemical composition are met with.

(2) *Pearly calculi.*—These are more frequent than the first-named variety. They are very hard and smooth on the surface, reflecting a play of various colors after the fashion of a pearl. This peculiarity appears to be caused by the thinness and semitransparency of the supposed layers. They have a specific gravity of 2,109 to 2,351, and nearly the same chemical composition as the coralline variety. Golding Bird found a specimen of this kind formed of carbonate of lime and organic matter only.

(3) *Green calculi* (*metalloid calculi*).—These are usually small and numerous, as they are exceedingly common. They are of a very hard

consistency, and have a clear-polished, greenish surface of almost metallic brilliancy. They have a specific gravity of 2.301 and a composition almost identical with the second variety.

(4) *White calculi.*—Pure white, smooth, lustrous calculi are rare. They have a specific gravity of 2.307, and contain as much as 92 per cent of carbonate of lime with carbonate of magnesia and organic matter.

(5) *Ammonio-magnesium calculi.*—These are of a grayish color and a very rough, crystalline surface, which proves very irritating to the mucous membrane. They have a specific gravity of 1.109 to 1.637, and are composed chiefly of ammonio-magnesium phosphate, oxalate of lime, and organic matter, with a little carbonate of lime and magnesia.

(6) *Siliceous calculi.*—These are clear, smooth, and hard, and usually spherical. They have a specific gravity of 1.265 to 1.376, and contain 57 per cent of silica with carbonates of iron and magnesia, organic matter, and traces of iron. In other specimens of siliceous calculi there was a specific gravity of 3.122, and there was 79 to 85 per cent of carbonate of lime together with carbonate of magnesia, and iron, silica, and organic matter. Others are almost exclusively made of silica.

(7) *Oxalate of lime calculi* (*mulberry calculi*) (Pl. XI, fig. 2).—These are characterized by their extremely rough, angular surface, formed by the octahedral crystals of oxalate of lime. Their specific gravity may be 3.441, and they contain oxalate of lime to the extent of 81 per cent, together with carbonates of lime and magnesia and organic matter.

(8) *Gravel* (*pultaceous deposits*).—Simple crystals may be met with at any point from the kidneys to the external opening at the end of the prepuce (sheath), and they may appear singly, as crystals, or they may accumulate in masses of fine spherical crystals almost like dirty powdered chalk suspended in water. In the ox this is especially common as a collection in the sheath, distending that into a soft, doughy swelling.

FORMS OF CALCULI IN DIFFERENT SITUATIONS.

Apart from the rough crystalline surfaces of the calculi of oxalate of lime and ammonio-magnesium phosphate, the general tendency is to a smooth, round outline. At times, however, they show more or less flattening with rounded angular edges, caused by the contact and mutual friction of two calculi. Sometimes two or more stones lying together become united into one by a new external deposit, and the resulting mass then shows rounded swellings on opposite sides. The large calculi occupying the pelvis of the kidneys usually show a central part having the outline of the main cavity of the pelvis and two or more projections that have been molded into the corresponding branches or channels which lead to corresponding lobes of the kidney. In winter and spring small concretions in the form of plates are often met with in the branches of the pelvis, having been formed and molded in the confined space between the projecting papilla and the surrounding cuplike branch of the pelvis. Finally, the pulplike deposits in the sheath and elsewhere are made up of globular masses, individually so small as to be often practically microscopic.

STONE IN THE KIDNEY (RENAL CALCULI).

[Pl. XI, fig. 1.]

In an animal leading the quiet, uneventful life of the ox, stones of large size may be present in the kidney without producing any disorder appreciable to the people about him. In cattle fattened on dry feed in winter, on the magnesian limestone of New York, it is exceptional to find the substance of the kidney free from calculi about the size of a grain of wheat or less, and standing out as white objects in the general red of the cut surface of the organ. Similarly around the papillæ in the cuplike arms of the pelvis we find minute, flattened or more or less rounded, yellowish-white concretions. Even the large concretions may prove apparently harmless. I have a calculus several ounces in weight which filled the entire pelvis of the kidney, that was found by accident in a fat carcass while being dressed. In work oxen, however, such concretions may give rise to symptoms of kidney disease, such as stiffness of the loins, shown especially in the acts of rising or turning, weakness of the hind parts when set to pull a heavy load, an irritability of the kidneys, shown by the frequent passage of urine in small quantity, tenderness of the loins, shown when they are pinched or lightly struck, and it may be the passage of blood or minute gritty masses with the urine. If the attack is severe, what is called "renal colic" (kidney colic) may be shown by frequent uneasy shifting of the hind limbs, shaking or twisting of the tail, looking around at the flanks, and lying down and rising again at short intervals without apparent cause. The frequent passage of urine, the blood or gritty masses contained in it, and perhaps the hard, stony cylinders around the tufts of hair of the sheath, show that the source of the suffering is the urinary organs. In bad cases active inflammation of the kidneys may set in. (See "Nephritis," p. 123.)

URETERAL CALCULI.

These are small stones which have passed from the pelvis of the kidney into the canal (ureter) leading from the kidney to the bladder, but, being too large to pass on easily, have blocked that canal and forced the urine back upon the kidney. The result is the production of symptoms more violent than in renal calculi, though not varying, save in intensity, from those of renal colic. In case of complete and unrelieved obstruction, the secretion of the kidney on that side is entirely abolished, and it becomes the seat of passive congestion, and it may even be absorbed in greater part or as a whole, leaving only a fibrous sac containing fluid with a urinous odor. In small cattle, in which the oiled hand introduced into the last gut may reach the affected part, the distended ureter may be felt as a tense, elastic cord, extending forward from the point of obstruction on the lateral wall of the pelvis and beneath the loins toward the kidney. If relief is obtained by the onward passage of the stone a free flow of urine usually follows, in the midst of which may often be found gritty masses. If the outlets from both kidneys are similarly blocked the animal becomes poisoned by the retention in the blood of the elements of the urine, and by their reabsorption after secretion.

Treatment of renal and ureteral calculi.—Treatment is not very successful, as only the smallest calculi can pass through the ureter and enter the bladder, and even if they should do so they are liable to a progressive increase there, so that later they may cause the symptoms of stone in the bladder. Fortunately, ordinary dairy, growing, or fattening cattle rarely show evident symptoms of illness, and even though they do so they can usually be fattened and slaughtered before the health is seriously impaired. In work oxen the case is different, and acute symptoms may develop, but even then the animal may often be fitted for the butcher. When treatment is demanded it is primarily soothing and antispasmodic. Fomentations with warm water over the loins should be persisted in without intermission until relief has been secured. The soothing effect on the kidney will often relieve inflammation and irritation, should the stone be in that situation, while if in the ureter the warm fomentations will at once soothe irritation, relax spasm of the muscular coat of the canal, and favor an abundant secretion from the kidney, which, pressing on the obstructing stone, may slowly push it on into the bladder. Large doses of laudanum (2 ounces) or of solid extract of belladonna (2 drams) will not only soothe the pain but relax the spasm and favor the onward passage of the calculus. The animal should be encouraged to drink large quantities of cool water to favor the free secretion of a very watery urine, which will not only serve to obviate irritation and continued deposit caused by a highly concentrated urine, but will press the stone onward toward the bladder, and even in certain cases will tend to disintegrate it by solution of some of its elements, and thus to favor its crumbling and expulsion. This is a principle which must never be lost sight of in the treatment of calculi. The immersion of the stone in a liquid of a lower specific gravity than that in which it has formed and grown tends to dissolve out the more soluble of its component parts, and thus to destroy its density and cohesion at all points, and thereby to favor its complete disintegration and expulsion. This explains why cattle taken from a herd on magnesian limestone in spring, after the long, dry feeding of winter, usually have renal calculi, while cattle from the same herd in the fall, after a summer's run on a succulent pasture, are almost always free from concretions. The abundance of liquid taken in the green feed and expelled through the kidneys and the low density or watery nature of the urine have so opened the texture and destroyed the density of the smaller stones and gravel that they have all been disintegrated and removed. This, too, is the main reason why benefit is derived from a prolonged stay at mineral springs by the human victims of gravel. If they had swallowed the same number of quarts of pure water at home and distributed it at suitable times each day, they would have benefited largely without a visit to the springs.

It follows from what has been just said that a succulent diet, including a large quantity of water (gruels, sloppy mashes, turnips, beets, potatoes, apples, pumpkins, ensilage, succulent grasses), is an important factor in the relief of the milder forms of stone and gravel.

Prevention.—Prevention of calculus especially demands this supply of water and watery rations on all soils and in all conditions in which there is a predisposition to the disease. It must also be sought by attempts to obviate all those conditions mentioned above as causative of the malady. Sometimes good rain water can be furnished in limestone districts, but putrid or bad-smelling rain water is to be avoided as probably more injurious than that from the limestone. Unsuccessful attempts have been made to dissolve calculi by alkaline salts and mineral acids, respectively, but their failure as a remedy does not necessarily condemn them as preventives. One dram of caustic potash or of hydrochloric acid may be given daily in the drinking water. In diametrically opposite ways these attack and decompose the less soluble salts and form new ones which are more soluble and therefore little disposed to precipitate in the solid form. Both are beneficial as increasing the secretion of urine. In cases in which the diet has been too highly charged with phosphates (wheat bran, etc.), these aliments must be restricted and water allowed ad libitum. If the crystals passed with the urine are the sharp angular (octahedral) ones of oxalate of lime, then the breathing should be made more active by exercise, and any disease of the lungs subjected to appropriate treatment. If the crystals are triangular prisms of ammonia-magnesium phosphate or starlike forms with feathery rays, the indications are to withhold the feed or water that abounds in magnesia and check the fermentation in the urine by attempts to destroy its bacteria. In the latter direction plenty of pure-water diuretics, and a daily dose of oil of turpentine in milk, or a dose thrice a day of a solution containing one-tenth grain each of biniodid of mercury and iodid of potassium would be indicated.

In considering the subject of prevention, it must never be forgotten that any disease of a distant organ which determines the passage from the blood into the urine of albumin or any other colloid (uncrystallizable) body is strongly provocative of calculus, and should, if possible, be corrected. Apart from cases from geological formation, faulty feeding, and other causes, the grand preventive of calculus is a long, summer's pasturage of succulent grasses, or in winter a diet of ensilage or other succulent feed.

The calculi formed in part of silica demand special notice. This agent is secreted in the urine in the form of silicate of potash and is thrown down as insoluble silica when a stronger acid displaces it by combining with the potash to its exclusion. In cases of siliceous calculi, accordingly, the appropriate chemical prevention is caustic potash, which being present in the free state would attract to itself any free acid and leave the silica in its soluble condition as silicate of potash.

STONE IN THE BLADDER (VESICAL CALCULUS, OR URETHRAL CALCULUS).

Stone in the bladder may be of any size, but in the ox does not usually exceed half an inch in diameter. There may, however, be a number of small calculi; indeed, they are sometimes so small and numerous as to form a small, pulpy magma by which the bladder is considerably distended.

Symptoms.—The symptoms of stone in the bladder may be absent until one of the masses escapes into the urethra, but when this occurs the escape of urine is prevented, or it is allowed to pass in drops or driblets only, and the effect of such obstruction becomes manifest. The point of obstruction is not always the same, but it is most frequently at the S-shaped curve of the penis, just above the testicles or scrotum. In cows and heifers the urethra is so short and becomes so widely dilated during the urination that the calculi easily escape in the flow of liquid and dangerous symptoms practically never appear.

Even in the male the signs of illness are at first very slight. A close observer may notice the cylinders of hard, earthy materials encircling the tufts of hair at the opening of the prepuce. It may further be observed that the stall remains dry and that the animal has not been seen to pass water when out of doors. The tail may at times be gently raised and contractions of the muscle (accelerator urinæ) beneath the anus (Pl. IX, fig. 2) may take place in a rhythmical or pulsating manner. As a rule, however, no symptom is noticed for two days, only the animal is lacking in his usual spirits. By this time the constantly accumulating urine has distended the bladder beyond its power of resistance and a rupture occurs, allowing the urine to escape into the cavity of the abdomen. Then dullness increases; the animal lies down most of his time; he becomes stupid and sometimes drowsy, with reddish-brown congestion of the lining membrane of the eyelids; pressure on the abdomen causes pain, flinching, and perhaps groaning, and the lowest part of the belly fluctuates more and more as the escaping urine accumulates in greater and greater amount. If at this stage the oiled hand is introduced into the rectum (last gut), the animal flinches when pressure is made downward on the floor of the pelvis, and no round, distended bladder is felt. If the same examination is made prior to the rupture, the rounded, tense, elastic bladder is felt extending forward into the abdomen, containing one or two gallons of liquid. There may be uneasy shifting of the hind limbs and twisting of the tail, also frequent lying down and rising, but these symptoms are exceptional.

When the obstruction is low down between the thighs (at the S-shaped flexure), the line of the pulsating urethra from the anus downward may be felt distended with liquid, and though, by the hard swelling of the urethra, it is seldom easy to distinguish the exact seat of the stone, yet there is usually tenderness at the point of obstruction, and from this it may be accurately located.

Treatment.—The treatment of stone in the bladder or urethra consists in the removal of the stone by incision and the use of forceps. (Pl. XI, fig. 4.) When the stone has been arrested at the S-shaped flexure just above the scrotum, the patient being lean, the thickened tender part of the penis may be seized between the fingers and thumb of the left hand, while the calculus is exposed by a free incision with the knife held in the right. If there is no other obstruction between this point and the bladder, and if the latter has not yet ruptured, a flow of urine should take place from the opening. If there is no escape of liquid, a catheter or sound, one-fourth of an inch in diameter, must be passed up through the canal (urethra) until it is arrested by the next stone, on which a similar incision should then be made to effect its extraction. In case the stone has been arrested in the portion of the urethra which is in front of the arch of the hip bone and inside the pelvis, it can be reached only by making an opening into the urethra beneath the anus and over the arch of the hip bone, and from this orifice exploring the urethra with fine forceps to the neck of the bladder or until the stone has been reached and extracted. Owing to the small size of the canal (urethra) to be opened and the great thickness of erectile tissue to be cut through, the operation requires a very accurate knowledge of the parts, while the free flow of blood is blinding to the operator. A staff should always be passed up through the urethra from the lower wound, if such has been made, or, in case of its absence, through the whole length of the penis, that organ having been drawn out of its sheath until the S-shaped curve has been effaced and the course of the canal rendered straight. Upon the end of this staff the incision can be made with far more confidence and certainty. The operation can be undertaken only by a skilled veterinary anatomist, but the hints given above may be valuable in showing the stock owner when he is being properly served in such a case.

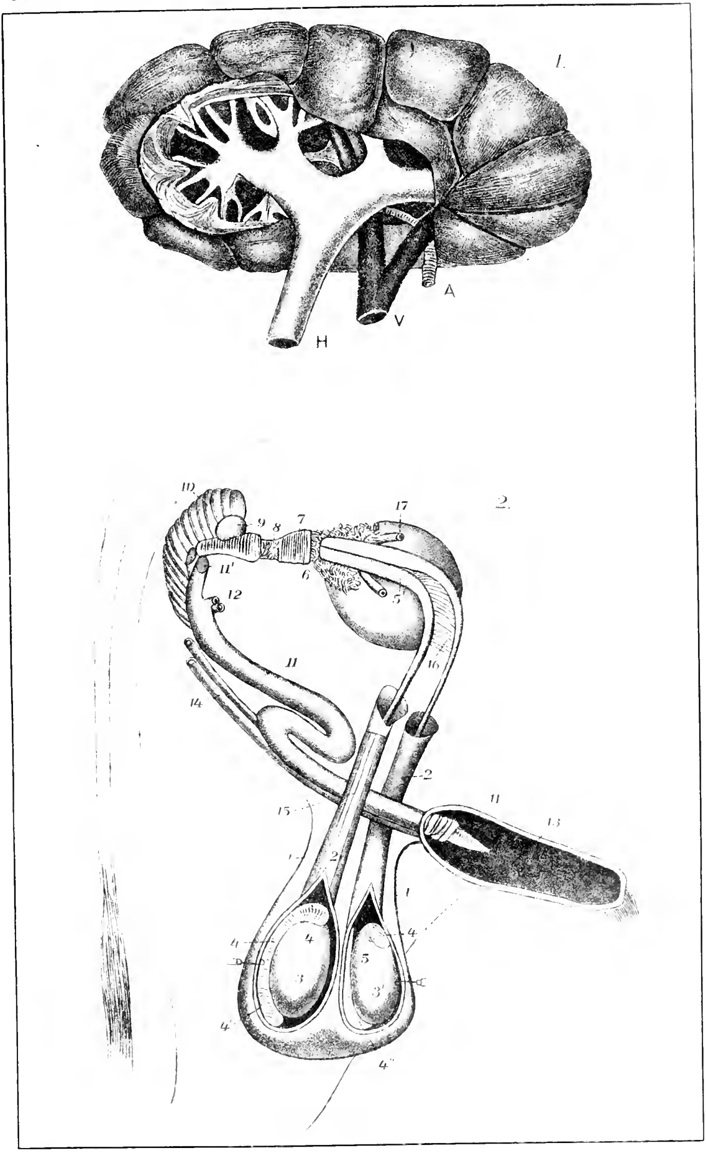
In outlying districts, where no skilled operator can be had, a transverse incision may be made with a clean, sharp knife through the root of the penis, just over the arch of the hip bone, when the urine will flow out in a full stream. The attendant bleeding may be ignored, or if profuse it may be checked by packing the wound firmly with cotton wool for several hours. The urine will continue to escape by the wound, and the ox should be fattened for the butcher.

The immediate relief is not to be looked upon as a permanent cure, as the calculi in the affected ox are usually numerous, and later attacks are therefore to be looked for. Hence it is desirable to fatten and kill such cases after a successful operation. If a breeding animal is too valuable to be killed, he should be subjected to preventive measures, as laid down under "Stone in the kidney," page 139.

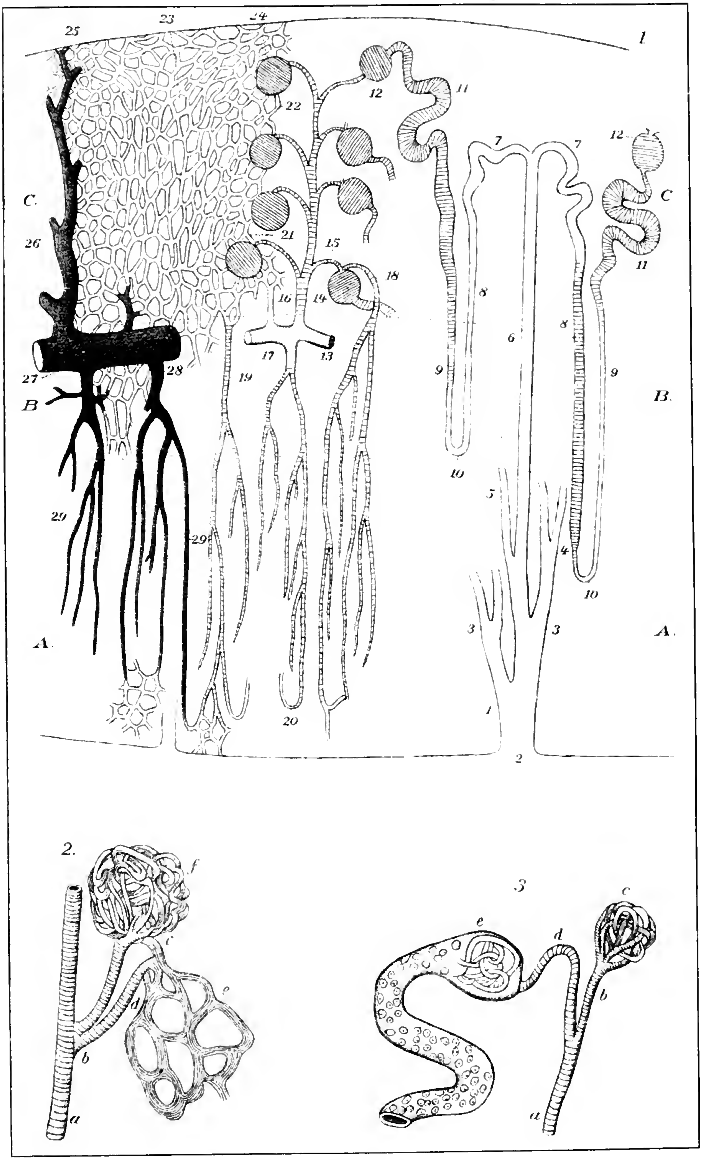
It should be added that when the bladder is filled with a soft magma a catheter may be introduced through the whole length of the urethra to be used in pumping water into the bladder. This water is extracted through the same channel when it has been charged with the suspended solids by manipulations of the bladder with the oiled hand introduced through the rectum.

CALCULI, OR GRAVEL, IN THE PREPUCE, OR SHEATH.

This is usually a collection of gravel, or a soft, puttylike material which causes distinct swelling of the sheath and gives it a soft, doughy feeling when handled. It may be removed in part by the oiled fingers introduced into the cavity, assisted by manipulation from without, or a tube may be inserted until the end extends behind the collection and water pumped in until the whole mass has been evacuated. Should even this fail of success, the sheath may be slit open from its orifice back in the median line below until the offending matter can be reached and removed. In all such cases the interior of the sheath should be finally lubricated with sweet oil or vaseline. It is unnecessary to stitch up the wound made in the sheath. (See "Inflammation of the sheath," p. 155.)



Kidney and Male Generative and Urinary Organs.



MICROSCOPIC ANATOMY OF THE KIDNEY.

DISEASES OF THE URINARY ORGANS.

DESCRIPTION OF PLATES.

PLATE IX. Kidney and male generative and urinary organs.

Fig. 1. Kidney of the ox. (From Handbuch des Vergleichenden Anatomie des Haus Säugethiere, vol. 7, 1890.) A, renal artery carrying blood into the kidney; V, renal vein carrying blood from the kidney back to the heart; H, ureter, the tube carrying the urine from kidney to bladder. It is formed by the union of a number of branches which begin as cups (calices), each inclosing the tip of a conical mass of tissue from which the urine exeludes.

Fig. 2. Genital and urinary organs of the bull. (From Leisering, Mueller, and Ellenberger, Handbuch des Verg. Anat. des Haus Säugethiere.) the serous membrane enveloping the testicles; 3, the right testicle, outer view; 3′, left testicle, inner view; 4, epididymis, or the beginning of the excretory canal of the testicle; 4′, globus major, or the head of the epididymis; 4″, globus minor, or the tail of the epididymis; 5, vas deferens, the duct through which the seminal fluid reaches the ejaculatory ducts; 5′, pelvic dilation of the vas deferens; 6, vesicula seminalis. The vesiculæ seminalis are two oval pouches, which, in addition to their own secretions, receive the semen conveyed by the seminal ducts and hold it in reserve until copulation; 7, membranous or intrapelvic portion of the urethral canal covered by Wilson's muscle; 8, part of the prostate gland, covered by Wilson's muscle; 9, Cowper's gland. This gland, like the prostate gland, secretes a fluid which is thrown into the urethai canal in abundance immediately before ejaculation; by this means the expulsion of the semen is facilitated; 10, ejaculator seminis, or accelerator urinæ muscle; 11, penis; 11′, cut portion of same; 12, cut suspensory ligaments of penis; 13, sheath, or prepuce laid open; 14, retractor muscles of sheath; 15, cremaster muscle cut at superior extremity; 16, duplicature of peritoneum; 17, ureters carrying urine from the kidneys to the bladder.

PLATE X. Microscopic anatomy of the kidney.

Fig. 1. In this figure the minute apparatus for the secretion, collection, and discharge of the urine into the pelvis of the kidney (see preceding plate) is shown. The course is as follows: The urine is secreted from the blood vessels in the little round bodies called glomeruli (12), and by the minute cells in the curved tubes (11, 9, 10, 8), and passes through the convoluted and straight tubes (7, 6) into the larger tube (1), and then out into the pelvis, thence through the ureters into the bladder. The fluid and salts dissolved in the urine are taken from the blood, and the minute blood vessels are therefore very abundant in the kidneys, as is shown by the branches and network on the left of the figure. The blood passes into the kidney in the artery (13), which then divides into branches which pass into the glomeruli (12) and also forms network around the secreting tubules (11, 9). The urine

PLATE X. Microscopic anatomy of the kidney—Continued.

and salts pass from these vessels through the cells lining the tubules into the latter, and are discharged as described above. The blood is again collected in veins drawn black in the figure.

Fig. 2 illustrates the manner in which the blood is distributed in the glomerulus (*f*), and also to the secreting tubules (*e*).

Fig. 3 shows the relation between the blood vessel in the glomerulus (*e*) the tubule which conducts the urine therein secreted from the blood vessel; (*c*) represents a glomerulus from which the urinary tubule has been removed.

PLATE XI. Calculi of kidney and bladder.

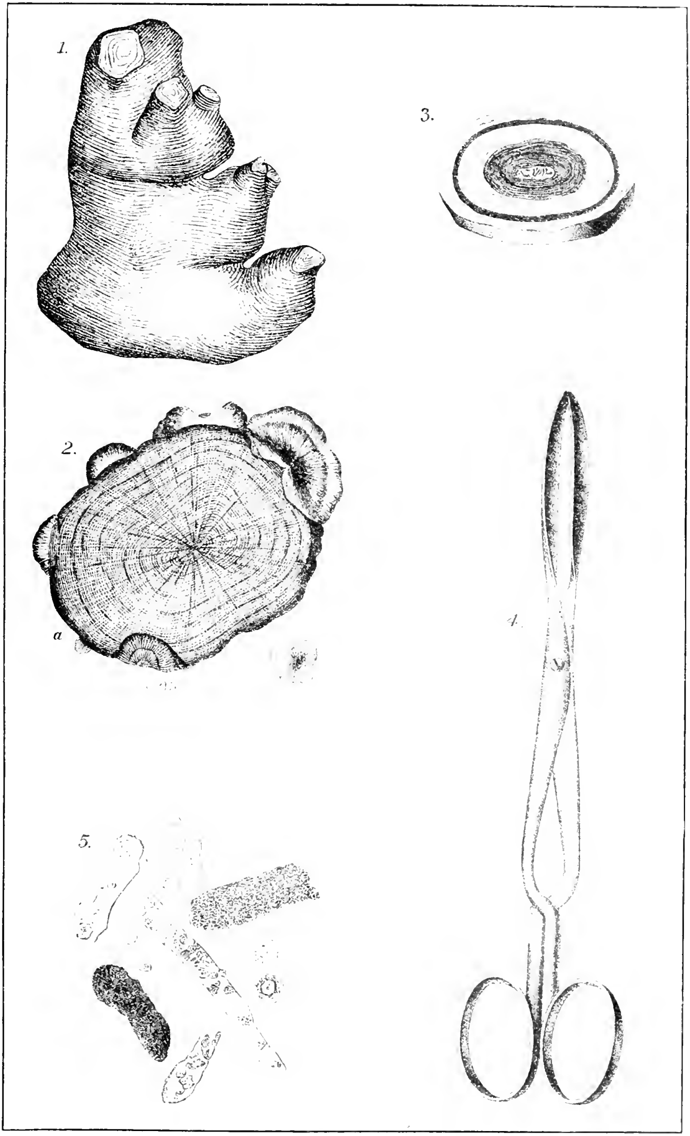
Fig. 1. Calculus, or stone, from the kidney. These are in the pelvis or portion of the ureter receiving the urine. The prolongations are casts of the branches of the pelvis. See the plates of the kidney for further description.

Fig. 2. Calculus made up of oxalate of lime magnified 215 times.

Fig. 3. Phosphatic calculus containing a nucleus of uric acid, sawed through to show concentric layers.

Fig. 4. Straight forceps used in removing stones from the bladder.

Fig. 5. Casts of the minute tubules of the kidney found in the urine in various kinds of kidney disease. Highly magnified.



Calculi of Kidney and Bladder.

DISEASES OF THE GENERATIVE ORGANS.

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[Revised by Adolph Eichhorn, D. V. S.]

GENERAL DISCUSSION.

Diseases of the generative organs are practically confined to animals which are kept for reproduction and the dairy. The castration of the bull condemns these organs to inactivity and protects them from the many causes of injury attendant on the engorged blood vessels in the frequent periods of sexual excitement, on the exposure to mechanical violence, and on the exposure to infective inoculation. In three respects the castrated male is especially subject to disease: (1) To inflammation and tumefaction of the cut end of the cord that supported the testicle and of the loose connective tissue of the scrotum; (2) to inflammation of the sheath and penis from the accumulation of gravel in the former, from which the penis is not usually protruded in passing water; and (3) to bruising, abrasion, and inflammation of the sheath and penis during suspension in the stocks for the purpose of shoeing. Apart from these the ox is practically almost exempt from the inflammations and injuries of the genital organs. The same applies to the castrated heifer. Inflammation may occur in the broad ligament of the womb whence the ovary has been removed or infective inflammation in the abdominal cavity (peritonitis) in case the operation has been performed through the flank, as it usually is in the young heifer. Apart from these, the castrated heifer is practically immune from any trouble of the generative apparatus. Even the virgin heifer is little subject to such troubles, though she is not exempt from inflammations, and above all, from morbid growths in the ovaries which are well developed and functionally very active after the first year, or in precocious animals after the first few months of life. The breeding cow, on the other hand, is subjected to all the disturbances attendant on the gradual enlargement of the womb, the diversion of a large mass of blood to its walls, the constant drain of nutrient materials of all kinds for the nourishment of the fetus, the risks attendant and consequent on abortion and parturition, the dangers of infection from the bull, the risks of sympathetic disturbance in case of serious diseases of other organs, but preeminently of the urinary organs and the udder, and finally the sudden extreme derangements of the circulation and of the nervous functions which attend on the sudden revulsion of a great mass of blood from the walls of the contracting womb into the body at large immediately after calving.

In reviewing this class of diseases, therefore, we have to note, first, that they are almost exclusively restricted to breeding animals, and secondly that in keeping with the absolute difference of the organs in the male and female we find two essentially distinct lists of diseases affecting the two sexes.

EXCESS OF VENEREAL DESIRE (SATYRIASIS IN MALE, OR NYMPHOMANIA IN FEMALE).

This may occur in the male from too frequent sexual intercourse, or from injury and congestion of the base of the brain (vasodilator center in the medulla), or of the posterior end of the spinal cord, or it may be kept up by congestion or inflammation of the testicles or of the mucous membrane covering the penis. It may be manifested by a constant or frequent erection, by attempts at sexual connection, and sometimes by the discharge of semen without connection. In bad cases the feverishness and restlessness lead to loss of flesh, emaciation, and physical weakness.

It is, however, in the female especially that this morbid desire is most noticeable and injurious. It may be excited by the stimulating quality of the blood in cows fed to excess on highly nitrogenous feed, as the seeds of the bean, pea, vetch, and tare, and as wheat bran, middlings, cotton seed, gluten meal, etc., especially in the case of such as have no free exercise in the fields, and are subject to constant association with a vigorous young bull. A more frequent cause is the excitation or congestion of some part of the genital organs. Disease of the ovaries is preeminently the cause, and this may be by the formation of cysts (sacs containing liquid) or of solid tumors or degenerations, or, more commonly than all, the formation of tubercle. Indeed, in case of tuberculosis attacking the abdominal organs of cows, the ovaries or the serous membranes that support and cover them (the broad ligaments of the womb) are peculiarly subject to attack, and the animal has constant sexual excitement, incessantly riding or being ridden by other cattle, having no leisure to eat or chew the cud, but moving restlessly, wearing the flesh off its bones, and gradually wasting. In some localities these cows are known as "bullers," because they are nearly always disposed to take the bull, but they do not conceive, or, if they do, they are subject to early abortions. They are, therefore, useless alike for the dairy and for the feeder, unless the removal of the ovaries subdues the sexual excitement, when, in the absence of tuberculous disease elsewhere, they may be fattened for the butcher.

Among the other sources of irritation charged with causing nymphomania are tumors and cancers of the womb, rigid closure of the neck of the womb so that conception can not occur and the frequent services by the male which stimulate the unsatisfied appetite, inflammation, and a purulent discharge from the womb or vagina.

Treatment.—The treatment in each case will vary with the cause and is most satisfactory when that cause is a removable one. Overfeeding on richly nitrogenous feed can be stopped, exercise in the open field given, diseased ovaries may be removed (see "Castration," p. 299), catarrhs of the womb and passages overcome by antiseptic, astringent injections (see Leucorrhea," p. 224), and tumors of the womb may often be detached and extracted, the mouth of that organ having been first dilated by sponge tents or otherwise. The rubber dilator (impregnator), sometimes helpful in the mare, is rarely available for the cow, owing to the different condition of the mouth of the womb.

DIMINUTION OR LOSS OF VENEREAL DESIRE (ANAPHRODISIA).

This occurs in either sex from low condition and ill health. Long-standing, chronic diseases of important internal organs, leading to emaciation and weakness, or a prolonged semistarvation in winter may be sufficient cause. It is, however, much more common as the result of degeneration or extensive and destructive disease of the secreting organs (testicles, ovaries) which elaborate the male and female sexual products, respectively. Such diseases are, therefore, a common cause of sterility in both sexes. The old bull, fat and lazy, becomes sluggish and unreliable in serving, and finally gets to be useless for breeding purposes. This is not attributable to his weight and clumsiness alone, but largely to the fatty degeneration of his testicles and their excretory ducts, which prevents the due formation and maturation of the semen. If he has been kept in extra high condition for exhibition in the show ring, this disqualification comes upon him sooner and becomes more irremediable.

Similarly the overfed, inactive cow, and above all the show cow, fails to come in heat at the usual times, shows little disposition to take the bull, and fails to conceive when served. Her trouble is the same in kind, namely, fatty degeneration of the ovaries and of their excretory ducts (Fallopian tubes), which prevents the formation or maturation of the ovum or, when it has formed, hinders its passage into the womb. Another common defect in such old, fat cows is a rigid closure of the mouth of the womb, which prevents conception, even if the ovum reaches the interior of that organ and even if the semen is discharged into the vagina.

Preventive.—The true preventive of such conditions is to be found in a sound hygiene. The breeding animal should be of adult age, neither overfed nor underfed, but well fed and moderately exercised; in other words, the most vigorous health should be sought, not only that a strong race may be propagated, but that the whole herd, or nearly so, may breed with certainty. Fleming gives 79 per cent as the general average of cows that are found to breed in one year. Here more than a fifth of the progeny is sacrificed and a fifth of the product of the dairy. With careful management the proportion of breeders should approach 100 per cent. The various local and general obstacles to conception should be carefully investigated and removed. The vigorous health which comes from a sufficiently liberal diet and abundant exercise should be solicited, and the comparative bloodlessness and weakness which advance with undue fattening should be sedulously avoided. In bull or cow which is becoming unduly fat and showing indications of sexual indifference, the treatment must be active. Turning out on a short pasture where it must work hard for a living will often suffice. The bull which can not be turned out to pasture may sometimes be utilized in the yoke or tread power, or he may be kept a part of his time in a field or paddock chained by the ring in his nose to a strong wire extending from one side of the lot to the other and attached securely to two trees or posts. The wire should be higher than the back of the bull, which will move frequently from end to end. If he is indisposed to take sufficient exercise in this way he may be safely driven. An instance of the value of the exercise in these incipient cases of fatty degeneration is often quoted. The cow Dodona, condemned as barren at Earl Spencer's, was sold cheap to Jonas Webb, who had her driven by a road a distance of 120 miles to his farm at Wilbraham, soon after which she became pregnant. In advanced cases, however, in which the fatty degeneration is complete, recovery is impossible.

In case of rigid closure of the mouth of the womb the only resort is dilatation. This is far more difficult and uncertain in the cow than in the mare. The neck of the womb is longer, is often tortuous in its course, and its walls so approximated to each other and so rigid that it may be all but impossible to follow it, and there is always danger of perforating its walls and opening into the cavity of the abdomen, or, short of that, of causing inflammation and a new, rigid, fibrous formation which on healing leaves matters worse than before. The opening must be carefully made with the finger, and when that has entered the womb further dilatation may be effected by inserting a sponge tent or by careful stretching with a mechanical dilator. (Pl. XX, fig. 6.)

STERILITY FROM OTHER CAUSES.

The questions as to whether a bull is a sure stock getter and whether a cow is a breeder are so important that it would be wrong to pass over other prominent causes of sterility. Breeding at too early an age is a common source of increasing weakness of constitution which has existed in certain breeds. Jerseys have especially been made the victims of this mistake, the object being to establish the highest milking powers in the smallest obtainable body which will demand the least material and outlay for its constant repair of waste. With success in this line there has been the counterbalancing disadvantage of impaired vigor, with too often lessened fertility as well as increased predisposition to disease. When the heifers of the race have for generation after generation been bred under a year old, the demand for the nourishment of the fetus is too great a drain on the immature animal, which accordingly remains small and stunted. As it fails to develop in size, so every organ fails to be nourished to perfection. Similarly with the immature bull put to too many cows; he fails to develop his full size, vigor, or stamina, and transfers his acquired weakness to his progeny. An increasing number of barren females and an increasing proclivity to abortions are the necessary results of both courses. When this early breeding has occurred accidentally it is well to dry up the dam just after calving, and to avoid having her served again until full grown.

Some highly fed and plethoric females seem to escape conception by the very intensity of the generative ardor. The frequent passage of urine, accompanied by contractions of the womb and vagina and a profuse secretion from their surfaces, leads to the expulsion of the semen after it has been lodged in the genital passages. This may be remedied somewhat by giving 1½ pounds of Epsom salt a day or two before she comes in heat, and subjecting her at the same time to a spare diet. Should the excessive ardor of the cow not be controllable in this way, she may be shut up for a day or two, until the heat is passing off, when under the lessened excitement the semen is more likely to be retained.

The various diseases of the ovaries, their tubes, the womb, the testicles and their excretory ducts, as referred to under "Excess of venereal desire," are causes of barrenness. In this connection it may be said that the discharges consequent on calving are fatal to the vitality of semen introduced before these have ceased to flow; hence service too soon after calving, or that of a cow which has had the womb or genital passages injured so as to keep up a mucopurulent flow until the animal comes in heat, is liable to fail of conception. Any such discharge should be first arrested by repeated injections as for leucorrhea, after which the male may be admitted.

Feeding on a very saccharine diet, which greatly favors the deposition of fat, seems to have an even more direct effect in preventing conception during such regimen. Among other causes of barrenness are all those that favor abortion, ergoted grasses, smutty wheat or corn, laxative or diuretic drinking water, and any improper or musty feed that causes indigestions, colics, and diseases of the urinary organs, notably gravel; also savin, rue, cantharides, and all other irritants of the bowels or kidneys.

Hermaphrodites are barren, of course, as their sexual organs are not distinctively either male or female. The heifer born as a twin with a bull is usually hermaphrodite and barren, but the animals of either sex in which development of the organs is arrested before they are fully matured remain as in the male or female prior to puberty, and are barren. Bulls with both testicles retained within the abdomen may go through the form of serving a cow, but the service is unfruitful; the spermatozoa are not fully elaborated. So I have examined a heifer with a properly formed but very small womb and an extremely narrow vagina and vulva, the walls of which were very muscular, that could never be made to conceive. A post-mortem examination would probably have disclosed an imperfectly formed ovary incapable of bringing ova to maturity.

A bull and cow that have been too closely inbred in the same line for generations may prove sexually incompatible and unable to generate together, though both are abundantly prolific when coupled with animals of other strains.

Finally, a bull may prove unable to get stock, not from any lack of sexual development, but from disease of other organs (back, loins, hind limbs), which renders him unable to mount with the energy requisite to the perfect service.

CONGESTION AND INFLAMMATION OF THE TESTICLES (ORCHITIS).

This usually results from blows or other direct injuries, but may be the result of excessive service or of the formation of some new growth (tumor) in the gland tissue. The bull moves stiffly, with straddling gait, and the right or left half of the scrotum in which the affected testicle lies is swollen, red, and tender, and the gland is drawn up within the sac and dropped again at frequent intervals. It may be treated by rest; by $1\frac{1}{2}$ pounds Epsom salt given in 4 quarts of water; by a restricted diet of some succulent feed; by continued fomentations with warm water by means of sponges or rags sustained by a sling passed around the loins and back between the hind legs. The pain may be allayed by smearing with a solution of opium or of extract of belladonna. Should a soft point appear, indicating the formation of matter, it may be opened with a sharp lancet and the wound treated daily with a solution of a teaspoonful of carbolic acid in a half pint of water. Usually, however, when the inflammation has proceeded to this extent, the gland will be ruined for purposes of procreation and must be cut out. (See "Castration," p. 299.)

INFLAMMATION OF THE SHEATH.

While this may occur in bulls from infection during copulation and from bruises, blows, and other mechanical injuries, the condition is more common in the ox in connection with the comparative inactivity of the parts. The sheath has a very small external opening, the mucous membrane of which is studded with sebaceous glands secreting a thick, unctuous matter of a strong, heavy odor. Behind this orifice is a distinct pouch, in which this unctuous matter is liable to accumulate when the penis is habitually drawn back. Moreover, the sheath has two muscles (protractors) which lengthen it, passing into it from the region of the navel, and two (retractors) that shorten it, passing into it from the lower surface of the pelvic bones above. (Pl. IX, fig. 2.) The protractors keep the sheath stretched, so that it habitually covers the penis, while the retractors shorten it up in the act of service, so that the penis can project to its full extent. In stud bulls the frequent protrusion of the erect and enlarged penis and the retraction and dilation of the opening of the sheath serve to empty the pouch and prevent any accumulation of sebaceous matter or urine. In the ox, on the other hand, the undeveloped and inactive penis is usually drawn back so as to leave the anterior preputial pouch empty, so that the sebaceous matter has space to accumulate and is never expelled by the active retraction of the sheath and protrusion of the erect penis in service. Again, the ox rarely protrudes the tip of the penis in urination, the urine is discharged into the preputial pouch and lodges and decomposes there, so that there is a great liability to the precipitation of its earthy salts in the form of gravel. The decomposing ammoniacal urine, the gritty crystals precipitated from it, and the fetid, rancid, sebaceous matter set up inflammation in the delicate mucous membrane lining the passage. The membrane is thickened, reddened, rendered friable, and ultimately ulcerated, and the now narrowed sheath is blocked by the increasing mass of sebaceous and urinous material and the decomposing mucus and pus. The penis can no longer be protruded, the urine escapes in a small stream through the narrowing sheath, and finally the outlet is completely blocked and the urine distends the back part of the sheath. This will fluctuate on being handled, and soon the unhealthy inflammation extends on each side of it, causing a thick, doughy, tender swelling under the belly and between the thighs. The next step in the morbid course is overdistention of the bladder, with the occurrence of colicky pains, looking at the flanks, uneasy movements of the hind limbs, raising or twisting of the tail, pulsatory contractions of the urethra under the anus, and finally a false appearance of relief, which is caused by rupture of the bladder. Before rupture takes place the distended bladder may press on the rectum and obstruct the passage of the bowel dejections. Two mistakes are therefore probable—first, that the bowels alone are to be relieved, and, second, that the trouble is obstruction of the urethra by a stone. Hence the need of examining the sheath and pushing the finger into its opening to see that there is no obstruction there, in all cases of retention of urine, overdistended bladder, or blocked rectum in the ox. The disease may be acute or chronic—the first by reason of acute, adhesive inflammation blocking the outlet, the second by gradual thickening and ulceration of the sheath and blocking by the sebaceous and calculous accretion.

Treatment.—The treatment of this affection depends on the stage. If recent and without instant danger of rupture of the bladder, the narrow opening of the sheath should be freely cut open in the median line below, and the sac emptied out with a finger or spoon, after which it should be thoroughly washed with tepid water. To make the cleansing more thorough a catheter or a small, rubber tube may be inserted well back into the sheath, and water may be forced through it from a syringe or a funnel inserted into the other end of the tube and considerably elevated. A fountain syringe, which should be in every house, answers admirably. The sheath may be daily washed out with tepid water, with a suds made with Castile soap, or with a weak solution of sulphate of zinc (one-half dram to a quart of water). If these attentions are impossible, most cases, after cleansing, will do well if merely driven through clean water up to the belly once a day.

In case the disease has progressed to absolute obstruction, with the bladder ready to rupture any moment, no time must be lost in opening into the urethra with a sharp knife over the bony arch under the anus, where the pulsations are seen in urinating. This incision is best made in the median line from above downward, but in the absence of a skillful operator a transverse incision with a sharp knife over the bone in the median line until the urine flows with a gush is better than to let the patient die. Considerable blood will be lost and the wound will heal tardily, but the ox will be preserved. Then the slitting and cleansing of the sheath can be done at leisure, as described above. If the bladder is ruptured, the case is hopeless.

INFLAMMATION OF THE SHEATH AND PENIS FROM BRUISING.

This also is an affection of work oxen, caused by the pressure and friction of the sling when the animals are held in stocks for shoeing. This crushing of both sheath and penis for half an hour or more leads to the development, some hours later, of a hard, hot, and painful swelling, extending from the scrotum as far as the opening of the sheath. Fever sets in, with dry muzzle, red eyes, hard, full, rapid pulse, accelerated breathing, and elevated temperature. The ox stands obstinately with his hind legs drawn apart and urine falling drop by drop from the sheath. Appetite and rumination are suspended. In twenty-four hours there may be indications of advancing gangrene (mortification), the swelling becomes cold, soft, and doughy; it may even crack slightly from the presence of gas; a reddish brown, fetid liquid oozes from the swelling, especially around the edges, and if the animal survives it is only with a great loss of substance of the sheath and penis.

Prevention.—The prevention of such an injury is easy. It is only necessary to see that the slings do not press upon the posterior part of the abdomen. They must be kept in front of the sheath.

Treatment.—Treatment, to be effective, must be prompt and judicious. Put around the patient a strap with soft pads in contact with the affected parts, constantly soaked in cold water for at least 24 hours. A pound or two of Epsom salt in 4 quarts of hot water should also be given. The second day the parts may be washed with 1 quart of witch-hazel (extract), 2 drams sugar of lead, and 1 ounce laudanum, or the cold-water irrigations may be continued if the active inflammation persists. In case the swelling continues hard and resistant, it may be pricked at the most prominent points to the depth of one-third of an inch with a lancet first dipped in dilute carbolic acid, and the whole surface should be washed frequently with some antiseptic solution.

When softening occurs in the center of a hard mass and fluctuation can be felt between two fingers pressed on different parts of such softening, it should be freely opened to let out the putrid pus, and the cavity should be syringed often with antiseptic solution.

In bad cases extensive sloughs of dead skin, of the whole wall of the sheath, and even of the penis, may take place, which will require careful antiseptic treatment. The soaking of the urine into the inflamed and softened tissue and the setting up of putrefactive action not only endanger great destruction of the tissues from putrid inflammation, but even threaten life itself from a general blood poisoning (septicemia). Every case should have skillful treatment to meet its various phases, but in the severe ones this is most urgently demanded.

INFLAMMATION OF THE URETHRA.

Like other males, the bull sometimes suffers from inflammation of the canal which conveys the urine through the penis, and a whitish mucopurulent discharge forms in consequence. It may have originated in gravel, the excitement of too frequent service, infection from a cow with leucorrhea, or from extension of inflammation from the sheath. Besides the oozing of the whitish liquid from the end of the penis and sheath, there is tenderness and pain when handled, and while there is no actual arrest of the urine, its flow is subject to frequent voluntary checks, as the scalding liquid irritates the tender surface.

Treatment.—If recognized before the discharge sets in, a dose of 1½ pounds of Epsom salt and local, warm fomentations would be appropriate. After the onset of the whitish discharge a daily injection of a solution of 20 grains of permanganate of potassium in a pint of water into the penis will be beneficial.

WARTS AND PAPILLARY GROWTHS ON THE PENIS.

These are not frequent in bull or ox. They may interfere with the protrusion of the organ from its sheath or with service, and always give rise to a bad-smelling discharge.

Treatment.—They may be twisted off with a pair of small tweezers or cut off with a pair of scissors, and the seat burned with a pencil of lunar caustic. To get hold of the penis in the bull, bring him up to a cow. In the ox it will be necessary to push it out by manipulation through the sheath. In difficult cases the narrow opening of the sheath may be slit open.

WOUNDS OF THE PENIS.

The most common wounds are those sustained by blows of horns, sticks, etc. The blood vessels and sacs are ruptured to a greater or less extent and considerable swellings filled with coagulated blood and inflammatory products occur, leading to distortion of the organ, and it may be to the impossibility of protruding it.

Treatment.—A lotion of a dram of alum in a quart of water may be applied (injected into the sheath, if necessary), and a large sponge constantly irrigated by a stream of cold water may be kept applied by means of a surcingle to the outer side of the sheath. Incisions are rarely applicable to an organ of this kind, but in case of the existence of an extensive clot which is unlikely to be absorbed the lancet may be resorted to. If the injury leads to paralysis of the penis and hanging out of its sheath, it should be supported in a sling and astringents used freely until inflammation subsides. Then the restoration of power may be sought by a blister between the thighs, by the use of electricity, or by the careful use of nerve stimulants, such as strychnin, 1 grain twice daily.

ULCERS ON THE PENIS.

Sores on the penis of the bull may result from gravel or sebaceous masses in the sheath or from having served a cow having leucorrhea.

Treatment.—These may be treated by frequent injections into the sheath of a lotion made with 1 dram sugar of lead, 60 drops carbolic acid, and 1 quart water.

POLYPUS OF THE VAGINA OR UTERUS.

A polypus is a tumor growing from the mucous membrane, and often connected to it by a narrow neck. A definite cause can not always be assigned. If growing in the vagina, a polypus may project as a reddish, rounded tumor from the vulva, especially during the act of passing water. It can be distinguished from descent of the womb by the absence of the orifice of that cavity, which can be felt by the oiled hand beyond the tumor in the depth of the vagina. From a vaginal hernia caused by the protrusion of some abdominal organ enveloped by the relaxed wall of the vagina it may be distinguished by its persistence, its firm substance, and the impossibility of returning it into the abdomen by pressure. A hernia containing a portion of bowel gurgles when handled and can be completely effaced by pressure, the gut passing into the abdomen.

A polypus in the womb is less easily recognized. At the time of calving it may be felt through the open mouth of the womb and recognized by the educated touch (it must be carefully distinguished from the mushroom-formed cotyledons (Pl. XIII, fig. 2), to which in ruminants the fetal membranes are attached). At other times, unless the womb is opened in the effort to expel it, the polypus can be detected only by examining the womb with the oiled hand introduced through the rectum.

Polypi may cause a mucopurulent discharge or they may only be suspected when they prove an obstacle to parturition. The best way to remove them is to put the chain of an écraseur around the neck, or pedicle, of the tumor and tear it through; or the narrow neck may be torn through by the emasculator, or in an emergency it may be twisted through by rotating the tumor on its axis. The removal of the tumor will allow calving to proceed; after this the sore may be treated by a daily injection of one-half dram sulphate of zinc, 1 dram carbolic acid, and 1 quart milk-warm water.

SIGNS OF PREGNANCY.

If a cow remains for three or four weeks after service without showing signs of heat (bulling), she is probably pregnant. There are very exceptional cases in which the well-fed cow will accept the bull weeks or months after actual conception, and others equally exceptional in which the well-thriven but unimpregnated female will refuse the male persistently, but these in no way invalidate the general rule.

The bull, no matter how vigorous or how ardent his sexual instinct, can not be made to pay any attention to a cow which is not in heat; hence indications of pregnancy can be had from both the male and female side. When she has conceived, the cow usually becomes more quiet and docile, and lays on flesh and fat more rapidly, especially during the first four months of gestation. The stimulus to digestion and nutrition created by the demands of the growing fetus, added to the quieter and more uneventful life, contributes to this result. Some feeders avail themselves of this disposition to prepare heifers and cows speedily for the butcher.

The enlargement of the abdomen, and its dropping so that it bulges below and to each side, while it falls in at the flank, between the outer angle of the hip bone and the last rib, are significant features which, though they may be caused by abdominal tumor or dropsy, are usually marks of pregnancy. From the same increasing weight of the abdomen the spine in the region of the loins sinks so that the bones of the croup seem to rise, especially back toward the root of the tail. In the early stages of pregnancy the udder develops slowly, and toward its completion quite rapidly. For a long time there is merely a sense of greater fullness when handled; the wrinkles in the skin become shallower and are effaced, and the teats are materially enlarged. Beginning a few weeks after conception, this tends to a steady development, though slight alternations in the sense of successive growth and shrinkage are not uncommon. In milking cows this does not hold, as the milk usually tends to a steady diminution and the udder shrinks slowly until near the completion of the period, when it undergoes its sudden, remarkable development, and yields at first a serous liquid and then the yellow colostrum, which coagulates when heated. As pregnancy advances the mucous membrane lining the vulva becomes swollen and of a darker, bluish-red hue; the mucous secretion also increases, becoming very abundant just before calving. When the feeding has not been altered or restricted, a steady diminution of the salts of lime excreted in the urine is an attendant on pregnancy, the lime being demanded for the growing body of the fetus.

After the fifth month the movements of the calf may often be observed in the right flank, nearly in front of the stifle, when the cow is drinking cold water. The sensation of cold on the side of the first stomach, which lies to the left and directly below the womb (Pl. I), stimulates the calf to active movements, which are detected on the sudden jerking outward of the abdominal wall as if from blows delivered from within. In a loose, pendent abdomen in the latter months of gestation the skin may often be seen pushed out at a sharp angle, irrespective of the period of drinking.

Another mode of examination through the flank is by touch. The palm of the hand is pressed strongly inward, about 8 inches in front of the stifle and a little below, several times in succession, and is then brought to rest with the pressure maintained. Presently there are felt distinct and characteristic movements of the fetus, which has been disturbed and roused to action. Another mode is to press the closed fist strongly inward in the same situation and hold it so, forming a deep indentation in the abdominal wall. Presently the knuckles are felt to be struck by a solid body, which is no other than the fetus that has been displaced to the left by the push of the hand, and now floats back in its liquid covering (amniotic fluid; see Pl. XII) downward and to the right.

Of all the modes of examination by touch, that done through the rectum gives the earliest satisfactory indications. The hand and arm, well oiled, are introduced, and the excrement having been removed if necessary, the palm of the hand is turned downward and the floor of the pelvis carefully examined. There will be felt in the median line the pear-shaped outline of the bladder, more or less full, rounded or tense, according to the quantity of urine it contains. Between this and the hand will be felt a soft, somewhat rounded tubular body, which divides in front into two smaller tubes or branches, extending to the right and left into the abdomen. This is the womb, which in its virgin, or unimpregnated, condition is of nearly uniform size from before backward, the main part or body being from 1½ to 2 inches across, and the two anterior branches or horns being individually little over an inch wide. Immediately after conception the body and one of the horns begin to enlarge, the vacant horn remaining disproportionately small, and the enlargement will be most marked at one point, where a solid, rounded mass indicates the presence of the growing embryo. In case of twins, both horns are enlarged. At a more advanced stage, when the embryo begins to assume the form of the future animal, the rounded form gives place to a more or less irregular nodular mass, while later still the head, limbs, and body of the fetus may be distinctly made out. The chief source of fallacy is found in the very pendent abdomen of certain cows, into which in advanced gestation the fetus has dropped so low that it can not be felt by the hand in the rectum. The absence of the distinct outline of the vacant womb, however, and the clear indications obtained on external examination through the right flank will serve to prevent any mistake. The fetus may still be felt through the rectum if the abdomen is raised by a sheet passed from side to side beneath it.

Still another sign is the beating of the fetal heart, which may be heard in the latter half of pregnancy when the ear is pressed on the flank in front of the right stifle or from that downward to the udder. The beats, which are best heard in the absence of rumbling, are about 120 a minute and easily distinguished from any bowel sounds by their perfect regularity.

DURATION OF PREGNANCY.

From extended statistics it is found that the average duration of pregnancy in the cow is 285 days. A calf born at the two hundred and fortieth day may live, and Dietrichs reported a case of a calf born on the three hundred and thirty-fifth day, and another was reported by the American Journal of Medical Science as having been born on the three hundred and thirty-sixth day. It is the general observation that in most cases of prolonged pregnancies the offspring are males. Lord Spencer found a preponderance of males between the two hundred and ninetieth and the three hundredth days, but strangely enough all born after the three hundredth day under his observation were females. It may be reasonably inferred that while the prevailing tendency is to carry the males overtime, yet that the smaller and comparatively much less developed female sometimes fails to stimulate the womb to contraction until very far beyond the regular date.

HYGIENE OF THE PREGNANT COW.

Among domestic animals considerations of hygiene must be made subservient to profit, and therefore the first consideration is not to obtain the most robust health, but such a measure of vigor and stamina as is compatible with the most profitable utilization of the animal. The breeding cow must carry a calf every year, and this notwithstanding that she is at the same time suckling another large, growing calf. The dairy cow must breed every year, and at the same time must furnish a generous flow of milk from nine to eleven months yearly. If her health is lowered thereby or her life shortened, the question of profit must still hold sway, and, when disqualified, she must yield her place to another. There are exceptions, of course, but this rule generally holds.

There are certain points, however, in which the interests of hygiene may be considered. The pregnant cow should have exercise, and as regards both exercise and feed, nothing is better than a run on a smooth pasture. She should be withheld from all violent excitement, hunting with dogs, riding or being ridden by cows in heat, driving in herd rapidly through narrow gateways, causing to jump ditches or fences, subjecting to blows with the horns of pugnacious cattle, driving on icy or otherwise slippery ground, carrying in railroad cars, kicking by vicious attendants, and fastening or throwing down for operations. The diet should be good, not of a kind to fatten, but with a generous quantity of nitrogenous constituents which will favor both the yield of milk and the nourishment of the fetus. Aliments like wheat bran, middlings, etc., which are rich in lime and phosphates, can be used to advantage, as there is a constant drain of earthy salts for the building of the body of the calf, and thereby the danger of undue concentration of the urine is lessened. Hard, innutritious, and indigestible aliments, musty grain or hay, partially ripened rye grass, millet, Hungarian grass, vetches, peas, or maize are objectionable, as they are liable to cause indigestion or even paralysis; and corn or hay affected by smut or ergot, or that has been spoiled by wet, overripened, and rendered fibrous and innutritious, is equally objectionable. In the main the feed should be laxative, as costiveness and straining are liable to cause abortion. Roots and green feed that have been frosted are objectionable, as being liable to cause indigestion, though in their fresh condition most wholesome and desirable. Ice-cold water should be avoided, as calculated to check the flow of milk, to derange digestion, and to cause abortion. A good temperature for the drink of the dairy cow is 55° F.

In the case of plethoric and heavy-milking cows of mature age and in the prime of life, the hitherto liberal diet must be changed at the last week for the scantiest possible fare, and the bowels must be kept open by laxatives, if need be, if the owner would avoid milk fever. Her stall should not incline downward from shoulder to croup, lest the pressure of the abdominal organs should produce protrusion or abortion. She should be kept aloof from all causes of acute diseases, and all existing diseases should be remedied speedily and with as little excitement of the abdominal organs as possible. Strong purgatives and diuretics are to be especially avoided, unless it is in the very last days of gestation in very plethoric cows.

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PROTRUSION OF THE VAGINA (PROLAPSUS VAGINÆ).

During pregnancy this is common from chronic relaxation of the vaginal walls and from lying in stalls that are lower behind than in front. The protusion is of a rounded form and smooth, and if it embraces both sides of the canal it is double, with a passage between. It may sometimes be remedied by raising the hind part of the stall higher than the front part. This failing, a truss may be applied as for eversion of the womb, and worn until the period of calving approaches. (Pls. XXII, XXIII.)

HERNIA (BREACH) OF THE UTERUS.

In advanced pregnancy this occurs usually from a gradual relaxation and distention of the lower wall of the abdomen in the region of the udder, so that the latter is displaced downward, and in the sac above and in front of it may be felt the form and movements of the fetus. In other cases the womb escapes through a great laceration of the abdominal muscles to one side of the udder, and the hernial mass extends down to one side of that organ. However unsightly, this often allows the animal to complete its pregnancy naturally, and a broad, supporting bandage placed around the abdomen is about all that can be recommended. After calving it is best to fatten the cow.

CRAMPS OF THE HIND LIMBS.

The compression of the nerves by the womb and fetus passing through the pelvis sometimes causes cramp and inability to move the limb, but it disappears under friction and motion and is never seen after calving.

DROPSY OF THE HIND LIMBS AND BETWEEN THE THIGHS.

In the latter months of pregnancy the hind legs may swell beneath the hocks, or a soft swelling which pits on pressure with the finger appears from the vulva down between the thighs to the udder and in front. It is mainly ascribable to the pressure of the enlarged womb on the blood vessels, is not dangerous, and disappears after calving.

DROPSY OF THE MEMBRANES OF THE FETUS (DROPSY OF THE WOMB).

The unimpregnated womb may be filled with a dropsical fluid, but the pregnant womb is more liable to become overdistended by an excess of fluid in the inner water bag in which the fetus floats. (Pl. XII.) From an unhealthy state of this membrane or of blood of the fetus (water blood) this liquid may go on accumulating until the cow seems almost as broad as she is long. If the trouble has not originated in the ill health of the cow, the result is still to draw on her system, overtax her strength, and derange her digestion, so that the result may prove fatal to both mother and offspring. On the other hand, I have known extreme cases that came to the natural term without help and produced a living calf, after which the dam did well. The natural resort is to draw off a portion of the fluid through a hollow needle passed through the neck of the womb or through its tense wall adjacent. This may be repeated several times, as demanded, to relieve the cow from the injurious distention.

PARALYSIS OF THE HIND PARTS.

In ill-fed, weak, unthrifty cows palsy of the hind limbs and tail may appear in the last weeks of pregnancy. The anus and rectum may participate in the palsy so far as to prevent defecation, and the rectum is more or less completely impacted. Exposure to wet and cold are often accessory causes, though the low condition, general weakness, and the pressure on the nerves going to the hind limbs are not to be forgotten. Something may be done for these cases by a warm, dry bed, an abundant diet fed warm, frictions with straw wisps or with a liniment of equal parts of oil of turpentine and sweet oil on the loins, croup, and limbs, by the daily use of ginger and gentian, by the cautious administration of strychnia (1 grain twice daily), and by sending a current of electricity daily from the loins through the various groups of muscles in the hind limbs. The case becomes increasingly hopeful after calving, though some days may still elapse before the animal can support herself upon her limbs.

EXTRAUTERINE GESTATION (FETUS DEVELOPING OUTSIDE THE WOMB).

These curious cases are rare and are usually divided into three types: (1) That in which the fetus is formed in or on the ovary (ovarian gestation); (2) that in which it is lodged in the Fallopian tube, or canal between the ovary and womb (tubal gestation); and (3) that in which it is lodged in the abdominal cavity and attached to one or more of its contents from which it draws its nourishment (abdominal gestation). Undoubted cases of the first and last varieties are recorded as occurring in the cow. The explanation of such cases is to be found in the fact that the actively moving sperm cells (spermatozoa) thrown into the womb have made their way through the Fallopian tubes to the ovary. If they met and impregnated an ovum in the tube, and if the consequent growth of that ovum prevented its descent and caused its imprisonment within the tube, it developed there, getting attached to and drawing nourishment from the mucous walls. Such product has its development arrested by compression by the undilatable tube, or, bursting through the walls of the tube, it escapes into the abdomen and perishes. If, on the contrary, the spermatozoa only meet and impregnate the ovum on or in the ovary, the development may take place in the substance of the ovary, from which the fetus draws its nourishment, or the impregnated ovum, escaping between the ovary and the open end of the tube, falls into the abdominal cavity and becomes adherent to and draws nourishment from some of the abdominal organs (womb, bowel, liver, stomach, etc.).

Symptoms.—The symptoms are those of pregnancy, which may be suddenly complicated by inflammation (peritonitis), owing to rupture of the sac containing the fetus; or at full term signs of calving appear, but no progress is made; an examination with the oiled hand in the vagina or rectum finds the womb empty and its mouth closed. Further examination will disclose the fetal sac attached in some part of the abdominal cavity and containing the more or less perfectly developed body of a calf. In the most hopeful cases the fetus perishes at an early stage of gestation, becomes inclosed in a fibrous sac, and is slowly absorbed, its soft parts becoming liquefied and removed and the bones remaining encysted. In some cases the bones have finally sloughed into the rectum or through an artificial opening in the side of the belly.

Treatment.—Little can be done in such cases except to quiet pain and excitement by anodynes (opium, chloral, etc.) and leave the rest to nature. A fistula discharging bones may be dilated and the bones extracted, the sac being then washed out with a solution of 10 grains bichlorid of mercury in a quart of water. In certain cases with a live calf a skillful operator may be justified in cutting into the abdomen and extracting the calf with its membranes, using the lotion just named as an antiseptic.

PROLONGED RETENTION OF THE FETUS.

Even when the fetus has developed within the womb it may fail to be delivered at the proper time; labor pains have quickly subsided and the cow resumed her usual health. In such cases the calf dies, and its soft parts are gradually liquefied and absorbed, while its bones remain for years in the womb inclosed in the remains of the fetal membranes. These may be expelled at any time through the natural channels, or they may remain indefinitely in the womb, not interfering with the general health, but preventing conception.

If the true condition of things is recognized at the time of the subsidence of the labor pains, the mouth of the womb may be dilated by the fingers, by the insertion of sponge tents, or by a mechanical dilator (Pl. XX, fig. 6). the fetal membranes may be ruptured and the calf extracted. After the removal of the calf and its membranes the danger of putrid poisoning may be obviated by injecting the antiseptic solution advised in the paragraph above.

ABORTION (SLINKING THE CALF).

Technically, abortion is the term used for the expulsion of the offspring before it can live out of the womb. Its expulsion before the normal time, but after it is capable of an independent existence, is premature parturition. In the cow this may be after seven and one-half months of pregnancy. Earl Spencer failed to raise any calf born before the two hundred and forty-second day. Dairymen use the term abortion for the expulsion of the product of conception at any time before the completion of the full period of a normal pregnancy, and in this sense it will be used in this article.

Abortion in cows is either contagious or noncontagious. It does not follow that the contagium is the sole cause in every case in which it is present. We know that the organized germs (microbes) of contagion vary much in potency at different times, and that the animal system also varies in susceptibility to their attack. The germ may therefore be present in a herd without any manifest injury, its disease-producing power having for the time abated considerably, or the whole herd being in a condition of comparative insusceptibility. At other times the same germ may have become so virulent that almost all pregnant cows succumb to its force, or the herd may have been subjected to other causes of abortion which, though of themselves powerless to actually cause abortion, may yet so predispose the animals that even the weaker germ will operate with destructive effect. In dealing with this disease, therefore, it is the part of wisdom not to rest satisfied with the discovery and removal of one specific cause, but rather to try to find every existent cause and to obtain a remedy by correcting all the harmful conditions.

NONCONTAGIOUS ABORTION.

As abortion most frequently occurs at those three-week intervals at which the cow would have been in heat if nonpregnant, we may assume a predisposition at such times owing to a periodicity in the nervous system and functions. Poor condition, weakness, and a too watery state of the blood is often a predisposing cause. This in its turn may result from poor or insufficient feed, from the excessive drain upon the udder while bearing the calf, from the use of feed deficient in certain essential elements, like the nitrogenous constituents or albuminoids, from chronic, wasting diseases, from roundworms or tapeworms in the bowels, from flatworms (flukes, trematodes) in the liver, from worms in the lungs, from dark, damp, unhealthful buildings, etc. In some such cases the nourishment is so deficient that the fetus dies in the womb and is expelled in consequence. Excessive loss of blood, attended as it usually is with shock, becomes a direct cause of abortion.

Acute inflammations of important organs are notorious causes of abortion, and in most contagious fevers (lung plague, rinderpest, foot-and-mouth disease) it is a common result. Affections of the chest which prevent due aeration of the blood induce contractions of the womb, as shown experimentally by Brown-Sequard. Pregnant women suffocated in smoke aborted in many cases. (Retoul.)

Ergoted grasses have long been known as a cause of widespread abortion in cows. The ergot is familiar as the dark purple or black, hard, spurlike growths which protrude from the seeds of the grasses at the period of their ripening. (Pl. V.) It is especially common in damp localities and cloudy seasons on meadows shaded by trees and protected against the free sweep of the winds. The same is to a large extent true of smut; hence, wet years have been often remarkable for the great prevalence of abortions. Abortions have greatly increased in New Zealand among cows since the introduction of rye grass, which is specially subject to ergot. As abortion is more prevalent in old dairying districts, the ergot may not be the sole cause in this instance.

The riding of one another by cows is attended by such severe muscular exertion, jars, jolts, mental excitement, and gravitation of the womb and abdominal organs backward that it may easily cause abortion in a predisposed animal.

Keeping in stalls that slope too much behind (more than 2 inches) acts in the same way, the compression from lying and the gravitation backward proving more than a predisposed cow can safely bear.

Deep gutters behind the stalls, into which one or both hind limbs slip unexpectedly, strain the loins and jar the body and womb most injuriously. Slippery stalls in which the flooring boards are laid longitudinally in place of transversely, and on which there is no device to give a firm foothold, are almost equally dangerous. Driving on icy ground, or through a narrow doorway where the abdomen is liable to be jammed, are other common causes. Aborting cows often fail to expel the afterbirth, and if this remains hanging in a putrid condition it is most injurious to pregnant cows in the near vicinity. So with retained afterbirth in other cows after calving. That some cows kept in filthy stables or with slaughterhouses near by may become inured to the odors and escape the evil results is no disproof of the injurious effects so often seen in such cases.

The excitement, jarring, and jolting of a railroad journey often cause abortion, especially as the cow nears the period of calving, and the terror or injury of railway or other accidents proves incomparably worse.

All irritant poisons cause abortions by the disorder and inflammation of the digestive organs, and if such agents act also on the kidneys or womb, the effect is materially enhanced. Powerful purgatives or diuretics should never be administered to the pregnant cow.

Among other causes of abortion must be named the death or the various illnesses of the fetus, which are about as numerous as those of the adult; the slipping of a young fetus through a loop in the navel string so as to tie a knot which will tighten later and interrupt the flow of blood with fatal effect, and the twisting of the navel string by the turning of the fetus until little or no blood can flow through the contorted cord. There is in addition a series of diseases of the mucous membrane of the womb, and of the fetal membranes (inflammation, effusion of blood, detachment of the membranes from the womb, fatty or other degenerations, etc.), which interfere with the supply of blood to the fetus or change its quality so that death is the natural result, followed by abortion.

Treatment.—Although the first symptoms of abortion have appeared, it does not follow that it will go on to completion. So long as the fetus has not perished, if the waters have not been discharged, nor the water bags presented, attempts should be made to check its progress. Every appreciable and removable cause should be done away with, the cow should be placed in a quiet stall alone, and agents given to check the excitement of the labor pains. Laudanum in doses of 1 ounce for a small cow or 2 ounces for a large one should be promptly administered, and repeated in three or four hours should the labor pains recur. This may be kept up for days or even weeks if necessary, though that is rarely required, as the trouble either subsides or abortion occurs. If the laudanum seems to lack permanency of action, use bromid of potassium, or, better, extract of *Viburnum prunifolium* (black haw), 40 grains, at intervals of two or three hours until five or six doses have been given

CONTAGIOUS ABORTION.

Contagious abortion (also known as epizootic abortion, enzootic abortion, and slinking of calves) is a disease affecting chiefly cattle and to a lesser degree other domestic animals, and characterized by an inflammatory condition of the female reproductive organs, which results in the expulsion of the immature young.

History.—This disease has been known in England and continental Europe for many years, and descriptions of it are mentioned in the writings of Mascal, Lafoose, Skellet, Lawrence, St. Cyr, Zündel, and Youatt. In the early part of the eighteenth century British veterinarians recognized its contagiousness, but it remained for Franck (1876), Lehnert (1878), and Bräuer (1880) to produce the disease in healthy, pregnant cows by the introduction of exudate and material from aborting animals. Nocard (1888) isolated from the exudate between the mucous membrane of the uterus and fetal membranes a micrococcus and a short bacillus which were found continually in contagious abortion, but he failed to reproduce the disease by inoculations of pure cultures of these organisms into healthy, pregnant animals. In 1897 Bang, assisted by Stribolt, published their findings regarding infectious abortion of cattle, in which they incriminated Bang's bacillus of abortion as the causative agent. With pure cultures of this bacillus they were able to produce the disease artificially and to recover the same organism from the experimental cases. Since that time many noted investigators, both in this country and in Europe, have confirmed these findings.

Cause.—The *Bacterium abortus* of Bang is now generally recognized as the causative agent of the disease of cattle. Formerly it was thought that abortion was due to injury, such as blows, horn thrusts, falls, etc., or the eating of spoiled feed and certain plants, and while this may be true in a limited number of cases, careful investigations have demonstrated these claims to be largely unfounded. It is now generally recognized that when abortion occurs in herds from time to time, it is safe to assume that the disorder is of an infectious nature and should be so treated.

Natural mode of infection.—This phase of the disease is of greatest importance for a clear understanding of the methods of prevention. Many investigators have demonstrated that the infection is transmitted through the digestive tract, through contaminated feed and water. The germs are taken up by the body from the intestines with the liquid nourishment, reach the blood, and are carried to the genital organs, where they find conditions best suited to their development. Some assert that calves are infected in this manner by suckling infected mothers, the germs being present in the milk, or the teats having been contaminated by coming in contact with infective discharges. It is claimed that infection contracted in this manner remains dormant in the body of the calf until pregnancy begins, and then the organism, finding conditions suitable for its development, produces the disease.

Abortion may occasionally be transmitted from cow to cow by direct contact. The discharges from diseased cows, swarming with the germs, soil the external genitals, tail, and hind quarters, and then a susceptible animal, by contact, gets the infective material upon the vulva, the infection traveling up the genital canal and directly infecting the uterus.

The belief long entertained that the female acquires the disease at the time of copulation as a result of transference of the infection from affected to healthy females on the genital organs of the bull has failed to receive the support of experimental evidence. The view that the disease is spread to any great degree in this way has been largely discredited. Cows of all ages are more or less susceptible, but young ones in first or second pregnancy most frequently abort. A second abortion is not unusual, and a third may occasionally occur, after which the cow usually becomes immune and thereafter carries her calf to maturity. Heifers from aborting mothers sometimes seem to be less susceptible than others.

Symptoms.—Contagious abortion is a very insidious disease, developing very slowly through several months of the gestation period, and resulting finally in the expulsion of the immature young, this act being simply an indication of the presence of the disease and not the disease itself. Because of this slow development and the fact that the health of the animal is not noticeably influenced, the presence of the disease may not be suspected until it has gained a firm foothold in the herd. The symptoms of approaching abortion are those preceding normal calving. In addition, there may be observed, a few days previous to abortion, a sticky, sometimes purulent, rusty, and odorless discharge. Abortion occurs most frequently from the third to the seventh month, according to the number of abortions, occurring early in first abortion, and later in each succeeding abortion until the calf is carried to full term and the mother has become immune. It happens frequently that calves are carried almost to full term, and are born alive, but are sickly, and soon die. Following abortion there is a dirty, yellowish-gray mucopurulent discharge which persists for two or more weeks. If abortion occurs early, the fetus is passed surrounded by its membranes, but if late in the period of pregnancy, the membranes are retained, decomposition sets in and blood poisoning, which may cause the death of the animal, or sterility may result.

Lesions.—The most characteristic change is found in the uterus where a dark-brown fluid, purulent or even gluey in consistency, and containing grayish-white flakes separates the material membranes from those of the fetus, preventing that intimate contact between the two which is so necessary for the interchange of fluids and gases by which the fetus is nourished and by which it obtains its oxygen. These being cut off, the fetus must of course die. The germs producing the disease are found in greatest numbers at this point. In addition there may be inflammatory changes, first in the walls of the uterus and then in the tissues of the fetus. These inflammatory changes seem most intense in the cotyledons and result in the destruction of the minute structure of those bodies, and they appear swollen, pale, and soft. The membrane of the uterus between the cotyledons also may show inflamed and necrotic patches.

Complications.—Serious results sometimes follow abortion, and this is particularly the case when there is retained afterbirth. The retained membranes decompose, the poisonous products of decomposition and the organisms of decomposition themselves are absorbed, blood poisoning results, and the animal dies. Sometimes, when the animal is able to resist the effects of this decomposition, the uterus becomes the seat of such severe changes that sterility results. The walls of that organ become thickened and hard, the lining membranes become eroded, and conception can not take place. At other times the ovaries, where the reproductive cells originate, become affected and lose their function. Abortion does not invariably follow infection, but the calf is carried to full term. In these cases, however, retained afterbirth is a common occurrence, even to the extent that frequent retention of afterbirth in a herd may be taken as an indication of the presence of the disease. Very often suppurative processes persist for a long time, preventing conception, or sterility may result without apparent cause. A sterile cow is valueless, of course, for any purpose except for beef. Such animals are a source of infection for the others and should not be allowed to remain in the herd.

Diagnosis.—The diagnosis of infectious abortion is made from the changes occurring in the fetal membranes and in the expelled fetus. This, however, is substantiated with certainty only by microscopic demonstration of the germ of abortion. The fact that repeated abortions are observed in a herd is also evidence of the presence of the disease. In consideration, however, of the fact that animals may be affected with the disease and disseminate the germs, even though they carry the fetus to full time, a diagnosis in such instances is only possible by laboratory methods. For this purpose the agglutination and also the complement-fixation tests are being used with splendid results, and by the aid of these biological tests it is possible to determine all infected animals in a herd. The tests are carried out with the serum from animals to be examined, only a teaspoonful of serum being necessary for the execution of both of these tests. It, however, has to be confined to laboratories which are properly equipped for such work.

Treatment and prevention.—It may be said in general that treatment is without avail and all efforts should be directed toward prevention. Various medicinal agents, such as carbolic acid administered subcutaneously and methylene blue fed in large quantities, have been recommended, but have failed to stand the tests of scientific investigation and practical use. Serums and vaccines have also been prepared and sold as cures and preventives, but the work is still considered in the experimental stage.

Bacterial vaccines are at present extensively used in the control of this disease, and while numerous reports indicate beneficial results from their administration, in other instances total failures have been recorded. It appears that the experiments in this line have not progressed sufficiently to justify definite conclusions.

The spread of the disease can be controlled to a great degree by the practice of sanitary measures directed toward the disinfection of premises and the isolation of animals at time of calving and aborting. For methods of disinfection of premises see page 363.

Make frequent observations of the animals of affected herds for symptoms of aborting, such as swelling of vulva or udder enlargement, and upon the discovery of an animal showing these symptoms place her immediately in a stall which is somewhat remote from healthy stock as a means of confining the products of abortion as much as possible should the act occur. If an animal aborts unexpectedly she should be removed to separate quarters and given proper attention as promptly as possible. The fetus, afterbirth, provided it has been expelled, and all litter that has been contaminated with them and uterine discharges should be gathered up and destroyed either by burning or burying. Clean and thoroughly disinfect the floor, gutters, and manger in the vicinity of the aborting animal.

Daily irrigations of the uterus with nonirritating antiseptic solutions, such as 0.5 per cent solution of cresol or compound solution of cresol, at body temperature have a tendency to prevent the multiplication of microorganisms in the uterus and in this way promote recovery. Douching of the uterus should be continued until the discharge ceases. In addition, the external genitals, root of the tail, escutcheon, etc., should be sponged daily with the antiseptic solution.

Aim to place all pregnant animals in disinfected individual pens or stalls a few days before they are expected to calve, and confine them to these quarters for three or four weeks following the delivery of the calf, or as long thereafter as uterine discharges are observed. Avoid carrying infection from the maternity stalls to other portions of stable, on shoes or otherwise. This may be prevented to some degree by the use of disinfectant solutions on shoes after the stalls have been entered or by wearing rubbers while in the maternity stalls, removing them after the isolated animals have been attended to. The isolation of cows at time of calving and the aborting animal is based upon the knowledge that the fetus, afterbirth, and uterine discharges of an affected animal at these times very frequently contain myriads of the abortion bacteria, and that unless these substances are confined and promptly destroyed an abundant opportunity is provided for the contamination of the food substances of the healthy animals and their contraction of the disease.

Refrain from breeding fresh cows for a period of six weeks to two months following calving. The aborting animal should be isolated for a period of six weeks to two months and under no consideration be permitted to mingle with the rest of the herd as long as uterine discharges are observed.

Douching of the external genitals of the bull, a practice formerly regarded as highly important for preventing the spread of the disease, is now recognized as being of doubtful value. The bull is protected from abortion infection to a great degree by permitting him to serve only such animals as have calved or aborted from six weeks to two months previously. Investigational work has indicated that when the bull is affected with the disease the organs of his generative system commonly involved are not reached by the antiseptic solutions. A more rational method for the prevention of the spread of the disease by the bull consists in keeping him in an inclosure separate from the females and in having all services take place on neutral ground.

Great care should be used in purchasing cattle, and cows not known to be free from the disease should be kept in separate quarters until this point is determined.

GRANULAR VENEREAL DISEASE (INFECTIOUS GRANULAR VAGINITIS).

The affection to which the foregoing names have been given is a chronic, mild, and apparently contagious disease of cattle, characterized by an inflammatory condition of the mucous membrane of the vagina and the development of nodules upon its surface.

This disease is very widely spread, but from an economic point of view it does not appear to have great significance. Williams, who investigated it, asserts that it is difficult to find a single herd in this country which is free of this disease. He considers it of great importance, claiming that granular vaginitis has a vital relation to abortion. This view, however, is not substantiated by other investigators, it being now generally accepted that the disease is only rarely responsible for abortion, and further, that it exerts no apparent ill effects on the health of the animal and that it has no effect on the milk yield.

Symptoms.—Natural infection may take place either by direct contact of animals or at the time of service. Most of the cows in the affected herd contract the disease, but the bulls are rarely or very mildly affected. The inflamed condition of the membranes of the vagina results in a catarrhal exudate, and this discharge, which soils the external genitals and the tail, and the uneasiness and sometimes the straining of the animal, are the first and most prominent symptoms observed. Upon examination, small, hard, grayish nodules can be seen and felt upon the inflamed membranes. This acute stage may last for three or four weeks, then it gradually subsides and assumes the chronic form, only to flare up again as the animal comes in heat.

These nodules are sometimes found on the membranes of the uterus, and some investigators have argued from this fact that it was responsible for abortion and sterility. Others, however, deny this and point out that the bacillus of abortion can be demonstrated in nearly every case. The importance of the disease is therefore in dispute and the decision must be left to future investigation.

Treatment.—The exaggerated importance which has been attached to this disease resulted in the exploitation of the most varied kinds of remedies for its treatment. It is true that with a protracted and laborious treatment it is possible to effect cures in from one to three months, but with our present knowledge of this disorder it is advisable to limit the treatment to animals which show an acute inflammatory condition of the vagina and vulva with a discharge as a result of the granular affection. The treatment should be local and confined to the application of antiseptic washes in the form of irrigations. For this purpose a 0.5 per cent solution of the compound solution of cresol or of Lugol's solution has been found satisfactory.

PARTURITION (CALVING).

SYMPTOMS OF CALVING.

In the cow the premonitions of calving are the enlargement of the udder, which becomes firm and resistant to the touch, with more or less swelling in front, and yields a serous, milky fluid: the enlargement and swelling of the vulva, which discharges an abundant, stringy mucus; the drooping of the belly, and the falling in of the muscles at each side of the root of the tail, so as to leave deep hollows. When this last symptom is seen, calving may be counted on in 24 hours or in 2 or 3 days. When the act is imminent, the cow becomes uneasy, moves restlessly, leaves off eating, in the field leaves the herd, lies down and rises again as if in pain, shifts upon her hind feet, moves the tail, and may bellow or moan. When labor pains come on the back is arched, the croup drooped, the belly is drawn up, and straining is more or less violent and continuous. Meanwhile blood may have appeared on the vulva and tail, and soon the clear water bags protrude between the lips of the vulva. They increase rapidly, hanging down toward the hocks, and the fore or hind feet can be detected within them. With the rupture of the bags and escape of the waters the womb contracts on the solid, angular body of the fetus and is at once stimulated to more violent contractions, so that the work proceeds with redoubled energy to the complete expulsion. This is why it is wrong to rupture the water bags if the presentation is normal, as they furnish a soft, uniform pressure for the preliminary dilation of the mouth of the womb and passages, in anticipation of the severe strain put upon them as the solid body of the calf passes.

The cow often calves standing, in which case the navel string is broken as the calf falls to the ground. If, however, she is recumbent, this cord is torn through as she rises. The afterpains come on 3 or 4 hours later and expel the membranes, which should never be left longer than 24 hours.

NATURAL PRESENTATION.

When there is but one calf the natural presentation is that of the fore feet with the front of the hoofs and knees turned upward toward the tail of the dam and the nose lying between the knees. (Pl. XV.) If there are twins the natural position of the second is that of the hind feet, the heels and hocks turned upward toward the cow's tail. (Pl. XVIII, fig. 1.) In both of these natural positions the curvature of the body of the calf—the back arched upward—is the same with the curvature of the passages, which descend anteriorly into the womb, ascend over the brim of the pelvis, and descend again toward the external opening (vulva). Any presentation differing from the above is abnormal.

OBSTACLES TO PARTURITION.

With a well-formed cow and calf and a natural presentation as above, calving is usually prompt and easy. Obstacles may, however, come from failure of the mouth of the womb to dilate; from twisting of the neck of the womb; from tumors in the vagina; from dropsy in the womb or abdomen; from overdistention of the rectum or bladder; from undue narrowing of the passages; from excess of fat in the walls of the pelvis; from the disturbance of a nervous cow by noises; from stone or urine in the bladder; from wrong presentation of the calf, its back being turned downward or to one side in place of upward toward the spine of the dam; from the bending backward of one or more limbs or of the head into the body of the womb; from presentation of the back, shoulder, or croup, all four limbs being turned back; from presentation of all four feet at once; from obstruction caused by an extra head or extra limbs, or double body on the part of the offspring (Pl. XIX); from dropsy or other disease of the calf; from excessive or imperfect development of the calf; from the impaction of twins into the passages at the same time; or at times it may be from the mere excessive volume of the fetus.

GENERAL MAXIMS FOR THE ASSISTANT CONCERNING DIFFICULT PARTURITION.

Do not interfere too soon. "Meddlesome midwifery is bad" with animals as with women. After labor pains set in, give a reasonable time for the water bags to protrude and burst spontaneously, and only interfere when delay suggests some mechanical obstruction. If there is no mechanical obstruction, let the calf be expelled slowly by the unaided efforts of the cow. Bruises and lacerations of the passages and flooding from the uncontracted womb may come from the too speedy extraction of the calf. When assistance is necessary, the operator should dress in a thick flannel shirt from which the sleeves have been cut off clear to the shoulders. This avoids danger of exposure and yet leaves the whole arm free and untrammeled. Before inserting the hand it and the arm should be smeared with oil, lard, or vaseline, care being taken that the oil or lard is fresh, neither salted nor rancid, and that it has been purified by boiling or rendered antiseptic by the addition of a teaspoonful of carbolic acid to the pound. This is a valuable precaution against infecting the cow by introducing putrid ferments into the passages and against poisoning of the arm by decomposing discharges in case the calving is unduly protracted. When labor pains have lasted some time without any signs of the water bags, the dropping in at the sides of the rump, and the other preparations for calving being accomplished, the hand should be introduced to examine. When the water bags have burst and neither feet nor head appear for some time, examination should be made. When one fore foot only and the head appear, or both fore feet without the head, or the head without the fore feet, examine. If one hind foot appears without the other, make examination. The presenting limb or head should be secured by a rope with a running noose, so that it may not pass back into the womb and get lost during the subsequent manipulations, but may be retained in the vagina or brought up again easily. In searching for a missing member it is usually better to turn the head of the cow downhill, so that the gravitation of the fetus and abdominal organs forward into the belly of the cow may give more room in which to bring up the missing limb or head. If the cow is lying down, turn her on the side opposite to that on which the limb is missing, so that there may be more room for bringing the latter up. Even if a missing limb is reached, it is vain to attempt to bring it up during a labor pain. Wait until the pain has ceased and attempt to straighten out the limb before the next pain comes on. If the pains are violent and continuous, they may be checked by pinching the back or by putting a tight surcingle aroung the body in front of the udder. These failing, 1 ounce or 1½ ounces of chloral hydrate in a quart of water may be given to check the pains. If the passages have dried up or lost their natural, lubricating liquid, smear the interior of the passages and womb and the surface of the calf, so far as it can be reached, with pure fresh lard; or pure sweet oil may be run into the womb through a rubber tube (fountain syringe). In dragging upon the fetus apply strong traction only while the mother is straining and drag downward toward the hocks as well as backward. The natural curvature of both fetus and passages is thus followed and the extraction rendered easier.

LABOR PAINS BEFORE RELAXATION OF THE PASSAGES.

Any of the various causes of abortion may bring on labor pains before the time. Straining comes on days or weeks before the time, and there is not the usual enlargement, swelling, and mucous discharge from the vulva. There is little or no falling in by the sides of the root of the tail; the abdomen has not dropped to the usual extent, and the udder is less developed and yields little or no milk. In spite of the pains no water bags appear, and the oiled hand cantiously introduced into the vagina finds the neck of the womb firmly closed, rigid, and undilatable. If it is known that the cow has not reached her proper time of calving, the examination through the vagina should be omitted and the animal should be placed in a dark, quiet place by herself, and be given 1 to 2 ounces laudanum. *Viburnum prunifolium* (black haw), 1 ounce, may be added, if necessary, and repeated in three hours. The pains will usually subside.

In some instances the external parts are relaxed and duly prepared, but the neck of the womb remains rigidly closed. In such case the solid extract of belladonna should be smeared around the constricted opening and the animal left quiet until it relaxes.

DISEASED INDURATION OF THE MOUTH OF THE WOMB.

From previous lacerations or other injuries the neck of the womb may have become the seat of fibrous hardening and constriction, so as to prevent its dilatation, when all other parts are fully prepared for calving. The enlarged, flabby vulva, the sinking at each side of the rump, the full udder, and drooping abdomen indicate the proper time for calving, but the labor pains effect no progress in the dilatation of the mouth of the womb, and the oiled hand introduced detects the rigid, hard, and, in some cases, nodular feeling of the margins of the closed orifice which no application of belladonna or other antispasmodic suffices to relax. Sponge tents may be inserted or the mechanical dilator (Pl. XX, fig. 6) may be used if there is opening enough to admit it, and if not, a narrow-bladed, probe-pointed knife (Pl. XXIV, fig. 2) may be passed through the orifice and turned upward, downward, and to each side, cutting to a depth not exceeding a quarter of an inch in each case. This done, a finger may be inserted, then two, three, and four, and finally all four fingers and thumb brought together in the form of a cone and made to push in with rotary motion until the whole hand can be introduced. After this the labor pains will induce further dilation, and finally the presenting members of the calf will complete the process.

TWISTING OF THE NECK OF THE WOMB.

This is not very uncommon in the cow, the length of the body of the womb and the looseness of the broad ligaments that attach it to the walls of the pelvis favoring the twisting. It is as if one were to take a long sack rather loosely filled at the neck and turn over its closed end, so that its twisting should occur in the neck. The twist may be one-quarter round, so that the upper surface would come to look to one side, or it may be half round, so that what was the upper surface becomes the lower. The relation of the womb of the cow to the upper and right side of the paunch favors the twisting. The paunch occupies the whole left side of the abdomen and extends across its floor to the right side. Its upper surface thus forms an inclined plane, sloping from the left downward and to the right, and on this sloping surface lies the pregnant womb.

It is easy to see how, in the constant movements of the paunch upon its contents and the frequent changes of position of the growing fetus within the womb, to say nothing of the contractions of the adjacent bowels and the more or less active movements of the cow, the womb should roll downward to the right. Yet in many cases the twist is toward the left, showing that it is not the result of a simple rolling downward over the paunch, but rather of other disturbances. The condition may be suspected when labor pains have continued for some time without any sign of the water bags, and it is confirmed when the oiled hand, introduced through the vagina, finds the mouth of the womb soft and yielding, but furnished with internal folds running forward in a spiral manner. If the folds on the upper wall of the orifice run toward the right, the womb is twisted to the right; if, on the contrary, they turn toward the left, it indicates that the womb is turned over in that direction. The direction of the twist must be known before treatment can be undertaken. Then, if the twist is toward the right, the cow is laid upon her right side with her head downhill, the hand of the operator is introduced through the spirally constricted neck of the womb, and a limb or other portion of the body of the calf is seized and pressed firmly against the wall of the womb. Meanwhile two or three assistants roll the cow from her right side over on her back to her left side. The object is to hold the womb and calf still while the body of the cow rolls over. If successful, the twist is undone, its grasp on the wrist is slackened, and the water bags and calf press into the now open passage. If the first attempt does not succeed, it is to be repeated until success has been attained. If the spiral folds on the upper wall of the opening turn toward the left, the cow is laid on her left side and rolled over on her back and on to the right side, the hand being, as before, within the womb and holding the fetus, so that all may not rotate with the cow. In introducing the hand it will usually be found needful to perforate the membranes, so that a limb of the calf may be seized direct and firmly held. Among my occasional causes of failure with these cases have been, first, the previous death and decomposition of the fetus, leading to such overdistention of the womb that it could not be made to rotate within the abdomen, and, second, the occurrence of inflammation and an exudate on the twisted neck of the womb, which hindered it from untwisting.

In obstinate cases, in which the hand can be made to pass through the neck of the womb easily, additional help may be had from the use of the instrument shown in Plate XX, figure 5. Two cords, with running nooses, are successively introduced and made fast on two limbs of the calf; the cords are then passed through the two rings on the end of the instrument, which is passed into the womb and the cords drawn tight and fixed round the handle. Then, using the handle as a lever, it is turned in the direction opposite to the twist. The hand should meanwhile be introduced into the womb and the snared limbs seized and pressed against its walls so as to secure the rotation of the uterus along with the body of the fetus. The relaxation of the constriction and the effacement of the spiral folds will show when success has been gained, and the different members at one end of the body should then be brought up so as to secure a natural presentation.

NARROW PELVIS FROM FRACTURE OR DISEASE.

In a small cow the pelvis may be too narrow to pass a calf sired by a bull of a large breed, but this is exceptional, as the fetus usually accommodates itself to the size of the dam and makes its extra growth after birth. When the pelvic bones have been fractured repair takes place with the formation of a large permanent callus, which, projecting internally, may be a serious obstacle to calving. Worse still, if the edge of the broken bone projects internally as a sharp spike or ridge, the vaginal walls are cut upon it during the passage of the calf, with serious or fatal result. In other cases, where the cow has suffered from fragility of bone (fragilitas ossium) the thickening of the bone causes narrowing of the long passage of the pelvis and the crumbling fractures poorly repaired, with an excess of brittle new material, may form an insuperable obstacle to parturition. Cows affected in any of these ways should never again be bred, but if they do get pregnant and reach full time a careful examination will be necessary to determine whether natural parturition can take place or if the calf must be extracted in pieces. (See "Embryotomy," p. 202.)

OBSTRUCTION BY MASSES OF FAT.

This is not unknown in old cows of the beef breeds, the enormous masses of fat upon and within the pelvis being associated with weakness or fatty degeneration of the muscles. If the presentation is natural, little more is wanted than a judicious traction upon the fetus to compress and overcome the soft resisting masses.

OBSTRUCTION BY A FULL BLADDER OR RECTUM OR BY STONE.

In all cases of delayed or tardy parturition the evacuation of rectum and bladder is important, and it is no less so in all difficult parturitions. Stone in the bladder is fortunately rare in the cow, but when present it should be removed to obviate crushing and perhaps perforation of the organ during calving.

CALVING RETARDED BY NERVOUSNESS.

In a public fair ground I have seen labor pains begin early in the day and keep up in a weak and insufficient manner for many hours, until the stall was thoroughly closed in and the cow secluded from the constant stream of visitors and the incessant noise, when at once the pains became strong and effective and the calf was soon born.

COAGULATED BLOOD UNDER THE VAGINAL WALLS.

This is common after calving, but sometimes occurs before, as the result of accidental injury. The mass may be recognized by its dark hue and the doughy sensation to the touch. It may be cut into and the mass turned out with the fingers, after which it should be washed frequently with an antiseptic lotion (carbolic acid 1 dram in 1 quart of water).

CONSTRICTION OF A MEMBER BY THE NAVEL STRING.

In early fetal life the winding of the navel string around a limb may cause the latter to be slowly cut off by absorption under the constricting cord. So at calving the cord wound round a presenting member may retard progress somewhat, and though the calf may still be born tardily by the unaided efforts of the mother, it is liable to come stillborn, because the circulation in the cord is interrupted by compression before the offspring can reach the open air and commence to breathe. If, therefore, it is possible to anticipate and prevent this displacement and compression of the navel string it should be done, but if this is no longer possible, then the extraction of the calf should be effected as rapidly as possible, and if breathing is not at once attempted it should be started by artificial means.

WATER IN THE HEAD OF THE CALF (HYDROCEPHALUS).

This is an enormous distention of the cavity holding the brain, by reason of the accumulation of liquid in the internal cavities (ventricles) of the brain substance. The head back of the eyes rises into a great rounded ball (Pl. XIX, figs. 4 and 5), which proves an insuperable obstacle to parturition. The fore feet and nose being the parts presented, no progress can be made, and even if the feet are pulled upon the nose can not by any means be made to appear. The oiled hand introduced into the passages will feel the nose presenting between the fore limbs, and on passing the hand back over the face the hard rounded mass of the cranium is met with. A sharp-pointed knife or a cannula and trocar should be introduced in the palm of the hand and pushed into the center of the rounded mass so as to evacuate the water. The hand is now used to press together the hitherto distended but thin and fragile walls, and the calf may be delivered in the natural way. If the enlarged head is turned backward it must still be reached and punctured, after which it must be brought up into position and the calf delivered.

If the hind feet present first, all may go well until the body and shoulders have passed out, when further progress is suddenly arrested by the great bulk of the head. If possible, the hand, armed with a knife or trocar, must be passed along the side of the shoulder or neck so as to reach and puncture the distended head. Failing in this, the body may be skinned up from the belly and cut in two at the shoulder or neck, after which the head can easily be reached and punctured. If in such case the fore limbs have been left in the womb, they may now be brought up into the passage, and when dragged upon the collapsed head will follow.

If the distention is not sufficient to have rendered the bony walls of the cranium thin and fragile, so that they can be compressed with the hand after puncture, a special method may be necessary. A long incision should be made from behind forward in the median line of the cranium with an embryotomy knife (Pl. XXI, fig. 1) or with a long embryotome (Pl. XX, fig. 3). By this means the bones on the one side are completely separated from those on the other and may be made to overlap and perhaps to flatten down. If this fails they may be cut from the head all around the base of the rounded cranial swelling by means of a guarded chisel (Pl. XX, fig. 8) and mallet, after which there will be no difficulty in causing them to collapse.

DROPSY OF THE ABDOMEN OF THE CALF (ASCITES).

This is less frequent than hydrocephalus, but no less difficult to deal with. With an anterior presentation the fore limbs and head may come away easily enough, but no effort will advance the calf beyond the shoulders. The first thought should be dropsy of the belly, and the oiled hand introduced by the side of the chest will detect the soft and fluctuating yet tense sac of the abdomen. If there is space to allow of the introduction of an embryotomy knife, the abdomen may be freely cut with this, when the fluid will escape into the womb and parturition may proceed naturally. If this can not be effected, a long trocar and cannula may be passed between the first two ribs and straight on beneath the spine until it punctures the abdomen. (Pl. XVIII, fig. 2.) Then the trocar is to be withdrawn and the liquid will flow through the cannula and will be hastened by traction on the fore limbs. In the absence of the trocar and cannula, two or three of the first ribs may be cut from the breastbone, so that the hand may be introduced through the chest to puncture the diaphragm with an embryotomy knife and allow an escape of the water. In some slighter cases a tardy delivery may take place without puncture, the liquid bulging forward into the chest as the abdomen is compressed in the pelvic passages. With a posterior presentation the abdomen may be punctured more easily either in the flank or with a trocar and cannula through the anus.

GENERAL DROPSY OF THE CALF.

This occurs from watery blood or disease of some internal organ, like the liver or kidney, and is recognized by the general puffed-up and rounded condition of the body, which pits everywhere on pressure but without crackling. If not too extreme a case, the calf may be extracted after it has been very generally punctured over the body, but usually the only resort is to extract it in pieces. (See "Embryotomy," p. 202.)

SWELLING OF THE CALF WITH GAS.

This is usually the result of the death and decomposition of the fetus when extraction has been delayed for a day or more after the escape of the waters. It is impossible to extract it whole, owing to its large size and the dry state of the skin of the calf, the membranes, and the wall of the womb. These dry surfaces stick with such tenacity that no attempt at traction leads to any advance of the calf out of the womb or into the passages. When the fetus is advanced the adherent womb advances with it, and when the strain is relaxed both recede to where they were at first. The condition may be helped somewhat by the free injection of oil into the womb, but it remains impossible to extract the enormously bloated body, and the only resort is to cut it in pieces and extract it by degrees. (See "Embryotomy," p. 202.)

RIGID CONTRACTIONS OF MUSCLES.

In the development of the calf, as in after life, the muscles are subject to cramps, and in certain cases given groups of muscles remain unnaturally short, so that even the bones grow in a twisted and distorted way. In one case the head and neck are drawn round to one side and can not be straightened out, even the bones of the face and the nose being curved around to that side. In other cases the flexor muscles of the fore legs are so shortened that the knees are kept constantly bent and can not be extended by force. The bent neck may sometimes be sufficiently straightened for extraction by cutting across the muscles on the side to which it is turned, and the bent knees by cutting the cords on the back of the shank bones just below the knees. If this fails, there remains the resort of cutting off the distorted limbs or head. (See "Embryotomy," p. 202.)

TUMORS OF THE CALF (INCLOSED OVUM).

Tumors or new growths grow on the unborn calf as on the mature animal, and by increasing the diameter of the body render its progress through the passage of the pelvis impossible. In my experience with large, fleshy tumors of the abdomen, I have cut open the chest, removed the lungs and heart, cut through the diaphragm with the knife, and removed the tumor piecemeal by alternate tearing and cutting until the volume of the body was sufficiently reduced to pass through. Where this failed it would remain to cut off the anterior part of the body, removing as much of the chest as possible, and cutting freely through the diaphragm; then, pushing back the remainder of the body, the hind limbs may be seized and brought into the passages and the residue thus extracted. The tumor, unless very large, will get displaced backward so as not to prove an insuperable obstacle.

In many cases the apparent tumor is a blighted ovum which has failed to develop, but has grafted itself on its more fortunate twin and from it has drawn its nourishment. These are usually sacs containing hair, skin, muscle, bone, or other natural tissues, and only exceptionally do they show the distinct outline of the animal.

MONSTROSITY IN THE CALF.

As a monstrous development in the calf may hinder calving, it is well to consider shortly the different directions in which these deviations from the natural form appear. Their origin and significance will be rendered clearer if we divide them according to the fault of development in individual cases. Monsters are such—

(1) From absence of parts—absence of head, limb, or other organ—arrested development.

(2) From some organ being unnaturally small, as a dwarfed head, limb, trunk, etc.—arrested development.

(3) From unnatural division of parts—cleft lips, palate, head, trunk, limbs, etc.—abnormal growth.

(4) From the absence of natural divisions—absence of mouth, nose, eye, anus; the cloven foot of ox or pig becomes solid, like that of the horse, etc.—confluence of parts which are rightfully separate.

(5) From the fusion of parts—both eyes replaced by central one, both nostrils merged into one central opening, etc.—confluence of parts.

(6) From unnatural position or form of parts—curved nose, neck, back, limbs, etc.—lack of balance in the growth of muscles during development.

(7) From excessive growth of one or more organs—enormous size of head, double penis, superfluous digits, etc.—redundancy of growth at given points.

(8) From imperfect differentiation of the sexual organs—hermaphrodites (organs intermediate between male and female), male organs with certain feminine characters, female organs with certain well-marked male characters.

(9) From the doubling of parts or of the entire body—double monsters, doubled heads, doubled bodies, extra limbs, etc.—redundant development. (Pl. XIX, figs. 1, 2, 3.)

Causes.—The causes of monstrosities are varied. Some, like extra digits, lack of horns, etc., run in families, which produce them with absolute certainty when bred in the direct line, although they were originally acquired peculiarities which have merely been fixed by long habit in successive generations. The earliest horse had five toes, and even the most recent fossil horse had three toes, of which the two lateral ones are still represented in the modern animal by the two splint bones. Yet if our horse develops an extra toe it is pronounced a monstrosity. A more genuine monstrosity is the solid-hoofed pig, in which two toes have been merged into one. Another of the same kind is the solid shank bone of the ox, which consists of two bones united into one, but which are still found apart in the early fetus. Though originally acquired peculiarities, they now breed as invariably as color or form.

Other monstrosities seem to have begun in too close breeding, by which the powers of symmetrical development are impaired, just as the procreative power weakens under continuous breeding from the closest blood relations. A monstrosity consisting in the absence of an organ often depends on a simple lack of development, the result of disease or injury, as a young bone is permanently shortened by being broken across the soft part between the shaft and the end, the only part where increase in length can take place. As the result of the injury the soft, growing layer becomes prematurely hard and all increase in length at that end of the bone ceases. This will account for some cases of absence of eye, limb, or other organ.

Sometimes a monstrosity is owing to the inclosure of one ovum in another while the latter is still but a soft mass of cells and can easily close around the first. Here each ovum has an independent life; they develop simultaneously, only the outer one having direct connection with the womb and being furnished with abundant nourishment advances most rapidly and perfectly, while the inclosed and starved ovum is dwarfed and imperfect often to the last degree.

In many cases of excess of parts the extra part or member is manifestly derived from the same ovum, and even the same part of the ovum, being merely the effect of a redundancy and vagary of growth. Such cases include most instances of extra digits or other organs, and even of double monsters, as manifested by the fact that such extra organs grow from the normal identical organs. Hence the extra digit is attached to the normal digit, the extra head to the one neck, the extra tail to the croup, extra teeth to the existing teeth, and even two similarly formed bodies are attached by some point common to both, as the navels, breastbones, backs, etc. (Pl. XIX, figs.

1, 2, 3.) This shows that both have been derived from the same primitive layer of the embryo, which possessed the plastic power of building up a given structure or set of organs. An inclosed ovum, on the other hand, has no such identity or similarity of structure to the part with which it is connected, showing an evident primary independence of both life and the power of building tissues and organs. The power of determining extra growth along a given natural line is very highly developed in the early embryo and is equally manifest in the mature examples of some of the lower forms of animal life. Thus a newt will grow a new tail when that member has been cut off, and a starfish will develop as many new starfishes as the pieces made by cutting up the original one. This power of growth in the embryo and in the lower form of animals is comparable to the branching out again of a tree at the places from which branches have been lopped. The presence of this vegetablelike power of growth in the embryo accounts for most double monsters.

The influence of disease in modifying growth in the early embryo, increasing, decreasing, distorting, etc., is well illustrated in the experiments of St. Hilaire and Valentine in varnishing, shaking, or otherwise disturbing the connections of eggs and thereby producing monstrosities. One can easily understand how inflammations and other causes of disturbed circulation in the womb, fetal membranes, or fetus would cause similar distortions and variations in the growing fetus. It is doubtless largely in the same way that certain mental disturbances of a very susceptible dam affect the appearance of the progeny. The monstrosities which seriously interfere with calving are mainly such as consist in extra members or head, which can not be admitted into the passages at the same time, where some organ of the body has attained extra size, where a blighted ovum has been inclosed in the body of a more perfect one, or where the body or limbs are so contracted or twisted that the calf must enter the passages doubled up.

Treatment.—Extraction is sometimes possible by straightening the distorted members by the force of traction; in other cases the muscles or tendons must be cut across on the side to which the body or limbs are bent to allow of such straightening. Thus, the muscles on the concave side of a wry neck or the cords behind the shank bones of a contracted limb may be cut to allow of these parts being brought into the passages, and there will still be wanting the methods demanded for bringing up missing limbs or head, for which see paragraphs below. In most cases of monstrosity by excess of overgrowth it becomes necessary to cut off the supernumerary or overdeveloped parts, and the same general principles must be followed as laid down in "Embryotomy" (p. 202).

WRONG PRESENTATIONS OF THE CALF.

The following is a list of abnormal presentations of the calf:

Simultaneous presentation of twins.

Anterior presentations.	Fore limbs		Limbs curved at the knee. Flexor tendons shortened.
			Limb crossed over the back of the neck.
			Limb bent back at the knee.
			Limb bent back from the shoulder.
	Head		Head bent downward on the neck.
			Head and neck turned downward beneath the breast.
			Head turned to one side upon the side of the neck.
			Head and neck turned back on the side of the chest and abdomen.
			Head turned upward and backward on the back.
	Hind limbs		Hind limbs rotated outward. Toes and stifles turned outward.
			Hind limbs bent forward, their feet resting in the pelvis.
	Transverse		Back of the calf turned to the right or left side.
	Inverted		Back of the calf turned to the floor of the pelvis and udder.
Posterior presentation.	Hind limbs		Hind limb bent on itself at the hock. Hock and buttocks present.
			Hind limb bent at the hips. Buttocks present.
	Transverse		Back of calf turned to the right or left side.
	Inverted		Back of calf turned to the floor of the pelvis and udder.
Trunk presentations.	Back and loins presented.	Position of calf vertical	Head up toward the spine, croup toward udder.
			Head down toward udder, croup toward spine.
		Position of calf transverse	Head toward the right side, croup toward the left.
			Head toward the left side, croup toward the right.
	Breast and abdomen presented.	Position of calf transverse	Head toward right side, croup toward left.
			Head toward left side, croup toward right.

These include all general presentations, yet other subsidiary ones will at once occur to the attentive reader. Thus, in each anterior or posterior presentation, with the back of the calf turned downward or to one side, the case may be complicated by the bending back of one or more members as a whole or at the joint just above the shank bones (knee or hock). So also in such anterior presentation the head may be turned back.

Head and fore feet presented—Back turned to one side.—The calf has a greater diameter from above down (spine to breastbone) than it has from side to side, and the same is true of the passage of the pelvis of the cow, which measures, on an average, $8\frac{7}{10}$ inches from above downward and $7\frac{9}{10}$ inches from side to side. Hence the calf passes most easily with its back upward, and when turned with its back to one side calving is always tardy and may be difficult or impossible. The obvious remedy is to rotate the calf on its own axis until its spine turns toward the spine of the cow. The operation is not difficult if the body of the calf is not yet fixed in the passages. The presenting feet are twisted over each other in the direction desired, and this is continued until the head and spine have assumed their proper place. If the body is firmly engaged in the passages the skin of the whole engaged portion should be freely lubricated with lard, and the limbs and head twisted over each other as above. The limbs may be twisted by an assistant when the head is manipulated by the operator, who drags on the rope turned halfway round the limbs and assists in the rotation with his other hand in the passages.

Head and fore feet presented—Back turned down toward the udder.—This position (Pl. XVI, fig. 6) is unnatural, and the parturition is difficult for two reasons: First, the natural curvature of the fetus is opposed to the natural curvature of the passages; and, second, the thickest part of the body of the calf (the upper) is engaged in the narrowest part of the passage of the pelvis (the lower). Yet unless the calf is especially large and the pelvis of the cow narrow, parturition may usually be accomplished in this way spontaneously or with very little assistance in the way of traction on the limbs. If this can not be accomplished, two courses are open: First, to rotate the calf as when the back is turned to one side; second, to push back the presenting fore limbs and head and search for and bring up the hind limbs, when the presentation will be a natural, posterior one.

Presentation of the hind feet with the back turned to one side or downward.—These are the exact counterparts of the two conditions last described, are beset with similar drawbacks, and are to be dealt with on the same general principles. (Pl. XVII, fig. 4.) With the back turned to one side the body should be rotated until the back turns toward the spine of the dam, and with the back turned down it must be extracted in that position (care being taken that the feet do not perforate the roof of the vagina) or it must be rotated on its own axis until the back turns upward, or the hind limbs must be pushed back and the fore limbs and head advanced, when the presentation will be a natural anterior one.

Impaction of twins in the passage.—It is very rare to have twins enter the passages together so as to become firmly impacted. As a rule, each of the twins has its own separate membranes, and as the water bags of one will naturally first enter and be the first to burst, so the calf which occupied those membranes will be the first to enter the passage and the other will be thereby excluded. When the membranes of both have burst without either calf having become engaged in the pelvis, it becomes possible for the fore legs of one and the hind legs of the other to enter at one time, and if the straining is very violent they may become firmly impacted. (Pl. XVIII, fig. 1.) The condition may be recognized by the fact that two of the presenting feet have their fronts turned forward, while the two others have their fronts turned backward. If the four feet belonged to one natural calf, they would all have the same direction. By means of this difference in direction we can easily select the two feet of one calf, place running nooses upon them just above the hoofs or fetlocks, and have an assistant drag upon the ropes while the feet of the other calf are pushed back. In selecting one of the twins to come first several considerations should have weight. The one that is most advanced in the passage is, of course, the first choice. Though the fore feet of one are presented, yet if the head is not in place the calf presenting by its hind feet is to be chosen as being less liable to obstruct. Again, if for either calf one limb only is presented and the other missing, the one presenting two feet should be selected to come first. As soon as one calf has been advanced so as to occupy the pelvis the other will be crowded back so that it will not seriously obstruct.

Fore limbs curved at the knee—Limbs sprawling outward.—In this case not only are the knees somewhat bent in a curve, but the calf has a position as if it rested on its breastbone, while the legs were drawn apart and directed to the right and left. The shoulder blades being drawn outward from the chest and the elbows turned out, the muscles extending from the trunk to the limb are unduly stretched and keep the knees bent and the feet directed outward so as to press on the sides of the passages. They become retarded in their progress as compared with the more rapidly advancing head, and may bruise or even lacerate the walls of the vagina. It would seem easy to rectify this by extending the legs, but the already tense and overstretched muscles operate against extension in the present position, and it is not easy to rotate the limbs so as to apply the shoulder flat against the side of the chest. Under these circumstances a repeller (Pl. XX, fig. 7) may be planted in the breast and the body of the calf pushed backward into the womb, when the limbs will extend easily under traction and the presentation becomes at once natural.

Fore limbs curved at knee—Flexor tendons shortening.—In this case the feet will press against the floor of the pelvis though the limb has no outward direction, and the shoulder meanwhile presses against the roof of the same passage. Unless the knees can be sufficiently straightened by force a knife must be used to cut across the cords behind the knee, when the limbs may be straightened sufficiently.

Fore limbs flexed at knee—Flexor tendons unshortened.—This is mostly seen in cases in which the body of the calf is in the proper position, its back being turned up toward the back of the dam, and in cows with a drooping abdomen. The feet have been supposed to catch beneath the brim of the pelvis, and being retarded while the head advances into the passages, they get bent at the knee and the nose and knees present. (Pl. XVI, fig. 2.) The calf, however, is not an inanimate body advanced by the mere contraction of the womb, but it moves its limbs freely under the stimulus of the unwonted compression, and in moving the feet as they are advanced they slip down over the pelvic brim and finding no other firm support they bend back until, under the impulsion, they can no longer straighten out again. The knees, therefore, advance with the neck and head, but the feet remain bent back. The result is that the upper part of the limb is also flexed, and the shoulder blade and arm bone with their masses of investing muscles are carried backward and applied on the side of the chest, greatly increasing the bulk of this already bulky part. As the elbow is carried back on the side of the chest, the forearm from elbow to knee further increases the superadded masses of the shoulder and renders it difficult or impossible to drag the mass through the passages. When the fore limbs are fully extended, on the contrary, the shoulder blade is extended forward on the smallest and narrowest part of the chest, the arm bone with its muscles is in great part applied against the side of the back part of the neck, and the forearm is continued forward by the side of the head so that the nose lies between the knees. In this natural presentation the presenting body of the calf forms a long wedge or cone, the increase of which is slow and gradual until it reaches the middle of the chest.

The difficulty of extending the fore limbs will be in proportion to the advance of the head through the pelvic cavity. In the early stage all that is necessary may be to introduce the oiled hand, the left one for the right leg or the right one for the left, and passing the hand from the knee on to the foot to seize the foot in the palm, bend it forcibly on the fetlock, and lift it up over the brim of the pelvis, the knee being, of course, pressed upward against the spine. As soon as the foot has been raised above the brim of the pelvis (into the passage) the limb can be straightened out with the greatest ease.

When, however, the shoulders are already engaging in the pelvis the feet can not thus be lifted up, and to gain room a repeller (Pl. XX, fig. 7) must be used to push back the body of the calf. This is an instrument with a long, straight stem, divided at the end into two short branches (2 to 3 inches long) united to the stem by hinges so that they can be brought into a line with the stem for introduction into the womb and then spread to be implanted in the breast. In the absence of a repeller a smooth, round, fork handle may be used, the prongs having been removed from the other end. A third device is to have an assistant strip his arm to the shoulder and, standing back to back with the operator, to introduce his right arm into the passages along with the operator's left (or vice versa) and push back the body of the calf while the operator seeks to bring up a limb. The repeller or staff having been planted safely in the breast of the calf, an assistant pushes upon it in a direction either forward or slightly upward, so as not only to follow the natural curve of the body and favor its turning in the line of that curve within the womb, but also to carry the shoulders upward toward the spine and obtain more room for bringing up the missing feet. It is good policy, first, to put a halter (Pl. XXI, figs. 4*a* and 4*b*) on the head or a noose (Pl. XXI, fig 3) on the lower jaw and a rope round each limb at the knee, so as to provide against the loss of any of these parts when the body is pushed back into the womb. This offers the further advantage that by dragging upon these ropes the body can be advanced in the passage until the foot is reached, when the rope must be slackened and the repeller used to get room for bringing up the foot. If the cow is lying, the operator should first secure the foot on the upper side and then, if necessary, turn the cow on its opposite side so as to bring up the other.

In using the instruments some precautions are demanded. They must be invariably warmed before they are introduced, and they should be smeared with lard or oil to make them pass easily and without friction. The assistant who is pushing on the instrument must be warned to stop if at any time resistance gives way. This may mean the turning of the fetus, in which case the object of repulsion has been accomplished, but much more probably it implies the displacement of the instrument from the body of the fetus, and unguarded pressure may drive it through the walls of the womb.

When the calf enters the passage with its back turned down toward the belly and udder, the bending back of the fore limbs is rare, probably because the feet can find a straighter and more nearly uniform surface of resistance in the upper wall of the womb and the backbone, and do not slide over a crest into an open cavity, as they do over the brim of the pelvis. The weight of the calf, too, gravitating downward, leaves more room for the straightening of the bent limbs, so that the desired relief is much more easily secured. The manipulation is the same in principle, only one must add the precaution of a steady traction on the feet in extraction, lest, owing to the adverse curvature of the fetus, the hoofs are suddenly forced through the roof of the vagina, and, perhaps, the rectum as well, during a specially powerful labor pain.

When the back of the calf is turned to the right side or the left the main difference is that in addition to straightening the limbs the fetus must be rotated to turn its back upward before extraction is attempted. In this case, too, it may be difficult to bring up and straighten the lower of the two limbs until the body has been rotated into its proper position. Cord the upper straightened limb and head, then rotate the body and search for the second missing limb.

Fore limbs bent back from the shoulders.—This is an exaggeration of the condition just named, and is much more difficult to remedy, owing to the distance and inaccessibility of the missing limb. It usually happens with the proper position of the body, the back of the calf being turned toward the back of the mother. The head presents in the passage and may even protrude from the vulva during an active labor pain, but it starts back like a spring when the straining ceases. Examination with the oiled hands in the intervals between the pains fails to detect the missing limbs. (Pl. XVI, fig. 1.) If, however, the hand can be introduced during a pain it may be possible to reach the elbow or upper part of the forearm. In the absence of a pain a halter or noose on the head may be used to advance the whole body until the forearm can be seized just below the elbow. This being firmly held and the head or body pushed back into the womb, room may be obtained for bringing up the knee. The forearm is used as a lever, its upper part being strongly forced back while its lower part is pressed forward. If a pain supervenes the hold must be retained, and whatever gain has been made must be held if possible. Then during the next pain, by pushing back the body and continuing to operate the forearm as a lever, a still further advance may be made. As the knee is brought up in this way, the hand is slid down from the elbow toward the knee, which is finally brought up over the brim of the pelvis and into the passage. It is now corded at the knee, and the subsequent procedure is as described in the last article. In a large, roomy cow with a small calf the latter may pass with one or both forelegs bent back, but this is a very exceptional case, and, as early assistance is the most successful, there should never be delay in hope of such a result.

One fore limb crossed over the back of the neck.—This is a rare obstacle to calving, but one that not altogether unknown. The hand introduced into the passage feels the head and one forefoot, and farther back on the same side of the other foot, from which the womb can be traced obliquely across the back of the neck. (Pl. XVI, fig. 3.) This foot, projecting transversely, is liable to bruise or tear the vagina. If still deeply engaged in the vagina, it may be seized and pushed across to the opposite side of the neck, when the presentation will be natural.

Head bent down beneath the neck.—In this case, with drooping belly and womb allowing the brim of the pelvis to form a ridge, the advancing calf, having unduly depressed its nose, strikes it on the brim of the pelvis, and the neck advancing, the head is bent back and the poll and ears either enter the pelvis or strike against its brim. The two forefeet present, but they make no progress, and the oiled hand introduced can detect no head until the poll is felt at the entrance of the pelvis, between the forearms. The two forefeet must be fixed with running nooses and dragged on moderately while the oiled hand seeks to bring up the head. The hand is slid down over the forehead and brim of the pelvis until the nose is reached, when it is passed into the mouth, the muzzle resting in the palm of the hand. The legs are now pushed upon, and in the space thus gained the muzzle is drawn up so as to enter it into the pelvis. In doing this the operator must carefully see that the mouth does not drop open so that the sharp, front teeth cut through the floor of the womb. Should this danger threaten, the hand should be made to cover the lower jaw as well. The lessened security of the hold is more than compensated by the safety of the procedure. With the nose in the pelvis, it has only to be drawn forward and the parturition is natural.

Head bent down beneath the breast.—This is an exaggerated condition of that last named. The head, arrested by the brim of the pelvis and already bent back on the neck, is pressed farther with each successive throe until it has passed between the forelegs and lodges beneath the breast bone. (Pl. XVI, fig. 4.) On examination, the narrow upper border of the neck is felt between the forearms, but as a rule the head is out of reach below. Keeping the hand on the neck and dragging on the feet by the aid of ropes, the hand may come to touch and seize the ear, or, still better, one or two fingers may be inserted into the orbit of the eye.

Then in pushing back upon the limbs, with or without the aid of a repeller applied against the shoulder, space may be obtained to draw the head into a vertical position, and even to slip the hand down so as to seize the nose. Should it prove impossible to draw the head up with the unassisted fingers, a blunt hook (Pl. XXI, fig. 6) may be inserted into the orbit, on which an assistant may drag while another pushes upon the limbs or repeller. Meanwhile the operator may secure an opportunity of reaching and seizing the nose or of passing a blunt hook into the angle of the mouth. Success will be better assured if two hooks (Pl. XXI, fig. 7) are inserted in the two orbits, so as to draw up the head more evenly. In other cases a noose may be placed on the upper jaw, or even around both jaws, and traction made upon this and on the hooks in the orbits while the legs are pushed back, and while the operator pushes back on the poll or forehead. In still more difficult cases, in which even the orbits can not be reached, a sharp hook on the end of a straight iron rod (Pl. XX, fig. 2) may be inserted over the lower jaw as far forward as it can be reached, and by dragging upon this while the body is pushed back the head will be brought up sufficiently to allow the operator to reach the orbit or nose. If even the jaw can not be reached, the hook may be inserted in the neck as near to the head as possible and traction employed so as to bring the head within reach.

In all such cases the cow's head should be turned downhill, and in case of special difficulty she should be turned on her back and held there until the head is secured. In old-standing cases, with the womb closely clasping the body of the calf, relaxation may be sought by the use of chloroform or a full dose of chloral hydrate—2 ounces; the free injection of warm water into the womb will also be useful.

Head turned back on the shoulder.—With a natural, anterior presentation this may happen because of the imperfect dilation of the mouth of the womb. Under the throes of the mother the forefeet pass through the narrow opening into the vagina, while the nose, striking against it and unable to enter, is pressed backward into the womb and turns aside on the right or left shoulder. The broad muzzle of the calf forms an especial obstacle to entrance and favors this deviation of the head. The worst form of this deviation is the old-standing one with shortening of the muscles of the neck on that side, and oftentimes distortion of the face and neck bones, as noticed under "Monstrosities" (p. 182).

When the head is bent on the shoulder the feet appear in the natural way, but no progress is made, and examination reveals the absence of the nose from between the knees, and farther back, from above and between the elbows, a smooth rounded mass is felt extending to the right or left, which further examination will identify with the neck. Following the upper border of this the hand reaches the crown of the head with the ears, and still further the eyes, or even, in a small calf, the nose.

As the bulky head of the calf can not be extracted along with the shoulders, it becomes necessary to push the body of the fetus back and straighten out the head and neck. The cow should be laid with her head downhill and with that side up toward which the head is turned. If the throes are very violent, or the womb strongly contracted on the calf, it may be best to seek relaxation by giving chloroform, or 2 ounces of laudanum, or 2 ounces of chloral hydrate. If the calf or the passages are dry, sweet oil may be injected, or the whole may be liberally smeared with fresh lard. In the absence of these, warm water rendered slightly slippery by Castile soap may be injected into the womb in quantity. Ropes with running nooses are placed on the presenting feet and the oiled hand introduced to find the head. If, now, the fingers can be passed inside the lower jawbone, and drag the head upward and toward the passage, it unwinds the spiral turn given to the neck in bending back, and greatly improves the chances of bringing forward the nose. If, at first, or if now, the lower jaw can be reached, a noose should be placed around it behind the incisor teeth and traction made upon this, so that the head may continue to be turned, forehead up, toward the spine and jaws down, thereby continuing to undo the screwlike curve of the neck. If, on the contrary, the nose is dragged upon by a cord passing over the upper border of the neck, the screwlike twist is increased and the resistance of the bones and joints of the neck prevents any straightening of the head. As soon as the lower jaw has been seized by the hand or noose, a repeller (Pl. XX, fig. 7), planted on the inside of the elbow or shoulder most distant from the head, should be used to push back the body and turn it in the womb, so that the head may be brought nearer to the outlet. In this way the head can usually be brought into position and the further course of delivery will be natural.

Sometimes, however, the lower jaw can not be reached with the hand, and then the orbit or, less desirably, the ear, may be availed of. The ear may be pulled by the hand, and by the aid of the repeller on the other shoulder the calf may be so turned that the lower jaw may be reached and availed of. Better still, a clamp (Pl. XVIII, figs. 3 and 4) is firmly fixed on the ear and pulled by a rope, while the repeller is used on the opposite shoulder, and the hand of the operator pulls on the lower border of the neck and lifts it toward the other side. To pull on the upper border of the neck is to increase the spiral twist, while to raise the lower border is to undo it. If the outer orbit can be reached, the fingers may be inserted into it so as to employ traction, or a blunt finger hook (Pl. XXI, fig. 8) may be used, or a hook with a rope attached, or, finally, a hook on the end of a long staff. Then, with the assistance of the repeller, the body may be so turned and the head advanced that the lower jaw may be reached and availed of.

In case neither the ears nor the orbit can be reached, a cord should be passed around the neck of the calf as near the head as possible, and traction made upon that while the opposite shoulder is pushed toward the opposite side by the repeller, assisted by the hand dragging on the lower border of the neck. To aid the hand in passing a rope around the neck a cord carrier (Pl. XXI, fig. 5) is in use. It fails, however, to help us in the most difficult part of the operation—the passing of the cord down on the deep or farthest side of the neck—and to remedy this I have devised a cord carrier, furnished with a ring at the end, a joint 6 or 8 inches from the end, and another ring on the handle, close to this joint. (Pl. XX, fig. 4.) A cord is passed through both rings and a knot tied on its end, just back of the terminal ring. The instrument, straightened out, is inserted until it reaches just beyond the upper border of the neck, when, by dragging on the cord, the movable segment is bent down on the farther side of the neck, and is pushed on until it can be felt at its lower border. The hand now seizes the knotted end of the cord beneath the lower border of the neck and pulls it through while the carrier is withdrawn, the cord sliding through its rings. The cord, pushed up as near to the head as possible, is furnished with a running noose by tying the knotted end round the other, or, better, the two ends are twisted around each other so as to give a firm hold on the neck without dangerously compressing the blood vessels. By pushing on the opposite shoulder with the repeller, and assisting with the hand on shoulder, breastbone, or lower border of the neck, such a change of position will be secured as will speedily bring the head within reach. Afterwards proceed as described above.

These cases are always trying, but it is very rarely necessary to resort to embryotomy. When absolutely required, first remove one fore limb, and then, if still unsuccessful, the other, after which the head can easily be secured. (See "Embryotomy," p. 202.)

Head turned upward and backward.—In this case the face rests upon the spine; the forefeet appear alone in the passage, but fail to advance, and on examination the rounded, inferior border of the neck can be felt, extending upward and backward beneath the spine of the dam, and if the calf is not too large the hand may reach the lower jaw or even the muzzle. (Pl. XVI, fig. 5.) A repeller is planted in the breast and the body of the calf pushed backward and downward so as to make room and bring the head nearer to the passage; or in some cases the body may be pushed back sufficiently by the use of the fore limbs alone. Meanwhile the head is seized by the ear or the eye socket, or, if it can be reached, by the lower jaw, and pulled downward into position as space is obtained for it. If the hand alone is insufficient, the blunt hooks may be inserted in the orbits or in the angle of the mouth, or a noose may be placed on the lower paw, and by traction the head will be easily advanced. In case of a large fetus, the head of which is beyond reach, even when traction is made on the limbs, a rope may be passed around the neck and pulled, while the breastbone is pressed downward and backward by the repeller, and soon the change of position will bring the orbit or lower jaw within reach. With the above-described position the standing position is most favorable for success, but if the calf is placed with its back down toward the udder, and if the head is bent down under the brim of the pelvis, the best position for the cow is on her back, with her head downhill.

In neglected cases, with death and putrefaction of the fetus and dryness of the passages, it may be necessary to extract in pieces. (See "Embryotomy," p. 202.)

Outward direction of the stifles—Abduction of hind limbs.—As an obstacle to parturition, this is rare in cows. It is most liable to take place in cows with narrow hip bones, and when the service has been made by a bull having great breadth across the quarter. The calf, taking after the sire, presents an obstacle to calving in the breadth of its quarters, and if at the same time the toes and stifles are turned excessively outward and the hocks inward the combined breadth of the hip bones above and the stifles below may be so great that the pelvis will not easily admit them. After the forefeet, head, and shoulders have all passed out through the vulva, further progress suddenly and unaccountably ceases, and some dragging on the parts already delivered does not serve to bring away the hind parts. The oiled hand introduced along the side of the calf will discover the obstacle in the stifle joints turned directly outward and projecting on each side beyond the bones which circumscribe laterally the front entrance of the pelvis. The evident need is to turn the stifles inward; this may be attempted by the hand introduced by the side of the calf, which is meanwhile rotated gently on its own axis to favor the change of position. To correct the deviation of the hind limb is, however, very difficult, as the limbs themselves are out of reach and can not be used as levers to assist. If nothing can be done by pushing the body of the calf back and rotating it and by pressure by the hand in the passages, the only resort appears to be to skin the calf from the shoulder back, cut it in two as far back as can be reached, then push the buttocks well forward into the womb, bring up the hind feet, and so deliver.

Hind limbs excessively bent on the body and engaged in the pelvis.—In this case the presentation is apparently a normal, anterior one; fore limbs and head advanced naturally and the parturition proceeds until half the chest has passed through the external passages, when suddenly progress ceases and no force will effect farther advance. An examination with the oiled hand detects the presence, in the passages, of the hind feet and usually the hind legs up to above the hocks. (Pl. XVII, fig. 1.)

The indications for treatment are to return the hind limbs into the body of the womb. If they have not advanced too far into the pelvis, this may be done as follows: A rope with running noose is passed over each hind foot and drawn tight around the lower part of the hock; the ropes are then passed through the two rings in the small end of the rotating instrument (Pl. XX, fig. 5) which is slid into the passages until it reaches the hocks, when the ropes, drawn tight, are tied around the handle of the instrument. Then in the intervals between the pains the hocks are pushed forcibly back into the womb. If by this means flexion can be effected in hocks and stifles, success will follow; the hind feet will pass into the womb and clear of the brim of the pelvis and the body may now be advanced without hindrance, the hind limbs falling into place when the hip joints are extended. At the same time the pressure upon hind limbs must not be relaxed until the buttocks are engaged in the pelvis, as otherwise the feet may again get over the brim and arrest the progress of delivery.

When the hind limbs are already so jammed into the pelvis that it is impossible to return them, the calf must be sacrificed to save the mother. Cords with running nooses are first put on the two hind feet. The body must be skinned from the shoulders back as far as can be reached, and is to be then cut in two, if possible, back of the last rib. The remainder of the trunk is now pushed back into the body of the womb and by traction upon the cords the hind feet are brought up into the passages and the extraction will be comparatively easy.

Hind presentation with one or both legs bent at the hock.—After the bursting of the water bags, though labor pains continue, no part of the fetus appears at the vulva unless it be the end of the tail. On examination the buttocks are felt wedged against the spine at the entrance of the pelvis and beneath them the bent hock joints resting on the brim of the pelvis below. (Pl. XVII, fig. 3.) The calf has been caught by the labor pains while the limb was bent beneath it and has been jammed into or against the rim of the pelvis, so that extension of the limb became impossible. With the thigh bent on the flank, the leg on the thigh, and the shank on the leg, and all at once wedged into the passage, delivery is practically impossible.

The obvious remedy is to push the croup upward and forward and extend the hind legs, and in the early stages this can usually be accomplished in the cow. A repeller (Pl. XX, fig. 7) is planted across the thighs and pointed upward toward the spine of the cow and pushed forcibly in this direction during the intervals between labor pains. Meanwhile the oiled hand seizes the shank just below the hock and uses it as a lever, pushing the body back and drawing the foot forward, thus effectually seconding the action of the repeller. Soon a distinct gain is manifest, and as soon as the foot can be reached it is bent back strongly at the fetlock, held in the palm of the hand, and pulled up, while the repeller, pressing on the buttocks, assists to make room for it. In this way the foot may be brought safely and easily over the brim of the pelvis without any risk of laceration of the womb of the foot. After the foot has been lifted over the brim, the whole limb can be promptly and easily extended. In cases presenting special difficulty in raising the foot over the brim, help may be had by traction on a rope passed around in front of the hock, and later still by a rope with a noose fastened to the pastern. In the worst cases, with the buttocks and hocks wedged deeply into the passages, it may prove difficult or impossible to push the buttocks back into the abdomen, and in such case the extension of the hind limb is practically impossible without mutilation. In some roomy cows a calf may be dragged through the passages by ropes attached to the bent hocks, but even when this is possible there is great risk of laceration of the floor of the vagina by the feet. The next resort is to cut the hamstring just above the point of the hock and the tendon on the front of the limb (flexor metatarsi) just above the hock, and even the sinews behind the shank bone just below the hock. This allows the stifle and hock to move independently of each other, the one undergoing extension without entailing the extension of the other; it also allows both joints to flex completely, so that the impacted mass can pass through a narrower channel. If now, by dragging on the hocks and operating with the repeller on the buttocks, the latter can be tilted forward sufficiently to allow of the extension of the stifle, the jam will be at once overcome, and the calf may be extracted with the hock bent, but the stifle extended. If even this can not be accomplished, it may now be possible to extract the whole mass with both hocks and stifles fully bent. To attempt this, traction may be made on the rope around the hocks and on a sharp hook (Pl. XX, fig. 2) passed forward between the thighs and hooked on to the brim of the pelvis. Everything else failing, the offending limb or limbs may be cut off at the hip joint and extracted, after which extraction may proceed by dragging on the remaining limb, or by hooks on the hip bones. Very little is to be gained by cutting off the limb at the hock, and the stifle is less accessible than the hip, and amputation of the stifle gives much poorer results.

Hind limbs bent forward from the hip—Breech presentation.—This is an exaggeration of the condition last described, only the hocks and stifles are fully extended and the whole limb carried forward beneath the belly. (Pl. XVII, fig. 2.) The water bags appear and burst, but nothing presents unless it may be the tail. Examination in this case detects the outline of the buttocks, with the tail and anus at its upper part.

The remedy, as in the case last described, consists in pushing the buttock upward and forward with a repeller, the cow being kept standing and headed downhill until the thigh bone can be reached and used as a lever. Its upper end is pushed forward and its lower end raised until, the joints becoming fully flexed, the point of the hock can be raised above the brim of the pelvis. If necessary a noose may be passed around the leg as far down toward the hock as possible and pulled on forcibly, while the hand presses forward strongly on the back of the leg above. When both hocks have been lodged above the brim of the pelvis the further procedure is as described under the last heading.

If, however, the case is advanced and the buttocks wedged firmly into the passages, it may be impossible safely to push the fetus back into the womb, and the calf must either be dragged through the passage as it is or the limbs or the pelvis must be cut off. To extract successfully with a breech presentation the cow must be large and roomy and the calf not too large. The first step in this case is to separate the pelvic bones on the two sides by cutting from before backward, exactly in the median line below and where the thighs come together above. This may be done with a strong embryotomy knife, but is most easily accomplished with the long embryotome (Pl. XX, fig. 3). The form which I have designed (Pl. XX, fig. 1), with a short cutting branch jointed to the main stem, is to be preferred, as the short cutting piece may be folded on the main stem so that its cutting edge will be covered, and it can be introduced and extracted without danger. This is pushed forward beneath the calf's belly, and the cutting arm opened, inserted in front of the brim of the pelvis and pulled forcibly back through the whole length of the pelvic bones. The divided edges are now made to overlap each other and the breadth of the haunch is materially reduced. One end of the cord may then be passed forward by means of a cord carrier (Pl. XXI, fig. 5) on the inner side of one thigh until it can be seized at the stifle by the hand passed forward on the outer side of that thigh. This end is now pulled back through the vagina, the other end passed through the cord carrier and passed forward on the inner side of the other thigh until it can be seized at the stifle by the hand passed forward outside that thigh. This end is drawn back through the vagina like the first, and is tied around the other so as to form a running noose. The rope is now drawn through the ring until it forms a tight loop, encircling the belly just in front of the hind limbs. On this strong traction can be made without interfering with the full flexion of the limbs on the body, and if the case is a suitable one, and the body of the fetus and the passages are both well lubricated with oil or lard, a successful parturition may be accomplished. A less desirable method is to put a rope around one thigh or a rope around each and drag upon these, but manifestly the strain is not so directly on the spine, and the limbs may be somewhat hampered in flexion.

This method being inapplicable, the next resort is to cut off one or both hind limbs at the hip joint. Free incisions are made on the side of the haunch so as to expose the hip joint, and the muscles are cut away from the head of the thigh bone down to its narrow neck, around which a rope is passed and firmly fixed with a running noose. The joint is now cut into all around, and while traction is made on the cord the knife is inserted into the inner side of the joint and the round ligament severed. The cord may now be dragged upon forcibly, and the muscles and other parts cut through as they are drawn tense, until finally the whole member has been extracted. Traction on the rope round the other thigh will now suffice to extract, in most cases, but if it should fail the other limb may be cut off in the same manner, and then hooks inserted in front of the brim of the pelvis or in the openings in the bones of its floor (obturator foramina) will give sufficient purchase for extraction. Another method is to insert a knife between the bone of the rump (sacrum) and the hip bone and sever their connections; then cut through the joint (symphysis) between the two hip bones in the median line of the floor of the pelvis, and then with a hook in the opening on the pelvic bones (obturator foramen) drag upon the limb and cut the tense soft parts until the limb is freed and extracted.

Presentation of the back.—In this presentation straining may be active, but after the rupture of the water bags no progress is made, and the hand introduced will recognize the back with its row of spinous processes and the springing ribs at each side pressed against the entrance to the pelvis. (Pl. XVII, fig. 6.) The presence or absence of the ribs will show whether it is the region of the chest or the loins. By feeling along the line of spines until the ribs are met with we shall learn that the head lies in that direction. If, on the contrary, we follow the ribs until they disappear, and a blank space is succeeded by hip bones, it shows that we are approaching the tail. The head may be turned upward, downward, to the right side, or to the left.

The object must be to turn the fetus so that one extremity or the other can enter the passage, and the choice of which end to bring forward will depend on various considerations. If one end is much nearer the outlet than the other, that would naturally be selected for extraction, but if they are equidistant the choice would fall on the hind end, as having only the two limbs to deal with without any risk of complication from the head. When the head is turned upward and forward it will usually be preferable to bring up the hind limb, as, owing to the drooping of the womb into the abdomen, rotation of the fetus will usually be easier in that direction, and if successful the resulting position will be a natural posterior presentation, with the back of the calf turned toward the rump of the cow. Similarly with the croup turned upward and forward, that should be pushed on forward, and if the forefeet and head can be secured it will be a natural anterior presentation, with the back of the calf turned upward toward the rump of the cow.

The womb should be injected with warm water or oil, and the turning of the calf will demand the combined action of the repeller and the hand, but in all such cases the operator has an advantage that the body of the fetus is wholly within the body of the womb, and therefore movable with comparative ease. No part is wedged into the pelvic passages as a complication. The general principles are the same as in faulty presentation fore and hind, and no time should be lost in making the manipulations necessary to bring the feet into the pelvis, lest they get in bent or otherwise displaced and add unnecessary complications.

With a transverse direction of the calf, the head being turned to one side, the pressure must be directed laterally, so that the body will glide around on one side of the womb, and the extremities when reached must be promptly seized and brought into the passages. Sometimes a fortunate struggle of a live fetus will greatly aid in rectifying the position.

Breast and abdomen presented—All four feet in the passages.—In this form the calf lies across the womb with its roached back turned forward and its belly toward the pelvis. All four feet may be extended and engaged in the passages, or one or more may be bent on themselves so as to lie in front of the pelvis. The head, too, may usually be felt on the right side or the left, and if detected it serves to identify the exact position of the fetus. The position may further be decided upon by examination of the feet and limbs. With the limbs extended the front of the hoofs and the convex aspect of the bent pasterns and fetlocks will look toward that flank in which lie the head and shoulders. On examination still higher the smooth, even outline of the knee and its bend, looking toward the hind parts, characterize the fore limb, while the sharp prominence of the point of the hock and the bend on the opposite side of the joint, looking toward the head, indicate the hind limb. (Pl. XVII, fig. 5.)

The remedy of this condition is to be sought in repelling into the womb those limbs that are least eligible for extraction, and bringing into the passages the most eligible extremities. The most eligible will usually be those which project farthest into the passages, indicating the nearer proximity of that end of the calf. An exception may, however, be made in favor of that extremity which will give the most natural presentation. Thus if, owing to obliquity in the position of the fetus, the hind extremities promised a presentation with the back of the fetus turned down toward the udder, and the anterior extremities one with the back turned up toward the spine, the latter should be selected. Again, if the choice for the two extremities is evenly balanced, the hind may be chosen as offering less risk of complication, there being no head to get displaced.

The first step in the treatment is to place a running noose on each of the four feet, marking those of the fore limbs to distinguish them from those of the hind ones. In case it is proposed to bring the anterior extremities into the passage, a noose should also be placed on the lower jaw. Then run the ropes attached to the two feet that are to be pushed back through the ring of a cord carrier (Pl. XXI, fig. 5), passing the rings down to the feet, and by the aid of the carrier push them well back into the womb and hold them there. Meanwhile drag upon the ropes attached to the two other feet so as to bring them into the passage (or, in case of the anterior extremity, on the two foot ropes and the head one). The other feet must be pushed back into the womb until the body of the calf is fully engaged in the passages. After this they can no longer find an entrance, but must follow as the body escapes.

NEGLECTED AND AGGRAVATED CASES.

In laying down the foregoing rules for giving assistance in critical cases of calving it is not intimated that all cases and stages can be successfully dealt with. Too often assistance is not sought for many hours or even days after labor pains, and the escape of the waters intimate the danger of delay. Not seldom the long delay has been filled up with unintelligent and injurious attempts at rendering assistance, violent pulling when resistance is insurmountable without change of position, injuries to the vagina and womb by ill-considered but too forcibly executed attempts to change the position, the repeated and long-continued contact with rough hands and rougher ropes and hooks, the gashes with knives and lacerations with instruments in ignorant hands, the infecting material introduced on filthy hands and instruments, and the septic inflammations started in the now dry and tender passages and womb. Not infrequently the death, putrefaction, and bloating of the calf in the womb render the case extremely unpromising and make it impossible to apply successfully many of the measures above recommended. The labor pains of the cow may have practically ceased from exhaustion; the passages of the vagina may be so dry, tender, friable, red, and swollen that it requires considerable effort even to pass the oiled hand through them, and the extraction of the calf or any portion of it through such a channel seems a hopeless task; the womb may be equally dry, inflamed and swollen, so that its lining membrane or even its entire thickness is easily torn; the fetal membranes have lost their natural, unctuous and slippery character, and cling firmly to the dry walls of the womb, to the dry skin of the calf, or to the hands of the operator; the dead and putrefying calf may be so bloated with gases that the womb has been overdistended by its presence, and the two adhere so closely that the motion of the one on the other is practically impossible. In other cases reckless attempts to cut the calf in pieces have left raw surfaces with projecting bones which dangerously scratch and tear the womb and passages.

In many cases the extreme resort must be had of cutting the fetus to pieces (embryotomy), or the still more redoubtable one of Cæsarean section (extraction through the flank).

DISSECTION OF THE UNBORN CALF (EMBRYOTOMY).

In some cases the dissection of the calf is the only feasible means of delivering it through the natural passages; and while it is especially applicable to the dead calf, it is also on occasion called for in the case of the living. As a rule, the living calf should be preserved, if possible, but if this threatens to entail the death of the cow it is only in the case of offspring of rare value that its preservation is to be preferred. To those acquainted with the toil, fatigue, and discomfort of embryotomy, no discussion is necessary so long as there is a prospect of success from the simple and generally easier method of rectifying the faulty position of the calf. When the correction of the position is manifestly impossible, however, when distortions and monstrosities of the fetus successfully obstruct delivery, when the pelvic passages are seriously contracted by fractures and bony growths, when the passages are virtually almost closed by swelling, or when the calf is dead and excessively swollen, no other resort may be available. In many cases of distortion and displacement the dismemberment of the entire calf is unnecessary, the removal of the offending member being all that is required. It will be convenient, therefore, to describe the various suboperations one by one and in the order in which they are usually demanded.

Amputation of the fore limb.—In cutting off a fore limb it is the one presenting that should be selected, since it is much more easily operated on, and its complete removal from the side of the chest affords so much more space for manipulation that it often makes it easy to bring the other missing limb or the head into position. The first consideration is to skin the limb from the fetlock up and leave the skin attached to the body. The reasons for this are: (*a*) That the skin is the most resistant structure of the limb, and when it has been removed the entire limb can be easily detached; (*b*) the tough skin left from the amputated limb may be used as a cord in subsequent traction on the body of the calf; (*c*) the dissection and separation of the limb are far more safely accomplished under the protection of the enveloping skin than if the operator's hands and instruments were in direct contact with the walls of the passages or womb; (*d*) the dissection can be much more easily effected while the skin is stretched by the left hand, so as to form a comparatively firmer resistant point for the knife, than when it is attempted to cut the soft, yielding, and elastic tissues which naturally offer little solid resistance, but constantly recede before the cutting edge of the instrument. The preservation of the skin is therefore a cardinal principle in the amputation of all parts in which it is at all feasible.

The presenting foot is inclosed in a noose and drawn well out of the passages. Then a circular incision through the skin is made around the limb just above the fetlock. From this the skin is slit up on the inner side of the limb to the breast. Then the projecting part of the limb is skinned up to the vulva, traction being made on the foot by an assistant so as to expose as much as possible. The embryotomy knife may now be taken (Pl. XXI, fig. 2), and a small hole having been cut in the free end of the detached portion of skin, that is seized by the left hand and extended while its firm connections with the deeper structures are cut through. The looser connections can be more quickly torn through with the closed fist or the tips of the four fingers held firmly together in a line or with the spud, of which there are several kinds. Much of the upper part of the limb can be skinned more speedily without the knife, but that must be resorted to to cut across tough bands whenever these interrupt the progress. The skinning should be carried upward on the outer side of the shoulder blade to the spine or nearly so. Then with the knife the muscles attaching the elbow and shoulder to the breastbone are cut across, together with those on the inner side of the shoulder joint and in front and behind it as far as these can be reached. Steady traction is now made upon the foot, the remaining muscles attaching the shoulder blade to the trunk are torn through with a cracking noise, and the whole limb, including the shoulder blade and its investing muscles, comes away. If the shoulder blade is left the bulk of the chest is not diminished, and nothing has been gained. Before going further it is well to see whether the great additional space thus secured in the passages will allow of the missing limb or head to be brought into position. If not, the other presenting part, limb or head, is to be amputated and extracted. For the limb the procedure is a repetition of that just described.

Amputation of the head.—The head is first seized and drawn well forward, or even outside the vulva, by a rope with a running noose placed around the lower jaw just behind the incisor teeth, by a sharp hook inserted in the arch of the lower jaw behind the union of its two branches and back of the incisor teeth, or by hooks inserted in the orbits, or, finally, in case the whole head protrudes, by a halter. (Pl. XXI, figs 4*a* and 4*b*.)

In case the whole head protrudes, a circular incision through the skin is made just back of the ear, and the cut edge being held firmly by the left hand, the neck is skinned as far as it can be reached. Then the great ligamentous cord above the spine is cut across at the farthest available point, together with the muscles above and below the spine. Strong traction on the head will then detach it at this point and bring it away, but should there still be too much resistance the knife is inserted between the bodies of two vertebræ just behind one of the prominent points felt in the median line below, and their connecting fibrous cartilage is cut through, after which comparatively moderate pulling will bring it away. The detached neck and body at once slip back into the womb, and if the fore limbs are now brought up and pulled they are advanced so far upon the chest that the transverse diameter of that is greatly diminished and delivery correspondingly facilitated.

If the head is still inclosed in the vagina two methods are available: (1) The removal of the lower jaw and subsequent separation of the head from the neck; (2) the skinning of the whole head and its separation from the neck.

To remove the lower jaw the skin is dissected away from it until the throat is reached. Then the muscles of the cheeks and side of the jaw (masseters) are cut through and those connecting the jaw with the neck. When traction is made on the rope around the lower jaw it will usually come away with little trouble. Should it resist, its posterior extremity on each side (behind the grinding teeth) may be cut through with bone forceps or with a guarded bone chisel. (Pl. XX, fig. 8.) After the removal of the lower jaw the way will be open to separate the head from the neck, the knife being used to cut into the first or second joint from below, or the bone forceps or chisel being employed to cut through the bones of the neck. Then traction is made on the head by means of hooks in the orbits, and the hand, armed with an embryotomy knife, is introduced to cut through the tense resisting ligament and muscles above the bones. The skin and the strong ligamentous cord attached to the poll are the essential things to cut, as the muscles can easily be torn across. Unless there are great difficulties in the way it is well to skin the head from the eyes back, and on reaching the poll to cut through the ligament and then bring the head away by pulling.

If it is decided to remove the entire head at once, it may be skinned from the front of the eyes back to behind the lower jaw below and the poll above, then cut through the muscles and ligaments around the first joint and pull the head away, assisting, if need be, in the separation of the head by using the knife on the ligament of the joint.

If the calf is a double-headed monster, the skinning of the head must be carried backward until the point has been reached where both heads branch from the single neck, and the separation must be made at that point. The muscles and ligaments are first to be cut through; and if the part can not then be detached by pulling, the bodies of the vertebræ may be separated by passing the knife through the joint. The second head may now be secured by a noose around the lower jaw or hooks in the orbits and brought up into place, the body being pushed back toward the other side by a repeller, so as to make room.

It should be added that, except in the case of a double-headed monster, or in case of the head protruding or nearly so, and one or both fore limbs presenting, it is rarely desirable to undertake amputation of the head. The space desirable in the passages can usually be obtained by the much simpler and easier procedure of removing one or both fore limbs.

Amputation of the hind limbs.—This is sometimes demanded on the one extended limb when the other can not be brought up and delivery can not be effected; also in case of monsters having extra hind limbs; when the calf is dead, putrid, and bloated with gas; and in some cases of breech presentation, as described under that head.

When the limb is extended the guiding principles are as in the case of the fore limbs. The skin is cut through circularly above the fetlock and slit up to beneath the pelvic bones on the inner side of the thigh. It is then dissected from the other parts as high as it has been slit on the inner side and to above the prominence (*trochanter major*) on the upper end of the thigh bone on the outer side of the joint. In this procedure the hands and spud can do much, but owing to the firmer connections the knife will be more frequently required than in the case of the fore limb. The muscles are now cut through all around the hip joint, and strong traction is made by two or three men on the limb. If there is still too much resistance, a knife is inserted into the joint on the inner side and its round ligament cut through, after which extraction will be comparatively easy. This accomplished, it will often be possible to extract the fetus with the other leg turned forward into the womb. If the calf is bloated with gas, it may be necessary to remove the other leg in the same way, and even to cut open the chest and abdomen and remove their contents before extraction can be effected. In the case of extra limbs it may be possible to bring them up into the passages after the presenting hind limbs have been removed. If this is not practicable, they may be detached by cutting them through at the hip joint, as described under "Breech presentation," page 197.

Another method of removing the hind limb is, after having skinned it over the quarter, to cut through the pelvic bones from before backward, in the median line below, by knife, saw, or long embryotome (Pl. XX, fig. 1), and then disjoint the bones of the spine (sacrum) and the hip bone (ilium) on that side with embryotome, knife, or saw, and then drag away the entire limb, along with all the hip bones on that side. This has the advantage of securing more room and thereby facilitating subsequent operations. Both limbs may be removed in this way, but on the removal of the second the operator is without any solid point to drag upon in bringing away the remainder of the fetus.

Division across the middle of the body.—In cases of extra size, monstrosity, or distortion of one end of the body it may be requisite to cut the body in two and return the half from the passages into womb, even after one-half has been born. The presenting members are dragged upon forcibly by assistants to bring as much of the body as possible outside. Then cut through the skin around the body at some distance from the vulva, and with hand, knife, and spud detach it from the trunk as far back into the passages as can be reached. Next cut across the body at the point reached, beginning at the lower part (breast, belly) and proceeding up toward the spine. This greatly favors the separation of the backbone when reached, and further allows of its being extended so that it can be divided higher up. When the backbone is reached, the knife is passed between the two bones, the prominent ridges across their ends acting as guides, and by dragging and twisting the one is easily detached from the other. With an anterior presentation the separation should, if possible, be made behind the last rib, while with a posterior presentation as many of the ribs should be brought away as can be accomplished. Having removed one half of the body, the remaining half is to be pushed back into the womb, the feet sought and secured with nooses, and the second half removed in one piece if possible; and if not, then after the removal of the extra limb or other cause of obstruction.

Removal of the contents of chest or abdomen.—If the body of the calf sticks fast in the passages by reason of the mere dryness of its skin and of the passages, the obstacle may be removed by injecting sweet oil past the fetus into the womb through a rubber or other tube, and smearing the passages freely with lard. When the obstruction depends on excess of size of the chest or abdomen or thickening of the body from distorted spine, much advantage may be derived from the removal of the contents of these great cavities of the trunk. We have already seen how the haunches may be narrowed by cutting the bones apart in the median line below and causing their free edges to overlap each other. The abdomen can be cut open by the embryotomy knife or the long embryotome in the median line, or at any point, and the contents pulled out with the hand, the knife being used in any case when especial resistance is encountered. If the abdomen is so firmly impacted that it can not be dealt within this way, one hind limb and the hip bone on the same side may be removed as described under "Amputation of the hind limbs," page 205. This will allow the introduction of the hand into the abdomen from behind, so as to pull out the contents. By introducing an embryotomy knife in the palm of the hand and cutting through the muscle of the diaphragm the interior of the chest can be reached in the same way and the heart and lungs removed.

When, in dealing with an anterior presentation, it becomes necessary to remove the contents of the chest, the usual course is to cut through the connections of the ribs with the breastbone (the costal cartilages) close to the breastbone on each side, and from the abdomen forward to the neck. Then cut through the muscles connecting the front of the breastbone with the neck and its hinder end with the belly, and pull out the entire breastbone. Having torn out the heart and lungs with the hand, make the rib cartilages on the one side overlap those on the other, so as to lessen the thickness of the chest, and proceed to extract the body. If it seems needful to empty the abdomen as well, it is easy to reach it by cutting through the diaphragm, which separates it from the chest.

Delivery through the flank (*Cæsarean section, or laparotomy*).—This is sometimes demanded, when the distortion and narrowing of the hip bones are such as to forbid the passage of the calf, or when inflammation has practically closed the natural passages and the progeny is more valuable and worthy of being saved than the dam: also in cases in which the cow has been fatally injured, or is ill beyond possibility of recovery and yet carries a living calf. It is too often a last resort after long and fruitless efforts to deliver by the natural channels, and in such cases the saving of the calf is all that can be expected, the exhausted cow, already the subject of active inflammation and too often also of putrid poisoning, is virtually beyond hope. The hope of saving the dam is greatest if she is in good health and not fatigued, in cases, for example, in which the operation is resorted to on account of broken hip bones or abnormally narrow passages.

The stock owner will not attempt such a serious operation as this. Yet, if the mother has just died or is to be immediately sacrificed, no one should hesitate to resort to it in order to save the calf. If alive, it is important to have the cow perfectly still. Her left fore leg being bent at the knee by one person, another may seize the left horn and nose and turn the head to the right until the nose rests on the spine just above the shoulder. The cow will sink down gently on her left side without shock or struggle. One may now hold the head firmly to the ground, while a second, carrying the end of the tail from behind forward on the inside of the right thigh, pulls upon it so as to keep the right hind limb well raised from the ground. If time presses she may be operated on in this position, or if the cow is to be sacrificed a blow on the head with an ax will produce quietude. Then the prompt cutting into the abdomen and womb and the extraction of the calf requires no skill. If, however, the cow is to be preserved, her two forefeet and the lower hind one should be safely fastened together and the upper hind one drawn back. Two ounces chloral hydrate, given by injection, should induce sleep in 20 minutes, and the operation may proceed. In case the cow is to be preserved, wash the right flank and apply a solution of 4 grains of corrosive sublimate in a pint of water.

Then, with an ordinary scalpel or knife, dipped in the above-mentioned solution. make an incision from 2 inches below and in front of the outer angle of the hip bone in a direction downward and slightly forward to a distance of 12 inches. Cut through the muscles, and more carefully through the transparent lining membrane of the abdomen (peritoneum), letting the point of the knife lie in the groove between the first two fingers of the left hand as they are slid down inside the membrane and with their back to the intestines. An assistant, whose hands, like those of the operator, have been dipped in the sublimate solution, may press his hands on the wound behind the knife to prevent the protrusion of the intestines. The operator now feels for and brings up to the wound the gravid womb, allowing it to bulge well through the abdominal wound, so as to keep back the bowels and prevent any escape of water into the abdomen. This is seconded by two assistants, who press the lips of the wound against the womb. Then an incision 12 inches long is made into the womb at its most prominent point, deep enough to penetrate its walls. but not so as to cut into the water bags. In cutting, carefully avoid the cotyledons, which may be felt as hard masses inside. By pressure the water bags may be made to bulge out as in natural parturition, and this projecting portion may be torn or cut so as to let the liquid flow down outside of the belly. The operator now plunges his hand into the womb, seizes the fore or hind limbs, and quickly extracts the calf and gives it to an attendant to convey to a safe place. The womb may be drawn out, but not until all the liquid has flowed out, and the fetal membranes must be separated from the natural cotyledons, one by one, and the membranes removed. The womb is now emptied with a sponge, which has been boiled or squeezed out of a sublimate solution, and if any liquid has fallen into the abdomen it may be removed in the same way. A few stitches are now placed in the wound in the womb, using carbolized catgut. They need not be very close together, as the wound will diminish greatly when the womb contracts. Should the womb not contract at once it may have applied against it a sponge squeezed out of a cold sublimate solution. or it may be drawn out of the abdominal wound and exposed to the cold air until it contracts. Its contraction is necessary to prevent bleeding from its enormous network of veins. When contracted, the womb is returned into the abdomen and the abdominal wound sewed up. One set of stitches, to be placed at intervals of 2 inches, is passed through the entire thickness of skin and muscles and tied around two quills or little rollers resting on the skin. (Pl. XXVII, fig. 7.) These should be of silver, and may be cut at one end and pulled out after the wound has healed. The superficial stitches are put in every half inch and passed through the skin only. They, too, may be of silver, or pins may be inserted through the lips and a fine cord twisted round their ends like a figure 8. (Pl. XXVII, fig. 9.) The points of the pins may be snipped off with pliers. The edges may be still further held together by the application of Venice turpentine, melted so as to become firmly adherent, and covered with a layer of sterilized cotton wool. Then the whole should be supported by a bandage fixed around the loins and abdomen.

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DISEASES OF THE GENERATIVE ORGANS.

DESCRIPTION OF PLATES.

Plate XII. Fetal calf within its membranes (at mid term). The uterus is opened on the left side. In the uterus the fetus is surrounded by several membranes which are known as the amnion or inner layer, the allantois or central layer, and the chorion or outer layer. The amnion is nearest the fetus and forms a closed sac around it filled with a fluid known as liquor amnii, in which the fetus floats. The allantois is composed of two layers, which form a closed sac in connection with the urachus, or the tube which extends from the fetal bladder through the umbilical cord. The one layer of the allantois is spread over the outer surface of the amnion and the other over the inner surface of chorion. The allantois also contains a fluid which is known as the allantoid liquid. The chorion is the outer envelope or membrane of the fetus, completely inclosing the fetus with its other membranes. On the outer surface of this membrane are found the fetal placentulæ, or cotyledons, which, through their attachment to the maternal cotyledons, furnish the fetus with the means of sustaining life. The relation of the fetal and maternal cotyledons to each other is illustrated on the following plate.

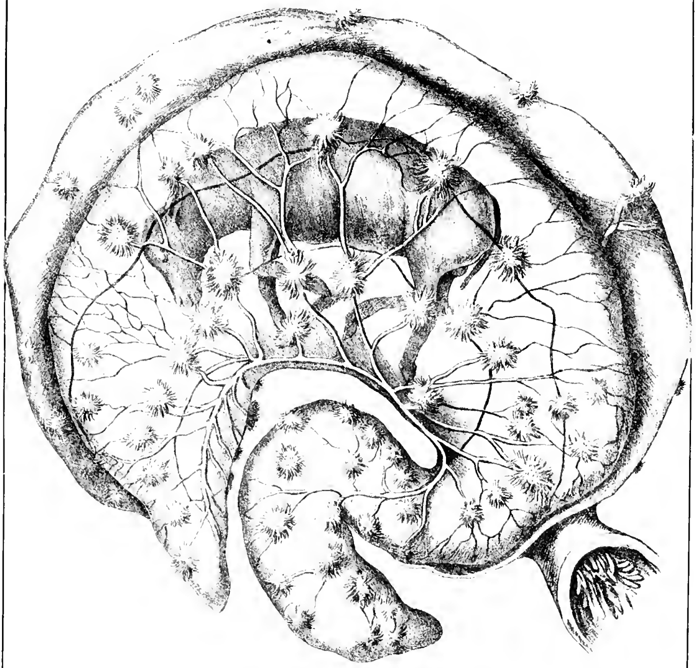
Plate XIII. Pregnant uterus with cotyledons.

Fig. 1. Uterus of the cow during pregnancy, laid open to show the cotyledons (*d*) on the internal surface of uterus (*c*). The ovary (*a*) is shown cut across, and the two halves are laid open to show the position of the discharged ovum at *a′*.

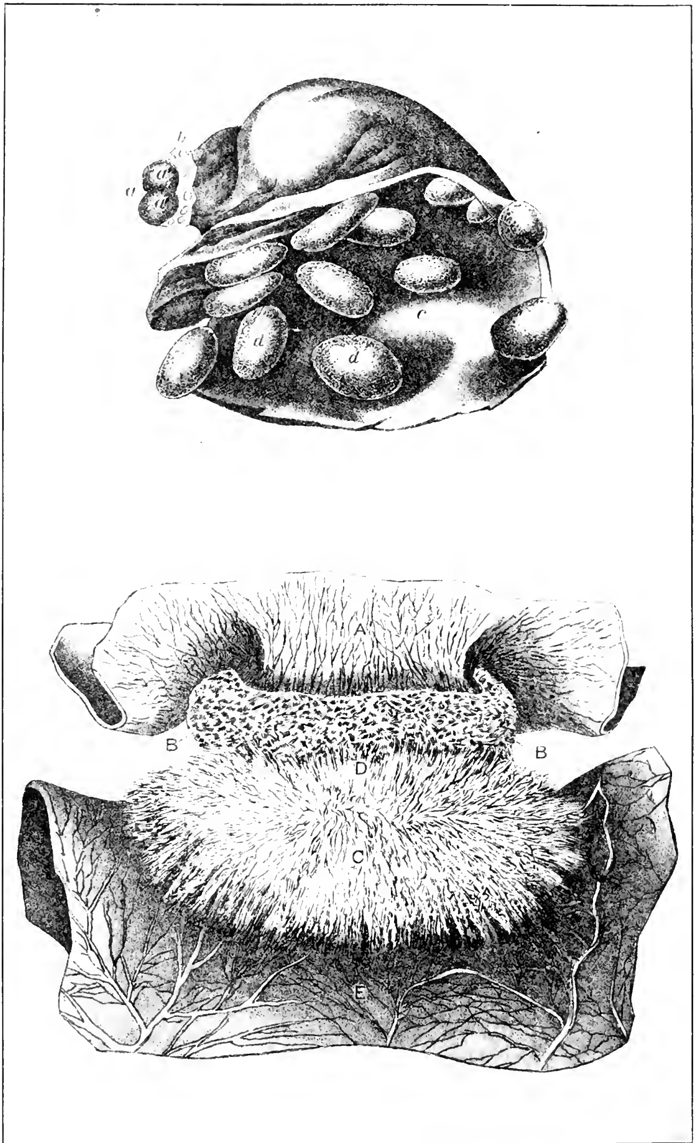
Fig. 2 illustrates the relation of the fetal and maternal parts of a cotyledon. A portion of the uterus (*A*) is shown with the maternal cotyledon (*BB*) attached to it. The fetal portion (*D*) consists of a mass of very minute hairlike processes on the chorion (*E*), which fit into corresponding depressions or pits of the maternal portion. Each portion is abundantly supplied with blood vessels, so that a ready interchange of nutritive fluid may take place between mother and fetus.

Plate XIV. Vessels of umbilical cord.

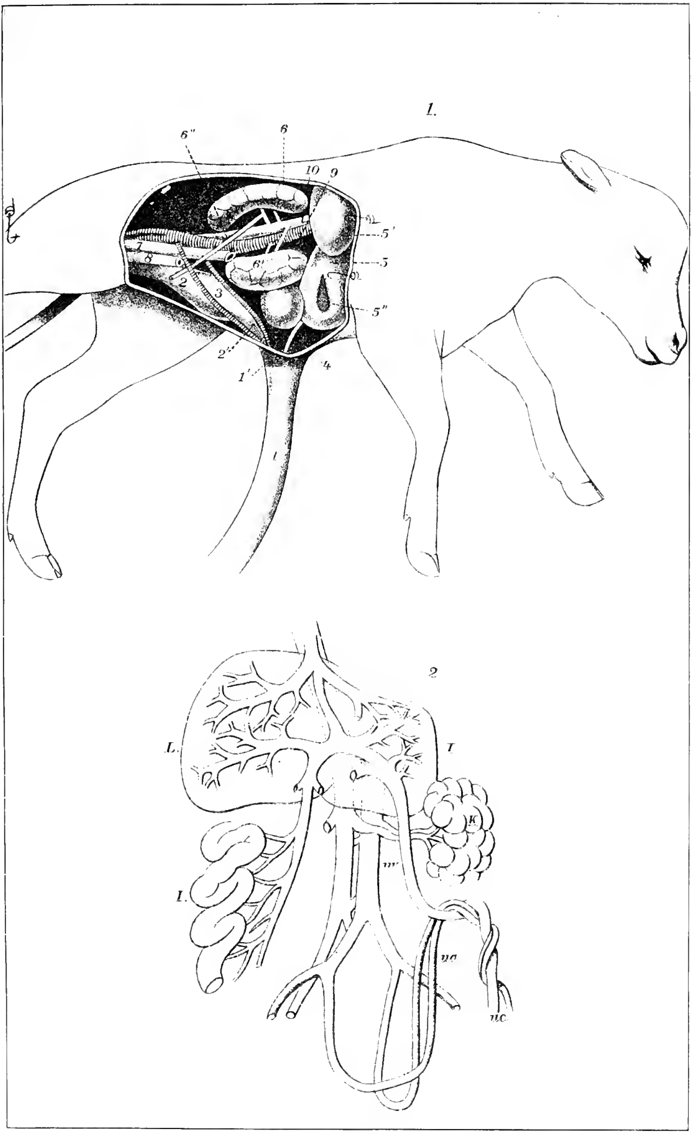
Fig. 1. Fetal calf with a portion of the wall of the abdominal cavity of the right side and the stomach and intestines removed to illustrate the nature of the umbilical or navel cord. It consists of a tube (1–1′) into which pass the two umbilical arteries (3) carrying blood to the placenta in the uterus or womb and the umbilical vein (4) bringing the blood back and carrying it into the liver. The cord also contains the urachus (2′) which carries urine from the bladder (2) through the cord. These vessels are all obliterated at birth. 5, liver; 5′, lobe of same, known as the lobus Spigelii; 5″, gall bladder; 6, right kidney; 6′, left kidney; 6″, ureters, or the tubes conducting the urine from the kidneys to the bladder; 7, rectum, where it has been severed in removing the intestines; 8, uterus of the fetus, cut off at the anterior extremity; 9, aorta; 10, posterior vena cava. (From *Fürstenberg-Leisering, Anatomie und Physiologie des Rindes.*)



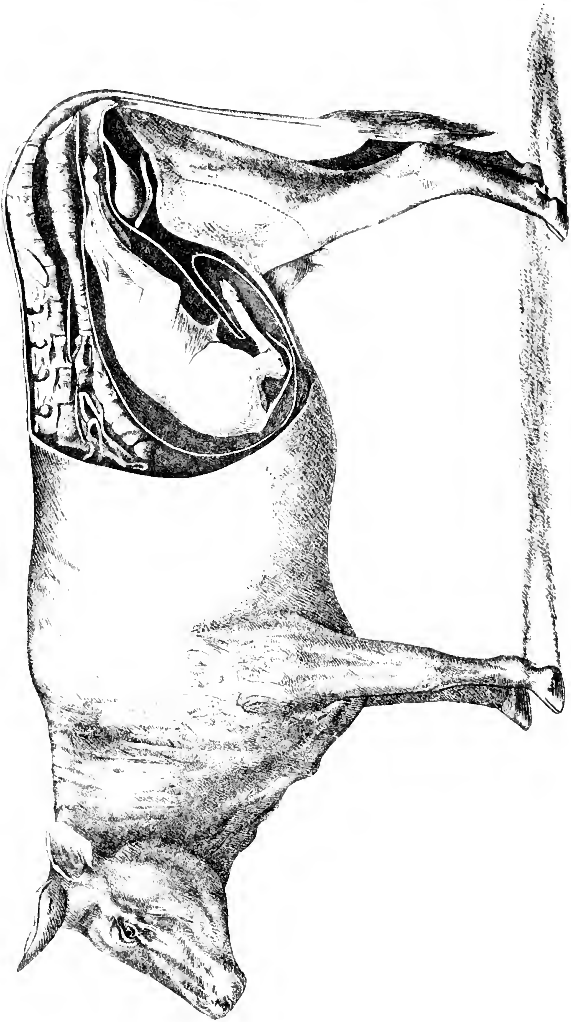
FETAL CALF WITHIN ITS MEMBRANES.



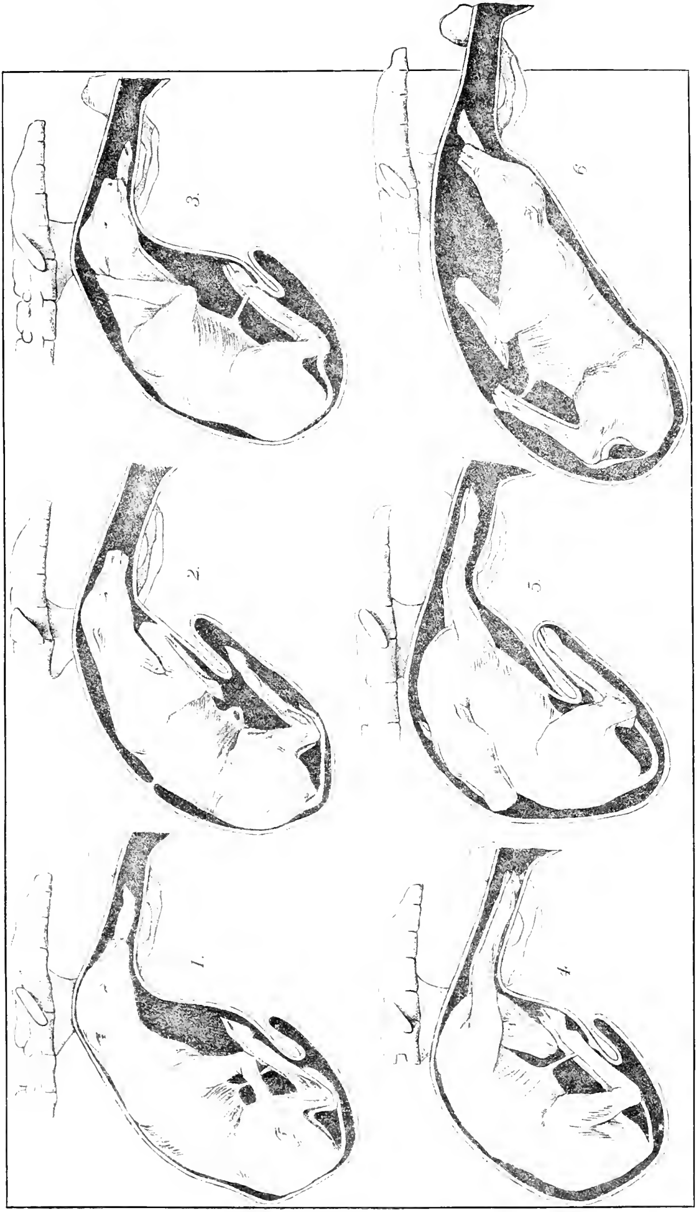
PREGNANT UTERUS WITH COTYLEDONS.



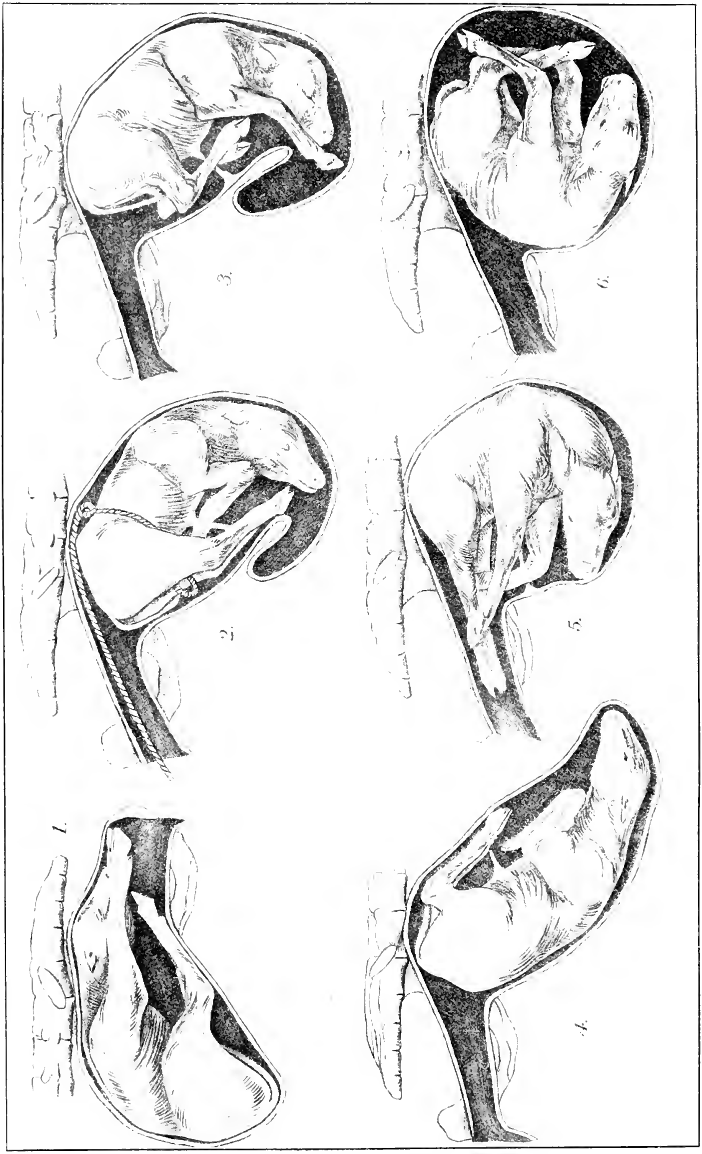
VESSELS OF UMBILICAL CORD.



NORMAL POSITION OF CALF IN UTERO.



ABNORMAL POSITIONS OF CALF IN UTERO.



ABNORMAL POSITIONS OF CALF IN UTERO.

PLATE XIV. Vessels of umbilical cord—Continued.

Fig. 2. Blood vessels passing through the umbilical cord in a human fetus. (From Quain's Anatomy, vol. 2.) *L*, liver; *K*, kidney; *I*, intestines; *U C*, umbilical cord; *Ua*, umbilical arteries. The posterior aorta coming from the heart passes backward and gives rise to the internal iliac arteries, and of these the umbilical arteries are branches. *Uv*, umbilical vein; this joins the portal vein, passes onward to the liver, breaks up into smaller vessels, which reunite in the hepatic vein; this empties into the posterior vena cava, which carries the blood back to the heart.

PLATE XV. Normal position of calf in utero. This is the most favorable position of the calf or fetus in the womb at birth, and the position in which it is most frequently found. This is known as the normal anterior position. The back of the fetus is directly toward that of the mother, the forelegs are extended back toward the vulva of the mother, and the head rests between them. The birth of the calf in this position usually takes place without artificial assistance.

PLATE XVI. Abnormal positions of calf in utero. (Figs. 1, 2, 3, and 5 from Fleming's Veterinary Obstetrics; fig. 4 after St. Cyr, from Hill's Bovine Medicine and Surgery; fig. 6 from D'Arboval, Dictionaire de Médecine et de Chirurgie.)

Fig. 1. Anterior presentation; one fore limb completely retained. The retained limb must be reached if possible and brought forward joint by joint and the fetus then extracted.

Fig. 2. Anterior presentation; fore limbs bent at knee. The limbs must be extended before delivery can be accomplished.

Fig. 3. Anterior presentation; fore limb crossed over neck. The leg should be grasped a little above the fetlock, raised, drawn to its proper side, and extended in genital canal.

Fig. 4. Anterior presentation; downward deviation of head. The head must be brought into position seen in Plate XV before delivery can take place.

Fig. 5. Anterior presentation; deviation of the head upward and backward. Retropulsion is the first indication, and will often bring the head into its normal position.

Fig. 6. Anterior presentation; head presented with back down. The fetus should be turned by pushing back the fore parts and bringing up the hind so as to make a posterior presentation.

PLATE XVII. Abnormal positions of calf in utero. (Figs. 2 and 3 from Fleming; figs. 4, 5, and 6 from D'Arboval.)

Fig. 1. Anterior presentation, with hind feet engaged in pelvis. A very serious malpresentation, in which it is generally impossible to save the fetus if delivery is far advanced. The indications are to force back the hind feet.

Fig. 2. Thigh and croup presentation, showing the fetus corded. The cord has a ring or noose at one end. The two ends of the cord are passed between the thighs, brought out at the flanks, and the plain end passed through the noose at the top of the back and brought outside the vulva. The fetus must be pushed back and an attempt made to bring the limbs properly into the genital passage.

Fig. 3. Croup and hock presentation. The indications in this abnormal presentation are the same as described for Fig. 2.

Fig. 4. Posterior presentation; the fetus on its back. Turn the fetus so as to make a normal anterior presentation.

PLATE XVII. Abnormal positions of calf in utero—Continued.

Fig. 5. Sterno-abdominal presentation. The fetus is on its side with limbs crossing and presenting. The limbs least eligible for extraction should be forced back into the uterus.

Fig. 6. Dorso-lumbar presentation; the back presenting. The fetus must be turned so that one or the other extremity can enter the passage.

PLATE XVIII. Abnormal positions of the calf in utero. Surgical instruments and sutures.

Fig. 1. Twin pregnancy, showing the normal anterior and posterior presentations. (From Fleming.)

Fig. 2. Abdominal dropsy of the fetus; normal presentation; fore limbs corded. (After Armatage.) The drawing illustrates the method of puncturing the abdomen through the chest with a long trocar and cannula. The fluid is represented escaping from the cannula after the withdrawal of the trocar.

Fig. 3. Tallich's short, bent, crotchet forceps. The forceps have bent and toothed jaws, which are intended to take hold of the fetus where neither cords nor hooks can be applied, as the ear, nose, or skin of cheek.

Fig. 4. Clamp for ear, skin, etc.: 1–1, blades with hooks and corresponding holes; 2, ring to close the blades; 3, stem with female screw for handle; 4, handle, which may be either straight or jointed and flexible.

PLATE XIX. Monstrosities. This plate illustrates various malformations and diseases of the fetus which act as the cause of difficult parturition.

Figs. 1, 2, 3. Fetuses with portions of their bodies double. Fig. 1 (from Fleming), double head, neck, and fore limbs. Fig. 2 (from Encyclop. der Gesam. Thierheilkunde, 1886), double head, neck, fore limbs, and body. Fig. 3 (from Fleming), double faced.

Fig. 4. Fetus with head very much enlarged. (From Fleming.) This affection is known as hydrocephalus, or dropsy of the brain, and is due to a more or less considerable quantity of fluid in the cranial cavity of the fetus.

Fig. 5. Skull of the calf represented in Fig. 4. The roof of the skull is absent. (From Fleming.)

PLATE XX. Instruments used in difficult labor.

Fig. 1. Long embryotome with joint.

Fig. 2. Long, sharp hook. This instrument is about 3 feet in length, including the handle. Hooks of this kind, both blunt and sharp, are applied directly to the fetus to assist in delivery.

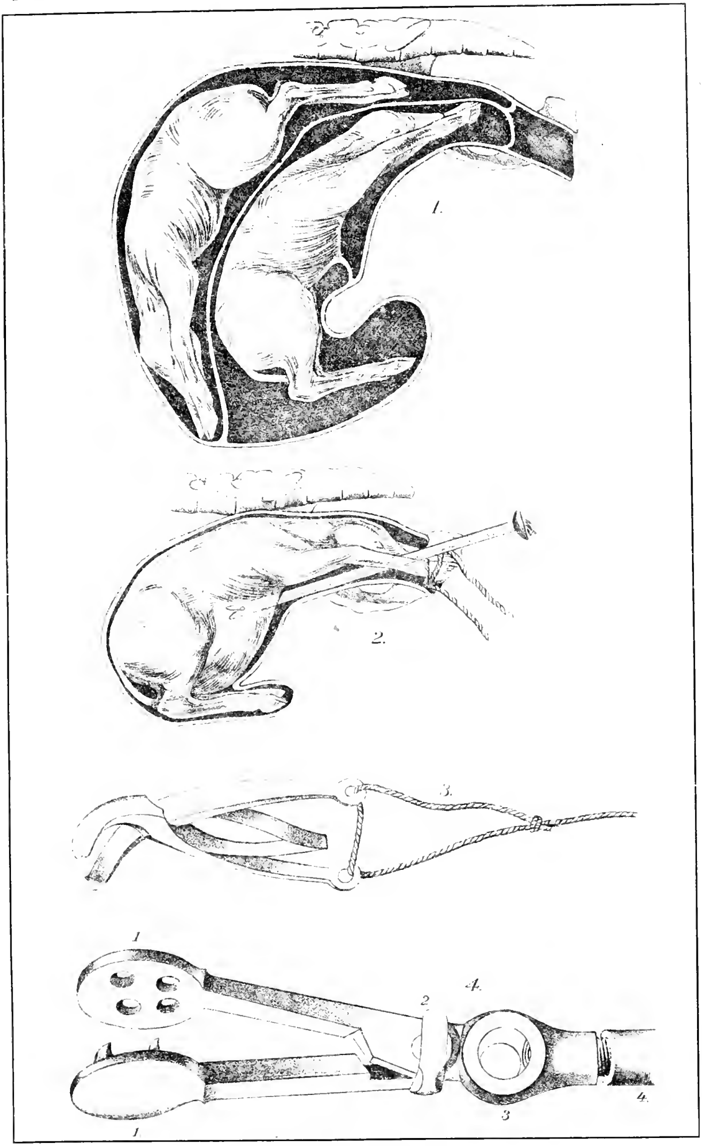
Fig. 3. Günther's long-handled embryotome. This instrument and that represented in Fig. 1 are of special value in cutting through muscular tissue and in separating the limbs from the trunk when the fetus can not be removed entire. These embryotomes are usually 30 inches long, but may be made either longer or shorter.

Fig. 4. Jointed cord-carrier, used in difficult parturition to carry a cord into regions which can not be reached by the arm.

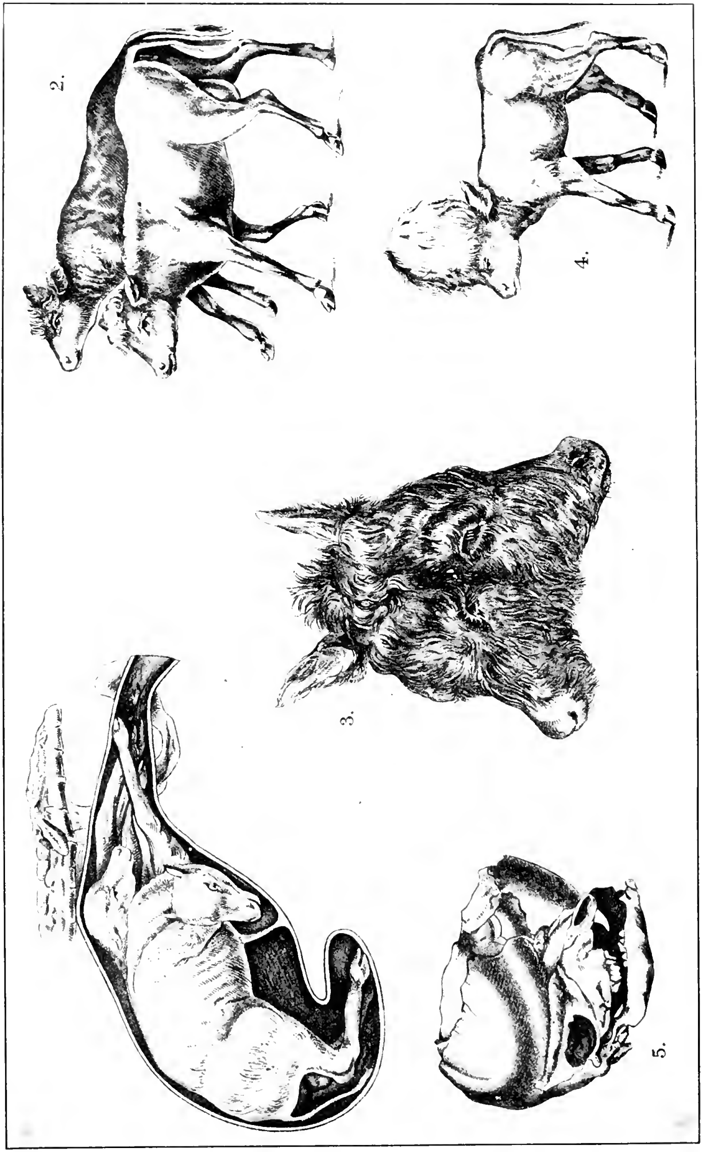
Fig. 5. Instrument used to rotate or turn the fetus, known as a rotator.

Fig. 6. Dilator of the neck of the womb, used when conception can not take place owing to a contracted condition of the neck of the womb.

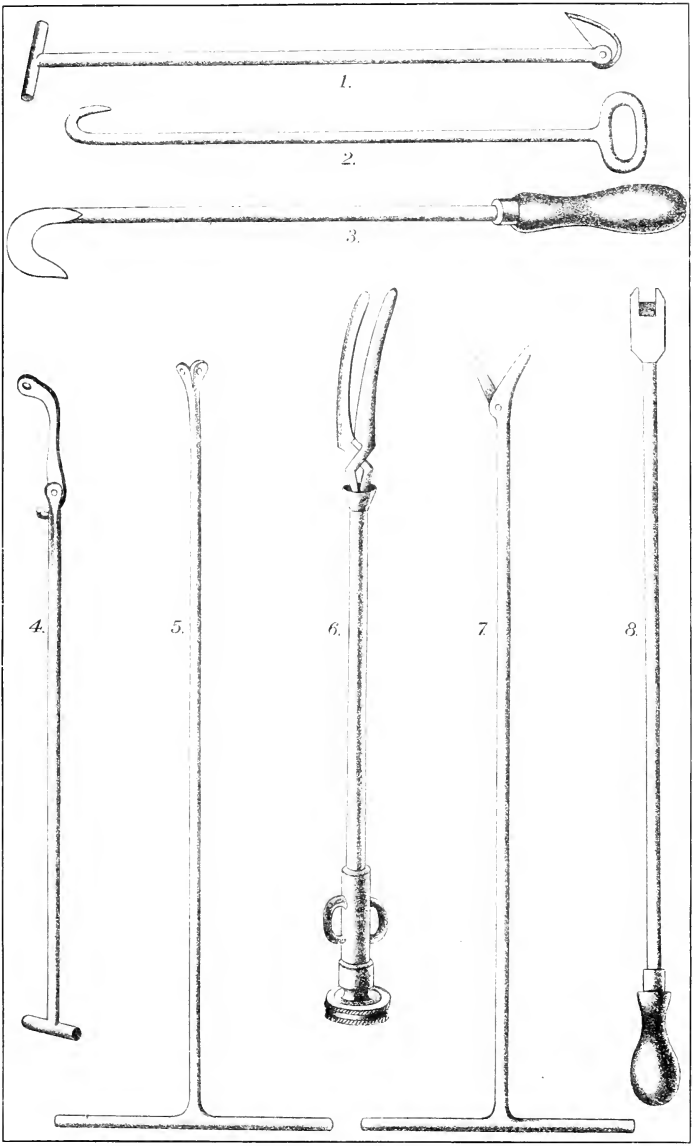
Fig. 7. Repeller. An instrument from 2 to 3 feet long, used to force the fetus forward into the womb. This operation is generally necessary when the presentation is abnormal and the fetus has advanced too far into the narrow inlet to the uterus to be moved.



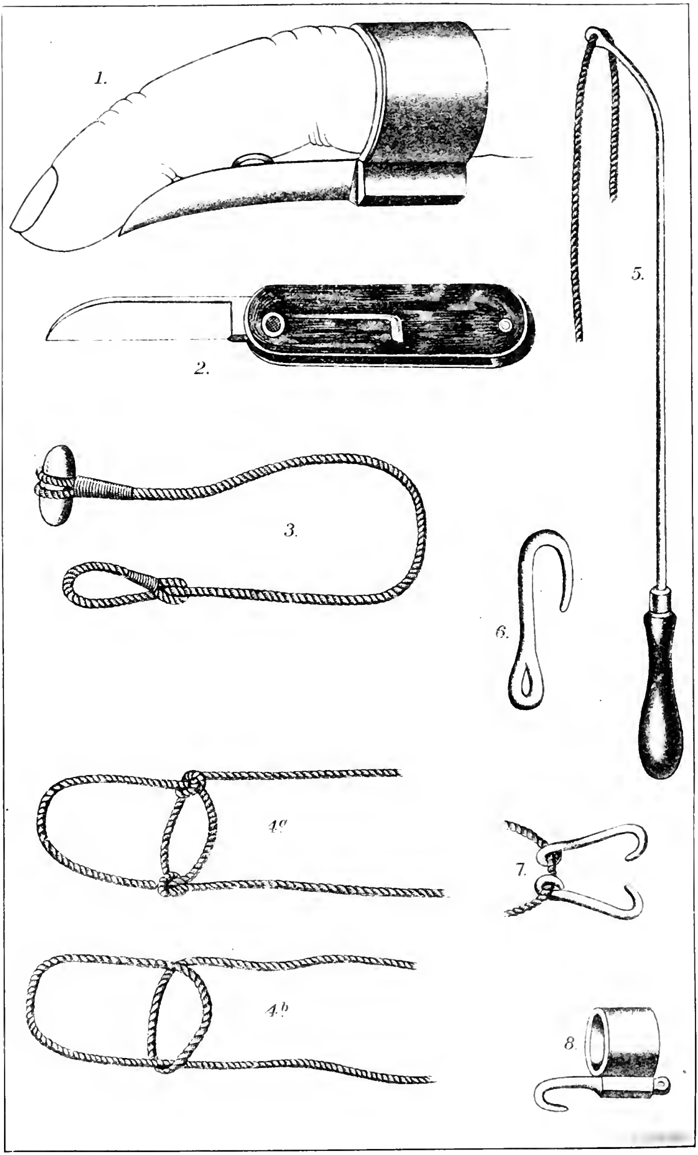
ABNORMAL POSITION OF CALF IN UTERO.
SURGICAL INSTRUMENTS AND SUTURES.



Monstrosities.



INSTRUMENTS USED IN DIFFICULT LABOR.



INSTRUMENTS USED IN DIFFICULT LABOR.

PLATE XX. Instruments used in difficult labor—Continued.

Fig. 8. Cartwright's bone chisel. Including the handle, this instruments is about 32 inches in length; the chisel portion is a little more than 2 inches long and 1 to 1½ broad. Only the middle portion is sharp, the projecting corners are blunt, and the sides rounded. This instrument is used for slitting up the skin of a limb and as a bone chisel when it is necessary to mutilate the fetus in order to effect delivery.

PLATE XXI. Instruments used in difficult labor.

Fig. 1. Embryotome, an instrument used when it is necessary to reduce the size of the fetus by cutting away certain parts before birth can be effected. This instrument may be long or short, straight or curved.

Fig. 2. Also an embryotome. The blade can be made to slide out of or into the handle. The instrument can thus be introduced into or withdrawn from the genital passage without risk of injury to the mother.

Fig. 3. Schaack's traction cord. This is merely a cord with a running noose at one end and a piece of wood at the other, to offer a better hold for the hand.

Figs. 4*a* and 4*b*. Reuff's head collar for securing the head of the fetus.

Fig. 5. Curved cord-carrier, used in difficult parturition to carry a cord into regions which can not be reached by the arm.

Fig. 6. Blunt hook, used in difficult parturition.

Fig. 7. Short hook forceps, used in difficult parturition.

Fig. 8. Blunt finger hook.

DISEASES FOLLOWING PARTURITION.

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FLOODING (BLEEDING FROM THE WOMB).

Though not so common in the cow as in the human female, flooding is sufficiently frequent to demand attention. It may depend on a too rapid calving and a consequent failure of the womb to contract when the calf has been removed. The pregnant womb is extraordinarily rich in blood vessels, especially in large and tortuous veins, which become compressed and almost obliterated under contraction, but remain overfilled and often bleed into the cavity of the womb should no contraction take place. Cox records cases in which the labor pains had detached and expelled the fetal membranes, while the calf, owing to large size or wrong presentation, was detained in the womb, and the continued dilatation of the womb in the absence of the fetal membranes led to a flow of blood which accumulated in clots around the calf. Other causes are laceration of the cotyledons of the womb, or from an antecedent inflammation of the placenta, and the unnatural adhesion of the membranes to the womb, which bleeds when the two are torn apart. Weakness of the womb from overdistention, as in dropsy, twins, etc., is not without its influence. Finally, eversion of the womb (casting the withers) is an occasional cause of flooding. The trouble is only too evident when the blood flows from the external passages in drops or in a fine stream. When it is retained in the cavity of the womb, however, it may remain unsuspected until it has rendered the animal almost bloodless. The symptoms in such case are paleness of the eyes, nose, mouth, and of the lips of the vulva, a weak, rapid pulse, violent and perhaps loud beating of the heart (palpitations), sunken, staring eyes, coldness of the skin, ears, horns, and limbs, perspiration, weakness in standing, staggering gait, and, finally, inability to rise, and death in convulsions. If these symptoms are seen, the oiled hand should be introduced into the womb, which will be found open and flaccid and containing large blood clots.

Treatment.—Treatment consists in the removal of the fetal membranes and blood clots from the womb (which will not contract while they are present), the dashing of cold water on the loins, right flank, and vulva, and if these measures fail, the injection of cold water into the womb through a rubber tube furnished with a funnel. In obstinate cases a good-sized sponge soaked in tincture of muriate of iron should be introduced into the womb and firmly squeezed, so as to bring the iron into contact with the bleeding surface. This is at once an astringent and a coagulant for the blood, besides stimulating the womb to contraction. In the absence of this agent astringents (solution of copperas, alum, tannic acid, or acetate of lead) may be thrown into the womb, and one-half-dram doses of acetate of lead may be given by the mouth, or 1 ounce powdered ergot of rye may be given in gruel. When nothing else is at hand, an injection of oil of turpentine will sometimes promptly check the bleeding.

EVERSION OF THE WOMB (CASTING THE WITHERS).

Like flooding, this is the result of failure of the womb to contract after calving. If that organ contracts naturally, the afterbirth is expelled, the internal cavity of the womb is nearly closed, and the mouth of the organ becomes so narrow that the hand can not be forced through, much less the whole mass of the matrix. When, however, it fails to contract, the closed end of one of the horns may fall into its open internal cavity, and under the compression of the adjacent intestines, and the straining and contraction of the abdominal walls, it is forced farther and farther, until the whole organ is turned outside in, slides back through the vagina, and hangs from the vulva. The womb can be instantly distinguished from the protruding vagina or bladder by the presence, over its whole surface, of 50 to 100 mushroomlike bodies (cotyledons), each 2 to 3 inches in diameter, and attached by a narrow neck. (Pls. XII, XIII.) When fully everted, it is further recognizable by a large, undivided body hanging from the vulva, and two horns or divisions which hang down toward the hocks. In the imperfect eversions the body of the womb may be present with two depressions leading into the two horns. In the cases of some standing the organ has become inflamed and gorged with blood until it is as large as a bushel basket, its surface has a dark-red, bloodlike hue, and tears and bleeds on the slightest touch. Still later lacerations, raw sores, and even gangrene are shown in the mass. At the moment of protrusion the general health is not altered, but soon the inflammation and fever with the violent and continued straining induce exhaustion, and the cow lies down, making no attempt to rise.

Treatment.—Treatment varies somewhat, according to the degree of the eversion. In partial eversion, with the womb protruding only slightly from the vulva and the cow standing, let an assistant pinch the back to prevent straining while the operator pushes his closed fist into the center of the mass and carries it back through the vagina, assisting in returning the surrounding parts by the other hand. In more complete eversion, but with the womb as yet of its natural bulk and consistency and the cow standing, straining being checked by pinching the back, a sheet is held by two men so as to sustain the everted womb and raise it to the level of the vulva. It is now sponged clean with cold water, the cold being useful in driving out the blood and reducing the bulk, and finally it may be sponged over with laudanum or with a weak solution of carbolic acid (1 dram to 1 quart water).

The closed fist may now be planted in the rounded end of the largest horn and pushed on so as to turn it back within itself and carry it on through the vagina, the other hand being used meanwhile to assist in the inversion and in pushing the different masses in succession within the lips of the vulva. In case of failure, resort should be had at once to a plan which I have successfully followed for many years. Take a long linen or cotton bandage, 5 or 6 inches wide, and wind it around the protruding womb as tightly as it can be drawn, beginning at the free end and gradually covering the entire mass up to the vulva. By this means the greater part of the blood will be forced out of the organ and its bulk greatly reduced, so that its reduction is much facilitated. An additional advantage is found in the protection given to the womb by its investing bandage while it is being pushed forward into the vagina and abdomen. In manipulating the exposed womb there is always danger of laceration, but when the organ is covered with a sheet it is next to impossible to tear it. The subsequent manipulation is as in the other case, by pushing the blind end forward within itself with the closed fist and carrying this on through the vagina into the abdomen with the constant assistance of the other hand. Often it will be found convenient to use the edge of the left hand to push the outer part of the protruding mass inside the lips of the vulva, while the right hand and arm are carrying the central portions forward through the vagina. An intelligent assistant, pushing with the palms of both hands on the outer portion of the mass, will also afford material assistance. As the womb is turned within itself the wrapping bandage will gradually loosen, but once the great mass has entered the passages it is easy to compel the rest to follow, and the compression by the bandage is no longer so important. When the womb is fully replaced the bandage is left in its interior in a series of loose folds, and can be easily withdrawn. It is well to move the hand from side to side to insure that the two horns of the womb are fully extended and on about the same level before withdrawing the arm and applying a truss.

When the womb has been long everted and is gorged with blood, inflamed, and friable there is often the additional disadvantage that the animal is unable or unwilling to rise. When lying down the straining can not be controlled so effectually, and, even in the absence of straining, the compression of the belly is so great as to prove a serious obstacle to reduction. The straining may be checked by 2 or 3 ounces of laudanum or 2 ounces of chloral hydrate, or by inhalation of chloroform to insensibility, and then by raising the hind parts on straw bundles the gravitation of the abdominal organs forward may be made to lessen the resistance. If not successful in this way, the cow may be further turned on her back, and if return is still impossible, the hind limbs may be tied together and drawn up to a beam overhead by the aid of a pulley. In this position, in place of the pressure backward of the bowels proving a hindrance, their gravitation forward proves a most material help to reduction. In seeking to return the womb the sponging with ice-cold water, raising on a sheet, and wrapping in a tight bandage should be resorted to. Another method which is especially commendable in these inflamed conditions of the womb is to bring a piece of linen sheet, 30 by 36 inches, under the womb, with its anterior border close up to the vulva, then turn the posterior border upward and forward over the organ, and cross the two ends over this and over each other above. The ends of the sheet are steadily drawn, so as to tighten its hold on the womb, which is thus held on the level of the vulva or above, and cold water is constantly poured upon the mass. The reduction is further sought by compression of the mass with the palms applied outside the sheet. Fifteen or twenty minutes are usually sufficient to cause the return of the womb, provided straining is prevented by pinching the back, or otherwise.

In old and aggravated cases, with the womb torn, bruised, or even gangrenous, the only resort is to amputate the entire mass. This is done by tying a strong, waxed cord around the protruding mass close to the vulva, winding the cord around pieces of wood, so as to draw it as tightly as possible, cutting off the organ below this ligature, tying a thread on any artery that may still bleed, and returning the stump well into the vagina.

Retention of the returned womb is the next point, and is most easily accomplished by a rope truss. Take two ropes, each about 18 feet long and an inch in thickness. Double each rope at its middle, and lay the one above the other at the bend, so as to form an ovoid of about 8 inches in its long diameter. Twist each end of the one rope twice around the other, so that this ovoid will remain when they are drawn tight. (Pls. XXII and XXIII.) Tie a strap or rope around the back part of the neck and a surcingle around the body. Place the rope truss on the animal so that the ovoid ring will surround the vulva, the two ascending ropes on the right and left of the tail and the two descending ones down inside the thighs on the right and left of the udder. These descending ropes are carried forward on the sides of the body and tied to the surcingle and to the neck collar.

The ascending ropes proceed forward on the middle of the back, twisting over each other, and are tied to the surcingle and collar. The upper and lower ropes are drawn so tightly that the rope ring is made to press firmly all around the vulva without risk of displacement. This should be worn for several days, until the womb shall have closed and all risk of further eversion is at an end. Variations of this device are found in the use of a narrow triangle of iron applied around the vulva and fixed by a similar arrangement of ropes, surcingle, and collar (Pl. XXIII, fig. 3), a common crupper similarly held around the vulva (Pl. XXII, fig. 1), stitches through the vulva, and wire inserted through the skin on the two hips (Pl. XXIII, fig. 2), so that they will cross behind the vulva; also pessaries of various kinds should be inserted into the vagina. None of these devices, however, present any advantage over the simple and comparatively painless rope truss described above. Such additional precautions as keeping the cow in a stall higher behind than in front; and seeing that the diet is slightly laxative and nonstimulating may be named. If straining is persistent, ounce doses of laudanum may be used twice a day, and the same may be injected into the vagina.

If the womb has been cut off, injections of a solution of a teaspoonful of carbolic acid in a quart of water should be used daily, or more frequently, until the discharge ceases.

EVERSION OF THE BLADDER.

A genuine eversion of the bladder is almost unknown in the cow, owing to the extreme narrowness of its mouth. The protrusion of the bladder, however, through a laceration sustained in calving, in the floor of the vagina and its subsequent protrusion through the vulva, is sometimes met with. In this case the protruding bladder contains urine; this can never be the case in a real eversion, in which the inner surface of the bladder and the openings of the ureters are both exposed outside the vulva. The presence of a bag containing water, which is connected with the floor of the vagina, will serve to identify this condition. If the position of the bladder in the vulva renders it impracticable to pass a catheter to draw off the urine, pierce the organ with the nozzle of a hypodermic syringe, or even a very small trocar and cannula, and draw off the water, when it will be found an easy matter to return the bladder to its place. The rent in the vagina can be stitched up, but as there would be risk in any subsequent calving it is best to prepare the cow for the butcher.

RUPTURE OF THE BLADDER.

This has been known to occur in protracted parturition when the fetus finally passed while the bladder was full. The symptoms are those of complete suppression of urine and tenderness of the abdomen, with a steady accumulation of liquid, and fluctuation on handling its lower part. If the hand is introduced into the vagina it is felt to be hot and tender, and perhaps slightly swollen along its floor. As a final test, if the lower, fluctuating part of the abdomen is punctured with a hypodermic needle, a straw-colored liquid of a urinous odor flows out. The condition has been considered as past hope. The only chance for recovery would be in opening the abdomen, evacuating the liquid, and stitching up the rent in the bladder, but at such a season, and with inflammation already started, there would be little to hope for.

RUPTURE OF THE WOMB.

When the womb has been rendered friable by disease rupture may occur in the course of the labor, but much more frequently it occurs from violence sustained in attempting assistance in difficult parturition. It is also liable to occur during eversion of the organ through efforts to replace it.

If it happens while the calf is still in the womb, it will usually bleed freely and continuously until the fetus has been extracted, so that the womb can contract on itself and expel its excess of blood. Another danger is that in case of a large rent the calf may escape into the cavity of the abdomen and parturition become impossible. Still another danger is that of the introduction of septic germs and the setting up of a fatal inflammation of the lining membrane of the belly (peritoneum). Still another is the escape of the small intestine through the rent and on through the vagina and vulva, so as to protrude externally and receive perhaps fatal injuries. In case of rupture before calving, that act should be completed as rapidly and carefully as possible, the fetal membranes removed, and the contraction of the womb sought by dashing cold water on the loins, the right flank, or the vulva. If the calf has escaped into the abdomen and can not be brought through the natural channels, it may be permissible to fix the animal and extract it through the side, as in the Cæsarian section. If the laceration has happened during eversion of the womb it is usually less redoubtable, because the womb contracts more readily under the stimulus of the cold air so recently applied. In case the abdomen has been laid open it is well to stitch up the rent, but if not, it should be left to nature, and will often heal satisfactorily, the cow even breeding successfully in after years.

Rupture of the floor of the vagina has been already referred to as allowing the protrusion of the bladder. Laceration of the roof of this passage is also met with as the result of deviations of the hind limbs and feet upward when the calf lies on its back. In some such cases the opening passes clear into the rectum, or the foot may even pass out through the anus, so that that opening and the vulva are laid open into one.

Simple, superficial lacerations of the vaginal walls are not usually serious, and heal readily unless septic inflammation sets in, in which case the cow is liable to perish. They may be treated with soothing and antiseptic injections, such as carbolic acid, 1 dram; water, 1 quart.

The more serious injuries depend on the complications. Rupture of the anterior part of the canal, close to the mouth of the womb, may lead to the introduction of infecting germs into the cavity of the abdomen, or protrusion of the bowel through the rent and externally, either of which may prove fatal. If both these conditions are escaped the wound may heal spontaneously. Rupture into the bladder may lead to nothing worse than a constant dribbling of the urine from the vulva. The cow should be fattened if she survives. Rupture into the rectum will entail a constant escape of feces through the vulva, and, of course, the same condition exists when the anus as well has been torn open. I have successfully sewed up an opening of this kind in the mare, but in the case of the cow it is probably better to prepare her for the butcher.

CLOTS OF BLOOD IN THE WALLS OF THE VAGINA.

During calving the vagina may be bruised so as to cause escape of blood beneath the mucous membrance and its coagulation into large bulging clots. The vulva may appear swollen, and on separating its lips the mucous membrane of the vagina is seen to be raised into irregular rounded swellings of a dark-blue or black color, and which pit on pressure of the finger. If the accumulation of blood is not extensive it may be reabsorbed, but if abundant it may lead to irritation and dangerous inflammation, and should be incised with a lancet and the clots cleared out. The wounds may then be sponged twice a day with a lotion made with 1 dram sulphate of zinc, 1 dram carbolic acid, and 1 quart water.

RETAINED AFTERBIRTH.

The cow, of all our domestic animals, is especially subject to this accident. This may be partly accounted for by the firm connections established through the fifty to one hundred cotyledons (Pl. XIII, fig. 2) in which the fetal membranes dovetail with the follicles of the womb. It is also most liable to occur after abortion, in which preparation has not been made by fatty degeneration for the severence of these close connections. In the occurrence of inflammation, causing the formation of new tissue between the membranes and the womb, we find the occasion of unnaturally firm adhesions which prevent the spontaneous detachment of the membranes. Again, in low conditions of health and an imperfect power of contraction we find a potent cause of retention, the general debility showing particularly in the indisposition of the womb to contract, after calving, with sufficient energy to expel the afterbirth. Hence we find the condition common with insufficient or innutrious feed, and in years or localities in which the fodder has suffered from weather. Ergoted, smutty, or musty fodder (Pl. V), by causing abortion, is a frequent cause of retention. Old cows are more subject than young ones, probably because of diminishing vigor. A temporary retention is sometimes owing to a too rapid closure of the neck of the womb after calving, causing strangulation and imprisonment of the membranes. Conditions favoring this are the drinking of cold (iced) water, the eating of cold feed (frosted roots), and (through sympathy between udder and womb) a too prompt sucking by the calf or milking by the attendant.

Symptoms.—The symptoms of retention of the afterbirth are usually only too evident, as the membranes hang from the vulva and rot away gradually, causing the most offensive odor throughout the building. When retained within the womb by closure of its mouth and similarly in cases in which the protruded part has rotted off, the decomposition continues and the fetid products escaping by the vulva appear in offensively smelling pools on the floor and mat together the hairs near the root of the tail. The septic materials retained in the womb cause inflammation of its lining membrane, and this, together with the absorption into the blood of the products of putrefaction, leads to ill health, emaciation, and drying up of the milk.

Treatment.—Treatment varies according to the conditions. When the cow is in low condition, or when retention is connected with drinking iced water or eating frozen feed, hot drinks and hot mashes of wheat bran or other aliment may be sufficient. If along with the above conditions, the bowels are somewhat confined, an ounce of ground ginger, or half an ounce of black pepper, given with a quart of sweet oil, or $1\frac{1}{2}$ pounds of Glauber's salt in at least 4 quarts of warm water, will often prove effectual. A bottle or two of flaxseed tea, made by prolonged boiling, should also be given at frequent intervals. Other stimulants, like rue, savin, laurel, and carminatives like anise, cumin, and coriander, are preferred by some, but with very questionable reason, the more so that the first three are not without danger. Ergot of rye, 1 ounce, or its extract, 1 dram, may be resorted to to induce contraction of the womb. The mechanical extraction of the membranes is, however, often called for; of this there are several methods. The simplest is to hang a weight of 1 or 2 pounds to the hanging portion, and allow this, by its constant dragging and by its jerking effect when the cow moves, to pull the membranes from their attachments and to stimulate the womb to expulsive contractions. It frequently happens that the afterbirth is only loosely adherent to the womb and its removal is effected if but a slight amount of traction on it is exerted. This can be determined by seizing the dependent part of the afterbirth between two sticks and rolling it up on them until they lie against the vulva; then, by careful traction, accompanied with slight jerking movements from side to side, the womb is stimulated to expulsive contractions and the afterbirth is wound up more and more on the sticks until finally its last connections with the womb are severed and the remainder is expelled suddenly en masse. It is quite evident that neglected cases with putrid membranes are poor subjects for this method, as the afterbirth is liable to tear across, leaving a mass in the womb. During the progress of the work any indication of tearing is the signal to stop and proceed with greater caution or altogether abandon the attempt in this way.

The following method (that with the skilled hand) is the most promptly and certainly successful. For this the operator had better dress as for a parturition case. Again, the operation should be undertaken within twenty-four hours after calving, since later the mouth of the womb may be so closed that it becomes difficult to introduce the hand. The operator should smear his arms with carbolized lard or vaseline to protect them against infection, and particularly in delayed cases with putrid membranes. An assistant holds the tail to one side, the operator seizes the hanging afterbirth with the left hand, while he introduces the other along the right side of the vagina and womb, letting the membranes slide through his palm until he reaches the first cotyledon to which they remain adherent. In case no such connection is within reach, with the left hand gentle traction is made on the membranes until the deeper parts of the womb are brought within reach and the attachments to the cotyledons can be reached. Then the soft projection of the membrane, which is attached to the firm fungus-shaped cotyledon on the inner surface of the womb, is seized by the little finger, and the other fingers and thumb are closed on it so as to tear it out from its connections. To explain this, it is necessary only to say that the projection from the membrane is covered by soft, conical processes, which are received into cavities of a corresponding size on the summit of the firm, mushroom-shaped cotyledon growing from the inner surface of the womb. To draw upon the former, therefore, is to extract its soft, villous processes from within the follicles or cavities of the other. (Pl. XIII, fig. 2.)

If at times it is difficult to start this extraction it may be necessary to get the finger nail inserted between the two, and once started the finger may be pushed on, lifting all the villi, in turn, out of their cavities. This process of separating the cotyledons must be carefully conducted, one after another, until the last has been detached and the afterbirth comes freely out of the passages. I have never found any evil result from the removal of the whole mass at one operation, but Shaack mentions the eversion of the womb as the possible result of the necessary traction, and in cases in which those in the most distant part of the horn of the womb can not be easily reached, he advises to attach a cord to the membranes inside the vulva, letting it hang out behind, and to cut off the membranes below the cord. Then, after two or three days' delay, he extracts the remainder, now softened and easily detached. If carefully conducted, so as not to tear the cotyledons of the womb, the operation is eminently successful; the cow suffers little, and the straining roused by the manipulations soon subsides. Keeping in a quiet, dark place, or driving a short distance at a walking pace, will serve to quiet these. When the membranes have been withdrawn, the hand, half closed, may be used to draw out of the womb the offensive liquid that has collected. If the case is a neglected one, and the discharge is very offensive, the womb must be injected as for leucorrhea.

INFLAMMATION OF THE VAGINA (VAGINITIS).

This may occur independently of inflammation of the womb, and usually as the result of bruises, lacerations, or other injuries sustained during calving. It will be shown by swelling of the lips of the vulva, which, together with their lining membrane, become of a dark-red or leaden hue, and the mucous discharge increases and becomes whitish or purulent, and it may be fetid. Slight cases recover spontaneously, or under warm fomentations or mild astringent injections (a teaspoonful of carbolic acid in a quart of water), but severe cases may go on to the formation of large sores (ulcers), or considerable portions of the mucous membrane may die and slough off. Baumeister records two cases of diphtheritic vaginitis, the second case in a cow four weeks calved, contracted from the first in a newly calved cow. Both proved fatal, with formation of false membranes as far as the interior of the womb. In all severe cases the antiseptic injections must be applied most assiduously. The carbolic acid may be increased to one-half ounce to a quart, or chlorin water, or peroxid of hydrogen solution may be injected at least three times a day. Hyposulphite of soda, 1 ounce to a quart of water, is an excellent application, and the same amount may be given by the mouth.

LEUCORRHEA (MUCOPURULENT DISCHARGE FROM THE PASSAGES).

This is from a continued or chronic inflammation of the womb, or the vagina, or both. It usually results from injuries sustained in calving or from irritation by putrid matters in connection with retained afterbirth, or from the use of some object in the vagina (pessary) to prevent eversion of the womb. Exposure to cold or other cause of disturbance of the health may affect an organ so susceptible as this at the time of parturition so as to cause inflammation.

Symptoms.—The main symptom is the glairy, white discharge flowing constantly or intermittently (when the cow lies down), soiling the tail and matting its hairs and those of the vulva. When the lips of the vulva are drawn apart the mucous membrane is seen to be red, with minute elevations, or pale and smooth. The health may not suffer at first, but if the discharge continues and is putrid the health fails, the milk shrinks, and flesh is lost. If the womb is involved the hand introduced into the vagina may detect the mouth of the womb slightly open and the liquid collected within its cavity. Examination with the oiled hand in the rectum may detect the outline of the womb beneath, somewhat enlarged, and fluctuating under the touch from contained fluid. In some cases heat is more frequent or intense than natural, but the animal rarely conceives when served, and, if she does, is liable to abort.

Treatment.—Treatment with the injections advised for vaginitis is successful in mild or recent cases. In obstinate ones stronger solutions may be used after the womb has been washed out by a stream of tepid water until it comes clear. A rubber tube is inserted into the womb, a funnel placed in its raised end, and the water, and afterwards the solution, poured slowly through it. If the neck of the womb is so close that the liquid can not escape, a second tube may be inserted to drain it off. As injections may be used chlorid of zinc, one-half dram to the quart of water, or sulphate of iron, 1 dram to the quart. Three drams of sulphate of iron and one-half ounce ground ginger may also be given in the feed daily.

INFLAMMATION OF THE WOMB (METRITIS, INFLAMMATION OF WOMB AND ABDOMEN, OR METROPERITONITIS).

Inflammation of the womb may be slight or violent, simple or associated with putrefaction of its liquid contents and general poisoning, or it may extend so that the inflammation affects the lining membrane of the whole abdominal cavity. In the last two cases the malady is a very grave one.

Causes.—The causes are largely the same as those causing inflammation of the vagina. Greater importance must, however, be attached to exposure to cold and wet and to septic infection.

Symptoms.—The symptoms appear two or three days after calving, when the cow may be seen to shiver, or the hair stands erect, especially along the spine, and the horns, ears, and limbs are cold. The temperature in the rectum is elevated by one or two degrees, the pulse is small, hard, and rapid (70 to 100), appetite is lost, rumination ceases, and the milk shrinks in quantity or is entirely arrested, and the breathing is hurried. The hind limbs may shift uneasily, the tail be twisted, the head and eyes turn to the right flank, and the teeth are ground. With the flush of heat to the horns and other extremities, there is redness of the eyes, nose, and mouth, and usually a dark redness about the vulva. Pressure on the right flank gives manifest pain, causing moaning or grunting, and the hind limbs are moved stiffly, extremely so if the general lining of the abdomen is involved. In severe cases the cow lies down and can not be made to rise. There is usually marked thirst, the bowels are costive, and dung is passed with pain and effort. The hand inserted into the vagina perceives the increased heat, and when the neck of the womb is touched the cow winces. Examination through the rectum detects enlargement and tenderness of the womb. The discharge from the vulva is at first watery, but becomes thick, yellow, and finally red or brown, with a heavy or fetid odor. Some cases recover speedily and may be almost well in two days; a large proportion perish within two days of the attack, and some merge into the chronic form, terminating in leucorrhea. In the worst cases there is local septic infection and ulceration, or even gangrene of the parts, or there is general septicemia, or the inflammation involving the veins of the womb causes coagulation of the blood contained in them, and the washing out of the clots to the right heart and lung leads to the blocking of the vessels in the latter and complicating pneumonia. Inflammation of the womb and passages after calving are always liable to these complications, and consequently to a fatal issue. Franck records three instances of rapidly fatal metritis in cows, all of which had been poisoned from an adjacent cow with retained and putrid afterbirth. Others have had similar cases.

Treatment.—Treatment in the slight cases of simple inflammation does not differ much from that adopted for vaginitis, only care must be taken that the astringent and antiseptic injections are made to penetrate into the womb. After having washed out the womb a solution of chlorid of lime or permanganate of potassium (one-half ounce to 1 quart of water), with an ounce each of glycerin and laudanum to render it more soothing, will often answer every purpose. It is usually desirable to open the bowels with 1½ pounds of Glauber's salt and 1 ounce of ginger in 4 quarts of warm water, and to apply fomentation of warm water or even mustard poultices or turpentine to the right flank.

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In the violent attacks with high temperature and much prostration, besides the salts agents must be given to lower the temperature and counteract septic poisoning. Salicylate of soda one-half ounce, or quinia 2 drams every four hours will help in both ways, or ounce doses of hyposulphite of soda or dram doses of carbolic acid may be given as often until six doses have been taken. Tincture of aconite has often been used in 20-drop doses every six hours. If the temperature rises to 106° or 107° F., it must be met by the direct application of cold or iced water to the surface. The animal may be covered with wet sheets and cold water poured on them frequently until the temperature in the rectum is lowered to 102° F. In summer the cow may be allowed to dry spontaneously, while in winter it should be rubbed dry and blanketed. Even in the absence of high temperature much good may be obtained from the soothing influence of a wet sheet covering the loins and flanks and well covered at all points by a dry one. This may be followed next day by a free application of mustard and oil of turpentine. When the animal shows extreme prostration, carbonate of ammonia (1 ounce) may be given to tide over the danger, but such cases usually perish.

In this disease, even more than in difficult and protracted parturition or retained placenta, the attendants must carefully guard against the infection of their hands and arms from the diseased parts. The hand and arm before entering the passages should always be well smeared with lard impregnated with carbolic acid.

MILK FEVER (PARTURITION FEVER, PARTURIENT APOPLEXY, OR PARTURIENT COLLAPSE).

This disease is not only peculiar to the cow, but it may be said to be virtually confined to the improved and plethoric cow. It further occurs only at or near the time of calving. Indeed, these two factors, calving and plethora, may be set apart as preeminently the causes of this disease. It is the disease of cows that have been improved in the direction of early maturity, power of rapid fattening, or a heavy yield of milk, and hence it is characteristic of those having great appetites and extraordinary power of digestion. The heavy milking breeds are especially its victims, as in them the demand for the daily yield of 50 to 100 pounds of milk means even more than a daily increase of 2 to 3 pounds of body weight, mainly fat. The victims are not always fat when attacked, but they are cows having enormous powers of digestion, and which have been fed heavily at the time. Hence the stall-fed, city-dairy cow, and the farm cow on a rich clover pasture in June or July are especially subject. The condition of the blood globules in the suffering cow attests the extreme richness and density of the blood, yet this peculiarity appears to have entirely escaped the notice of veterinary writers. I have never examined the blood of a victim of this disease without finding the red-blood globules reduced to little more than one-half their usual size. Now, these globules expand or contract according to the density of the liquid in which they float. If we dilute the blood with water they will expand until they burst, whereas if solids, such as salt or albumin, are added they shrink to a large extent. Their small size, therefore, in parturition fever indicates the extreme richness of the blood, or, in other words, plethora.

Confinement in the stall is an accessory cause, partly because stabled cattle are highly fed, partly because the air is hotter and fouler, and partly because there is no expenditure by exercise of the rich products of digestion.

High temperature is conducive to the malady, though the extreme colds of winter are no protection against it. Heat, however, conduces to fever, and fever means lessened secretion, which means a plethoric state of the circulation. The heats of summer are, however, often only a coincidence of the real cause, the mature rich pastures, and especially the clover ones, being the greater.

Electrical disturbances have an influence of a similar kind, disturbing the functions of the body and favoring sudden variations in the circulation. A succession of cases of the malady often accompany or precede a change of weather from dry to wet, from a low to a high barometric pressure.

Costiveness, which is the usual concomitant of fever, may in a case of this kind become an accessory cause, the retention in the blood of what should have passed off by the bowels tending to increase the fullness of the blood vessels and the density of the blood.

Mature age is a very strong accessory cause. The disease never occurs with the first parturition, and rarely with the second. It appears with the third, fourth, fifth, or sixth—after the growth of the cow has ceased and when all her powers are devoted to the production of milk.

Calving is an essential condition, as the disturbance of the circulation consequent on the contraction of the womb and the expulsion into the general circulation of the enormous mass of blood hitherto circulating in the walls of the womb fills to repletion the vessels of the rest of the body and very greatly intensifies the already existing plethora. If this is not speedily counterbalanced by a free secretion from the udder, kidneys, bowels, and other excretory organs, the most dire results may ensue. Calving may thus be held to be an exciting cause, and yet the labor and fatigue of the act are not active factors. It is after the easy calving, when there has been little expenditure of muscular or nervous energy and no loss of blood, that the malady is seen. Difficult parturitions may be followed by metritis, but they are rarely connected with parturition fever.

All these factors coincide in intensifying the one condition of plethora and point to that as a most essential cause of the affection. It is needless to enter here into the much-debated question as to the mode in which the plethora brings about the characteristic symptoms and results. As the results show disorder or suspension of the nervous functions mainly, it may suffice to say that this condition of the blood and blood vessels is incompatible with the normal functional activity of the nerve centers. How much is due to congestion of the brain and how much to bloodlessness may well be debated, yet in a closed box like the cranium, in which the absolute contents can not be appreciably increased or diminished, it is evident that, apart from dropsical effusion or inflammatory exudation, there can be only a given amount of blood; therefore, if one portion of the brain is congested, another must be proportionately bloodless; and as congestion of the eyes and head generally and great heat of the head are most prominent features of the disease, congestion of the brain must be accepted. This, of course, implies a lack of blood in certain other parts or blood vessels.

The latest developments of treatment indicate very clearly that the main cause is the production of poisonous, metabolic products (leucomains and toxins) by secreting cells of the follicles of the udder, acting on the susceptible nerve centers of the plethoric, calving cow. Less fatal examples of udder poisons are found in the first milk (colostrum), which is distinctly irritant and purgative, and in the toxic qualities of the first milk drawn from an animal which has been subjected to violent overexertion or excitement. Still more conclusive as to the production of such poisons is the fact that the full distention of the milk ducts and follicles, and the consequent driving of the blood out of the udder and arrest of the formation of depraved products, determines a speedy and complete recovery from the disease. This does not exclude the other causes above named, nor the influence of a reflex nervous derangement proceeding from the udder to the brain.

Symptoms.—It may be said that there are two extreme types of this disease, with intervening grades. In both forms there is the characteristic plethora and more or less sudden loss of voluntary movement and sensation, indicating a sudden collapse of nervous power; in one, however, there is such prominent evidence of congestion of head and brain that it may be called the congestive form par excellence, without thereby intimating that the torpid form is independent of congestion.

In the congestive form there is sudden dullness, languor, hanging back in the stall, or drooping the head, uneasy movements of the hind limbs or tail; if the cow is moved, she steps unsteadily, or even staggers; she no longer notices her calf or her feed; the eyes appear red and their pupils dilated; the weakness increases and the cow lies down or falls and after that is unable to rise. At this time the pulse is usually full, bounding, and the temperature raised, though not invariably so, the head, horns, and ears being especially hot and the veins of the head full, while the visible mucous membranes of nose and eyes are deeply congested.

The cow may lie on her breastbone with her feet beneath the body and her head turned sleepily round, with the nose resting on the right flank; or, if worse, she may be stretched full on her side, with even the head extended, though at times it is suddenly raised and again dashed back on the ground. At such times the legs, fore and hind, struggle convulsively, evidently through unconscious nervous spasm. By this time the unconsciousness is usually complete; the eyes are glazed, their pupils widely dilated, and their lids are not moved when the ball of the eye is touched with the finger. Pricking the skin with a pin also fails to bring any wincing or other response. The pulse, at first from 50 to 70 a minute, becomes weaker and more accelerated as the disease advances. The breathing is quickened, becoming more and more so with the violence of the symptoms, and at first associated with moaning (in exceptional cases, bellowing), it may, before death, become slow, deep, sighing, or rattling (stertorous). The temperature, at first usually raised, tends to become lower as stupor and utter insensibility and coma supervene. The bowels, which may have moved at the onset of the attack, become torpid or completely paralyzed, and, unless in case of improvement, they are not likely to operate again. Yet this is the result of paralysis and not of induration of the feces, as often shown by the semiliquid, pultaceous condition of the contents after death. The bladder, too, is paralyzed and fails to expel its contents. A free action of either bladder or bowels, or of both, is always a favorable symptom. The urine contains sugar, in quantity proportionate to the severity of the attack.

In nearly all cases the torpor of the digestive organs results in gastric disorder; the paunch becomes the seat of fermentation, producing gas, which causes it to bloat like a drum. There are frequent eructations of gas and liquid and solid feed, which, reaching the paralyzed throat, pass in part into the windpipe and cause inflammations of the air passages and lungs.

In the torpid form of the disease there is much less indication of fever or violence. There may be no special heat about the horns, ears, or forehead, nor any marked redness or congestion of the eyes or nose, nor engorgement of the veins of the head. The attack comes on more slowly, with apparent weakness of the hind limbs, dullness, drowsiness, suspension of rumination and appetite, and a general indifference to surrounding objects. Soon the cow lies down, or falls and is unable to rise, but for one or two days she may rest on the breastbone and hold the head in the flank without showing any disorderly movements. Meanwhile there is not only loss of muscular power and inability to stand, but also considerable dullness of sensation, pricking the skin producing no quick response, and even touching the edge of the eyelids causing no very prompt winking. Unless she gets relief, however, the case develops all the advanced symptoms of the more violent form, and the animal perishes.

In advanced and fatal cases of either form the insensibility becomes complete; no irritation of skin or eye meets any response; the eye becomes more dull and glassy; the head rests on the ground or other object; unless prevented the cow lies stretched fully on her side; the pulse is small, rapid, and finally imperceptible; the breathing is slow, deep, stertorous, and the expirations accompanied with puffing is slow, the cheeks, and death comes quietly or with accompanying struggles.

Prevention.—For such fatal disease prevention is of far more consequence than treatment. Among the most efficient preventives may be named a spare diet (amounting to actual starvation in very plethoric, heavy-milking cows) for a week before calving and at least four days after. A free access to salt and water is most important, as the salt favors drinking and the water serves to dilute the rich and dense blood. Iced water, however, is undesirable, as a chill may favor the onset of fever. A dose of Epsom salt (1 to 2 pounds) should be given 12 to 24 hours before calving is due, so that it may operate at or just before that act. In case calving has occurred unexpectedly in the heavy milker, no time should be lost in giving the purgative thereafter. A most important precaution in the fleshy, plethoric cow, or in one that has been attacked at a previous calving, is to avoid drawing any milk from the bag for 12 or 24 hours after calving. Breeders on the island of Jersey have found that this alone has almost abolished the mortality from milk fever. If Epsom salt is not at hand, saltpeter (1 ounce) should be used for several days. Daily exercise is also of importance, and, excepting in midsummer, when the heat of the sun may be injurious, the value of open air is unquestionable. Even in summer an open shed or shady grove is incomparably better than a close, stuffy stall. A rich pasture (clover especially), in May, June, or July, when at its best, is to be carefully avoided. It is better to keep the cow indoors on dry straw with plenty of salt and water than to have access to such pastures.

Treatment.—Treatment of milk fever has been completely revolutionized, with the result that a former mortality of 50 to 70 per cent has been practically abolished. Formerly the most vigorous treatment was practiced by bleeding, purging, the increase of peristalsis by eserin or pilocarpin, enemas, cold in the head, counterirritants, aconite, tartar emetic, sponging, wet-sheet packing, etc. The gross mortality, however, was not materially reduced, and nearly all that were attacked within the first two days after calving perished.

The first step in the modern treatment was made in 1897, when J. Schmidt published his successful treatment by the injection of the teats and milk ducts with a solution of iodid of potassium ($1\frac{1}{2}$ drams to 1 quart of water). This reduced the mortality to 17 per cent. Others followed this lead by the injection of other antiseptics (lysol, creolin, creosol, chinosol, common salt, etherized air, oxygen). These succeeded as well as the iodid solution. With the injection of gases, however, a fuller distention of the udder was usually secured, and virtually every case recovered. This suggested the full distention of the udder with common atmospheric air filtered and sterilized, and this with the most perfect success. With sterile air Schmidt-Kolding claimed 96.7 per cent recoveries in 914 cases.

In America the full distention of the udder, whether with oxygen or filtered air, has proved invariably successful in all kinds of cases, including the violent ones that set in within a few hours after calving. In 1 or 2 hours after the injection the cow has got up, had free passages from the bowels and bladder, bright expression of countenance, and some return of appetite. In my cases which had made no response for 8 hours to the iodid injection, the injection of the udder to full repletion with the gas (oxygen or air) has had immediately beneficial results. A similar full distention of the bag with a common-salt solution (0.5 to 100), or even with well-boiled water, is equally effective, but in these cases the weight of the liquid causes dragging upon the udder and a measure of discomfort which is escaped under the treatment with gas.

The value of each method depends on the fullness of distention of the udder and the arrest in larger part of the circulation and chemical changes in its tissues. This distention acts like magic, and seems hardly to admit of failure in securing a successful outcome.

It can not, however, be recommended as absolutely devoid of dangers and serious complications. To get the best results it should be applied only by one who has been trained in the careful antiseptic methods of the bacteriological laboratory. Some readers will recall the case of the injection of the udders of show cows at Toronto to impose upon the judges. The cows treated in this way had the udders infected and ruined, and several lost their lives. There is no better culture medium for septic and other germs than the first milk (colostrum) charged with albumin and retained in the warm udder. Already in the hands of veterinarians even the Schmidt treatment has produced a small proportion of cases of infective mammitis. How many more such cases will develop if this treatment becomes a popular domestic resort, applied by the dairyman himself in all sorts of surroundings and with little or no antiseptic precautions? Even then, however, the losses will by no means approach the past mortality of 50 to 70 per cent, so that the economy will be immeasurable under even the worst conditions. A fair test and judgment of this treatment, however, can be obtained only when the administrator is trustworthy and painstaking, well acquainted with bateriological antisepsis and with the general and special pathology of the bovine animal.

The necessary precautions may be summarized as follows:

(1) Provide an elastic rubber ball and tubes furnished with valves to direct the current of air, as in a common Davidson syringe.

(2) Fill the delivery tube for a short distance with cotton sterilized by prolonged heating in a water bath.

(3) In the free end of the delivery tube fit a milking tube to be inserted into the teat.

(4) Sterilize the entire apparatus by boiling for 30 minutes, and, without touching the milking tube, wrap it in a towel that has been sterilized in a water bath or in live steam and dried.

(5) Avoid drawing any milk from the teats; wash them and the udder thoroughly with warm soapsuds; rinse off with well-boiled and cooled water, and apply to the teats, and especially to their tips, a 5 per cent solution of carbolic acid or lysol, taking care that the teats are not allowed to touch any other body from the time they are cleansed until the teat tube is inserted. It is well to rest the cleansed and disinfected udder on a sterilized pad of cotton or a boiled towel.

(6) The injecting apparatus is unwrapped; the teat tube, seized by its attached end and kept from contact with any other body, is inserted into the teat, while an assistant working the rubber pump fills the quarter as full as it will hold. The tube is now withdrawn and a broad tape is tied around the free end of the teat to prevent escape of the air.

(7) The teat tube, which has been carefully preserved from possible contact with other bodies, is dipped in the carbolic acid solution and inserted in a second teat, and the second quarter is inflated, and so with the third and fourth.

(8) The recumbent cow is kept resting on her breastbone, with the head elevated, even if it should be necessary to pack around her with straw bundles or to suspend the head by a halter. When lying on her side she is liable to develop fatal bloating and to have belching of gas and liquids, which, passing down the windpipe, cause fatal bronchopneumonia.

(9) If in 2 hours the cow is not on her feet, if there is no brighter or more intelligent expression, if she has passed no manure or urine, and if the air has become absorbed, leaving the udder less tense, the injection of the bag may be repeated, under the same scrupulous and rigid precautions as at first. In all cases, but especially in severe ones, it is well to keep watch of the patient, and to repeat the distention on the first indication of relapse. Should there not be a free discharge of feces and urine after rising, indicating a natural resumption of the nervous functions, the case should be all the more carefully watched, so that the treatment may be repeated if necessary.

Accessory treatment may still be used, but is rarely necessary. A dose of purgative medicine ($1\frac{1}{2}$ pounds of Epsom salt) in warm water may be given in the early stages, while as yet there is no danger of its passing into the lungs through paralysis of the throat. Eserin or pilocarpin ($1\frac{1}{2}$ grains) may be given under the skin to stimulate the movements of the bowels. Sponging the skin, and especially the udder, with cool water, may be resorted to in hot weather.

Bloating may demand puncture of the paunch, in the left flank, with a cannula and trocar, the evacuation of the gas, and the introduction through the tube of a tablespoonful of strong liquid ammonia in a quart of cold water or other antiferment.

The economic value of the new treatment of milk fever is enormous. The United States has more than 22,000,000 milk cows. If we could raise their quality by preserving and breeding from the largest producers of both milk and butterfat, in place of losing the best by milk fever, as in the past, and if we could thus obtain an average increase of 2 quarts a day, the proceeds at 3 cents a quart would amount to $130,000,000 a year.

PALSY AFTER CALVING (DROPPING AFTER CALVING).

This consists in a more or less complete loss of control of the hind limbs occurring after calving, and caused by low condition, weakness, and exposure to cold or to injurious compression of the nerves of the hind limbs by a large calf passing through the pelvis. Its symptoms do not differ from those of palsy of the hind limbs, occurring at other times, and it may be treated in the same way, except so far as bruises of the vagina may demand special smoothing treatment.

CONGESTION OF THE UDDER (GARGET).

In heavy milkers, before and just after calving, it is the rule that the mammary gland is enlarged, hot, tense, and tender, and that a slight exudation or pasty swelling extends forward from the gland on the lower surface of the abdomen. This physiological congestion is looked upon as a matter of course, and disappears in two or three days when the secretion of milk has been fully established. This breaking up of the bag may be greatly hastened by the sucking of a hungry calf and the kneading it gives the udder with its nose, by stripping the glands clean thrice daily, and by active rubbing at each milking with the palm of the hand, with or without lard or, better, with camphorated ointment.

The congestion may be at times aggravated by standing in a draft of cold air or by neglect to milk for an entire day or more (overstocking, hefting) with the view of making a great show of udder for purposes of sale. In such cases the surface of the bag pits on pressure, and the milk has a reddish tinge or even streaks of blood, or it is partially or fully clotted and is drawn with difficulty, mixed, it may be, with a yellowish serum (whey) which has separated from the casein. This should be treated like the above, though it may sometimes demand fomentations with warm water to ward off inflammation, and it may be a week before the natural condition of the gland is restored.

INFLAMMATION OF THE UDDER (SIMPLE MAMMITIS).

Congestion may merge into active inflammation, or it may arise direct, in connection with exposure to cold or wet, with standing in a cold draft, with blows on the udder with clubs, stones, horns, or feet, with injury from a sharp or cold stone, or the projecting edge of a board or end of a nail in the floor, with sudden and extreme changes of weather, with overfeeding on rich albuminous feed like cotton seed, beans, or peas, with indigestions, with sores on the teats, or with insufficient stripping of the udder in milking. In the period of full milk the organ is so susceptible that any serious disturbance of the general health is liable to fall upon the udder.

Symptoms.—The symptoms and mode of onset vary in different cases. When following exposure there is usually a violent shivering fit, with cold horns, ears, tail, and limbs, and general erection of the hair. This is succeeded by a flush of heat (reaction) in which the horns, ears, and limbs become unnaturally warm and the gland swells up and becomes firm and solid in one, two, three, or all four quarters. There is hot dry muzzle, elevated temperature, full, accelerated pulse, and excited breathing, impaired or suspended appetite and rumination, with more or less costiveness, suppression of urine, and a lessened yield of milk, which may be entirely suppressed in the affected quarter.

In other cases the shivering escapes notice, the general disorder of the system is little marked or comes on late, and the first observed sign of illness is the firm swelling, heat, and tenderness of the bag. As the inflammation increases and extends, the hot, tender udder causes the animal to straddle with its hind limbs, and, when walking, to halt on the limb on that side. If the cow lies down it is on the unaffected side. With the increase in intensity and the extension of the inflammation the general fever manifests itself more prominently. In some instances the connective tissue beneath the skin and between the lobules of the gland is affected, then the swelling is uniformly rounded and of nearly the same consistency, pitting everywhere on pressure. In other cases it primarily attacks the secreting tissue of the gland, then the swelling is more localized and appears as hard, nodular masses in the interior of the gland. This last is the usual form of inflammation occurring from infection entering by the teats.

In all cases, but especially in the last-named form, the milk is suppressed and replaced by a watery fluid colored with blood (sometimes deeply) and mingled with masses of clotted casein. Later it becomes white and purulent, and in many cases of an offensive odor.

The course of the disease is sometimes so rapid and at others so slow that no definite rule can be laid down. In two or three days, or from that to the end of the week, the bag may soften, lose its heat and tenderness, and subside into the healthy condition, even resuming the secretion of milk. The longer the inflammatory hardness continues the greater the probability that its complete restoration will not be effected. When a portion of the gland fails to be restored in this way, and has its secretion arrested, it usually shrinks to a smaller size. More commonly a greater quantity of the inflammatory product remains in the gland and develops into a solid, fibrous mass, causing permanent hardening (induration). In other cases, in place of the product of inflammation developing into a fibrous mass, it softens and breaks down into white, creamy, liquid pus (abscess). This abscess may make its way to the surface and escape externally, or it may burst into a milk duct and discharge through the teat. It may break into both and establish a channel for the escape of milk (fistula). In the worst types of the disease gangrene may ensue, a quarter or half or even the whole udder, losing its vitality, and sloughing off if the cow can bear up against the depressing influence. These gangrenous cases are probably always the result of infection and sometimes run a very rapidly fatal course. I remember one to which I was called as soon as the owner noticed it, yet I found one-quarter dark blue, cold, and showing a tendency to the formation of blebs containing a bloody secretion. The cow, which had waded through a depth of semiliquid manure to reach her stall, died within 24 hours.

Treatment.—Treatment varies with the type and the stage of the disease. If the case is seen in the shivering fit, every effort should be made to cut it short, as the inflammation may be thereby greatly moderated, if not checked. Copious drinks of warm water thrown in from horn or bottle; equally copious warm injections; the application of heat in some form to the surface of the body (by a rug wrung out of hot water; by hanging over the back and loins bags loosely filled with bran, sand, salt, chaff, or other agent previously heated in a stove; by the use of a flatiron or the warming of the surface by a hot-air bath), or by active friction with straw wisps by two or more persons; the administration of 1 ounce of ground ginger may serve to shorten the attack. After half an hour's sweat the animal should be rubbed and covered with a dry blanket.

If, on the other hand, there is little or no fever, and only a slight inflammation, rub well with camphorated ointment or a weak iodin ointment, and milk three, four, or six times a day, rubbing the bag thoroughly each time. Milking must be done with great gentleness, squeezing the teat in place of pulling and stripping it, and if this causes too much pain, the teat tube (Pl. XXIV, fig. 4) or the spring teat dilator (Pl. XXIV, fig. 3) may be employed. Antiseptic injections of the teats and udder are often useful, and iodoform in water has been especially recommended. It may be replaced by one of the injections advised for parturition fever, used with the same careful precautions.

In cases in which the fever has set in and the inflammation is more advanced, a dose of laxative medicine is desirable (Epsom salt, 1 to 2 pounds; ginger, 1 ounce), which may be followed, after the purging has ceased, by daily doses of saltpeter, 1 ounce. Many rely on cooling and astringent applications to the inflamed quarter (vinegar, sugar-of-lead lotion, cold water, ice, etc.), but a safer and better resort is continued fomentation with warm water. A bucket of warm water, replenished as it cools, may be set beneath the udder, and two persons can raise a rug out of this and hold it against the udder, dipping it anew whenever the temperature is somewhat lowered. A sheet may be passed around the body, with holes cut for the teats, soft rags packed between it and the udder, and kept warm by pouring water on every 10 or 15 minutes, as warm as the hand can bear. When this has been kept up for an hour or two, the bag may be dried, well rubbed with soap, and left thus with a soapy coating. If the pain is great, extract of belladonna may be applied along with the soap, and a dry suspensory bandage with holes for the teats may be applied. Strong, mercurial ointment is very useful in relieving pain and softening the bag. This is especially valuable when the disease is protracted and induration threatens. It may be mixed with an equal quantity of soap and half as much extract of belladonna. In cases of threatened induration excellent results are sometimes obtained from a weak-induction current of electricity sent through the gland daily for 10 minutes.

If *abscess* threatens, it may be favored by fomentation and opened as soon as fluctuation from finger to finger shows the formation of matter at a point formerly hard. The wound may bleed freely, and there is a risk of opening a milk duct, yet relief will be obtained; also a dressing twice daily with a lotion of carbolic acid 1 part, water 20 parts, and glycerin 1 part will suffice to keep the wound clean and healthy.

Gangrene of the affected part is often fatal. It demands antiseptics (chlorid of zinc, 1 dram to 1 quart water) applied frequently to the part, or, if the case can not be attended, smear the affected quarter with Venice turpentine, melted, or even wood tar. Antiseptic tonics (tincture of chlorid of iron, 4 drams) may also be given four times daily in a quart of water.

CONTAGIOUS MAMMITIS (CONTAGIOUS INFLAMMATION OF THE UDDER).

As stated in the last article, that form of inflammation of the udder which attacks the gland ducts and follicles, causing deep-seated, hard, nodular swellings, is often contagious. Franck has demonstrated this by injecting into the milk ducts in different cows (milking and dry) the pus from the bags of cows affected with mammitis, or the liquids of putrid flesh, or putrid blood, and in every case he produced acute inflammation of the gland tissue within twenty-four hours. He thinks that in ordinary conditions the septic germ gains access by propagating itself through the milk, filling the milk canal and oozing from the external orifice. He points to this as a reason why dry cows escape the malady, though mingling freely with the sufferers, and why such dry cows do not suffer from inflammation of the gland tissue when attacked with foot-and-mouth disease. In this last case it is evident that it is not simply the inoculation with the milker's hand that is lacking, for the skin of the bag is attacked, but not its secreting, glandular parts. Now that in any case of abscess we look for the cause in the chain forms of globular bacteria (*Streptococcus pyogenes*), in the cluster form of white, globular bacteria (*Staphylococcus pyogenes albus*), and in the golden and citron-yellow forms of clustered globular bacteria (*Staphylococcus pyogenes aureus* and *Staphylococcus pyogenes citreus*), the formation of pus gives presumptive evidence of the action of one or more of these germs. So in cases of mortification of the bag; in the very occurrence there is fair circumstantial evidence of the presence of erysipelas micrococcus or other germ which kills the local tissues. Again, in tuberculosis affecting the bag (a not uncommon condition), the active local cause is without doubt the tubercle bacillus.

It has been found that false membranes have formed in certain cases of mammitis in the cow, and Klein, after inoculating the diphtheria of man on the cow, found an ulcerous sore in the seat of inoculation and blisters on the teats and udder, in which he found what he believed to be the bacillus of diphtheria. The results are doubtful, even in the absence of false membranes. Löffler, too, in the diphtheria of calves, found that the germ was longer and more delicate than that of man, and that its pathogenesis for rodents was less, guinea pigs having only a nonfatal abscess. The presence of false membranes in one form of mammitis in cows does not necessarily imply its communicability to man.

It has been asserted that scarlet fever has been transmitted from the cow to man, and it can not be denied that in many cases the infection has been spread by means of the milk. The facts, however, when brought out fully have shown that in almost every case the milk had first come into contact with a person suffering or recovering from scarlet fever, so that the milk was infected after it left the cow. The alleged exceptional cases at Hendon and Dover, England, are not conclusive. In the Hendon outbreak inoculations were made on calves from the slight eruption on the cow's teats, and they had a slight eruption on the lips and a form of inflammation of the kidneys, which Dr. Klein thought resembled that of scarlatina. The cows that had brought the disease to the Hendon dairies were traced back to Wiltshire, where cows were found suffering from a similar malady, but no sign of scarlet fever resulted. In the Dover outbreak the dairyman first denied any disease in his cows, and brought a certificate of a veterinarian to prove that they were sound at the time of the investigation; then later he confessed that the cows had had foot-and-mouth disease some time before, and consequent eruption on the teats. So the question remains whether the man who denied sickness in the cows to begin with, and adduced professional evidence of it, did not later acknowledge the foot-and-mouth disease as a blind to hide the real source of the trouble in scarlatina in his own family or in the family of an employee.

In America Dr. Stickler said that he had produced scarlatina in children by inoculation with imported virus of foot-and-mouth disease, but his contention is negatived by the facts that with foot-and-mouth disease constantly present in Europe scarlatina does not accompany it, and that in America, with scarlatina constantly prevailing at some point, foot-and-mouth disease is unknown locally except at long intervals and as the result of the importation of infected animals or their products. Man is susceptible to foot-and-mouth disease, but it never appears during the frequent epidemics of scarlatina.

Among other contagious forms of mammitis I may name one which I have encountered in large dairies, starting as a sore and slight swelling at the opening of the teat and extending up along the milk duct to the gland structure in the bag, all of which become indurated, nodular, and painful. The milk is entirely suppressed in that quarter of the bag, and from that it may extend to the others as it does from cow to cow through the milker's hands.

Another form almost universally prevalent in this district of central New York in 1889 broke out on the teats and udders as blisters strongly resembling cowpox, but which were not propagated when inoculated on calves. It was only exceptionally that this extended through the teat to the gland tissue, yet in some instances the bag was lost from this cause. Scarlatina in man was very prevalent at the time (many schools were closed in consequence), but no definite connection seemed to exist between this and the cow disease, and on different dairy farms there were families of young children that had never had scarlet fever and who did not at that time contract it.

The most common cause of contagious mammitis in cattle is a spherical bacterium in chain form (*Streptococcus*) (Moore, Ward). Yet it is clear that contagious mammitis is not a single affection, but a group of diseases which have this in common, that they attack the udder.

Prevention.—Prevention is to be especially sought in all such cases. In purchasing new cows see that they come from a herd where the teats and udder are sound. If a new cow with unknown antecedents comes from a public market, let her be milked for a week by a person who does not milk any other cows. Keep her in a separate stall from others, so that there may be no infection from litter or flooring. Wash the udder with soap and water, and wet with a solution of two teaspoonfuls of carbolic acid in a pint of water before letting the regular milker of the other cows take her. If any cow in the herd shows the indurated end of the teat or the inflammation and nodular tender character of the gland, sequestrate her at once and give her a separate milker. If another cow is to be put into the stall she occupied, first clean and scrape it, and wet it with a strong solution of bluestone, 5 ounces in a gallon of water. The milk may be drawn off with a teat tube, or spring teat dilator (Pl. XXIV, figs. 3 and 4), and the milk ducts injected frequently with a solution of peroxid of hydrogen or iodoform. I have had little success in checking the upward progress of the disease through the teat with carbolic acid or boric-acid solutions. Used on the outside of the other teats, however, they may serve to prevent them from becoming infected. In the absence of peroxid of hydrogen the affected teat may be injected with a solution of 1 grain corrosive sublimate in a pint of water, and the same may be used on the other teats, provided it is washed off every time before milking.

As additional precautions, no cow with a retained afterbirth or unhealthy discharge from the womb should be left with the other cows. Such cows doubtless infect their own udders and those of the cows next them by lashing with the soiled tail. If milkers handle retained afterbirth or vaginal discharge, or unhealthy wounds, or assist in a difficult and protracted parturition, they should wash the hands and arms thoroughly with soap and warm water and then rub them with the corrosive-sublimate solution, or if not, at least with one of carbolic acid. Clothes stained with such offensive products should be thoroughly washed.

The general treatment of contagious mammitis does not differ from that of the simple form, except that antiseptics should be given by the mouth as well as applied locally (hyposulphite of soda, one-half ounce daily).

COWPOX.

This is another form of contagious inflammation of the udder which does not spread readily from animal to animal except by the hands of the milker. It is held to occur spontaneously in the cow, but this is altogether improbable, and so-called spontaneous cases are rather to be looked on as instances in which the germs have been preserved dry in the buildings or introduced in some unknown manner. It is not uncommon in the horse, attacking the heels, the lips, or some other inoculated part of the body, and is then easily transferred to the cow, if the same man grooms and dresses the horse and milks the cow. It may also appear in the cow by infection, more or less direct, from a person who has been successfully vaccinated. Many believe that it is only a form of the smallpox of man modified by passing through the system of cow or horse. It is, however, unreasonable to suppose that this alleged modified smallpox could have been transmitted from child to child (the most susceptible of the human race) for 90 years, under all possible conditions, without once reverting to its original type of smallpox. Chauveau's experiments on both cattle and horses with the virus of smallpox and its inoculation back on the human subject go far to show that in the climate of western Europe, at least, no such transformation takes place. Smallpox remains smallpox and cowpox, cowpox. Again, smallpox is communicable to a person who visits the patient in his room but avoids touching him, while cowpox is never thus transferred through the air unless deliberately diffused in the form of spray.

The disease in the cow is ushered in by a slight fever, which, however, is usually overlooked, and the first sign is tenderness of the teats. Examined, these may be redder and hotter than normal, and at the end of two days there appear little nodules, like small peas, of a pale-red color, and increasing so that by the seventh day they may measure three-fourths of an inch to 1 inch in diameter. The yield of milk diminishes, and when heated it coagulates slightly.

From the seventh to the tenth day the eruption forms into a blister, with raised margins and a depression in the center, and from which the whole of the liquid can not be drawn by a single puncture. The blister, in other words, is chambered, and each chamber must be opened to evacuate the whole of the contents. If the pock forms on a surface where there is thick hair it does not rise as a blister, but oozes out a straw-colored fluid which concretes on the hairs in an amber-colored mass. In one or two days after the pock is full it becomes yellow from contained pus and then dries into a brownish-yellow scab, which finally falls, leaving one or more distinct pits in the skin. Upon the teats, however, this regular course is rarely seen: the vesicles are burst by the hands of the milker as soon as liquid is formed, and as they continue to suffer at each milking they form raw, angry sores, scabbing more or less at intervals, but are slow to undergo healing.

The only treatment required is to heal the sores. As milking is the main cause of their persistence, that must be done as gently as possible, or even with the teat tube or dilator. (Pl. XXIV, figs. 3 and 4.) It is essential to check the propagation of the germ, and for this purpose the sore teats may be washed frequently with a solution of half an ounce hyposulphite of soda in a pint of water. This will usually check the inflammation and cut short the malady.

SUPPRESSION OF MILK.

The absence of milk in the udder may result from ill health, debility, emaciation, chronic disease of the bag, wasting of the gland from previous disease, or insufficient feed, but sometimes it will occur suddenly without any appreciable cause. The treatment consists in removing the cause of the disease, giving rich albuminoid feed made into warm mashes, and administering ounce doses of aromatic carminatives, like anise seed, fennel seed, etc. Rubbing and stripping the udder are useful; the application of oil of lavender or of turpentine, or even a blister of Spanish flies, will sometimes succeed.

BLOODY MILK.

Blood may escape with the milk when the udder has been injured by blows; also when it is congested or inflamed, when the circulation through it has been suddenly increased by richer and more abundant feed, or when the cow is under the excitement of heat. The milk frothing up and assuming a pink tinge is often the first sign of red water, and it may result from eating acrid or irritant plants, like the Ranunculaceæ, resinous plants, etc. Deposits of tubercle or tumors in the udder, or induration of the gland, may be efficient causes, the irritation caused by milking contributing to draw the blood. Finally, there may be a reddish tinge or sediment when madder or logwood has been eaten.

In milk which becomes red after it is drawn it may be from the presence in it of the *Bacillus prodigiosus*. This also grows on bread, and is the explanation of the supposed miracle of the "bleeding host."

The treatment will vary with the cause. In congested glands give 1 pound of Epsom salt, and daily thereafter one-half ounce saltpeter, with a dram of chlorate of potassium; the bag should be bathed with hot or cold water, and rubbed with camphorated lard. If the feed is too rich or abundant it must be reduced. If from acrid plants, they must be removed from pasture or fodder. Induration of the udder may be met by rubbing with a combination of iodin ointment 1 part, soft soap 2 parts; mercurial ointment and soap also may be used. Careful milking is imperative.

BLUE MILK.

Watery milk is blue, but the presence of a germ (*Bacillus cyanogenes*) causes a distinct blue shade even in rich milk and cream. It may reach the milk after it has been drawn, or it may find its way into the opening of the milk ducts and enter the milk as it is drawn. In the latter case frequent milking and the injection of a solution of 2 drams of hyposulphite of soda in a pint of water into the teats will serve to destroy the germs.

STRINGY MILK.

This may be caused by fungi developing in the liquid, and that the spores are present in the system of the cow may be safely inferred from the fact that in a large herd two or three cows only will yield such milk at a time, and that after a run of 10 days or a fortnight they will recover and others will be attacked. I have found that such affected cows had the temperature raised one or two degrees above the others. Like most other fungi this does not grow out into filaments within the body of the cow, but in five or six hours after milking the surface layers are found to be one dense network of filaments. If a needle is dipped in this and lifted the liquid is drawn out into a long thread. In one case which I investigated near Ithaca, N. Y., the contamination was manifestly from a spring which oozed out of a bank of black-muck soil and stood in pools mixed with the dejections of the animals. Inoculation of pure milk with the water as it flowed out of this bank developed in it the fungus and the stringy characters. By fencing the spring in and giving the affected cows each 2 drams bisulphite of soda daily, the trouble was arrested promptly and permanently.

CHAPPED TEATS.

These may be caused by anything which irritates them. The powerful sucking of the calf; the sudden chilling of the teat in winter after the calf has just let it go or after the completion of milking with a wet hand; contact with cold water or stagnant, putrid water, or with filth or irritants when lying down; slight congestions of the skin in connection with overstocking; indeed, any source of local irritation may cause chapping. This may be slight or extend into great, gaping sores and induce retention of milk or even mammitis. Soothing applications of vaseline or a combination of equal parts of spermaceti and oil of sweet almonds may be applied. If healing is tardy, add 10 grains balsam of Peru to the ounce of ointment. If the irritation is very great, wash first with a solution of 1 dram sugar of lead in 1 pint of water and then apply benzoated zinc-oxid ointment.

WARTS ON THE TEATS.

These are often very troublesome, yet they may be greatly benefited or entirely removed by smearing them thickly with pure olive oil after each milking. If they persist they may be cut off with a pair of sharp scissors and the sore touched with a stick of lunar caustic. They may now be oiled and the caustic repeated as demanded to prevent their renewed growth.

Scabby teats may be smeared with vaseline containing carbolic acid enough to give it an odor.

TEAT BLOCKED BY CONCRETION OF CASEIN.

Under unhealthy conditions of the gland or milk ducts clots of casein form which, pressed clear of most of their liquid and rolled into rounded masses, may block the passage. They can be moved up and down by manipulation of the teat, and if they can not be pressed out they may be extracted by using the spring teat dilator (Pl. XXIV, fig. 3), being held surrounded by its three limbs. Before extraction is attempted an ounce of almond oil, boiled, should be injected into the teat.

TEAT BLOCKED BY CALCULUS.

When the calcareous matter of the milk has been precipitated in the form of a smooth, rounded stone, a rough, conglomerated concretion, or a fine, sandlike débris, it may cause obstruction and irritation. These bodies are felt to be much harder than those formed by casein, and the milk usually contains gritty particles. Extraction may be attempted, in the case of the finely divided gritty matter, by simple milking or with the spring dilator (Pl. XXIV, fig. 3) in the case of the larger masses. Should this fail the teat may be laid open with the knife and sewed up again or closed with collodion, but such an operation is best deferred until the cow is dry.

TEAT BLOCKED BY A WARTY OR OTHER GROWTH INSIDE.

In this case the obstruction may be near the orifice of the teat or farther up, and the solid mass is not movable up and down with the same freedom as are concretions and calculi. The movement is limited by the elasticity of the inner membrane of the teat from which it grows, and is somewhat freer in certain cases because the growth has become loose and hangs by a narrow neck. In the case of the looser growths they may be snared by a fine, spring wire passed as a loop through a fine tube (like a teat tube open at each end) and introduced into the teat. When this can not be done, the only resort is to cut in and excise it while the cow is dry.

THICKENING OF THE MUCOUS MEMBRANE AND CLOSURE OF THE MILK DUCT.

As a result of inflammation extending from without inward, a gradual narrowing of the milk duct may occur from thickening and narrowing of its lining membrane. This may be limited to a small area near the lower end, or it may extend through the whole length of the teat. The stream of milk becomes finer and finer until it finally ceases altogether, and a firm cord is felt running through the teat. If the constriction is only at the outlet, the teat may be seized and distended by pressing the milk down into it from above, and an incision may be made with a sharp penknife in two directions at right angles to each other and directly in the original opening. The knife should be first cleansed in boiling water. The opening may be kept from closing by a dumb-bell shaped bougie of gutta-percha (Pl. XXIV, fig. 5) or by the spring dilator. If the obstruction is more extended it may be perforated by Lüthi's perforating sound. (Pl. XXIV, fig. 1A and 1B.) This is a steel wire with a ring at one end, and at the other is screwed on to the wire a conical cap with sharp cutting edges at the base, which scrapes away the thickened masses of cells as it is drawn back. This may be passed again and again to enlarge the passages sufficiently, and then the passage may be kept open by wearing a long, dumb-bell bougie, a thick piece of carbolized catgut, or a spring dilator. If the passage can not be sufficiently opened with the sound it may be incised by the hidden bistoury. (Pl. XXIV, fig. 2.) This is a knife lying alongside a flattened protector with smooth, rounded edges, but which can be projected to any required distance by a lever on the handle. The incisions are made in four directions, as deep as may be necessary, and the walls then can be held apart by the spring dilator until they heal. In case the constriction and thickening of the canal extend the whole length of the teat, it is practically beyond remedy, as the gland is usually involved so as to render it useless.

CLOSURE OF THE MILK DUCT BY A MEMBRANE.

In this form the duct of the teat is closed by the constriction of its lining membrane at one point, usually without thickening. The closure usually takes place while the cow is dry; otherwise its progress is gradual, and for a time the milk may still be pressed through slowly. In such case, if left at rest, the lower part of the teat fills up and the milk flows in a full stream at the first pressure, but after this it will not fill up again without sufficient time for it to filter through. This is to be cut open by the hidden bistoury (Pl. XXIV, fig. 2), which may be first passed through the opening of the membrane, if such exists. If not it may be bored through, or it may be pressed up against the membrane at one side of the teat and opened toward the center, so as to cut its way through. Incisions should be made in at least two opposite directions, and the edges then may be held apart by wearing the spring dilator until healing has been completed.

In all cases of operations on the teats the instruments must be thoroughly disinfected with hot water, or by dipping in carbolic acid and then in water that has been boiled.

OPENING IN THE SIDE OF THE TEAT (MILK FISTULA).

This may occur from wounds penetrating the milk duct and failing to close, or it may be congenital, and then very often it leads to a distinct milk duct and an independent portion of the gland. In the first form it is necessary only to dissect away the skin leading into the opening for some distance down, to close the orifice with stitches, and to cover the whole with collodion. A teat tube or spring dilator may be worn to drain the milk off and prevent distention and reopening of the orifice. In case of an independent milk duct and gland one of two courses may be selected—to open the one duct into the other by incision and then close the offending opening, or to inject the superfluous gland through its duct with a caustic solution, so as to destroy its secreting power. In both cases it is desirable to wait until the cow goes dry.

DISEASES FOLLOWING PARTURITION.

DESCRIPTION OF PLATES.

PLATES XXII, XXIII. Supports for prolapsed uterus. These illustrations show various appliances used in prolapse or inversion of the uterus. The uterus should first be returned to its proper situation and then some apparatus applied to prevent a recurrence of the inversion or protrusion.

PLATE XXII:

Fig. 1. Crupper, strap truss. (From Hill's Bovine Medicine and Surgery.)

Fig. 2. Renault's rope truss. The rope for this truss should be from 25 to 30 feet long and about the thickness of the little finger.

PLATE XXIII:

Fig. 1. Cow to which Delwart's rope truss has been applied.

Fig. 1*a* shows the loop of Delwart's truss.

Fig. 2. Zundel's labial sutures. These consist of two wires passed through the lips of the vulva in a horizontal direction, and two additional wires passed through the loops at the ends of the horizontal wires in order to hold them in place.

Fig. 3. Iron truss for holding the vagina or uterus in place after calving. The cords are passed through the eyes at the corners of the triangular iron; the base of the triangle fits under the tail. The truss is from 5 to 7 inches long and about 2½ inches wide.

PLATE XXIV. Instruments used in diseases following parturition.

Fig. 1. Lüthi's perforating sound, for opening the milk canal through the teat when this has become occluded; A, the sound one-half the natural size; B, section of head of sound, natural size, showing cutting edge.

Fig. 2. Bistouri caché. A blade hidden in its sheath which by pressure of the finger may be made to protrude a certain distance. This distance is regulated by the screw near the handle. The instrument is used to open the milk canal when closed up. It is introduced into the milk canal with its blade in the sheath and withdrawn with the blade protruding.

Fig. 3. Spring teat dilator, about one-half natural size, for dilating the milk canal.

Fig. 4. Ring teat syphon, for withdrawing milk when the teat is sore or injured.

Fig. 5. Gutta-percha bougie, for dilating the opening of the teat.

Fig. 6. Truss applied to calf for umbilical or navel hernia. (From Fleming's Veterinary Obstetrics.)

Fig. 7. Armatage's iron clamp for umbilical or navel hernia. When this clamp is applied care must be taken not to include a portion of the bowel.

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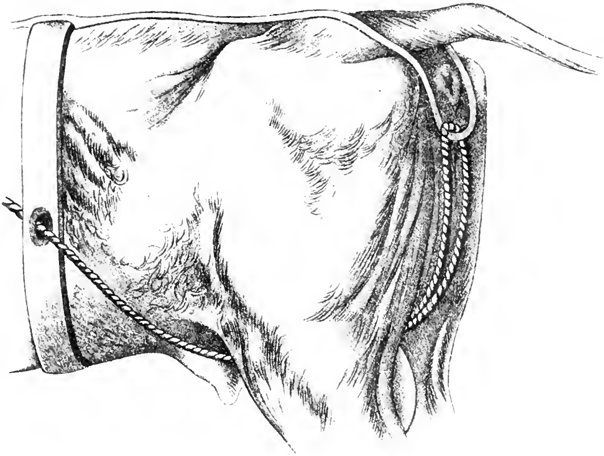

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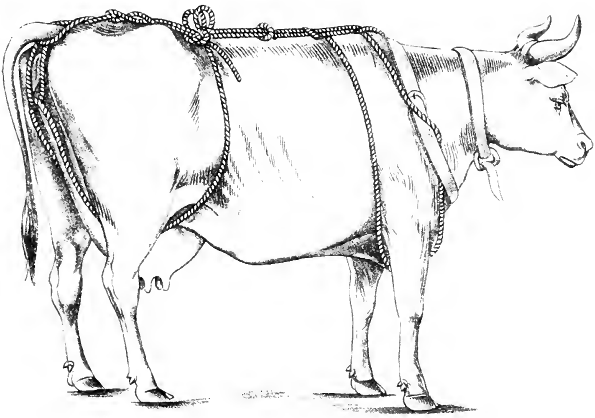
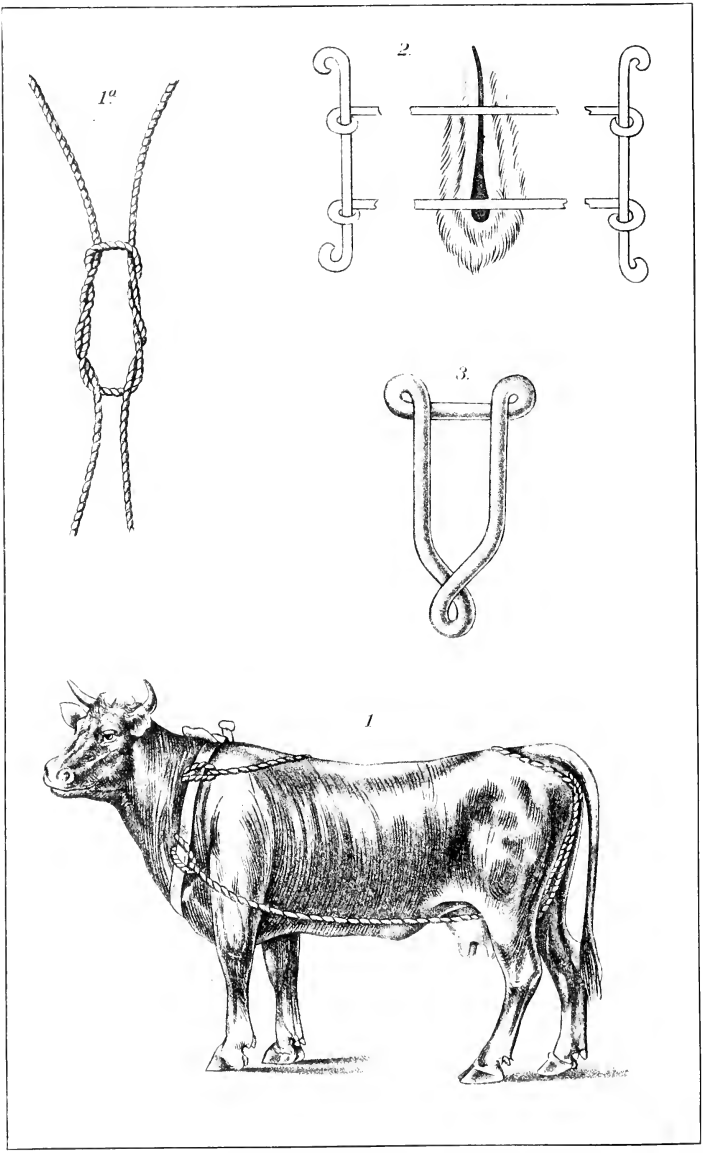
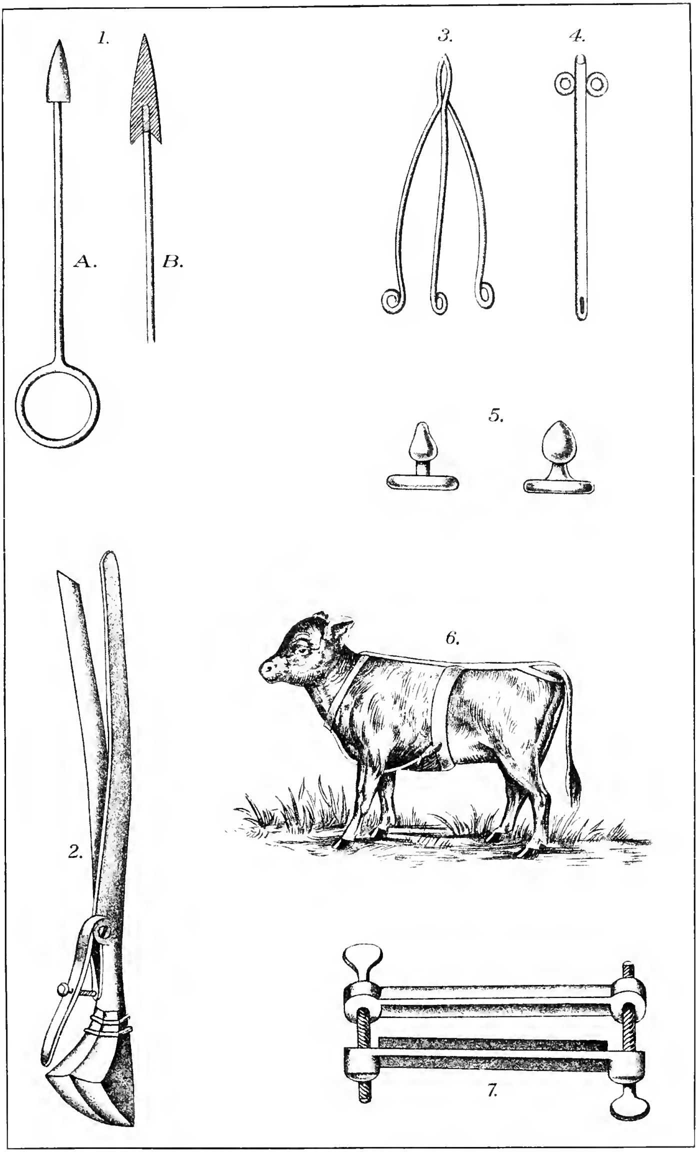


Supports for Prolapsed Uterus.



SUPPORTS FOR PROLAPSED UTERUS.



INSTRUMENTS USED IN DISEASES FOLLOWING PARTURITION.

DISEASES OF YOUNG CALVES.

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SUSPENDED BREATHING.

The moment the circulation through the navel string is stopped the blood of the calf begins to become overcharged with carbon dioxid (CO_2), and unless breathing is speedily established death promptly follows. Fortunately the desire to breathe, roused by the circulation of the venous blood and the reflex action from the wet and chilling skin, usually starts the contractions of the diaphragm at once and life is insured. Among the obstacles to breathing may be named suffocation before or during birth from compression of the navel cord and the arrest of its circulation; the detachment of the fetal membranes from the womb before the calf is born; a too free communication between the two auricles (foramen ovale) of the heart by which the nonaerated blood has mixed too abundantly with the aerated and induced debility and profound weakness; a condition of ill health and debility of the calf as a result of semistarvation, overwork, or disease of the cow; fainting in the debilitated calf when calving has been difficult and prolonged; the birth of the calf with its head enveloped in the fetal membranes, so that it has been unable to breathe, and the presence of tenacious phlegm in the mouth and nose, acting in the same manner.

Besides the importance of proper care and feeding of the cow as a preventive measure, attention should be given at once to relieve the newborn calf of its investing membrane and of any mucus that has collected in mouth or nostrils. Wiping out the nose deeply with a finger or feather excites to sneezing, hence to breathing. Blowing into the nose has a similar effect. Sucking the nostril through a tube applied to it is even more effective. Slapping the chest with the palm of the hand or with a towel dipped in cold water, compression and relaxation alternately of the walls of the chest, may start the action, and ammonia or even tobacco smoke blown into the nose may suffice. Every second is precious, however, and if possible the lungs should be dilated by forcibly introducing air from a bellows or from the human lungs. As the air is blown in through bellows or a tube the upper end of the windpipe must be pressed back against the gullet, as otherwise the air will go to the stomach. In a large dairy a piece of elastic tubing one-third of an inch in bore should be kept at hand for sucking and blowing in such cases.

BLEEDING FROM THE NAVEL.

This may occur in two conditions—when the cord is cut off too close to the navel and left untied and when it tears off at the navel. (Pl. XIV.) It may also bleed when torn across naturally, if it is sucked by the dam or another calf. In an animal with little plasticity to its blood it will flow under almost any circumstances. When any cord is left it is always safe to tie it, and it is only when it is swollen and may possibly contain a loop of the bowel that there is danger in doing so. By pressing upward any bulky contents such danger is avoided. If torn or cut too close to be tied the bleeding may be checked by applying alum, copperas, or for a fraction of a second the end of an iron rod at a dull-red heat. If much blood has been lost it may be requisite to transfuse several ounces of blood or of a weak, common-salt solution into the open, umbilical vein.

URINE DISCHARGED THROUGH THE NAVEL (PERSISTENT URACHUS).

Before birth the urine passes from the bladder by a special tube through the navel and navel string into the outer water bag (allantois). (Pl. XII.) This closes at birth, and the tube shrinks into a fine cord up to the bladder. It is only in the bull calf that it is liable to remain open, doubtless because of the long, narrow channel through which the urine must otherwise escape. The urethra, too, is sometimes abnormally narrow, or even closed, in the male. If part of the cord remains, it should be tied and the whole allowed to wither up naturally. If the cord has been removed and the tube (urachus) protrudes, discharging the urine, that alone must be tied. If there is nothing pendent the urachus must be seized, covered by the skin, and a curved needle being passed through the skin and above the duct, it may be tied along with this skin. A blister of Spanish flies, causing swelling of the skin, will often close the orifice—so with the hot iron. If the urethra of the male is impervious it can rarely be remedied.

INFLAMMATION OF THE URACHUS (NAVEL URINE DUCT).

This may originate in direct, mechanical injury to the navel in calving, or shortly after, with or without the lodgment of irritant or septic matter on its lacerated or cut end. The mere contact with healthy urine, hitherto harmless, can now be looked on as becoming suddenly irritating. The affection is usually marked by the presence of redness and swelling at the posterior part of the navel and the escape of urine and a few drops of whitish, serous pus from the orifice of the urachus. In those cases in which urine is not discharged a tender swelling, like a thick cord extending upward and backward from the navel into the abdomen, may be identified. The navel enlargement may be considerable, but it is solid, does not gurgle on handling, and can not be done away with by pressing it back into the abdomen, as in a case of hernia.

In cases at first closed the pus may burst out later, coming from the back part of the navel and the swelling extending backward. In other cases whitish pus may pass with the urine by the ordinary channel, showing that it has opened back into the bladder. In other cases the umbilical veins become involved, in which case the swelling extends forward as well as backward. Thus the disease may result in destructive disorders of the liver, lungs, and, above all, of the joints.

The disease may usually be warded off or rendered simple and comparatively harmless by applying antiseptics to the navel string at birth (carbolic acid 1 part, water and glycerin 5 parts each, or wood tar). Later, antiseptics may be freely used (hyposulphite of soda 4 drams, water 1 quart) as an application to the surface and as an injection into the urachus, or even into the bladder if the two still communicate. If they no longer communicate, a stronger injection may be used (tincture of chlorid of iron 60 drops, alcohol 1 ounce). Several weeks will be required for complete recovery.

ABSCESS OF THE NAVEL.

As the result of irritation at calving or by the withered cord, or by licking with the rough tongue of the cow, inflammation may attack the loose connective tissue of the navel to the exclusion of the urachus and veins, and go on to the formation of matter. In this case a firm swelling appears as large as the fist, which softens in the center and may finally burst and discharge. The opening, however, is usually small and may close prematurely, so that abscess after abscess is formed. It is distinguished from hernia by the fact that it can not be returned into the abdomen, and from inflammations of the veins and urachus by the absence of swellings forward and backward along the lines of these canals.

Treatment consists in an early opening of the abscess by a free incision and the injection twice a day of an astringent antiseptic (chlorid of zinc one-half dram, water 1 pint).

INFLAMMATION OF THE NAVEL VEINS (UMBILICAL PHLEBITIS).

In this affection of the navel the inflammation may start directly from mechanical injury, as in either of the two forms just described, but on this are inoculated infective microbes, derived from a retained and putrefying afterbirth, an abortion, a metritis, a fetid discharge from the womb, an unhealthy open sore, a case of erysipelas, from overcrowding, from filthy floor or bedding, or from an offensive accumulation of manure, solid or liquid. As the microbes vary in different cases, given outbreaks will differ materially in their nature. One is erysipelatoid; another purulent infection with the tendency to secondary abscesses in the joints, liver, lungs, etc.; another is from a septic germ and is associated with fetid discharge from the navel and general putrid blood poisoning. In estimating the causes of the disease we must not omit debility of the calf when the mother has been underfed or badly housed or when either she or the fetus has been diseased.

Symptoms.—The symptoms vary. With the chain-form germs (streptococci) the navel becomes intensely red, with a very firm, painful swelling, ending abruptly at the edges in sound skin and extending forward along the umbilical veins. The secondary diseases are circumscribed, black engorgements (infarctions) or abscesses of the liver, lungs, kidneys, bowels, or other internal organs, and sometimes disease of the joints.

With the ordinary pus-producing germs (*Staphylococcus pyogenes aureus* and *Streptococcus pyogenes*) the local inflammation in the navel causes a hot, painful swelling, which rapidly advances to the formation of matter (pus), and the raw, exposed surface, at first bright red, becomes dark red or black, soft, friable, and pultaceous. If the pus is white, creamy, and comparatively inoffensive in odor, the secondary formations in internal organs and joints are mainly of the same purulent character (secondary abscesses).

If, on the other hand, the discharge is very offensive and the pus more serous, watery, or bloody, there is reason to suspect the presence of some of the septic bacteria, and the results on the general system are a high fever and softening of the liver and spleen and no tendency to abscesses of the internal organs. Diarrhea is a common symptom, and death ensues early, the blood after death being found unclotted.

Complicated cases are common, and in all alike the umbilical veins usually remain open and can be explored by a probe passed at first upward and then forward toward the liver.

Prevention is sought by applying a lotion of carbolic acid or iodin solution to the navel string at birth, or it may be smeared with common wood tar, which is at once antiseptic and a protective covering against germs. In the absence of either a strong decoction of oak bark may be used.

Local treatment consists in the application of antiseptic to the surface and their injection into the vein. As a lotion carbolic acid, 1 ounce in a quart of strong decoction of oak bark, should be used, or salicylic acid or salol may be sprinkled on the surface. The interior of the vein should be swabbed out with a probe wrapped around with cotton wool and dipped in boracic salicylic acid.

If complications have extended to the liver or other internal organs, or the joints, other treatment will be demanded. In acute cases of general infection an early fatal result is to be expected.

PYEMIC AND SEPTICEMIC INFLAMMATION OF JOINTS IN CALVES (JOINT ILL).

This occurs in young calves within the first month after birth. It persists in the joints when once attacked, and is usually connected with disease of the navel. Rheumatism, on the other hand, rarely occurs in a calf under a month old. It tends to shift from joint to joint, and is independent of any navel disease. Again, it affects the fibrous structures of the joints, and rarely results in the formation of white matter, while the affection before named attacks the structures outside as well as inside the joints and, above all, the ends of the bones, and tends to the destruction and crumbling of their tissue, and even to the formation of open sores, through which the fragile bones are exposed. The microbes from the unhealthy and infected wound in the navel pass into the system through the veins, or lymphatics, and form colonies and local inflammations and abscesses in and around the joints.

Symptoms.—The symptoms are the swelling of one or more joints, which are very hot and tender. The calf is stiff and lame, lies down constantly, and does not care to suck. There is very high fever, accelerated breathing and pulse, and there is swelling and purulent discharge (often fetid) from the navel. There may be added symptoms of disease of the liver, lungs, heart, or bowels, on which we need not here delay. The important point is to determine the condition of the navel in all such cases of diseased and swollen joints beginning in the first month of life, and in all cases of general stiffness, for besides the diseases of the internal organs there may be abscesses formed among the muscles of the trunk, though the joints appear sound. Cases of this kind, if they do not speedily die, tend to become emaciated and perish later in a state of weakness and exhaustion.

Prevention.—Prevention must begin with the purity of the buildings and the navel, as noted in the last article.

Treatment.—Treatment is in the main antiseptic. The slighter forms may be painted daily with tincture of iodin, or an ointment of biniodid of mercury (1 dram) and lard (2 ounces) may be rubbed on the affected joints daily until they are blistered. In case of swellings containing matter, this may be drawn through the nozzle of a hypodermic syringe and the following solution injected: Compound tincture of iodin, 1 dram; distilled (or boiled) water, 2 ounces. Internally the calf may take 5 grains quinin twice daily and 15 grains hyposulphite of soda, or 20 grains salicylate of soda three times a day.

UMBILICAL HERNIA (BREACH AT THE NAVEL).

This may exist at birth from imperfect closure of the muscles around the opening; it may even extend backward for a distance, from the two sides failing to come together. Apart from this, the trouble rarely appears after the calf has been some time on solid feed, as the paunch then extends down to the right immediately over the navel, and thus forms an internal pad, preventing the protrusion of intestine.

Symptoms.—The symptoms of umbilical hernia are a soft swelling at the navel, with contents that usually gurgle on handling, and can be entirely returned into the abdomen by pressure. The diseases of the navel hitherto considered have no gurgling contents and can not be completely returned into the abdomen. The only exception in the case of the hernia is when the walls of the sac have become greatly thickened. These will, of course, remain as a swelling after the bowel has been returned; and when the protruding bowel has contracted permanent adhesion to the sac, it is impossible to return it fully without first severing that connection.

Treatment.—Treatment is not always necessary. A small hernia, like an egg, in a new-born calf, usually recovers of itself as the animal changes its diet to solid feed and has the paunch fully developed as an internal pad.

In other cases apply a leather pad 8 inches square attached around the body by two elastic bands connected with its four corners, and an elastic band passing from its front border to a collar encircling the neck, and two other elastic bands from the neck collar along the two sides of the body to the two bands passing up over the back. (Pl. XXIV, fig. 6.)

For small hernias nitric acid may be used to destroy the skin and cause such swelling as to close the orifice before the skin is separated. For a mass like a large goose egg one-half ounce of the acid may be rubbed in for three minutes. No more must be applied for 15 days. For large masses this is inapplicable, and with too much loss of skin the orifice may fail to close and the bowels may escape.

The application of a clamp like those used in castration is a most effective method, but great care must be taken to see that all the contents of the sac are returned so that none may be inclosed in the clamp. (Pl. XXIV, fig. 7.)

Another most effective resort is to make a saturated solution of common salt, filter and boil it, and when cool inject under the skin (not into the sac) on each side of the hernia a dram of the fluid. A bandage may then be put around the body. In 10 hours an enormous swelling will have taken place, pressing back the bowel into the abdomen. When this subsides the wound will have closed.

DROPSY OF THE NAVEL.

A sac formed at the navel, by contained liquid accumulated by reason of sucking by other calves, is unsightly and sometimes injurious. After making sure that it is simply a dropsical collection it may be deeply punctured at various points with a large-sized lancet or knife, fomented with hot water, and then daily treated with a strong decoction of white-oak bark.

BLUE DISEASE (CYANOSIS).

This appearing in the calf at birth is due to the orifice between the two auricles of the heart (foramen ovale) remaining too open, allowing the nonaerated (venous) blood to mix with the aerated (arterial) blood, and it is beyond the reach of treatment. It is recognized by the blueness of the eyes, nose, mouth, and other mucous membranes, the coldness of the surface, and the extreme sensitiveness to cold.

CONSTIPATION.

At birth the bowels of the calf contain the meconium, a tenacious, gluey, brownish-yellow material largely derived from the liver, which must be expelled before they can start their functions normally. The first milk of the cow (colostrum, beestings), rich in albumin and salts, is nature's laxative to expel this now offensive material and should never be withheld from the calf. If, for lack of this, from the dry feeding of the cow, or from any other cause, the calf is costive, straining violently without passage, lying down and rising as in colic, and failing in appetite, no time should be lost in giving relief by an ounce dose of castor oil, assisting its action by injections of soapsuds or oil. Whatever meconium is within reach of the finger should be carefully removed. It is also important to give the cow a sloppy, laxative diet.

INDIGESTION.

This may occur from many different causes, as costiveness; a too liberal supply of milk; milk too rich; the furnishing of the milk of a cow long after calving to a very young calf; allowing a calf to suck the first milk of a cow that has been hunted, driven by road, shipped by rail, or otherwise violently excited; allowing the calf too long time between meals, so that impelled by hunger it quickly overloads and clogs the stomach; feeding from the pail milk that has been held over in unwashed (unscalded) buckets, so that it is fermented and spoiled; feeding the milk of cows kept on unwholesome feed; keeping the calves in cold, damp, dark, filthy, or bad-smelling pens; feeding the calves on artificial mixtures containing too much starchy matter; or overfeeding the calves on artificial feed that may be appropriate enough in smaller quantity. The licking of hair from themselves or others and its formation into balls in the stomach will cause obstinate indigestion in the calf.

Symptoms.—The symptoms are dullness, indisposition to move, uneasiness, eructations of gas from the stomach, sour breath, entire loss of appetite, lying down and rising as if in pain, fullness of the abdomen, which gives out a drumlike sound when tapped with the fingers.

The costiveness may be marked at first, but soon it gives place to diarrhea, by which the offensive matters may be carried off and health restored. In other cases it becomes aggravated, merges into inflammation of the bowels, fever sets in, and the calf gradually sinks.

Prevention.—Prevention consists in avoiding the causes enumerated above or any others that may be detected.

Treatment.—Treatment consists in first clearing away the irritant present in the bowels. For this purpose 1 or 2 ounces of castor oil with 20 drops of laudanum may be given, and if the sour eructations are marked a tablespoonful of limewater or one-fourth ounce calcined magnesia may be given and repeated two or three times a day. If the disorder continues after the removal of the irritant, a large tablespoonful of rennet, or 30 grains of pepsin, may be given at each meal along with a teaspoonful of tincture of gentian. Any return of constipation must be treated by injections of warm water and soap, while the persistence of diarrhea must be met as advised under the discussion following this. In case of the formation of loose hair balls inclosing milk undergoing putrid fermentation, temporary benefit may be obtained by giving a tablespoonful of vegetable charcoal three or four times a day, but the only real remedy is to cut the paunch open and extract them. At this early age they may be found in the third or even the fourth stomach; in the adult they are confined to the first two and are comparatively harmless.

DIARRHEA (SCOURING) IN CALVES (SIMPLE AND CONTAGIOUS).

As stated in the last article, scouring is a common result of indigestion, and at first may be nothing more than an attempt of nature to relieve the stomach and bowels of offensive and irritating contents. As the indigestion persists, however, the fermentations going on in the undigested masses become steadily more complex and active, and what was at first the mere result of irritation or suspended digestion comes to be a genuine contagious disease, in which the organized ferments (bacteria) propagate the affection from animal to animal and from herd to herd. More than once I have seen such epizootic diarrhea start on the headwaters of a creek and, traveling along that stream, follow the watershed and attack the herds supplied with water from the contaminated channel. In the same way the disease, once started in a cow stable, is liable to persist for years, or until the building has been thoroughly cleansed and disinfected. It may be carried into a healthy stable by the introduction of a cow brought from an infected stable when she is closely approaching calving. Another method of its introduction is by the purchase of a calf from a herd where the infection exists.

In enumerating the other causes of this disease we may refer to those noted above as inducing indigestion. As a primary consideration any condition which lowers the vitality or vigor of the calf must be accorded a prominent place among factors which, apart from contagion, contribute to start the disease de novo. Other things being equal, the strong, vigorous races are the least predisposed to the malady, and in this respect the compact form, the healthy coat, the clear eye, and the bold, active carriage are desirable. Even the color of the hair is not unimportant, as in the same herd I have found a far greater number of victims among the light colors (light yellow, light brown) than among those of a darker tint. This constitutional predisposition to indigestion and diarrhea is sometimes fostered by too close breeding, without taking due account of the maintenance of a robust constitution; hence animals that are very much inbred need to be especially observed and cared for unless their inherent vigor has been thoroughly attested.

The surroundings of the calf are powerful influences. Calves kept indoors suffer to a greater extent than those running in the open air and having the invigorating influences of sunshine, pure air, and exercise; close, crowded, filthy, bad-smelling buildings are especially causative of the complaint. The presence in the air of carbon dioxid, the product of breathing, and of the fetid, gaseous products of decomposing dung and urine diminish by about one-fourth of their volume the life-giving oxygen and in the same ratio hinder the aeration of the blood and the maintenance of vigorous health. Worse than this, such fetid gases are usually direct poisons to the animal breathing them; for example, sulphureted hydrogen (hydrogen sulphid 2 SH_2) and various alkaloids (ptomaines) and toxins (neutral poisonous principles) produced in the filth fermentations. These lower the general health and stamina, impair digestion, and by leading to the accumulation in stomach and bowels of undigested materials they lay the foundation for offensive fermentations within these organs and consequent irritation, poisoning, and diarrhea. They further weaken the system so that it can no longer resist and overcome the trouble.

The condition of the nursing cow and her milk is another potent cause of trouble. The feed of the cow is important. The influence of this is shown in the following tables:

Influence of feed on milk. (From Becquerel and Vernois.)

Character of feed.	Water.	Casein and extractive matter.	Milk sugar.	Butter.	Salts.
	Parts in 1,000.	*Parts in 1,000.*	*Parts in 1,000.*	*Parts in 1,000.*	*Parts in 1,000.*
Cows on winter feed:					
Trefoil or lucern, 12-13 pounds; oat straw, 9-10 pounds; beets, 7 pounds; water, 2 buckets	871.26	47.81	33.47	42.07	5.34
Cows on summer feed:					
Green trefoil, lucern, maize, barley, grass, 2 buckets water	859.56	54.70	36.38	42.76	6.80
Goat's milk on different feed:					
On straw and trefoil	858.68	47.38	35.47	52.54	5.93
On beets	888.77	33.81	38.02	33.68	5.72
Normal mean	844.90	35.14	36.90	56.87	6.18

In these examples the deterioration of the milk in casein on the less nutritious winter feeding is very marked, although the relative quantity of butter remains almost unchanged. In the case of the goat the result is even more striking, the beet diet giving a very large decrease of both casein and butter and an increase of milk sugar.

The second table following, condensed from the Iowa Agricultural Experiment Station Bulletin, gives the results in butter and total solids when the same cows were fed on different rations in succession. Each cow was fed a daily ration of 12 pounds corn fodder and 4 pounds clover hay, besides the test diet of (1) 12¼ pounds corn-and-cob meal, and (2) 10 pounds sugar meal—a product of the glocuse manufacture. This special feed was given seven days before the commencement of each test period to obviate the effects of transition. The analyses of the special rations are given below:

Analyses of special rations.

Constituents.	Corn-and-cob meal.	Sugar meal.
	Per cent.	*Per cent.*
Moisture	13.37	6.10
Salts	1.43	1.17
Fat	2.81	11.16
Carbohydrates (heat formers)	65.99	52.66
Woody fiber	8.03	8.64
Proteids (flesh formers)	8.37	20.27

The great excess of fat and nitrogenous or flesh-forming principles in the sugar meal is very evident.

Influence of feed on milk. (*Iowa station.*)

Animal.	Milk.	Fat.	Solids.	Fat.	Solids.	Ratio of fat to solids not fat.
Grade Shorthorn cow:	*Pounds.*	*P. ct.*	*Per ct.*	*Pounds.*	*Pounds.*	
First period, 21 days, corn-and-cob meal....	631.25	3.43	11.57	21.67	73.02	422.0:1,000
Second period, 21 days, sugar meal.........	641.50	4.04	12.53	25.93	83.38	476.2:1,000
Third period, 21 days, corn-and-cob meal...	559.00	3.22	11.86	17.97	66.32	371.7:1,000
Grade Shorthorn cow:						
First period, 21 days, corn-and-cob meal....	604.75	3.57	11.95	21.56	72.28	425.1:1,000
Second period, 21 days, sugar meal.........	582.00	3.91	12.37	22.74	72.57	456.3:1,000
Third period, 21 days, corn-and-cob meal...	527.00	3.37	12.05	17.78	63.48	389.1:1,000
Grade Shorthorn cow:						
First period, 21 days, sugar meal...........	753.50	3.97	12.43	29.94	93.67	469.8:1,000
Second period, 21 days, corn-and-cob meal..	601.50	3.15	11.45	18.97	68.89	380.0:1,000
Third period, 21 days, sugar meal..........	560.50	3.85	12.16	21.58	68.16	463.3:1,000
Grade Holstein cow:						
First period, 21 days, sugar meal...........	487.50	4.15	13.27	20.25	64.69	455.6:1,000
Second period, 21 days, corn-and-cob meal..	379.00	3.51	12.69	13.30	48.09	382.3:1,000
Third period, 21 days, sugar meal..........	374.50	3.72	13.01	13.95	48.74	401.0:1,000

Here we see in every instance a marked relative increase of the butter, and to a less extent of the other milk solids whenever the sugar meal—rich in fat and albuminoids—was furnished. The opposite theory having been largely taught, it becomes needful thus to sustain the old and well-founded belief of the dairymen.

Not only does the richness of the milk vary with the nature of the food, but it varies also according to the time of the day when it is drawn, the morning milk giving 7½ per cent of cream and the evening milk 9½ per cent (Hassall). Boedecker found that the morning milk had 10 per cent of solids, while the evening milk had 13 per cent. Again, the milk first drawn at any milking is always poorer than the last drawn. The first may have only one-half, or in extreme cases one-fourth, the cream of the last. Once more, when the cow is in heat the milk becomes richer in solids (casein and butter), and contains granular and white blood cells like the colostrum, and often disagrees with the young animal living on it. Now, while these various modifications in the amount of solid matters may prove harmless to a strong and vigorous calf, they can easily be the occasion of intestinal disorder in a weaker one, or in one with health already somewhat impaired by sickness, exposure, or unwholesome buildings. The casein of the cow's milk coagulates in one solid mass, and is much less easily penetrated by the digesting fluids than the fine, flaky coagula of woman's or mare's milk. An excess of casein, therefore, thrown on an already overtaxed stomach can all the more readily induce disorder. So it is with butter fat. While a most important element in nutrition, it may be present in the stomach in such quantity as to interfere with the action of the gastric juice on the casein, and with the interruption of the natural stomach digestion the fats themselves undergo decomposition with the production of offensive and irritating fatty acids.

The milk of the very young cow is usually more watery than that of the mature animal, and that of the old cow has a greater liability to become acid. It varies much with the breed, the Channel Island cattle being notorious for the relatively large quantity of cream, while the Holsteins, Ayrshires, and Shorthorns are remarkable rather for the quantity of casein. The milk of cows fed on potatoes and grass is very poor and watery; that from cows fed on cabbage or Swedish turnips has a disagreeable taste and odor (from the former an offensive liquid has been distilled).

Cows fed on overkept, fermented, and soured rations have acid milk, which readily turns and coagulates. Thus old, long-kept brewer's grains, swill, the refuse of glucose factories, and ensilage which has been put up too green all act in this way. The same may come from disease in the cow's udder, or any general disease of the cow with attendant fever, and in all such cases the tendency is to rapid change and unwholesomeness. If the milk is drawn and fed from a pail, there is the added danger of all sorts of poisonous ferments getting into it and multiplying; it may be from the imperfect cleansing and scalding of the pail; from rinsing the pails with water that is impure; from the entrance of bacterial ferments floating in the filthy atmosphere of the stable, or from the entrance of the volatile chemical products of fermentation.

In addition to the dangers coming through the milk, the calf suffers in its digestive powers from any temporary illness, and among others from the excitement attendant on the cutting of teeth, and impaired digestion means fermentations in the undigested masses and the excessive production of poisonous ptomaines and toxins.

Whatever may be the starting or predisposing cause of this malady, when once established it is liable to perpetuate itself by contagion and to prove a veritable plague in a herd or a district.

Symptoms.—The symptoms of a diarrhea may appear so promptly after birth as to lead to the idea that the cause already existed in the body of the calf, and it usually shows itself before the end of the second week. It may be preceded by constipation, as in retained meconium, or by fetid eructations and colicky pains, as in acute indigestion. The tail is stained by the liquid dejections, which are at first simply soft and mixed with mucus with a sour odor, accompanied with a peculiar and characteristic fetor (suggesting rotten cheese), which continually grows worse. The quantity of water and mucus steadily increases, the normal predominance of fatty matters becoming modified by the presence of considerable undigested casein, which is not present in the normal feces, and in acute cases death may result in one or two days from the combined drain on the system and the poisoning by the absorbed products of the decomposition in the stomach and bowels. When the case is prolonged the passages, at first 5 or 6 a day, increase to 15 or 20, and pass with more and more straining, so that they are projected from the animal in a liquid stream. The color of the feces, at first yellow, becomes a lighter grayish yellow or a dirty white (hence the name white scour), and the fetor becomes intolerable.

At first the calf retains its appetite, but as the severity of the disease increases the animals shows less and less disposition to suck, and has lost all vivacity, lying dull and listless, and, when raised, walking weakly and unsteadily. Flesh is lost rapidly, the hair stands erect, the skin gets dry and scurfy, the nose is dry and hot, or this condition alternates with a moist and cool one. By this time the mouth and skin, as well as the breath and dung, exhale the peculiar, penetrating, sour, offensive odor, and the poor calf has become an object of disgust to all that approach it. At first, and unless inflammation of the stomach and bowels supervenes (and unless the affection has started in indigestion and colic), the belly is not bloated or painful on pressure, symptoms of acute colicky pains are absent, and the bowels do not rumble; neither are bubbles of gas mingled with the feces. The irritant products of the intestinal fermentations may, however, irritate and excoriate the skin around the anus, which becomes red, raw, and broken out in sores for some distance. Similarly the rectum, exposed by reason of the relaxed condition of the anus, or temporarily in straining to pass the liquid dejection, is of a more or less deep red, and it may be ulcerated. Fever, with rapid pulse and increased breathing and temperature, usually comes on with the very fetid character of the feces and is more pronounced as the bowels become inflamed, the abdomen sore to the touch and tucked up, and the feces more watery and even mixed with blood.

Prevention.—The prevention of these cases is the prevention of constipation and indigestion, with all their varied causes as above enumerated, the selection of a strong, vigorous stock, and, above all, the combating of contagion, especially in the separation of the sick from the healthy, and in the thorough purification and disinfection of the buildings. The cleansing and sweetening of all drains, the removal of dung heaps, and the washing and scraping of floors and walls, followed by a liberal application of chlorid of lime (bleaching powder), 4 ounces to the gallon, are indicated. Great care must be exercised in the feeding of the cow to have sound and wholesome feed and water, so apportioned as to make the milk neither too rich nor too poor, and to her health, so that the calf may be saved from the evil consequences of poisonous principles that may be produced in the body of the cow. The calves should be carefully kept apart from all calving cows and their discharges. Similarly each calf must have special attention to see that its nurse gives milk which agrees with it, and that this is furnished at suitable times. If allowed to suck, it should either be left with the cow or be fed three times a day. If it becomes hungry twice a day, it is more liable to overload and derange the stomach, and if left too long hungry it is tempted to take in unsuitable and unwholesome feed, for which its stomach is as yet unprepared. So, if fed from the pail, it is safer to do so three times daily than twice. There should be the utmost cleanliness of feeding dishes, and the feeder must be ever on the alert to prevent the strong and hungry from drinking the milk of the weaker in addition to their own. In case the cow nurse has been subjected to any great excitement by reason of travel, hunting, or carrying, the first milk she yields thereafter should be used for some other purpose and only the second allowed to the calf. Indeed, one and all of the conditions indicated above as causes should be judiciously guarded against.

Treatment.—Treatment varies according to the nature and stage of the disease. When the disease is not widespread, but isolated cases only occur, it may be assumed to be a simple diarrhea and is easily dealt with. The first object is to remove the irritant matter from stomach and bowels, and for this 1 or 2 ounces of castor oil may be given, according to the size of the calf. Reduce the milk by one-half or two-thirds. If the stools smell particularly sour, the milk may be replaced by 1 ounce calcined magnesia, and in any case a tablespoonful or two of limewater must be given with each meal. Great harm is often done by giving opium and astringents at the outset. These serve merely to bind up the bowels and retain the irritant source of the trouble; literally, "to shut up the wolf in the sheepfold." When the offending agents have been expelled in this way, carminatives and demulcent agents may be given—1 dram of anise water, 1 dram nitrate of bismuth, and 1 dram of gum arabic, three times a day. Under such course the consistency of the stools should increase until in a day or two they become natural.

If, however, the outbreak is more general and evidently the result of contagion, the first consideration is to remove all sources of such contamination. Test the milk of the cow with blue litmus paper; if it reddens, reject the milk until by sound, dry feeding, with perhaps a course of hyposulphite of soda and gentian root, the milk is made alkaline. The castor oil or magnesia will be demanded to clear away the (now infecting) irritants, but they should be combined with antiseptics, and, while the limewater and the carminative mixture may still be used, a most valuable addition will be found in the following: Calomel, 10 grains; prepared chalk, 1 ounce; creosote, 1 teaspoonful; mix, divide into 10 parts, and give one four times a day Or the following may be given four times a day: One dram Dover's powder, 6 grains powdered ipecacuanha; mix, divide into 10 equal parts. Injections of solutions of gum arabic are often useful, and if the anus is red and excoriated, one-half dram of copperas may be added to each pint of the gummy solution. All the milk given must be boiled, and if that does not agree, eggs made into an emulsion with barley water may be substituted. As the feces lose their watery character and become more consistent, tincture of gentian in doses of 2 teaspoonfuls may be given three or four times a day. Counter-irritants, such as mustard, ammonia, or oil of turpentine, may be rubbed on the abdomen when it becomes tender to the touch.

ACUTE CONTAGIOUS SCOURING IN THE NEWBORN.

The most violent and deadly form of diarrhea in the newborn calf deserves a special mention. This may appear immediately after birth, and shows itself almost invariably within the first or second day. The most intense symptoms of white scour are complicated by great dullness, weakness, and prostration, sunken eyes, retracted belly, short, hurried breathing, and very low temperature, the calf lying on its side, with the head resting on the ground, lethargic and unconscious or regardless of all around it. The bowel discharges are profuse, yellowish white, and very offensive. As a rule death ensues within 24 to 36 hours.

A marked characteristic of this form of illness is that it attacks almost every calf born in the herd, or in the building, rather, and if the calf escapes an attack in the first two or three days of its life it usually survives. Those that recover from an attack, however, are liable one or two weeks later to suffer from an infective inflammation of the lungs. The infection clings to a stable for years, in many cases rendering it impossible to preserve and raise the calves. It has frequently coincided with abortions and failures to conceive in the same herd, so that it has been thought that the same infective germ produces one type of abortion. On the other hand, the removal of the calving cow from the herd to calve in a separate building, hitherto unused and therefore uninfected, usually effects the escape and survival of the offspring.

The disease has been traced by Nocard and Lignières to a small bacillus having the general characters of those that produce hemorrhagic septicemia, which is usually combined with a variety of others, but is in some cases alone and in pure culture, especially in the joints. The theory of Lignières is that this bacillus is the primary offender, and that once introduced it so depresses the vital powers of the system and tissue cells that the healthy resistance to other bacteria is impaired or suspended, and hence the general and deadly invasion of the latter.

Inoculations with this bacillus killed guinea pigs or rabbits in 6 to 18 hours, and calves in 30 hours, with symptoms and lesions of hemorrhagic septicemia, including profuse fetid diarrhea.

The predominance of the early and deadly lesions in the alimentary tract would seem to imply infection through the feed, and the promptitude of the attack after birth, together with the frequent coincidence of contagious abortion in the herd. suggest the presence of the germ in the cow; yet the escape of the calf when the cow calves in a fresh building is equally suggestive of the infection through germs laid up in the building. This conclusion is further sustained by the observation that the bacillus evidently enters by the raw, unhealed navel, that it is diffused in the blood, and that a very careful preservation of the navel against infection gives immunity from attack.

Prevention.—The disease is so certainly and speedily fatal that it is hopeless to expect recovery, and therefore prevention is the rational resort.

When a herd is small, the removal of the dam to a clean, unused stable a few days before calving and her retention there for a week usually succeeds. It is in the large herd that the disease is mainly to be dreaded, however, and in this it is impossible to furnish new and pure stables for each successive group of two or three calving cows. The thorough disinfection of the general stable ought to succeed, yet I have seen the cleanest and purest stable repeatedly disinfected with corrosive sublimate without stopping the malady. It would appear as if the germ lodged on the surface or in the bowels of the cow and tided the infection over the period of stable disinfection. Though insufficient of themselves, the supply of separate calving boxes and the frequent thorough cleaning and disinfection of both these and the stables should not be neglected. The most important measure, however, is the disinfection of the navel.

The cow should be furnished with abundance of dry, clean bedding, sprinkled with a solution of carbolic acid. As soon as calving sets in the tail and hips and anus and vulva should be sponged with a carbolic-acid solution (one-half ounce to the quart), and the vagina injected with a weaker solution (2 drams to the quart). Fresh carbolized bedding should be constantly supplied, so that the calf may be dropped on that and not on soaked litter nor manure. The navel string should be at once tied with a cord that has been taken from a strong solution of carbolic acid. The stump of the cord and the adjacent skin should then be washed with the following solution: Iodin, one-half dram; iodid of potassium, one-half dram; water, 1 quart. When dry it may be covered with a coating of collodion or tar, each containing 1 per cent of iodin.

Whenever a calf shows any sign of scouring it should be instantly removed to another pen and building, and the vacated one should be thoroughly cleaned and disinfected. Different attendants should take care of the sound calves and the infected ones, and all utensils, litter, etc., kept scrupulously apart.

After one week the healthy calves may usually be safely herded together, or they may be safely placed in the cow stable.

OTHER AILMENTS OF THE CALF.

Among these may be named several congenital imperfections, such as imperforate anus, vulva, or prepuce, which are to be recognized by the inability to pass dung or urine, in spite of straining, and the formation of swellings in the anus, vulva, or sheath. Each must be carefully incised with the knife, taking care not to injure the muscles which circumscribe the respective openings; also tongue-tie, in which the thin, flaccid, mucous membrane passing from the median line of the lower surface of the tongue binds the latter too closely to the floor of the mouth and renders the tongue unfit for gathering in the food in after life. This must be cut with knife or scissors, so as to give the tongue a reasonable degree of liberty.

Aphtha, or thrush, is another trouble of the sucking calf, showing itself as a white, curdy elevation on the tongue, lips, cheeks, or gums, and when detached leaving a raw, red, angry surface. It is due to the growth of a vegetable parasite long recognized as the *Oïdium albicans* (*Saccharomyces albicans*). It is easily removed by rubbing with powdered borax, but inasmuch as other colonies are liable to start either in the mouth or in the pharynx, gullet, or stomach, it is well to give a dose of one-half dram of hyposulphite of soda in water day by day for several days.

Rickets is not a common disease in calves, and comes on, if at all, later than those we have been considering. It consists in softening and friability of the bones from a deficiency of lime salts, and appears to be mainly connected with an inherited weakness of constitution, unsuitable feeding, cold, close, damp buildings, microbian infection, and other conditions inimical to health. The prevention and treatment of rickets consists essentially in the improvement of the digestion and general health; hence sunshine, open air, exercise, nourishing food, and tonics are indicated. (See p. 267.)

BONES: DISEASES AND ACCIDENTS.

By V. T. Atkinson, V. S.

[Revised by John R. Mohler, V. M. D.]

Some knowledge of the skeleton is advisable to facilitate the study of diseases of bones and the accidental injuries to which they are exposed. The skeleton of the adult ox is made up of the following number of bones:

Spinal column	45	
Head	28	
Chest	27	
Shoulder	2—	1 on each side.
Arm	2—	1 on each side.
Forearm	4—	2 on each side.
Forefoot	40—	20 on each side.
Pelvis	2—	1 on each side.
Thigh	2—	1 on each side.
Leg	6—	3 on each side.
Hind foot	38—	19 on each side.
Total	196	

Without attempting to burden the reader with the technical names and a scientific classification of each, it appears desirable to describe some of the characteristics of forms in general and of a few classes into which they may be divided, leaving the special study of individual bones to the illustrations of the skeleton (Pl. XXV), which will serve better than a great deal of writing to fix in the mind of the reader the location, relation, and function of each one. In early fetal life the place of bone is supplied by temporary cartilage, which gradually changes to bone. For convenience of study, bones may be said to be composed of a form of dense connective tissue impregnated with lime salts and to contain two elementary constituents—the organic or animal and the inorganic or earthy. In young animals the former predominates; with increasing years the relative proportions of the two change, so that when advanced age is reached the proportion of inorganic far exceeds the organic. The gradual change with advancing years from organic to inorganic has the effect of rendering the bone harder and more brittle, and though it is stronger, the reparative process is slower when injury does occur.

The bones are nourished in two ways: First, from the outside through their covering, called the periosteum—the thin, strong membrane that covers every part of the bone except the articular surface of the joints; and, second, from within through the minute branches of blood vessels which pass into the bones through holes (foramina) on their surface and are distributed in the soft structure (medulla) of the inside. The structure of the bone is divided into two parts—the compact or hard material of the outside, which gives strength and is more abundant in the shafts of long bones, and the cancellated, softer tissue of the inside, which affords accommodation to the blood vessels necessary for the nourishment of that part of the structure.

In shape, bones are divided into three classes—long, flat, and short. The long bones are the ribs and those mostly found in the limbs; the flat bones are found in the head, the shoulder, and the pelvis; the short bones in the spinal column and in the lower portions of the limbs.

With this little introduction, which seems almost indispensable, we will proceed at once to the consideration of diseases of bones, for they undergo disease processes like any other living tissue.

OSTEITIS.

Inflammation of the compact structure of bones (osteitis) may be either acute or chronic, and may involve the whole extent of the bone affected or may be confined to only a portion of it. This inflammation results from injury, such as concussion, laceration, or a crushing bruise; also from specific influences, as in actinomycosis (lumpy jaw) or cases of foul foot. The latter affection frequently involves the bones, and for this reason the pastern is the most frequent seat of osteitis. There is dull pain on pressure and a painful swelling of bone when pus is present. Suppuration may involve the overlying soft tissues, causing an abscess, which may finally break through the skin. The inflammatory condition sometimes assumes an ulcerated form (caries) or from interrupted nutrition of the part deprived of the blood necessary to its nourishment may cause death of a large section of bone (necrosis); this dead fragment (sequestrum), becoming separated from the main portion of bone, acts as a foreign body.

Treatment.—This consists in resting the affected part and in giving vent at the earliest possible moment to whatever pus may be present. Free drainage should then be maintained. Apply dressings of lactic acid or inject with 5 per cent zinc-chlorid solution and pack with tampons of cotton soaked in antiseptic solutions. A laxative to keep the bowels moving freely is the only internal treatment necessary.

PERIOSTITIS.

This disease is an inflammation of the external covering of bone (periosteum) and is usually produced by wounds, pressure, or crushing the part. The periosteum is well supplied with sensitive nerve endings and when inflamed is very sensitive to pressure and may cause lameness. This condition is often difficult to determine, and even an acute observer may fail to locate the point of its existence. There are three forms of periostitis—aseptic, purulent, and fibrous.

Aseptic periostitis when it becomes chronic causes such a bony enlargement (exostosis) as is seen in the callous formation following the fracture of a bone. The formation of such a tumor or enlargement on the surface of a bone is liable to occur in any part of the bone covered with periosteum, and when found near a joint involving two or more bones it is liable to result in their union (anchylosis).

Treatment.—Applications of cold water to check the inflammatory processes is indicated for the first few days in aseptic periostitis, followed by hot fomentations to hurry resorption of fluids. Massage should then be given with camphor ointment, mercurial ointment. soap liniment, or Lugol's solution. In the chronic form point firing or a biniodid-of-mercury blister will be found beneficial.

Purulent periostitis follows wounds which reach the periosteum and become infected, as observed in compound fractures, or it may result from advancing purulent conditions in neighboring structures, as in foul foot. It may also occur in the course of an infectious disease, when small abscesses are formed under the periosteum (subperiosteal abscess). It may lead to necrosis of the bone or a fistulous tract from the bone to the surface. There is usually much pain and fever, and the odor from the wound is offensive.

Treatment.—In this form of periostitis the periosteum should be freely incised, followed either by continuous irrigation or frequent injection of the wound with antiseptic solutions.

Fibrous periostitis.—This form of the disease consists in the thickening of the outer layer of the periosteum from the inflammation reaching it from neighboring structures. This newly formed fibrous tissue may become ossified or may transmit the inflammation to the deeper bony structures. It is frequently seen in cases in which there has been an intense inflammation of the skin close to an underlying bone.

Treatment.—The treatment should be the same as that recommended for aseptic periostitis.

OSTEOMYELITIS.

This term refers to an inflammation of the bone marrow, which is most commonly seen following the bacterial infection of a compound fracture and usually results in pus formation. The bone is melted away and pus escapes from the bone under the periosteum, involving the soft tissues. It is principally confined to the long bones and seldom affects more than one.

Treatment.—The bone should be opened for the purpose of curetting out the diseased portion of the marrow cavity and removing all the necrotic pieces of bone. This should be undertaken only by a competent veterinarian. The after-treatment consists in tamponing the wound with pledgets of iodoform gauze or a mixture of iodoform 1 part and glycerin 4 parts. The wound in the soft tissue should be kept open until the cavity in the bone has filled with granulation tissue.

RICKETS.

This disease, also called "rachitis," is an inflammatory affection of young, growing bones, and mostly involves the ribs and long bones of the legs. It consists in a failure of the organism to deposit lime salts in bone, and for this reason the bones do not ossify so rapidly as they should. The cartilaginous ends of the bones grow rapidly, but ossification does not keep pace with it. The bones become long and their ends bend at the joints, the legs become crooked, and the joints are large and irregular. All the bones affected with this disease are thicker than normal, and the gait of the animal is stiff and painful. A row of bony enlargements may be found where the ribs articulate with the cartilages connecting them with the breastbone and is called the "beaded line." A catarrhal condition of the digestive tract is usually observed. The disease may result from an inherited weakness of constitution, poor hygienic surroundings, or improper diet. Calves and foals are less frequently affected with rickets than dogs and pigs.

Treatment.—The affected animal should have nourishing feed containing a proper quantity of lime salts. Outdoor exercise and plenty of fresh air are indispensable. Limewater should be given once daily for drinking purposes and ground bone meal mixed with the food. Phosphorus, one-fortieth of a grain, and calcium phosphate, 1 dram, given twice daily to a 2-month-old calf, and proportionally increased for older animals, has proved efficacious in this disease. In some cases the long bones of the limbs are too weak at birth to support the weight of the animal, and temporary splints, carefully padded and wrapped on with some soft bandages, become necessary.

OSTEOMALACIA (CREEPS).

This is a condition of bone brittleness or softening of bone found usually in adult life. It consists in the decalcification of mature bone, with the advancing diminution of the compact portion of bone by absorption. The periosteum strips very easily from the bone. This disease is seen in milch cows during the period of heavy lactation or in the later stages of pregnancy, and the greater the yield of milk the more rapid the progress of the disease. Heifers with their first calves are frequently affected, as these animals require a considerable quantity of mineral salts for their own growth and for the nourishment of their offspring.

Symptoms.—In marked cases there is a gradual emaciation and symptoms of gastrointestinal catarrh, with depraved appetite, the animal eating manure, decayed wood, dirt, leather, etc. Muscular weakness is prominent, together with muscle tremors, which simulate chills, but are not accompanied with any rise of temperature. The animal has a stiff, laborious gait; there is pain and swelling of the joints, and constant shifting of the weight from one leg to another. The restricted movements of the joints are frequently accompanied with a crackling sound, which has caused the name of "creeps" to be applied to the disease. The coat is dull and rough and the skin dry and hidebound. The animal is subject to frequent sprains or fracture of bones without apparent cause, as in lying down or turning around, and when such fractures occur they are difficult to unite. The bones principally involved are the upper bones of the legs, the haunch bone, and the middle bones of the spinal column. The disease in this country is confined to localized areas in the Southwest, known as the "alkali districts," and in the old dairy sections of New York State. The cause of this affection is the insufficiency of lime salts in the food, also to feeding hay of low, damp pastures, kitchen slops, and potatoes, or to overstocking lands. It occurs on old, worn-out soil poor in lime salts, and has also been observed to follow a dry season.

Treatment.—This should consist in a change of feed and the artificial feeding of lime salts, such as magnesium and sodium phosphate. Feed rich in mineral salts may be given, such as beans, cowpeas, oats, cottonseed meal, or wheat bran. Cottonseed meal is one of the best feeds for this purpose, but it should be fed carefully, as too large quantities of it are injurious to cows. Phosphorus may also be given in one-fourth grain doses twice daily, together with a tablespoonful of powdered bone meal or crude calcium phosphate at each meal. Ordinary lime dissolved in drinking water (limewater) will also be found efficacious in combating this disease, and can be provided at slight expense. A change of pasture to a locality where the disease is unknown and a free supply of common salt and bone meal will be the most convenient method of treating range cattle.

SPRAINS.

The most common accident occurring to bones and joints is a sprain of the ligaments uniting the bones, or the tendons uniting the muscles and bones. A sprain is the result of a sudden forcing of a joint in an unnatural direction, or, if in a natural direction, beyond the power of the ligament or tendon to restrain it properly, so that part of the fibers of either are ruptured. When such an accident occurs pain is immediately inflicted, varying in degree with the extent of the injury, which is soon followed by swelling, with more or less heat and tenderness. If the seat of the injury be in any of the limbs, lameness is likely to result. Of the causes of sprain, slipping on ice or a wet floor, playing, and fighting with another animal are the most common.

Sprain of the shoulder joint.—This is liable to occur from any of the causes mentioned above or from the animal slipping suddenly into a rut or hole. When such an accident occurs, sudden lameness will attract attention. The animal will be noticed to drag the leg when walking and to carry it in a circular direction, outward and forward, at each step. The leg should be carefully examined, pressure over the joint causing the animal to evince pain. If the person making the examination is in doubt, it is well to make a comparison between the shoulders by pressing first on one and then the other. After such an accident the animal should be tied up so as to limit so far as possible the use of the injured joint.

Soft feed should be given with a view of keeping the bowels acting freely.

Treatment.—During the first three days the treatment should consist of cold-water irrigation to check the inflammation and relieve the pain. Hot fomentations may then be applied to hasten the absorption of the inflammatory fluids. When the pain has somewhat abated, equal parts of mercurial ointment and green soap may be rubbed into the swollen tissue. Should lameness continue after the tenth day, good results will be obtained from the application of a blister. This may be done by carefully clipping off the hair over the joint, including a surface of 4 or 5 inches in circumference, and rubbing in the following preparation:

Powdered cantharides	dram	1
Biniodid of mercury	do	1
Vaseline	ounce	1

The animal's head should be carefully tied until the third day, to prevent its licking the blister. The blistered surface should then be smeared with lard or vaseline every other day until the scabs fall off. Gentle exercise should be allowed after the fourth or fifth day from the application of the blister. If the lameness still remains the blister may be repeated in three weeks or a month.

Sprain of the fetlock.—This may occur from misstep when the animal is moving rapidly, and the twisting or wrenching of the foot is sufficient to rupture partially the ligaments which bind the bones together at that part. Such an accident also frequently occurs by the foot getting fastened in a hole in the floor; the wrenching is the result of the animal's attempt to liberate it. Lameness, followed by swelling of the joint and pain when it is handled, or when the animal moves the joint, and heat, are the more noticeable symptoms. If the sprain is very severe, the animal occasionally does not bear its weight on the limb.

Treatment.—The most important consideration in the treatment of this affection is rest, which is best enforced by keeping the animal in the stall and placing strong, muslin bandages about the inflamed joint. As in the sprain of the shoulder, cold water in the form of douches, continuous irrigation with hose or soaking tub, or finely chopped ice poultices are indicated for the first three days. Following this apply a Priessnitz bandage[1] moderately tight about the joint, which not only conduces to rest, but also favors absorption. Massage with stimulating liniments, such as soap or camphor, may later be applied to the affected parts.

If the lameness has not disappeared by the tenth day, the blister advised for the sprain of the shoulder should be applied and the same precautions observed as to tying the animal's head and subsequent smearing with vaseline. When a blister is applied in this locality, the back part of the heel should be first filled with lard or vaseline, and care taken to prevent any of the blistering preparation from coming in contact with the skin of that part. If this precaution is not observed, scratches may ensue and prove troublesome.

Sprain of the hip.—This is liable to result from the animal's slipping in such way as to spread the hind feet wide apart. The patient goes stiff in the hind legs, or lame in one hind leg, walking with a straddling gait and swinging the leg outward as it is carried forward. Tenderness may occasionally be detected on pressure, but owing to the heavy covering of muscles outside the joint this test is not always reliable.

In the acute cases give rest and cold local applications. After the fourth or fifth day the blister mentioned for sprain of the shoulder may be applied with advantage, and if this proves insufficient, as a last resort we may fire in points over the joint.

Sprain of the back.—Sprain of the back, particularly in the region of the loins, is not an uncommon accident among cattle. It is liable to occur from the animals slipping with both hind feet side-

[1] A Priessnitz bandage is a dressing which combines the three properties of keeping a part warm, moist, and subjecting it to uniform pressure. It consists of three layers of material. The inner layer is composed of absorbent cotton or some other material which is capable of holding moisture. This is soaked in water and wrapped around the part. The second layer consists of a substance which is impervious to moisture, as oiled silk or oiled paper, and is applied about the inner layer to prevent evaporation. The third or outside layer is composed of a flannel or woolen bandage to prevent the radiation of heat and thus keep the moist inner layer at the temperature of the body.

wise so as to twist the back, or from slipping violently backward so that great stress is thrown on the loins. The patient moves with difficulty, using the hind parts in a guarded manner, as if afraid of causing severe pain. Occasionally, if the sprain is severe, the animal will rise with difficulty. Pressure on the back in the immediate region of the loins causes pain. Such cases may be mistaken for paralysis, and, in fact, in severe cases, during the early stages of the injury, although the nerve supply is not interfered with, the injury to the muscles and resulting pain is so great that the condition is almost equal to paralysis, although liable to be attended with more favorable results. Hot applications, such as blankets wrung out of hot water and changed often, will be likely to afford relief during the earlier stages. Afterwards the blister mentioned for sprain of the shoulder may be applied with advantage.

FRACTURES (BROKEN BONES).

Bones may be accidentally broken in many ways and from different causes. Fractures in general are liable to be produced by external force suddenly and violently applied, either directly to the part or at a distance, the force being transmitted through the stronger bones until it expends itself by breaking a weaker one remote from the seat of the injury. Occasionally violent contraction of muscles is sufficient to break a bone. Certain bones, those of the limbs in particular, owing to their exposed position, are more liable to fracture than others. Owing to certain predisposing causes, such as age, habit, or hereditary constitutional weakness, the bones of some animals are more easily fractured than those of others. The bones of an animal advanced in years are more subject to fracture because of the preponderance of inorganic matter rendering them more brittle. They are also occasionally rendered liable to fracture by a previously existing diseased condition. Fractures are divided into four classes—partial, simple, compound, and comminuted.

Partial fractures.—Partial fractures are those which are liable to occur in a young animal in which the preponderance of animal matter or the semicartilaginous condition of the bone renders it tough, so that even when considerable force is applied the bone bends, breaking on the side opposite that to which the force was applied, after the manner in which a green stick bends and breaks.

Simple fractures.—Simple fracture is one in which the bone is severed in two parts, transversely, longitudinally, or obliquely, without serious injury to the adjoining structures.

Compound fractures.—Compound fracture is one in which there is an open wound permitting the air to communicate with the ends of the broken bones.

COMMINUTED FRACTURES.—Comminuted fracture is one in which the bone is shattered or divided into a number of fragments.

COMPLICATED FRACTURES.—Complicated fracture is one in which other structures surrounding the bones are injured.

GENERAL SYMPTOMS OF FRACTURE.—When a fracture of one or more of the large bones of a limb occurs, symptoms are sure to be well marked. After the accident the animal refuses to touch the foot to the ground and, if compelled to move, does so with great pain and reluctance. There is more or less shortening of the limb, with trembling of the muscles in the vicinity of the injury; deformity, and increased mobility, so that, instead of the natural joints of the limb and the natural, muscular control of their motion, a new joint, over which the animal has no control, is formed where the fracture occurred. As the leg, shortened by the ends of the bones being forced past one another from the muscular contraction which invariably takes place, hangs dependent from the body it swings in an awkward and unnatural manner, permitting the toe and foot to assume positions in their relations to other parts of the body which otherwise would be impossible. If the fractured bone is so situated that the parts may be moved one upon another, a grating sound, known as crepitus, will be heard.

GENERAL TREATMENT OF FRACTURES.—When a fracture occurs, the advisability of attempting treatment must first be determined. If the animal is young, valuable, and of reasonably quiet temperament, and the fracture is not too great in extent, the chances of recovery are fair. On the other hand, if the animal should be of little value, irritable, advanced in years, and the fracture is a serious compound or comminuted one, the wiser course would generally be to put the creature out of its misery.

Having determined to attempt treatment, no time should be lost in restoring the parts as nearly as possible to their natural position and retaining them there. If the ends of the bones have been drawn one past the other, they should be drawn out by firm and continuous tension, until they again assume the position in which they were before the accident. All this can better be done before the swelling (which is sure to result) takes place. If the swelling has occurred before the injury is noticed, do not attempt to treat it, but proceed at once to treat the fracture as though the swelling were not present, for no step can be taken toward recovery until the ends of the bone have been restored to their proper position. When that is done and proper appliances have been used to prevent them from being again misplaced, the swelling, which is the result of irritation, will be relieved. In selecting the appliances to be used in the treatment of fracture the judgment and ingenuity of the operator are of much importance. Splints, made of wood shaped to fit the limb and padded with soft material where they come in contact with bony prominences, and held in position by means of bandages, are the oldest method, and with some are still most popular. The fracture pads used in human surgery, and for sale in surgical depots, are very convenient. After being dipped in water they may be molded to fit the limb and be retained by means of bandages. Heavy sole leather is also used after being soaked in warm water and molded to the shape of the limb and holes cut in it to fit over any sharp irregularities in the natural shape of the bones. Gutta-percha sheets are also used and answer well. They are prepared and used in the same way as the leather.

Another and perhaps the simplest of all methods is the application of a plaster-of-Paris bandage, which is made as follows: Strips of thin cheesecloth 3 inches wide and 8 or 9 feet long are laid flat on a board and on them is spread a layer of plaster of Paris about one-eighth of an inch thick; then, starting at one end, roll carefully so as to gather the plaster in between the layers of the bandage. It is of course important that the cloth be thin and the plaster of Paris fresh and active. After preparing four or five of such bandages the operator is ready to dress the fracture, which, after the parts have been brought into position, should be done by covering all that part of the limb to which the plaster-of-Paris bandage is to be applied with a single layer of the dry bandage, letting it extend both above and below the part to which the plaster bandage is to be applied and including under the folds of the dry bandage at each end a layer of absorbent cotton, which is intended to form a pad to prevent the ends of the plaster bandage from chafing the skin beneath. When this is done one of the plaster bandages should be placed in a vessel of water and allowed to remain till the air bubbles have ceased to rise from it, which will generally indicate that it is soaked through. Then, taking it in the hand, wind it carefully around and around the limb, unrolling the bandage as it is wound around the limb, occasionally smoothing down the plaster of Paris. Should it form roughly or in ridges the hand may be dipped in water to impart increased moisture to it. When about finished with one bandage, place another one in the water, so that the winding operation may be continued without delay. The bandages should be applied till the cast is from one-half to three-quarters of an inch thick, then gently restrain the animal for one-half or three-quarters of an hour till the plaster is hardened. Any of the appliances used should be so manipulated as to prevent absolutely any motion of the detached parts. If the fracture is near a joint, it is generally best to include the joint in the appliance. The part of the limb below the bandage should be carefully and firmly wrapped with an ordinary cotton bandage all the way from the plaster bandage down to the hoof. This last bandage will tend to prevent swelling, which is liable to occur, the result of the dependent position in which the animal is forced by nature to keep the injured limb.

When plaster-of-Paris bandages are applied to a compound fracture the injured part may be previously dressed with a small, thick pad of cotton immediately over the wound. In applying the bandage the operator may with a little care so arrange it as to keep the folds of the bandages off the cotton, or have only a thin layer over it, which may be easily cut out and the cotton removed, leaving a convenient opening through which to dress the wound without removing the bandage. The ends of the bandage or other appliance should be carefully watched to see that the skin does not become chafed, particularly at the lower end. If the bandage should become weak or broken at any part, it may be strengthened without removal by applying other bandages immediately over it. If swelling has taken place before the bandage has been applied, there is liable to be some loosening as it disappears, and even without the swelling there may be a tendency of the bandage to slide downward. This may be overcome by fastening it to a suspender attached to a surcingle or passed over the body and attached to the opposite leg. If the looseness can not be overcome in this way, the space may be filled by pouring in a thin paste of plaster of Paris. A better method, however, is to remove the bandage and apply another. Owing to the hardness of the bandage it will be removed with some difficulty. A deep groove should be cut down completely through it on the opposite sides. This may be done with a chisel and a small hammer if the bandage is carefully held by an assistant so that the concussion of the blows is not transmitted to the injured bones. The patient should have a roomy stall, and should be tied by the head to prevent any attempts to move around. In some cases slings have been used. Ordinarily, however, they are not satisfactory in cattle practice, and if applied should be for only a few days at a time, and with a view to lessen the animal's disposition to lie down, rather than to prevent it. When they are used continuously the pressure on the abdomen may interfere with digestion and the general health of the animal.

Modes of union.—The animal should be kept as quiet as possible and given such feed as will have a tendency to keep the bowels slightly relaxed. The success of the operation depends chiefly on the skill of the operator, but not alone in the selection and use of the appliances, for as much attention must be given to subsequent management. The patients are restless, and a single awkward motion may undo the work of weeks so far as the union of the parts of the bone is concerned. Union takes place after the same process and, if the conditions are favorable, with greater rapidity than in the human being. The injury that caused the fracture is almost sure to have extended to some of the adjacent tissues, and even though the fracture may be of the simplest type there is almost sure to be considerable hemorrhage around the ends of the broken bone. This, however, is unimportant if the skin remains intact, unless a very large vessel should be injured, or the fracture should open some of the important cavities of the body, in which case a fatal hemorrhage may result. If, on the other hand, the fracture is compound the external opening furnishes a fertile field for the lodgment of disease-producing germs.

Unless great care is taken in such cases, a suppurative process is liable to be established which will seriously interfere with, if not entirely arrest, the process of union between the bones; or it may become so serious as to endanger the general health of the animal and even be attended with fatal results. This last danger is greater if the injury has occurred to the bones of the arm or thigh. In such cases, owing to the dense covering of fascia which ensheathes the muscular covering pus is liable to be imprisoned, and, burrowing downward, saturate the whole structure, not only endangering the limb, but, by absorption, may set up blood poisoning and seriously interfere with the general health of the patient, even to causing death. In order so far as possible to prevent such an unfortunate complication, the wound should be carefully cleansed with a mild solution of carbolic acid, then dusted over with iodoform before the bandages are applied, and cleansed and dressed daily in the same way. After dressing, always cover with absorbent cotton. In the early process of union an exudation of lymph takes place, which is at first fluid, gradually becoming thicker and firmer till it forms a callus, known as the external or ensheathing callus, in the shape of a ring or ferrule surrounding the detached portions of the bone. It occasionally happens that this callus forms only at the ends of the bones, filling the spaces that exist between them, when it is known as the intermediate callus. The process of union may be divided into five stages. In the first stage, including the first eight days, the detached portions of the bone and the sharp projections that are not sufficiently nourished are absorbed; the blood which escaped into the surrounding tissues, the result of the injury, is gradually absorbed, and the effused lymph, which is ultimately to constitute the temporary cartilage, takes it place. In the second stage, from the tenth to the twentieth day, the tumor or callus is formed and fibrocartilage is developed inside and around the exposed end of the bone. In the third stage, extending from the twentieth to the fortieth or fiftieth day, according to the age and strength of the animal, the fibrocartilaginous structure undergoes a change and is gradually converted into bone, forming a ferrule on the outside and a plug on the inside, which serve to hold the part in position. In the fourth stage, extending to about the sixth month, the whole of the new structure is converted into bone. In the fifth stage, extending to the end of the first year, the callus is absorbed, being no longer necessary, and the connection between the cavities of the two bones is again established.

Common complications.—The process of union just described is healthy and normal. Diseased conditions may at any time supervene during the treatment and render the operation unsuccessful. In the case of compound fracture, the open wound communicating with the ends of the bones, a septic condition is liable to arise which may become so serious as to endanger the animal's life and bring about conditions which in human surgery would indicate amputation. Although that operation is not a general one in veterinary practice, there is no reason why it should not be attempted as a last resort, particularly if the animal is valuable or is one whose existence is necessary in order to perpetuate some valuable strain. Even in the simplest form of fracture, if the splints or bandages are improperly applied and the fractured bone left so loosely guarded that the broken ends move one upon another, the formation of the calluses previously described is liable to be interfered with, and in place of a strong, rigid, and healthy union a formation of elastic cartilage is the result. This false structure unites the broken ends of the bones in such way that they move one upon another, depriving the bone of its stability and usefulness. When once the healthy process of union is interrupted in the manner just described, it is again established with great difficulty. It no longer does any good to continue the restraining power; in fact, the change of the temporary cartilage into bone is more liable to be reestablished if the parts move violently upon each other for a short time so as to set up and renew the process of inflammation. Then if the restraint is again applied there is some chance of union. In order so far as possible to avoid this danger, care should be taken to see that the bandage fits closely and that it is kept on till there is no longer any danger but that a perfect union has taken place. It is impossible to say at just what time the splints or bandages can safely be removed. In a young and healthy animal of quiet temperament, if the parts have been firmly held in position throughout the whole time, from 30 to 40 days may be regarded as reasonably safe. Under more unfavorable conditions as to age, vitality, and restraint, the period would better be extended to 60 days, if the general condition of the animal is such as to permit of so long a continuance. After the appliance has been removed the animal should be allowed to stand quiet for a few days, then be given very gentle exercise, gradually increased for a week or 10 days, by which time the patient will be so far recovered as to be placed in pasture.

It should, however, be alone for a time, so as not to take any chance of injury from fighting or other accidents that association with other animals might involve.

SPECIAL FRACTURES.

FRACTURE OF THE HORNS.—Of the special fractures liable to occur, that of the horn is perhaps the most common. It is always the result of violent mechanical means, such as blows, injury occurring while fighting, or from the animal getting its head locked in some manner while feeding from a rack. When it occurs there are two ways in which the injury may affect the animal. First and most common, the horny crust is liable to be stripped from the bony projection which it covers. Second, the crust and bone may both be broken or bent down, the fracture occurring in that case at the root of the horn and involving part of the bones of the head in the immediate vicinity. In the first case, if the horny covering is knocked off, little attention is necessary. The animal may be relieved from suffering if the stump is smeared with pine tar and wrapped in cloth. If the core is much lacerated, perhaps it would be better to amputate. The necessity for such operation must be determined by the condition of the injury, influenced to some extent by the owner's ideas on the subject. When the operation is performed, it should be done with a sharp, fine-toothed saw, and by sawing the horn off close enough to include a little of the skin and hair around its base. The practice of dehorning has grown popular in many parts of the country. It is a simple operation, and, although attended with some immediate suffering, does not produce serious constitutional disturbance. The advisability of performing the operation on all cattle is a question of expediency and must be justified by the expectation of benefit on the part of the feeder. If the horn should be broken so that the core and crust are bent out of shape without the detachment of one from the other, it may be restored to its normal position and retained there by means of a splint made to fit across the back of the head, so as to be laced to both horns, the sound horn serving to hold the broken one in position. Such a splint may be fastened on by means of either a wire or cord and allowed to remain six weeks or two months.

If both the horn and core have been broken off, bleeding is usually severe and should be checked by astringents, such as alum, or by pressure. After the hemorrhage has ceased the exposed portion of the fracture should be covered with pine tar, with or without a bandage. An imperfect growth of horn will in due time cover the exposed bone.

FRACTURES OF THE BONES OF THE FACE.—These occasionally occur, and when over the cavities of the nose produce depression, disfigurement, and impeded respiration, owing to the lessening of the caliber of the nasal passages.

When such accident occurs, the depressed bone should be gently forced back to place by introducing the finger in the nostril, or if the fracture is too far up for this, a probe may be passed and the parts retained by placing immediately over it a plaster of thin leather or strong canvas smeared with tar, extending out to the sound surroundings, taking care to embed the hair over the fractured portion in the tar of the plaster, so that it will be firmly held and prevented from again becoming depressed. If only one nostril is involved, the depressed portion may be held in position by packing that nostril with absorbent cotton. This practice, however, has the objection of giving the animal great discomfort and in some cases a disposition to aggravate the injury.

Fracture of the skull (cranium).—Fractures of the bones forming the cavity in which the brain is situated are, owing to their strength, comparatively rare among cattle. Such an accident can only be the result of external violence, and it is hardly possible that it could occur without some fragment of the broken bone pressing upon the brain so as to cause coma or other severe nervous derangement, or even death.

If the animal survives the first shock, the efforts should be directed toward relieving the pressure, which may be done by making an opening in the bone (trephining), and with a hook drawing the depressed part outward. Interference is not so liable to be attended with good results as to be warranted in all cases. The effects of a very severe shock which may not have produced a fracture, although the symptoms were alarming, will in many cases pass off, leaving the animal in a better condition than if an operation had been performed.

Fracture of the lower jaw.—This occasionally occurs, and is more liable to result from the kick of a horse than from any other cause. The front part of the jaw may be split or shattered in any direction in which the force may have been applied. Bloody discharges from the mouth and failure to eat or ruminate are symptoms most likely to attract attention.

The treatment is simple and consists in first removing detached pieces of bone, then drawing the parts together and retaining them by means of pieces of copper wire fastened around the teeth, and feeding the animal on sloppy feed until recovery takes place. The wound should be dressed once or twice a day with a 3 per cent solution of carbolic acid, forced gently in with a syringe, so as to remove any feed which may have become impacted and interfere with the healing process.

Fracture of the vertebra (spinal column).—This is not so common among cattle as other animals. If the fracture should be through the body of the bone, there may be pressure on or laceration of the spinal cord, causing paralysis of all parts posterior to the seat of injury. Fractures of the prominences on a vertebra occasionally occur without interfering with the canal in which the spinal cord is situated. Such accidents are liable to pass unnoticed, for, although the animal may suffer considerable pain, it may not be manifested in such way as to attract attention, and the deep covering of muscles serves effectually to conceal the injury. When the fracture occurs in the upper part of the neck, paralysis of the muscles used in respiration must result, and death from asphyxia very shortly ensues. The more common accident is to the loins, and when a fracture of the body of a vertebra occurs in this region so as to produce pressure on the spinal cord, paralysis of the hind legs and quarters is the result. Diagnosis of such an accident is more difficult than in the case of any other fracture. The parts can not be moved one upon another so that crepitus is noticeable. The heavy coating of muscles conceals irregularities of shape, which otherwise may attract attention. About the only reliable symptom is paralysis or loss of use and sensation of the parts posterior to the injury. Careful examination may reveal the seat of the injury. If it was the result of a blow, there may be some abrasion of the skin. The diagnosis is only important as an aid in determining the proper course to pursue.

If paralysis is present and a depression or irregularity of the spinal column is so apparent as to leave no doubt of the existence of a fracture, the only alternative is to destroy the animal, for of recovery there can be no hope. If, on the other hand, the paralysis is incomplete and there is no depression or irregularity of the spinal column or other evidence of fracture, the patient should be made as comfortable as possible by being placed in a well-bedded box stall and a few days permitted to elapse before the case is abandoned. The symptoms last described may possibly be the result of a severe strain of the muscles of the loins, in which case an improvement will soon be noticeable.

Fractures of the pelvis.—The pelvis, or bony framework which gives shape to the posterior part of the body, is liable to fracture in many ways. A common one is by a separation of the two bones which constitute the whole pelvis along the bottom and center line (symphysis pubis). In early life the two bones are separate and distinct. The union between them, which is at first cartilaginous, undergoes a change and is converted into bone, so that in adult life the whole pelvis is practically one bone. The point on which the two bones are united is weaker than the adjoining parts of the bone. When an animal slips violently, spreading the legs wide apart, the weaker materials give way and the bones are divided. If the accident is noticed when it occurs, it is likely to throw light on the nature of the injury. The animal will immediately go stiff behind, the legs being spread apart. Further examination may be made by introducing the hand, previously carefully oiled, into the rectum or vagina and pressing down along the central line, which will cause the patient to evince acute pain. In this case no appliance can be used to advantage. The animal should be tied in a stall until the parts become reunited and the lameness disappears.

Fracture of the posterior parts of the bone (ischium), which forms the point of the buttocks occasionally occurs. The buttock on the injured side will be less prominent than the other. Careful manipulation will generally move the parts so that crepitus may be recognized. If the fracture is through the posterior part of the bone, it is unimportant and deserving of no more attention than placing the animal in such position as to insure it against subsequent injury until the bones are united. Some distortion may result, but not sufficient to warrant interference.

Fracture through the body of the bone on a line with the hip joint (acetabulum) occasionally, though rarely, occurs, and is nearly always associated with dislocation of the hip joint and the forcing of the head of the upper bone of the leg (femur) upward, far out of its place. The violent contraction of the powerful muscles of the hip renders it impossible to reduce the dislocation, and even if it were possible the fractured pelvis could not be held in position, so that the case becomes at once hopeless. It may be recognized by the animal's standing on three legs, the leg on the injured side seeming shorter than its fellow and hanging pendulous, the muscles of the hip violently contracted and hard to the touch. The animal evinces great pain when the limb is moved. There is liable to be some apparent distortion in the relations between the point of the hip and the point of the buttock. This will be more readily noticed by comparing the injured side with the other. The parts may be moved so as to produce crepitus. The examination may be completed by introducing the oiled hand into the vagina or rectum, when the two sides of the pelvis will reveal well-marked differences.

Fracture of the point of the hip.—The anterior and external part of the pelvis (ilium), commonly known as the point of the hip, is liable to fracture, which stock owners describe as "hipping," or being "hipped," or having the hip "knocked down." This accident may be the result of crowding while passing through a narrow door, of falling violently on the point of the hip, or from a violent blow directed downward and forward against it. The lesion generally extends across the flat surface of the bone from its outer and posterior edge forward and inward. Distortion is liable to be the only noticeable symptom. The detached portion varies in size in different cases and with it the resulting deformity. The animal is noticed to be slightly lame, but this symptom soon disappears. The detached portion of the bone is drawn downward and away from the main part by the action of the muscles below, which are so powerful as to render return impossible. The bones therefore remain permanently separated, union taking place by fibrous callus. The animal suffers very little inconvenience, and for practical use may be as serviceable as before the accident, though the distorted appearance depreciates its value.

Fracture of the ribs.—Such an occurrence can take place only as the result of a direct injury, as from blows or crowding. The posterior ribs, being more exposed, are more liable to fracture. Pain in moving, slight swelling over the seat of injury, and difficult breathing are obvious symptoms. If the fracture is complete, crepitation may be occasionally noticed by placing the hand flat over the injured part, carefully observing the motion as the chest contracts and expands during respiration. This symptom is more noticeable when the animal coughs. Unless the point of the broken bone penetrates the cavity of the chest the fracture is usually unimportant and calls for no treatment other than quiet. If the breathing is very labored and attended with much pain, motion may be limited by applying a wide bandage firmly around the chest. The animal should be restricted in the amount of feed and water for a few days, the stomach being kept as nearly empty as possible. Sloppy feed should be given to encourage, as much as possible, free action of the diaphragm in breathing.

Fracture of bones of the limbs.—On this subject much has been said in the preceding remarks on general fractures. As a rule, fracture through one of the large bones of the shoulder (scapula) or thigh (femur) is very difficult to manage. The powerful contraction of the muscles and the changing shape of the limb resulting from their action renders it impossible to retain the detached parts of the bone in proper position. Therefore, though the union should take place, there is almost sure to be considerable deformity and more or less lameness. Fracture of the arm (humerus) or leg (tibia) is likely to be attended with better results. The muscular covering is not so thick, the sheath in which they are held is more tense, and the change in the shape of the limb from muscular action not so noticeable, the muscular force not so great, all of which facilitate replacing the dislodged ends and retaining them.

Fracture of the knee (carpus) and hock (tarsus).—This seldom occurs unless it is the result of a very violent injury, and is generally associated with other injury and serious complications. Displacement does not generally occur to any considerable extent. The treatment, of course, consists in holding the limb perfectly quiet in a natural position, which may be done by the application of long, wooden splints retained by bandages, or a plaster-of-Paris bandage.

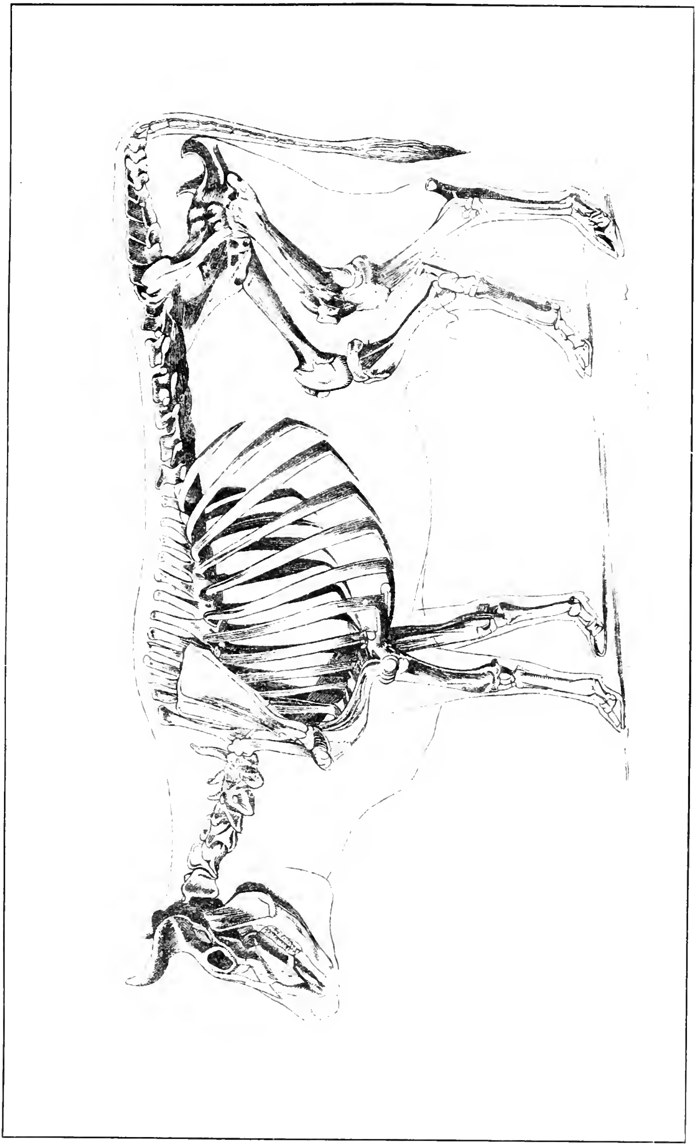
FRACTURES BELOW THE KNEE.—Fracture of the long bone below the knee (metacarpus) and hock (metatarsus) is more common. In young animals of quiet temperament the treatment of simple fractures here is likely to be attended with good results. On the other hand, a compound fracture in this region becomes a serious matter. The structures which surround the bones are so thin that a very small degree of sloughing will expose parts of the bones and be liable to lead to serious complications and probably fatal results.

FRACTURES OF BONES BELOW THE FETLOCK.—These fractures are comparatively unimportant unless associated with other serious injury. The parts can generally be held in position without much difficulty, and union generally takes place quite rapidly.

APPLIANCES.—Of the appliances used in the treatment of the fracture of limbs above the knee, splints made of wood or iron strips and bandages are likely to serve best. Below the knee plaster-of-Paris bandages are preferable. The writer is well aware that many of the standard authors deprecate the use of the latter, but an extensive experience leads me to believe that they have many advantages over any of the other appliances when used alone, and in many ways they may be used with advantage in combination with others.

DISLOCATIONS.

Luxation, or displacement without fracture of the bones forming a joint, is comparatively rare among cattle. It most frequently occurs in the stifle joint, where dislocation of the kneepan (patella) takes place. A glance at the skeleton (Pl. XXV) will show the relations better than they can be described. It will be observed that the small, irregularly shaped bone (patella) plays on the anterior rounded part of the lower edge of the thigh bone (femur) and between it and the upper end of the shank bone (tibia). The outer ridge on the lower end of the thigh bone is less prominent than the inner one, so that displacement, when it does take place, is by slipping outward. Such an accident may occur from direct injury or external force, as a blow, or from slipping. When it does occur the symptoms produced are somewhat alarming. The animal is unable to draw the leg forward, and either stands with it thrown back with the toe pointing downward, or, if it should succeed in getting its weight upon it, holds it firmly on the ground, fearing to move it. Examination of the outside of the joint will disclose the situation of the patella outside its proper place. If the operator



SKELETON OF THE COW.

is not familiar with the normal appearance of the joint, it is well to make a comparison between the injured and the sound one. If compelled to move, the animal does so with great difficulty, jerking the leg which it is unable to bring forward, hopping with the other, and partially dragging the injured one.

Treatment.—The treatment is simple. A rope 20 feet long should be applied around the fetlock of the affected leg, passed forward between the front legs and up over the opposite side of the neck, back over the withers, and wrapped once behind the elbow around that portion of the rope which passes between the front legs. The leg is then drawn away from the body and forcibly pushed forward by an assistant, while another person tightens up the slack in the rope until the affected leg is off the ground in front of the supporting leg. The rope is then drawn taut and the assistant grasps the tail and pulls the cow toward the affected side. The animal makes a lurch to keep from falling, contracts the muscles, and the patella slips into place with a sharp click, and the animal walks off as if nothing had happened. If the animal resists this method of handling, it may suffice to manipulate the dislocated kneepan by shoving it inward and forward with the heel of the hand while the affected leg is drawn well forward. Unless some precaution is taken the accident is liable to recur, as the ligaments have been stretched by the dislocation till they no longer hold the bone with that firmness necessary to retain it. The animal should be tied and the foot fastened forward, so that the patient can just stand on it comfortably, by means of a rope or strap around the fetlock carried forward between the front legs, around the neck, and tied on the breast.

Should this accident occur more than once it is a good practice to apply a blister around the joint, as in the formula recommended for sprain of shoulder, and observe the precautions as to restraint and subsequent treatment there recommended. With this one exception dislocations in the ox occurring independently of other complications are rare.

Dislocation with fracture may occur in any of the joints, and if one is suspected or discovered, examination should always be made for the other before treatment is applied. When a fracture occurs near a joint the force sufficient to rend the bone is liable to be partly exerted on the immediate tissues, and when the bone gives way the structures of the joints may be seriously injured. It occasionally happens that the injury to the joint becomes the most important complication in the treatment of a fracture. In order clearly to understand the reason for this a few words are necessary in relation to the structure of joints.

The different pieces constituting the skeleton of the animal body are united in such manner as to admit of more or less motion one upon another. In some of the more simple joints the bones fitting one into another are held together by the dense structures around them, admitting of very little or no movement at all, as the bones of the head. In other joints the bones are bound together by dense, cartilaginous structures, admitting of only limited motion, such as the union of the small bones at the back part of the knee and hock (metacarpal and metatarsal). In the more nearly perfect form of joint the power of motion becomes complete and the structures are more complex. The substance of the bone on its articular surface is not covered with periosteum, but is sheathed in a dense, thin layer of cartilage, shaped to fit the other surfaces with which it comes in contact (articular). This layer is thickest toward its center when covering bony eminences, and is elastic, of a pearly whiteness, and resisting, though soft enough to be easily cut. The bones forming an articulation are bound together by numerous ligaments attached to bony prominences. The whole joint is sealed in by a band or ribbonlike ligament (capsular ligament) extending around the joint and attached at the outer edge of the articular surface, uniting the bones and hermetically sealing the cavities of the articulation. This structure and the articular surface of the bone is covered by a thin, delicate membrane, known as the "synovial membrane," which secretes the joint oil (synovia). This fluid is viscid and colorless, or slightly yellow, and although it does not possess a large quantity of fat, its character somewhat resembles oil, and it serves the same purpose in lubricating the joints that oil does to the friction surface of an engine. Although the tissues of the joint when used in a natural way are able to withstand the effect of great exertion, when unnaturally used, as they are very delicate and complex, they are liable to inflammatory and other changes of a very serious nature. The synovial membrane, and in fact the whole structure of the joint, is susceptible to injury and serious inflammatory derangement, and the capsular ligament is liable to be distended from excessive secretion of synovia. The latter process may be almost noninflammatory, and attended with little inconvenience or importance other than a blemish to the animal, which in cattle is not serious. It may occur on the back part of the leg above the fetlock or on the inner and fore part of the hock, corresponding in its location to windgalls and bog spavin of the horse. Continuous support by bandages will generally force reabsorption, and as the limb is not subjected to violent action, as in the case of the horse, the affection is not so liable to recur.

SPAVIN.

Occasionally working oxen that are used in the lumber woods and made to pull heavily, with bad footing, are afflicted with this condition. When it occurs lameness is the first symptom. During the early stages of the disease the lameness is most severe in the morning, and disappears after the animal is exercised; it gradually becomes more severe as the disease advances, so that when the disease is well established the animal is lame continuously. Shortly after the lameness appears a bunch (exostosis) will be noticed on the inner and fore part of the affected joint. This bunch differs from bog spavin in that it is hard, while bog spavin is soft. It increases in size as the disease advances till the animal is too lame to be used for labor. As the disease is always attended with considerable pain there is more or less loss of flesh. In the most advanced stage the animal will step with difficulty, frequently holding the foot from the ground, or, if forced to take a few steps, stands with it elevated, twitching with pain. In the earlier stages of the disease only a small portion of the fore part of the lower, or second, articulation is involved, but the inflammatory process gradually extends over the whole surface of the lower joints of the hock. The structures of the joint are broken down and the bones are united (anchylosis). This process may include any or all of the three lower joints of the hock. The joint of motion which is situated on the lower end of the leg bone is seldom involved.

Treatment.—Treatment of spavin in the ox, as in the horse, is likely to be tedious, and not always resulting in perfect cure. Usually it is best to fatten the animal for slaughter. If, however, treatment is decided upon, it should consist of complete rest and counter-irritation of the part either by sharp blisters or the firing iron. It is advisable to try the effect of blistering first, and for this purpose the following mixture is recommended:

Powdered cantharides	drams	2
Biniodid of mercury	do	2
Vaseline	ounces	1½

Clip the hair off and apply over the inner and fore part of the joint, covering the surface an inch and a half in every direction from the enlargement, or over an area 3 to 4 inches across. Fasten the animal's head so that it can not reach the part to lick it; after the third day grease with lard every other day until the scabs come off. This blister may be repeated three or four times at intervals of three weeks. The lameness will generally begin to disappear about the third or fourth month if the above-described treatment proves beneficial. Should lameness persist, firing in points by a qualified veterinarian may effect the desired result and should be tried as a last resort.

In a case of spavin the cure is not effected by restoring the diseased parts to their natural condition, but by uniting the bones and obliterating the joints. If this union extends over the whole articular surface of the joints affected and is sufficiently strong to prevent any motion of the bones, the animal will again go sound. The joints that are obliterated, not being those of motion, are not important, so that the animal suffers no inconvenience in their loss.

RHEUMATISM.

Rheumatism is a constitutional disease from a specific condition of the blood and characterized by inflammation of the fibrous structures of the body. It is usually accompanied with stiffness, lameness, and fever. The parts affected are usually swollen, but swelling may be lacking. The inflammation may be transitory; that is, it changes from place to place. The parts usually affected are the fibrous structures of the joints, tendons, ligaments, and muscles. The serous membranes and heart may also be affected. According to its location, rheumatism is specified as articular or muscular. According to its course, it is designated as acute or chronic.

Cause.—Among the factors which are actively causative of rheumatism may be mentioned exposure to dampness and cold, especially while the animal is perspiring or fatigued after severe physical exertion. Among other causes often mentioned are acidity of the blood, nervous derangement, microbes, and injuries. It occasionally follows another disease, such as pleurisy. The influence of age and heredity may be considered as secondary or predisposing causes. Sometimes the disease appears without any apparent cause. On the whole, it may be said that any of the above-mentioned factors may have more or less influence on the production of rheumatism, but the specific cause is as yet unknown.

Symptoms of articular rheumatism.—The symptoms appear suddenly and with varying degrees of severity. The animal presents a downcast appearance, with staring coat, horns and ears cold, and the mouth and muzzle hot and dry. Appetite and rumination may be impaired and followed later or be accompanied at the same time by constipation. Constipation may be followed by impaction of the stomach or bowels. Thirst is increased, but the amount of urine voided is scanty. Respiration and pulse are accelerated, and there is usually a fever, rising sometimes as high as 108° F. The animal prefers to lie down, and when forced to rise stands with its back arched. The movements are stiff and lame and cause great pain. The disease may attack one or more joints at the same time; in fact, it is often symmetrical. One joint may improve while another becomes affected, thus showing the shifting tendency of the inflammation. The affected joints, including their tendons, ligaments, and synovial membranes, may be swollen, hot, and distended with liquid. They are very tender, and, if treated carelessly or injured, may become infected, thus leading to suppuration. While rheumatism attacks perhaps more frequently the knees and fetlocks, it has no special affinity for any joint and may attack the stifle, hip, shoulder, or elbow joint. In mild cases of articular rheumatism, the animal may fully recover in a few days.

In chronic articular rheumatism there is less tendency of the disease to shift about, but there is a greater liability of structural change in the affected joints. This change may consist of induration, exostosis, or even anchylosis. These structural changes about the joints may lead to permanent deformity, such as the bending of the neck. Fever is not so constant in the chronic form as in the acute, and the latter may lapse into the former.

Symptoms of muscular rheumatism.—This form of rheumatism may appear under the same general conditions as the articular form. The general appearance of the animal is the same in both forms. The cow usually assumes a recumbent position, and all the movements made are stiff and lame. The method of rising or of locomotion indicates pain in certain muscles or groups of muscles, as of the croup, shoulder, or neck. As in the case of articular rheumatism, the tendons, ligaments, and synovial membranes may become involved. The constitutional symptoms in both articular and muscular rheumatism are similar, so that it is often perplexing to differentiate between the two forms.

Prevention.—It is somewhat difficult to procure preventive treatment for cattle, especially when there are large numbers with little or no shelter. In general, it is advisable to protect the animals so far as possible from inclement weather conditions, such as cold rains, heavy dews, and frosts. This is more particularly necessary for animals in poor condition, or those which are perspiring or fatigued after long physical exertion. Careful feeding is also essential.

Treatment.—In attempting to treat cattle for rheumatism the first step is to procure proper shelter and environment. The animal should be quartered in a large, clean, dry stall, with plenty of light and fresh air, but protected from strong drafts. There should be an abundance of clean, dry bedding. The feed should be soft, easily digestible, and slightly laxative, and the animal should have access to clean, pure, cool water.

For general or constitutional treatment of acute rheumatism, sodium salicylate is indicated. In order to gain the best results from this drug, it should be administered with the idea of rapidly saturating the system. To cattle it may be given in doses of one-half ounce every two hours for ten hours or until immediate relief is obtained. This drug should not be continued indefinitely, but may be given once a day after immediate relief has been obtained, and this single dose continued daily until permanent relief ensues, when it should be stopped. The use of sodium salicylate in chronic rheumatism is not advisable on account of the danger of depressing the heart, whose action is already somewhat impaired by the lesions which have attacked it. In this case one-half ounce doses of potassium nitrate or bicarbonate may be given three times a day. Besides the constitutional treatment, it may be necessary to give special attention to the bowels in order to relieve constipation. Cattle may be given saline laxatives at the outset, such as 1 pound of Epsom salt for an ordinary-sized cow, and the bowels kept regular by an occasional smaller dose.

In chronic rheumatism the best course of treatment is to give tonics and local treatment. Local treatment may also be advisable in acute rheumatism in addition to the constitutional treatment already prescribed.

External treatment depends solely on the local conditions and should be applied judiciously. Among the various remedies may be mentioned hot or cold moist packs, hot air and vapor baths, friction, etc. Anodynes are often applied locally with good results. Blisters are occasionally indicated. As anodynes may be mentioned liniments and ointments containing salicylic acid or sodium salicylate in combination with laudanum, aconite, or chloral hydrate. Camphorated spirit, soap liniment, and essential oils also afford some relief when applied locally. Of blisters, those containing cantharides are most effective.

SURGICAL OPERATIONS.

By William Dickson and William Herbert Lowe, D. V. S.

[Revised by B. T. Woodward, V. M. D.]

Surgery is both a science and an art. The success of surgical operations depends on the judgment, skill, and dexterity, as well as upon the knowledge of the operator. The same fundamental principles underlie and govern animal and human surgery, although their applications have a wide range and are very different in many essential particulars. We must not lose sight of the fact that hygiene and sanitation are essential to the best results in veterinary as well as in human surgery.

Asepsis is an ideal condition which, although not always possible in animal surgery, is highly important in connection with the mechanical details of all surgical operations in proportion to the nature and seriousness of the same.

Aseptic surgery is considered to be the performance of operations with sterile instruments with the hands of the operator and the site of operation being rendered as nearly sterile as possible, and the wound treated during operation with sterile solutions and protected following the operation with sterile bandage material. In other words, it is the preservation of the highest degree of cleanliness in connection with operations.

Local or general anesthesia should be resorted to in painful and serious surgical operations, as operations upon all living creatures should be humanely performed and all unnecessary pain and suffering avoided. Anesthesia is necessary where absolute immobility of the patient is essential and where entire muscular relaxation is indispensable. The anesthetic condition is also favorable for the adjustment of displaced organs.

Large animals have to be cast and secured before an anesthetic is administered. For complete anesthesia inhalations of chloroform are generally employed; sometimes of both ether and chloroform. The quantity of chloroform required to produce insensibility to external impressions varies much in different cases and must be regulated, as well as the admixture of air, by a competent assistant.

If the probability of the success of an operation is remote and the animal is in healthy physical condition, so that its flesh is good for human food, it is more advisable to butcher the animal than to attempt a surgical operation that offers little encouragement to the owner. The best judgment has to be exercised in determining a matter of this kind, for no animal suffering from inflammation or that is in a feverish condition is fit for human food.

All cases of major operative surgery require the skill and dexterity of the experienced veterinary surgeon, and no one else should attempt such an operation, for unnecessary suffering must be prevented. Nevertheless, the more knowledge and understanding an owner of animals has of the principles of surgical operations and manipulations, the better for all concerned. In the first place, such an owner will appreciate more fully the skill of the qualified veterinarian, and, in the second place, he will be the better prepared and equipped to render assistance to his suffering dumb dependents where no practitioner is accessible and in cases of emergency. There are, moreover, some minor operations upon cattle, some of which can hardly be classed as surgical, that the stockman and farmer should be able to perform himself.

In the performance of any operation upon an animal of the size and strength of the bull or cow, the first consideration is to secure the animal in such a manner as to preclude the possibility of its injuring either itself or those taking any part in the operation. The nature and time likely to be occupied by an operation must, of course, largely determine the method to be adopted.

The majority of operations with which the present chapter is concerned are usually performed on the animal in a standing position. A bull should always be held by a staff attached to the ring in his nose. To secure the cow in a standing position, grasp the nose, the finger and thumb being introduced into the nostrils, and press against the cartilage which makes a division between them. If she has horns, grasp one of them with the disengaged hand. If this is insufficient the animal should be secured to a post, along the side of a fence, or put into a stanchion. An excellent method of restraint is to tie a long rope in a slip noose over the horns, pass it around the chest just behind the forelegs, taking a half hitch on itself, taking another half hitch in front of the hind limbs, passing the free end under the tail, bringing it forward and making it fast either to the head or one of the hitches. The head should be raised to the level of the back before the final knot is tied, so as to render it too serious and painful a matter for her to repeat the first attempt she makes to lower it. Should the nature or extent of the operation be likely to take up considerable time, it is invariably the best plan to throw the animal. In the case of the ox this is very easily done, either by use of horse hobbles, should they be at hand, or by the application of a simple rope. If the horse hobbles are used, they should be fastened on the leg just above the fetlocks (ankle joints), as in that position they are less liable to come off than if placed around the pastern.

Of the many ways of applying the rope for this purpose we will describe only two, which we consider the best and simplest:

First. Take a long, strong rope (one which has been used a few times is more flexible), double it, and at 2 or 3 feet from the doubled end, according to the size of the animal, make a knot and pass the collar thus formed over the animal's head, allowing it to rest on what would be the collar place in a horse. Now, pass the ends of the rope between the forelegs, carry one around each hind leg just above the fetlock joint, from outside in, under itself once, and bring the free ends forward, passing each through the collar loop on its own side and bringing the slack back toward and beyond the hind quarters. (Pl. XXVI, fig. 2.) Two or three men should then take hold of each rope and at a given signal pull. The animal's hind legs being drawn forward, the balance is lost, and if the animal does not fall or lie down he can be readily pushed over on his side and secured in the desired position.

Second. The three half hitches. Take a rope 30 or more feet long, make a slip noose at the end and pass it over the animal's horns, leaving the knot in the loop between the horns; then pass the rope backward along the neck to the withers, just in front of which take a half hitch on it, passing it along the back, take one half hitch just behind the forelegs and a second in front of the hind limbs round the flank. (Pl. XXVI, fig. 1.) The free end of the rope is taken hold of by one or two assistants while another holds the animal's head. By pulling firmly on the rope, or inducing the animal to make a step or two forward while steady traction is made on the rope, the beast will lie down, when his feet can be secured in the way most convenient for the operator.

There are numerous other methods, involving more or less complete restraint, which may be equally efficacious, but one or other of the ways indicated will doubtless be found to meet fully all ordinary cases.

RINGING THE BULL.

This is usually and ought always to be done before the calf has attained sufficient weight or strength to make his restraint a matter of serious difficulty. An ordinary halter is usually all that is required, the strap being secured to a tree or post. A jointed steel or copper ring is ordinarily used. Those made of the latter metal are preferable.

The common method of punching a round piece out of the nasal septum for the introduction of the ring is, I think, open to objection, as portions of the fine nervous filaments are destroyed. The sensibility of the parts is thus lessened and the object of ringing to some extent defeated. The insertion of the ring by means of a trocar and cannula is preferable, as the method is not open to this objection.

For some years we have used a little instrument, which can be made by any worker in metal, consisting of a steel point riveted into a short cannula made to fit on one end of the ring while open. (Pl. XXVII, fig. 11.) When attached to the ring it is easily and quickly passed through the septum, the half of the ring following as a matter of course. It can then be removed and the ends of the ring brought together and fastened by means of the screw for that purpose.

DEHORNING.

In the wild state the utility of the horns of cattle as weapons of offense and defense is apparent, but with domestication of cattle and their confinement the presence of horns constitutes a menace to the safety of their companions. Horned cattle frequently inflict with their horns painful and serious injuries to others. Deaths as a result of such injuries are not unusual. The operation of dehorning would therefore be indicated as a matter of general safety.

On farms where breeding is conducted, the most desirable method is to prevent the horns from growing on the young calves. This action results in a more symmetrical appearance of the poll and eliminates the dangers which would result from the presence of horns on the young cattle prior to their operative removal at a later age. A calf should be treated not later than one week after it is born—preferably when it is from 3 to 5 days old. The agent to be used may be either caustic soda or potash in the form of sticks about the thickness of an ordinary lead pencil. These caustics must be handled with care, as they dissolve the cuticle and may make the hands or fingers sore. The preparation of the calf first consists in clipping the hair from the parts, washing clean with soap or warm water, and thoroughly drying with a cloth or towel. The stick of caustic should be wrapped in a piece of paper to protect the hands and fingers, leaving one end of the stick uncovered. Moisten the uncovered end slightly and rub it on the horn buttons or little points which may be felt on the calf's head—first on one, then on the other—two or three times, allowing the caustic to dry after each application. Be careful to apply the caustic to the horn button only, for if it is brought in contact with the surrounding skin it will cause pain. Too much moisture on the stick of caustic will allow the application to spread to the surrounding skin. After treatment keep the calf protected from rain, as water on the head after application of the caustic will cause it to run down over the face.

Dehorning of adult animals is usually performed after the age of 2 years, as after that age there is less probability of the horns again growing. The horns should be severed from the head from a quarter to a half-inch below where the skin joins the base of the horn, cutting from the back toward the front if a saw is used. If the horn is not cut close enough to the head, an irregular, gnarly growth of horn is liable to follow.

Before attempting to dehorn the animal, it should be securely controlled by ropes in a stanchion or by casting. Upon the range the cattle are usually controlled by casting or by placing them in a "squeezer" connected with a corral. A clean, sharp meat saw or a miter saw with a rigid back may be used. Various types of dehorning shears or clippers are in general use. One type of dehorner has a stationary knife edge with its cutting edge shaped like a very wide V, and opposing this, another knife of similar shape moving in a slide, so that the cutting edges act upon the horn from all four sides at once, all the edges passing the center at the same time. Another type has a movable knife, with one oblique or one curved edge, and the cutting is done in one direction only. The power for cutting with these instruments is supplied by pulling together two long handles which, in order to transmit a greater force, are generally so constructed that they act through the medium of a series of cogs. In dehorning with these instruments the cutting edges should be slipped down over the horn and the knives closed, so that their edges set firmly against the horn in such position that the cut will be made in the right place and in the right direction. The handles should then be drawn together with a quick, firm, strong pull so that the horn will be completely severed by the first act and without twisting.

Dehorning should, when possible, be performed in cool weather when the flies are not plentiful. The loss of blood from the operation is not sufficient, as a rule, to be of consequence, and after care being taken to prevent substances from getting into the openings left after the removal of the horns it is not usual to apply any dressing. Pine tar or a mixture of pine tar and tannic acid may be applied, particularly if the weather is warm.

SETONING.

The ordinary use of a seton is to keep up constant drainage from a cavity containing matter or to act as a stimulant or counterirritant. To insert a seton, the place of entrance and exit having been decided on, with the finger and thumb make a small fold of the skin transversely to the direction the seton is to be inserted, and cut it through, either with a sharp knife or a pair of scissors (this should be done at both the entrance and exit); then with a steady pressure and slight lateral movement insert the seton by means of a seton needle. (Pl. XXVII, figs. 1 and 2.) The seton should consist of a piece of strong tape, varying in breadth according to circumstances, and should be kept in place either by a knot on each end or by tying the ends together.

Setons should be gently moved once a day after suppuration is set up, and they should not be allowed to remain in over three weeks, or a month at the outside.

TRACHEOTOMY.

This operation consists in making an opening in the trachea, or windpipe. It is indicated whenever there is an obstruction from any cause in the upper part of the respiratory tract which threatens the death of the animal by asphyxia (suffocation). The mode of procedure is as follows: Have an assistant extend the animal's head as far as possible to make the trachea tense and prominent; make a longitudinal incision about 2 to 2½ inches long through the skin and deeper tissues and trachea at the most prominent part of the trachea, which is about the middle or upper third, and then insert the tracheotomy tube. The latter should be removed once or twice daily and cleansed, and the wound dressed antiseptically. To ascertain when it is time to discontinue the use of the tube and to allow the wound to close, the hand should be held over the opening, which will require the animal to use its natural passages in breathing. Observe whether it is performed in a natural manner, and if so, remove the tube and allow the wound to close. Often the operation has to be performed in great haste without the proper instruments and under great disadvantages, the operator having to cut down quickly, open the trachea and spread the parts, using some instrument improvised by him at the time. This operation only gives the animal relief in breathing, and therefore the proper remedial treatment should be adopted at the onset of the attack and continued until the cause (the disease) has been overcome.

RUMENOTOMY.

The opening of the paunch, or rumen, in cattle and the removal of a part or the whole of the ingesta through said opening is termed rumenotomy. The operation should be performed in severe cases only, where the rumen is excessively overloaded and distended. The animal is placed with its right side against a wall and firmly held in position by strong assistants. The incision is made in the same place that the trocar is inserted for puncturing that organ in cases of hoven. The opening is increased in size until the operator's hand can be inserted into the rumen. Before any of the contents are removed from that organ a linen cloth should be placed from the outer wound into the rumen in order to prevent any of the ingesta from getting into the abdominal cavity. Some practitioners, after removing a portion of the contents of the rumen, introduce such medicine as may be indicated before closing the wound. Clean the wound and close the opening in the rumen with uninterrupted (Pl. XXVII, fig. 8) carbolized catgut sutures. Next close the external wound, consisting of the integument, muscle, and peritoneum, with stout, interrupted (Pl. XXVII, fig. 6) metallic sutures. No feed should be given for several hours after the operation, and then gruels only. (See "Distention of rumen or paunch with feed," p. 26.)

TREATMENT OF ABSCESSES.

An abscess may be detected, if situated externally, by heat, pain, redness, and swelling in the early stages, and, if further developed, by the fluctuation which is present. When any of these symptoms are absent, the suppuration should be encouraged by the means of hot fomentations and poultices. Care must be taken that the abscess is not opened too soon, or to some extent it may cause it to scatter, and the escape of pus will be lessened. The time to open an abscess is just before it is ready to break, and should be done with a sharp lance, a crucial incision sometimes being necessary. The cavity should be syringed out with an antiseptic solution. Care should be taken not to allow the wound to close too rapidly, to prevent which a tent of lint or oakum should be introduced.

WOUNDS.

For the purposes of the present work wounds may be divided into three classes: (1) Incised; (2) punctured; (3) lacerated or contused. In any wound all that the most suitable applications can accomplish is, in the first place, to prevent the access of those poisonous germs which exist in the animal's surroundings, such as the soil and the manure, and, in the second place, when the process of repair is for some reason temporarily inactive or altogether arrested, to incite that curative inflammation that is the invariable method by which the cure is effected.

Incised wound.—This is one with clean-cut edges, and may be either superficial or deep. In wounds of all descriptions there is necessarily more or less bleeding, and this is especially liable to be the case in incised wounds, particularly when they penetrate to a considerable depth, or when inflicted on a part where blood vessels of any considerable size approach the surface. To arrest the hemorrhage must therefore be the first consideration. If slight, a generous use of cold water is all that is necessary, but if one or more vessels of any size have been wounded or entirely severed, they should be taken up and ligated. If the blood flows continuously and is dark in color, it proceeds from a vein, but if bright-colored and jerky in its flow, it is arterial.

The taking up of an artery simply means the tying up of the bleeding vessel, which should be accomplished as follows: To discover the bleeding artery take a piece of clean absorbent cotton, dip it in cold water, and by gentle pressure on the wound clear it of the accumulated blood. The jet of fresh blood reveals the end of the vessel, which is readily recognized by its whitish-yellow or buff color. It should be seized with a forceps or pincers and slightly drawn clear of the surrounding tissues. Now take the thread and place the middle of it under the artery, take up the ends, tie one simple knot tightly, pressing the thread down with the forefinger so as not to include the forceps, then a second one over it and cut off the ends. The bleeding being arrested, the operator can now carefully clean and inspect the wound, taking care to remove all blood and foreign matters and clip the hair around the edges before proceeding to stitch it up. If the wound is superficial, the lips may be brought together by a series of independent stitches (Pl. XXVII, fig. 6) about one-half of an inch to three-fourths of an inch apart. The stitches should not be drawn tightly; it is sufficient to bring the edges of the wound in apposition.

If the wound is deep, the needle should be introduced perpendicularly at as great a distance from the lip of the wound as the depth it is to be inserted, so as to give the thread sufficient hold. All the stitches should be as nearly as possible at equal distances from the border of the wound, to prevent unequal strain, and the knots should be made at the side, not over the wound. (Pl. XXVII, fig. 6.) When the wound is large and deep, care should be taken to have an opening in the lowest part to allow for the escape of the discharges.

In deep wounds which run crosswise of a limb or muscle it is often advisable to use what is technically known as the "quilled suture," which is most readily understood by reference to Plate XXVII, figure 7. To accomplish this method a curved needle with an eye in the point and a strong double thread should be used. The needle thus threaded is introduced perpendicularly at least an inch from the wound on one side, carried across below and brought out the same distance from the border of the cut on the opposite side, the thread being seized and held in position while the needle is withdrawn, leaving a loop of thread protruding on one side and two loose ends on the other side of each stitch. When enough stitches have been made, take a light piece of wood about the size of a lead pencil, corresponding in length to the size of the wound or slightly longer, and insert it through each of the loops, drawing up the free ends of the threads, which should in turn be tied securely on a similar piece of wood on that side.

PUNCTURED WOUNDS.—Owing to the uncertainty of their depth and the structures they may involve, punctured wounds are by far the most dangerous and difficult to treat. Not only is the extent of the damage hidden from view, but the very character of the injury, as can be readily understood, implies at least the possibility of deep-seated inflammation and consequent discharge of pus (matter), which, when formed, is kept pent up until it has accumulated to such an extent that it burrows by simple gravity, as no other exit is possible. In this way foreign matters, such as a broken piece of the stake or snag, or whatever caused the wound, may be carried to an indefinite depth, or the cavity of a joint may be invaded and very serious, if not fatal, consequences occur.

The danger is especially marked when the injury is inflicted on parts liable to frequent and extensive motion, but all cases of punctured wounds should receive unusual care, as no judgment can be accurately formed from the external appearance of the wound. While a probe can ascertain the depth, it throws but little light on the extent or exact nature of the internal injury. For this reason all punctured wounds should invariably be carefully searched by means of a probe or some substitute devised for the occasion, such as a piece of wire with a smooth blunt end, or a piece of hard wood shaped for the purpose. Stitching is not admissible in the case of punctured wounds. After thoroughly cleansing the opening of the wound and its surroundings, tincture of iodin should be injected directly into the wound.

If a punctured wound is not very deep, and when the bruising and laceration are slight, it is possible for healing to take place by adhesion, and this should always be encouraged, as the process of repair by this method is far superior to that by granulation, which will be referred to later. With this object in view, the animal should be kept as quiet as possible. A dose of physic, such as a pound of Glauber's or Epsom salt, should be administered, and warm antiseptic fomentations or poultices, when this is practicable, applied frequently to the surface of the wound.

In wounds of this description the process of repair may be complicated by the appearance of exuberant granulations, popularly known as "proud flesh," which is really an overgrowth of new tissue—granulation tissue; but these should not be interfered with unless they continue after the acute stage of inflammation has been subdued. If, after this, they persist, they may be treated with a 10 per cent solution of sulphate of copper (bluestone) or nitrate of silver (lunar caustic) in water.

Contused or lacerated wounds.—These are usually caused by a blow with some blunt instrument or by falls. The seriousness depends largely on the depth of the injury, and treatment should be directed to allaying the inflammation and preventing the consequent tendency to sloughing. To this end soothing applications, such as antiseptic fomentations and poultices, are plainly indicated.

Methods of healing.—Technically these may be divided into a number of distinct processes, but practically we may speak of them as two only, namely, by primary union, or adhesion, and by granulation. As suppuration is not so liable to occur in cattle as in horses, healing by the former and more speedy process is much more common in the first-named species, more particularly in clean-cut or incised wounds, provided they have been stitched within 12 hours from the time the injury which caused them was inflicted, that they have been kept antiseptically clean, and that the patient by some means has been kept fairly still. This latter stipulation is probably hardest to comply with. Quiet is an important factor in the process of repair among the lower animals.

The second method of healing, namely, by granulation, which is, however, the manner in which most wounds in animals heal, takes much longer. In punctured wounds of any depth healing necessarily takes place in this way only, and the treatment should be directed largely to alleviating pain and moderating inflammation.

After-treatment and dressing of wounds.—The dressing of wounds is one of the most important branches of veterinary surgery, and one of the most constant difficulties that the practicing veterinarian has to contend with lies in the lack of cooperation on the part of owners in the care and attention in the after-treatment of wounds.

In summarizing the treatment of wounds, the following recommendations should be observed: wounds must be cleansed and kept clean, using antiseptic solutions which do not produce irritation, and applying the solutions with a syringe or with clean pieces of absorbent cotton. Bleeding should be stopped before the closing of the wound by sutures or bandages. An opening at the bottom of all wounds except small superficial wounds should be provided as a drainage outlet for the escape of wound secretions or pus if it should form. The edges of wounds and the muscles involved in the wound should be kept as quiet as possible during the process of healing. Every wound should be protected by a sterile or antiseptic dressing whenever it is possible to retain a dressing in place. Dressings should be changed when it is apparent that they have become drenched with wound secretions or pus, or have become disarranged or too loose, permitting dirt to enter between them and the skin. If swelling appears beyond the edges of a bandage, it is an indication that it is too tight and it should then be removed and again applied.

The hands of the operator and all instruments and dressings coming in contact with a wound at any time should be made as clean as possible by the use of antiseptics.

Barbed-wire cuts.—We have specified these simply because in some sections of the country there is a fixed idea that there is a specific poison in barbed wire, causing injuries which require treatment differing from that which is applicable to ordinary wounds. Barbed-wire cuts differ from ordinary wounds only in the parts being often lacerated and torn, and the treatment already indicated for wounds of that description is applicable to them.

CASTRATION.

Castration consists in the removal of the essential organs of generation, and is performed upon both the male and the female. In the male the organs removed are the testicles and in the female the ovaries.

CASTRATION OF THE MALE.

Castration in the male is performed for several different purposes. It may be necessary, as is the case in certain diseased conditions of the testicles and in strangulated hernia, but the usual object of the operation is to enhance the general value of the animal. For example, if the animal is intended for burden, the operation will better fit him for his work by so modifying his temperament and physical condition that he may easily be controlled by his master. Again, if he is merely to be used for beef purposes, the operation will improve the quality of the flesh and cause an added development of the most valuable portions of the dressed carcass.

The operation upon the female may be performed on account of diseased conditions, but we may say that the chief object of the operation is to make the animal one of more profit to its owner by lessening the lacteal secretion and also improving the physical condition from the point of view of beef production. When the cow is spayed, it does away with all trouble attending estrum, or heat, gestation, and parturition with its accidents and ailments. The flesh of the spayed cow is more tender and juicy than that of the natural animal.

The operation upon the male may be either the uncovered or the covered. In the former the incision is made down to the testicle proper, and in the latter the cut is made through the scrotum or the outside covering and through the dartos, or the next coat, care being taken to cut no deeper tissues or coats. The age at which the operation is performed varies, but usually it is performed between the second and third month. If done in early life, there is less danger of complications, the organs being in a latent condition and not fully developed. There are many different methods of operating, the principal ones of which we shall mention. In the uncovered operation a good free incision should be made, exposing the testicle completely. Now it may be removed by simply cutting it off. The only danger of doing this is that hemorrhage is liable to follow. To obviate this, before the division of the spermatic cord it should be twisted several times in the following manner: Take hold of the cord with the left hand, having it between the thumb and the index finger. Now twist the free portion several times with the right hand, all the time being careful to push with the left hand toward the body of the animal. In this way the danger of injury to the cord during the animal's struggles will be overcome. There will be no hemorrhage, or very little, if it has been done properly. This is the most simple manner of torsion. There are forceps and other instruments made to perform the operation in this manner. The actual cautery is an old method, but we shall not describe it, as we consider that we have better methods now. The next method with the clamps, although extensively used upon the horse, is not practiced to so great an extent upon the bovine at the present time. It is a very old method, and is considered very safe. Clamps are used in the covered and uncovered operations.

More modern methods are by the use of special instruments known as the emasculator and the écraseur.

The operation of "mulling" or crushing the spermatic cord is an unscientific and barbarous procedure, causing unnecessary pain and suffering.

The methods described above apply only to the animal in a normal condition. Before operating everything should be examined to see that it is as it should be. If otherwise, a special operative procedure will be necessary. Whichever mode of operation is adopted from a practical standpoint, the principal precautions to be taken in order to attain success are as follows: First, thorough cleanliness under strict aseptic and antiseptic precautions; second, a free and boldly made incision; third, the avoidance of undue pulling or tension upon the spermatic cord; fourth, free drainage, which can be maintained, provided the original incision has been properly made.

The operation of castration of the male is by no means a serious one, and when properly performed there is little danger from complications. Although the danger is trifling, the complications which may arise are sometimes of a serious nature. Hemorrhage, either primary or secondary, tetanus (or lockjaw), abscesses, hernia (or rupture), gangrene, and peritonitis are the most serious complications that follow castration. Whichever complication arises will require its own special treatment, which we will not go into here, as it will be fully dealt with under another heading. We would add, however, that, generally speaking, the animal, after being castrated, should either be regularly exercised or be allowed freedom so that it can exercise itself. Sudden changes of the temperature are dangerous. The animal should be fed moderately, but of a diet easily digestible.

CASTRATION OF THE FEMALE.

The operation of ovariotomy (spaying) should be performed when the heifer is in her prime and in moderate condition not too plethoric and not in heat or pregnant. This operation may be performed in one of two ways—namely, by the flank or by the vagina—each operation having its special advantages. In the flank operation the animal may be operated upon either while standing or while in the recumbent position. If standing, she should be placed against a wall or a partition and her head held by a strong assistant. The legs also must be secured to prevent the animal from kicking. A vertical incision should be made in the left flank, about the middle of the upper portion, care being taken not to make the opening too far down, in order to avoid the division of the circumflex artery which traverses that region. The operator should now make an opening through the peritoneum, which is best done with the fingers. Next the hand and arm should be introduced into the abdominal cavity and the hand directed backward toward the pelvis, searching for the horns of the uterus; if followed up the ovaries will easily be found. They should then be drawn outward and may be removed either by the écraseur or by torsion. Closing and suturing the wound will complete the operation. An adhesive plaster bandage can be beneficially applied.

The operation by the vagina is more complicated and requires special and expensive instruments. The mode of procedure in brief is as follows: A speculum is introduced into the vagina, and an incision is made into the superior wall of that passage about 2 inches from the neck of the uterus, cutting from below upward and from before backward. An incision which should not exceed $3\frac{1}{2}$ inches in length should be made. The next step is to get possession of the ovaries. They are situated in a fold of the broad ligament and should be drawn carefully through the incision into the vagina. Now take the long-handled scissors, specially made for this purpose, with which the thick border of the broad ligament is divided. The torsion forceps are introduced and applied to the broad ligament above the ovary. The left hand is then introduced, and the thumb and the index finger grasp hold of the broad ligament above the forceps. With the right hand torsion is applied and the ovary removed. The other ovary may be removed in the same manner.

What has been said with regard to complications and aftertreatment in the case of the male also applies to the female.

OTHER SURGICAL OPERATIONS.

Descriptions of other surgical operations not given in this chapter may be found in other parts of this work by reference to the index.

SURGICAL OPERATIONS.

DESCRIPTION OF PLATES.

PLATE XXVI. Devices for casting cattle. (From Fleming.)

Fig. 1. Reuff's method of throwing or casting the ox.

Fig. 2. Miles's method of throwing or casting the ox.

PLATE XXVII. Surgical instruments and sutures. (After Reynders and Fleming.)

Figs. 1 and 2. Seton needles. These may be either long or short, straight or curved, according to the locality in which a seton is to be inserted.

Fig. 3. Various forms of surgical needles.

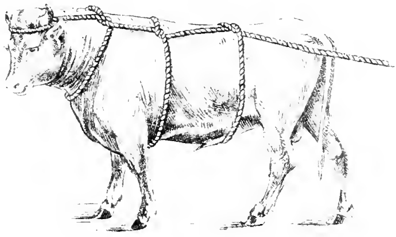
Fig. 4. Suture forceps or needle holder, for passing needles through thick and dense tissues.

Fig. 5. Knot properly tied.

Figs. 6, 7, 8, 9, 10. Various forms of sutures. Fig. 6, interrupted suture; 7, quilled suture; 8, uninterrupted suture; 9, twisted suture, made by passing suture pins through the parts to be held together and winding the thread about them so as to represent the figure 8; 10, single-pin suture.

Fig. 11. Appliance for ringing the bull, one-fourth natural size.

Fig. 12. Nose clamp, with spring and keeper.



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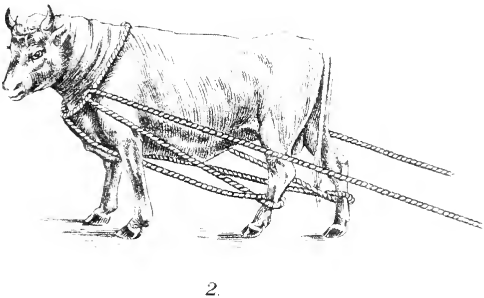

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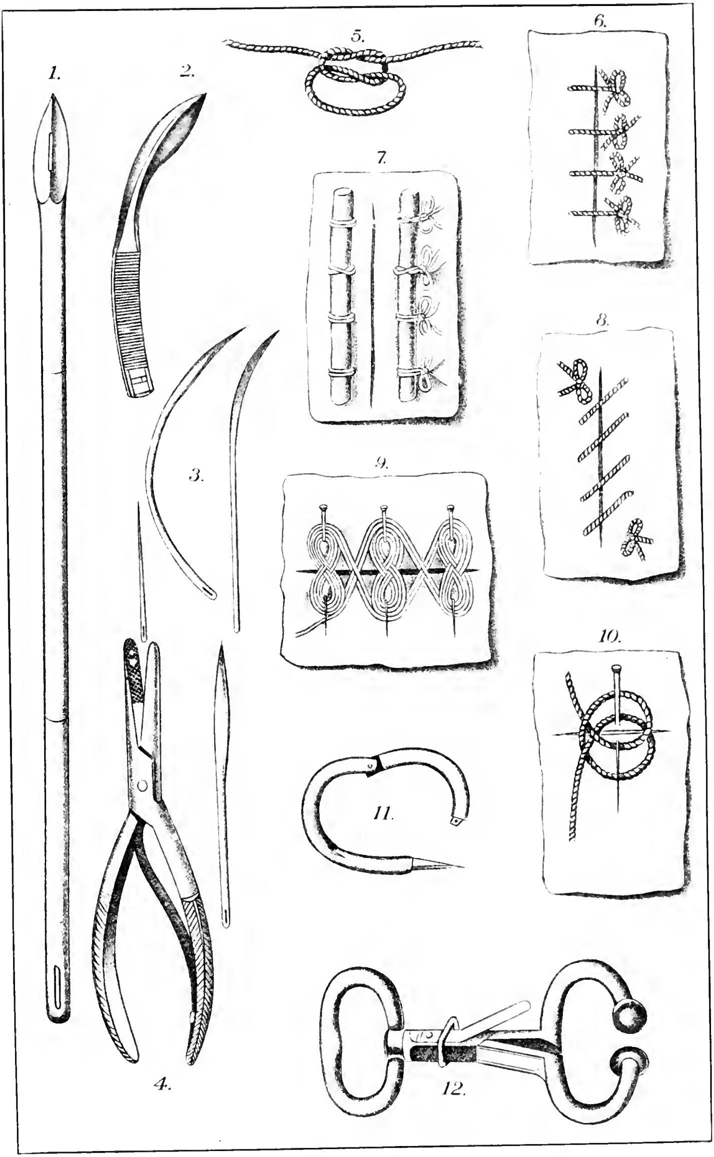
Devices for Casting Cattle.



SURGICAL INSTRUMENTS AND SUTURES.

TUMORS AFFECTING CATTLE.

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[*Synonyms:* New growth, neoplasm, neoformation, pseudoplasm, swelling, and hyperplasia.]

Definition.—Tumors[1] are abnormal masses of tissue, noninflammatory and independent in character, arising, without obvious cause, from cells of preexistent tissue, possessing no physiologic function, and characteristically unrestrained in growth and structure.

Tumors are abnormal masses of tissue. The application of the term "tumor" is directly connected with the fact that they produce local enlargement.

They are noninflammatory; that is, the process of inflammation is not directly the cause or accompaniment of them. An inflammatory new growth tends to disappear upon the subsidence of the inflammatory process, while spontaneous disappearance of a tumor is comparatively rare.

Tumors are independent. For instance, their nutrition bears no relation to the nutrition of the body. A lipoma, or fatty tumor, in the subcutaneous tissue, may go on increasing to huge bulk while the body is steadily emaciating. Again, the tissues of the aged gradually undergo atrophy, yet cancers arise at this time and grow rapidly.

Tumors are unrestrained in growth and structure. In the development of an animal we know at what period of its existence the mass of tissue called liver will develop—what its site, structure, and size will be. We know that it will remain only in that locality, and not, as it were, colonize throughout the system. With tumors it is different; there are no laws by which we can forecast the time, place, nature, or size of development of them. There is no cartilage in the kidney or parotid gland, yet a chondroma, or cartilage tumor, may develop in either. Even when a new growth of tissue is started by

[1] The term "tumor" literally means a swelling, and thus has been applied to the prominence caused by an overdistended bladder, to the enlargement of pregnancy, to the swelling produced by an abscess, to the overgrowth of tissue (hyperplasia) associated with injury and consequent inflammation, and to numerous other phases of tissue enlargement directly connected with recognized disease processes. For this reason it is becoming more common for scientists to apply the word "neoplasm" to the new growths described in this chapter. Because of the still popular use of the word "tumor," it is retained in this chapter for the designation of those new growths to which the sevenfold characterization of our descriptive definition applies.

an injury and consequent inflammation—as, for instance, proud flesh—there is a limitation of its size, but the controlling influences which govern the size of an organ or normal mass of tissue and limit the extent of an inflammatory overgrowth are all absent in the case of tumors. They are unrestrained, lawless.

Metastasis expresses the lawlessness of tumors as regards being limited to the original site of development. Small particles of tumors enter the blood vessels or lymph streams and are carried to distant parts of the body, where they lodge and start new tumor formations. Expansion by colonization in this manner is a rule with many tumors, and, since they exercise no function of use to the organism, this dissemination of actively growing particles becomes a menace to the system by numerically increasing the body's burden, opening new channels of drain upon the system and adding new centers for the absorption of putrefactive materials when the secondary tumors shall have degenerated. It is this which makes metastasis such an important element in the malignancy of tumors.

Tumors possess no physiological function. They are absolutely useless. Fibrous tumors bind no parts of the organism together; bony tumors add nothing to the supporting framework of the body; the tissue of fatty tumors never serves as a storehouse of feed and energy; the cells of an adenoma, or gland tumor, furnish no secretion; a tumor composed of muscle tissue produces no increase to the strength of the individual—its muscle cells are not contractile.

Tumors arise from cells of preexistent tissue. Tumor tissue is not a new variety. Whatever the structure of a tumor, its counterpart is found among the tissues of the body, the lawlessness of the tumor, however, showing itself in more or less departure from the normal type. This departure is usually a reversion to a more elementary or embryonic stage, so that the tumor tissues may be said to be structurally immature.

Tumors arise without obvious cause. Concerning the ultimate cause of tumor formation we are absolutely ignorant. Various theories have been advanced from time to time, but none of them have been applicable to more than a limited number of cases. The most important theories may be briefly mentioned.

(1) *The theory of tumor diathesis.*—Bilroth taught that tumors are caused by a peculiar predisposition consisting of a diseased state of the fluids of the body. This constitutional taint might be acquired, but, having been acquired, is also hereditary. This theory is known also as the heredity hypothesis, but, while it is true that heredity appears to play some rôle in the causation of certain neoplasms, its application is too limited to make it of value.

(2) *The mechanical or irritant theory.*—Virchow assumed that tumors arise as the result of previous irritation of the part. This

has been noticed particularly in the case of certain cancers. They frequently develop on the edges of old ulcers, thus being dependent apparently on chronic irritation. Cancer of the lip in pipe smokers is a case in point. Cancerous tumors of the skin often develop on the arms of workers in paraffin, tar, or soot, the chemical irritation of these substances being the cause. On the contrary, the proportion of those thus affected among the exposed is very small and forces the conclusion that if the real cause were in the irritation vastly more cases would occur.

(3) *The theory of nervous influence.*—That is based upon (*a*) the observed fact that tumors occur more frequently in man and the higher animals than in those lower in the scale, among which the nervous system is less highly developed; (*b*) that certain formations seem to be directly connected with nerve distribution, while others have been associated with alternations in neighboring nerve trunks.

(4) *The embryonal theory.*—This is known also as Cohnheim's hypothesis. In early fetal life there occurs a production of cells in excess of those required for the construction of the various parts of the body, so that a certain number of them are left over in the fully developed tissue or become misplaced during the sorting of cells for future development of tissues and organs. These cells lie dormant until favorable conditions arise or until some sufficient stimulus is applied, when, released from their inactivity, they begin to reproduce and grow. Not being normally related to their site, they lack the controlling and limiting influences of the part, and, their embryonic character enduing them with a most potent proliferating power, they develop in a lawless and unrestrained manner. There are tumors whose existence can be explained only on these grounds. Still, this theory falls far short of answering the question as to the origin of tumors.

(5) *The parasitic theory.*—This is not only one of the latest, but, merely as a hypothesis, it is the most attractive and plausible of all. The serious objections to it, however, are the almost uniform failure that has met the attempts to transplant these tumors from one animal to another and the absence of any constant variety of organism in them. Several forms of parasites have been found in certain tumors, but nothing definite has been shown with reference to the relation they bear to the causation of the neoplasm.

CLASSIFICATION OF TUMORS.

In Senn's work on tumors occurs the following: "A uniform system of classification of tumors is one of the great wants of modern pathology, and all attempts in this direction have proved failures." It would be folly, therefore, to burden the pages of a work of this kind with one or several of the proposed systems which have, admittedly, at some important point, failed of their purpose. Since the value of this chapter depends chiefly upon its practical character, which in turn is measured by its aid in diagnosis, prognosis, and treatment, the old but important clinical division is here adopted.

Tumors are either malignant or benign. The essential difference between the two classes is that while *benign tumors depend for their ill effects entirely upon their situation, malignant neoplasms wherever located inevitably destroy life.* The clinical features of each group are in many cases sufficiently marked to distinguish them.

MALIGNANT TUMORS.

(1) These are invariably pernicious, and from the beginning tend to destroy life.

(2) The cellular element predominates; therefore they grow rapidly.

(3) Possessing no capsule, they infiltrate surrounding tissues.

(4) They infect adjacent lymph glands.

(5) They recur even after complete removal.

(6) They give metastasis; that is, they become disseminated in different organs.

(7) Their presence develops a progressive emaciation.

BENIGN TUMORS.

(1) These in and of themselves do not tend to produce death.

(2) As the cellular element is not liable to predominate, they grow slowly.

(3) They are encapsulated, and when diffuse do not infiltrate surrounding tissues.

(4) They do not infect adjacent lymph glands.

(5) They do not recur after complete removal.

(6) They do not manifest metastasis.

Benign tumors, though harmless, may, by the accident of their location, indirectly produce death. Mere pressure on the brain substance of an otherwise innocent tumor, compression of the blood supply for vital organs, growth in such manner as to cause obstruction in the alimentary tract or pressure upon nerves, may cause death, or, prior to death, so combine the effects of anemia (deficiency of blood), starvation, and pain, with its consequent restlessness, as to produce a veritable cachexia (condition of general ill health).

On the other hand, a malignant tumor in its primary growth may so implicate a vital organ as to destroy life before metastasis can occur or even before cachexia can develop. Thus, to the untrained observer, environment may so operate as to cause these two classes of new growths to simulate each other. The boundary lines may seem to overlap. It is here that the microscope, as the court of last appeal, adjudicates positively in the diagnosis between these two clearly marked divisions.

It may almost be asserted that a true classification of tumors can not be made until we know more about the cause of them. The arrangement here presented is offered to meet the practical needs of the veterinarian, student, and farmer rather than of the pathologist.

We may roughly divide the tissues of the body into structural and lining tissues. The structural tissues are composed of the tissues of special function and simple connective tissues. The lining or covering tissues, both internal and external, are known as epithelium.

Section A of the table below contains the true tumors or proper neoplasms.

Section B includes the cysts, some of which are true tumors, while others are false ones, but the latter are added because of their gross resemblance to the true and the consequent necessity of considering them at the same time.

TUMORS AND CYSTS.

A.—Tumors.

BENIGN.

I.—*Tumors composed of tissues resembling those of special function.*

1. Type of muscle tissue — Myoma.
2. Type of nerve tissue — Neuroma.
3. Type of vascular tissue — Angioma.
4. Type of gland tissue — Adenoma.

II.—*Tumors composed of fully developed connective tissue.*

1. Type of fibrous tissue — Fibroma.
2. Type of adipose, or fat, tissue — Lipoma.
3. Type of cartilage tissue — Chondroma.
4. Type of osseous, or bone, tissue — Osteoma.
5. Type of neuroglia, or nerve, sheath — Glioma.
6. Type of mucoid, or mucous, tissue — Myxoma.

MALIGNANT.

III.—*Tumors composed of embryonic or immature connective tissues.*

1. Type of immature connective tissue — Sarcoma.
2. Type of endothelial tissue — Endothelioma

IV.—*Tumors in which epithelial elements predominate.*

1. Type of various epithelial cells and associated tissues — Carcinoma.

B.—Cysts.

I.—Cysts which develop in preexisting cavities.

1 .... Retention cysts.
2 .... Proliferation cysts.

II.—Cysts which are of congenital origin and are true tumors.

1 .... Dermoid cysts.

III.—Cysts which originate independently as the result of pathological changes and are nontumorous.

1. Cysts formed by the softening and disintegration of lesions—Softening cysts.
2. Cysts formed around parasites .... Parasitic cysts.
3. Cysts formed by an outpouring of blood and lymph into the tissue spaces with subsequent encapsulation of the fluid .... Extravasation cysts.

Terminology.—The principle of naming tumors is quite simple. The Greek word "oma" (plural "omata") means tumor. This word "oma" is added to the stem of the word ordinarily used to designate the kind of tissue of which the tumor is composed. Thus a tumor formed after the type of fibrous tissue is a fibroma. The only exception to this is in the naming of the two large classes of malignant neoplasms. There the names were formed from the fleshlike appearance of the one and the crablike proliferations of the other—namely, Sarcoma (sarks = flesh), carcinoma (karkinos = crab).

Diagnosis.—In the diagnosis of tumors note is taken of (1) clinical history and (2) examination of the tumor.

(1) *Clinical history.*—Circumstances connected with the origin of the tumor and its rapidity of growth may point to an inflammatory swelling rather than a tumor. The location of the tumor at its commencement is important, as, for instance, in diagnosing between lipoma and carcinoma, the former being more or less movable under the skin, while a carcinoma develops in the skin. While tenderness on pressure may be caused by compression of a sensitive nerve by a tumor or by tumors of the nerve or nerve sheaths, as a rule this symptom is indicative of inflammatory swelling rather than of the existence of a tumor.

(2) *Direct examination of the tumor.*—In the application of this diagnosis the trained observer will note color, size, shape, and surface structure, transmission of light, movableness, consistence, resistance, pulsation, and crepitation. Percussion, auscultation, and exploration are also available methods. Finally, microscopic examination of the growing portions of the tumor by a pathologist will be found most satisfactory.

GENERAL TREATMENT OF TUMORS.

For benign tumors treatment is required only when it damages the animal's value or when merely for sake of appearance. When it is possible, the removal of the tumor by an operation is indicated. If the tumor has a small, constricted base, remove by torsion, ligation, or with an écraseur. Ligation following the incision of the skin with a knife avoids the pain of pressing on the sensitive nerves of the skin and is suitable for tumors of broad base and small bodies. A firing iron, such as is used in line or feather firing, may also be used in removing tumors with small attachments. This not only stops the bleeding but forms a firm scab, under which healing may occur rapidly. Those tumors that can not be removed by the above methods may be treated with caustics or acids, such as sulphuric acid, hydrochloric acid, caustic potash, arsenic, silver nitrate, or chromic acid, but it is difficult to limit the action of these drugs. The injection, into the tumor, of such chemicals as anilin dyes, alcohol, acetic acid, citric acid, or ergotin, is of doubtful value, as is also the injection of the germs of erysipelas—thought by some to be a specific. Certain specific tumors, such as actinomycosis and botryomycosis, may be successfully treated by the internal administration of potassium iodid, together with the injection into the tumor or the painting of its surface with either Lugol's solution or the tincture of iodin. The most reliable means of treating tumors is by extirpation with cutting instruments. Dissect the tumor from the surrounding tissue, ligating all the larger blood vessels, and tearing the tissues with the fingers rather than cutting with a knife. The bleeding may be stopped with a hot iron. The after treatment is the same as for any ordinary wound of similar size.

DESCRIPTION OF INDIVIDUAL TUMORS.

Although a full list of the tumors that may be found in bovines has been given above, there are a number that warrant a detailed description, and the following mention will be made of the most important of them:

MYOMA.

These tumors are after the type of muscle. They are sharply circumscribed and, as a rule, are very hard, a condition owing usually to combination with fibroma and are then known as fibromyoma. In fact, the clinical differentiation between myoma and fibroma is almost impossible. Myomas are found in the uterus, vagina, stomach, intestines, gullet, and bladder of a bovine animal. They grow very large, but, as a rule, are benign. Treatment should consist of their removal.

NEUROFIBROMA.

A true neuroma built up of nerve fibers and nerve cells is infrequent, if it ever occurs, in cattle. False neuromas, or neurofibromas, are knotty, spreading tumors of the size of a large potato, which are developed within the nerve sheaths and composed of nerve fibers and connective tissue bands interlaced. The commingling of these varied fibers is often so intricate that separation is practically impossible. This tumor is most frequently found upon the shoulder of cattle. Treatment is surgical.

ANGIOMA.

The angiomas are tumors composed mainly of blood vessels or blood spaces and are observed on the skin of man, where they are called "birthmarks" or "mother marks." Cavernous angiomas are seen in cattle, affecting the liver and the mucous membrane of the nasal septum. In the liver they appear as smooth, flat, nonprojecting tumors of a dark-red or purple color and of about the size of a silver 10-cent piece. They are somewhat softer in consistency than the adjoining liver substance into which they are gradually fused. These tumors are frequently observed by meat inspectors in livers of slaughtered cattle. Treatment of angioma is unnecessary.

ADENOMA.

The structure of this tumor is after the type of gland tissue. It is rarely seen in cattle except in combination with cancer or sarcoma. A growth which occurs more frequently in bovines, especially calves, and which in some instances bears a striking resemblance to an adenoma is the so-called goiter.

GOITER (STRUMA).

This is a noninflammatory enlargement or a hyperplasia of the thyroid gland. While it can not be definitely classed among tumors, yet, owing to its resemblance to the latter, it will be discussed at this time. The cause of goiter has never been definitely ascertained. Among the most probable causes may be mentioned heredity, insufficient and improper diet, close confinement, unhygienic surroundings, and an unknown toxic substance which is supposed to obtain in those localities rich in magnesium and lime salts. Certain organisms found in goiter have been suspected of producing this trouble, but their relation to the disease has not been satisfactorily proved. A goiter may consist of (1) simple enlargement of the follicles which are filled with albuminous matter (follicular goiter); (2) an increase of connective tissues between the follicles, causing the swelling to be dense and resistant (fibrous goiter); (3) a great increase in size of one or more follicles, forming a cyst (cystic goiter); (4) great dilatation of the blood vessels in the gland accompanied with pulsation with each heart beat (vascular goiter).

Symptoms.—Goiter may be observed at the side of the throat, reaching the size of a fist or even larger, or it may hang down below the windpipe. In cattle the two thyroid glands are close together, and when the disease affects both there may be but one uniform swelling placed in front of the windpipe below the angle of the jaw. This swelling may be hard, soft, or doughy in consistence, and with each beat of the heart it may pulsate like an artery. It may cause labored breathing by pressure on the windpipe, and death may result from pressure on this structure, on the gullet, or on the adjoining large vessels.

Treatment.—In young animals the treatment is usually satisfactory, and consists in giving the animal a complete change of feed and plenty of exercise in the open air. If the condition appears enzootic in the district, remove the animal to another location when possible. Iodin, either in the form of ointment or the tincture, should be applied to the swelling. Injections of iodin solution, 5 grains of iodin in 1 dram of 25 per cent alcohol, may also be made into the substance of the gland. When the swelling which follows this injection has subsided it may be repeated. Potassium iodid should be given internally in 1½-dram doses twice daily for a cow, or in 20-grain doses twice a day for a calf. Extirpation of all but a small section of the swelling may be successfully accomplished by a qualified veterinarian, but if it should be entirely removed, myxedema and death follow.

FIBROMA.

Fibromas are tumors made up chiefly of connective tissue and are usually confined to the skin and subcutaneous tissue. Indurative fibromas of the skin appear as tumors of gelatinous connective tissue or as firm, white vascular connective tissue growths, which are more or less sharply outlined, move readily over the underlying tissues in company with the skin, and owe their origin to mechanical injuries, perforating wounds, repeated abrasions, or the invasion of pus cocci or botryomyces into the tissues.

These tumors in cattle are frequently found upon the dewlap as solid lumps, hard as stone to the touch, lying loosely between the layers of skin, and gradually losing themselves in the softer tissues of the neck above, or as smooth, hard tumors of glistening white substance with interlacing lines of softer tissue. They may also be found in the region of the knee or at the elbow. The skin over the growths, in accordance with the originating cause, will be found chafed, covered with scabs, or even ulcerated and accompanied with collateral edema.

These connective tissue tumors grow slowly but reach enormous size. They sometimes follow injuries to the region of the throat and form there as hard, firm growth, even reaching the size of a child's head.

A fibroma upon the larynx is not an infrequent occurrence in the ox. These tumors are always sharply outlined and have a roughened surface. They may be differentiated from actinomycotic tumors (see chapter on "Infectious diseases of cattle," p. 358) in the same location by their firm, fibrous structure and by the absence of pus from the interior.

A tumor is sometimes seen upon the muzzle of cattle, which assumes a diameter equaling the width of the muzzle. It is a voluminous connective-tissue formation known by the name of "fibroma diffusum."

Another form is sometimes observed upon the tongue. It grows upon a broad, spreading base, becoming very hard. It is almost lacking in blood vessels, although the few that are present are plainly in view, and in consequence is poorly supplied with fluids. It is of a smooth contour, white or whitish yellow in color, is sharply limited from the normal substance of the tongue, may be covered with mucous membrane, on which prominent papillæ are located, or only by a thin, delicate layer of epithelium, and is usually found in the middle part of the tongue, where it may reach the size of two fists.

Pedunculate or stemmed fibrous tumors are frequently noticed growing upon or near the extremity of the tails of cows. They are apparently of traumatic origin, such as tying the tail fast while milking or shaving it too closely while trimming for show purposes, and usually contain bloody or gelatinous material within, or, again, they may be strongly edematous throughout.

Treatment.—The treatment of large fibromas is surgical and consists of the operative removal of the tumor, followed by suturing of the wound. Small external tumors may be painted with zinc chlorid, chromic acid, or a concentrated solution of bichlorid of mercury.

PAPILLOMA (WART).

When fibromas develop from the lining or covering tissues they frequently form papillary growths, more or less thickly covered with epithelium, and are then called papillomas, or warts.

Papillomas consist of villouslike projections, resulting from a proliferation of the outer layer (epithelium) of the skin or mucous membrane. These growths are also called "angle berries," and may assume a variety of forms. Sometimes there is a preponderance of epidermis in the formation, and the tumor then appears as a hard, dense, insensitive, clublike growth, or wart. Again the swelling is chiefly in the derm, or true skin, and we have what is known as a flesh wart (verucca carnea). In other cases the growth of papillar bodies projects in great cauliflowerlike tumors with deeply furrowed and lobulated surface, over which a covering of epidermis may or may not be present. These are usually much softer and are well supplied with blood vessels. It is not uncommon for them to be pedunculate or stemmed, and in this case considerable rotary motion or twisting is possible. Their color is cloudy gray or grayish red, with white bands of connective tissue radiating from the center. Their consistence varies. Upon their surfaces and within their clefts and fissures they undergo retrogressive changes, softening, bleeding, or ulcerations.

A favorite location for the papilloma in cattle is the udder and teats, where they may develop in such numbers as to cover the entire surface and make the animal troublesome to milk. The sides of the head, neck, and shoulders also afford satisfactory conditions for their growth, and are frequently seen to be affected by them.

Treatment.—Warts may be removed with the scissors, twisted off with the fingers, or ligatured by means of a rubber band or horsehair. The roots should then be cauterized with tincture of iron, glacial acetic acid, or lunar caustic. Acids should never be used in removing warts about the eyes or in the mouth. Papillomas of the eyelids sometimes change to cancers and should be removed by taking out a wedge-shaped section of the eyelid. Young cattle should be given arsenic internally in the form of Fowler's solution, 1 tablespoonful twice a day for a 6-months-old calf.

POLYPS.

Polyps are usually fibromas or myxomas, occurring on the mucous membrane of the nasal passages or genital tract. They grow upon a narrow stem, bleed readily when injured, and often contain a center of thin, limpid fluid. A bloody discharge is sometimes seen coming from the affected nostril, but this is not always easy of detection in cattle, owing to the pliancy of their tongues and to their habit of licking an irritated nostril. Usually these tumors grow downward and may project from the nostril, causing snoring sounds and uneasy breathing. They may occasionally force themselves backward into the throat, where they interfere seriously with respiration, the patient being obliged to breathe with an effort, and even forced to cough in order to dislodge temporarily the obstruction from the larynx. Such tumors, when near the nostril, may easily be removed by the use of forceps or a loop made of bailing wire. Serious bleeding is not liable to follow their removal, but an astringent wash, such as a solution of the perchlorid of iron, if applied to the cut surface, will be found very beneficial. In case the tumor is not within easy reach, the services of a qualified veterinarian should be obtained to perform the necessary operation.

LIPOMA.

This is a tumor consisting chiefly of fat cells. The growth is irregularly rounded and distinctly lobulated, very soft, and almost fluctuating. It is insensitive, grows slowly, and is always inclosed in a distinct fibrous capsule, from which it can be easily shelled out. It may become very large and often hangs pendulous from a long, elastic pedicle. In cattle this tumor may be found in the subcutaneous tissues, especially of the back and shoulders, uterus, and intestines, and in the latter position it may cause strangulation, or "gut tie," by winding around a loop of the intestine.

Treatment.—When found on the skin the tumor may be readily removed with a knife or by a ligature. Caustics and the cautery produce wounds that heal slowly and can not be recommended in the treatment of this tumor.

CHONDROMA.

This tumor formation is composed of cartilage cells. It is a rounded and very often unevenly nodular and sharply described tumor. It is very hard, dense, elastic, and painless and develops principally where we find normal cartilage cells. It is rare in cattle, but has been found in the subcutaneous tissues and nasal cavities.

Treatment.—Extirpation.

OSTEOMA (BONY TUMOR).

Bones may occasionally grow in such a profuse and irregular manner that the product, or osteophyte, assumes the character of a tumor. The bone tissue may possess either spongy or compact properties and grow either from the periphery of the bone or within its interior. These tumors most frequently appear about the head of the animal, either upon the jawbones, within the nasal passages, or in connection with the horns. They are usually of bony hardness, painless, benign, and sharply outlined.

Treatment.—The treatment consists in either removing them with a saw, chisel, or trephine, or preventing their further development by counterirritation with blisters or firing iron.

MYXOMA.

Characteristic myxomas are mucoid tumors which chiefly originate from the mucous membrane and are especially to be found within the nasal passages and uteri of cattle. They can reach a size of three fists, are smooth or velvetlike, or may be lobulated, broad at the base, and consist of a glassy-looking mass of connective tissue, which usually shows a distinctive yellowish color. Being homogeneous and elastic, the moist, jellylike tissue composing the tumor may be easily destroyed or crushed. When cut through, these tumors soon collapse from the loss of their fluids. They sometimes inclose elliptical cavities filled with slimy, gelatinous masses.

Treatment.—Extirpation.

SARCOMA.

This is a malignant tumor after the type of embryonal tissue, and consists of several varieties, such as the round cell, spindle cell, giant cell, alveolar, and melanosarcoma. They grow by preference in connective tissue and are quite vascular. Sarcomas appear either as single or multiple nodules, varying in size from a hempseed to a hazelnut, or else as a moderate number of tumors of the size of hen eggs. Their surface, at first smooth, later becomes lumpy and tuberous from internal degeneration. Secondary nodules may appear near the primary tumor. The outer skin is not involved so soon as in cancer, nor does ulceration follow so rapidly. Sarcoma is about the most frequent and dangerous tumor that is found in cattle. It occurs in young animals, and is found on the serous membranes, in the glandular organs, and on the outer skin, especially of the neck and shoulders—in fact, in nearly every tissue and in almost every part of the body. This tumor is often found in places exposed to traumatisms and at seats of scars, or of irritations from pressure and inflammation.

Treatment.—Treatment should consist in early and complete removal by the knife, including one-half or three-quarters of an inch of the sound tissue adjoining the tumor. If there is a possibility that sarcomatous tissue still remains, either cauterize the wound with a hot iron or powder the walls of the cavity with arsenious acid.

CANCER (CARCINOMA).

Cancers are tumors of epithelial tissues and are malignant. There are several varieties of cancers, such as hard, soft, and colloid, but only those growing on the surface will be mentioned here. These malignant tumors of the superficial organs develop primarily from the epidermis or from the glands of the skin. They appear secondarily as spreading infections from milk glands, thyroids, anal glands, or as embolisms. In such cases their sole character depends wholly upon the kind of cancer from which they have sprung. The infiltrating cancer begins as an elevation of the skin, which progresses until it becomes rough and nodular. The surface later becomes attacked, and an ulcer results whose edges are outlined by a hard, firm zone.

The ulcerations may remain limited by cicatricial tissue, but it is more likely that the infiltration and destruction of tissue will spread out wider and deeper until a rodent ulcer (so called) is formed. One of the most frequent sites of cancer in cattle is in the eye, where they are called fungus hematodes, but they also occur on the skin, on the genitals, in the stomach, and within the organs.

Fungus hematodes.—This starts at the inner corner of the eye as a papillary elevation or as small nodules which become fused. They grow larger and become papillomatous, with superficial ulcerations and a tendency toward hemorrhage. In some cases the eye is displaced by the growing tumor or is attacked by the cancer cells and entirely destroyed.

Cancerous growths upon the external genitals and the anus usually present a rough, irregular surface from which there is a constant sloughing of decomposed tissue accompanied with a penetrating disagreeable odor.

The diagnosis of cancer may be made clinically by noting the simultaneous infection of the lymph glands which surround the primary lesion. Deeply burrowing and infiltrating forms which appear as lumps and ulcerations cause marked disfiguration of the affected part. The surface becomes a soft, greasy mass; later it cracks open and from the fissures blood-colored pus exudes, being continually formed by the moist degeneration of the tissues beneath. At first the general health of the animal does not appear affected, but later the cancer nodules spread to important organs and give rise to marasmus and progressive emaciation. Cancer is not a frequent tumor of cows. Fröhner states that of 75 cases of tumors in cattle which came under his observation 2, or 2.6 per cent, were found to be cancers, while 20, or 26.6 per cent, were sarcomas.

Treatment.—Treatment consists in the early and complete removal of the tumor, taking care to include a wide border of healthy tissue. This has been most successful in such superficial cancers as those of the eye, penis, anus, testicle, vulva, and sheath. If the disease has advanced too far, this treatment may not prove efficacious, owing to the great malignancy of the cancer and its tendency to recur. In such cases the animal may be slaughtered, but the flesh should be used for food only after inspection by a competent veterinarian.

CYSTS.

Cysts may be true or false tumors and consist of a capsule containing a fluid or semisolid content. Among the most important cysts, which have been briefly referred to in a previous table, the following are probably the most noteworthy, owing to the frequency with which they are found in bovines:

SOFTENING CYSTS.

Softening cysts, which result from the degenerative liquefaction of normal or diseased tissues, especially of tumors of different kinds, followed by the encapsulation of the fluid.

PARASITIC CYSTS.

Parasitic or foreign-body cysts, from the inflammatory reaction induced by such parasites as the echinococcus (hydatid cyst) or by the presence of various kinds of foreign bodies.

EXTRAVASATION CYSTS.

Extravasation cysts, caused by injuries which rupture blood vessels, followed by an increase of fibrous tissue which forms a capsule about the fluid. The hygromata in front of the knee in cattle, so-called tumor of the knee, and serous cysts belong to this variety.

Hygromata, or tumors of the knee.—These consist in the simplest form of a collection of serous fluid mixed with fibrin within a distended bursa. The walls surrounding the fluid become firm, smooth, and dense.

Outwardly the tumor appears fluctuating, though tense, while the skin which covers it may be normal, denuded of hair, or covered with hard epidermal scales, possibly half an inch in thickness, forming a hard, horny plate. The cavity which contains the fluid may have the dimensions of a hen's egg, an apple, or a child's head. Its walls are formed by the diseased secreting membrane of the bursal sac, and are readily detachable from the subcutis of the skin. Their internal surfaces are often uneven or supplied with projections or tufted growths which support a fibrous network within the tumor.

Tumors of the knee may also assume a granular type, as the result of chronic inflammation or following operative or spontaneous evacuation of pus from the part. They are either firmly connected with the skin or are detachable from it, and when laid open disclose a whitish-red, porklike tissue surrounding a central nucleus of pus, or a fistulous tract leading to the outer surface. They are caused by the chronic inflammation which follows the bruises received by cattle in lying down and in rising, or they may be due to falls on uneven, hard ground.

Treatment for hygromata.—When the swelling first appears cold water should be applied, followed later by bandaging with cloths wrung out of warm water. If the swelling is soft, it should be punctured at the lowest point, and afterwards the cavity should be syringed with Lugol's solution. If the tumor is hard and nonfluctuating, a mercurial blister may cause absorption and at the same time prevent further injury to the part by making it more painful, thus sparing it.

Serous cysts.—These swellings are another variety of extravasation cysts, and are caused by such injuries as butting, running against hard objects, and shipping bruises, which are followed by an outpouring of blood and lymph into the tissue spaces. These cysts develop rapidly and may reach the size of a man's head or even larger. They are soft, edematous, and hot at first and contain a serous or blood-tinged fluid. Later, partially organized clots and shreds of a fibrinous nature and of a gelatinous consistence are formed within, and the temperature of the swelling is reduced. They appear on the surface of the body, especially on the belly and flank of cattle.

Treatment of serous cysts.—Treatment consists in opening the cyst at the most dependent point with a sharp knife. The cavity should be washed out twice daily with a 5 per cent solution of carbolic acid, and drainage encouraged by keeping the incision open.

DERMOID CYSTS.

These cysts have a wall which is almost an exact duplicate of the structure of the skin, and frequently contain epidermal structures, such as hair and teeth, which, in the development of the embryo, have been misplaced. Thus we may find in an ovary or testicle a dermoid cyst, containing a tooth or a ball of hair. Dental cysts are included in the class above.

Dental cysts.—It happens occasionally that the teeth of cattle, instead of developing normally within strong supporting alveolæ, remain inclosed within a cystic membrane, which assumes a tumorlike character. One tooth may be included alone in the cyst or a number may be inclosed together. However this may be, the malformation progresses, especially if confined to the incisor teeth, until the remaining teeth that began to develop normally are crowded out of position and rendered useless. The tumor may reach the size of a man's fist. It appears to be fleshy and dents upon pressure, but it may also appear on closer examination as though it contained irregular sections of thin bone. The outer surface is always smooth, and no indication of purulence, softening, or scab formation is ever exhibited. Upon being laid open with the knife the tumor is seen to be surrounded by a firm, smooth membrane which limits it completely from the adjoining tissues. It is filled with material which possesses partly edematous, partly fleshy, and partly bony properties. It is supposed that this mass is composed of rudiments of the jawbone or of the alveolar walls which, becoming spongy, lose themselves in the soft, fleshy mass contained within the capsule of the tumor. It occasionally happens that the tumor is hollow and that the cavity extends back into the body of the lower jaw for a considerable distance.

Tumors of this kind, being of congenital origin, are very naturally observed most frequently in young cattle, but they may continue to expand for a period of several months after the birth of the calf, even until they become troublesome and unsightly.

Treatment for dental cysts.—Treatment consists in the complete extirpation of the cyst and the destruction of the lining pouch by curetting.

RETENTION CYSTS.

Retention cysts arise from the retention of normal secretions, owing to obstruction of a duct leading from a gland. The mucous cysts found in the mouth, udder, and vestibule of cows are samples of this form.

Mucous cysts.—Saclike dependent tumors, caused by retention of the secretions from the mucous glands, sometimes develop in the mouth, nose, pharynx, and vulva of cattle. They are called "mucous cysts." These are of sizes varying from peas to pigeon eggs, are roundish and translucent, and surrounded by a delicate, vascular membrane. They contain a siruplike substance more or less thick and transparent and whitish yellow in color.

Treatment consists in the puncturing of the swelling, if accessible, and the destruction of the cyst walls by the injection of Lugol's solution.

PROLIFERATION CYSTS.

These are found especially in the ovaries of cows, called "cystic ovaries," and may produce nymphomania (chronic bulling).

The treatment indicated in this case is the removal of the diseased ovaries.

DISEASES OF THE SKIN.

By M. R. Trumbower, D. V. S.

[Revised by John R. Mohler, V. M. D.]

GENERAL DISCUSSION.

The skin consists of two parts—a superficial layer, the epidermis, or cuticle, and the deep, or true, skin, the dermis, cutis vera, or corium.

The epidermis, cuticle, or scarf skin, is an epithelial structure, forming a protective covering to the corium. It varies in thickness, is quite insensible and nonvascular, and consists of a sheet of cells.

The epidermis is divided into a firm and transparent superficial and a deep, soft layer. The latter is the rete mucosum, whose cells contain the pigment which gives color to the skin. The deep surface of the epidermis is accurately molded on the papillary layer of the true skin, and, when removed by maceration, presents depressions which correspond to the elevations on the dermis. From the cuticle tubular prolongations pass into the sebaceous and sudorific glands; thus the entire surface of the body is inclosed by the cuticle.

The dermis, or true skin, is vascular and highly sensitive, containing the tactile ends of the nerves of touch. It is covered by epidermis and attached to the underlying parts by a layer of areolar tissue, which usually contains fat. The cutis consists of a fibro-areolar tissue and vessels of supply. It is divided into two layers, the deep, or true, corium and the upper, or papillary. The corium consists of strong interlacing fibrous bands, chiefly white; its meshes are larger and more open toward the attached surface, giving lodgment to the sweat glands and fat. The papillary, or superficial, layer is formed of a series of small conical eminences or papillæ, which are highly sensitive, and consists of a homogenous, transparent tissue. The blood vessels form dense capillary plexuses in the corium, terminating by loops in the papillæ. The papillary nerves run in a waving manner, usually terminating in loops.

Hair is an appendage of the skin and forms its external covering. It is a special modification of epidermis, having the same essential structure, and consists of a root, shaft, and point. The root has a bulbous extremity, is lighter and softer than the stem, and is lodged in a recess or hair follicle, which may either be in the corium or subcutaneous areolæ. The follicle is dilated at the bottom to correspond to the root bulb, and the ducts of one or more sebaceous glands open into it. At the bottom of each follicle is a concial, vascular papilla, similar in every respect to those on the surface of the dermis; this papilla fits into a corresponding depression in the root of the hair. The shaft consists of a center, or medulla, a surrounding fibrous portion, and an external coating, or cortex. The medulla consists of cells containing pigment or fat, is opaque, and deeply colored. All kinds of hair do not have this medulla. The fibrous portion occupies the bulk of the stem, and the cortex is merely a single layer of thin, flat, imbricated (shinglelike) scales.

The sebaceous glands, lodged in the corium, are most abundant in parts exposed to friction. They generally open into the hair follicles, occasionally on the surface of the body. Each gland consists of a small duct which terminates in a lobulated recess. These lobules vary, and are, as is the duct, lined with epithelium. They are filled with sebaceous matter which, as it is secreted, is detached into the sacs. They are very plentiful between the claws of cattle.

The sudorific glands, or sweat glands, are situated in the subcutaneous areolar tissue, surrounded by a quantity of fat. They are small, round, reddish bodies, each of which consists of one or more fine tubes coiled into a ball, the free end of the tube being continued up through the true skin and cuticle, and opening on the surface. Each sweat gland is supplied with a cluster of capillary blood vessels which vary in size, being very large when perspiration is excessive. The contents of the smaller ones are fluid, and of the larger, semifluid.

The skin may be regarded as an organ supplementary in its action to the lungs and kidneys, since by its secretion it is capable of removing a considerable quantity of water from the blood; it also removes small quantities of carbon dioxid, salts, and in certain instances during suppression of the renal secretions a small quantity of urea. The skin is also the chief organ for the regulation of animal heat, by or through conduction, radiation, and evaporation of water, permitting of loss of heat, while it also, through other mechanisms, is able to regulate the heat lost. The hair furnishes protection against extreme and sudden variations of temperature by reason of the fact that hairs are poor conductors of heat, and inclose between them a still layer of air, itself a nonconductor. The hairs are also furnished with an apparatus by which the loss of heat may be regulated; thus, in cold weather, through the contraction of unstriped muscular fibers of the skin, the hairs become erect and the external coat becomes thicker. Cold, too, acts as a stimulus to the growth of hair, and we find, in consequence, a thicker coat in winter than in summer. The hairs also furnish protection against wet, as they are always more or less oily from the secretion of sebaceous glands, and thus shed water. Through their elasticity they furnish mechanical protection, and through the thickness of the coat, to a certain degree, resist the attacks of insects. Finally, the hairs assist the sense of touch.

The sweat glands are constantly discharging a watery secretion in the form of insensible perspiration, and by their influence act as regulators of the temperature of the body; hence, in warm weather, the secretion of the skin is increased, which tends to prevent overheating. Sweating, in addition to regulating heat, is also an active agent in removing effete material from the blood; therefore this secretion can not be checked without danger. If the skin is covered with an impermeable coating of grease or tar, death results from blood poisoning, owing to the retention of materials destined to be excreted by the skin.

All secretion poured out by the skin is not only modified by the condition of the atmosphere but also by the character and quantity of the food, by the amount of exercise, and especially by the quantity of fluid taken.

The sebaceous secretion is intended to lubricate the skin and hairs. It consists of soft, fatty material suspended in water, and is characterized by an odor peculiar to the animal by which it is secreted.

I will not attempt to classify the various diseases of the skin, for in a work of this kind it would serve only to confuse the reader.

We shall first consider a class of diseases which are of an inflammatory type; next, those caused by faulty secretion and abnormal growth; then, diseases of parasitic origin; lastly, local injuries of the skin.

PRURITIS (ITCHING).

We shall consider pruritis first as a distinct subject. It is not a disease, only a sensation, and therefore a symptom. It is one of the symptoms accompanying the majority of the diseases which we will consider in this chapter. It is, then, a functional affection produced by slight irritation from without or by an internal cause acting upon the sensory nerves of the skin. Nothing characteristic is seen except the secondary lesions, produced mechanically by scratching or rubbing.

There are various forms of itching, the result of specific skin diseases, where the pruritis is a secondary symptom. In such cases it should not be regarded as an independent affection.

Causes.—Many causes may induce the condition which we recognize here as pruritis. The most common one is dirt on the skin, resulting from insufficient care. If the ceiling of the stable is open, so that dust and straw may fall, the skin is irritated and pruritis results. It also occurs in some forms of indigestion.

The parts of the body most exposed to this condition are the croup, the back, the top of the neck, and the root of the tail.

Another cause is found in affections of the liver and of the kidneys, when an increase of effete material has to be thrown off by the skin. Morbid materials circulating in the blood may produce a tickling or smarting sensation of the skin in their passage from the blood to the free surface of the skin. Certain irritating substances when eaten may be excreted by the skin, and coming thus in direct contact with the sensory nerves produce itching, or may go further and cause distinct inflammation of the skin. In another class of cases the pruritis may be ascribable to an atrophy, contraction, or hardening of the skin, when the nerves become irritated by the pressure. These conditions may be so slightly marked in a thick skin like that of the ox that they can not be recognized. It is frequently noticed that cattle rub themselves as soon as they pass from the stable into the open air—changing from a warm to a cold atmosphere. Again, we may find one that does all its rubbing in the stall. We may look for lice, but fail to find them. These conditions are generally attributable to high feeding and to too close confinement. They may be associated with inflammatory irritation or not; certainly we fail to discover any morbid changes in the skin. There is to some extent a delightful sensation produced by rubbing, and it may partly become a habit of pleasure.

Treatment.—We must place our chief reliance upon a change of food, plenty of exercise, and in most cases the administration of an active cathartic—1 to 1½ pounds of Epsom salt, a handful of common salt, a tablespoonful of ginger or pepper, mixed with 2 quarts of water, all of which is to be given at one dose. Afterwards half an ounce of hyposulphite of soda mixed with the feed may be given twice a day for a week. For an external application, when the skin is abraded or thickened from rubbing, a solution of borax, 4 ounces to the quart of water, may be used. Carbolic acid, ½ ounce to a quart of water, will give relief in some cases.

INFLAMMATORY DISEASES OF THE SKIN.

ERYTHEMA.

This is the simplest form of inflammation of the skin. It consists of an increased redness, which may occur in patches or involve considerable surface. The red coloration disappears when pressed by the finger, but soon returns after the pressure is removed. There is seldom much swelling of the affected part, though often there is a glutinous discharge which dries and mats the hair or forms a thin scale upon the skin. In simple erythema the epidermis alone is affected; when it becomes chronic, fissures form and extend into the corium, or true skin.

Causes.—Simple erythema, consisting of an inflammatory irritation, is seen in very young calves, in which the navels leak. The discharge being urine, it causes an irritation of the surrounding skin. Chafing, which is another form of erythema, is occasionally seen on the udders of cows from rubbing by the legs; chafing between the legs is not uncommon among fat steers. Chronic erythema is found in the form of chapped teats of cows and chapped lips in sucking calves. It frequently occurs in cows when they are turned out in winter directly after milking, and in others from chafing by the sucking calf. Some cows are peculiarly subject to sore teats. The fissures when neglected in the early stage of formation become deep, very painful, often bleeding at the slightest touch, and when milked in that condition cause the animal to become a kicker. Occasionally the lower portions of the legs become irritated and chapped when cattle are fed in a muddy or wet yard in winter, or if they are compelled to wade through water in frosty weather. Another form of erythema occurs in young cattle highly fed and closely stabled for a long winter. The erythema appears in patches, and as it is most common near the end of the winter it is known as the "spring eruption" or "spring itch."

Treatment.—In ordinary cases of erythema the removal of the cause and the application of benzoated oxid of zinc ointment, carbolized cosmoline, or ichthyol ointment applied a few times, will restore the skin to a healthy condition.

When there are fissures the zinc ointment is the best. If at the teats, a milk siphon (Pl. XXIV, fig. 4) should be used instead of milking by hand, and the calf, if one is suckled, should be taken away. The calf should be fed by hand if its mouth is affected. When the legs are irritated or chapped, dry stabling for a few days and the application of tar ointment will soon heal them.

URTICARIA (NETTLE RASH, OR SURFEIT).

This is a mild, inflammatory affection of the skin, characterized by sudden development of patches of various sizes, from that of a nickel to one as large as the hand. The patches of raised skin are marked by an abrupt border and are irregular in form. All the swelling may disappear in a few hours, or it may go away in one place and reappear on another part of the body. It is always accompanied with a great desire to rub the affected part. In its simplest type, as just described, it is never followed by any serous exudation or eruptions, unless the surface of the skin becomes abraded from scratching or rubbing.

Causes.—Digestive derangements caused by overloading the stomach when the animal is turned out to graze in the spring, certain feed constituents, high feeding of fattening stock, functional derangement of the kidneys, spinal and other nervous affections, are the most common sources of nettle rash.

The disease consists in paralysis of the nerve ends that control the volume of the capillary vessels in certain areas of skin, thus permitting the vessels to expand, their contents in part to exude, and thus produce a soft, circumscribed swelling.

Treatment.—Administer a full dose of Epsom salt. Give soft, easily digested feed, and wash the affected parts with a solution of bicarbonate of soda (common baking soda), 8 ounces to the gallon of water twice a day, or diluted glycerin may be applied to the skin. If it assumes a persistent tendency, give a tablespoonful of the following powder in the feed three times a day: Cream of tartar, sulphur, and nitrate of potassium. equal parts by weight; mix.

ECZEMA.

Eczema is a noncontagious inflammation of the skin, characterized by any or all of the results of inflammation at once or in succession, such as erythema, vesicles, or pustules, accompanied with more or less infiltration and itching, terminating in a watery discharge, with the formation of crusts or in scaling off. The disease may run an acute course and then disappear, or it may become chronic; therefore two varieties are recognized, vesicular (or pustular) and chronic eczema.

Causes.—Eczema is not so common among cattle as in horses and in dogs, in which it is the most common of all skin diseases. Among cattle it is occasionally observed under systems of bad hygiene, filthiness, lousiness, overcrowding, overfeeding, excessively damp or too warm stables. It is found to develop now and then in cattle that are fed upon sour substances, distillery swill, house or garden garbage, etc. Localized eczema may be caused by irritant substances applied to the skin—turpentine, ammonia, the essential oils, mustard, Spanish-fly ointment, etc. Occasionally an eruption with vesiculation of the skin has been induced by the excessive use of mercurial preparations for the destruction of lice. It is evident that eczema may arise from local irritation to the skin or from an autointoxication. Cattle fed on the refuse from potato-starch factories develop a most obstinate and widespread eczema, beginning on the legs.

Symptoms.—In accordance with the variety of symptoms during the progress of the disease we may divide it into different stages or periods: (1) Swelling and increased heat of the skin; the formation of vesicles, which are circumscribed, rounded elevations of the epidermis, varying in size from a pinhead to a split pea, containing a clear, watery fluid; (2) exudation of a watery, glutinous fluid, formation of crusts, and sometimes suppuration, or the formation of vesicles containing pus (pustules); (3) scaling off (desquamation), with redness, and thickening of the skin. From the very beginning of the disease the animal commences to rub the affected parts; hence the various stages may not always be easily recognized, as the rubbing produces more or less abrasion, thus leaving the skin raw—sometimes bleeding. Neither do these symptoms always occur in regular succession, for in some cases the exudation is most prominent, being very profuse, and serve to spread the disorder over a large surface. In other cases the formation of incrustations, or rawness of the skin, is the most striking feature. The disease may be limited to certain small areas, or it may be diffused over the greater part of the body; the vesicles, or pustules, may be scattered in small clusters, or a large number run together. The chronic form is really only a prolongation of the disease, successive crops of pustules appearing on various portions of the body, frequently invading fresh sections of the skin, while the older surfaces form scabs, or crusts, upon the raw, indurated skin.

In old, standing cases the skin breaks, forming fissures, especially on portions of the body that bend—the neck and limbs. Thus the disease may be prolonged indefinitely. When eczema reaches its latest period, either acute or chronic, desquamation of the affected parts is the most prominent feature. The formation and shedding of these successive crops of scales constitute the character of the disease frequently denominated psoriasis.

Treatment.—The treatment of eczema is often anything but a pleasant task. There is no one method of treatment which always proves successful, no matter how early it is begun or how small an area is involved. We must endeavor to remove the cause by giving attention to the general health of the animal and to its environment. Feeding should be moderate in quantity and not too stimulating in character—green feed, bran mashes, ground oats, clean hay, plenty of salt. If the animal has been fed too high, give an active purgative—Epsom salt preferred—once a week, if necessary, and half an ounce of acetate or nitrate of potassium may be given in the feed twice a day. If the animal is in poor condition and debilitated, give a tablespoonful of the following mixture in feed twice a day: Powdered copperas, gentian, sulphur, and sassafras bark, equal parts by weight. If the animal is lousy, the parasite must be destroyed before the eczema can be cured. The external treatment must vary with the character of the lesions; no irritating application is to be made while the disease is in its acute vesicular, or pustular, stage, and, in the chronic stage, active stimulants must be used. Much washing is harmful, yet crusts and scales must be removed in order to obtain satisfactory results from the external applications. Both objects, however, can be attained by judiciously combining the curative agents with such substances as will at the same time cleanse the parts.

In the vesicular stage, when the skin is feverish and the epidermis peeling off, thus exposing the exuding dermis, an application of boric-acid solution, 2 drams of the acid to 8 ounces of water, often relieves the smarting or itching, and also serves to check the exudation and dry the surface. If this fails to have the desired effect compound cresol, 1 ounce to 2 quarts of water, should be used as a wash. Either of these washes may be used several times a day until incrustation is well established. Then compound cresol, 1 ounce to 2 quarts of sweet oil, or the benzoated oxid of zinc ointment, giving the affected surfaces a thorough application once a day, will be efficacious. When the eczema is not the result of an external irritant, it takes usually from one to two weeks to heal.

In chronic eczema, when there is a succession of scabs or scales, indolent sores or fissures, the white precipitate ointment, nitrate of mercury ointment, or blue ointment, mixed with equal parts of cosmoline or fresh lard, may be applied every second day, taking care to protect the parts so that the animal can not lick it off.

The internal administration of arsenic often yields excellent results in chronic eczema. Dissolve 1 dram of arsenic and 1 dram of carbonate of potassium in 1 pint of boiling water, and give 1 ounce of this twice a day in water, after feeding. An alkali internally may be of service. As such, one may give 2 ounces of bicarbonate of soda twice daily. Sublimed sulphur may also be tried in ounce doses twice daily.

PUSTULES (IMPETIGO).

Impetigo is an inflammatory disease of the skin, characterized by the formation of distinct pustules, about the size of a pea or a bean, without itching. The pustules develop from the papular layer of the skin, and contain a yellowish-white pus. Afer reaching maturity they remain stationary for a few days, then they disappear by absorption and dry up into crusts, which later drop off, leaving upon the skin a red spot that soon disappears. Occasionally the crusts remain firmly adherent for a long time, or they may be raised and loosened by the formation of matter underneath. The dry crusts usually have a brown or black appearance.

Causes.—Impetigo affects sucking calves, in which the disease appears upon the lips, nostrils, and face. It is attributed to some irritant substance contained in the mother's milk. Impetigo is also witnessed among grazing animals, regardless of age, and it especially attacks animals with white hair and skin. The mouth, face, and limbs become covered with pustules, which may rupture in a few hours, followed by rapid and successive incrustations; the scabs frequently coalesce, covering a large surface; pus may form under them, and thus the whole thickness of the skin become involved in the morbid process. This form of the disease is attributed to the local irritant properties of such plants in the pasture as St. John's wort (*Hypericum perforatum*), smartweed (*Polygonum hydropiper*), vetches, honeydew, etc. Buckwheat, at the time the seeds become ripe, is said to have caused it; also bedding with buckwheat straw.

Treatment.—Sucking calves should be removed from the mother, and a purgative given to the latter to divert the poisonous substance secreted with the milk. When the more formidable disease among grazing cattle appears, the pasturage should be changed and the affected parts of the animal thoroughly anointed once a day with sweet oil containing 2 drams of carbolic acid to the pint. This should be continued until the crusts soften and begin to drop off, then the parts may be cleansed thoroughly with warm water and soap. Subsequently the white precipitate ointment or carbolized cosmoline should be applied daily until the parts are healed.

PEMPHIGUS (WATER BLISTERS).

This is an inflammatory disease of the skin, characterized by successive formations of rounded, irregularly shaped water blisters, varying in size from a pea to a hen's egg.

Causes.—Obscure.

Symptoms.—The formation of a blister is preceded by a congestion or swelling of the skin. Yellowish-colored water collects beneath the cuticle, which raises the latter from its bed in the form of a blister. The blisters appear in a succession of crops; as soon as one crop disappears another forms. They usually occur in clusters, each one being distinct, or they may coalesce. Each crop usually runs its course in a week. The disease is attended with itching or burning sensations which cause the animal to rub, thereby frequently producing excoriations and formation of crust on the affected region.

Treatment.—Give a tablespoonful of the following-described mixture in feed twice a day: Saltpeter, cream of tartar, and sulphur, equal parts by weight. The blisters should be opened as soon as formed, to allow the escape of the serum, followed by a wash composed of chlorid of zinc, 1 dram to 15 ounces of water. When there is any formation of crusts, carbolized cosmoline should be applied.

FURUNCULUS (BOILS).

This is an acute affection of the skin, usually involving its whole thickness, characterized by the formation of one or more abscesses, originating generally in a sebaceous gland, sweat gland, or hair follicle. They usually terminate by absorption, or by the formation of a central core, which sloughs out, leaving a deep, round cavity that soon heals.

Causes.—Impoverished state of blood, the result of kidney diseases or of local friction or contusions, with the entrance of pus cocci through the damaged skin or through a hair follicle or a sebaceous gland.

Symptoms.—Boils in cattle usually appear singly, not in clusters; they may attain the size of a hen's egg. The abscess begins as a small round nodule, painful on pressure, gradually increases in size until death of the central portion takes place, then the surface of the skin gives way to internal pressure and the core is released and expelled. Constitutional symptoms are generally absent, unless the boils occur in considerable numbers, or by their size involve a great deal of tissue.

Treatment.—Poulticing to ripen the abscess. If this can not be done, apply camphorated oil two or three times a day until the core is formed. As soon as the central or most prominent part becomes soft, the abscess should be opened to release the core. Then use carbolized cosmoline once a day until the healing is completed. If the animal is in poor condition, give tonics—copperas, gentian, ginger, and sulphur, equal parts by weight, 1 tablespoonful twice a day. If the animal manifests a feverish condition of the system, give half an ounce of saltpeter twice a day, continuing it several days or a week.

FAULTY SECRETIONS AND ABNORMAL GROWTHS OF THE SKIN.

PITYRIASIS (SEBORRHEA, DANDRUFF, OR SCURF).

This is a condition characterized by an excessive secretion of sebaceous matter, forming upon the skin in small crusts or scales.

Causes.—It is ascribable to a functional derangement of the sebaceous glands, usually accompanied with dryness and loss of pliancy of the skin. The animal is hidebound, as it is commonly termed, thin in flesh, inclined to rub, and very frequently lousy. The condition is observed most often toward the spring of the year. Animals that are continually housed, and the skins of which receive no cleaning, generally present a coat filled with fine scales, composed of epithelium from the epidermis and dried sebaceous matter. This, however, is a physiological condition and compatible with perfect health.

Symptoms.—Pityriasis may affect the greater portion of the body, though usually only certain parts are affected—the ears, neck, rump, etc. The skin becomes scurfy, the hairy coat filled with branlike gray or whitish scales.

Treatment.—Nutritious feed, such as oil-cake meal, bran, ground oats, and clean hay. In the spring the disease generally disappears after the animal is turned out to pasture. When lice are present they should be destroyed.

ELEPHANTIASIS (SCLERODERMA).

This condition consists in a chronic thickening of the skin, which may affect one or more limbs or involve the whole integument. It is characterized by recurrent attacks of swelling of the skin and subcutaneous areolar tissue. After each attack the affected parts remain infiltrated to a larger extent than before, until finally the skin may attain a thickness of an inch, becoming wrinkled and fissured. In cattle this disease is confined to hot climates. The predisposing cause is unknown.

EDEMA (ANASARCA OF THE SKIN).

This is a dropsical condition of the skin and subcutaneous areolar tissue, characterized by pitting under pressure, the fingers leaving a dent which remains a short time.

Causes.—Edema generally results from a weakened state of the system arising from previous disease. It may also be dependent upon a functional derangement of the kidneys, upon weak circulation, or obstruction to the flow of blood through the lungs. In debilitated animals and in some animals highly infested with parasites there is swelling of the dewlap or of the fold of the skin between the jaws.

Symptoms.—Painless swelling of a limb, udder, lower surface of abdomen, or lower jaw becomes apparent. This may increase in dimensions for several days or may attain its maximum in less than 24 hours. Unless complicated with some acute disease of a specific character, there is not much, if any, constitutional disturbance. The deep layer of the skin is infiltrated with serum, which gives it the characteristic condition of pitting under pressure.

Treatment.—When the cause can be ascertained and removed we may expect to see the edema disappear. When no direct specific cause can be discovered and the animal is debilitated, give general tonic. If, on the contrary, it is in good flesh, give a purgative, followed by half an ounce of acetate of potassium twice a day. External applications are useless.

Edema may be distinguished from erysipelas or anthrax by the absence of pain and fever.

DERMOID AND SEBACEOUS CYSTS (WENS).

A dermoid cyst is formed by an involution of the skin with a growth of hair on the inner wall of the sac. It may become embedded deeply in the subcutaneous tissues or may just penetrate the thickness of the skin, where it is movable and painless. They are generally found within the ear or at its base, although they may form on any part of the body. Usually they have a small opening, from which a thick, cheesy matter can be squeezed out. The rational treatment is to dissect them out.

Sebaceous cysts appear not unlike the former. They are formed by a dilatation of the hair follicle and sebaceous duct within the skin, and contain a gray or yellowish sebaceous mass. The tumor may attain the size of a cherry stone or a walnut. Generally they are round, movable, and painless, soft or doughy in consistency, and covered with skin and hair. They develop slowly. The best treatment is to dissect out the sac with contents entire.

VERRUCA (WARTS).

Cattle are affected with two varieties of warts. One, the verruca vulgaris, is composed of a cluster of enlarged papillæ, covered with a thickened epidermis, the number of papillæ determining the breadth and their length its height. They are generally circular in figure, slightly roughened on the surface, and spring from the skin by a broad base. Occasionally large numbers of very thin, long, pedunculated warts grow from the skin of the ear, lips, about the eyes, and vulva. Another variety, the verruca acuminata, sometimes erroneously denominated epithelial cancers, are irregularly shaped elevations, tufted or club shaped, occasionally existing as thick, short, fleshy excrescences, giving the growth the appearance of granulation tissue. Their color is red or purplish, and oftentimes by friction they become raw and bleeding, emitting then a very offensive odor. They usually grow in clusters and their development is rapid.

Causes.—An abnormal nutrition of the skin, determined by increased energy of growth operating upon a healthy skin; at other times, upon a weak or impoverished skin.

Treatment.—When they are small and pedunculated, they may be snipped off with shears and the stump touched with nitrate of silver. When they are broad and flattened, they may be dissected out and the wound cauterized if necessary. If they are large and very vascular, they may be ligated, one by one, by taking a strong cord and tying it as firmly around the base as possible. They will then shrivel, die, and drop off. If there is a tendency to grow again, apply a red-hot iron or nitric acid with a glass rod. Very often warts quickly disappear if they are kept soft by daily applications of sweet or olive oil.

KELIS.

Kelis is an irregularly shaped flat tumor of the skin, resulting from hypertrophy—increased growth of the fibrous tissue of the corium, producing absorption of the papillary layer.

Causes.—It may arise spontaneously or follow a scar after an injury.

Symptoms.—Kelis generally appears below the knee or hock, and may occur singly or in numbers. There are no constitutional symptoms. Its growth is very slow and seldom causes any inconvenience. It appears as a flattened, irregular, or spreading growth within the substance of the skin, is hard to the touch, and is especially characterized by divergent branches or roots, resembling the claws of a crab; hence the name. Occasionally some part of it may soften and result in an abscess. It may grow several inches in length and encircle the whole limb.

Treatment.—So long as it causes the animal no inconvenience it is best not to meddle with it: when it does the animal ought to be fattened for beef, the meat being perfectly harmless to the consumer.

PARASITIC DISEASES OF THE SKIN.

RINGWORM (TINEA TONSURANS AND TINEA FAVOSA).

Ringworm is an affection of the skin, caused by a vegetable parasite.

The form known as tinea tonsurans is produced by the presence of a minute or microscopic fungus—the *Trichophyton tonsurans*, which affects the hair and the epidermic layer of the skin, and is highly contagious, being readily transmitted from one animal to another. This fungus consists of spores and filaments. The spores, being the most numerous, are round and seldom vary much in size. They are very abundant in the hair follicle. The filaments are articulated, waving, and contain granules. This disease is productive of changes in the root and shaft of the hair, rendering it brittle and easily broken off.

This disease becomes manifest by the formation of circular patches on the skin, which soon becomes denuded of hair. The cuticular layer of the skin in slightly inflamed, and vesication with exudation occurs, followed by the formation of scaly, brittle crusts. The patches appear silvery gray when incrusted, and are mostly confined to the head and neck. It is a common disease among young cattle in the winter and spring. Very early in the development of the patches the hairs split, twist, and break off close to the skin. This disease is attended with more or less itching. It is communicable to man.

Tinea favosa comes from another fungus, the *Achorion schönleinii*. This enters the hair follicle and involves the cuticle surrounding it, small crusts form which increase in diameter and thickness and then become elevated at their margin, forming a cup-shaped scab, the favus cup, which gives the disease its distinctive character. The number of these cups varies from a few to many hundreds. The hairs involved become brittle and broken, fall off with the crusts, leaving small bald patches. The crusts are of a pale or sulphur-yellow color at first; as they grow older they turn darker, or to a brown color. This form of ringworm has a peculiar odor, resembling that of mice or musty straw. It is occasionally communicated to cattle by man, mice, cats, etc., all being subject to it.

Treatment.—Remove all crusts by washing with soap and water, then apply acetic acid, sulphur ointment, tincture of iodin or nitrate of mercury ointment once a day. Cleanse the stable and whitewash it to destroy the spores scattered by the crusts.

OTHER PARASITES AND PARASITIC DISEASES OF THE SKIN.

For discussion of mange, itch, scab, lousiness, warbles (grub in the skin), buffalo gnats, hornfly (*Hæmatobia serrata*), ticks, flies, etc., see the chapter on "The animal parasites of cattle," page 502.

WOUNDS OF THE SKIN.

SNAKE BITES AND VENOMOUS STINGS.

[See discussion of these subjects in chapter on "Poisons and poisoning."]

BURNS AND SCALDS.

This is a rare accident among cattle, yet in cases of fire it may occur. The application of heat, whether dry or moist, unless sufficient instantly to destroy the life of a part, is always followed by the development of vesicles or blisters, which contain a thin, watery fluid. The blisters may be isolated and not very large, or one blister may cover a very large surface. When the burn is very severe the skin may be wholly devitalized, or the injury may extend into the deeper structures of the skin. Then sloughs will occur, followed by a contraction of the parts in healing; if on a limb, this may render the animal stiff. When the burn or scald has been a severe one, the resulting pain is great and the constitutional disturbance very marked.

Treatment.—For a superficial burn use a mixture of equal parts of limewater and linseed oil, or common white paint—white lead ground in oil—to exclude the atmosphere and protect the inflamed skin. If it is not convenient to get anything else, chimney soot, flour, or starch may be spread on the wound (dry), and covered with cotton batting and light bandage. The blisters should be opened to let the contained fluid escape, but do not pull off the thin cuticle which has been raised by the blister. When the burn is extensive and deep sloughing occurs, the parts should be treated, like other deep wounds, by poulticing, astringent washes, etc. When the system has sustained much shock, the animal may require internal stimulants, such as 2 drams of carbonate of ammonia every hour until it rallies. When the pain is very great, hypodermic injections of 6 grains of morphia may be administered every six hours.

Frostbite on any portion of the body may be treated as recommended in the article on diseases of the ears.

EMPHYSEMA (AIR OR GAS UNDER THE SKIN).

Emphysema of the skin is not a true disease of the skin, but it is mentioned as a pathological condition. It is characterized by a distention of the skin with air or gas contained in the subcutaneous areolar tissue. It may depend upon a septic condition of the blood, as in anthrax or blackleg, or air may be forced under the skin about the head, neck, and shoulders, as a result of rupture of the windpipe. It occurs in the region of the chest and shoulders from penetrating wounds of the chest and lung, and occasionally follows puncture of the rumen when the escaping gas is retained under the skin.

Symptoms.—The skin is enormously distended over a greater or less portion of the body; thus any region of the body may lose its natural contour and appear like a monstrosity. There is a peculiar crackling beneath the skin when the hand is passed over it, and on tapping it with the fingers a resonant, drumlike sound is elicited.

Treatment.—Puncture the distended skin with a clean, broad-bladed knife and press the air out. Further treatment must be directed with a view to the removal of the cause.

DISEASES OF THE FOOT.

By M. R. Trumbower, D. V. S.

[Revised by Leonard Pearson, B. S., V. M. D.]

LAMINITIS (FOUNDER).

Laminitis denotes an active inflammation of the sensitive structures within the wall of the hoof, which in severe cases may result in suppuration and the loss of one or more claws. Owing to the simplicity of the structure of the foot of an ox compared with that of the horse, this disease is rarely seen in an acute form, but a mild form, commonly called "foot soreness," is not of infrequent occurrence.

Causes.—Laminitis in cattle may be caused by overfeeding, overheating, continued standing without exercise on a stone or cement floor without sufficient bedding, or by driving long distances over rough or stony soil.

Symptoms.—An unwillingness to maintain the standing position; the animal persists in lying down. The feet will be found unnaturally hot, and frequently some swelling may be noticed above the hoof. Pressure upon the hoof with blacksmith's hoof pincers causes pain and flinching. The general body temperature is increased and the breathing accelerated. Ordinarily the animal eats and drinks as usual. When it is made to move excessive tenderness of the feet becomes manifest, as is shown by reluctance to walk and by the very short, hesitating step. Founder affects the hind as well as the fore feet, although the front feet are more often exposed.

Treatment.—Cold packs to the feet, or if the animal can be made to stand in a stream of water, having a soft bottom, the inflammation is often relieved without the necessity of any additional treatment. It may be well, however, to give a full dose of Epsom salt, 1 to 1½ pounds, followed by half-ounce doses of saltpeter two or three times a day.

SORENESS (FOOT SORENESS).

Cattle that have been stabled or pastured on soft ground and are driven over stony roads soon wear down the soles of their feet and become lame from foot soreness. Draft oxen, for this reason, require to be shod. When the soreness is excessive it may develop into an active inflammation of all the sensitive structures of the foot—laminitis, or into a local bruise commonly called a "corn."

Treatment.—Rest, poulticing the feet with moistened clay, followed by astringent washes—strong white-oak bark or alum water.

If the pain and heat last several days, it is probable that pus has formed beneath the wall of the hoof. In this case it is necessary to cut through the wall, usually at the most prominent part of the sole, to allow the accumulation to drain out. The animal should then stand for several hours daily in a tub containing a 3 per cent solution of some good milky coal-tar disinfectant. When not in the disinfecting solution the foot should be dressed with pine tar and cotton and bandaged with bagging.

LOSS OF HOOF.

Cattle sometimes become fastened between planks or otherwise and pull off the wall of one or both claws in the effort to extricate themselves. The claws of one or more feet may be shed as the result of acute laminitis.

Treatment.—Wash the bleeding surface with an antiseptic and then with an astringent, such as a weak solution of alum, then apply a thick coating of pine tar; cover this with a layer of oakum or absorbent cotton; apply another coat of tar over this, and then bandage closely and firmly. This may remain without disturbance until the new growing wall becomes sufficiently strong to sustain the pressure and weight of the animal. If, however, at any time oozing or bad smell indicates that pus is forming under this dressing, the bandage should be removed and the suppurating surface freshly cleaned and dressed. This may have to be repeated every few days and should be continued so long as there is any pus formation. If the loss of hoof is owing to suppurative laminitis, the parts denuded of the horny covering must be thoroughly cleansed and disinfected with carbolic acid, lysol, or other antiseptic. Then apply a moderately thick layer of absorbent cotton and over this apply the tar and bandage. After this the antiseptic solution may be poured in daily at the top of the dressing. It will thus soak in and saturate the dressing and inflamed tissue. It may become necessary to remove all the dressing at daily or longer intervals to give the parts a fresh cleaning, and then to reapply it.

FOUL IN FOOT (FOOT ROT).

A variety of causes may produce inflammation of the foot between the claws or toes. It may be on account of overgrowth of the claws and inward pressure, as in ingrowing nail of man, or it may be caused by the irritation of stable filth by impaction and hardening of soil between the claws, or by other foreign substances becoming wedged in, causing inflammation and softening or ulceration of the skin in the interdigital space. Under some conditions several cattle in the same herd become affected, which has led some to think that the disease may be contagious. Occurrences have been reported in which foot rot of cattle has appeared within a short time among a large proportion of the cattle in a farming district. This disease is most frequently seen in the hind feet, though all four feet may become affected.

Symptoms.—The animal is observed to limp. On examination of the foot we discover heat and swelling above the hoof and of the soft parts between the claws which frequently spreads the claws apart to a considerable extent, or the inflammation may have advanced to softening and sloughing of the interdigital membrane. If the disease is neglected at this stage, deep abscesses may form and the pus burrow under the horny wall, or the joint within the hoof may become inflamed and the articular attachments destroyed, in which case the treatment will be difficult and recovery will be very tedious.

Treatment.—In the earlier stages of the disease, before pus burrows beneath the horn, a thorough cleansing and an application of a carbolic-acid solution—1 ounce to a pint of water—clean stabling, and laxative food will usually remedy the evil. Compound solution of cresol is an excellent remedy at this stage. It should be applied, in its pure or undiluted state, to the suppurating and putrefying tissue between the claws. It is best applied by means of a cotton swab on a thin stick. Care must be taken to keep it from contact with the skin about the coronary band or heels. If deep sloughing has taken place the carbolic solution should be used, and a wad of oakum or cotton smeared with pine tar should be secured firmly in the cleft. This can be done by taking a strip of strong cloth, 2 inches wide, passing the middle between the claws, then tying the ends after winding them in opposite directions above the hoof. Sometimes warm poulticing with flaxseed meal or bran is necessary to relieve excessive fever and pain. If the pus burrows under the horn, its channel must be followed by paring away the horn until the bottom is reached. The aftertreatment is the same as that already recommended. If the joint becomes diseased an amputation of that toe is the quickest and surest method to relieve the suffering of the animal, and offers the best chance for an early recovery.

ULCERATION OF THE HEEL.

Occasionally we find ulcers at the junction of the hair with the hoof at the heel, which present an elevated, raw, or ragged surface, and cause considerable lameness. This is generally caused by a bruise of the fibrous cushion of the back part of the foot. Subsequent sloughing or necrosis may occur, or pus may form deep within the wall and gain an exit at the margin of the heel. Sometimes, from no visible cause, large pieces of skin slough from the heel and pastern.

This condition is caused by an infection with certain microorganisms (streptococci, necrosis bacilli) and may be contagious.

Treatment.—If there is a deep opening, inject carbolic solution once a day until it closes. If the ulcer is only superficial, wash with carbolic solution and apply a mixture of equal parts of blue vitriol and alum in dry powder.

FISSURE OF THE WALL (SPLIT HOOF).

This is rarely seen among cattle. It may occur in weak walls, in heavily bodied cattle, caused by stepping on an uneven surface, especially when the point of the toe is grown out long. One may find the point of the toe broken and the wall split almost up to the hair.

Treatment.—The divided sections may be brought into approximation and held in place by drilling a small hole from one side into and through the other, commencing half an inch back of the fissure on each side; then drive a light horseshoe nail through the hole and clinch it. Pare the injured claw as short as it will bear.

INTERDIGITAL FIBROMA.

Hard, nodular, fibrous tumors sometimes grow in the cleft of the foot, and cause inconvenience, lameness, absorption, or ulceration of the contiguous parts.

Treatment.—They should be dissected out and the wound dressed with carbolic-acid lotion and pine tar once a day until healing is completed.

DEFORMITIES.

Deformities in the feet of cattle usually consist in overgrowth of horn, generally from want of wear in animals which are stabled. The hoof may turn inward, outward, or upward, and may give rise to lameness, inability to walk, foul foot, etc. Bulls which are continually stabled and dairy cows very frequently have misshapen feet from want of an occasional trimming, and this deformity may eventually lead to permanent injury.

Treatment.—Cut the superabundant growth of horn down with saw, knife, or rasp, until the foot assumes its natural form.

PRICKS AND WOUNDS.

If an animal suffers with a penetrating wound from prick of fork or nail, the orifice of the wound should be enlarged to permit a free discharge of pus; then the foot should be soaked in a cresol compound solution (3 per cent) in a tub, or a flaxseed poultice applied, changing it three times a day until the fever has abated. The foot should be kept bandaged and dressed with pine tar and oakum; the animal must also be kept on a clean floor until the wound is closed and all or nearly all lameness has disappeared.

If an animal is cut in the foot with barbed wire, piece of glass, or any other substance, the wound, after proper cleansing, should be dressed with carbolic-acid solution, 1 ounce of the acid to 20 of water. If any uneven edges of horn, skin, or lacerated flesh project, trim them off, and in all cases when it can be done a tarred bandage should be applied. This will serve to sustain the cut surfaces in their place, exclude dirt, and protect against flies, maggots, etc.

When the wound has extended into a joint, surgical treatment, which will require the services of an educated veterinarian, may be necessary.

Occasionally an animal gets caught by the foot in a crevice and sustains severe bruising, wrenching, or fracture of some part of the foot. In such cases cold-water packs to the injured member are of service until the fever and swelling disappear. Afterwards the animal should rest until the usefulness of the foot is restored. Sometimes such an accident, causing fracture, renders necessary plaster bandages or amputation.

DISEASES OF THE EYE AND ITS APPENDAGES.

By M. R. Trumbower, D. V. S.

[Revised by Leonard Pearson, B. S., V. M. D.]

DESCRIPTION.

For the sake of gaining a clear comprehension of the diseases of the eye it becomes necessary to review the anatomy of this important organ. The essential organ of vision, or globe of the eye, will be first described, then its receptacle or orbital cavity, the muscles that move it, the protective membranes, or eyelids, the membrana nictitans, or accessory eyelids, and, lastly, the lacrimal apparatus.

The globe or ball of the eye is almost spherical in form. On closer inspection, however, it appears to be made up of two combined portions from spheres of different sizes. The posterior portion, forming about five-sixths of the ball, is a sphere of comparatively large size with a small segment cut off it in front, and at this point there is applied to it the anterior portion, which, being a segment of a smaller sphere, projects at the front of the ball with a greater convexity than the posterior portion.

The eyeball consists of concentrically arranged coats and of refracting media inclosed in them. The coats are three in number, namely, (1) an external protective tunic made up of the sclerotic and cornea; (2) a middle vascular and pigmentary tunic, the choroid; (3) an internal nervous layer, the retina. The sclerotic is the white, opaque part of the outer tunic, of which it forms about the posterior five-sixths, being coextensive with the larger sphere already mentioned. The cornea forms the remaining one-sixth of the outer tunic, being coextensive with the segment of the smaller sphere. It is distinguished from the sclerotic by being colorless and transparent. The choroid coat will be recognized as the black layer lying subjacent to the sclerotic. It does not line the cornea, but terminates behind the line of junction of that coat with the sclerotic by a thickened edge—the ciliary processes. At the line of junction of the sclerotic and cornea the iris passes across the interior of the eye. This (which may be viewed as a dependency of the choroid) is a muscular curtain perforated by an aperture termed the pupil. The retina will be recognized as a delicate, glassy layer, lining the greater part of the choroid.

The refracting media of the eye are three in number, namely (1) the aqueous humor, a watery fluid inclosed in a chamber behind the cornea; (2) the crystalline lens and its capsule, a transparent, soft solid of a biconvex form, and placed behind the iris; (3) the vitreous humor, a transparent material with a consistence like thin jelly, and occupying as much of the interior of the eye as is subjacent to the choroid.

The sclerotic is a strong, opaque, fibrous membrane, which, in a great measure, maintains the form of the eyeball and protects the more delicate structures within it. Its interior portion, which is covered by the ocular conjunctiva, is commonly known as the "white of the eye." In form it is bell-shaped, and the optic nerve pierces it behind like a handle, the perforation being a little to its inner side. In front, the rim of the bell becomes continuous with the cornea. The outer surface of the membrane receives the insertion of the muscles of the eyeball. The coat is thickest over the posterior part of the eyeball, and is thinnest a little behind its junction with the cornea.

The cornea is the anterior transparent portion of the outer coat of the eyeball. It may be viewed as a part of the sclerotic specially modified to permit the passage of light into the interior of the eye. Its outline is elliptical, nearly circular, and its greatest diameter is transverse. At its periphery it joins the sclerotic by continuity of tissue, and as the edge of the cornea is slightly beveled and has the fibrous sclerotic carried for a little distance forward on its outward surface, the cornea is generally said to be fitted into the sclerotic like a watch glass into its rim. The venous canal of Schlemm runs circularly around the eyeball at the line of junction of the sclerotic and cornea. The anterior surface of the cornea is exquisitely smooth, and is kept moist by the lacrimal secretions. Its posterior surface forms the anterior boundary of the chamber in which the aqueous humor is contained. The cornea is of uniform thickness and is of a dense, almost horny, consistence. Save a few capillary loops of blood vessels at its margin the cornea is without vessels. Its structure is comprised of five distinct layers.

The aqueous humor occupies a chamber which is bounded in front by the posterior surface of the cornea and behind by the capsule and suspensory ligament of the lens and by the ends of the ciliary processes. It is across this chamber that the iris extends. The aqueous humor is composed of water, with a small proportion of common salt in solution.

The iris is a muscular, pigmented curtain extending across the interior of the eye and having about its center an aperture termed the pupil. By variations in the size of this aperture the amount of light transmitted to the retina is regulated. It varies somewhat in color, but is most frequently of a yellowish-brown tint. Its anterior face is bathed by the aqueous humor. The greater part of the posterior surface is in contact with the capsule of the lens and glides on it during the movements of the curtain. The circumferential border is attached within the junction of the sclerotic cornea. The inner border circumscribes the pupil, which varies in outline according to its size. When much contracted the pupil is a very elongated ellipse, the long axis of which is in the line joining the nasal and temporal angles of the eyelids. It contains muscular tissue, which, by contracting or relaxing, lessens or dilates the pupillary opening.

The choroid coat is a bell-shaped, dark membrane which lines the sclerotic. Its outer surface has a shaggy appearance, caused by the tunica fusca, which unites the two coats. Between the two the ciliary vessels and nerves pass forward. Behind it is pierced by the optic nerve; in front it is continued as the ciliary processes, which form, as it were, the rim of the bell. The ciliary processes form a fringe around the slightly inverted rim of the choroid.

The retina is the most delicate of the coats of the eyeball. It is formed by the expansion of the optic nerve on the inner surface of the choroid, and, like that coat, it is bell-shaped. Its inner surface is molded on the vitreous humor. The nervous structures of the retina terminate at a wavy line, the ora serrata, behind the ciliary processes. Ten distinct layers are described as composing the thickness of the retina.

The lens is situated behind the pupil and is contained within a capsule of its own.

The capsule is a close-fitting, firm, transparent membrane. The anterior surface forms the posterior boundary of the cavity containing the aqueous humor, and the iris in its movement glides on it. The posterior surface is in contact with the vitreous humor.

The vitreous humor occupies four-fifths of the interior of the eyeball. It is globular in form, with a depression in front for the lodgment of the lens. It is colorless, transparent, and of a consistency like thin jelly. It is enveloped by a delicate capsule—the hyaloid membrane—which is connected in front with the suspensory ligament of the lens, and ends by joining the capsule behind the lens.

The orbital cavity, at the side of the head, is circumscribed by a bony margin; posteriorly, however, there are no bony walls, and the cavity is often confounded with the depression above and behind the orbit—the temporal fossa. A fibrous membrane completes this cavity and keeps it distinct from the temporal fossa. This membrane—the ocular sheath or periorbita—is attached posteriorly around the opening in the back part of the orbital cavity (the orbital hiatus) and anteriorly to its inner face; then it becomes prolonged beyond the margin to form the fibrous membrane of the eyelids. When complete the orbital cavity has the form of a regular hollow cone, open at its base and closed at the apex. The opening of this cone is directed forward, downward, and outward. Independently of the globe of the eye, this cavity lodges the muscles that move it, the membrana nictitans, and the lacrimal gland.

The muscles of the eye are seven in number—one retractor, four straight, and two oblique. The retractor oculi envelops the optic nerve between the brain and the ball of the eye and becomes attached upon the external face of the sclerotic tunic. When this muscle contracts, it draws the globe back into the orbit, away from the light. The superior, inferior, external, and internal recti or straight muscles are attached to the back part of the orbital sheath and spread forward in four bundles over the globe of the eye, where they are inserted by a fibrous expansion into the sclerotic at the margin of the cornea. When they act singly, they turn the globe either upward, downward, inward, or outward. The great oblique, by its action, pivots the eye inward and upward in the orbit. The small oblique turns the eye outward and downward.

The eyelids are two movable curtains, superior and inferior, which cover and protect the eye in front. They are attached to the circumference of the orbit and have a convex external face formed by the skin and a concave internal face molded on the anterior surface of the eye and are lined by the conjunctiva, which is reflected above and below on the eyeball. The border of each lid is slightly beveled on the inner side and shows the openings of the Meibomian glands. These glands secrete an unctuous fluid, which is thrown out on the border of the lids, the function of which is to facilitate their movements and enable them to retain the tears in the ocular cavity. The eyelid is composed of a fibrous inner membrane ending in a stiff arch near the border, a muscle to close the lid, another to open it, the skin externally, and the conjunctival mucous membrane internally. The border of each lid is covered and protected by long hairs to prevent floating particles of matter in the atmosphere from gaining entrance to the eye.

The membrana nictitans, which is also named the third eyelid, winking eyelid, haw, etc., is placed at the inner angle of the eye, whence it extends over the eyeball to relieve it from foreign bodies which may fall upon it. It has for its framework a fibro-cartilage, irregular in shape, thick, nearly prismatic at its base, and thin anteriorly where it is covered by the conjunctiva; behind, it is loosely attached to a fatty cushion.

The lacrimal gland is situated between the orbital process and the upper part of the eyeball. It secretes the tears destined to lubricate the anterior surface of the eye. This fluid escapes upon the organ at the outer angle of the lids and is carried between them and the eyeball toward the inner angle.

The caruncula lacrimalis is a small round body, frequently entirely or partially black, situated in the inner angle of the eye, and is designed to direct the tears toward the puncta lacrimalia.

The puncta lacrimalia are two little openings, situated one in each eyelid, a short distance from the inner corner, which admit the tears into the lacrimal ducts leading to the lacrimal canal, whence they are emptied into the nasal passages.

CONJUNCTIVITIS (SIMPLE OPHTHALMIA).

This is an inflammation of the conjunctival mucous membrane of the eyeball and lids; in severe cases the deeper coats of the eye are involved, seriously complicating the attack.

Causes.—It may result from a bruise of the eyelid; from the introduction of foreign matters into the eye, as chaff, hayseed, dust, gnats, etc.; from exposure to cold; poisonous or irritating vapors arising from filthiness of stable. Dust, cinders, or sand blown into the eyes during transportation frequently cause conjunctivitis.

Symptoms.—A profuse flow of tears, closure of the eyelids from intolerance of light, retraction of the eyeball and corresponding protrusion of the haw, disinclination to move, diminution of milk secretion, etc. On parting the lids the lining membrane is found injected with an excess of blood, giving it a red and swollen appearance; the sclerotic, or white of the eye, is bloodshot and the cornea may be cloudy. If the disease advances, keratitis results, with its train of unfavorable symptoms.

Treatment.—Careful examination should be made to discover particles of chaff, etc., which may have lodged in the eye, and upon the discovery of such a cause prompt removal is indicated. This may be accomplished by flushing the eye with warm water by means of a syringe, or, if the foreign substance is adherent to the eyeball or lid, it may be scooped out with the handle of a teaspoon or some other blunt instrument. To relieve the congestion and local irritation, a wash composed of boracic acid in freshly boiled water, 20 grains to the ounce, or acetate of zinc, 5 grains to the ounce of pure soft water, may be used, to which may be added 20 drops of laudanum. A few drops of this should be placed in the eye with a camel's-hair pencil or soft feather three or four times daily. The animal should be placed in a cool, darkened stable; then a cloth folded into several thicknesses should be fastened to the horns in such manner as to reach below the eyes. This should be kept wet with cold water during the day and removed at night. If there is much fever and constitutional disturbance, it becomes advisable to administer 1 pound of Epsom salt dissolved in 1 quart of water.

INFECTIOUS CATARRHAL CONJUNCTIVITIS (SPECIFIC OPHTHALMIA).

This generally appears in an enzootic or epizootic form and affects a considerable number in the herd. It is distinctly a contagious disease and may be brought into a previously healthy herd by one infected animal. It may continue in a herd for a season or for several years, affecting all newly purchased animals. It is seldom seen in the winter months. It affects old and young animals alike.

Symptoms.—This form of catarrh conjunctivitis is characterized chiefly by a mucopurulent discharge from the eyes, an intense degree of inflammation of the mucous membrane, accompanied with swelling of the eyelids and an early opacity of the cornea. The flow of tears is mixed with pus, sometimes streaked with blood, and the skin of the face is kept moist and soiled. The eyes are kept continually closed. The implication of the cornea in the disease frequently blinds the animal for a time, and occasionally suppurative keratitis, ulcers of the cornea, or staphyloma supervene. The attack is marked from the onset by fever, partial loss of appetite, partial loss of milk, suspended rumination, and separation from the herd.

Treatment.—The animal should be housed in a cool, dark stable, supplied with plenty of fresh water to drink and soft, succulent feed. Administer 1 pound of Epsom salt—if a very large animal, use 1½ pounds—dissolved in 2 or 3 pints of water. For an eyewash, take boracic acid, 1 dram, and pour 4 ounces of boiling water over it. Use this as often as is convenient, applying it directly to the eye. In the majority of cases improvement becomes manifest in a few days, and the eye becomes clear and free from inflammation in 10 days or 2 weeks. Where the disease develops ulceration of the cornea, or well-marked, deep-seated keratitis, the treatment recommended for those conditions should be adopted.

Prevention.—Whenever this affection appears in a herd all the unaffected animals should be moved to fields which possess a different character of soil and feed. The water should also be changed, especially if they have been obtaining it from a stagnant pond.

KERATITIS (CORNEITIS).

This is an inflammation of the cornea proper, although the sclerotic at the corneal border becomes involved to some extent. It may be divided into diffuse and suppurative.

Causes.—The cornea constitutes the most prominent portion of the eyeball, hence it is subject to a variety of injuries—scratches, pricks, contusions, lacerations, etc. Inflammation of the cornea may also be due to the extension of catarrhal conjunctivitis or intraocular disease, and it may occasionally occur without any perceptible cause.

Symptoms.—Diffuse keratitis is characterized by an exudation into and an opacity of the cornea. The swelling of the anterior part of the eyeball may be of an irregular form, in points resembling small bladders, or it may commence at the periphery of the cornea by an abrupt thickening, which gradually diminishes as it approaches the center. If the whole cornea is affected, it has a uniform gray or grayish-white appearance. The flow of tears is not so marked as in conjunctivitis, nor is the suffering so acute, though both conditions often exist together. Both eyes usually become affected, unless it is caused by an external injury.

In favorable cases the exudate within the cornea begins to disappear within a week or 10 days, the eye becomes clearer and regains its transparency, until it eventually is fully restored. In unfavorable cases blood vessels form and are seen to traverse the affected part from periphery to center, vision becomes entirely lost, and permanent opacity (albugo or leucoma) remains. When it arises from constitutional causes recurrence is frequent, leaving the corneal membrane more cloudy after each attack, until the sight is permanently lost.

Suppurative keratitis may be a sequel of diffuse keratitis; more commonly, however, it abruptly becomes manifest by a raised swelling on or near the center of the cornea that very soon assumes a yellow, turbid color, while the periphery of the swelling fades into an opaque ring. Suppurative keratitis is seldom noticed for the first day or two—not until distinct pus formation has occurred. When it is the result of diffuse keratitis, ulceration and the escape of the contained pus is inevitable; otherwise the pus may be absorbed. When the deeper membranes covering the anterior chamber of the eye become involved, the contents of this chamber may be evacuated and the sight permanently lost.

Treatment.—Place the animal in a darkened stable, give green or sloppy feed, and administer 4 ounces of Glauber's salt (sulphate of soda) dissolved in a quart of water once a day. If the animal is debilitated a tablespoonful of tonic powder should be mixed with the feed three times a day. This may be composed of equal parts by weight of powdered copperas (sulphate of iron), gentian, and ginger. As an application for the eye, nitrate of silver, 3 grains to the ounce of soft water, with the addition of 1 grain sulphate of morphia, may be used several times a day. If ulceration occurs, it is well to dust powdered calomel into the eye twice daily, or apply to the eyelids a salve of yellow oxid of mercury, 5 per cent in lanolin. Some of this may go on to the cornea and beneath the lids. Apply twice daily. (See "Ulcers of the cornea.")

To remove opacity, after the inflammation has subsided, apply a few drops of the following solution twice a day: Iodid of potassium, 15 grains; tincture sanguinaria, 20 drops; distilled water, 2 ounces; mix.

Sometimes keratitis exists in a herd as a transmissible disease, spreading like infectious conjunctivitis. Calomel, applied to the eye, is especially useful in such cases.

ULCERS OF THE CORNEA.

An ulcer comes from erosion or is the consequence of the bursting of a small abscess, which may have formed beneath the delicate layer of the conjunctiva, continued over the cornea; or, in the very substance of the cornea itself, after violent keratitis, or catarrhal conjunctivitis. At other times it is produced by bruises, scratches, or other direct injury of the cornea.

Symptoms.—The ulcer is generally at first of a pale gray color, with its edges high and irregular, discharges instead of pus an acrid, watery substance, and has a tendency to spread widely and deeply. If it spreads superficially upon the cornea, the transparency of this membrane is lost; if it proceeds deeply and penetrates the anterior chamber of the aqueous humor, this fluid escapes, the iris may prolapse, and the lens and the vitreous humor become expelled, thus producing destruction of the whole organ.

Treatment.—It is of the greatest importance, as soon as an ulcer appears upon the cornea, to prevent its growing larger. The corroding process must be converted into a healthy one. For this purpose nothing is more reliable than the use of solid nitrate of silver. A stick of this medicine should be scraped to a point; the animal's head should be firmly secured; an assistant should part the lids; if necessary, the haw must be secured within the corner of the eye and then all parts of the ulcer should be lightly touched with the silver. After waiting a few minutes the eye should be thoroughly washed out with a very weak solution of common salt. This operation generally has to be repeated at the end of three or four days. If healthy action succeeds, the ulcer assumes a delicate fleshy tint, and the former redness around the ulcer disappears in proportion as the ulcer heals.

In superficial abrasions of the cornea, where there is no distinct excavation, this caustic treatment is not needed. The eye should be bathed several times a day with sulphate of zinc, 30 grains to half a pint of soft water, and protected against exposure to cold air and sunlight. Excessive ulceration sometimes assumes the form of fungous excrescence upon the cornea, appearing to derive its nourishment from loops of blood vessels of the conjunctiva. Under these circumstances the fungoid mass must be cut away and the wound cauterized with the nitrate of silver, or else the eye will soon be destroyed. When ulcers of the cornea appear indolent, with a tendency to slough, in addition to the treatment already prescribed, tonic powders of copperas, gentian, and ginger, equal parts by weight, should be given twice a day, mixed with the feed; dose, one tablespoonful.

STAPHYLOMA.

This is a disease of the eyeball, in which the cornea loses its transparency, rises above the level of the eye, and even projects beyond the eyelids in the form of an elongated, whitish, or pearl-colored tumor, which is sometimes smooth, at other times uneven.

Causes.—Inflammation is the only known cause, although it may not occur immediately; it frequently follows catarrhal conjunctivitis and keratitis as a sequela.

Treatment.—In a few cases restoration of sight may be effected by puncturing the projecting tumor and treating it afterwards with nitrate of silver in the same manner as prescribed for ulceration of the cornea. In some cases spontaneous rupture has occurred, and healing without any treatment at all.

CATARACT.

In cataract the crystalline lens becomes opaque and loses its transparency, the power of refraction is lost—the animal can not see.

Causes.—Cataract generally arises from a diminution (atrophy) or other change in the nutrition of the lens; it may occur as a result of inflammation of the deep structures of the eye. Cataract may be simple, or complicated with amaurosis, adhesions, etc.

Symptoms.—It is known by the whiteness or loss of transparency of the lens, although the pupil dilates and contracts. Sight may be totally lost; however, evidence is usually manifested that the animal distinguishes light when brought out of a darkened stable. For the most part the formation of cataract takes place slowly, the cases in which it originates very quickly being but few.

Treatment.—There is only one method for the treatment of cataract—a surgical operation for the removal of the lens; but this is not advisable, for the sight can not be perfectly restored, and objects would be seen imperfectly without the aid of glasses.

AMAUROSIS.

This is a paralysis of the nerve of sight or the expansion of the retina.

Causes.—This is the result of concussion from a blow upon the forehead, fracture of bone over the eye (causing downward pressure), rheumatic inflammation of the optic nerve, or from extension of deep inflammation of the eye involving the retina. It sometimes occurs as the result of excessive loss of blood or of great debility.

Symptoms.—In this disease observation is seldom made until the animal in its gait and by its action indicates blindness. Generally both eyes are affected. The eyeball remains clear, and the pupil is permanently dilated. No response to light is manifested.

Treatment.—If caused by debility, loss of blood, or associated with rheumatism, general blood tonics may be given in the feed, namely, powdered sulphate of iron, 1 dram; gentian, 2 drams; nux vomica, one-half dram; to be given twice a day. In cases of rheumatism, one-half ounce of saltpeter may be added.

FILARIA OCULI (WORM IN THE EYE).

Filaria oculi (provisionally taken as the larva of *F. cervina*) is a small white worm, found swimming in the aqueous fluid in the anterior chamber. It may be apparently harmless for a long time, but will eventually induce keratitis with inflammatory exudations.

Treatment.—The cornea may be punctured at its upper and outer margin, and the worm squeezed out with the aqueous humor. The latter will be formed again. This operation results disastrously unless the greatest care and skill are employed.

CORNEAL DERMATOMA (HAIRY TUMOR ON THE EYEBALL).

In a few instances this has been seen as a congenital growth. The tumor arises from the cornea or the sclerotic, covered by its respective membrane, with a growth of hair upon its surface. These tumors may be quite prominent or flattened, and are dark in color; the hair may protrude between the eyelids, giving the animal the appearance of having a double eyelid.

Treatment.—A surgical operation becomes necessary for their removal—one requiring a skilled operator.

STRABISMUS (SQUINTING).

This is a very rare affection among cattle. Strabismus may be either single or double—affecting one eye or both. It is caused by a paralysis, or a weakening of one of the straight muscles of the eyeball. Generally it is a congenital defect, and the squinting is toward the nose—strabismus convergens. It is best not to attempt to remedy the defect, as the risk in an operation is greater than the chances of success warrant.

PTERYGIUM.

This term is applied to a flesh-colored membrane, triangular in form, which most frequently grows from the inner angle of the eye and extends over the cornea, thus interfering with vision. It may grow from the outer angle, or even from either the superior or inferior hemisphere of the eyeball. The figure is invariably that of a triangle, with its base on the white of the eye and its apex more or less advanced over the cornea toward its center.

The distinguishing characteristics are the constancy of the triangular form, and the facility with which the whole of it may be taken hold of with a pair of forceps and raised into a fold on the cornea. Every other kind of excrescence attached to this membrane continues firmly adherent to it, and can not be folded and raised from the surface of the cornea in any manner whatever.

Treatment.—Raise the fold and dissect it away from all points of attachment.

TRICHIASIS (INVERSION OF THE EYELASHES).

In the simplest form the eyelashes bend inwardly, touching the eyeball, causing irritation and simple conjunctivitis. It may be also associated with entropion.

Treatment.—The offending eyelashes should be cut off or pulled out. In case the natural growth of the eyelashes is directed inward, an operation similar to that for entropion becomes necessary.

ENTROPION (INVERSION OF THE EYELID).

In inversion of the eyelid the eyelashes soon irritate the anterior face of the cornea and produce more or less inflammation and opacity. The inversion may be due to the growth of a tumor within or without the lid, to abscess, laceration, or injury, causing the lid to lose its natural conformity to the eyeball, ulcerations, etc. Surgical interference in either case becomes necessary to restore the lid to its natural direction.

ECTROPION (EVERSION OF THE EYELID).

This serves to injure the eye by permitting dust or other foreign substances to enter the eye and interferes with the natural removal of them.

Treatment.—A delicate surgical operation—the removal of an elliptic section of the palpæbral conjunctiva—may remedy the defect.

TUMORS OF THE EYELIDS.

Occasionally tumors form upon or within the substance of the eyelid. They may be of a fibroid nature and arise from the follicles of the hair as sebaceous tumors or may be in the form of an abscess. In debilitating diseases the lids sometimes become swollen and puffy, a condition which may possibly be taken for the growth of a tumor. This generally disappears with the improvement of the health of the animal. Warts not uncommonly appear on or about the eyelids of cattle.

Treatment.—The removal of a tumor in the vicinity of so delicate an organ as the eye should not be attempted by anyone not qualified to perform the operation.

LACERATION OF THE EYELID.

This accident is not uncommon where cattle are fenced in by barbed wire; an animal may be caught under the eyelid by the horn of another, or the laceration may occur in the stable by means of a projecting nail or splinter of wood.

Treatment.—The edges of the wound should be brought together closely and correctly, by means of pins pushed through very nearly the whole thickness of the lid, extending through each lip of the torn part; then a waxed silk or linen thread must be wound over each end of the pin, crossing the torn line in the form of the figure 8 (Pl. XXVII, fig. 9); the pins should be placed about three-eighths of an inch apart. The projecting ends of the pins should be cut off close to the ligature, and the parts kept anointed with vaseline, to which 2 per cent of compound cresol has been added. In place of a pin suture, silver wire, catgut, or strong linen thread may be used in the way of an ordinary suture.

FOREIGN BODIES IN THE EYE.

Splinters of wood, hedge thorns, pieces of cornstalk or leaves, stems of hay or straw, twigs of trees, or weeds may penetrate into the eye, break off, and remain, causing inflammation, blindness, abscess, etc. These substances may penetrate the eyeball, but more frequently they glide off and enter between the eye and the ocular sheath.

Treatment.—Their removal becomes often a very difficult task, from the fact that the organ is so extremely sensitive, and the retracting power so strong as to necessitate casting the animal, or even the administration of sufficient chloroform to render it completely insensible. The removal, however, is of paramount importance, and the after treatment depends upon the extent and location of the injury—cold water compress over the injured eye, the application of mild astringent and cooling washes, such as acetate or sulphate of zinc, 5 grains to the ounce of water. When there is extreme suffering from pain a solution of atropia or morphia, 5 grains to the ounce of water, may be dropped into the eye, alternating with the cooling wash several times a day. When abscesses form within the orbit a free opening must be maintained for the discharge of pus. In deep penetrating wounds of the eye there is a great tendency to the formation of a fungous growth, which often necessitates the enucleation of the whole eyeball.

ORBITAL AND PERIORBITAL ABSCESS.

Orbital abscess may form outside the globe and within the orbital sheath, as the result of a previous wound of the parts or from fracture of the bony orbit, etc. Periorbital abscess commences outside the ocular sheath, beneath the periosteal membrane covering the bone, and is usually the result of a disease or fractured bone which enters into the formation of the orbital cavity.

Symptoms.—Orbital abscess is manifested by a pushing forward of the eyeball (exophthalmos), a swelling of the conjunctiva and eyelids. The bulging out of the eye is in proportion to the size of the abscess: the movement of the eye is fixed, due to the painfulness of any voluntary movement of the eyeball. Periorbital abscess generally pushes the eye to one side; otherwise the symptoms are similar to the foregoing. The pain generally is very great; paralysis of the nerve of sight may occur, and death may be caused by the abscess extending to the brain.

Treatment.—The treatment for either orbital or periorbital abscess is the same as that for abscess occurring in any other part of the body—a free opening for the escape of imprisoned pus. This should be made as soon as the true nature of the disease is recognized. Afterwards antiseptic injections may be needed to stimulate healthy granulation and to prevent septic infection of the ocular membranes. For this purpose a saturated solution of boric acid or listerine 1 part to 10 of water may be used. When the fever runs high, Glauber's salt (sulphate of soda) may be given in 4-ounce doses once a day. The animal should be kept in a darkened stable, on soft or green feed.

FRACTURE OF THE ORBIT.

This accident occasionally occurs among belligerent animals, or as the result of blows delivered by brutal attendants. The orbital process above the eye may be entirely crushed in, pressing down upon the eyeball. In such an event the depressed bone should be elevated into its proper place, and if it fails to unite it may have to be removed with saw or chisel. The margin of the orbit may be crushed at any point and cause periorbital abscess, or necrosis may result from the presence of a splinter of bone or the excessive destruction of bone. In all cases of fracture the animal should be kept by itself until the injured part heals.

NECROSIS OF THE BONY ORBIT.

As the result of fracture of the margin of the orbit a part of the injured bone may become necrosed (dead), and periostitis and periorbital abscess will follow as a consequence. The discovery of this disease will at first resemble abscess, but on making an examination with a probe after the abscess is open we find the bone rough and brittle at the point of disease. The discharge has a peculiar fetid odor, and is often mixed with blood.

Treatment.—The affected bone must be laid bare and all diseased portions removed by scraping or, if necessary, with saw or chisel, disregarding the extent of the injury or the size of the wound necessary to be inflicted. A large portion of the bony orbit may be removed without serious danger to the eye, provided the eyeball itself has not been previously affected by the disease or involved in the original injury.

TUMORS OF THE ORBIT.

A fungous tumor of the eyeball or orbit occasionally appears, which is designated fungus hæmatodes. This may arise without any appreciable cause, or as the result of a wound. It frequently commences within the eyeball as a small, red mass, eventually bursts through, and pushes its way outside the orbit as a large, dark-red mass, bleeding at the slightest touch. It has a peculiar, fetid odor, and early in its appearance destroys sight, involving all the contents of the orbit, not infrequently the bony wall itself.

Unless the tumor is totally removed in its early stage of growth, together with the eyeball, the disease will eventually cause emaciation and death of the animal. The enucleation of the eyeball should not be undertaken by anyone unacquainted with the anatomical structures involved in such an operation. When the operation is performed early enough the result is generally satisfactory.

Bony tumors of the orbit, the result of bruises, fractures, etc., are occasionally present in cattle. They may encroach upon the contents of the orbit, causing paralysis of the optic nerve—the condition known as amaurosis—or by pressure upon the posterior surface of the eyeball force it forward, or produce atrophy (shrinking). They may displace the eye in any direction, with or without disturbing vision.

Fibrous tumors growing within the orbit will produce symptoms similar to those of bony tumors.

Treatment.—When the outlines of the tumor, whether fungoid, bony, or fibrous, can be detected, an operation for its removal should be undertaken as soon as the sight of the eye is in any manner disturbed.

DISLOCATION OF THE EYEBALL.

The eyeball may be torn out of its socket by the horns of another animal, or it may be crowded out with the blunt end of a club, cane, or probe in the hands of a brutal attendant.

Treatment.—When the optic nerve is not lacerated and the retractor muscles at the back of the eye are intact, an attempt at reduction

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is advisable. This, however, must follow very soon after the injury—before swelling takes place. Divide the outer corner of the eyelid to enlarge the orifice, then by pressure with the fingers of both hands placed upon the sides of the eye the ball may be put into its place. Apply a firm compress over the injured eye and keep it constantly wet with cold water containing 1 dram of sugar of lead to each quart.

If the attempt at reduction proves unsuccessful the artery at the back of the eye should be ligated, and then the whole mass cut off as deep within the orbit as possible. The orbital cavity, after washing it out with a 3 per cent solution of carbolic acid or compound cresol, should be packed daily with fresh absorbent cotton.

INFLAMMATION AND ENLARGEMENT OF THE HAW.

The haw, or membrana nictitans, is subject to inflammation and swelling from the extension of conjunctivitis, or direct injury by foreign substances. It presents a red, swollen appearance, accompanied with considerable pain and a profuse flow of tears. A slight scarification with a sharp knife and the application of a cooling lotion, such as is recommended for conjunctivitis, will soon reduce the swelling and restore it to its normal function.

There is, however, a tendency for an inflammation of this membrane to take on a chronic character, which may eventually result in a permanent enlargement, resembling a tumor. When it attains sufficient size to protrude itself permanently over the eye, or project between the lids so as to obstruct the sight, its removal may become necessary. A threaded needle is passed through the body of the enlarged mass, by which the membrane is drawn out as far as possible, then with a blunt pair of scissors it may be dissected away from its attachments. The eye is afterwards treated with simple cooling lotions.

DISEASES OF THE EAR.

By M. R. Trumbower, D. V. S.

[Revised by Leonard Pearson, B. S., V. M. D.]

Diseases of the ears of cattle are not very common, for the reasons probably that they are not subjected to the brutality of drivers so much as horses and that the horns to a great extent protect them against external violence.

OTITIS (INFLAMMATION OF THE INTERNAL EAR).

Inflammation of the deep part of the ear is often difficult to recognize in cattle. It may be caused by disease of bone in that region, from blows inflicted by drivers, or from injury by other cattle. Occasionally the ear becomes involved in actinomycosis (lumpy jaw), or the inflammation may be the result of a tuberculous affection.

Symptoms.—The animal will hold its head to one side, or shake it, while the ear itself is held immovable. The movement of the jaws in eating usually gives rise to a manifestation of pain; the base of the ear may be feverish and swollen, and very sensitive to the touch. If the inflammation has advanced to a suppurative stage, offensive matter will flow from the ear.

Treatment.—At first, hot fomentations to reduce pain and fever, followed by a sharp blister below the ear. Laudanum, 1 part to 10 of sweet oil, may be injected into the ear to relieve pain and to soften the secretions. If there is a discharge from the ear, it should be thoroughly washed out by injecting warm soapsuds until all the matter has been washed away; then inject the following mixture twice a day: Sulphate of morphia, 20 grains; water, 1 pint; glycerin, 4 ounces.

ABSCESS.

Abscesses, caused by contusions, sometimes form about the base of the ear, either inside or outside. A serous cyst is found occasionally between the cartilage and the skin on the base of the ear, which may be from a similar cause.

Treatment.—With the knife make a free incision into the most prominent part of the abscess or cyst, then, with a syringe, wash out the sac with carbolized water. If the abscess recurs, open it again, wash it out, and inject tincture of iodin, or fill it with iodoform.

FUNGOID GROWTHS.

As a result of laceration or wound of any kind, fungous growths, characterized by a raw, bleeding, granulating surface, with a tendency to become pendulous, may develop on the ear.

Treatment.—The whole tumor or diseased structure should be cut away, and the wound treated daily with a dressing of carbolized cosmoline or turpentine and sweet oil, 1 part of the former to 4 of the latter.

FOREIGN BODIES IN THE EAR.

Bugs have been known to gain entrance into the ears of animals. I once removed an acorn from the ear of a cow that had been roaming in the woods; also pieces of wood from a stanchion may be lodged accidentally in the ear.

Symptoms.—There is usually a continuous uneasiness or frequent shaking of the head, occasionally the manifestation of exceedingly great pain. The animal may rub the head and ear against trees or other objects in an endeavor to dislodge the offending body.

Treatment.—A careful examination reveals the cause, which may be removed with a pair of forceps or scraped out with a hairpin or piece of wire bent at one end. If much inflammation exists, the ear may be swollen so that the foreign substance is hidden from sight; then a probe may be inserted to feel for the object, which, when found, should be removed, even if it becomes necessary to split the ear at the base. Afterwards treat the ear with frequent warm water fomentations and the injection of soapy water or oil and water.

SCURFY EARS.

Cattle are subject to scurfy ears, which may be owing to a generally morbid condition of the skin, or may be confined to the ears alone. The affected animal shows an inclination to rub the ear; thick scales, which sometimes have the appearance of hard, dry, horny scales, of scurf collect on it. This condition is chiefly caused by a faulty secretion of the sebaceous glands of the ear. Thoroughly clean the ear with a stiff brush, then anoint it, so far as affected, with vaseline 4 parts to 1 part of white precipitate ointment. If the scurfy ears are only a part of a general scurfiness of the skin, the condition of the animal needs attention. (See "Pityriasis," p. 329.)

FROSTBITE.

It is not uncommon among young cattle which are poorly nourished and exposed outdoors to storms and extreme cold to suffer frostbite of the ear, which may constitute actual freezing of the part.

Symptoms.—Frostbite presents naturally every degree of severity from the mere chilling of the tip of the ear to positive freezing and death of a portion. In a day or two after the freezing has occurred the ear becomes swollen and very painful; the dead part remains cold and begins to shrivel; a line of separation then forms between the inflamed and the dead or dying portion, and finally the piece destroyed drops off, leaving a raw healing surface. When the ear is only slightly affected by the cold, an excoriation or peeling off of superficial skin takes place, accompanied with some pain and itching.

Treatment.—A good liniment for frozen ears is a mixture of turpentine, ammonia, and chloroform, of each 1 part, added to 6 parts of sweet oil. Rub this on the ear several times a day. It will relieve pain and stimulate the circulation, thus favoring a recovery of the injured structures.

LACERATIONS OF THE EAR.

Aggressive dogs are the most frequent cause of lacerated ear, generally leaving a torn, ragged edge and bruised cartilage.

If the wound is extensive, a trimming of the ragged edges becomes necessary; then the edges should be fastened together with silver wire, catgut, or strong, thick, linen thread, taking a deep hold, and pine tar applied.

DISEASE OF THE CARTILAGE AND NECROSIS.

Occasionally the cartilages of the ear become affected, usually the result of a deep bruise; pus forms, burrows under the skin, and may find a discharge from any part of the ear more or less distant from the seat of the disease. When the cartilage has been extensively injured, pieces of it may become dead (necrosed) and dissolve, to be carried away with the pus, or it may lead to extensive sloughing and the formation of numerous running sores. In the disease of the cartilage there is seldom much swelling or great pain. The discharge is usually very offensive, and occasionally streaked with blood. Whenever there is a long-continued, persistent discharge from one or more openings in the ear, disease of the cartilage may be suspected.

Treatment.—The sinus formed by the passage of matter should be probed and searched to the bottom for the presence of a foreign substance or the evidence of decaying cartilage. When the probe touches necrosed cartilage it will feel like a piece of dry leather or partially softened wood. A counter opening must then be made at this place, and all diseased cartilage cut away with the knife. The subsequent treatment consists in keeping the artificial wound open for the discharge of pus, and the injection of chlorid of zinc, 5 grains to the ounce of water, once or twice a day, until the wound is healed.

ENCHONDROMA OF THE EAR.

This is an excessive growth of cartilage, found at the base of the ear in the form of a hard, painless tumor, firmly attached to the movable ear. The only recourse for its removal is the knife in the hands of one acquainted with the anatomy of the part involved in the operation.

INFECTIOUS DISEASES OF CATTLE.

Revised by JOHN R. MOHLER, A. M., V. M. D.,
Chief, Bureau of Animal Industry.

GENERAL INTRODUCTION.

The importance, to the farmer and stock raiser, of a general knowledge of the nature of infectious diseases need not be insisted on, as it must be evident to all who have charge of farm animals. The growing facilities for intercourse between one section of a country and another, and between different countries, cause a wide distribution of the infectious diseases once restricted to a definite locality. Not only the animals themselves, but the cars, vessels, or other conveyances in which they are carried may become agents for the dissemination of disease. The growing tendency of specialization in agriculture, which leads to the maintenance of large herds of cattle, sheep, and hogs, makes infectious diseases more common and more dangerous. Fresh animals are being continually introduced which may be the carriers of disease from other herds, and when disease is once brought into a large herd the losses become very high, because it is difficult, if not impossible, to check it after it has once obtained a foothold.

These considerations make it plain that only by the most careful supervision by intelligent men who understand the nature of infectious diseases and their causes in a general way can these be kept away. We must likewise consider how incomplete our knowledge concerning many diseases is, and probably will be for some time to come. The suggestions and recommendations offered by investigators, therefore, may not always be correct, and may require frequent modification as our information grows more comprehensive and exact.

An infectious disease may be defined as any malady caused by the introduction, into the body, of minute organisms of a vegetable or animal nature which have the power of indefinite multiplication and of setting free certain peculiar poisons which are chiefly responsible for the morbid changes.

This definition might include diseases caused by certain animal parasites, such as trichinæ, for example, which multiply in the digestive tract, but whose progeny is limited to a single generation. By common consent the term "infectious" is restricted to those diseases caused by the invasion and multiplication of certain very minute unicellular organisms included under the general classes of bacteria and protozoa. Nearly all the diseases of cattle for which a definite cause has been traced are from bacteria. Among these are tuberculosis, anthrax, blackleg, and tetanus (or lockjaw). Some diseases, such as Texas fever and nagana, are traceable to protozoa, while others, like actinomycosis and aspergillosis, are caused by fungi. Those diseases of which the cause is unknown or imperfectly worked out are pleuropneumonia, rinderpest, foot-and-mouth disease, rabies, cowpox, malignant catarrh, and dysentery.

Bacteria may be defined as very minute, unicellular organisms of a plantlike character. Their form is very simple, as may be seen from an inspection of the various species depicted on Plate XXVIII. The description of these figures will be found on page 360. The magnification there given will furnish the reader some idea of their very minute size. They multiply in two ways. The bacterium elongates and then divides in the middle to form 2 daughter cells. These go through the same process at once, and thus 4 cells are produced. The division of these leads to 8, the division of 8 to 16, and so on indefinitely. The rapidity with which this multiplication takes place depends upon the nature of the bacterium. The bacillus of tuberculosis multiplies very slowly, while that of anthrax does so with great rapidity, provided both are in the most favorable condition. Another mode of reproduction, limited to certain classes of bacteria, consists in the formation of a spore within the body of the bacterium. Spore formation usually takes place when the conditions pertaining to the growth of the bacteria become unfavorable. The spores are much more resistant to destructive agents than the bacteria which produced them. The anthrax spore may live several years in a dried state, but the anthrax bacillus perishes in a few days under like conditions. This matter will be referred to again when we come to discuss the subject of disinfection.

Of the protozoa which cause disease very little is at present known. One which produces Texas fever is pictured on Plate XLV, in figs. 4 and 5. These parasites have a more complex life history than bacteria; and as they can not be grown in artificial media, their thorough investigation is at present hampered with great difficulties.

The differences in the symptoms and lesions of the various infectious diseases are due to differences in the respective organisms causing them. Similarly the great differences observed in the sources from which animals become infected and the manner in which infection takes place are due to differences in the life history of these minute organisms. Much discussion has taken place of late years concerning the precise meaning of the words "infection" and "con-

VARIOUS BACTERIA WHICH PRODUCE DISEASE IN CATTLE.

DESCRIPTION OF PLATE XXVIII.

The bacteria on this plate are partly from tissues, partly from cultures, and stained artificially with aniline colors (fuchsin or methylene blue). Figs 6 and 7 are copied from Fränkel and Pfeiffer's atlas. All but fig. 7 are magnified 1,000 times; fig. 7, 500 times.

Fig. 1. Bacteria from pneumonia in cattle. These are also the cause of hemorrhagic septicemia and are closely related to swine-plague bacteria. These bacteria were drawn from a piece of spleen pulp (rabbit).

Fig. 2. Micrococci (streptococcus) which produce inflammation of the lining membranes of the abdomen, thorax, heart, brain, and joints. Frequently associated with the preceding bacteria in abscesses.

Fig. 3. Micrococci (staphylococcus) which produce inflammation and suppuration; also pyemia.

Fig. 4. Bacilli of blackleg. The pale oval bodies as well as the light spots in one end of the bacilli represent spores.

Fig. 5. Bacilli which produce tetanus or lockjaw. The light spot in the enlarged end of each rod represents a spore.

Fig. 6. Bacilli of tuberculosis. Microscopic sections of a pearly nodule from the lining membrane of the chest cavity. The bacilli are stained red and appear as small straight rods within the cells of the nodule or tubercle.

Fig. 7. Bacilli of anthrax. Bacilli from the spleen of a mouse inoculated with a culture. The bacilli were obtained from the blood of a cow which died of anthrax in Mississippi. The bacilli appear as rods stained blue. The round bodies are blood corpuscles, also stained artificially.

Fig. 1

Fig. 3

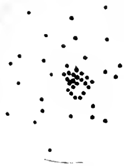

Fig. 2

Fig. 4

Fig. 5

Fig. 6

Fig. 7

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VARIOUS BACTERIA WHICH PRODUCE DISEASE IN CATTLE.

tagion." These words, however, are now wholly inadequate to express the complex processes of infection, and it may be said that each species of bacterium or protozoon has its own peculiar way of invading the animal body, differing more or less from all the rest. There are, however, a few broad distinctions which may be expressed with the help of these old terms. Infection, as laid down above, refers at present in a comprehensive way to all microorganisms capable of setting up disease in the body. Some microorganisms are transmitted directly from one animal to another, and the diseases produced may be called contagious. Among these are included pleuropneumonia, rinderpest, foot-and-mouth disease, rabies, cowpox, and tuberculosis. Again, certain organisms are perhaps never transmitted from one animal to another, but may come from the soil. Among these are tetanus, blackleg, anthrax to a large extent, and perhaps actinomycosis in part. These diseases, according to some authorities, may be called miasmatic. There is a third class of infectious diseases, the specific bacteria of which are transmitted from one animal to another, as with the contagious diseases, but the bacteria may, under certain favorable conditions, find food enough in the soil and in the surroundings of animals to multiply to some extent after they have left the sick animal and before they gain entrance into a healthy one.

This general classification is subject to change if we take other characteristics into consideration. Thus tuberculosis, because of its insidious beginning and slow course, would not by many be considered contagious in the sense that foot-and-mouth disease is; yet, in either case, the bacillus must come from preexisting disease. The disease of rabies, or hydrophobia, is not contagious in the sense that rinderpest is, because the virus of rabies must be inoculated into a wound before it can take effect; yet, in both cases, the virus passes without modification from one animal to another, though in different ways.

Again, all the diseases under the second group, which seem to come from the soil and from pastures, are in one sense contagious in that the virus may be taken from a sick animal and inoculated directly, with positive results, into a healthy animal. Other illustrations may be cited which show that these old terms are not in themselves satisfactory. There are so many conditions which enter into the process of infection that no single classification will give a sufficiently correct or comprehensive idea of it. These statements will be easily understood if the different infectious diseases in the following pages are studied with reference to the way or ways in which each disease may be contracted. Enough has been said, therefore, to show that if we wish to make ourselves acquainted with the dangers of any given disease, we must study it and not rely upon any single work to tell the whole story.

Infectious diseases have, as a general rule, a period of incubation, which comprises the time elapsing between the exposure to the infection and the actual appearance of the disease. This period varies with the malady. The most common symptom of this class of diseases is fever. The severity of the fever is measured by the temperature of the animal; this is readily and accurately ascertainable by the clinical thermometer. (See Pl. III, fig. 1.) The other symptoms are variable and depend upon the particular organ or organs most implicated. Loss of appetite, cessation of rumination and milk secretion, and general dullness are symptoms quite invariably present in most infectious diseases.

During the course of infectious diseases secondary diseases or complications may arise which are largely caused by bacteria other than those producing the original malady. These complications are often so severe as to become fatal. In general it may be stated that they are due to filthy surroundings, and hence cleanliness may become an important aid to recovery.

The treatment of infectious diseases is given under each malady so far as this is allowable or advisable. These diseases are not, as a rule, amenable to treatment. When the symptoms have once appeared the disease is liable to run its course in spite of treatment, and if it is one from which animals usually recover, all that can be done is to put them into the most favorable surroundings. Many infectious diseases lead sooner or later to death, treatment is useless so far as the sick are concerned, and it may be worse than useless for those not yet infected. All animals suffering with infectious diseases are more or less directly a menace to all others. They represent for the time being manufactories of disease germs, and they are giving them off more or less abundantly during the period of disease. They may infect others directly or they may scatter the virus about, and the surroundings may become a future source of infection for healthy animals. This leads us to the subject of prevention as the most important of all which claim our attention. In this place only a few general remarks will suffice to bring the subject before the reader.

The most important thing is to keep disease away from a herd or farm. To do this all sick or suspicious animals should be avoided. A grave form of disease may be introduced by apparently mild or trivial cases brought in from without. It is generally conceded that continual change and movement of animals are the most potent means by which infectious diseases are disseminated.

With some cattle diseases, such as anthrax, rinderpest, and pleuropneumonia, preventive inoculation is resorted to in some countries. This may be desirable when certain diseases have become established in any locality so that eradication is impossible. It should not be practiced in territories where a given disease may still be extirpated by ordinary precautions. Preventive inoculation is applicable to only a few maladies, and therefore its aid in the control of diseases is limited.

When an infectious disease has gained foothold in a herd the course to be pursued will depend upon the nature of the malady. A good rule is to kill diseased animals, especially when the disease is liable to run a chronic course, as in tuberculosis. The next important step is to separate the well from the sick by placing the former on fresh ground. This is rarely possible; hence the destruction or removal of the sick, with thorough disinfection of the infected locality, is the next thing to be done. As to the disinfectants to be used, special directions are given under the various diseases, to which the reader is referred. Here we will simply call attention briefly to the general subject.

DISINFECTION AND DISINFECTANTS.

Disinfection consists in the use of certain substances which possess the power to destroy bacteria or their spores, or both. Those which are cheapest and most available for animal diseases are ordinary freshly slaked lime or unslaked in powder, chlorid of lime, crude carbolic acid, corrosive sublimate, formaldehyde gas, formalin, and compound cresol solution.

(1) Slaked lime is perhaps the most easily procured, but its disinfecting power is limited. While it is capable of destroying all bacteria in their vegetative state, it is unable to destroy such spores as those of anthrax and blackleg. It is probable, however, that in incrusting spores it may destroy their vitality sooner or later. It is regarded as safe practice to use only spore-destroying substances for the virus of those diseases of which we have no definite knowledge. Nevertheless, in the absence of other disinfectants, lime is very useful. It may be employed as a whitewash on wood and stone and sprinkled as a dilute wash or in powder over yards, manure heaps, and over carcasses before they are buried, and over the ground on which they have lain to prevent other animals from carrying the infection away.

(2) Chlorid of lime is more efficient than simple slaked or unslaked lime, as it destroys spores. It is the ordinary bleaching powder of commerce and is quite unstable, hence old preparations, unless sealed, are of little value. A 5 per cent solution is sufficiently strong for all spore-bearing bacteria (3 ounces in 2 quarts of water). It may be efficiently applied to the walls and floor of an infected stable by mixing with limewash in the proportion of 6 ounces of the lime to each gallon of limewash. The ceilings and those portions of the walls which can not be reached should be disinfected by means of

chlorin gas liberated from the chlorid of lime by crude carbolic acid. This is accomplished by making a cone of 5 or 6 pounds of chlorid of lime, in the top of which a deep crater is made for the placement of from 1 to 2 pints of crude acid. The edge of the crater is thereupon pushed into the fluid, when a lively reaction follows. The fumes of chlorin are strongly irritating to the respiratory tract and therefore all live stock should be removed before the work is started. Owing to the heat generated, it is advisable to place the lime in an iron crucible and to have nothing inflammable within a radius of 2 feet. The number and location of these cones of chlorid of lime depend on the size and structure of the building to be disinfected. As a rule, it may be stated that chlorin gas liberated from the above-sized cone will be sufficient for disinfecting 5,200 cubic feet of air space.

(3) Crude carbolic acid. The ordinary purified carbolic acid is too expensive to be used on a large scale, and the crude produce is a very good substitute. This is made more powerful by mixing with it an equal volume of commercial sulphuric acid. While the sulphuric acid is being added to the crude carbolic acid much heat is evolved, and if the glass jar in which the two are mixed is placed in cold water the resulting product is said to have a higher disinfecting power. The mixture is added to water enough to make a 5 per cent solution (about 7 ounces to 4 quarts of water). This is strong enough for all purposes. It may be kept in wood or glass, but not in metal, owing to the corroding action of the acid. It should be used freely on woodwork and on infected floors, and a force pump of the kind used by orchardists is very convenient as a means of applying the disinfectant. If the solution is warm when applied, it will penetrate the woodwork better than when cold, especially if the spraying is done during cold weather. The addition of air-slaked lime in any quantity that will dissolve in water to the above solution (say 1½ pounds of lime to 7 ounces of crude carbolic acid to each gallon of water) is preferred by many, as it makes any neglected places at once visible and leaves cleaner and better air within the buildings. In most cases in which its application becomes desirable—and this rule should apply to all disinfections—the disinfected stables, stalls, etc., should remain vacant as long as possible before cattle are again stabled therein.

(4) Mercuric chlorid, or corrosive sublimate, is a powerful disinfectant, but it is likewise very poisonous; hence its uses are limited. Cattle are especially susceptible to its action and caution must be used in its application. A solution of one-tenth of 1 per cent is usually sufficient (1 ounce to 8 gallons of water). It should not be placed in wooden pails, which would form the tannate of mercury, a weak antiseptic; nor, owing to its corrosive action, should expen-

sive metal pails be used. Agate vessels or tin pails are to be preferred. All solutions should be labeled "poison," and to avoid accidents none should be kept on hand.

(5) Formalin and formaldehyde gas have been found very efficacious as sanitary agents. Formalin is the commercial name for the 40 per cent solution of formaldehyde gas in water, and is one of the most powerful antiseptic and disinfectants that we possess. Solutions of this strength are manufactured by different commercial houses and sold by the drug trade under the name of "formalose" and "formal." In this connection it should be mentioned that while the 40 per cent solution of formaldehyde gas and formalin are exactly the same thing, the former can be purchased at 33⅓ to 64 per cent less than the latter. Formalin, diluted with water in the proportion of 1 pint to 30 parts of water, or 4 ounces to each gallon of water, may be applied, and it may thus be used as a wash or as a spray on all paints, metals, and woodwork, as well as on clothing and other fabrics, without injuring them. It may also be applied to floors, walls, and woodwork in whitewash by mixing 1 part to 30 parts of limewash, or 4 ounces to each gallon of limewash. Formalin has the appearance of water and in the strong solution is poisonous, but when diluted as recommended above it is not dangerous. The fumes given off by it, however, are very disagreeable and irritating to the eyes and nasal mucous membranes. One and one-half ounces of formalin added to 1 gallon of water is a valuable agent for the disinfection of the skin or septic wounds, but is somewhat painful and irritating to raw surfaces.

Formaldehyde is a gas which is soluble in 2½ parts of water (40 parts of formaldehyde gas to 100 parts of water); this solution constitutes the formalin of commerce. The use of formaldehyde gas is in most cases impracticable for stable disinfection. In case the stable is not too large and can be made almost air-tight the generation of formaldehyde gas, after removing all the animals, will be found very serviceable. It penetrates all parts of the stable—the walls, crevices, floors, ceiling—and is probably the best fumigating disinfectant that we have.

Probably one of the most simple and practical methods of liberating this gas is by means of the chemical reaction which takes place when formalin is poured upon permanganate of potassium. For each 1,000 cubic feet of air space, 16⅔ ounces of crystallized or powdered permanganate of potassium is placed in a wide-surfaced pan; 20 ounces of formalin is then poured upon it, and the stable immediately closed for a period of 12 hours or longer. This method is efficient only when it is possible to seal tightly the place to be disinfected, and should be used only by experienced persons.

(6) Some coal-tar products are cheap, effective, and easily applied disinfectants, their action being due to the carbolic acid and creosote in their composition. They may be used in 3 to 5 per cent solution. As a rule they form a milky solution in water.

(7) Compound solution of cresol (liquor cresolis compositus), now recognized as an official preparation, is composed of equal parts of cresol and linseed-oil-potash soap. The mixture is a thick, dark, amber-colored fluid which mixes readily with water in all proportions to form a clear, soap solution. It is an efficient disinfectant in a 3 or 4 per cent solution, and in this strength it may be applied in the same manner as a 5 per cent solution of carbolic acid.

When it is desired to apply one of these above-mentioned agents to the stable or barnyard, a preliminary cleaning up of all débris and litter is advisable, together with the scraping of the floor, mangers, and walls of the stable with hoes; also the removal of all dust and filth. This should be followed by the burning of all such accumulations, inasmuch as this material likewise contains the infectious principle and is best destroyed by heat. Heat may be applied to the surface of the affected pen, byre, or barnyard by means of a cyclone burner, which consists of a tank, pump, hose, and cyclone nozzle for spraying with paraffin (gas oil). The latter is ejected in the form of spray, which when ignited gives a very hot and effective flame to be applied to the infected ground. Where such burning is impracticable the surface soil of the yard and surroundings should be removed to a depth of 5 or 6 inches and then placed in a heap and thoroughly mixed with air-slaked lime. The fresh surface of the soil thus exposed may then be sprinkled with the disinfectant.

In addition to these artificial substances there are several natural sanitary agents of great importance as destroyers of virus. These are cleanliness, ventilation, drying, and sunshine. All virus, excepting such as may live in the soil, is killed sooner or later by drying and sunshine, and the importance of these factors in the daily life of animals need not be insisted on here. Finally, all sanitary measures which contribute to the healthfulness of animal surroundings are directly or indirectly inimical to disease germs, and all carelessness in the keeping of animals may be regarded as an ally of these destructive organisms.

CONTAGIOUS PLEUROPNEUMONIA.

[Pls. XXIX–XXXII.]

Definition and history.—This disease has been eradicated from the United States, and it is not probable that it will ever be seen in this country again. As, however, much interest was manifested in regard to it for a number of years, and as our cattle are still prohibited from some foreign markets on account of its previous existence here, the subject is treated at greater length than would otherwise be necessary.

The contagious pleuropneumonia of cattle is a specific, epizootic disease which affects bovine animals, and from which other species are exempt. It is characterized, when the disease results from exposure in the usual manner, by an inflammation of the lungs and pleuræ, which is generally extensive, and which has a tendency to invade portions of these organs not primarily affected and to cause death of the diseased portion of the lung. This disease is frequently called the lung plague, which corresponds to its German name of Lungenseuche. In French it is spoken of as the péripneumonie contagieuse.

The history of the contagious pleuropneumonia of cattle can not be traced with any certainty to a period earlier than the beginning of the eighteenth century. No doubt it existed and ravaged the herds of Europe for many years and perhaps centuries before that time, but veterinary knowledge was so limited that the descriptions of the symptoms and post-mortem appearance are too vague and too limited to admit of the identification of the maladies to which they refer. It has been supposed by some writers that certain passages in the writings of Aristotle, Livy, and Virgil show the existence of pleuropneumonia at the time that their works were composed, but their references are too indefinite to be seriously accepted as indicating this rather than some other disease.

It seems quite plain that as early as 1713 and 1714 pleuropneumonia existed in Swabia and several Cantons of Switzerland. There are even clearer accounts of its prevalence in Switzerland in 1732, 1743, and 1765. In 1769 a disease called murie was investigated in Franche-Comté by Bourgelat which undoubtedly was identical with the pleuropneumonia of to-day. From that period we have frequent and well-authenticated accounts of its existence in various parts of Europe. During the period from 1790 to 1812 it was spread throughout a large portion of the Continent of Europe by the cattle driven for the subsistence of the armies, which marched and countermarched in all directions. It was generally prevalent in Italy in 1800. It appears to have been unknown, however, in the Department of the Nord, France, until 1826, but during the years from 1820 to 1840 it penetrated into most parts of that country. During the same period it was introduced into and allowed to spread over Belgium and Holland.

This contagion is said to have been carried to Ireland from Holland in 1839, and is reported as existing in England in 1842. The disease was brought to the United States at several different times. Probably its first introduction was with a diseased cow sold in Brooklyn, N. Y., in 1843. It came to New Jersey by importing affected animals in 1847. Massachusetts was infected in the same way in 1859.

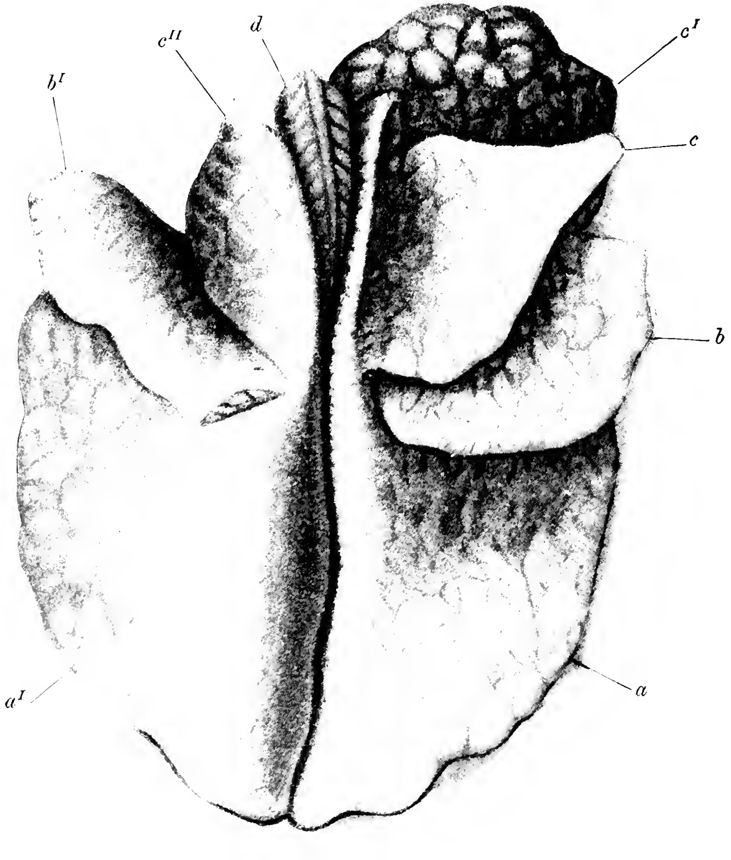
South Africa was infected by a bull brought from Holland in 1854, and Australia likewise received the contagion with an English cow in 1858. It is also reported as existing in various parts of the Continent of Asia, but the time of its first appearance and the extent of its distribution are very uncertain.

Some countries, such as Norway, Sweden, and Denmark, which had been infected for only a short time, have succeeded in eradicating the disease without much difficulty by slaughtering all affected and exposed animals. Other countries long infected and in which the contagion was thoroughly established, like Australia, South Africa, Italy, France, Belgium, and parts of Germany, have labored long, in some cases making no progress and in others being only partially successful. Holland was one of the first of the thoroughly infected countries to free itself from the contagion.

In the United States, Massachusetts eradicated pleuropneumonia during the period from 1860 to 1866. New York and New Jersey made an attempt to eradicate it in 1879, but were not successful. Late in 1883 the contagion was carried to Ohio, probably by Jersey cattle purchased in the vicinity of Baltimore, Md., to which place it had extended before 1868. From the herd then infected it was spread by the sale of cattle during 1884 to a limited number of herds in Illinois, to one herd in Missouri, and to two in Kentucky. The alarm caused among the stock owners of the United States by this widespread dissemination of a disease so much dreaded led to the adoption of active measures for its control and eradication. By coöperation between the United States Department of Agriculture and the authorities of the affected States it was found possible to prevent the further spread of the contagion and to eradicate it after a few months' delay.

In 1886 pleuropneumonia was discovered in some of the large distillery stables of Chicago and among cows on neighboring lots. This led to renewed efforts for the complete extirpation of this disease from the country. Congress in 1887 enlarged the appropriation available for this purpose and gave more extended authority. During the same year the disease was stamped out of Chicago, and has not since appeared in any district west of the Allegheny Mountains.

The work of eradication was at the same time commenced in all the infected States. Before the end of the year 1889 Pennsylvania, Delaware, Maryland, the District of Columbia, and Virginia had been freed from the disease. More difficulties, however, were encountered in the States of New York and New Jersey, on account of the larger territory infected and the density of the population. The long struggle was successful, however, and the last animal in which the disease



Haines del.

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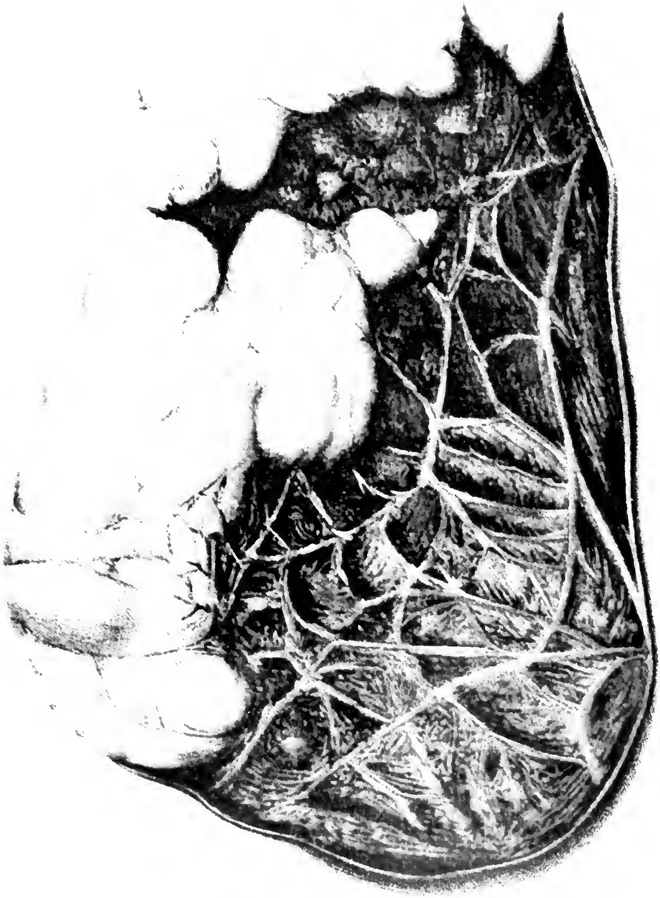
UPPER OR DORSAL SURFACE OF THE LUNGS OF THE OX.

(ONE-TWELFTH NATURAL SIZE.)



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BRONCHOPNEUMONIA.

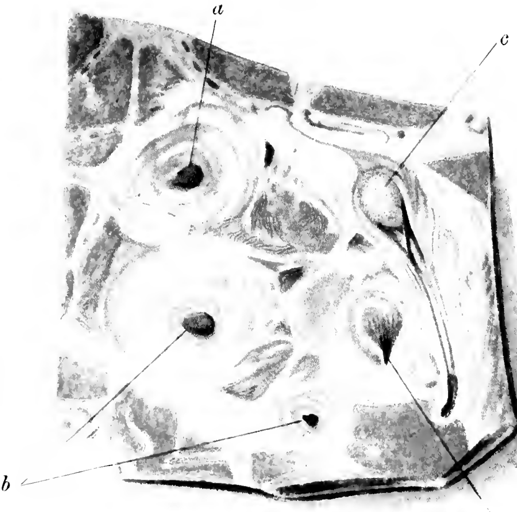

Fig. 1

Haines del.

Fig. 2

CONTAGIOUS PLEUROPNEUMONIA.

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CONTAGIOUS PLEUROPNEUMONIA.

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appeared in the State of New York was slaughtered early in 1891, and the last one affected in New Jersey met the same fate early in the spring of 1892.

During these same years a supreme effort had been made to stamp out this lung plague from Great Britain. From the official reports it appears that the number of infected districts and of diseased animals had rapidly diminished, but it was not until 1898 that the infection was finally eradicated.

The other infected European countries, though they maintain a veterinary sanitary service, are not making satisfactory progress in eradicating the disease. This is owing partly to delays in carrying out the provisions of the laws and partly to mistaken ideas as to the measures which are necessary to accomplish the object. The United States was the last of the countries having old infected districts which undertook to stamp out this contagion, and, except Holland, it was the first to reach success.

The cause (etiology) of pleuropneumonia.—This is a contagious disease, and arises only by contagion from a previously affected animal; consequently it can never be seen here except as the result of importing affected animals from the Old World. When thoroughly stamped out it does not reappear; and if imported animals continue to be properly inspected and quarantined, we have every reason to believe that pleuropneumonia will never again be seen in this country.

The exact nature of the virus or contagion of lung plague has never been determined. Various investigators have from time to time claimed the discovery of the specific organism of the disease, but it was not until 1898 that Nocard and Roux, by an ingenious method of cultivation, succeeded in obtaining a very feeble growth of an exceedingly minute microorganism. With these cultures the disease was produced in cattle.

Some investigators and writers are of the opinion that the disease can be contracted only by an animal coming near enough to a living diseased one to receive the contagion directly from it. They hold that the contagion is expired with the air from the affected lungs, and that it must be almost immediately inspired by another animal in order to produce the disease. Some experimental attempts to infect animals by placing them in stables where diseased animals have been, and by placing the diseased lungs of slaughtered animals in their feeding troughs have failed, and, consequently, apparently confirm this view.

On the other hand, it is known that the serum from affected lungs retains its virulence and may be used successfully for inoculation weeks or months after the death of the animal from which it was taken. This is particularly the case when this liquid is hermetically

CONTAGIOUS PLEUROPNEUMONIA.

DESCRIPTION OF PLATES.

PLATE XXIX. Upper or dorsal surface of the lungs of the ox, reduced to one-twelfth of the natural size: *a*, *a'*, the right and left principal lobes. These are the largest and are situated posteriorly, resting upon the diaphragm; *b*, *b'*, the ventral lobes, situated between the principal lobes; and c, *c'*, *c''* the most anterior, or cephalic, lobes. The right anterior is divided into two lobes (*c*, *c'*), the left is single (*c''*); *d*, trachea, or windpipe.

In the majority of the lungs examined in the laboratory of the bureau which were affected with contagious pleuropneumonia the principal lobes (*a*, *a'*) were primarily affected.

PLATE XXX. Bronchopneumonia. The ventral or middle lobe of the right lung affected with collapse and beginning bronchopneumonia. The light yellowish portions represent healthy lung tissue; the red represents the disease. It will be noticed that the lines between the lobules are quite faint, indicating little or no inflammation of the connective tissue between the lobules. The healthy lung tissue is seen to be raised above the level of the diseased portion. In contagious pleuropneumonia the exact reverse is the case, the diseased portions being very much larger than the healthy.

PLATE XXXI. Contagious pleuropneumonia. Appearance of a cow's lung affected with contagious pleuropneumonia when sections or slices are made of it and cut surfaces examined.

Fig. 1. Transverse section through the right principal lobe in a case of acute pleuropneumonia. The area drawn includes the air tubes, veins, and arteries, and illustrates the great thickening of the interlobular connective tissue into broad whitish bands and of the walls of the air tubes, veins, and arteries: *a*, air tube cut obliquely; *a'*, air tube cut directly across; *b*, arteries cut across; *c*, large vein completely occluded by a thrombus or plug formed during life. The great thickening of the walls of the artery and vein in this disease is especially brought out by stating that in the healthy lung they are so thin as to be easily overlooked.

Fig. 2. Transverse section of the principal lobe in a case of acute pleuropneumonia, illustrating the different kinds of hepatization or consolidation of the lung. These are indicated by the different colors from dark red to reddish yellow. This variation of color is regarded by some as the real marbling characteristic of pleuropneumonia, while the whitish bands penetrating the lung tissue in all directions constitute the true marbling according to other observers.

PLATE XXXII. Contagious pleuropneumonia. This illustrates what are called infarctions. The right half of the figure shows nearly normal lung tissue. The left represents a blackish mass, in which the lung tissue is filled with blood and solidified. This is caused by the plugging of the vein carrying away the blood from this portion. The heart forces the blood through the artery into the tissue at considerable pressure, but owing to the fact that its return is prevented, the minute blood vessels rupture and the air vesicles become distended with blood, which coagulates and causes the firmness of the tissue.

sealed in glass tubes. Other investigators state that they have successfully infected cattle by placing, in the nostrils, sponges or pledgets of cotton saturated with such serum. Cattle have also, according to the best evidence obtainable, been infected from the clothing of attendants, from horns used in drenching, and from smelling about wagons which have been used to transport affected carcasses. In the work of eradicating pleuropneumonia from the United States many stables were found in which the disease would appear and reappear after the slaughter of affected herds, and in spite of any precautions which were adopted. These were always old stables, with woodwork in a decaying condition and with floors underlaid with filth which could not be thoroughly removed or disinfected. In every one of these cases the destruction of the stable, the burning of the lumber of which it was constructed, the removal of the accumulations beneath the floors, and thorough disinfection, prevented the recurrence of the plague in new stables built upon the same premises. This experience conclusively shows that under certain conditions, at least, stables may retain the infection for a considerable time, and that when restocked the disease may break out again from such infection.

As a rule, however, the disease is acquired by a healthy animal being near an affected one and receiving the contagion direct. Affected animals may give off the contagion in the early stages of the disease before the symptoms are apparent to the observer; also, they may retain this infectious character, if they survive the attack, for six months and probably for a year after all symptoms of the disease have disappeared.

Incubation.—The time which elapses between exposure to the contagion of pleuropneumonia and the first appearance of the symptoms of this disease varies greatly with different individuals and with different outbreaks of the disease. Ordinarily the symptoms of disease make their appearance within three to six weeks after exposure; they may be observed, however, within two weeks or they may not become apparent until nearly or quite three months. It is this long period of incubation and the great length of time that an animal may disseminate the contagion after apparent recovery which give the plague that insidious character so often spoken of, and which greatly increase the difficulties of eradication.

Symptoms.—The symptoms are such as would be expected with inflammation of the lungs and pleuræ, but they vary considerably, according to the type which the disease manifests. If the attack is an acute one, as is frequently seen in hot weather, the symptoms appear suddenly; the breathing becomes rapid and difficult, the animal grunts or moans with each expiration, the shoulders stand out from the chest, the head is extended on the neck, the back is arched, the temperature is 104° to 107° F., the milk secretion is suspended, there is no appetite, rumination is stopped, the animal may bloat and later be affected with a severe diarrhea. Such cases are generally fatal in 7 to 20 days.

Very often the attack comes on slowly and the symptoms are much less clear. In the mildest cases there is a cough for a week or two, but no appreciable loss of appetite or elevation of temperature. The lungs are but slightly affected and recovery soon follows. Such animals may disseminate the contagion for a long time without being suspected, and for that reason are the most dangerous of all.

A more severe type of the plague is the most frequently seen. In these cases the cough is frequent, more or less painful, the back somewhat arched, and the milk secretion diminished. The prominence of these symptoms increases, the appetite is affected, the animal loses flesh, the breathing becomes more rapid, the cough more painful, pressure of the fingers between the ribs shows tenderness, the hair loses its gloss and stands erect, the skin becomes adherent, little, if any, milk is secreted, and the temperature rises, varying in different animals from 103° to 107° F. Animals thus affected may continue to grow worse and die in from three to eight weeks, or they may after a time begin to improve and make an apparent recovery. The inflammation of the lung does not, as a rule, subside and the organ return to its normal condition, as is the case in ordinary pneumonia, but with this disease the life of the affected portion of the lung is destroyed, the tissue dies, and a fibrous wall is formed around it to shut it away from the living parts. The tissue, thus encysted, gradually softens, becomes disintegrated, and breaks down into pus. The recovery, therefore, is not complete; it is only apparent and partial.

To those accustomed to examining the lungs of cattle, other and extremely important symptoms may be apparent during the course of the disease. By applying the ear over the walls of the chest an area of a certain extent may be found in which the natural breathing sound is diminished or entirely lost. This represents the diseased portion of the lungs. In other cases a loud blowing sound may be heard, quite different from any sound produced when the lung is in a healthy condition. In some cases crepitation is heard near the border line of the diseased area and friction sounds produced by the roughened pleura; these can be appreciated, however, only by those whose ears have been trained to distinguish between the different sounds which reach the ear when applied to the chest wall. By percussion—that is, by pressing the fingers of the left hand firmly against the wall of the chest and tapping upon the middle finger with the ends of the fingers of the right hand—an area of dullness may be discovered corresponding to the portion from which the respiratory murmur has disappeared. This loss of respiration detected by auscultation, and the dullness brought out by percussion, are the most important evidences of an inflamed or consolidated lung.

Seriously affected animals remain standing if they have sufficient strength, but those which lie down always lie on the affected side.

The proportion of animals which become affected after being exposed varies according to the virulence of the outbreak, the susceptibility of the animals, and the length of time during which exposure is continued. Sometimes not more than 15, 20, or 30 per cent will contract the disease when a large herd is exposed; on the other hand, however, 80 or 90 per cent may be affected. The proportion of cases in which the disease proves fatal also varies greatly—it may not exceed 10 and it may reach 50 per cent. In general, it may be said that about 40 per cent of the exposed animals will contract the disease and about one-half of these cases will prove fatal.

Post-mortem appearances.—Owing to the complexity of the structure of the lung tissue, its ramifications of bronchial tubes and blood vessels, and its abundant supply of lymphatics, the pathological changes in pleuropneumonia are interpreted with great difficulty. Furthermore, there are certain kinds of pneumonia which present some resemblances to pleuropneumonia and which may therefore be confused with it in some of its phases.

If we kill an animal affected with acute pleuropneumonia and examine the cavity of the chest and lungs, the following appearances will be noted:

The thorax may contain more or less serum, which may be clear or clouded. There may be firm adhesions of different parts of the lungs to the chest wall, the extent of which depends on the stage and severity of the disease. The diseased lobes are unusually large and exceedingly firm to the touch. The weight of a single large lobe may reach 40 pounds. Usually only one side is affected, often but a single lobe, and this most commonly the large or principal lobe. The pleura may be covered with one or more layers of a firm, elastic, grayish membrane, which varies in thickness and which sometimes may be pulled away entirely. Sometimes it is absent. The pleura, however, is opaque and apparently very much thickened. This is owing to the diseased condition of the connective tissue beneath the pleura, as will be explained later. When an affected lobe is cut through at right angles to its long diameter, the cut surface presents a variety of interesting changes. In the first place the spaces between the small subdivisions of the lung (the lobules), which in the healthy lung are barely visible, are distended with a yellowish-white, usually quite firm, substance, which is coagulated fibrin. The cut surface thus appears divided into small fields by yellowish-white bands of varying thickness running in various directions through the lung tissue and beneath the pleura. (Pl. XXXI.) These bands may appear honeycombed and the spaces filled with yellowish fluid (serum) or they may be uniformly solid. It will also be noticed that the space immediately outside of and around the artery, vein, and air tube is similarly broadened by fibrinous deposits. Some authorities look upon these bands as constituting the so-called "marbling" of pleuropneumonia.

In addition to these changes which have taken place in the connective tissue between the lobules, the lung tissue itself may be markedly altered. Certain areas of the cut surface may be very firm in texture and of a brownish-red color. The cut surface is granular or roughened, not smooth to the eye. Other areas equally firm may be more grayish yellow and still others may be blackish. (Pl. XXXII.) Besides these areas which represent solidified (hepatized) lung tissue there may be others which approach the normal lung tissue in color, are soft, and float in water. From these a milky, purulent fluid may often be expressed. These different shades are represented in Plate XXXI, fig. 2, within a small compass. Some authorities are inclined to consider these variations in color on the same cut surface as the co-called marbling of pleuropneumonia. It matters not whether we regard the bands between the lobules or the varying shades of the lobules themselves as the marbling, provided either or both are peculiar to contagious pleuropneumonia. If we examine the blood vessels appearing on such cut surface they will usually be found plugged within the firmly hepatized regions. The artery contains a dark, soft, removable clot, the vein a grayish-pink, granular, fragile plug (thrombus), which adheres firmly to the wall of the vein, and if this is slit open, indications of a diseased condition of the inner coat will be readily detected. When large regions of the lung tissues are hepatized, the main air tube and its branches are usually filled with grayish, cylindrical branched masses of fibrin that are easily removed, as they do not adhere to the mucous membrane.

The views of pathologists differ as to the nature of the earliest changes in pleuropneumonia, and it is not within the scope of this work to present controverted or imperfectly developed theories. In the foregoing description we have taken as a type the acute pleuropneumonia in its fully developed phase, which can scarcely be mistaken for any other disease. We have seen that there is an inflammatory condition of the connective tissue between the lobules, resulting in the exudation of coagulable lymph. This inflammation is equally marked around the blood vessels and air tubes. It leads to inflammatory changes in the inner wall of the veins, and these cause the deposition of thrombi or plugs in the vessels, which prevent the return of the blood. The blood pumped into the lung tissue through the artery, but unable to get out by way of the vein, leaves the meshwork of capillaries around the air vesicles, enters the latter, and produces the firm, hepatized condition so characteristic of this disease. If we bear in mind that the veins in different parts of the lung tissue are plugged at different times, and that, therefore, the affected regions are in different stages of disease, it will be easily understood how the different shades of color from dark red to grayish or yellowish red are produced.

The complete plugging of the veins may lead to the death of circumscribed masses of lung tissue. A line of separation forms between the living and the dead tissue and a thick cyst wall of fibrous tissue forms around the latter. The dead tissue for a time preserves the appearance of lung tissue, then undergoes disintegration and liquefaction. The softened mass is finally absorbed, and the walls of the cyst, or capsule around it, gradually collapse and form a cicatrix. This favorable termination takes place only when the dead mass is not too large. It may, however, involve over half of one of the large lobes. Under such circumstances recovery is improbable. A more favorable termination is the abundant growth of fibrous tissue around and into the hepatized masses. The formation of fibrous tissue may extend to the pleura, or lung covering, and cause firm adhesion of the lungs to the chest wall and to the pericardium, or heart case.

The same peculiar, inflammatory changes which take place between the lobules of the lung and around the bronchi and vessels may invade the pleural cavity, cause extensive membranous and spongy deposits on the pleura and firm deposits around the heart and large arteries, the gullet, and windpipe.

These are the main features of the lung disease caused by contagious pleuropneumonia. In the typical, acute cases there are a a sufficient number of peculiarities to enable us to make a positive diagnosis. There are, however, many cases in which the disease is restricted to small areas, or to the interlobular tissue, or in which the changes are still imperfectly developed, or else so far advanced that doubts may arise as to the true nature of the affection. In such cases all obtainable facts, including the history of the case, the symptoms during life, and the pathological changes observed on post-mortem examination must be taken into consideration. Only one who has made a careful study of the disease is fitted to decide in such cases.

Other kinds of lung disease, because of certain features common to most lung diseases of cattle, may be confounded with pleuropneumonia. The inflammation of the connective tissue between the lobules is not infrequently observed in so-called interstitial pneumonia and may lead to the formation of whitish bands intersecting the lung tissues in various directions. On the cut surface these bands may give rise to a decidedly marbled appearance. Again, in traumatic pneumonia, caused, as its name implies, by the entrance of foreign bodies into the lung tissue, generally from the paunch, the connective tissue around the place of disease becomes inflamed and thickened, and the disease itself may simulate pleuropneumonia in its retrogressive stages when it is confined to a small portion of lung tissue. The filling up of the interlobular spaces with fibrin and connective tissue of inflammatory origin is not thus limited to pleuropneumonia, but may appear in a marked degree in other lung diseases. It must not be inferred from this statement that these interlobular changes are necessarily the same as those in pleuropneumonia, although to the naked eye they may appear the same. We simply note their presence without discussing their nature.

In general, the distinction between pleuropneumonia and bronchopneumonia is not difficult to make. In the latter disease the pneumonia generally invades certain lobes. The disease attacks the smaller lobes in their lowest portions first and gradually extends upward, i. e., toward the root of the lung or the back of the animal and backward into the large principal lobes. Again, both lungs in advanced cases are often symmetrically affected. In contagious pleuropneumonia the large principal lobe of one side is most frequently affected, and a symmetrical disease of both lungs is very rare, if, in fact, it has ever been observed. The lung tissue in bronchopneumonia is not enlarged, but rather more contracted than the normal tissue around it. This is well illustrated in Plate XXX. Normal, air-containing lobules may be scattered among and around the hepatized portion in an irregular manner. In pleuropneumonia the diseased and healthy portions are either sharply divided off, one from the other, or else they shade into each other by intermediate stages.

The hepatized lung tissue in bronchopneumonia when the cut surface is examined is usually of a more or less dark flesh color with paler grayish-yellow dots regularly interspersed, giving it a peculiar, mottled appearance. In the more advanced stages it becomes more firm, and may contain nodular and firmer masses disseminated through it. The air tubes usually contain more or less soft, creamy, or cheesy pus or a turbid fluid quite different from the loose, fibrinous casts of acute pleuropneumonia. The interlobular tissue may or may not be affected. It sometimes contains loose, fibrinous plugs, or it may be greatly distended with air, especially in the still normal portions of the lung. The pleura is seldom seriously diseased. If we contrast with these features the firm dark-red hepatizations, the plugging of the veins, the extensive interlobular deposits, and the well-marked pleuritis in pleuropneumonia, there is little chance for confusion between well-developed cases of these two lung diseases.

It should not be forgotten, however, that the lesions of the disease known as contagious pleuropneumonia may be confined to the serous membranes of the thorax, or they may be confined to the parenchyma of the lungs; they may affect a whole lobe, or only a small portion of it; they may or may not cause the so-called marbled appearance. In the same way bronchopneumonia may vary as to the parts of the lung affected, the extent of the lesions, the degree and kind of pathological changes in the interlobular tissue, the color of the lung on cross section and the amount of hepatization. In individual cases, therefore, it is often necessary to take into account the history of the animal, the course of the disease, and the communicability of the affection before a diagnosis can be made between the two diseases.

Prevention and treatment.—The prevention of pleuropneumonia, as of other contagious diseases, consists in keeping animals so that they will not be exposed to the contagion. As the disease arises only by contagion, there is no possibility of an animal becoming affected with it unless it has been exposed. If, therefore, pleuropneumonia exists in a locality the owner of healthy cattle should make every effort to keep his animals from coming near affected ones or which have been exposed. He should be equally particular not to allow persons who have been on the infected premises to visit his own pastures, stables, or cattle.

If pleuropneumonia breaks out in a herd, every animal in it should be slaughtered, the stables thoroughly cleaned and disinfected, and no other cattle allowed on the premises until a period of 90 days has elapsed.

Medical treatment of affected animals is unavailing and should not be attempted. No matter how valuable the diseased animals may have been before they contracted the disease, they should at once be destroyed and the contagion eradicated. This is the best policy for the individual as well as for the community.

The eradication of this disease by local or National Governments can be successful only when the same principles are adopted and carried out as here recommended for individual stables. It is then a difficult undertaking, simply because the contagion is generally widely disseminated before any measures are adopted, and because a great majority of cattle owners will never report the existence of the disease. Regulations must therefore be enforced which will insure the prompt discovery of every herd in which the disease appears, as well as the destruction of all diseased and exposed animals and the thorough disinfection of the premises.

To discover pleuropneumonia sufficiently early for this purpose, the district supposed to be infected should be clearly defined and inspectors should be constantly employed to inspect every herd in it at least once in two weeks, or, better, once a week. No bovine animal should be allowed to go out of the defined district alive, and all which enter it should be carefully inspected to insure their freedom from disease. As an assistance to the discovery of diseased herds, every animal which, from any cause, dies in the infected district and every animal which is slaughtered, even if apparently in good health, should be the subject of a careful post-mortem examination. Many affected herds will be found in this way.

In addition to these measures it is also necessary to guard against the removal of animals from one stable to another and the mixing of herds upon common pastures or in the public highways. The object must be to isolate every individual's cattle as completely as possible, or otherwise a single affected animal may infect a dozen or more herds. To prevent surreptitious sale or trading of cattle, each animal must in some way be numbered and recorded in the books kept by the official in charge of the district. In the work of the United States Department of Agriculture a numbered metal tag was fastened to each animal's ear and index books were so arranged that with a number given the owner could be at once ascertained, or from the owner's name the cattle for which he was responsible could be at once learned. In this way, if an animal was missing from a stable, the fact became apparent at once, or if one too many was found in a stable the number in its ear would indicate where it came from.

When pleuropneumonia is discovered by these means, the entire herd should be slaughtered as soon as the formalities of appraisement can be arranged. In country districts the carcasses should be buried, as it is generally impracticable to dispose of them in any other way. In city districts the animals may be taken to a slaughterhouse, with such precautions as are possible to prevent dissemination of the contagion. The animals should be slaughtered under the supervision of an inspector. The healthy carcasses may be utilized for food, but the blood, entrails, and all diseased carcasses should be heated to a temperature equal to that of boiling water or above, and then used for the manufacture of fertilizers.

The disinfection of premises should be thorough and should be carried out by a trained corps of men employed for the purpose. The floors of stables should be removed, the accumulations removed from beneath them, the contents of haylofts should be destroyed, and the woodwork and soil beneath the stables should be thoroughly drenched with a solution of bichlorid of mercury, 1 part to 2,000 of water. After the flooring is replaced the woodwork should be coated with limewash, containing one-fourth pound of chlorid of lime to the gallon of mixture.

Usually in these cases the owners are dependent upon their herd of cows for a living, and consequently it is difficult or impossible to hold the stables vacant for any considerable period. In a majority of instances cattle may be admitted at once to stables so disinfected, without the reappearance of the disease. Occasionally, however, it will reappear without apparent cause. For this reason the inspection and other measures must be maintained in the infected district for six months or a year after the last case of disease has been disposed of.

Many people have objected to the slaughter of diseased and exposed animals as an unscientific and expensive method of eradicating the disease. To these it may be answered that it is the only method which has ever proved successful, and that in the end it is much more economical than temporizing measures.

Inoculation has been adopted in many countries, and has undoubtedly lessened the death rate, but where this practice is allowed the disease is kept up and spreads. For this reason it should be prohibited wherever there is a possibility and disposition to eradicate the contagion.

RINDERPEST.

Rinderpest, also known as cattle plague, is an acute, infectious disease of cattle, in which the digestive organs are mainly involved. Though unknown in this country, the importance of having near at hand a few definite facts concerning this disease, should it ever reach our shores, will be at once appreciated. A knowledge of such facts may aid in an early recognition of the disease. It must not be forgotten, on the other hand, that a superficial knowledge of diseases, such as the layman may gain through reading, not infrequently leads to confounding comparatively harmless, noninfectious maladies with such as are truly dangerous (foot-and-mouth disease, rinderpest, etc), and causes temporary panics among stock owners.

According to some authorities, rinderpest has its home in the territory around the Black Sea and the Volga River in Russia; according to others, in Central Asia. Thence it has been conveyed at various times by cattle to nearly every country of Europe and Asia, where it has proved to be a veritable bovine scourge. It probably visited Europe as early as the beginning of the Christian era, and since then the migrations of the people from the Far East have from time to time introduced the disease. Especially during the eighteenth century it was more or less prevalent in Europe, owing to the frequent wars, during which herds of cattle were brought from eastern Europe and Asia to supply the demands of the armies. It prevailed in Europe during the Franco-Prussian War. At present it exists in eastern Europe and in portions of Asia and Africa.

The virus is conveyed from one country to another chiefly by means of infected cattle, although infected hides, wool, and feed may play an important part in its dissemination. The railroad facilities of the present, which furnish the means of such rapid communication, are particularly liable to aid in the spread of the disease.

In the past rinderpest has been supposed to be identical with various human diseases, among them smallpox and typhoid fever. These suppositions are unfounded, and the view of authorities to-day is that it is a disease of a peculiar kind, not identical with any other known infectious disease.

The contagion of rinderpest.—The cause of rinderpest must be looked for among microorganisms—most likely bacteria. The investigations made thus far for this causal factor have been fruitless. However, certain recent experiments would indicate that the unseen microbe is of such dimensions that it is withheld by the dense bacterial filters, but passes through the more porous ones. Formerly it was supposed by various authorities that rinderpest virus appeared spontaneously under the influence of deteriorated feed and long and exhausting drives; also during unusual meteorological conditions. This view, however, is no longer maintained. It is probable that in its home in Asia the disease is perpetuated by continual infection of fresh animals, and some authorities go even so far as to believe that the disease would be entirely stamped out, even in its native haunts, by a destruction of all sick and infected herds. However this may be, the success of such an undertaking would largely depend on the nature of the cause. If a strictly parasitic organism, like the contagion of pleuropneumonia, it might be completely extirpated in this way. If, however, the germs or bacteria may live and multiply outside of the bovine body, in the soil, water, or in some other animal, extirpation would be impossible.

The virus may be transmitted in a variety of ways, both direct and indirect, from sick to healthy animals. It is said to be present in the various excreta, such as the discharges from the nose, and the saliva, the urine, and the manure, of the diseased. For months it retains its vitality in a moist state outside the body, and the disease is reported to have developed after feeding hay a year after it had lain in an infected stable; hence manure and the fodder and bedding soiled with discharges may convey it. Persons may carry the virus on their shoes, clothing, or implements. Even small animals, such as cats and rats, which frequent barns and stables, have been looked upon as carriers of the virus.

Cattle are very susceptible to the disease, and in its virulent type all those exposed are said to become infected. Buffaloes, sheep, and goats are likewise susceptible, but in a less degree.

It is also claimed that animals after having passed through one attack successfully resist future attacks. Inoculation with virus is said to produce immunity, but in many cases the process of inoculation itself is followed by death.

Symptoms.—The symptoms of rinderpest are not very characteristic, and hence the diagnosis of a suspected case in the beginning of an invasion is attended with difficulties. Certain appearances which are characteristic of one epizootic may be absent in another. Different observers are not quite agreed as to the most constant and important.

The period of incubation, i. e., the time between the exposure to infection and the earliest outward symptoms, varies from three to nine days. The first sign is a very high fever, which may reach 107° F. The heat of the skin varies in different parts of the body, and may be felt at the base of the ears and horns. Repeated chills are frequently observed. The pulse reaches 50 to 60 beats a minute, and in very severe attacks may rise to 90 or 100.

The animal manifests great debility. The head droops and rests on some object of support. One or both ears may droop. The coat is staring and the muzzle dry. The secretion of milk diminishes very rapidly. Within twelve to twenty hours the usual quantity may have become reduced one-half or two-thirds. The back is arched, and the four limbs are brought together under the body.

As the disease progresses, symptoms with reference to the digestive and respiratory organs become prominent. The mucous membrane of the mouth and the nose, as well as that of the rectum and vagina, becomes reddened, either in patches or diffusely, and assumes a scarlet hue. The discharges, at first firm, become softer, and soon diarrhea sets in. This is said to be one of the most constant symptoms. The rectum may become everted and paralyzed, and the bowels move spontaneously. The discharges become fetid, viscid, and streaked with blood. Coughing is a common symptom, and by some is considered characteristic. It is associated with discharges from the nose and vagina and dribbling of saliva from the mouth. The eyes also are affected. There is an increased formation of a viscid secretion which flows down the face.

Another series of changes prominent in some epizootics and mild or absent in others are the ulcers, or so-called "erosions," in the mouth. These begin as red patches and streaks. The mucous membrane in such localities is converted into a grayish-white slough, which, when shed, leaves a small erosion, or ulcer. At the same time similar changes may go on in the skin of the thighs, the udder, or the scrotum, or about the vagina, which lead to small sloughs.

In severe cases, which are the most common in the susceptible cattle of western Europe, death ensues four to seven days after the first appearance of the disease, and is preceded by great emaciation and debility, fetid, purulent discharges from the nose and mouth, and the relaxed rectum and vagina.

After death, if the animal is opened and the organs carefully examined, the chief changes are found in the digestive organs. The lining membrane of the mouth and pharynx is covered with mucus, is reddened in spots, and shows superficial, yellowish-gray, cheesy patches, which represent dead tissue, and when removed expose ulcerated depressions. The same reddening in spots and the yellowish-gray, cheesy deposits or patches are found in the fourth stomach, the small intestines, and more rarely in the cecum, while the third stomach, or manyplies, is more or less impacted with dry, hard feed. Similar changes may be found on the mucous membrane of the nasal cavity, larynx, trachea, the uterus, vagina, and rectum. The lungs may be injected, edematous, or pneumonic. The heart muscle is pale and flabby, and frequently hemorrhages are observed in its internal membrane. The liver may be pale or injected with blood, and at times shows hemorrhages beneath its capsule. The bile is thin and watery in consistence. The kidneys may be inflamed or contain small hemorrhages within their substance or under the capsule. The lymphatic glands may be swollen and injected or even hemorrhagic.

Treatment.—On account of the danger of spreading the infection, neither medicinal treatment nor inoculation is permitted in European countries, with the exception of Russia, where the disease is more generally diffused. The most effective method of exterminating rinderpest in those districts in which the disease is not indigenous has been found to be the slaughter of all affected and exposed animals. Where the disease is general, successful efforts adopted for its control have followed the immunization by inoculation of the exposed animals and a strict application of appropriate sanitary measures. This protective inoculation has been practiced with very gratifying results in Russia, South Africa, and in the Philippine Islands. An active immunity is thus induced in susceptible animals which lasts until the danger from exposure to the disease is over. This immunity may be attained (1) by the inoculation of pure bile from an animal which recently died of rinderpest, (2) by the inoculation of glycerinated bile, followed by pure bile or virulent blood, or (3) by the simultaneous inoculation of strong standardized serum and virulent blood.

The latter method has been adopted by the United States Government in its endeavor to exterminate the disease in the Philippines, and to protect the cattle and carabaos against rinderpest after their importation into those islands. Owing to the existence of this and other infectious diseases in the Philippine Islands, an order has been issued by the Department of Agriculture prohibiting the landing of any live stock or animals of any kind from the Philippines at any of the ports of the United States or the dependencies thereof. This prohibition removes the greatest source of danger to which the United States is exposed as the result of its intercourse with the islands. The introduction of rinderpest from those countries from which we import animals is rendered extremely improbable, especially in live animals, owing to its short period of incubation and to the 90-day quarantine for cattle (counting from date of shipment) and 15-day (counting from date of landing) quarantine for sheep and other ruminants and swine which are at present enforced in the United States at all ports of entry.

FOOT-AND-MOUTH DISEASE.

[Pl. XXXIII.]

Foot-and-mouth disease, also known as aphthous fever, epizootic aphtha, and eczema contagiosa, is an acute, highly communicable disease chiefly confined to cloven-footed animals and characterized by an eruption of vesicles or blisters on the mucous membrane of the mouth and on the skin between the toes and above the hoofs. The vesicles rupture, forming erosions and ulcerations; there are also salivation, tenderness of the affected parts, loss of appetite, lameness, emaciation, and diminution in the quantity of milk secreted.

The tremendous ravages of the disease are seen in the number and variety of the species attacked. While it may be regarded as essentially a disease of cattle, hogs would seem to be as easy a prey. Almost in the same grade of receptivity are sheep and goats. Next in order of susceptibility come the buffalo, American bison, camel, chamois, llama, giraffe, and antelope. Horses, dogs, cats, and even poultry may occasionally become infected with the disease, the last three being particularly dangerous as carriers of the contagion. Man himself is not immune, and the frequency of his infection by coming in contact with diseased animals is established by numerous observations.

As with other communicable diseases, the source and origin of foot-and-mouth disease have given rise to much speculation. The disease had been known in Europe for centuries, but it was not until comparatively recent years that the erroneous conceptions of its spontaneous origin as a result of climatic and meteorological conditions, exhausting journeys, etc., were abandoned. It is now conceded that foot-and-mouth disease is propagated by a specific virus and that every outbreak starts from some preexisting outbreak.

So far investigators have been unable to identify or isolate the specific organism causing the disease, although numerous attempts have been made to cultivate and stain it by laboratory methods. Experiments have shown that the virus will pass through standard germ-proof filters, thus indicating its minute size and the reason it has not been detected by the staining methods. The contagion may be found in the serum of the vesicles on the mouth, feet, and udder; in the saliva, milk, and various secretions and excretions; also in the blood during the rise of temperature.

A wide distribution of the virus and a rapid infection of a herd is the result. Animals may be infected directly, as by licking, and in calves by sucking, or indirectly by such things as infected manure, hay, utensils, drinking troughs, railway cars, animal markets, barnyards, and pastures. Human beings may carry the virus on their shoes and clothing and transmit it on their hands when milking, since the udder is occasionally the seat of the eruption. It may also be carried by dogs, cats, rats, chickens, pigeons, etc. Milk in a raw state may also transmit the disease to animals fed with it.

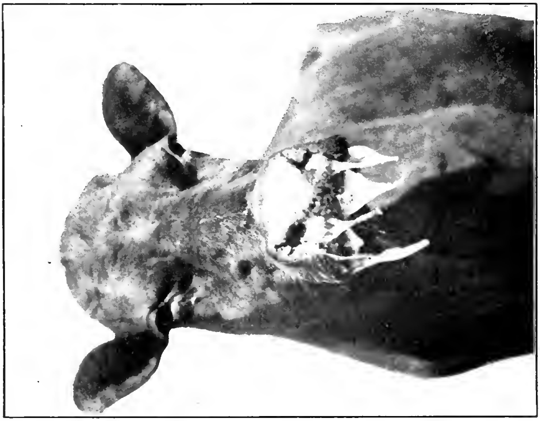
The observations made by some veterinarians would lead us to suppose that the virus is quite readily destroyed. It is claimed that stables thoroughly cleaned become safe after drying for a short time; hence, litter of all kinds, such as manure or soiled hay and straw, may remain infective for a longer time because they do not dry out. Other authorities maintain that the virus is quite tenacious and may live in stables even so long as a year. They also state that animals which have passed through the disease may be a source of infection for several months after recovery.

Unlike most other infectious diseases, foot-and-mouth disease may repeatedly attack the same animals. The immunity conferred by an attack is of limited duration.

The period of incubation (that is, the time between the exposure of an animal to infection and the development of the disease) is variable, usually from three to six days. The disease may appear in 24 hours, or, in exceptional cases, not for 18 days or even longer.

Losses.—The highly contagious character of foot-and-mouth disease and its rapid spread to practically all exposed susceptible animals lead to heavy losses. Since the mortality is comparatively low, ranging from only 3 per cent or less in mild forms to 30 or 40 per cent in malignant cases, the havoc caused by the pestilence is sometimes underestimated. But there are other sources of loss which are much more important than the actual mortality. The fever and the difficulty of eating cause a rapid and extreme loss in flesh and a lessening or cessation of the milk secretion. The udders often become inflamed and ruined by the formation of abscesses, and cows affected in this way are sometimes rendered permanently valueless for milk production. The inflammation of the feet may cause the horn to drop from the toes, producing great lameness and lasting injury. Abortion is frequent, and typical lesions have been observed in the newly born at birth. Altogether these losses may amount to 20 or 30 per cent of the value of the affected animals.

In addition there are indirect losses of a commercial nature. Dairy farmers are put out of business for a time. Necessary quarantine restrictions greatly interfere with the movement of live stock and such commodities as hay, straw, hides, and farm produce. The



FOOT-AND-MOUTH DISEASE.

business of the stockyards and slaughtering centers is greatly interfered with. Sometimes it is necessary to close stockyards for disinfection. The whole business of marketing, transporting, feeding, and slaughtering is interrupted and deranged. Losses of this character may reach enormous proportions.

The disease in other countries.—Foot-and-mouth disease has prevailed in Europe for a great many years and has occasioned tremendous economic losses there.

In Italy, France, Switzerland, Germany, and Russia the plague has existed so long and has gained such a foothold that it is economically impossible to fight it with the American methods of slaughter and disinfection, for to do so would kill a large percentage of the live stock of those countries. In consequence, little or no progress toward eradication has been made by the authorities, though the severity of the disease in France appears to have abated somewhat in recent months.

The outbreak which appeared in Germany in 1888 increased steadily until 1892, when it diminished gradually for a few years, but the disease again reached great proportions in 1899. Thereafter it continued to exist to a greater or less extent until in 1911 it attained a virulence unequaled before. In that year 3,366,369 cattle, 1,602,927 sheep, 2,555,371 hogs, and 53,674 goats were affected. At that time the total number of cattle, sheep, swine, and goats in Germany was only 51,319,000, while there were in the United States 172,572,000, or between three and four times as many. It can readily be imagined, therefore, what it would mean to the United States if the disease were to gain the foothold here that it had in Germany, where, as these figures show, approximately one out of seven of the animals susceptible to the disease was affected.

The German Government, of course, has not left the disease to itself. It attempted to control some outbreaks by the method of slaughter, but the pestilence had gained too much headway and was too firmly established in too many portions of the country for this method to succeed, and the slaughter of the infected herds had to be abandoned. It now appears that there is no hope of getting rid of it until the virus has worn itself out. As soon as the animals' period of acquired immunity is over and favorable conditions present themselves, the contagion breaks out with renewed virulence. It has been impossible to control it by means of quarantines. One scientist has asserted that unless all the infected farms were absolutely isolated and the movement, not only of live stock but of persons, absolutely prohibited, the disease could not be stamped out. Such a quarantine is, of course, utterly impossible to enforce. In portions of Germany the farmers, realizing that the disease is inevitable, make haste to be done with it by exposing their stock deliberately to mild cases in the hope that this will result in an immediate, mild attack and immunity for several years thereafter. Such immunity, however, is very uncertain.

Great Britain, Denmark, Norway, and Sweden, on account of their comparatively isolated positions, have been more successful in keeping out the disease. The outbreaks in those countries have been more sporadic, and by resorting to immediate slaughter the authorities have been able to stamp them out. Great Britain has applied both quarantine and slaughter for many years, and in an outbreak near Dublin in 1912 measures were adopted which were even more stringent than any that have been used in the United States. A British official (Cope) asserted in 1899 that after his country's experience with this disease it was "more dreaded by the farmers and stock raisers of Great Britain than cattle plague or pleuropneumonia, and they are now willing and ready to put up with any restrictions, of however drastic a character, considered necessary by the central department to stamp it out." The British authorities have succeeded in suppressing each outbreak, but reinfection often occurs from the neighboring continent. At the present time (April, 1922) Great Britain is having a siege of the disease, but is applying vigorous measures for its suppression.

In November, 1906, the disease reached Belgium from France, where it was quite prevalent, and by the end of the year every Province in Belgium was affected, and the Netherlands as well. Efforts to eradicate it from Belgium were unavailing. The Netherlands apparently succeeded in stamping it out for about six months, but it reappeared there.

The disease is also more or less prevalent in Central Europe, Spain, and in the Balkan countries.

Australia and New Zealand have remained free from it.

We have less accurate information regarding Asia and Africa, but the disease is known to prevail in Japan and China and in the Philippine Islands, and it is doubtful whether any considerable part of the Orient is free from it.

In South America it is reported as common in Brazil, Argentina, and Uruguay, and it probably exists in other countries.

Canada and Mexico are fortunately free from the disease.

Outbreaks in the United States.—Foot-and-mouth disease has appeared in the United States on six different occasions—1870, 1880, 1884, 1902, 1908, and 1914.

An extensive outbreak in 1870 was introduced by way of Canada, where the infection was brought by an importation of cattle from Scotland. It spread into the New England States and New York and appears to have been arrested within a few months. Its failure to spread more extensively and its early disappearance have been ascribed to favorable conditions, such as the movement of live stock from west to east, the limited trading at that period as compared with the present time, the restriction of traffic by winter weather, and the infrequency of travel which obtained at that time among people.

About 1880 two or three lots of animals affected by this disease were brought to the United States, but there was no extension from the animals originally affected.

In 1884, at Portland, Me., there was a small outbreak caused by imported cattle, and the disease spread to a few herds outside the quarantine station. Owing to the small number of animals affected and the limited area of territory covered by the disease, it was easily controlled by the ordinary measures of quarantine and disinfection.

It will be observed that in all these early outbreaks the contagion was introduced with imported animals. Since the development of a stringent system of inspection and quarantine of imported live stock, no instance of that kind has occurred. On subsequent occasions the infection has evidently been brought in with contaminated products or materials and not by means of live animals.

In November, 1902, the disease was discovered in Massachusetts and Rhode Island. The earliest cases were traced to Chelsea, Mass., near the docks, and it was suspected for a time that the infection was brought in with foreign shipping, by some such means as hay, straw, halters, ropes, hides, hair, wool, etc. Later developments, however, and especially investigations into the cause of the 1908 outbreak, led to the belief that a more probable source of the infection was cowpox vaccine virus imported from a country (probably Japan) where foot-and-mouth disease existed, the vaccine virus being contaminated with the virus of foot-and-mouth disease.

A Federal quarantine was declared by the Secretary of Agriculture on November 27, 1902, as soon as the nature of the disease was established, and steps for eradication were at once taken by the Bureau of Animal Industry of the United States Department of Agriculture in cooperation with authorities of the affected States. The methods followed consisted of inspection to trace and detect the disease, quarantine of infected premises and territory, slaughter and burial or burning of diseased and exposed animals, and disinfection of premises.

This outbreak involved Massachusetts, New Hampshire, Vermont, and Rhode Island, and was eradicated in about six months. Two hundred and forty-four herds, including 4,712 cattle, were found infected. Of these, 205 herds with 3,872 cattle, as well as 360 hogs and 220 sheep and goats, were slaughtered. The cattle infected but not slaughtered were those that either died or completely recovered before slaughtering could be carried out. The animals slaughtered were valued at $184,155.10, and the Federal Government reimbursed owners to the extent of 70 per cent, or $128,908.57. It is understood that the States paid the remainder. The total cost to the Department of Agriculture of stamping out the disease was about $300,000.

The next appearance of the foot-and-mouth disease was early in November, 1908, when it was observed in cattle near Danville, Pa. A Federal quarantine was issued November 12. The infection was traced back to the stockyards at East Buffalo, N. Y., and to Detroit, Mich. The disease appeared in the States of Michigan, New York, Pennsylvania, and Maryland. A careful and thorough investigation made by Mohler of the Bureau of Animal Industry and Rosenau of the Public Health Service demonstrated that the outbreak started from calves used to propagate vaccine virus at an establishment near Detroit, and that the source of the infection was contaminated Japanese vaccine virus.

Vigorous measures of eradication similar to those employed in 1902–3 were at once put into effect and the disease was stamped out in about five months at an expense of about $300,000 to the Department of Agriculture, and of about $113,000 to the States. The inspectors made 108,683 visits to farms, stockyards, etc., and inspected more than 1,500,000 animals (including reinspections). One hundred and fifty-seven premises were found infected, and 3,636 animals (2,025 cattle, 1,329 hogs, and 282 sheep and goats), valued at $90,033.18, were slaughtered. Owners were reimbursed for the value of their animals and property destroyed, one-third being paid by the States and two-thirds by the Federal Government.

The latest invasion was discovered in the vicinity of Niles, Mich., in October, 1914, after it had evidently been under way since August of the same year. This is the most serious and extensive outbreak ever known in this country. The disease extended to 22 States and the District of Columbia, at places ranging from the Atlantic to the Pacific coasts. The work of eradication was not completed for more than a year. The affected States were Connecticut, Delaware, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Virginia, Washington, West Virginia, and Wisconsin. Illinois had the largest infected area and the largest number of animals affected. The Union Stock Yards at Chicago became infected and were a source of dissemination of the contagion north, east, south, and west. These and other yards found infected were closed temporarily and disinfected.

The first Federal quarantine was issued October 19, 1914. A campaign to check the spread of the disease and to stamp it out was immediately begun by the United States Department of Agriculture in cooperation with the State authorities. Quarantines against the movement of animals and certain materials from the infected areas were declared, shipments were traced, rumors investigated, and thorough inspections made in an effort to discover all infected stock. As measures of eradication, diseased herds were slaughtered and buried and the premises disinfected. The owners of live stock and other property destroyed on account of the disease were reimbursed to the extent of the appraised value, half of which is paid by the Federal Government and half by the State. There were slaughtered 172,720 animals (76,575 cattle, 86,492 swine, 9,511 sheep, 133 goats, and 9 deer), in 3,482 herds. The total appraised value of these animals was more than $5,800,000. The expense to the Federal Government of eradicating this outbreak was about $4,540,000.

Symptoms.—In three to six days, or even longer, after the exposure of the animal to the infection the disease makes its appearance. It is usually first indicated by the animal suffering from a chill, quickly followed by an invasion of fever, which may cause the temperature to rise as high as 106° F. These symptoms are not always present, or may be in so slight a form as to escape notice. Following this in one or two days it will be noticed that small vesicles or blisters about the size of hempseeds or peas are making their appearance upon the mucous membranes of the mouth at the border and upper surface of the tongue near the tip, the inside of the cheeks, on the gums and the inner surface of the lips, or on the margin of the dental pad. These little blisters contain a yellowish, watery fluid and gradually become more extensive as the disease advances. Soon after the eruptions have appeared in the mouth of the animal considerable swelling, redness, and tenderness will be noticed about the feet, at the coronet, and between the digits of each foot. A day or two later eruptions similar to those within the mouth make their appearance upon these swollen regions of the foot, and at this stage it is usual to find that like lesions have made their appearance upon the perineum of the victim. In the case of milk cows the udder, and more particularly the teats, show the same vesicular eruption, but the latter as the result of milking soon become covered with reddened spots deprived of the superficial layer of skin and may develop deep, obstinate fissures.

As soon as the disease has become well established the patient evinces pain when attempting to eat; in fact, the appetite is often so seriously affected that all feed is refused, and the animal uneasily opens and shuts its mouth with a characteristic smacking sound, while strings of cohesive, ropy saliva hang suspended from the lips. With the advance of the disease the vesicles widen and extend until they may reach a diameter ranging from that of a dime to that of a silver dollar. These rupture soon after their appearance, sometimes on the first day, more rarely on the second or third day. After they have ruptured, the grayish-white membrane forming the blister may remain attached for a day or more, or disappear speedily and leave deeply reddened, sensitive spots or erosions, both within the mouth and upon the coronet and between the claws of the feet. Similar erosions, which quickly form scabs, as a rule, may be noticed in cases in which the teats of milk cows have become affected, and instances are reported in which sloughing of the tegument immediately around the lesions upon the udder has occurred. Owing to the tough, fibrous nature of the bovine skin, it is exceedingly rare for sloughing to occur upon any part of the body other than those mentioned.

The attack upon the feet of an animal is frequently manifested in all four feet at once, but one or more of the feet may entirely escape and remain unaffected throughout the course of the disease. The ulceration of the interdigital tissue may extend to the ligaments of the fetlock or produce disease of the joint or bone. As the feet become sensitive and sore the animal persistently lies down, and it has been found that bedsores develop with amazing rapidity in all such cases and wholly baffle all attempts at treatment until after the patient has regained its feet.

The disease may attack some of the internal organs before it appears upon any of the external tissues. These cases are very liable to prove quickly fatal. The animal dies from paralysis of the heart, due to the formation of poisonous principles within the system; it may suffocate by reason of the action of these same poisons upon the tissues of the lungs, or it may choke to death as a result of paralysis of the throat.

In cases of serious affection of the udder the erosions will often be found within the passages of the teats, resulting in a "caked" udder, and the same toxic poisoning which is the cause of death in the apoplectiform types just mentioned may arise from this source. In any event the milk from such cases is dangerous for use, causing fatal diarrhea in sucking calves or young pigs and serious illness in human consumers. The milk obtained from cows suffering with foot-and-mouth disease is not readily converted into either butter or cheese, but remains thick, slimy, and inert in spite of churning and attempts at curdling. Pregnant animals may abort. In pigs, sheep, and goats the lesions in the foot are most common, but both forms may be observed or only the mouth lesions.

When the disease has become fully established it will be found that the duration of the attack will vary greatly with different animals. From 10 to 20 days are usually required for the recovery of the normal appetite and spirits in mild outbreaks, while the return to a full flow of milk, in the case of milk cows, seldom occurs before the arrival of the following season.

In the malignant type of the disease it requires from three months to a year for an animal to recover. The mortality, as already stated, is usually low. The disease is more fatal in young animals that have been fed on infected milk, and produces death in from 60 to 80 per cent of these cases as a result of gastroenteritis. In the 1914 outbreak numerous new centers of infection started among hogs and calves which were fed on unpasteurized, infected milk from creameries.

Diagnosis.—The recognition of this affection should not, as a rule, be difficult, especially when the disease is known to be in the vicinity; in fact, the group of symptoms form a clinical picture too decided to be doubted. The combination of high fever, vesicular inflammation of the mouth, and hot, painful, swollen condition of the feet, followed 24 to 48 hours later by the appearance of numerous blisters varying in size from that of a pea to that of a walnut on the udder and feet and in the mouth should prevent any serious or long-continued error in the diagnosis; however, in the inoculation of calves we have a certain and final test. In 24 to 96 hours after inoculation the calves present the characteristic blisters. Such inoculation should be practiced, however, only by officials properly authorized to deal with contagious diseases.

Differential diagnosis.—The lesions of no other disease of cattle closely simulate the vesicular eruption of foot-and-mouth disease on the lining membrane of the mouth. When the blisters have ruptured, however, and the resulting lesions have become contaminated by numerous secondary forms of microorganisms, the correct recognition of the disease may be involved in considerable difficulty.

Cowpox or horsepox may be accidentally transmitted by inoculation. But the eruption of the "pox" goes on to the development of a pustule, while in foot-and-mouth disease the eruption is never more than a vesicle, even though the contained fluid may become turbid. The inoculation test in the case of cowpox does not respond with fever and eruption for at least 10 days, and often longer.

Necrotic stomatitis (sore mouth due to a germ) may be distinguished from foot-and-mouth disease by the fact that in the latter there is a rapid infection of the entire herd, including the adult cattle, as well as the infection of hogs and sheep. The characteristic lesion of foot-and-mouth disease is the appearance of blisters containing a serous fluid upon the mucous membrane of the mouth and upon the udder, teats, and feet of the affected animals. In necrotic stomatitis blisters are never formed, destruction of the tissues occurring from the beginning and being followed by the formation of yellowish, cheesy patches, principally found involving the lining membrane of the mouth, especially the tongue and cheeks.

In mycotic stomatitis (sore mouth due to a fungus or mold), portions of the lining membrane become inflamed and in a few days it changes to a croupous membrane which peels off, leaving a raw surface, while the thin skin between the toes may also be inflamed. The previous history of the case; the failure of the blisters, if any appear, to spread extensively; the absence of vesicular eruptions on other portions of the body, notably the udder and teats, and, characteristically, the hoof, together with the absence of rapid spread to practically all cattle in the herd and the complete negative character of inoculation of calves, distinguish between the local disease named and foot-and-mouth disease. Mycotic stomatitis occurs in only from 10 to 50 per cent of the animals in a herd, usually in the late summer or early fall after a dry spell, and it does not run a regular course.

The lesion resulting from ergotism may be distinguished from those of foot-and-mouth disease by the lack of eruptions in the mouth and by the location of the disease at the tips of the ears, end of the tail, or upon the lower part of the legs, usually below the knees or hocks. The lesion of ergotism does not take the form of pustules or blisters, but manifests itself first as a swelling about the ankle, which later may slough and circumscribe the limb, forming a deep crack, extending entirely around the limb and forming a distinct line of demarcation between the healthy skin above and the diseased below. The absence of ulcerous sores on the coronet and between the claws, together with the healthy condition of the membranes of the mouth and the knowledge that the lesion upon the limb in question extends uninterruptedly around it, should point conclusively to a diagnosis of ergotism and to the exclusion of all fears of foot-and-mouth disease.

In foul foot or ground itch of cattle, the inflammation of the skin and toes is general and not in certain spots, as in foot-and-mouth disease. The mouth remains unaffected, and the presence of the disease may be traced to filth and poor drainage.

The severer forms of the disease might be confounded with certain general diseases. If gastrointestinal symptoms predominate, acute gastric catarrh or inflammation of the intestines might be thought of. Involvement of the lungs may lead to a diagnosis of acute congestion of the lungs or pneumonia. The distinction is apparent in these diseases by the lack of vesicular eruption on the mucous membrane or skin, and also by lack of evidences of infection in the herd or neighboring animals.

Prevention and eradication.—The measures to be adopted to prevent the spread of the affection must take into consideration the highly infectious nature of the disease, its ease of dissemination, and the liability of the virus to live for long periods outside the body of an animal. Great care should therefore be observed in keeping healthy animals unexposed to the contagion. When an outbreak occurs in a community the owner should make every effort to keep other animals from coming in contact with his diseased cattle. This especially applies to dogs, cats, goats, and poultry, which usually have access to the stables and barnyards and in this way furnish excellent means for disseminating the infectious principle. He should be equally particular in prohibiting any person from coming onto his premises, especially an attendant or owner or other person in any way connected with cattle. Such a herd may be placed under quarantine, with an inspector appointed to keep the premises under constant surveillance.

This method of quarantine alone, while very satisfactory in many instances, is rather tardy in obtaining the desired result. The experience of European Governments already mentioned shows that eradication by this method alone, when the disease has obtained a foothold, is practically impossible. For this reason, when the disease breaks out in a country like the United States, where the contagion is likely to spread rapidly by means of infected cars, manure, hay, and other feed, and where the results of its obtaining a firm foothold would be so disastrous, it seems that this method of temporizing is rather tedious, and more radical steps are required in order to suppress and eradicate completely the infection in the quickest and most thorough manner possible.

It would therefore appear better, after judicious appraisement, to concentrate the expense incident to the extermination of foot-and-mouth disease by purchasing and slaughtering all affected and exposed cattle. The carcasses of these animals should be totally destroyed, preferably by cremation, or otherwise by burying them in a hole 6 feet deep and covering them with air-slaked lime. The infected stable should be disinfected by thoroughly cleaning it, scrubbing the floor with hot water, brushing down all loose dust from the walls, and tearing off all woodwork which is partly decayed. Then the whole interior of the stable should be disinfected with one of the following substances:

A 5 per cent solution of pure carbolic acid.

Chlorid of lime, U. S. P. strength (30 per cent available chlorin), 1 pound to 3 gallons of water.

Formaldehyde, 1 quart 40 per cent solution to 5 gallons of water.

A 3 per cent solution of cresol compound, U. S. P., or accepted substitute therefor, containing at least 50 per cent cresylic acid.

All stable utensils should be thoroughly cleaned and disinfected by the application of a solution of one of the above-named disinfectants. The manure should be burned or disinfected and spread over ground (other than meadow land) that is to be turned under. No other cattle should be purchased for at least sixty days after the complete disinfection of the premises.

The success in eradicating the disease by combined quarantine, slaughter, and disinfection, as practiced in the United States, Denmark, Great Britain, and a few other countries, demonstrates in a striking manner the efficacy of slaughtering and the futility of relying upon quarantine alone to stamp out the disease.

Inoculation has been adopted in some countries in order to have the disease spread quickly through the herds, and while this practice has undoubted value where the disease is indigenous, it is not desirable in this country and should not be adopted.

As a rule medicinal treatment with a view of curing affected animals is not to be recommended under conditions prevailing in the United States, where the disease has not become established, and the first object is to stamp it out as quickly as possible. Even though most animals would recover, with or without treatment, it would be practically impossible, while they were being held for recovery, to prevent the spread of the infection to others. The disease would be liable to spread faster than it could be cured. As already pointed out, it has been found impossible to prevent absolutely the spread of the contagion by the strictest quarantine alone, under the usual farm conditions. In addition, the affected animals that have passed through the disease may become a source of further infection as virus carriers for weeks and months after they have apparently recovered, and are susceptible of reïnfection, as one attack does not confer permanent immunity.

Foot-and-mouth disease in man.—Foot-and-mouth disease is primarily and principally a disease of cattle; secondarily and casually, a disease of man. It is transmissible to man through the eating or drinking of raw milk, buttermilk, butter, cheese, and whey from animals suffering from foot-and-mouth disease. It is also transmitted directly, though more rarely, from the salivary secretions or other infected material which may gain entrance through the mucous membrane of the mouth. It is doubtful whether the disease can be transmitted to man by cutaneous or subcutaneous inoculation, though it is probable that the infection may be communicated if the virus directly enters the blood through wounds of any kind. Children are not infrequently infected by drinking unboiled milk during the periods in which the disease is prevalent in the neighborhood, while persons in charge of diseased animals may become infected through contact with the diseased parts or by milking, slaughtering, or caring for the animals.

The symptoms in man resemble those observed in animals. There is fever, sometimes vomiting, painful swallowing, heat and dryness of the mouth, followed by an eruption of vesicles on the mucous membrane of the mouth, and very rarely by similar ones on the fingers. The vesicles appear on the lips, gums, cheek, and edge of the tongue, and are about the size of a pea. The vesicles soon rupture, leaving a small erosion which is soon covered by a thin crust under which the new formation of epithelium proceeds rapidly. The skin eruption mostly appears on the hands, tips of the fingers, base of the nails, and more seldom on the toes and other parts of the body. Besides these local changes, during the course of the disease headache, pain in the limbs, vertigo, abdominal cramps, vomiting, diarrhea, and weakness are occasionally observed. The disease is seldom fatal, usually appearing in a very mild form except in weakened children, in whom an accompanying intestinal catarrh may lead to a fatal termination.

Veterinarians who have had considerable experience with the disease among animals regard the human affection as by no means uncommon in countries where foot-and-mouth disease prevails, but the disturbance of health is usually too slight to come to the notice of the family physician.

But few outbreaks of the disease in man have occurred in the United States, and therefore cases of its transmission to man in this country are rather rare. Dr. James Law reports having observed the disease in man from drinking infected milk during the epizootic of 1870 in the Eastern States, but the outbreaks of 1880 and 1884 affected such a small number of animals and were so quickly suppressed that no instance of its transmission to man was recorded. A few cases have been reported by Brush accompanying the New England outbreak of 1902. Similar reports have been likewise received concerning the appearance of vesicular eruptions in the mouths of children during the 1908 and 1914 outbreaks, and the history of these cases incriminates the milk supply.

Experiments by Loeffler and Froesch, as well as recent experiments which have been made in Denmark and Germany, indicate that the infection is comparatively easy to destroy by heat or the usual antiseptics. Milk pasteurized at a temperature of 60° C. for 20 minutes is safe so far as infection by foot-and-mouth disease is concerned.

SEPTICEMIA AND PYEMIA.

These two names are applied to diseased conditions which are so nearly alike in their symptoms that it is sometimes difficult to distinguish the one from the other. Indeed, the name pyosepticemia, or septicopyemia, is often applied when it is impossible to make a distinction between septicemia and pyemia or where each is equally responsible for the diseased condition. The name septicemia is derived from two Greek words meaning "poison" and "blood," and signifies that the germ lives in the blood, hence the use of the term "blood poisoning" for this disease. Pyemia is likewise derived from two Greek words, meaning "pus" and "blood," and is that form of septicemia caused by pus-producing organisms and characterized by secondary abscesses.

Causes.—Neither of these diseases is brought about, strictly speaking, by any specific organism; hence neither can be looked upon as a specific disease. The organisms most frequently found in cases of septicemia are, on the whole, the same as those of pyemia, and may be pus cocci, the bacillus coli, or other pus-producing organisms. These organisms are often found as secondary invaders in other diseases, such as advanced cases of tuberculosis, in which cases they are responsible for the formation of pus.

Aside from the causative organism, or, in other words, the active cause, there are many secondary causes. The most important of these in pyemia is a break in continuity of the protective covering, as a wound, which affords an entrance into the tissues for the organisms. Among the different varieties of wounds may be mentioned cuts, bruises, punctures, burns, chemical or frozen wounds, and compound fractures of bones. Injuries received during parturition, stoppage of the milk ducts, and infection of the umbilicus in the newly born are also frequent causes of pyemia. Septicemia usually follows surgical wounds, local suppuration, enteritis, bronchitis—in fact, wherever there is a local lesion of any kind permitting germs to enter the blood. Septicemia was formerly applied to designate the condition in which the organisms were localized, but in which their toxins were diffused in the blood. Pyemia was made to represent that condition when the organisms were localized, but in which the pus was transported by the blood. These terms now are applied to conditions in which both the organisms and their toxins, or the pus, are present in the blood. The term septicemia is indicated when intoxication is the more pronounced symptom and pyemia if pus formation and metastatic or secondary abscess formation are observed.

Symptoms.—The symptoms of both diseases include primarily a high fever (104° to 107° F.). Coupled with this there is disinclination to move, the animal is depressed and not cognizant of its surroundings. The pulse is rapid, small, and feeble, respiration increased, mucous membrane injected, swollen, and of a yellowish tinge. Appetite is lost and death follows in the case of septicemia in from two to four days. In pyemia the symptoms come on more slowly and are not so intense as in septicemia, while the course of the disease is longer, lasting from six days to four weeks. The mortality is not so great as in septicemia, but the period of convalescence is always long.

Lesions.—Septicemia is characterized by the destructive changes in the blood, which is chocolate colored, noncoagulable, and swarms with bacteria. The lining membranes of the heart are studded with red spots, often running together to form a large hemorrhagic area. The lungs, liver, and kidneys may also show these hemorrhages. The spleen is enlarged and full of black blood. The cadaver decomposes very rapidly and in some cases forms great quantities of fetid gas. In pyemia, in addition to these lesions, abscesses are formed in the various organs throughout the body. If the disease develops slowly a post-mortem examination shows the abscesses to be the chief alterations. The pus content is usually greenish, stained with blood, and contains strings of fibrous tissue and necrosed matter.

Treatment.—Treatment is almost futile in advanced cases of either disease. Septicemia is usually fatal and pyemia frequently so. Prevention and the immediate treatment of local infections are the surest means of combating them. For local treatment of wounds the usual antiseptics are indicated, such as 3 per cent compound cresol or carbolic acid, or one one-thousandth bichlorid-of-mercury solution. For pyemia, where the abscesses are near the skin, they should be opened and treated antiseptically by injecting any of the previously mentioned germicides. General and heart stimulants are indicated, such as a drench containing digitalis 2 drams and alcohol 2 ounces. Quinin and calomel in repeated small doses of one-half dram each three times a day are sometimes beneficial. Camphor in the form of oil of camphor (camphor dissolved in 10 parts of sweet oil) is a good stimulant and has some antiseptic properties, which make it a valuable drug in combating these diseases when it is given in doses of 2 drams three times daily.

HEMORRHAGIC SEPTICEMIA.

Hemorrhagic septicemia is a name applied to a highly fatal, infectious disease existing in various species of domestic and wild animals, from a microorganism having definite biological characters and possessing the properties of producing clearly defined and characteristic lesions.

This causal agent, *Bacterium bovisepticum*, belongs to the same group of cocco-bacilli as those causing chicken cholera, swine plague, and rabbit septicemia, and may be described as an ovoid, nonmotile, polar-staining bacterium with rounded ends, $\frac{1}{38000}$ of an inch wide by $\frac{1}{20000}$ of an inch long, sometimes seen in pairs and sometimes in chains.

Various names have been applied to this disease, and though the causative agent and the distinctive lesions are well known, it is more than likely that the affection is seldom recognized. It was described by Bollinger in 1878, and named Wild und Rinderseuche, from its having affected deer, wild boars, cattle, and horses in an epizootic which swept over Germany at that time. Before this, however, several epizootics of what was evidently the same disease had been well described, notably that which occurred in England in 1854. Since then it has occurred in epizootic and enzootic forms in many sections of Europe, Asia, Africa, and America. In this country the disease has been observed in Texas, Tennessee, New York, Minnesota, Pennsylvania, District of Columbia, South Dakota, and Wisconsin. Other names given to it are game and cattle disease, buffalo disease, barbone, pasteurellosis bovina, ghotwa, and infectious pneumoenteritis.

In earlier times it was evidently confounded with gloss anthrax, and even now it is probably mistaken in a great many instances for anthrax, blackleg, cornstalk disease, and cerebrospinal meningitis.

The disease is essentially a septicemia, or blood poisoning, and the microbic invasion occurs from inoculation probably either through abrasions of the skin or by injury to the mucous membranes from coarse fodder, etc. Moore and Smith have found in the mouths and nasal cavities of healthy animals, including cattle, bacteria belonging to this group; but these organisms proved to be nonpathogenic. As is well known, however, many pathogenic germs at times exist in a saprophytic state, and it is not hard to conceive how a microbe may cease such existence and assume parasitic or pathogenic properties when the surroundings are eminently favorable. This may be a connecting link in the etiology of sporadic outbreaks of the disease in which all other hypotheses as to its genesis seem untenable. The disease seems to occur most frequently in swampy or mucky localities or in pastures receiving the overflow from infected fields. It is said to occur usually in the spring of the year, when the melting snows and rains bring to the surface the subterranean waters from rich soils containing nitrogenous materials in which the bacteria have been existing. In a great many instances there does not seem to be any plausible explanation for an outbreak of the disease and one can only surmise as to its origin.

Symptoms.—Three forms of the disease are recognized, based upon the distribution of the lesions—the superficial, or cutaneous, the pectoral, or thoracic, and the intestinal form. The last is a usual accompaniment of the other two and may be mild or severe. Naturally the symptoms vary according to the violence of the attack and to the particular form of disease with which the animal is affected. In the superficial, or cutaneous, form the presence of a swollen tongue, throat, and dewlap, or even of the lower portion of the legs, gives us a clew to the trouble. An entire loss of appetite occurs, and in milk cows there is a diminution of the milk secretion. The temperature may be only slightly elevated, but it is usually very high. Salivation is set up by the inflammation of the mouth and pharynx. Unsuccessful efforts at eating and swallowing are made. There may be difficulty in breathing, depending on the amount of involvement of the larynx, trachea, bronchi, or lungs. There may be a blood-stained discharge from the nostrils, and the mucous membrane thereof will often show punctiform hemorrhages. The pulmonary form shows the same symptoms as croupous pneumonia, with a frequent suffocative cough and oppressed breathing, or dyspnea. When the intestines are involved the patient strains to defecate, and passes shreds of intestinal mucus along with blood-stained feces. The urine also may be tinged with blood. Finally a severe diarrhea takes place, the animal becomes correspondingly weak, and death takes place in 24 to 36 hours. Cases may die in as short a period as six to eight hours, while in the pectoral form of the disease the animal may linger six or eight days. Cases have been reported which became chronic and in which death did not take place for a month or more. In some of the cases running an acute course, symptoms of toxemia are present; there is a lack of sensation of the skin, staggering gait, trembling, eyes fixed, neck at times bent to one side, and the eyes showing a wild expression. At times the animals appear as if in pain and look around at the flanks. In the pectoral form they may stand with the forelegs wide apart in evident effort to breathe more freely. Sometimes there is a champing of the jaws and a very free flow of glairy saliva dropping from the mouth.

The prognosis is decidedly unfavorable and 80 to 90 per cent of the cases result fatally.

Lesions.—The characteristic lesions of hemorrhagic septicemia consist of hemorrhagic areas in the subcutaneous, subserous, and muscular tissues, the lymph glands, and the viscera; in fact, they are distributed more or less widely throughout the body and vary in size from a mere speck to the diameter of a half dollar or even larger. The superficial form presents itself first as a doughy tumefaction of the skin about the region of the throat, neck, dewlap, or legs, which pits on pressure. This tumefaction consists essentially of a cero-gelatinous exudate into the subcutaneous and intermuscular tissues.

Bloody extravasations may take place in subcutaneous tissues in various places, but they are usually seen about the lower portion of the neck. The mucous membranes and submucous tissues of the mouth, tongue, pharynx, and larynx become involved in the process and are greatly thickened, inflamed, and infiltrated with serum. The mucous membrane becomes reddish purple, and that of the nostrils may in addition show hemorrhagic spots on its surface. The lymphatic glands in this region are also swollen and infiltrated with bloody serum. The salivary glands are pale and dry. The pectoral type, though at times existing alone, may coexist with the cutaneous form. The inflammatory edema of the mouth extends to the mucous membrane of the trachea and bronchi, producing an extensive thickening and a yellowish infiltration. The lung shows interstitial thickening from the outpouring of serum into its meshes. It may become pneumonic.

The diaphragm, heart sac, and heart walls show numerous hemorrhagic points and larger bloody extravasations. Sometimes there is a serous pleurisy, with more or less fibrinous exudate. In the intestinal form the submucous and subperitoneal tissues show alterations from a few hemorrhagic spots to large bloody suffusions, or even gelatinous infiltrations. This latter is seen about the region of the pancreas and in the folds of the mesentery. There is a severe hemorrhagic inflammation of the intestines and a staining of the intestinal contents with blood. The muscular system throughout shows hemorrhagic areas. The abdominal viscera, liver, spleen, and kidneys often present hemorrhagic lesions.

Differential diagnosis.—Anthrax, which presents superficial swellings, like hemorrhagic septicemia, may be distinguished from that affection on post-mortem examination by the enlargement and engorgement of the spleen, the contents of which are soft and tarry. The blood of anthrax animals is very dark, and does not become light red on exposure to air, nor does it coagulate, while in hemorrhagic septicemia the blood is normal in appearance and coagulates. The detection of the anthrax bacillus in the blood would be final.

In blackleg the animals affected are usually under 2 years of age. The swellings are quite evident, and usually occur on the legs, above the knees or hocks, and are distended with gas, which crackles, or crepitates, when pressed upon. If one of these tumors is opened, a bloody serum will exude, and the gas gives off the odor of rancid butter. The internal hemorrhages are not general, although they may occur. A microscopic examination of the juices from the tumefaction will show the blackleg bacillus.

In cerebrospinal meningitis the causative agent is unknown, but probably exists in the feed. It may occur in any locality and at any season of the year. There are no local swellings, and cattle are not frequently affected.

Cornstalk disease may be differentiated from this affection from the fact that it always occurs after the cattle are turned into a cornstalk field, by its sudden onset, the absence of any characteristic symptoms or post-mortem lesions, and the failure to find the causative agent in the blood.

In making a post-mortem examination of animals affected with hemorrhagic septicemia, it would be well to examine the articular surfaces of the long bones, as it has been reported that they are frequently ulcerated. This should apply especially to those cases that have shown lameness.

Treatment.—Treatment is absolutely useless, so far as we know at present, and for all practical purposes prophylaxis alone should be relied upon. The same sanitary precautions, such as isolation, disinfection, and burial or burning of all dead carcasses, should be observed as for anthrax and other highly infectious diseases. All the premises, barns, stalls, litter, and stable utensils should be thoroughly disinfected. Separate the apparently well animals from the sick by placing them in a separate lot.

Experiments by the Bureau of Animal Industry toward protective inoculation of the exposed cattle on infected premises have been made and the results have been so satisfactory that several commercial houses handling biological products are manufacturing a vaccine for hemorrhagic septicemia in accordance with the Government's experiments on this subject. The method of preparing the vaccine is similar to that recommended by Lignières. It consists in growing the cultures of the organism of the disease at 42 to 43° C. and preparing from them growing at this temperature two different strengths of vaccine. The weaker vaccine, which is used for the first injection, is grown for five days at this temperature, whereas the stronger vaccine, for the second injection, is grown for only two days. These vaccines are used with an interval of 10 days between the injections, the dose being 1 cubic centimeter at each injection. The effect of this vaccine in abating outbreaks already in progress has been highly satisfactory and it is plain that the general introduction of preventive vaccination for hemorrhagic septicemia must be of material benefit to the cattle raisers in the infected districts.

VESICULAR ERUPTION OF THE GENITAL ORGANS.

This contagious disease is called coital exanthema or vesicular exanthema, and is more or less prevalent on the Continent. It has also been observed in the breeding districts of the United States It is the subject of legislation in Germany, and governmental statistics are published annually concerning its distribution in the Empire. According to the reports from Hungary 492 head of cattle were attacked during 1898, 587 in 1899, and 207 in 1900.

A similar or perhaps identical disease of horses has the same distribution and is transmissible from horses to cattle and vice versa.

The disease may be defined as a highly contagious eruption situated upon the external genital organs of both sexes and accompanied with little or no general disturbance of health. The contagion, the nature of which remains still unknown, is transmitted mainly during copulation. The bull may have the disease and convey it to all the cows with which he comes in contact, or he may become infected by one cow, and, although not showing the disease, he may, during copulation, transmit it for several days after to all other cows. Simple contact between one cow and another may convey the disease, or the sponges used in cleaning the diseased may carry the virus to the healthy. It has also been conveyed to healthy cows by these animals lying with their hind quarters against infected wooden troughs.

Symptoms.—The period between the infection and the appearance of symptoms is somewhat variable. It is usually given as three to six days. It may be briefer or much longer. In cows the mucous membrane of the vagina and the vulva become swollen, inflamed, very tender, and covered with dark-red spots. The secretion is very abundant and consists at first largely of serum and mucus resembling the white of an egg. Small vesicles then appear, which rapidly burst and are converted into excoriations or deeper ulcerations. The secretion becomes more purulent and is apt to dry in crusts about the root of the tail. The eruption is accompanied with much itching and difficulty in urinating. The walk may be stiff and awkward. In bulls the eruption is situated on the prepuce and the end of the penis, and consists of pimples, vesicles, and ulcers, as in cows. It is accompanied with a little purulent discharge from the prepuce, itching, and difficulty in urinating. In severe cases the inflammation and swelling may extend backward to the scrotum and forward upon the abdomen.

The disease lasts from one to four weeks and always terminates in recovery. The acute stage lasts only four or five days, while the complete healing of the inflammation is slow. The eruption is usually accompanied with very little general disturbance. If the pain and irritation are severe, there may be some light loss of appetite and diminished milk secretion in cows. The disease rarely causes abortion. Chronic catarrh of the vagina and permanent sterility frequently follow as sequelæ.

Treatment need not be resorted to excepting in severe cases. The secretion and exudation should be washed off and a mild antiseptic applied, such as a 1 per cent solution of carbolic acid (1 ounce to 3 quarts of water) or 2 per cent solution of cresol compound in water. Care must be taken not to carry the disease from the sick to the well by sponges, etc., which have come in contact with the affected organs. These should be destroyed. To prevent the spread of the disease the infected animals should be kept isolated until they have recovered.

RABIES OF CATTLE.

Rabies is a disease preeminently affecting the canine race, although all warm-blooded animals, including man, are susceptible to the malady, which is always communicated through bites from a preceding case. It has required many years of patient, scientific research to lead the ablest investigators to a clear comprehension of the cause, nature, and characteristics of this affection. It was known and described several centuries prior to the beginning of the Christian era, and from the earliest dawn of history it has been feared and dreaded. Its terrible manifestations have always been surrounded with an atmosphere of awe and mystery, and it is not surprising that myths, fallacies, and misconceptions in regard to it have been common and widely accepted. As the investigations by which we have come to a tolerably clear understanding of the facts concerning rabies have been comparatively recent, and for the most part, have appeared in scientific periodicals, fallacies in regard to the disease continue to have a strong hold upon the public mind. For instance, it is still a widely prevalent belief that if persons or animals are bitten by a dog they are liable to become rabid if the dog should contract the disease at any future time. There is no foundation for this impression, and it would be a great comfort to many people who are now and then bitten by animals if the fallacy of this idea were known. All experience, both scientific and practical, goes to show that rabies is transmitted only by animals that are actually diseased at the time the bite is inflicted. Rabies is an infectious disease involving the nervous system and characterized by extreme excitability and other nervous disorders and always terminating in death. The contagion of this disease has never been isolated, but the fact that it is caused by a specific organism principally found in the nervous system is indisputable. For instance, if an emulsion of the brain of a rabid animal is filtered through a germ-proof filter, the filtrate will be harmless. This fact indicates that the infectious principle is not in solution, but is an organism withheld from the filtrate by the filter. This contagion can be propagated only in the body of an animal. It is transmitted naturally from one animal to another solely by bites, and the old idea of spontaneous appearance of the disease is absolutely fallacious. It may be produced artificially by inoculating susceptible animals with an emulsion of the brain or spinal cord, as well as the saliva, milk, and other secretions of the affected animal. The blood, on the contrary, seems to be free from the infectious principle. The saliva contains the virus, which, under natural conditions, is introduced into or under the skin on the tooth of the rabid animal. The disease is widespread, being found in many countries of Europe, Asia, and Africa, and in certain sections of the United States.

Owing to the rigid quarantine regulations enforced against dogs imported into Australia, that country remains absolutely free from the disease. Following the canine race, cattle seem to be the most frequently affected, probably because rabid dogs, next to their morbid desire to attack other members of their own race, have a better opportunity to bite grazing cattle than any other species of animal. The relative frequency of rabies in these two species of animals is indicated by the carefully compiled statistics of the German Empire, which shows that 904 dogs and 223 cows died of rabies in 1898, while in 1899 there were 911 cases in dogs and 171 in cattle. The latter receive bites most frequently on the hind legs and in the hips and about the lower jaw. These places are most accessible to dogs, owing to the habit of cattle to drive their tormentors away by lowering their heads and using their horns. Every animal bitten does not necessarily develop the disease, but the per cent of fatalities has been variously estimated, and averages from 25 to 30. This, however, depends on the location and size of the wound as well as the amount of hemorrhage produced, and various other conditions. In general, the nearer the bite is located to the central nervous system and the deeper the wound inflicted, the greater the danger of a fatal result. In cases in which the hemorrhage resulting from the bite is profuse, there is a possibility that the virus will be washed out of the wound and thus obviate the danger of subsequent appearance of the disease.

The virus after being deposited in the wound remains latent for an extremely variable period of time, which also depends on the size and depth of the wound as well as its location and the amount of the virulent saliva introduced. Experiments have proved that the virus follows the course of the nerves to the spinal cord and along the latter to the brain before the symptoms appear. Gerlach, having collected the statistics from 133 cases, has found this time, known as the period of incubation, to vary from 14 to 285 days. The great majority of cases, however, contract the disease in one to three months after the bite has been inflicted.

Symptoms.—As in dogs, both furious and dumb rabies are met with, the former being more common in cattle. A sharp line of distinction, however, can not be drawn between these two forms of the disease, as the furious form usually merges into the dumb, from the paralysis which appears prior to death. The typical cases of dumb rabies are those in which the paralysis appears at the beginning of the attack and remains until death. The disease first manifests itself by a loss of appetite and rumination, stopping of the secretion of milk, great restlessness, anxiety, manifestation of fear, and change in the disposition of the animal. This preliminary stage is followed in a day or two by the stage of excitation, or madness, which is indicated by increasing restlessness, loud roaring at times with a peculiar change in the sound of the voice, violent butting with the horns and pawing the ground with the feet, with an insane tendency to attack other animals, although the desire to bite is not so marked in cattle as in the canine race. A constant symptom is the increased secretion of saliva with a consequent frothing at the mouth, or the secretion may hang from the lips in long strings. Constipation is marked, and there is manifested a continual, although unsuccessful, desire to defecate.

Spasms of the muscles in different parts of the body are also seen at intervals. About the fourth day the animal usually becomes quieter and the walk is stiff, unsteady, and swaying, showing that the final paralysis is coming on. This is called the paralytic stage. The loss of flesh is extremely rapid, and even during the short course of the disease the animal becomes exceedingly emaciated. The temperature is never elevated, it usually remaining about normal or even subnormal. Finally, there is complete paralysis of the hind quarters, the animal being unable to rise, and but for irregular convulsive movements lies in a comatose condition and dies usually from the fourth to the sixth day after the appearance of the first symptom.

Anatomy.—If animals which have succumbed to rabies are examined post mortem, very slight evidence of disease will be found in any of the organs, and, indeed, the absence of any specific lesions may be considered as characteristic. The blood is dark and imperfectly coagulated. The throat is frequently reddened, and there may be small spots of extravasated blood in the intestines. The stomachs are usually empty. In the spleen there may be hemorrhagic enlargements (infarcts). The cadavers rapidly undergo decomposition.

Differential diagnosis.—It is not an easy matter to decide definitely that a given animal has rabies, since the symptoms given above belong in part to a variety of other diseases, among which may be mentioned the excitement seen in young animals following close confinement, certain vegetable and mineral poisons, acute enteritis, and alterations of the central nervous system in cattle, the most common of which is tuberculosis of the brain and its covering membranes. The post-mortem lesions, however, should assist in making a correct diagnosis. Tetanus may readily be differentiated from rabies by the persistence of muscular cramps, especially of the face and abdomen, which cause these muscles to become set and as hard as wood. In tetanus there is also an absence of a depraved appetite or of a willful propensity to hurt other animals or to damage the surroundings. The cow remains quiet and the general muscular contraction gives her a rigid appearance. There is an absence of paralysis which marks the advanced stage of rabies. The form of dumb rabies in dogs is characterized by the paralysis and pendency of the lower jaw, while in tetanus the jaws are locked. This locking of the jaws in cattle renders the animal incapable of bellowing, as in rabies. Finally, tetanus may be distinguished from rabies by the fact that the central nervous system does not contain the infectious principle, while in rabies the inoculation of test rabbits with the brain or cord of a rabid animal will produce the disease with characteristc symptoms after an interval of 15 to 20 days. This period of incubation is much longer than in tetanus, since the inoculation of rabbits with tetanus cultures invariably results in death after a short period and usually within three days. The positive evidence that a rabid dog has been near cattle would greatly assist in making a decision in doubtful cases.

The disease in dogs is pretty well recognized by most people, but in case a suspected dog is killed it is desirable to open the animal and examine the contents of the stomach. While feed is absent, a variety of odd things may be present which the abnormally changed appetite of the rabid dog has induced it to swallow. Among such things may be straws, sticks, glass, rags, earth, pieces of leather, and whatever the animal may have encountered small enough to be swallowed. This miscellaneous collection in the stomach of dogs, together with absence of feed, is regarded by authorities as a very valuable sign, and in case of doubt may be made use of by laymen. In important cases, however, the head of the dog, cow, or other suspected animal should be removed and sent to the nearest biological laboratory, where a positive diagnosis can be made within 36 hours by the histological examination of the plexiform nerve ganglia, and within two or three weeks by the intracerebral inoculation of rabbits with an emulsion of the brain of the suspected animal.

Treatment.—This is useless after the first appearance of symptoms. When, however, a wound inflicted by a rabid animal can be discovered, it should be immediately cauterized or even completely extirpated, care being taken to cut entirely around the wound in the healthy tissues. For cauterizing the wound, fuming nitric acid, the hot iron, and 10 per cent solution of zinc chlorid are the most efficacious. To afford an absolute protection, this should be done within a few moments after the bite has been inflicted, although even as late as a few hours it has been known to thwart the development of the disease.

Pasteur originated and perfected a system of preventive inoculation against this disease which has greatly reduced the mortality in human subjects. Its application to animals, however, is difficult and requires considerable time and expense. A method of vaccination applicable to animals, consisting of a single injection of a suspension of "fixed" rabies virus, is now being quite extensively employed by veterinarians. Sanitary regulations which seek to control effectively the disease by exterminating it among dogs are most likely to prove successful. The measures which are adopted to this end can not be discussed in this place, but it is a striking fact that where the muzzling of all dogs has been rigidly enforced, as in England and in certain German districts, the disease has been practically stamped out.

TUBERCULOSIS.

[Pls. XXXIV–XXXVIII.]

Tuberculosis is an infectious and communicable disease characterized in its early stages by the formation, in various organs of the body, of minute nodules or tubercles, which contain *Mycobacterium tuberculosis*, the cause of the disease.

The disease, in its various manifestations, has been known for many centuries, and legislative enactments having reference to the destruction of affected animals and forbidding the use of the flesh date far back into the Middle Ages. The opinions entertained regarding the nature and the cause of the malady varied much in different periods and very markedly influenced the laws and regulations in vogue. Thus, in the sixteenth century, the disease was considered identical with syphilis in man. In consequence of this belief very stringent laws were enacted, which made the destruction of tuberculous cattle compulsory. In the eighteenth century this erroneous conception of the nature of the disease was abandoned and all restrictions against the use of meat were removed. Since that time, however, its communicable nature has been established by many investigators, and the tide of opinion has again turned in favor of repressing the disease and prohibiting the sale of contaminated products.

Occurrence.—The statistics concerning tuberculosis show that it is a disease prevalent in all civilized countries. In some countries, such as the northern part of Norway and Sweden, on the steppes of eastern Europe and Russia, in Sicily and Iceland, and in Algiers, it is said to be quite rare.

The returns from testing British cattle with tuberculin, supplied by the Royal Veterinary College, as stated in March, 1900, showed that among 15,392 animals tested 4,105, or 26 per cent, reacted.

During the slaughter of cattle for pleuropneumonia careful examinations of the carcasses were made for tuberculosis. Of 300 head killed near Edinburgh 120, or 40 per cent, were tuberculous. Of 4,160 killed in England 20 per cent were tuberculous. Of one of these lots of cattle (451 animals) the president of the Lancashire Farmers' Association testified that they were fairly representative cattle—cows, heifers, and growing stock—a thoroughly mixed lot; 20 per cent of them had tuberculosis.

Of 398 bovine animals taken haphazard in the city of Manchester, 120, or 30 per cent, were tuberculous. Among them were 168 cows, 69, or 41 per cent, being tuberculous, and 2 having diseased udders.

The result of testing the Queen's herd at Windsor was that 36 out of 40, or 90 per cent, were found tuberculous.

The investigations made by the British Dairy Farmers' Association deserve particular attention, coming as they do directly from a cattle owners' organization. The council of this association "resolved to submit the general consideration of the question to a committee, with a view to some more definite understanding as to the possible extent to which tuberculosis exists in dairy cattle." The secretary was instructed to write to a number of dairy farmers being members of the association, asking their cooperation and the use of their herds for the application of the tests. Of the herds offered, 9 were selected, containing 461 cows and 12 bulls, and 188 of these animals reacted, being 40.8 per cent. There were among these cattle 335 Shorthorns, of which 119, or 35 per cent, reacted; 67 crossbreds, of which 28, or 42 per cent, reacted; 47 Ayrshires, of which 37, or 80 per cent, reacted.

Another experiment of much interest is that of the Cheshire County Council. The technical instruction committee set aside £250 to be used by a joint committee from the agricultural and horticultural schools and Worleson Dairy Institute for applying the tuberculin test to their herds. The tests were made February 15, 1899. The results were: Worleson herd of 54 animals, 16 diseased, or 29.6 per cent; agricultural school herd of 17 animals, 4 diseased, or 23.5 per cent. The Worleson herd consisted of Shorthorn cows. In each herd the purebred Shorthorn bull was tuberculous. The results of the tuberculin test were confirmed by the slaughter of the animals and examination of the carcasses.

Sir T. D. G. Carmichael, member of Parliament for Midlothian, gave evidence before the royal commission that his Polled Angus herd was tested in the spring of 1895. "The results of the test were fearfully unexpected and alarming." Of 30 tested 13 showed decided reaction—43 per cent. Again, he speaks of having 41 animals tested the same spring and 16 reacted—39.5 per cent.

Of 80 Shorthorn cattle intended for export which were tested 34 reacted, or 42 per cent.

Of a herd of 25 British Shorthorns recently tested in quarantine 40 per cent were found tuberculous.

The addition of these animals above referred to gives 20,930 head examined and 5,441, or 26 per cent, pronounced tuberculous. And these herds were not selected because they were supposed to be tuberculous, but represent the general cattle stock of the country. These animals included at least 470 head of Shorthorns, of which 170, or 34 per cent, were tuberculous.

To these facts may be added the evidence of Prof. Bang that in the first half of the nineteenth century tuberculosis was brought to Denmark by cattle from Switzerland, Schleswig, and England, and that the same thing is now going on in Sweden and Norway, particularly through English cattle. Also the evidence of M. Sivori, chief of section at the ministry of agriculture, Argentina, who has investigated tuberculosis in that country and who says that "30 or 40 years ago tuberculosis was unknown in Argentine cattle, and it is still unknown among the native (criollo) cattle. Its appearance dates from the introduction of pure breeding animals. Statistics prove that tuberculosis is observed among the grades—above all among those of the Durham and less among the Hereford."

Moreover, the reports of the royal commission of Victoria, Australia, and of the New Zealand department of agriculture show a large proportion of tuberculous cattle in those colonies, where the disease was almost certainly carried by British cattle.

In the same manner that tuberculosis has been carried from Great Britain to Denmark, Sweden, Norway, Argentina, and Australia, it has also been taken to Canada. In one herd of imported cattle slaughtered in the Canadian quarantine station, 13 of the 14 animals were found tuberculous. One of the largest Shorthorn herds in Canada was some time ago tested because an animal from it was condemned when offered for shipment to the United States. This herd was found to be very bady affected, and an effort is being made to eradicate the disease by the Bang method. A Canadian official publication says of another Shorthorn herd, which at one time had a very high reputation, that when an investigation in regard to tuberculosis was recently made the disease was found among ordinary cattle wherever animals from this herd had been introduced, and that this herd, which had been looked upon as one of the greatest benefits to the farming community, was really a danger, because it disseminated tuberculosis among the farmers' herds. Still another well-known herd recently attracted attention because four animals from it offered for export to the United States were all tuberculous.

From December 23, 1900, to February 19, 1901, the period that the department inspector tested all Canadian cattle intended for shipment to the United States, 140 purebred Shorthorns and 3 Shorthorn grades were tested, and of the total number 26, or 18 per cent, reacted. During the first month that this inspection was enforced, and when it may be assumed that the condition of the cattle most nearly represented what it had previously been, 74 cattle were offered for importation, and 18, or 24.3 per cent, were found tuberculous.

In justice to Shorthorn cattle it should be said in this connection that they are probably no more susceptible to tuberculosis than are other breeds, but the disease has been allowed to spread in certain herds and families to such an extent as to give a wrong impression concerning the breed as a whole.

The slaughterhouse statistics of Prussia show 14.6 per cent of the cattle and 2.14 per cent of the hogs to be tuberculous. In Saxony the percentage is 29.13 with cattle and 3.10 with hogs. In the city of Leipzig the figures are 36.4 for cattle and 2.17 for hogs. (Siedamgrotzky.) Of 20,850 animals in Belgium tested with tuberculin in 1896, 48.88 per cent reacted. (Stubbe.) Of 25,439 tested in Denmark from 1893 to 1895, 49.3 per cent reacted; and of 67,263 tested from 1896 to 1898, 32.8 per cent reacted. (Bang.)

Figures available in the United States allow us to make a reliable estimate of the extent of tuberculosis of cattle. The following summary is presented:

Statistics of tests for tuberculosis in the United States, 1917 to March 1, 1922.

State.	Number tested.	Number tuberculous.	Per cent tuberculous.
Alabama	68,772	1,071	1.6
Arkansas	5,917	98	1.7
Colorado	1,959	76	3.9
Connecticut	29,286	4,695	16.0
Delaware	19,003	2,132	11.2
Florida	56,533	1,438	2.5
Georgia	46,522	998	2.1
Idaho	57,731	1,052	1.8
Illinois	92,781	6,112	6.6
Indiana	142,833	3,991	2.8
Iowa	158,514	9,958	6.3
Kansas	64,341	1,796	2.8
Kentucky	66,839	1,492	2.2
Louisiana	36,391	981	2.7
Maine	67,406	1,792	2.7
Maryland	65,888	5,491	8.3
Massachusetts	26,297	2,371	9.0
Michigan	163,323	5,361	3.3
Minnesota	240,888	7,555	3.1
Mississippi	99,245	503	.5
Missouri	196,208	2,587	1.3
Montana	165,640	3,346	2.0
Nebraska	125,162	3,947	3.2
Nevada	29,541	1,042	3.5
New Hampshire	16,623	1,697	10.2
New Jersey	32,184	2,542	7.9
New Mexico	3,897	39	1.0
New York	167,852	23,071	13.7
North Carolina	64,008	1,098	1.7
North Dakota	139,501	4,142	3.0
Ohio	97,612	4,470	4.6
Oklahoma	67,522	2,453	3.6
Oregon	123,792	2,581	2.1
Pennsylvania	102,465	6,322	6.2
Rhode Island	3,458	338	9.8
South Carolina	41,868	740	1.8
South Dakota	43,433	2,353	5.4
Tennessee	63,631	956	1.5
Texas	61,956	1,256	2.0
Utah	59,711	586	1.0
Vermont	160,361	11,486	7.2
Virginia	135,677	3,881	2.9
Washington	154,292	3,864	2.5
West Virginia	36,603	798	2.2
Wisconsin	285,269	8,166	2.9
Wyoming	22,811	322	1.4

Reports of tuberculin tests made on 400,000 cattle in the United States during the years 1893 to 1908 by Federal, State, and other officers with tuberculin prepared by the Bureau of Animal Industry show 37,008 reactions, or 9.25 per cent. These were mostly dairy cattle, and in some cases herds were suspected of being diseased.

Later reports of tuberculin tests made in the United States from July 1, 1917, to March 1, 1922, on 3,911,546 cattle by State, county, and Federal officers engaged in cooperative tuberculosis eradication work showed 153,046 reactions, or 3.9 per cent.

All cattle in the District of Columbia, numbering 1,701, were tested with tuberculin in 1909–10, and 18.87 per cent reacted. In 1909–11 herds in Maryland and Virginia supplying milk to the District of Columbia were tested, with 19.03 and 15.38 per cent of reactions, respectively, among 4,501 cattle.

All cattle in the District of Columbia were tuberculin tested in 1920–21, numbering 1,313, and 5 animals reacted, or 0.4 per cent, demonstrating that tuberculosis may be eradicated from all the herds in a circumscribed area.

The beef cattle of the United States show a much smaller proportion of the disease than dairy cattle, though the percentage of cattle found tuberculous in the Government meat-inspection service has increased considerably in recent years. This increase is due partly, but not wholly, to more stringent inspection. Of 7,781,030 adult cattle slaughtered under Federal inspection during the fiscal year ended June 30, 1911, 76,448 were found tuberculous, a percentage of 0.98.

From the statistics above referred to, and other data, it appears that in the more densely populated areas of Europe and America from 5 to 50 per cent of the dairy cattle are more or less affected with tuberculosis, while the proportion of beef cattle affected is distinctly less, ranging from 0.14 to 30 per cent. This difference is due to a number of causes. Beef cattle average younger when slaughtered. They are not so frequently stabled, and are for that reason less liable to infection, and as the males constitute a large proportion of this class of animals the effect of milk secretion in lowering the vital forces is not so apparent. In the United States it has been estimated that about 10 per cent of the dairy cattle are tuberculous, while only about 2 per cent of the beef cattle are so infected.

Cause and nature of the disease.—The cause of tuberculosis is the tubercle bacillus, which gains entrance to the body, lodges somewhere in the tissues, and begins to grow and multiply at that point. As this bacillus vegetates and increases in numbers it excretes substances which act as irritants and poisons and which lead to the formation of a small nodule, called a tubercle, at the point of irritation. As the bacilli are disseminated through the animal body they affect many parts and cause the formation of an enormous number of tubercles. By the union of such tubercles, masses of tubercular material are formed, which in some cases are of great size. The disease is called tuberculosis because it is characterized by the formation of these peculiar nodules, and the bacillus which causes the disease is for the same reason known technically as the *Mycobacterium tuberculosis*.

There are undoubtedly predisposing conditions which contribute toward the development of the disease; some of these are found in the animal body and others in the environment. An enfeebled condition caused by insufficient feed, exposure to great extremes of atmospheric temperature and insanitary surroundings, or the drain occasioned by heavy production of milk, appear to aid the development of the bacillus, and there is also a special individual susceptibility in some cases which may be otherwise described as an inability of the animal tissues to resist and destroy the bacilli when they have penetrated to the inner recesses of the body.

Among the conditions of environment which aid the development of tuberculosis may be mentioned stabling with lack of ventilation, damp buildings, the keeping of many animals together, drafts of air which cause colds and catarrhs, and, in general, everything which prevents the animals from developing and maintaining the highest condition of health. None of these conditions of body or environment are sufficient to cause the disease, however, unless the animals are exposed to the *Mycobacterium tuberculosis* and it penetrates the tissues of their bodies.

The ways in which the tubercle bacilli find their way into the body may be considered under four heads: (1) By inhalation into the lungs; (2) by taking into the digestive tract in the milk of tuberculous cows or with other contaminated feed; (3) during coition when the sexual organs are tuberculous; (4) from the tuberculous mother to the fetus in the uterus. The bacilli can reach the lungs by inhalation only when the bacilli are thoroughly dried and pulverized and in condition to be carried by currents of air.

It is well known that the bacilli withstand drying for months before they lose their power of producing disease. They leave the bodies of diseased animals in several ways. There may be a little discharge occasionally coughed up as a spray from the diseased lungs, or this material may be swallowed and the bacilli carried off with the excrement, or milk may be spilt, or there may be a discharge from the vagina when the genital organs are tuberculous. There may also be ulcers of the intestines, from which many bacilli escape with the feces. The bacilli from these sources may become dried and pulverized and carried in the air of the stable and into the lungs of still healthy cattle, where the disease then develops.

The disease of the stomach, intestines, and mesenteric glands is very probably the result of feed infection. Tubercle bacilli may have been scattered upon the feed by diseased animals, but the most common source of such infection is the milk of tuberculous cows. Calves may become infected in this way. The disease may remain latent until the animal becomes older. The not infrequent occurrence of tuberculosis of the uterus and ovaries makes it probable that the disease may be transmitted by a diseased bull or carried by a healthy one from a diseased cow to a number of healthy cows.

The source of infection is always some previous case of the disease, for the disease can never rise spontaneously; hence, in those stables in which there is frequent change of cattle the introduction of tuberculosis by cattle coming from other infected stables is the most frequent source of infection. Since the bacilli when dried can be carried by the air, it is not necessary that healthy animals come in direct contact with cases of disease to become infected. In general, the greatest number of cases occur in the immediate environment of cities, where there are not only abundant opportunities for infection, owing to the frequent introduction of new animals into herds, but where the sanitary conditions may be regarded as the poorest.

The bacillus of tuberculosis was discovered by Robert Koch in 1882. It is a slender, rodlike body (see Pl. XXVIII, fig. 6) from one-third to two-thirds the diameter of a red blood corpuscle in length. As already explained, when the bacillus has become lodged in any organ or tissue it begins to multiply, and thereby causes an irritation in the tissue around it, which leads to the formation of the so-called tubercle. The tubercle, when it has reached its full growth, is a little nodule about the size of a millet seed. It is composed of several kinds of tissue cells. Soon a change takes place within the tubercle. Disintegration begins, and a soft, cheesy substance is formed in the center, which may contain particles of lime salts. When these tubercles continue to form in large numbers they run together, forming masses of various sizes. The disintegration which attacks them leads to the formation of large cheesy masses of a yellowish color, containing more or less of lime salts in the form of gritty particles. These large tuberculous masses are surrounded by or embedded in layers of fibrous tissue which in some cases becomes very dense and thick.

The disease is thus a development of these tubercles in one or more organs of the body. The distribution and number of the tubercles determine the course of the disease.

In a large number of cases the changes are limited to the lungs and the serous membranes[1] of the thorax and abdomen. Pathologists have been in the habit of calling the lung disease tuberculosis and the disease of the serous membranes "pearly disease." Statistics have shown that in about one-half of the cases both lungs and serous membranes are diseased, in one-third only the lungs, and in one-fifth only the serous membranes. At the same time the lymphatic glands near the diseased organs are usually involved. Other organs, such as the liver, not infrequently contain tubercles. Though the disease

[1] These membranes comprise the smooth, very delicate, glistening lining of the large body cavities. In the thorax the serous membrane (pleura) covers the ribs and diaphragm as well as the whole lung surface. In the abdomen a similar membrane (peritoneum) lines the interior of the cavity and covers the bowels, liver, spleen, etc.

may remain restricted to a single organ, it now and then is found generalized, affecting all organs of the body.

In the lungs (Pl. XXXIV) the changes observed vary according to the age and intensity of the disease process. They usually begin with the appearance of very minute tubercles. These may appear in large numbers on the surface of the lungs or within the lung tissue. Later the contents become cheesy and partly calcified. When these tubercles are sufficiently numerous to become confluent, large masses may be formed, which undergo the same retrogressive changes of caseation and calcification. In addition to the formation of tubercles in the lung tissue, certain other changes take place. There is usually bronchitis with abundant catarrhal secretion; this plugs up the smaller air tubes, and the lung tissue supplied with air by the tubes collapses. Subsequently it becomes filled with yellowish, cheesy matter, which greatly distends the small air tubes and air vesicles (bronchopneumonia). The connective tissue between the lung lobules, around the tubercles, and around the air tubes becomes thickened and indurated. In the larynx and the bronchi tubercles may vegetate upon the mucous membrane, and ulcers may result from their breaking down. The inflammatory irritation which the growth of the tubercles on the surface of the lungs arouses gives rise to adhesion of the lungs to the ribs and diaphragm. This adhesion is sometimes so firm and extensive that the lungs appear grown to the chest wall.

When, therefore, the lungs in advanced stages of the disease are cut open we observe large yellowish masses, from one-quarter to three-quarters of an inch in diameter, of a cheesy texture, in which calcified, gritty particles are embedded and which are surrounded by very firm connective tissue. The neighboring lung tissue, when collapsed and involved in bronchopneumonia, has the color and consistency of pale-red flesh. The air tubes, large and small, stand out prominently on the cut surface. They are distended with a pasty, yellowish, cheesy mass, surrounded and enveloped in thick mucus, and their walls greatly thickened. The larger bronchi may be sacculated, owing to the distention produced by the cheesy contents.

The disease usually attacks the bronchial glands, which are situated on the trachea and bronchial tubes at the bifurcation. The changes in the glands are the same as those going on in the lung tissue, and they frequently reach an enormous size.

The tubercle formation on the serous membranes covering the lungs and chest wall (Pl. XXXVII, fig. 2), which may go on at the same time with the lung disease or independent of it, has been called "pearly disease," on account of the peculiar appearance of the tubercles. These begin as very minute, grayish nodules, which give the originally smooth, lustrous membrane a roughened appearance. These minute tubercles enlarge, become confluent, and project above the surface of the membrane as wartlike masses, attaining the size of peas. In this stage their attachment to the membrane is by means of delicate fibers. The attachment is loose, so that the tubercle hangs by a short pedicle or neck and may be moved slightly to and fro. Large masses are frequently formed by a coalescence of many tubercles and the secondary formation of the same. These may be found on the lungs, the ribs, and the diaphragm. These tubercles likewise undergo degenerative changes. The center partly softens and partly calcifies into a grayish mortarlike mass, and is gritty. Associated with the formation of tubercles on the pleura, those glands situated back of the center of the lungs between the two main lobes (posterior mediastinal) become greatly enlarged and the center cheesy. (Pl. XXXVI, fig. 1.) They may compress the esophagus and interfere with swallowing. The size attained by these tumors and new growths is well illustrated by the fact that, taken together, they not infrequently weigh from 60 to 80 pounds. The bronchial glands, which in the healthy state are not so large as horse-chestnuts, have been found to attain a weight of more than 10 pounds.

In the abdominal cavity tubercles may be found, both in the organs and on the serous membranes covering them. They are situated usually on the omentum, or caul (see Pl. XXXVI, fig. 2), the diaphragm, and the walls of the abdomen. In the liver large and small tubercular masses are occasionally encountered. (See Pl. XXXV.) The mesenteric glands are occasionally enlarged and tuberculous; likewise the glands near the liver. Tubercles may also develop in the spleen, the kidneys, the uterus and ovaries, and the testicles.

Tubercular affection of the intestines seems to be quite rare, although ulcers of the large intestines have been observed. Nodules may also form under the serous covering of the intestines.

The brain and spinal cord are occasionally found tuberculous. Of 40 cases, Semmer found tuberculosis of the brain in 4. It is not improbable that, owing to the infrequency of exposing the brain and spinal cord, tuberculosis may have escaped the attention of pathologists, and it may be that it is not so uncommon as is generally supposed. The tubercles occur on the membranes of the brain as well as in the substance of the brain itself. They project into the ventricles as masses, varying in size from a pinhead to a hen's egg. They finally lead to various inflammatory changes. Jöhne has observed numerous small tubercles on the membranes of the spinal cord.

Very rarely tuberculous lesions have been observed in the bones and muscles of the body. Not so rare, however, is the affection of the lymphatic glands embedded in the muscular tissue, and those which can be felt beneath the skin. These are situated at the joints, under the jaw, and along the neck.

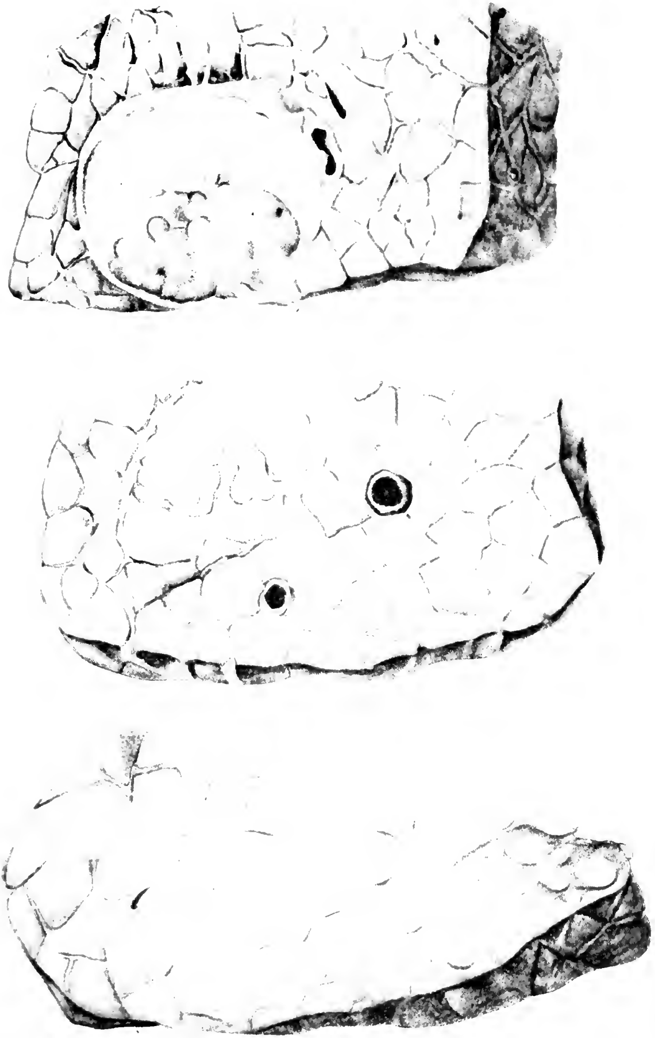
Of late tubercular disease of the udder in cows (Pl. XXXVIII) has received considerable attention from sanitarians, owing to the infection of the milk with the virus of tuberculosis. According to those who have given this subject special attention, the udder becomes swollen uniformly and quite firm. This swelling, which is painless, frequently attacks but one quarter, more rarely two, these being usually the hind quarters. The larger milk ducts contain yellowish, cheesy particles, in which are many tubercle bacilli. Later larger nodules can be felt within the udder, which undergo the various changes to which tubercles are subject. The udder may grow very hard to the touch and become very large, weighing in some cases up to 40 pounds. The milk, at first normal, becomes thin and watery after a month or so, and is mixed with flakes and tubercle bacilli.

As regards the frequency of the tuberculous processes in the different organs, the following carefully compiled statistics of the disease in Bavaria and Baden may serve as a guide:

	Per cent.
Bavaria:	
Tuberculosis of lungs and serous membranes	41
Tuberculosis of lungs alone	33
Tuberculosis of serous membranes alone (pearly disease)	17
Tuberculosis of other organs	8
Baden:	
Tuberculosis of lungs alone	21
Tuberculosis of serous membranes alone	28
Both combined	39
Generalized tuberculosis	9
Tuberculosis of the sexual organs alone	3

Symptoms.—The beginning of the disease usually passes unnoticed, inasmuch as it is very slow and insidious and rarely accompanied with fever. When the lungs are involved a dull, short cough is noticed, which may later on become prolonged, convulsive, and very troublesome to the animal. The cough is more frequent in the morning after movement and drinking. The breathing varies. Only when much of the lung tissue is diseased is it labored and accompanied with active movements of the chest and nostrils. Discharge from the nose is rare or absent. At times, however, when the tubercles have broken down and cavities containing cheesy masses have formed in the lung tissue, or when the air tubes have become filled with cheesy and mucous masses, coughing will dislodge them and cause their discharge. In advanced stages the breath may have a disagreeable odor. Pressure on the chest wall may give rise to pain.

The general effect on the body is at first slight. In fact, animals may remain in good flesh for a considerable time. Invariably as the disease progresses loss of flesh and appetite and paleness of the mucous membranes become manifest. These symptoms are accompanied with a gradual diminution of the milk secretion. The debilitated condition of the animal is also manifested by a staring coat and a tough, dry, harsh skin (hidebound). Digestive disturbances are indicated by tympanites, or distention of the rumen by gas, colic,



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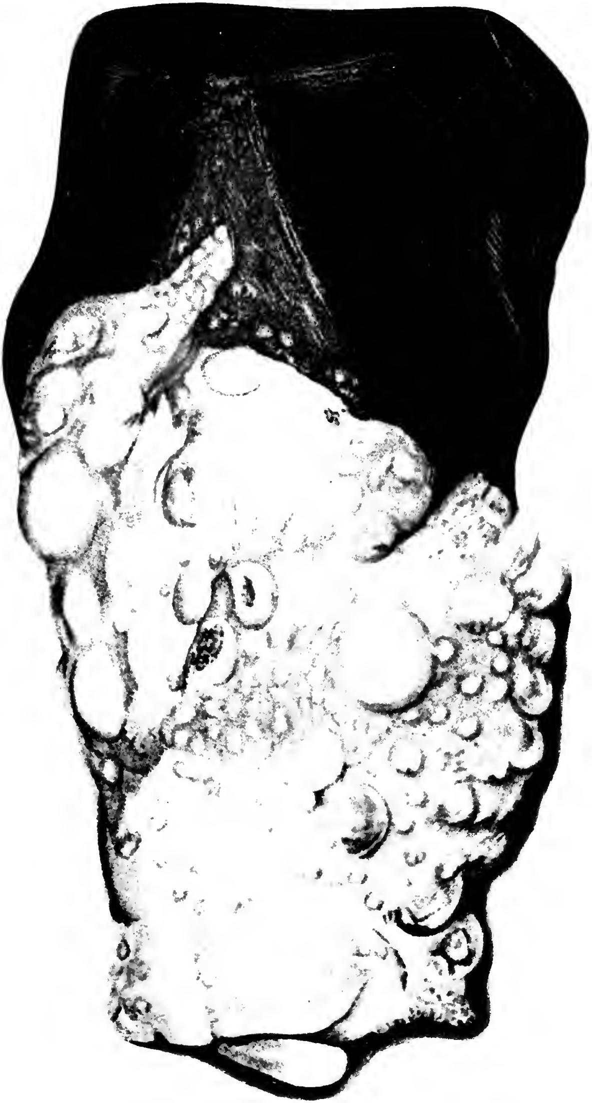
TUBERCULOSIS OF THE LUNGS OF CATTLE.



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TUBERCULOSIS OF THE LIVER.

Fig. 1

Fig. 2

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TUBERCULOSIS OF LYMPH GLAND AND OF OMENTUM (CAUL).

FIG. 1.—TUBERCULOSIS OF SIRLOIN AND PORTERHOUSE CUTS OF BEEF.

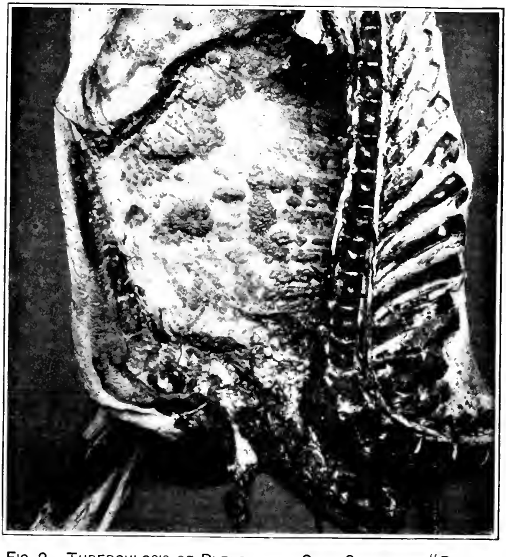
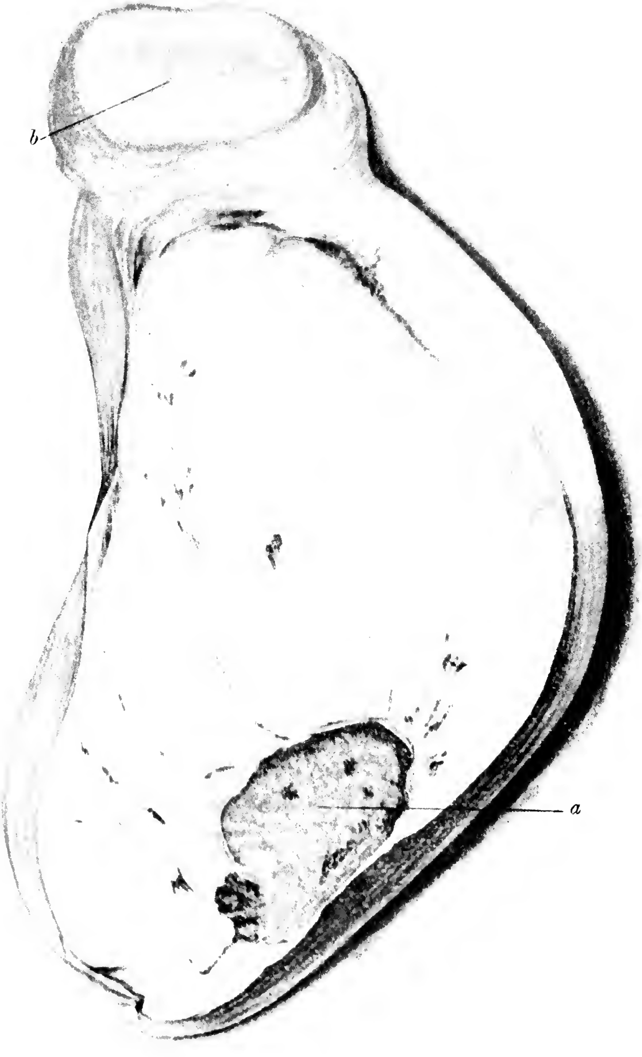


FIG. 2.—TUBERCULOSIS OF PLEURA OF A COW, SO-CALLED "PEARLY DISEASE."



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TUBERCULOSIS OF COW'S UDDER.

and diarrhea, alternating with constipation. The animal generally dies from exhaustion after a period of sickness which may last months or even years.

Tuberculosis in the abdominal organs is often signalized by abortion and by abnormal sexual manifestations. When the brain is involved, the disease may cause convulsions, unconsciousness, paralysis, as well as peculiar movements in a circle, oblique position of the head, etc. Lydtin quotes the following description of the disease as taken from a Swiss sanitary order:

A dry, short, interrupted, hoarse cough, which the sick animals manifest, especially in the morning at feeding time, still more after somewhat violent exertion. At first these animals may be full blooded and lay on a considerable amount of fat when well fed. As the disease progresses they grow thin and show more and more those appearances which indicate diseased nutrition, such as a staring, lusterless, disheveled coat; dirty, tense skin, which appears very pale in those regions free from hair. The temperature of the skin is below normal. The loss of fat causes sinking of the eyes in their sockets. They appear swimming in water, and their expression is weak. The cough is more frequent, but never or very rarely accompanied with discharge. The body continues to emaciate, even with plenty of food and a good appetite, so that the quantity of milk is small. At times in the early stages of the disease, still more in the later stages, the diseased animals manifest considerable tenderness when pressure is applied to the front or the sides of the chest by coughing, moaning, etc. Often symptoms are wanting in spite of the existence of the disease.

Lydtin also quotes at length a description of the abnormal sexual desire occasionally observed among cows when affected with this disease.

Diagnosis.—A disease so varied in its attack upon the different organs of the body and in the extent of the disease process must necessarily lead to mistakes when diagnosis is attempted by ordinary means of examination. It has been confounded with the later stages of pleuropneumonia, with parasitic diseases of the brain, the lungs, the intestines, and with actinomycosis. A careful examination of the lungs by ausculation and percussion enables the expert to locate large tuberculous masses, owing to dullness, loss of respiratory murmur, and abnormal sounds, such as blowing, whistling, and creaking. The majority of cases of tuberculosis in cattle, however, including many in which the lungs are quite seriously involved, can not be detected in this manner.

THE TUBERCULIN TEST.

The tuberculin test, which is marvelously accurate in its indications, has been almost universally adopted for the detection of tuberculosis. Tuberculin is a drug prepared by sterilizing, filtering, and concentrating the liquids in which the tubercle bacillus has been allowed to vegetate. It contains the cooked products of the growth

TUBERCULOSIS.

DESCRIPTION OF PLATES.

PLATE XXXIV. Tuberculosis of the lungs of cattle. The upper figure represents a large cheesy mass, surrounded by a capsule of connective tissue, the whole embedded in healthy lung tissue. The lower figure illustrates in section a mass of tubercles which have undergone cheesy degeneration, and some of which are surrounded by dense connective tissue.

PLATE XXXV. Tuberculosis of the liver. A large portion of the lobe represented in the plate has undergone tuberculous changes. Numerous nodules are shown in various stages of the disease, the majority of which, however, contain the yellowish, partly cheesy, partly gritty areas characteristic of advanced tuberculous degeneration. This large mass involves the surface of the liver, and also extends into the liver substance.

PLATE XXXVI. Tuberculosis of lymph gland and of omentum (caul).

Fig. 1. A lymph gland from the region of the thorax behind or above the esophagus, or gullet (posterior, or dorsal, mediastinum). The gland is shown cut through and laid open. It is very much enlarged, and the yellowish cheesy masses which represent tissue undergoing tuberculous changes are well shown on the cut surface.

Fig. 2. Omentum, or caul, resting upon the paunch. The reddish nodules with which the membrane is beset are tubercles, the product of the disease.

PLATE XXXVII. Fig. 1. Tuberculosis of the sirloin and porterhouse cuts of beef. The grapelike tuberculous growths are mainly restricted to the lining membrane of the abdomen.

Fig. 2. Tuberculosis of the pleura of a cow, so-called "pearly disease." Notice the grapelike clusters of tubercular nodules scattered over the lining membrane of the chest (pleura).

PLATE XXXVIII. Tuberculosis of cow's udder. The udder was uniformly swollen and quite firm. Small cheesy foci and yellowish lines of tuberculous material follow the course of the milk ducts. The mucous membrane of the milk cistern (*a*) is ulcerated and covered with yellowish cheesy particles. The supramammary lymphatic gland (*b*) is greatly enlarged and contains many miliary tubercular foci.

of these bacilli, but no living bacilli; consequently, when this substance is injected under the skin of an animal it is absolutely unable to produce the disease, cause abortion, or otherwise injure the animal. In case the injected animal is normal there is no more effect upon the system than would be expected from the injection of sterile water; however, if the animal is tuberculous, a decided rise of temperature will follow the use of tuberculin by the subcutaneous method. This substance, discovered by Koch, has the effect, when injected into the tissues of a tuberculous animal, of causing a decided rise of temperature or other manifestations while it has no such effect upon animals free from the disease. The value of tuberculin for this purpose was tested during the years 1890 and 1891 by Guttman, Roeckl and Schütz, Bang and Salomonsen, Lydtin, Jöhne and Siedamgrotzky, Nocard, and many others. It was at once recognized as a most remarkable and accurate method of detecting tuberculosis even in the early stages and when the disease had yet made but little progress. It is now quite generally employed.

The tuberculin test came into existence through the most careful and thorough scientific experimentation.

As a result of its use an accurate diagnosis may be established in more than 90 per cent of the cases tested. The relatively few failures in diagnoses are included among two classes of cattle. The first class contains those that are tuberculous, but which do not react either because of the slight effect of an ordinary-sized dose of tuberculin on an advanced case of the disease with so much natural tuberculin already in the system, or on account of a recent previous test with tuberculin which produces a tolerance to this material, lasting for about six weeks. The second class includes those that are not tuberculous, but which show indications of a reaction as a result of (*a*) advanced pregnancy, (*b*) the excitement of œstrum, (*c*) concurrent diseases, as inflammation of the lungs, intestines, uterus, udder, or other parts, abortion, retention of afterbirth, indigestion, etc., (*d*) inclosure in a hot, stuffy stable, especially in summer, or exposure to cold drafts or rains, (*e*) any change in the method of feeding, watering, or stabling of the animal during the test. Notwithstanding all these possibilities of error, the results of thousands of tests show that in less than 3 per cent of the cases tested do these failures actually occur. In the first class the chances of error are decidedly reduced by the skilled veterinarian by making careful physical examination and diagnosing clinically these advanced cases, and by the injection of double or triple doses into all recently tested cattle, with the taking of the after-temperature, beginning two hours following the injection and continuing hourly for 20 hours.

It is therefore apparent that tuberculin should be applied only by or under the direction of a competent veterinarian, capable not only of injecting the tuberculin but also of interpreting the results, and particularly of picking out all clinical cases by physical examination. The latter observation is extremely important and should always be made on every animal tested.

In the second class, where the temperature test is used, errors are avoided by eliminating from the test those cases that are nearing parturition or are in heat or show evidence of the previously mentioned diseases or exhibit temperatures sufficiently high to make them unreliable for use as normal. Where other methods of test are used these conditions do not have an important bearing on the results. In addition, a satisfactory tuberculin must be used: also an accurate thermometer and a reliable syringe, in order that a sufficient dose of tuberculin may be given. Finally, the number of apparent errors of the tuberculin test will be greatly diminished if a careful post-mortem examination is made, giving especial attention to the lymph glands. This low percentage of failures being the case, cattle owners should welcome the tuberculin test, not only for their own interest but for the welfare of the public as well. Where this method of diagnosing the disease has been adopted tuberculosis is gradually being eradicated. Without its use the disease can not be controlled and the owner is confronted with serious and continuous losses; with its use the disease can be eradicated from the herd, a clean herd established in a few years without very serious loss or hardship, and the danger of its spread to man removed. Tuberculin may therefore be considered a most beneficial discovery for the stock raiser.

Law has clearly stated the question when he says—

> Many stock owners still entertain an ignorant and unwarranted dread of the tuberculin test. It is true that when recklessly used by ignorant and careless people it may be made a root of evil, yet as employed by the intelligent and careful expert it is not only perfectly safe, but it is the only known means of ascertaining approximately the actual number affected in a given herd. In most infected herds living under what are in other respects good hygienic conditions two-thirds or three-fourths are not to be detected without its aid, so that in clearing a herd from tuberculosis and placing both herd and products above suspicion the test becomes essential. * * * In skilled hands the tuberculin test will show at least nine-tenths of all cases of tuberculosis when other methods of diagnosis will not detect one-tenth.

Probably the most popular objection to tuberculin is that it is too searching, since it discovers cases in which the lesions are small and obscure. While this fact is admitted, it should also be remembered that such a small lesion to-day may break down and become widely disseminated in a relatively short period. Therefore any cow affected with tuberculosis, even to a slight degree, must be considered as dangerous not only to the other animals in the herd but also to the consumer of her products.

In 1898 Bang, of Copenhagen, one of the highest European authorities, in his paper presented to the Congress for the Study of Human and Animal Tuberculosis, at Paris, said:

Numerous tests made in almost every civilized country have demonstrated that in the majority of cases tuberculin is an excellent means for diagnosing the existence or nonexistence of the disease, but giving us no positive information as to the extent to which the disease has progressed. When tuberculin produces a typical reaction we may be almost sure that there exists in the body of the animal a tubercular process. The cases in which a careful examiner has not succeeded in finding it are very rare, and I am led to believe that when, notwithstanding all the pains taken, it has escaped discovery, the reason is that it is located in a portion of the body that is particularly inaccessible. Nevertheless, it is not to be denied that a fever, entirely accidental and of short duration, may in some rare cases have simulated a reaction. However this may be, the error committed in wrongly condemning an occasional animal for tuberculosis is of no practical consequence.

A worse aspect of the case is that there are some diseased animals in which tuberculin fails to discover the existence of tuberculosis. In most of these, no doubt, the deposits are old, insignificant, and generally calcified, or they are cases where the disease is arrested and perhaps in process of recovery, and which are possibly incapable of disseminating the contagion. But it is known that there are cases, not altogether rare, where tuberculin fails to cause a reaction in a highly tuberculous animal, and consequently one in which the disease exists in an extremely contagious form. For this reason a clinical examination should always be made of an animal which does not give a reaction but which shows symptoms indicating that, notwithstanding the test, it may suffer from tuberculosis.

Nocard, of Paris, wrote also in 1898 as follows:

The degree of certainty of the indications furnished may be stated in precise terms. *The observation of a clear reaction to tuberculin is unequivocal; the animal is tuberculous.* The pretended errors imputed to the method are explained by the extreme sensitiveness of the reagent, which is capable of detecting the smallest lesion. It often requires prolonged and minute researches in the depths of all the tissues to discover the few miliary centers, the presence of which has been revealed. The reaction is absolutely specific. In those cases where it is observed with animals which show lesions of another disease (actinomycosis, hydatid disease, verminous bronchitis, distomatosis), it may be affirmed that there exists, in addition to these conspicuous changes, a tuberculous center which alone has provoked the reaction.

The failure to react does not necessarily imply absence of tuberculosis. Such failures of tüberculin are very exceptional. They are seen most frequently with animals affected with tuberculosis in a very advanced stage and made evident by plain external signs. Sometimes, also, there are found at the post-mortem examination of animals which have not reacted small fibrous or calcified lesions in such a condition that one is tempted to believe them cured. Whether sterile or not, these lesions have no tendency to increase, and they are not very dangerous from the point of view of contagion.

These opinions of two eminent authorities, living in different countries, after long experience of their own and after studying the results of the many tests made in different parts of the world, should have great weight. They are essentially the same throughout.

In 1897 Voges compiled statistics of tuberculin tests, the accuracy of which had been determined by post-mortem examination. Of 7,327 animals tested, it appeared that errors had been made with 204, or 2.78 per cent. In the work of the Pennsylvania Live Stock Sanitary Board post-mortem examinations were made on about 4,400 reacting cattle and the disease was found in all but 8 of those which had given characteristic reactions.

The results of a much larger number of tests might be compiled at this time, but they would not materially change the average of those already mentioned. It is plain that tuberculin is a remarkably accurate test of tuberculosis, that the animals which react may be safely considered as tuberculous, and that when a careful clinical examination is practiced in addition to the test there are few animals in a dangerous condition which escape detection.

The first questions asked by those who oppose the adoption of the tuberculin tests are: Is this test infallible? and, if it is not infallible, why should it be forced upon the cattle owners of the country?

In answer to these questions it may be said that tuberculin is not absolutely infallible, and yet it is by far the best method of diagnosing tuberculosis that has been discovered. It is much better than any test known for pleuropneumonia when that disease was eradicated.

Practically all the animals that react are affected with tuberculosis and should be separated from the herd, not only in the interest of the public, but in the interest of the owner of the herd. The best authorities admit, after studying many thousands of tests, that there are few, if any, mistakes made in condemning cattle which show a typical tuberculin reaction. The errors are principally in the other direction—that is, some tuberculous animals are not discovered by the tuberculin test, but as the most dangerous of these may be picked out by ordinary clinical examination this fault of tuberculin is not so serious as it at first sight appears. This being the case, it should not be necessary to force the tuberculin test upon owners. They should be anxious to adopt it in their own interests and for the protection of their patrons. There is to-day no greater danger to the cattle and hog industries than that which confronts them in the form of tuberculosis, a disease already widespread and rapidly extending. Furthermore, in view of the results revealed by numerous tests covering vast numbers of animals, tuberculin must be considered as harmless for healthy animals. It has also been clearly demonstrated that tuberculin interferes in no way with the milking function in healthy cattle; neither in the quantity of milk nor in butter-fat value has any variation been detected. The conclusions of some of the best authorities on the subject of its harmlessness to healthy animals are given below.

Nocard and Leclainche state:

Direct experiments and observations collected by thousands show that the tuberculin injections have no unfavorable effect. With healthy animals the system is indifferent to the inoculation; with tuberculous animals it causes slight changes which are not at all serious.

Bang has written as follows on this question:

We will now consider the following question, a very important one, in the application of tuberculin, viz: Can the reaction produce a worse condition in tuberculous animals than before existed? Hess emphatically states that it can, and on this account he earnestly warns against its application. My attention has been directed to this question from the beginning. In my first publication on tuberculin injection I reported two cases in which acute miliary tuberculosis was proved in two high-grade tuberculous cows several weeks after the tuberculin injection. I then stated my suspicion that perhaps the tuberculin injection had some connection with this, just as is often supposed to be the case in human practice. With my present very large amount of material for observation at hand I may express the following opinion: Such an acute development of tuberculosis as a result of tuberculin injection is to be feared only exceptionally, and then in cases of advanced tuberculosis. *It must not be forgotten that acute miliary tuberculosis by no means rarely accompanies an advanced tuberculosis of long standing.* It is therefore impossible to offer strict proof of the causal connection with the injection, and only oft-repeated observation could make this probable. In support of my view I offer the following: In the course of the last three years I have made careful post-mortem examinations of 83 tuberculous animals, which have been removed from my experiment farm, Thurebylille. Among these were 18 (or, strictly speaking, 23) high-grade tuberculous animals. I have been able to prove miliary tuberculosis in only 4 of these. Among the others, which showed less developed tuberculosis, I have never found miliary tuberculosis, and with very many I have never found any sign of a more rapid development of the process. On the contrary, it has been proved that the disease was restricted locally, often for years, in spite of yearly repeated injections. Dissections were made at very different periods after the injections—in 17 cases from 4 to 12 days after the last test. In all of these cases earlier tests had been made months or years before. In 28 cases the injection took place from 19 days to 2 months before the butchering; in 3 of these cases earlier injections had been made. In 38 cases from two and one-half months to one year intervened between the last injection and the dissection. Dissection gives the best explanation of this question, but a clinical observation, continued for years, of a herd tested with tuberculin can render very essential aid. If Hess's opinion is correct, it is to be assumed that tuberculosis must take an unusually vicious course in such herds, but this I have been unable to prove. At Thurebylille there has existed for three years a reacting division, consisting originally of 131 head and now 69. Although these animals are yearly tested, and although most of them react every year, the division certainly appears to be made up of healthy animals, and the farm inspector has expressed the decided opinion that the tuberculosis in this division is no more developed than at the beginning of the experiment. The testimony of many owners of large herds of cattle which have long ago been injected is to the same effect. I will adduce statements from several. A farm tenant whose cattle were injected 20 months previously, when 82 per cent of the grown animals reacted, wrote me recently as follows: "Only 2 cows from the division of 100 head had been sold as decidedly tuberculous. The majority appeared afterwards, just as before, entirely healthy. The fat animals which had been slaughtered had been pronounced healthy by the butchers." Another farm tenant with a herd injected in 1894 had not been obliged to remove a single animal from the tuberculosis division, numbering 70 head. A large farm owned in Jutland stated in September that he had traced no undesirable result from the injection. His herd of 350 had been injected in February and about 75 per cent reacted. Similar answers have been given by other owners and veterinarians.

A veterinarian who had injected 600 animals, among them a herd of a large farm, 18 months previously, expressed the belief that the injection had produced in no single case an unusually rapid or vicious course of tuberculosis. In spite of a demand made months ago, I have received thus far no report from any veterinarian of an undesirable result.

On a large farm, on which before the injection tuberculosis had appeared in a vicious form, the owner had the impression that the severe cases had afterwards become more numerous. He had, however, not suffered severe losses, and 8 months later the large reacting division by no means made a bad impression. Finally, it is to be noticed that tuberculin has been employed on a large scale in Denmark for years, and still the demand from farmers constantly increases. This could certainly not be the case if the injections were generally followed by bad results.

Paige said, after the tests of the herd of the Massachusetts Agricultural College, that "its use is not followed by any ill effects of a serious or permanent nature."

Lamson, of the New Hampshire College Agricultural Experiment Station, said: "There is abundant testimony that its use is not in any way injurious to a healthy animal."

Conn, who made a special study of the present attitude of European science toward tuberculosis in cattle, reached the following conclusions:

It has been, from the first, thought by some that the use of tuberculin produces a direct injury upon the inoculated animals. This, however, is undoubtedly a mistake, and there is no longer any belief anywhere on the part of scientists that the injury thus produced is worthy of note. In the first place, the idea that it may produce the disease in a perfectly healthy animal by the inoculation is absolutely fallacious. The tuberculin does not contain the tubercle bacillus, and it is absolutely certain that it is impossible to produce a case of tuberculosis in an animal unless the tubercle bacilli are present. The use of tuberculin, therefore, certainly can never produce the disease in the inoculated animal.

It has been more widely believed, however, that the inoculation of an animal with this material has a tendency to stimulate an incipient case of tuberculosis. It has been thought that an animal with a very slight case of the disease may, after inoculation, show a very rapid extension of this disease and be speedily brought to a condition where it is beyond any use. The reasons given for this have been the apparent activity of the tuberculosis infection in animals that have been slaughtered shortly after inoculation. This has been claimed, not only by agriculturists who have not understood the subject well, but also by veterinarians and bacteriologists. But here, too, we must recognize that the claim has been disproved, and that there is now a practical unanimity of opinion on the part of all who are best calculated to judge that such an injurious effect does not occur. Even those who have been most pronounced in the claim that there is injury thus resulting from tuberculin have, little by little, modified their claim, until at the present time they say either that the injury which they formerly claimed does not occur or that the stimulus of the disease is so slight that it should be absolutely neglected in view of the great value which may arise from the use of tuberculin. Apart from two or three who hold this very moderate opinion, all bacteriologists and veterinarians unite in agreeing that there is no evidence for believing that any injury results. In Denmark, especially, many hundreds of thousands of animals have been inoculated, and the veterinarians say there is absolutely no reason in all their experience for believing that the tuberculin inoculation is followed by any injurious results.

In 1898 tuberculosis was found in the large Shorthorn herd belonging to W. C. Edwards, of Canada, who with commendable promptness and public spirit had his animals tested, and at once proceeded to separate the diseased from the healthy animals. They were all finely bred animals, and of the very class which we have been told are most susceptible to the injurious effects of tuberculin. After using this test regularly for two years, Mr. Edwards wrote as follows:

> I have seen nothing to lead me to believe that the tuberculin test had any injurious influence on the course of the disease. It is by no means our opinion that the disease has been stimulated or aggravated by the application of the tuberculin test. All animals that we have tested two or three times continue as hale and hearty as they were previously, and not one animal in our herds has broken down or failed in any way since we began testing.

Mr. Edwards, in December, 1901, verbally stated that his views as to the harmlessness of tuberculin remained unchanged, and that he had not seen the least ill effect in any of his cattle from its use.

Those who have had most experience with tuberculin have failed to observe any injurious effects following its use upon healthy cattle. With tuberculous cattle it produces a fever of short duration, and in the great majority of cases all derangement of the system which it causes disappears within 48 hours after the tuberculin is administered. There appear to have been a very few cases in which the disease was aggravated, and a greater number in which it was benefited by the injection of tuberculin. The cases of abortion following the tuberculin test have not been numerous, even when cows were tested within a few weeks of the normal time of calving. The few cases of this kind which have occurred may be explained by the fact that abortion in cattle is a very common occurrence, and that it would inevitably happen sometimes after the tuberculin test as a mere coincidence and without any relation between the test and the loss of the calf. The cases of abortion which have been cited appear to be no more numerous than might be expected to have occurred among the same number of cattle within the same period if the test had not been applied.

At the present time there is ample evidence to show that tuberculin is the most reliable means of detecting tuberculosis in the living animal and that its use is not attended by any harmful aftereffects.

An act of Congress was approved July 24, 1919, for the purpose of controlling and eradicating tuberculosis of animals. The official means of detecting tuberculosis in the living animal is the tuberculin test, which may be applied by three different methods—the subcutaneous, the intradermic, and the ophthalmic. It is not necessary to discuss here the details of these three methods, which are made use of in the work of eradication of tuberculosis.

The plan adopted by the State and Federal authorities in eradication of the disease is known as "The Accredited-Herd Plan." Under this plan herds are tested under State and Federal supervision, the diseased animals are appraised, removed, and slaughtered under Federal inspection. Retests are then made after definite periods of time until two successive tests show all the animals to be free from the disease. At this time the herd owner is given a certificate of an accredited herd.

Details concerning the accredited-herd plan may be obtained by applying to the Chief of the Bureau of Animal Industry, Washington. D. C.

THE TUBERCULIN TESTS.

Testing animals with tuberculin is the process of introducing tuberculin into the animal and interpreting results according to well-known standards.

From the investigations and observations that have been mentioned, it may be safely concluded—

1. That the tuberculin test is a wonderfully accurate method of determining whether an animal is affected with tuberculosis.
2. That by its use the animals diseased with tuberculosis may be detected and removed from the herd, thereby eradicating the disease.
3. That it has no injurious effect upon healthy cattle.
4. That the comparatively small number of cattle which have aborted, suffered in health, or fallen off in condition after the test were either diseased before it was made or were affected by some cause other than the tuberculin.

THE SUBCUTANEOUS TEST (UNDER THE SKIN).

The most frequently used method of testing is the subcutaneous test, which consists in injecting the proper quantity of tuberculin underneath the skin into the subcutaneous tissue. If an animal is tuberculous, the action of the tuberculin causes a fever, which is indicated by a rise in temperature. This rise, under ordinary conditions, may occur any time between the eighth and twentieth hours after the tuberculin is injected, but in some cases it is desirable to measure the temperature before the eighth hour and continue to the twenty-fourth hour or longer.

The temperatures are measured at least 3 times in advance of the injection, at 2-hour intervals, to learn whether the animal is in proper condition to receive the test. The temperatures after injection are taken every 2 hours until the test is completed. The proper interpretation of the temperatures is made by the person applying the test, and a careful observance of any clinical changes is always important in determining the result. It can not be set forth too strongly that the test, including the two following methods, should be attempted only by those who are properly qualified to do the work.

THE INTRADERMIC TEST (INTO THE SKIN).

The intradermic test for detecting tuberculosis is used to a considerable extent, especially in area work and on range cattle not easily controlled. When made by those who have become skilled in its application, it is very accurate. In this test the tuberculin is injected between the layers of the skin, only a few drops being used, and it is usually applied in the region at the base of the tail, where the skin is soft and nearly hairless. The intradermic test is satisfactory also for the diagnosis of tuberculosis in swine and, when so used, the tuberculin is applied into the skin of the ear near its base.

The reaction from the intradermic test consists of a swelling at the point of injection and is observed from 72 to 150 hours after the injection. The character of the swelling varies, and a proper diagnosis of tuberculosis by this test can be made only by an experienced person.

THE OPHTHALMIC TEST (INTO THE EYE).

Still another method, known as the ophthalmic test, is used quite frequently and has been found to be of considerable value in what is known as "check" testing; that is, it is used in connection with either of the previously described methods. Sometimes a tuberculous animal that fails to react to those tests shows evidence of the disease upon the application of the ophthalmic test. The ophthalmic tuberculin is placed in one eye and the other eye is used as a check. A reaction is indicated by a characteristic discharge from the eye receiving the treatment, which may occur in from 3 to 10 hours after the application or even later. Some swelling and inflammation of the eye and lids are often noted.

TREATMENT OF TUBERCULOSIS.

Treatment of the disease is not seriously considered by any authorities at the present time.

The measures to be adopted to prevent the spreading of the disease must take into consideration not only the tubercle bacillus, but likewise all those circumstances that make cattle more susceptible to the disease, and which have already been dwelt upon. It would be useless to repeat here all that has been said above on the transmission of tubercle bacilli from one animal to another, and on the dangers of certain debilitating influences. A careful study of these influences will show how tuberculosis may, at least in some cases, be prevented. Great care should be bestowed upon the breeding, the surroundings, and the feed of the animal, so that the latter may be put into a condition to resist infection even when exposed to it. A tuberculin test should be applied to all strange cattle before they are introduced into the herd, and those which show a reaction should be refused.

A rigid exclusion of tuberculous animals is all that is necessary to prevent the appearance of the disease, provided cattle are not infected by consumptive persons and animals. The transmission of the disease from man to cattle is probably not frequent, but is regarded as a possible source of infection.

Tuberculosis in cattle must also be considered as bearing upon tuberculosis of other domesticated animals, particularly hogs. In Europe and the United States this disease is not uncommon among hogs, and appears to be on the increase. The reason for its existence may be looked for in the feeding of pigs with skim milk, buttermilk, and whey from creameries, with the offal of the abattoirs, with the household refuse generally, and behind tuberculous cattle. If tuberculosis is common among cattle, it is likely to be transmitted to hogs kept in this way.

The carcasses of animals which have died of tuberculosis should be buried deeply so that they can not be eaten by other animals. This is likewise true of all organs or tissues of slaughtered animals containing tubercles. These should never be fed to other animals, such as hogs, dogs, and cats, and should either be destroyed by fire or deeply buried.

When any of the animals in a herd of cattle show evident symptoms of tuberculosis, or when the tuberculin test proves that they are affected with this disease, the best method of procedure in most cases is to have the affected animals slaughtered and the stables disinfected. A large proportion of the animals which are slightly affected yield carcasses which are perfectly wholesome and fit for human food, but in all such cases there should be an inspection by an expert at the time of slaughter to determine which carcasses may be used and which should be destroyed.

The disinfection of stables may be accomplished by thoroughly cleaning them, scrubbing the floors with hot water, brushing down all loose dust from the walls, and tearing off all woodwork which is partly decayed. Then the whole interior of the stable should be covered with a good coat of limewash containing 1 part of formalin (which is a 40 per cent watery solution of formaldehyde) to 30 parts of the lime wash, or 4 ounces of formalin to each gallon of lime wash.

Similar precautions should be observed in removing the manure of the infected herd from the barnyard and other places accessible to cattle, since it is known that tuberculous cattle frequently eliminate large numbers of tubercle bacilli through the feces. The ground under the manure pile should then be disinfected, either by the above-mentioned formalin solution or by unslaked lime thickly sprinkled over the soil.

If all the animals which react are destroyed and the stables disinfected in this manner, the herd should remain free from the disease unless other affected animals are added to it. The introduction of the disease in this manner may be avoided by requiring a tuberculin test of all new animals admitted on the premises.

Unfortunately it is a fact that tuberculous animals which have been tested several times may become so accustomed to tuberculin that they will no longer react; consequently it is always advisable to purchase cattle from some one who is known to be reliable, as otherwise animals of this kind may be treated with tuberculin for the purpose of hiding the disease.

In the case of very valuable purebred animals and under exceptional circumstances it may be more advantageous to retain the reacting animals which are in good condition in order to breed from them and in that manner avoid the excessive loss which would follow from their immediate slaughter. This may be done if proper precautions are adopted.

The disposal of reactors depends upon the State laws and live-stock regulations of the State in which the herd belongs. If this policy is followed it should be attempted only after careful study of the plan known as the Bang method of controlling tuberculosis. The live-stock officials of the State should be frequently consulted and their advice followed; otherwise failure will surely ensue. The plan necessitates considerable trouble and is not recommended except under the circumstances mentioned.

BOVINE TUBERCULOSIS AND THE PUBLIC HEALTH.

The increasing amount of evidence pointing to the identity of human and animal tuberculosis, combined with the extraordinary mortality of human beings from this disease, often amounting to 10 to 14 per cent, has raised the question in all civilized countries as to how far animal, and especially bovine, tuberculosis is to blame for this high mortality. The medical and veterinary professions have approached this problem with equal zeal, and much has come to light within recent years which enables us to come to some conclusion. If this disease is transmitted from animals to man, how does the transmission take place? As comparatively few people come in direct contact with tuberculous cattle, it must be either through the meat, the milk, the butter, the cheese, or through all these products that the virus enters the human body. The question has thus narrowed itself down to the food products furnished by cattle.

It has become a very urgent question, especially in the poorer countries of Europe, whether all flesh from tuberculous animals is unfit for human food. It is argued there that if it can be shown that in the majority of cases of tuberculosis the bones and the muscular system are free from infection, there is no reason why the meat should not be put on sale under certain restrictions. The question may be resolved into two divisions: (1) How frequently does the disease invade those parts of the body which are used as food? (2) When the disease process is manifestly restricted to the internal organs, do tubercle bacilli circulate in the blood and lymph and can they be detected in the muscular tissue?

(1) Disease of the bones is not unknown, although very rare. According to Walley, it appears chiefly in the spongy bones of the head and backbone and in the long bones of the limbs. Occasionally the ends of the bones, where they are covered by the synovial membrane of the joints, are dotted with tubercles. The muscular system itself is very rarely the seat of tuberculous deposits, although the lymphatic glands lying near and among the muscles may be not infrequently diseased.

(2) Whether tubercle bacilli are found in muscle juice independent of any tuberculous deposits is a question which must be approached experimentally. There is on record a great variety of opinions on this matter, some authorities considering all flesh from tuberculous animals unfit for food, while others hold a contrary view. Experiments have shown that in rare cases the flesh of tuberculous cattle contains a small number of tubercle bacilli. In Germany the flesh of animals in which the disease is just beginning, or in which it is restricted to one or more related organs, is not rejected. When, however, the disease has affected the muscles or bones, or lymphatic glands situated on or between them, the flesh is condemned as unfit and dangerous. Animals are also rejected in which it is evident, from the general distribution of tubercles throughout the various organs, that the bacilli have been distributed by the blood and may have been carried into the muscular system (generalized tuberculosis).

Concerning the infectious nature of milk secreted by tuberculous cows, authorities have universally agreed that when the udder itself is in the slightest degree involved the milk possesses infectious properties, and is therefore dangerous. Tubercle bacilli in large numbers have been found in the milk and the udder under such circumstances. Unlike other affections of the udder, tuberculosis of this organ does not at once change the appearance and the quality of the milk secreted. Bang states that for at least a month after the disease has appeared the milk is normal in appearance and may be consumed and sold without arousing the suspicion of the owner. Considerable danger is, therefore, involved in this disease, and the necessity for the careful inspection of dairy cows seems more urgent than ever.

Authorities are, however, not fully agreed as to whether the milk from tuberculous cows in which the udder is apparently not invaded by the disease should be considered dangerous or not. Some incline to the belief that the milk secreted by healthy udders is never infectious, even when the lungs or other organs are affected; that, in other words, the tubercle bacilli are rarely, if ever, separated from the lesions which they produce, and that the udder itself must be diseased before tubercle bacilli can appear in the milk. Experiments made with the milk of tuberculous cows in which there were no indications of udder disease do not bear out this theory, since tubercle bacilli have been found in their milk. Some authorities still believe that the udder is diseased when the milk is infected, but that the disease escapes observation. However this may be, the fact that the udder may be diseased and the disease not recognizable simply casts suspicion upon all milk from tuberculous animals. We know that the milk of tuberculous cattle may or may not contain tubercle bacilli when the udder is apparently free from disease, but we have no rapid method of determining whether in any given case the milk contains tubercle bacilli or not. Moreover, the bacilli may be absent at one time and present at another in milk from the same cow. When we consider, therefore, the extent of tuberculosis and the hidden character of the disease, a certain degree of suspicion rests upon all milk from untested cattle. Fortunately, tubercle bacilli are readily destroyed by the temperature of boiling water, and hence both meat and milk are made safe, the former by the various processes of cooking, the latter by boiling for a few moments. It is incumbent upon all communities to have dairy cows examined and tested with tuberculin. If disease is detected, the affected animal should be killed at once or else all opportunity for the sale of such milk removed by appropriate measures. Where milk or cream is sold to the trade in large towns or cities pasteurization should be required as an additional safeguard.

Recently there has been much discussion of the question as to whether human and animal tuberculosis are identical diseases and as to the possibility of the tuberculosis of animals being transmitted to man or that of man being transmitted to animals.

The fact that tuberculous material from human subjects often failed to produce serious disease in cattle was observed by a number of the earlier investigators who experimented with such virus. It was the experiments and comparative studies of Theobald Smith, however, which attracted special attention to the difference in virulence shown by tubercle bacilli from human and bovine sources when inoculated upon cattle. Smith mentioned also certain morphological and cultural differences in bacilli from these two sources, and in the location and histology of the lesions in cattle produced by such bacilli. He did not conclude, however, that bovine bacilli could not produce disease in the human subject, but said:

> It seems to me that, accepting the clinical evidence on hand, bovine tuberculosis may be transmitted to children when the body is overpowered by large numbers of bacilli, as in udder tuberculosis, or when certain unknown favorable conditions exist.

Koch, however, in his address at the British Congress on Tuberculosis, went far beyond this and maintained that "human tuberculosis differs from bovine and can not be transmitted to cattle." As to the susceptibility of man to bovine tuberculosis, he said it was not yet absolutely decided, but one was "nevertheless already at liberty to say that, if such a susceptibility really exists, the infection of human beings is but a very rare occurrence." He emphasizes this view in the following language:

> I should estimate the extent of infection by the milk and flesh of tubercular cattle and the butter made of their milk as hardly greater than that of hereditary transmission, and I therefore do not deem it advisable to take any measures against it.

This conclusion was so radically different from the views of most experimenters and so out of harmony with facts which had apparently been demonstrated by others that it at once aroused opposition in the congress, followed by the adoption of dissenting resolutions, and led to numerous investigations in various countries. Koch's conclusions were based upon his failure to produce tuberculosis in cattle and other animals by inoculating them with tuberculous material of human origin and his success in causing progressive and fatal tuberculosis in the same kinds of animals when inoculated with tuberculous material of bovine origin. With such positiveness did he hold to the constant and specific difference between the human and bovine bacillus that he promulgated an experimental method of discriminating between them. Speaking of the etiology of intestinal tuberculosis in man, he said:

> Hitherto nobody could decide with certainty in such a case whether the tuberculosis of the intestine was of human or of animal origin. Now we can diagnose them. All that is necessary is to cultivate in pure culture the tubercle bacilli found in the tubercular material, and to ascertain whether they belong to bovine tuberculosis by inoculating cattle with them. For this purpose I recommend subcutaneous injection, which yields quite specially characteristic and convincing results.

These important and comprehensive conclusions followed from a comparatively few experiments upon animals, and apparently no effort had been made to learn to what extent human tubercle bacilli may differ in their virulence for cattle or what grades of virulence there might be among bacilli of bovine origin. Vagedes had already shown that bacilli were sometimes present in human lesions which were as virulent as bovine bacilli, but his work was wholly ignored by Koch.

A considerable number of investigators, including Chauveau, Vagedes, Ravenel, De Schweinitz, Mohler, De Jong, Delépine, Orth, Stenström, Fibiger and Jensen, Max Wolff, Nocard, Arloing, Behring, Dean and Todd, Hamilton and Young, the German Tuberculosis Commission, and Theobald Smith, have found tubercle bacilli in the bodies of human beings who died of tuberculosis which proved to have about the same virulence for cattle as had the bacilli from bovine animals affected by the disease.

Kossel, in a preliminary report, stated that the German commission had tested 7 cultures of tuberculosis from cattle and hogs—4 from cattle and 3 from hogs. Two proved acutely fatal in cattle after eight to nine weeks; 4 likewise produced a generalized tuberculosis, but which certainly had a more chronic course, while 1 of the cultures caused only an infiltration at the point of inoculation, with some caseous foci in the adjoining prescapular gland and in one of the mediastinal glands, and there was lacking the spreading of the tuberculosis over the entire body which they were accustomed to see after the injection of cultures of bovine tuberculosis. "Hence," says Kossel, "among bovine tuberculosis bacilli there can also occur differences with regard to the virulence."

The German commission also tested 39 different freshly made cultures from tuberculous disease in man. Nineteen did not produce the slightest symptoms in cattle; with 9 others the cattle exhibited after four months very minute foci in the prescapular glands, which were mostly encapsuled and showed no inclination to progress; with 7 other cases there was somewhat more marked disease of the prescapular glands, but it did not go so far as a material spreading of the process to the adjoining glands. There were 4 cultures, however, which were more virulent and caused generalized tuberculosis in the cattle inoculated with them.

It would appear, therefore, that hereafter everyone must admit that it is impossible always to tell the source of a culture of the tubercle bacillus by its effect when it is inoculated upon cattle. One of the bovine cultures failed to produce generalized tuberculosis in cattle, and some of the human cultures did produce it in such animals. Moreover, while some of the human cultures caused no disease at all, others led to the development of minute foci in the prescapular glands, and still others to somewhat more marked disease of the glands. There were, consequently, four degrees of virulence noted in these 39 cultures of bacilli from human sources and three degrees of virulence in the 7 cultures from animal.

Now, if we accept the views of Koch as to the specific difference between human and bovine tubercle bacilli, and that the human bacilli produce only localized lesions in cattle, while bovine bacilli produce generalized lesions in them, must we not conclude that the one nonvirulent bovine culture was in reality of human origin, and that the animal from which it was obtained had been infected from man? This is a logical deduction, but reverses the dictum laid down at London that human tuberculosis is not transmissible to cattle. Again, how are we to explain the human cultures of medium virulence? Are they human bacilli which, for some unknown reason, are increasing in virulence and approaching the activity of the bovine bacillus, or are they really bovine bacilli which have multiplied in the human body until their virulence has become attenuated? In whatever manner these questions are decided it would seem that the findings of the German commission, instead of supporting Koch's views that we can decide with certainty by the inoculation of cattle as to the source of any given bacillus, really show that this method of diagnosis is extremely uncertain in the present condition of our knowledge.

It is definitely admitted that 4 of the human cultures caused generalized tuberculosis in cattle; Kossel suggest, however, that it may be possible that the bacilli in cases of human tuberculosis under certain circumstances can likewise attain a very high pathogenic activity for cattle without being for that reason bovine bacilli. Undoubtedly the German commission is confronting the two horns of a dilemma, either one of which is fatal to the views of Koch as stated with such positiveness at London. If we accept this suggestion thrown out by Kossel, we must conclude that Koch was wrong in his claim that human tuberculosis can not be transmitted to cattle, and thus with one blow we destroy the entire experimental support which he had for his argument before the British Congress on Tuberculosis. If, on the other hand, we accept the conclusion which follows from the principle laid down by Koch for the discrimination between human and bovine bacilli, and which appears to be favored by Kossel, we must admit that bovine tuberculosis is an extremely important factor in the etiology of human tuberculosis. Of the 39 cases of human tuberculosis tested, 4, or more than 10 per cent, were virulent for cattle and would be classified as of bovine origin; however, these 4 cases, were all found among the 16 cases of tuberculosis in children which the commission investigated; hence it is plain that 25 per cent of the cases tested of tuberculosis in children would by Koch's method be classified as of bovine origin.

In the Bureau of Animal Industry two distinct lines of experiments have been carried on, in order that one might serve as a check against the other. There has been, however, no discrepancy in the results. De Schweinitz, in the Biochemic Division, Bureau of Animal Industry, isolated 9 cultures from human tuberculosis. Two were derived from human sputum, 3 from cases of generalized tuberculosis in adults, and 4 from cases of generalized tuberculosis in children. By comparing these cultures with a newly isolated virulent culture of bovine tuberculosis, there were found among them 2 cultures from children which were identical in their cultural and morphological characters with the bovine bacillus. These cultures also killed rabbits and guinea pigs in as short a time as did the bovine bacillus. Hogs which were inoculated subcutaneously with these 2 cultures from children died of generalized tuberculosis. Two calves weighing more than 300 pounds each were inoculated subcutaneously with these virulent human cultures, and as a result developed generalized tuberculosis. A yearling heifer inoculated with 1 of the cultures showed generalized tuberculosis when killed three months after inoculation. Both the cattle and the hogs had been tested with tuberculin and found to be free from tuberculosis before the inoculations were made. It is important to observe in this connection that 2 out of 4, or 50 per cent, of the cultures obtained from cases of generalized tuberculosis in children proved virulent for cattle.

Mohler, working in the Pathological Division, Bureau of Animal Industry, obtained 3 very virulent cultures of tubercle bacilli from the human subject. A goat inoculated subcutaneously with 1 of these cultures died in 37 days with miliary tuberculosis of the lungs involving the axillary and prescapular glands. This bacillus was obtained from the mesenteric gland of a boy. Of still greater interest is a bacillus isolated by Mohler from human sputum. A goat inoculated subcutaneously with a culture of this germ died in 95 days of pulmonary tuberculosis. A cat inoculated in the same manner died in 23 days of generalized tuberculosis. A rabbit similarly inoculated died in 59 days of pulmonary tuberculosis. Another rabbit inoculated with a bovine culture for comparison lived 10 days longer than the one inoculated with this sputum germ. Mohler also inoculated subcutaneously a 1-year-old heifer with a culture derived from the tuberculosis mesenteric gland of a boy 4 years of age. This culture was always refractory in its growth under artificial conditions, and the bacilli were short, stubby rods, corresponding in appearance to the bovine type. At the autopsy, held 127 days after the inoculation, the general condition was seen to be poor and unthrifty, and large, hard tumors were found at the points of inoculation. On the right side the swelling measured 3½ by 5 inches, and the corresponding lymph gland was 2¾ inches long by 1¾ inches in diameter. This gland contained numerous calcareous foci; one at the apex was an inch in diameter. The lesions on the left shoulder of the animal were very similar to those found on the right side, but the dimensions of the tumor were slightly less. The lungs presented an irregular mass of tuberculous nodules, and 7 or 8 grapelike nodules were seen on the parietal pleura. Bronchial and mediastinal lymph glands contained numerous tuberculous foci, and the pericardium, peritoneum, spleen, and liver also were affected.

In order to throw some light, if possible, upon the morphological constancy of the different types of tubercle bacilli, Mohler made comparative studies of bacilli from various sources, and which had been passed through various species of ainmals, by making the cultures upon dog serum after the method described by Theobald Smith. Some important results have been obtained. One culture of human bacilli which had morphological and cultural peculiarities similar to those of the bovine bacillus, and which produced only local lesions in cattle, was passed through a series of five cats. It was then found to be completely changed in its morphological characters, the rods being elongated, slender, more or less beaded, and entirely of the human type. Far from decreasing in virulence, however, as might be expected from its morphological appearance, this bacillus had so increased in its pathogenic activity that it produced generalized tuberculosis in a cow. This cow was inoculated subcutaneously in front of each shoulder with 2 cubic centimeters of a salt-solution emulsion of the tuberculous omentum of the last cat of the series. The cow rapidly lost flesh, had a temperature of 104° F., with the point of inoculation and adjacent glands greatly swollen. The autopsy revealed generalized tuberculosis, involving the lungs, mediastinal glands, spleen, liver, and kidneys. Tubercle bacilli of the bovine type obtained from the mesenteric glands of a sheep, hog, and cow were similarly transformed in their morphological appearance after being passed through a series of cats and recovered on dog serum. These bacilli also increased in virulence, as the last cat in the series invariably succumbed in a shorter time than the first of the series.

These experiments and observations indicate that the types of tubercle bacilli are very inconstant, and that under suitable conditions they readily change both in morphology and in virulence. A similar conclusion was reached by other investigators in working with the avian and porcine types of tubercle bacilli several years ago, and was reasonably to have been expected with the human and bovine types.

Later investigations made by Park and Krumweide, of the Research Laboratory of New York City, Novick, Richard M. Smith, Ravenel, Rosenau, Chung Yik Wang, and others tend to show the incidence of bovine infection in the human family. Chung Yik Wang stated in 1917 that studies of 281 cases of various clinical forms of tuberculosis in Edinburgh, Scotland, resulted in the isolation of the bovine tubercle bacilli in 78.4 per cent of cases under the age of 5 years, in 70.3 per cent between the ages of 5 and 16, and in 7.8 per cent over the age of 16. This investigator states that from the prophylactic point of view any measure resorted to in combating the disease should be directed not only against the human spread of infection, but also, more particularly in children's cases, against the bovine source of infection.

Ravenel, in summarizing the work of Drs. Park and Krumweide, as well as others throughout the world, gives the following results:

Of 63 children dying of tuberculosis at the babies' hospital 59 cases proved to be human infection and 4 bovine, a percentage of $6\frac{1}{3}$.

Of 9 children dying of tuberculosis at the foundling hospital 4 proved to have derived their infection from human sources and 5 from bovine, a percentage of 55.

Of a total of 88 children under 5 years of age who died of tuberculosis 77 proved to have derived their infection from human sources and 11 from bovine, a percentage of $12\frac{1}{2}$.

Combining the cases studied in New York with those of other observers in different parts of this country and Europe, the following results are obtained:

Adults, 787 cases—777 human and 10 bovine infection.
Children, 5 to 16 years, 153 cases—117 human and 36 bovine infection.
Children under 5 years, 280 cases—215 human and 65 bovine infection.

The figures of the foundling hospital show the real danger of unprotected cows' milk.

The conclusion from these studies is inevitable, namely, that in children, in addition to the large number of deaths which occur from bovine infection, there are many cases of infection resulting in deformities, necessitating operations more or less severe in character and which frequently leave the patient disfigured permanently.

It must be plain to all, from these recent developments, that too much has been made of the slight differences in cultural characteristics, in morphology, and in virulence which have been observed in some cases in comparing the human and the bovine bacilli. The observations were interesting, and it was important that they be followed up until their significance was made entirely clear, but it was an almost unpardonable error, from a sanitary point of view, to promulgate sweeping generalizations calculated to arrest and abolish important measures for preventing human tuberculosis before the soundness of these generalizations had been established by a thorough course of experimentation.

When Koch said in the British Congress on Tuberculosis that he should estimate the extent of infection by the milk and flesh of tuberculous cattle and the butter made of their milk as hardly greater than that of hereditary transmission, and that he therefore did not deem it advisable to take any measures against it, he went far beyond what was justified by any experiments or observations which he reported, and he did a great deal of harm, which will be manifested for years to come, to those who endeavor to guard the human race from the dangers of animal tuberculosis. The researches which have been alluded to make these dangers more definite and certain than they have appeared before, and sanitarians should therefore most earnestly endeavor to counteract the erroneous and harmful impression which was made by Koch's address at London and his subsequent address at the International Conference on Tuberculosis at Berlin.

VACCINIA OR COWPOX.

Variola of cattle, more correctly vaccinia, is a contagious disease of cattle which manifests its presence through an elevation of temperature, a shrinkage in milk production, and by the appearance of characteristic, pustular eruptions, especially upon the teats and udders of dairy cows. Although this is a contagious disease, strictly speaking, it is so universally harmless and benign in its course that it is robbed of the terrors which usually accompany all spreading diseases, and is allowed to enter a herd of cattle, run its course, and disappear without exciting any particular notice.

The contagion of cowpox does not travel through the air from animal to animal, but is transfused only by actual contact of the contagious principle with the skin of some susceptible animal. It may be carried in this manner, not alone from cattle to cattle, but horses, sheep, goats, and man may readily contract the disease whenever suitable conditions attend their inoculation.

An identical disease frequently appears upon horses, attacking their heels, and thence extending upward along the leg, producing, as it progresses, inflammation and swelling of the skin, followed later by pustules, which soon rupture, discharging a sticky, disagreeable secretion. Other parts of the body are frequently affected in like manner, especially in the region of the head, where the eruptions may appear upon lips and nostrils, or upon the mucous surfaces of the nasal cavities, mouth, or eyes.

Variola of the horse is readily transmitted to cattle, if both are cared for by the same attendant, and, conversely, variola of cattle may be carried from the cow to the horse on the hands of a person who has been milking a cow affected with the disease.

The method of vaccination with material derived from the eruptions of cowpox as a safeguard against the ravages of smallpox in members of the human family is well known. The immunity which such vaccination confers upon the human subject has led many writers to assert that cowpox is simply a modified form of smallpox, whose harmless attack upon the human system is owing to a certain attenuation derived during its passages through the system of the cow or horse. The results of numerous experiments which have been carried out for the purpose of determining the relationship existing between variola of the human and bovine families seem to show, however, that although possessing many similar characteristics, they are nevertheless distinct, and that in spite of repeated inoculations from cattle to man, and vice versa, no transformation in the real character of the disease ever takes place.

Symptoms.—The disease appears in four to seven days after natural infection, or may evince itself in two or three days as the result of artificial inoculation. Young milch cows are most susceptible to an attack, but older cows, bulls, or young cattle are by no means immune. The attack causes a slight rise in temperature, which is soon followed by the appearance of reddened, inflamed areas, principally upon the teats and udder, and at times on the abdominal skin or the skin of the inner surface of the thighs. In a few cases the skin of the throat and jaws has been found similarly involved. If the affected parts are examined on the second day after the establishment of the inflammation numerous pale-red nodules will be found, which gradually expand until, within a few days, they reach a diameter of one-half inch or even larger. At this period the tops of the nodules become transformed into vesicles which are depressed in the center and contain a pale, serous fluid. They usually reach their maturity by the tenth day of the course of the disease and are then the size of a bean. From this time the contents of the vesicles become purulent, which requires about three days, when the typical pox pustule is present, consisting of a swelling with broad, reddened base, within which is an elevated, conical abscess varying from the size of a pea to that of a hazelnut.

The course of the disease after the full maturity of the pustule is rapid if outside interference has not caused a premature rupture of the small abscess at the apex of the swelling. The pustules gradually become darker colored and drier until nothing remains but a thick scab, which at last falls off, leaving only a slight, whitish scar behind. The total duration of the disease covers some 20 days in each animal, and owing to the slow spread of the infection from animal to animal, many weeks may elapse before a stable can be fully freed from it. The fallen scabs and crusts may retain their contagious properties for several days when mixed with litter and bedding upon the floor of the stable, and at any time during this period they are capable of producing new outbreaks should fresh cattle be brought into the stalls and thus come into actual contact with them. Again, the pustules may appear, one after another, on a single animal, in which case the duration of the disease is materially lengthened.

Treatment.—In herds of cattle that regularly receive careful handling, no special treatment will be found necessary beyond the application of softening and disinfecting agents to such vesicles upon the teats as may have become ruptured by the hands of the milker. Carbolized vaseline or iodoform ointment will be found well suited to this work. In more persistent cases it may be found desirable to use a milking tube in order to prevent the repeated opening of the pustules during the operation of milking. Washing the sores twice daily with a weak solution of zinc chlorid (2½ per cent solution) has been found to assist in checking the inflammation and to cleanse and heal the parts by its germicidal action. When the udder is hard, swollen, and painful, support it by a bandage and foment frequently with hot water. If calves are allowed to suckle the cows the pustules become confluent, and the ulcerations may extend up into the teat, causing garget and ruining the whole quarter of the udder.

As young cows are most susceptible to variola, the milker must exercise constant patience with these affected animals so long as their teats or udders are sore and tender, else the patient may contract vicious habits while resisting painful handling. The flow of milk is usually lessened as soon as the fever becomes established, but is again normal with the return of perfect health.

The practice of thorough cleanliness in handling or milking affected cattle may, in many instances, prevent the dissemination of the trouble among the healthy portion of the herd, but even the greatest care may prove insufficient to check the spread until it has attacked each animal of the herd in turn.

ACTINOMYCOSIS (LUMPY JAW).

[Pls. XXXIX–XLI.]

Actinomycosis, also known as lumpy jaw, big jaw, wooden tongue, etc., is a chronic infectious disease characterized by the formation of peculiar tumors in various regions of the body, more particularly the head, and is due to the specific action of a certain funguslike germ (actinomyces). This fungus is an organism which occurs in the tissues in the form of rosettes, and it has therefore been termed the "ray fungus." The disease is not directly transmitted from one animal to another, but it seems apparent that the fungus is conveyed into the tissues by various feedstuffs through slight wounds of the mucous membrane of the mouth, decayed teeth, or during the shedding of milk teeth. The ray fungus is found in nature vegetated on grasses, on the awns of barley, the spears of oats, and on other grains. Quantities of the fungi have been found between the vegetable fibers of barley which had penetrated the gums of cattle and on the awns of grain embedded in the tongues of cows.

Although actinomycotic tumors on cattle had been the object of study for many years, it was not until 1877 that the constant presence of actinomyces was pointed out by Bollinger, of Munich, and since that time considered the cause. This fungus was observed in these tumors as early as 1860 by Rivolta, and by others subsequently, without having been suspected as causing them.

Since Bollinger's publication much work has been done, many observations made, and many hitherto obscure disease processes brought into relation with this fungus. Furthermore, a similar disease in man was first definitely shown to be associated with the same fungus in 1878 by Israel, and in the following year Ponfick pointed out that the disease described by Bollinger in animals and that found by Israel in man were due to the same cause; that is, that the fungi described by these observers were one and the same.

The tumors and abscesses wherever they may be are all found to be the same in origin by the presence of the actinomyces fungus. When they are incised, a very close scrutiny with the naked eye, or, at most, a hand lens, will reveal the presence of minute grains which vary from a pale-yellow to a sulphur-yellow color. They may be very abundant or so few as to be overlooked. They are embedded in the soft tissue composing the tumor or in the pus of the abscess. With a needle they are easily lifted out from the tissue, and then they appear as roundish masses about one-half millimeter ($\frac{1}{50}$ inch) in diameter. To anyone familiar with the use of a microscope the recognition of these grains or particles without any previous preparation is a comparatively easy task.

When examined in the fresh condition under a microscope magnifying up to 250 diameters the general structure is made out without much difficulty. These grains consist of collections of minute, roundish masses. Their outer surface is made up of club-shaped bodies all radiating from the center of the mass (see Pl. XXXIX, fig. 2), somewhat like a rosette. If the fungus is crushed, the interior is found made up of bundles of very fine filaments, which are probably continuous into the club-shaped bodies. The addition of a dilute solution of caustic soda or potash greatly aids the examination, as it removes the layer of cells adhering to the fungus, which obscures the structure. Now and then these grains are found to be in a calcified condition. The exterior is incrusted in lime salts, which are dissolved by adding some weak dilute acid, like acetic acid. Only by this procedure can the fungus be definitely recognized when in a mummified condition.

These are the bodies whose presence causes sufficient irritation in the tissues into which they find their way to set up inflammatory growths. These growths increase as the fungus continues to multiply until they reach enormous dimensions, if the affected animal is permitted to live long enough. The true nature of this parasite is not yet definitely settled, although many excellent observers have occupied themselves with it. According to earlier observers, it is a true fungus. Later ones are inclined to place it among the higher bacteria. Present knowledge concerning the actinomyces growth indicates that it should be classified with the higher bacteria or trichomycetes.

Whatever the situation of the disease caused by actinomyces may be, its nature is fundamentally the same and peculiar to the fungus. The pathological details which make this statement clear can not be entered upon in this place, nor would they be of any practical value to the farmer. We will simply dwell upon a few obvious characters.

The consistency of the tumor varies in different situations according to the quantity of fibrous or connective tissue present. When very little of this is present the tumor is of a very soft consistency. As the quantity of connective tissue is increased the tumor is firmer and of a more honeycombed appearance. The individual actinomyces colonies are lodged in the spaces or interstices formed by the meshwork of the connective tissue. There they are surrounded by a mantle of cellular elements which fill up the spaces. By scraping the cut surface of such a tumor these cell masses inclosing the fungi come away, and the latter may be seen as pale-yellow or sulphur-yellow specks, as described above.

Location of the disease.—In cattle the disease process may be located both externally, where it is readily detected, and in internal organs. Its preferred seat is on the bones of the lower and upper jaws, in the parotid salivary gland in the angle of the jaw, and in the region of the throat. It may also appear under the skin in different parts of the body. Internally it may attack the tongue and appear in the form of a tumor in the mouth, pharynx, or larynx. It may cause extensive disease of the lungs, more rarely of the digestive tract.

It appears, furthermore, that in certain districts or countries the disease seems by preference to attack certain parts. Thus in England actinomycosis of the tongue is most prevalent. In Denmark the soft parts of the head are most prone to disease, while in Russia the lips are the usual seat. In certain parts of Germany actinomycotic tumors are most frequently encountered in the throat region and in the jawbones.

A description of actinomycosis of the jaw (lumpy jaw) and of the tongue has already been given in a previous chapter, and hence they will be dealt with here only very briefly. When the disease attacks the soft parts of the head a rather firm swelling appears, in which are formed one or more smaller projecting tumors, varying from the size of a nut to that of an egg. These push their way outward and finally break through the skin as small, reddish, funguslike bodies covered with thin sloughs. Or the original swelling, in place of enlarging in the manner described, may become transformed into an abscess which finally bursts to discharge creamy pus. The abscess cavity, however, does not disappear, but is soon filled with fungus-like growths, which force their way outward through the opening.

When the tumors are situated within the cavity of the pharynx they have broken through from some gland, perhaps beneath the mucous membrane, where the disease first appeared, and hang or project into the cavity of the pharynx, either as pendulous masses with slender stems or as tumors with broad bases. Their position may be such as to interfere with swallowing and with breathing. In either case serious symptoms will soon appear.

The invasion of the bones of the jaws by actinomycosis must be regarded as one of the most serious forms of the disease. (Pls. XXXIX, XL.) It may start in the marrow of the bone and by a slow extension gradually undermine the entire thickness of the bone itself. The growth may continue outward, and after working its way through muscle and skin finally break through and appear externally as stinking fungoid growths. The growth may at the same time work its way inward and appear in the mouth. The disease may also begin in the periosteum, or covering of the bone, and destroy the bone from without inward.

Actinomycosis of the lungs is occasionally observed, and it is not improbable that at times it has been mistaken for tuberculosis. The actinomyces grains are, however, easily observed if the diseased tissue is carefully examined. The changes in the lungs as they appear to the naked eye vary considerably from case to case. Thus in one animal the lungs were affected as in ordinary bronchopneumonia as to the location, extent, and appearance of the disease process. The affected lobes had a dark-red flesh appearance, with yellowish areas sprinkled in here and there. (See Pl. XLI, figs. 1, 2.) These latter areas were the seat of multiplication of the actinomyces fungus. In another case, of which only a small portion of the lungs was sent to the laboratory, they were completely transformed into a uniformly grayish mass, very soft and pulpy to the touch, and appearing like very soft and moist dough. (Pl. XLI, fig. 3.) The actinomyces grains were exceedingly abundant in this tissue, and appeared when the tissue was incised as minute sulphur-yellow grains, densely sprinkled through the tissue, which readily came away and adhered to the knife blade. In still another case a portion of the lung tissue was converted into large, soft masses from 1 to 3 inches in diameter, each partly inclosed in very dense connective tissue. These soft, grayish-yellow masses likewise resembled moist dough in their consistency, and the actinomyces grains, though neither very distinct nor at all abundant, were easily fished out and identified as such. A portion of this growth, which was as large as a child's head, was converted into an abscess filled with creamy semiliquid pus.

This case differed from the preceding in that all appearance of lung tissue had disappeared from the diseased mass. Only on the exterior the lung tissue could be recognized, although even there it had been largely converted into very dense, whitish connective tissue inclosing the fungoid growth. In the other case the external form of the lung and the shape and outline of the lobules were preserved, but the lung tissue itself was not recognizable as such. In the case first mentioned the changes were still less marked, and actinomycosis would not have been suspected by a simple inspection. These few illustrations suffice to show that antinomycosis of the lungs may appear under quite different forms, and that the nature of the disease can be accurately determined only by finding the fungus itself. Rarely actinomycosis attacks the body externally in places other than the head and neck. Crookshank describes the case of a bull in which the flank was attacked and subsequently the scrotum became diseased. A large portion of the skin of the flank was destroyed and covered with a leathery crust. When this was pulled away the pus beneath it showed the actinomyces grains to the naked eye.

Actinomycosis may also involve the udder, the spermatic cord of castrated animals, the vagina, and, when it becomes generalized, the brain, liver, spleen, and muscular tissue.

Actinomycosis may in some cases be confounded with tuberculosis. The diagnosis does not offer any difficulties, since the presence of the actinomyces fungus at once removes any existing doubts. As has already been intimated, these grains, simulating sulphur balls, are visible to the naked eye, and their nature is readily determined with the aid of a microscope.

The course of the disease is quite slow. As the tumors grow they may interfere with the natural functions of the body. According to their situation, mastication, rumination, or breathing may be interfered with, and in this way the animal may become emaciated. Actinomycosis of the jawbones leads to destruction of the teeth and impedes the movements necessary to chewing the feed. Similarly, when the disease attacks the soft parts of the head obstructions may arise in the mouth by an inward growth of the tumor. If tumors exist in the pharynx they may partially obstruct the movements necessary to breathing, or close the air passages and cause partial suffocation. Actinomycosis of the tongue, in interfering with the many and varied movements of this important organ, is also a serious matter. There is no reason to suppose that the localized disease interferes with the general health in any other way than indirectly until internal organs, such as the lungs, become involved.

A very small proportion of the cases may recover spontaneously, the tumors being encysted or undergoing calcification. In most cases the disease yields readily to proper treatment, and about 75 per cent of the affected animals may be cured.

Prevention.—The question as to how and where animals take this disease is one concerning which we are still in the stage of conjecture, because so far we possess very little information concerning the life history of the actinomyces itself. The quite unanimous view of all observers is that animals become infected from the feed. The fungus is lodged upon the plants and in some way enters the tissues of the head, the lungs, and the digestive tract, where it sets up its peculiar activity. It is likewise generally believed that the fungus is, as it were, inoculated into the affected part. This inoculation is performed by the sharp and pointed parts of plants which penetrate the mucous membrane and carry the fungus with them. The disease is therefore inoculable rather than contagious. The mere presence of the diseased animal will not give rise to disease in healthy animals unless the actinomyces grains pass directly from the diseased into some wound or abrasion of the healthy or else drop upon the feed which is consumed by the healthy. Not only are these views deducible from clinical observation, but they have been proved by the positive inoculation of calves and smaller animals with actinomyces. The danger therefore of the presence of actinomyces for healthy animals is a limited one. Nevertheless an animal affected with this disease should not be allowed to go at large or run with other animals. If the fungus is being scattered by discharging growths we certainly can not state at this stage of our knowledge that other animals may not be infected by such distribution, and we must assume, until more positive information is at hand, that this actually occurs.

It is, however, the opinion of the majority of authorities that when actinomycosis appears among a large number of animals they all contract it in the same way from the feed. Much speculation has therefore arisen whether any particular plant or group of plants is the source of the infection and whether any special condition of the soil favors it. Very little positive information is at hand on these questions. It would be very desirable for those who live in localities where this disease is prevalent to make statistical and other observations on the occurrence of the disease with reference to the season of the year, the kind of feed, the nature of the soil (whether swampy or dry, recently reclaimed, or cultivated for a long time) upon which the animals are pastured or upon which the feed is grown.

It is highly probable that such investigations will lead to an understanding of the source of the fungus and the means for checking the spread of the disease itself. Veterinarian Jensen, of Denmark, made some observations upon an extensive outbreak of actinomycosis a number of years ago which led him to infer that the animals were inoculated by eating barley straw harvested from pieces of ground just reclaimed from the sea. While the animals remained unaffected so long as they pastured on this ground or ate the hay obtained from it, they became diseased after eating the straw of cereals from the same territory. Others have found that cattle grazing upon low pastures along the banks of streams and subject to inundations are more prone to the disease. It has also been observed that feed gathered from such grounds, even after prolonged drying, may give rise to the disease. Actinomycosis is not infrequent in cattle in the Southwest and is generally supposed to be the result of eating the prickly fruit of the cactus plant, causing wounds of the mucous membrane and subsequent infection with the parasite. Much additional information of a similar kind must be forthcoming before the source and manner of infection in this disease and its dependence upon external conditions will be known. It is not at all improbable that they may vary considerably from place to place.

Treatment.—Until recently this has been almost entirely surgical. When the tumors are external and attached to soft parts only, an early removal may lead to recovery. This, of course, can be undertaken only by a trained veterinarian, especially as the various parts of the head and neck contain important vessels, nerves, and ducts which should be injured as little as possible in any operation. Unless the tumor is completely removed it will reappear. Disease of the jawbones is at best a very serious matter and treatment is liable to be of no avail.

In March, 1892, an important contribution to our knowledge of this subject was made by Nocard, of the Alfort Veterinary School, in a communication to the French Central Society of Veterinary Medicine. He showed clearly that the actinomycosis of the tongue, a disease which appears to be quite common in Germany, and is there known as "wooden tongue," could be quickly and permanently cured by the administration of iodid of potassium. Nocard calls attention to the success of Thomassen, of Utrecht, who recommended this treatment so long ago as 1885, and who has since treated more than 80 cases, all of which have been cured. A French veterinarian, Godbille, has used the same remedy in a number of cases of actinomycosis in the tongue, all of which have been cured. Nocard also gives details of a case which was cured by himself.

All the cases referred to were of actinomycosis of the tongue, and no one appears to have attempted the cure of actinomycosis of the jaw until it was undertaken by Nörgaard, of the Bureau of Animal Industry. In April, 1892, he selected a young steer in fair condition which had a tumor on the jaw measuring 15½ inches in circumference and from which a discharge had already been established. This animal was treated with iodid of potassium, and the result was a complete cure.

The iodid of potassium is given in doses of $1\frac{1}{2}$ and $2\frac{1}{2}$ drams once a day, dissolved in water, and administered as a drench. The dose should vary somewhat with the size of the animal and with the effects that are produced. If the dose is sufficiently large signs of iodism appear in the course of a week or 10 days. The skin becomes scurfy, there is weeping from the eyes, catarrh of the nose, and loss of appetite. When these symptoms appear the medicine may be suspended for a few days and afterward resumed in the same dose. The cure requires from three to six weeks' treatment. Some animals, generally the ones which show no signs of iodism, do not improve under treatment with iodid of potassium.

If there is no sign of improvement after the animals have been treated four or five weeks, and the medicine has been given in as large doses as appear desirable, it is an indication that the particular animal is not susceptible to the curative effects of the drug, and the treatment may therefore be abandoned.

It is not, however, advisable to administer iodid of potassium to milch cows, as it will considerably reduce the milk secretion or stop it altogether. Furthermore, a great part of the drug is excreted through the milk, making the milk unfit for use. It should not be given to animals in advanced pregnancy, as there is danger of producing abortion.

The best results are obtained by pushing the drug until its effect is seen. The many tests to which this treatment has been subjected have proved, with few exceptions, its specific curative value. In addition to this the tumor should be painted externally with either the tincture of iodin or Lugol's solution, or the drug should be injected subcutaneously into the tumor.

Godbille has given as much as 4 drams of potassium iodid in one day to a steer, decreasing the dose one-fourth dram each day until the dose was $1\frac{1}{4}$ drams, which was maintained until the twelfth day of treatment, when the animal appeared to be entirely cured.

Nocard gave the first day $1\frac{1}{2}$ drams in one dose to a cow; the second and succeeding days a dose of 1 dram in the morning and evening, in each case before feeding. This treatment was continued for 10 days, when the animal was cured.

Actinomycosis and the public health.—The interest which is shown concerning this cattle disease is largely due to the fact that the same disease attacks human beings. Its slow progress, its tendency to remain restricted to certain localities, and the absence of any directly contagious properties have thus far not aroused any anxiety in other countries as to its influence on the cattle industry, not even to the point of placing it among the infectious diseases of which statistics are annually published. Its possible bearing on public health has, however, given the disease a place in the public mind which it hardly deserves.

It has already been stated that the actinomyces fungus found in human disease is considered by authorities the same as that occurring in bovine affections. It is therefore of interest to conclude this article with a brief discussion of the disease in man and its relation to actinomycosis in cattle.

In man the location of the disease process corresponds fairly well to that in cattle. The majority of cases which have been reported in different parts of the world—and they are now rather numerous—indicate disease of the face. The skin, tongue, or the jawbones may become affected, and by a very slow process it may extend downward upon the neck and even into the cavity of the chest. In many cases the teeth have been found in a state of more or less advanced decay and ulceration. In a few cases disease of the lungs was observed without coexisting disease of the bones or soft parts of the head. In such cases the fungus must have been inhaled. The disease of the lungs after a time extends upon the chest wall, where it may corrode the ribs and work its way through the muscles and the skin. An abscess is thus formed discharging pus containing actinomyces grains. Disease of the digestive organs caused by this fungus has also been observed in a few instances.

Granting the identity of the disease in man and cattle, the question has been raised whether cattle are responsible for its occurrence in man. Any transmission of the infectious agent may be conceived of as taking place during the life of the animal and from the meat after slaughter. That human beings have contracted actinomycosis by coming in contact with diseased cattle is not shown by the cases that have been reported, for the occupations of most of the patients did not bring them into any relation whatever with cattle. While the possibility of such direct transmission is not denied, nevertheless it must be considered as extremely remote. Practically the same position is maintained at present by most authorities as regards the transmission of the disease to man by eating meat. Israel, who has studied this question carefully, found the disease in Jews who never ate pork,[1] and who likewise were protected from bovine actinomycosis by the rigorous meat inspection practiced by that race. Furthermore, it must be borne in mind that actinomycosis is a local disease, causing great destruction of tissue where the fungus multiplies, but which very rarely becomes generally disseminated over the body from the original disease focus. The fungus is found only in places where the disease process is manifest to the eye or becomes so in a very short time after the lodgment of the fungus. Only the greatest negligence

[1] Hogs are subject to actinomycosis.

would allow the actually diseased parts to be sold and consumed. Finally, this parasite, like all others, would be destroyed in the process of cooking. Most authorities thus do not believe that actinomycosis in man is directly traceable to the disease in animals, but are of the opinion that both man and animals are infected from a third source, which has already been discussed above. How far these views may be modified by further and more telling investigations of the parasite fungus itself no one can predict. There are still wide gaps in our knowledge, and the presentation above simply summarizes the prevailing views, from which there are dissenters, of course. An attempt to give the views of both sides on this question would necessitate the summarizing and impartial discussion of all the experiments thus far made—a task entirely beyond the scope of the present work.

Whether an animal affected with actinomycosis should be used for human food after all diseased organs and tissues have been thoroughly removed is a question the answer to which depends on a variety of circumstances. Among these may be mentioned the thoroughness of the meat inspection itself, the extent of the disease, and the general condition of the animal affected.

The Federal meat-inspection regulations require that carcasses of animals showing generalized actinomycosis shall be condemned. If carcasses are in a well-nourished condition, showing uncomplicated localized lesions of actinomycosis, they may be passed after the infected organs or parts have been removed and condemned. When the disease of the jaw is slight, strictly localized, and without pus formation, fistulous tracts, or lymph-gland involvement, the tongue, if free from disease, may be passed. The heads affected with actinomycosis (lumpy jaw), including the tongue, shall be condemned, except that when the lesions in the jaw are strictly localized and slight in extent, the tongue may be passed, if free from disease.

ANTHRAX.

Anthrax or charbon may be defined as an infectious disease which is caused by specific bacteria, known as anthrax bacilli, and which is more or less restricted by conditions of soil and moisture to definite geographical localities. While it is chiefly limited to cattle and sheep, it may be transmitted to goats, horses, cats, and certain kinds of game. Smaller animals, such as mice, rabbits, and guinea pigs, speedily succumb to inoculation. Dogs and hogs are slightly susceptible, while fowls are practically immune. The variety of domesticated animals which it may attack renders it one of the most dreaded scourges of animal life. It may even attack man. Of this more will be stated further on.

ACTINOMYCOSIS (LUMPY JAW).

DESCRIPTION OF PLATES.

PLATE XXXIX. Actinomycosis. (From Jöhne's Encyklopädie d. gesammt. Thierheilkunde.)

Fig. 1. Actinomycosis of the jaw. The lower jawbone has been extensively eaten away by the disease.

Fig. 2. Actinomyces fungus from a tumor of the jawbone in cattle, magnified 550 times.

PLATE XL. Actinomycosis of the jaw. (Reduced one-half. From Jöhne's Encyklopädie d. gesammt. Thierheilkunde.) The lower jaw is sawed through transversely, i. e., from right to left, and shows the disease within the jawbone itself; *a*, within the mouth, showing the papillæ on the mucous membrane of the cheek; *b*, front view of a molar tooth; *c*, the skin covering the lower surface of the jawbone; *d*, the jawbone hollowed out and enlarged by the formation of cavities within it, which are filled with the soft growth of the actinomycotic tumor. The section makes it appear as if the bone were broken into fragments and these forced apart; *e*, a portion of the tumor which has broken through the bone and the skin and appears as a tumor on the cheek. The little roundish masses represent the granulomata (minute tumors) in which the fungus vegetates.

PLATE XLI. Actinomycosis of the lungs.

Fig. 1. Transverse section of the ventral lobe of the right lung, from a case studied in the laboratory. The yellowish dots represent the places where the actinomyces fungus is lodged. The larger yellowish patches are produced by the confluence of a number of isolated centers. The entire lobe is of a dark flesh-red color, due to collapse and bronchopneumonia.

Fig. 2. The cut surface of a portion of the principal lobe of the same lung, showing the recent invasion of antinomycosis from the other lobe: *a*, large air tube; *b*, artery; *c*, a pneumatic lobule; *d*, lobule containing minute yellowish dots. In these the actinomyces fungus is lodged.

Fig. 3. Cut surface of a small portion of another lung, showing a few lobules, *a*. The fungus is sprinkled throughout the lung tissue in the form of yellowish grains, as shown in the illustration. The pleural covering of the lung tissue is shown in profile above.

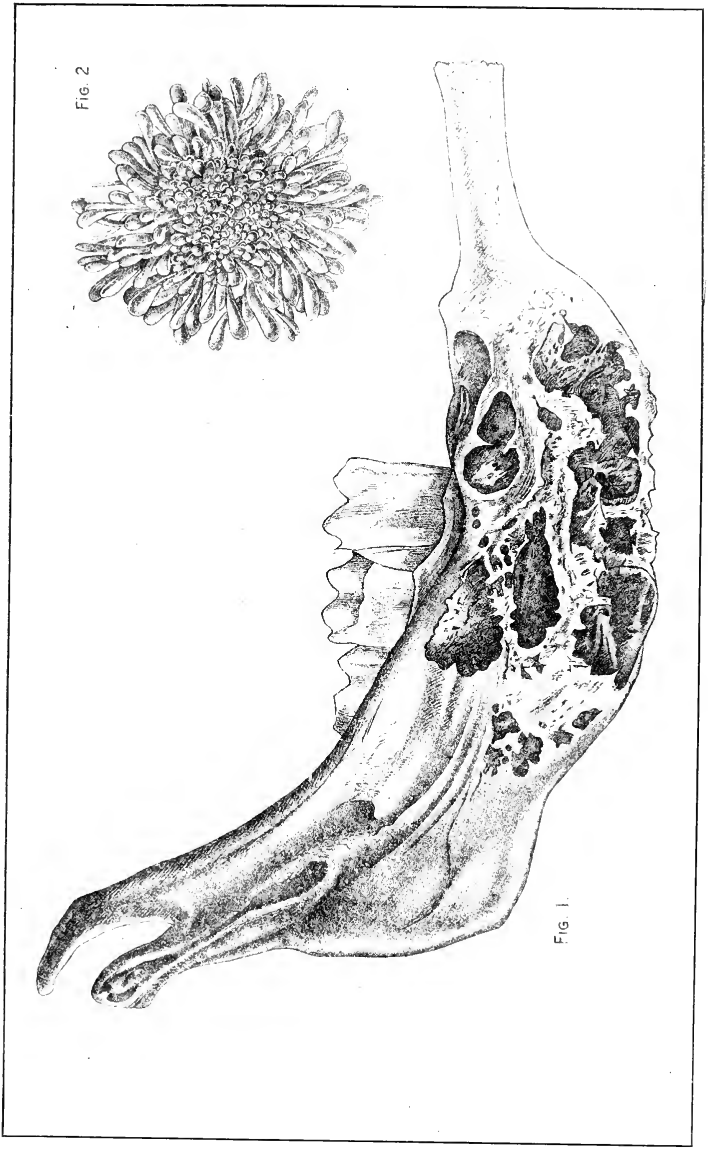

FIG. 2

FIG. 1

ACTINOMYCOSIS.

Cause.—The cause of anthrax is a microscopic organism known as the anthrax bacillus. (See Pl. XXVIII, fig. 7.) In form it is cylindrical or rodlike, measuring $\frac{1}{5000}$ to $\frac{1}{2500}$ inch in length and $\frac{1}{25000}$ inch in diameter. Like all bacteria, these rodlike bodies have the power of indefinite multiplication, and in the bodies of infected animals they produce death by rapidly increasing in numbers and producing substances which poison the body. In the blood they multiply in number by becoming elongated and then dividing into two, each new organism continuing the same process indefinitely. Outside the body, however, they multiply in a different way when under conditions unfavorable to growth. Oval bodies, which are called spores, appear within the rods, and remain alive and capable of germination after years of drying. They also resist heat to a remarkable degree, so that boiling water is necessary to destroy them. The bacilli themselves, on the other hand, show only very little resistance to heat and drying. It has long been known that the anthrax virus thrives best under certain conditions of the soil and on territories subject to floods and inundations. The particular kinds of soil upon which the disease is observed are black, loose, warm, humous soils; also those containing lime, marl, and clay, finally peaty, swampy soils resting upon strata which hold the water, or, in other words, are impervious. Hence fields containing stagnant pools may be the source of infection. The infection may be limited to certain farms, or even to restricted areas on such farms. Even in the Alps, more than 3,000 feet above sea level, where such conditions prevail in secluded valleys, anthrax persists among herds.

Aside from these limitations to specific conditions of the soil, anthrax is a disease of world-wide distribution. It exists in most countries of Europe, in Asia, Africa, Australia, and in our own country in the lower Mississippi Valley, the Gulf States, and in some of the Eastern and Western States. It seems to be gradually spreading in this country and every year occurs in new districts.

Meteorological conditions also have an important share in determining the severity of the disease. On those tracts subject to inundations in spring a very hot, dry summer is liable to cause a severe outbreak. The relation which the bacillus bears to these conditions is not positively known. It may be that during and immediately after inundations or in stagnant water the bacilli find nourishment enough in the water here and there to multiply and produce an abundant crop of spores, which are subsequently carried, in a dry condition, by the winds during the period of drought and disseminated over the vegetation. Animals feeding upon this vegetation may contract the disease if the spores germinate in the body.

Another source of the virus, and one regarded by many authorities as perhaps the most important, is the body of an animal which has died of anthrax. It will be remembered that in such bodies the anthrax bacilli are present in great numbers, and wherever blood or other body fluids are exposed to the air on the surface of the carcass there the formation of spores will go on with great rapidity in the warm season of the year. It will thus be readily understood how this disease may become stationary in a given locality and appear year after year and even grow in severity if the carcasses of animals which have succumbed to it are not properly disposed of. These carcasses should be buried deeply, so that spore formation may be prevented and no animal have access to them. By exercising this precaution the disease will not be disseminated by flies and other insect pests.

We have thus two agents at work in maintaining the disease in any locality—the soil and meteorological conditions, and the carcasses of animals that have died of the disease. Besides these dangers, which are of immediate consequence to cattle on pastures, the virus may be carried from place to place in hides, hair, wool, hoofs, and horns, and it may be stored in the hay or other fodder from the infected fields and cause an outbreak among stabled animals feeding upon it in winter. In this manner the affection has been introduced into far-distant localities.

How cattle are infected.—We have seen above that the spores of the anthrax bacilli, which in their functions correspond to the seeds of higher plants and which are the elements that longest resist the unfavorable conditions in the soil, air, and water, are the chief agents of infection. They may be taken into the body with the feed and produce disease which begins in the intestinal tract, or they may come in contact with scratches, bites, or other wounds of the skin, mouth, and tongue, and produce in these situations swellings or carbuncles. From such swellings the bacilli penetrate into the blood and produce a general disease.

It has likewise been asserted that the disease may be transmitted by various kinds of insects which carry the bacilli from the sick and inoculate the healthy as they pierce the skin. When infection of the blood takes place from the intestines the carbuncles may be absent. It has already been stated that since anthrax spores live for several years, the disease may be contracted in winter from feed gathered on permanently infected fields.

The disease may appear sporadically, i. e., only one or several animals may be infected while the rest of the herd remain well, or it may appear as an epizootic attacking a large number at about the same time.

Symptoms.—The symptoms in cattle vary considerably, according as the disease begins in the skin, in the lungs, or in the intestines. They depend also on the severity of the attack. Thus we may have what is called anthrax peracutus or apoplectiform, when the animal dies very suddenly as if from apoplexy. Such cases usually occur in the beginning of an outbreak. The animal, without having shown any signs of disease, suddenly drops in the pasture and dies in convulsions, or one apparently well at night is found dead in the morning.

The second type (anthrax acutis), without any external swellings, is the one most commonly observed in cattle. The disease begins with a high fever. The temperature may reach 106° to 107° F. The pulse beats from 80 to 100 a minute. Feeding and rumination are suspended. Chills and muscular tremors may appear and the skin show uneven temperature. The ears and base of the horns are cold, the coat staring. The animals are dull and stupid and manifest great weakness.

To these symptoms others are added in the course of the disease. The dullness may give way to great uneasiness, champing of the jaws, spasms of the limbs, kicking and pawing the ground. The breathing may become labored. The nostrils then dilate, the mouth is open, the head raised, and all muscles of the chest are strained during breathing, while the visible mucous membranes (nose, mouth, rectum, and vagina) become bluish. If the disease has started in the bowels, there is much pain, as shown by the moaning of the animal; the discharges, at first firm, become softer and covered with serum, mucus, and blood.

As the disease approaches the fatal termination the weakness of the animal increases. It leans against supports or lies down. Blood vessels may rupture and give rise to spots of blood on the various mucous membranes and bloody discharges from nose, mouth, rectum, and vagina. The urine not infrequently contains blood (red water), and death ensues within one or two days.

A third type of the disease (anthrax subacutus), which is rarely observed, includes those cases in which the disease is more prolonged. It may last from three to seven days and terminate fatally or end in recovery. In this type, the symptoms are practically as described in the acute form, only less marked.

In connection with these types of intestinal anthrax, swellings may appear in different parts of the body under the skin, or the disease may start from such a swelling, caused by the inoculation of anthrax spores in one of the several different ways already described. If the disease begins in the skin, it agrees in general with the subacute form in prolonged duration, and it may occasionally terminate in recovery if the swellings are thoroughly incised and treated.

Lesions.—These swellings appear as edemas and carbuncles. The former are doughy tumors of a more or less flattish form passing gradually into the surrounding healthy tissue. As a rule, they are situated beneath the skin in the fatty layer, and the skin itself is at first of healthy appearance, so that they are often overlooked, especially when covered with a good coat of hair. When they are cut open they are found to consist of a peculiar, jellylike mass of a yellowish color and more or less stained with blood. The carbuncles are firm, hot, tender swellings, which later become cool and painless and undergo mortification. The edemas and carbuncles may also appear in the mouth, pharynx, larynx, in the tongue, and in the rectum.

The bodies of cattle which have died of anthrax soon lose their rigidity and become bloated, because decomposition sets in very rapidly. From the mouth, nose, and anus bloodstained fluid flows in small quantities. When such carcasses are opened and examined it is found that nearly all organs are sprinkled with spots of blood or extravasations of various sizes. The spleen is enlarged from two to five times, the pulp blackish and soft and occasionally disintegrated. The blood is of tarry consistency, not firmly coagulated, and blackish in color. In the abdomen, the thoracic cavity, and in the pericardium, or bag surrounding the heart, more or less blood-stained fluid is present. In addition to these characteristic signs, the carbuncles and swellings under the skin, already described, will aid in determining the true nature of the disease. The most reliable method of diagnosis is the examination of the blood and tissues for anthrax bacilli, which requires a trained bacteriologist. The cases of fatal anthrax number from 70 to 90 per cent, and are usually more numerous at the first outbreak of the disease.

Differential diagnosis.—The diagnosis from blackleg may be made by noting the subcutaneous swellings which appear upon the patient. Those of blackleg are found to crackle under pressure with the finger, owing to the presence of gas within the tissues, while the tumors of anthrax, being caused by the pressure of serum, are entirely free from this quality and have a somewhat doughy consistence. The tumors of blackleg are usually on the shoulder or thigh and are not found so frequently about the neck and side of the body as are the swellings of anthrax. The blood of animals dead of blackleg is normal, and the spleen does not appear swollen or darkened, as in those affected with anthrax. The chief differences between anthrax and Texas fever are that the course of the former is more acute and the blood of the animal is dark and of a tarlike consistence, while in the latter it is thinner than normal. The presence of Texas-fever ticks on the cattle would also lead one to suspect that disease in regions where cattle are not immune from it.

Treatment.—In cases which originate from external wounds, the swellings should be opened freely by long incisions with a sharp knife and washed several times daily with carbolic-acid solution (1 ounce to a quart of water). Care should be taken to disinfect thoroughly any fluid discharge that may follow the incision. When suppuration has set in the treatment recommended in the chapter on wounds should be carried out.

In the treatment of animals showing symptoms of anthrax, the serum recommended under the next heading of "Prevention" should be administered in large doses. Animals showing only a high temperature with no other symptoms of the disease should be given from 30 to 50 cubic centimeters of the serum, but if the gravity of the disease is pronounced 100 cubic centimeters should be administered. In most instances a drop in temperature may be observed and a diminishing of the severity of the symptoms. At times, however, a relapse occurs about the second or third day following the serum injection, when it becomes necessary to administer another dose of serum. It has been proved that animals affected with anthrax may recover after injections of potent serum.

Prevention.—In this disease prevention is the most important subject demanding consideration. The various means to be suggested may be brought under two heads: (1) The surroundings of the animal, and (2) preventive inoculation.

(1) Surroundings.—What has already been stated of those conditions of the pastures which are favorable to anthrax, after a little thought, will suggest to most minds some of the preventive measures which may be of service in reducing losses in anthrax localities. All that conduces to a better state of the soil should be attempted. The State or Nation, by appropriate engineering, should do its share in preventing frequent inundations. If pools of stagnant water exist in the pastures, or if any particular portions are known by experience to give rise to anthrax, they should be fenced off. Efforts should likewise be made toward the proper draining of swamp lands frequented by cattle. Sometimes it has been found desirable to abandon for a season any infected or dangerous pastures. This remedy can not be carried out by most farmers, and it is liable to extend the infected territory. In some instances withdrawal of cattle from pastures entirely and feeding them in stables is said to have reduced the losses.

It is of the utmost importance that carcasses of animals which have died of anthrax be properly disposed of, as every portion of such animal contains the bacilli, ready to form spores when exposed to the air. Perhaps the simplest means is to bury the carcasses deep, where they can not be exposed by dogs or wild animals. It may be necessary to bury them on the pasture, but it is better to remove them to places not frequented by susceptible animals and to a point where drainage from the graves can not infect any water supply.

If they are moved some distance it must be borne in mind that the ground and all objects which have come in contact with the carcass should be disinfected. This is best accomplished with chlorid of lime. For washing utensils, etc., a 5 per cent solution may be prepared by adding 3 ounces to 2 quarts of water. This should be prepared fresh from the powder, and it is but little trouble to have a small tin measure of known capacity to dip out the powder, to be added to the water whenever necessary. The carcass and the ground should be sprinkled with powdered chlorid, or, if this is not at hand, an abundance of ordinary, unslaked lime should be used in its place.

The removal of carcasses to rendering establishments is always fraught with danger, unless those who handle them are thoroughly aware of the danger of scattering the virus by careless handling in wagons that are not tight. As a rule, the persons in charge of such transfer have no training for this important work, so that deep burial is to be preferred. Burning large carcasses is not always feasible; it is, however, the most certain means of destroying infectious material of any kind, and should be resorted to whenever practicable and economical. All carcasses, whether buried, rendered, or burned, should be disposed of unopened. When stables have become infected they should be thoroughly cleaned out, and the solution of chlorid of lime freely applied on floors and woodwork. The feed should be carefully protected from contamination with the manure or other discharges from the sick.

(2) Preventive inoculation.—One of the most important discoveries in connection with the disease was made by Louis Pasteur in 1881, and consisted in the new principle of producing immunity by the inoculation of weakened cultures of the bacillus causing the disease. This method has been quite extensively adopted in France, and to some extent in other European countries, and in the United States. The fluid used for inoculation consists of bouillon in which modified anthrax bacilli have multiplied and are present in large numbers. The bacilli have been modified by heat so that to a certain degree they have lost their original virulence. Two vaccines are prepared. The first or weaker, for the first inoculation, is obtained by subjecting the bacilli to the attenuating effects of heat for a longer period of time than in the case of the second, or stronger vaccine, for a second inoculation some 12 days later.

There are several difficulties inherent in the practical application of Pasteur's vaccine. Among them may be mentioned the variable degree of attenuation of different tubes of the vaccine and the varying susceptibility of the animals to be inoculated. The use of this vaccine is increasing, nevertheless, and has reduced the mortality in the affected districts from an average of 10 per cent in the case of sheep, to less than 1 per cent, and from 5 per cent with cattle, to less than one-half of 1 per cent.

It is very important to call attention to the possibility of distributing anthrax by this method of protective inoculation, as the bacilli themselves are present in the culture liquid. It is true that they have been modified and weakened by the process adopted by Pasteur, but it is not impossible for such modified virus to regain its original virulence after it has been scattered broadcast by the inoculation of large herds. It is obviously unsafe to have such vaccine injected by a layman; instead, it should be handled only by a competent veterinarian.

There are other disadvantages in this method of vaccination, and they all must be given due consideration. The unstable keeping quality of the Pasteur vaccine is a very important factor to be considered. Experience in this line has proved that Pasteur vaccine may deteriorate within a very short time after its preparation, and in repeated instances it has proved inert within three months of its preparation. When exposed to warm temperature and light, it deteriorates very rapidly; and when it is considered that the products of manufacturers may be stored under unfavorable conditions in branch houses and on the shelves of rural drug stores, the loss of potency can be readily explained. These deficiencies have been recognized by many investigators, and because of the superior keeping qualities particular attention has been directed toward the preparation of a spore vaccine by Zenkowsky of Russia, Detre of Hungary, and Nitta of Japan. For the purpose of producing a spore vaccine it is desirable to use a peptone-free agar medium, and after inoculation with an attenuated culture of the anthrax bacillus, it is allowed to grow at a temperature of 37° C. for 4 to 7 days. By this time an abundance of spores will have formed. The growth is then collected in sterile flasks and heated to a temperature of 60° C. for one-half hour to destroy the vegetative forms of the organism. If it is desired to use for vaccination one million spores, it is advisable to dilute the vaccine to a quantity of which 1 cubic centimeter would contain this number. Of such a vaccine 1 cubic centimeter would constitute the dose for cattle and horses. In all forms of vaccination against anthrax in sheep the greatest care must be exercised, as these animals are very susceptible to the disease, and at times vaccines which have no ill effects on cattle will prove fatal to sheep. Therefore the dose of the spore vaccine for sheep should not be more than one-fourth of that given to cattle.

Sclavo, Sobernheim, and others have established that injections of increasing quantities of virulent cultures into immune animals produced a serum which has great protective value against anthrax. Such protective serum may be produced in the various susceptible animals.

For immunization purposes it is advisable to use the simultaneous method; that is, both the spore vaccine and the anthrax serum should be injected. It is desirable to divide the herd to be treated into groups of ten or twelve and inject, first, each animal of the group with the serum, following this with the injection of the spore vaccine. The serum should be injected on one side, either on the neck or back of the shoulder, and the spore vaccine on the other side, injections being made subcutaneously. In herds in which the disease has already made its appearance it is necessary to take the temperatures of all the animals and to subject to the simultaneous vaccination only those that show no rise in temperature. All others should be given the serum-alone treatment in doses varying in accordance with the severity of the symptoms manifested by the individual animals. If the examination reveals a considerable number of infections, it is advisable to use the serum alone for all the animals, and in three or four weeks to revaccinate by the simultaneous method. The dosage should depend on the potency of the serum, serum of a high potency naturally being most desirable. Thus serum in 10 cubic centimeter doses for large animals, and 3 to 5 cubic centimeter doses for smaller ones, has been found to be effective in producing a temporary immunity.

As anthrax is entirely different from blackleg, vaccine for the latter does not act as a preventive against the former.

ANTHRAX IN MAN (MALIGNANT PUSTULE, OR CARBUNCLE).

Anthrax may be transmitted to man in handling the carcasses and hides of animals which have succumbed to the disease. The infection usually takes place through some abrasion or slight wound of the skin into which the anthrax spores, or bacilli, find their way. The point of inoculation appears at first as a dark point or patch, compared by some writers to the sting of a flea. After a few hours this is changed into a reddened pimple, which bears on its summit, usually around a hair, a yellowish blister, or vesicle, which later on becomes red or bluish in color. The burning sensation in this stage is very great. Later this pimple enlarges, its center becomes dry, gangrenous, and is surrounded by an elevated, discolored swelling. The center becomes drier and more leatherlike, and sinks in as the whole increases in size. The skin around this swelling or carbuncle is stained yellow or bluish, and is not infrequently swollen and doughy to the touch. The carbuncle itself rarely grows larger than a pea or a small nut, and is but slightly painful.

Anthrax swellings or edemas, already described as occurring in cattle, may also be found in man, and they are at times so extensive as to produce distortion in the appearance of the part of the body on which they are found. The color of the skin over these swellings varies according to the situation and thickness of the skin and the stage of the disease, and may be white, red, bluish, or blackish.

As sooner or later these carbuncles and swellings may lead to an infection of the entire body, and thus be fatal, surgical assistance should at once be called if there is well-grounded suspicion that any swellings resembling those described above have been caused by inoculation with anthrax virus. Inasmuch as physicians differ as to medicinal treatment of such accidents in man, it would be out of place to make any suggestions in this connection.

Extensive data are available, however, on the effectiveness of anthrax serum for the treatment of the disease in man. It is recommended that from 30 to 40 cubic centimeters of serum be injected in three or four different places. Should no improvement follow in 24 hours additional injections of 20 to 30 cubic centimeters should be administered.

In most instances the results are favorable, and this treatment is acknowledged to be superior to any other mode of treatment known for the disease.

To show that the transmission of anthrax to man is not so very uncommon, we take the following figures from the 1890 report of the German Government: The attention of the authorities was brought to 111 cases, of which 11 terminated fatally. The largest number of inoculations were caused by the slaughtering, opening, and skinning of animals affected with anthrax; hence, the butchers suffered most extensively. Of the 111 thus affected, 36 belonged to this craft. Infected shaving brushes also are very dangerous.

In addition to anthrax of the skin (known as malignant pustule), human beings are subject, though very rarely, to the disease of the lungs and the digestive organs. In the former case the spores are inhaled by workmen in establishments in which wool, hides, and rags are worked over, and it is therefore known as woolsorter's disease. In the latter case the disease is contracted by eating the flesh of diseased animals which has not been thoroughly cooked. These forms of the disease are more fatal than those in which the disease starts from the skin.

BLACKLEG.

[Pl. XLII.]

Blackleg, black quarter, quarter ill, symptomatic anthrax, charbon symptomatique of the French, Rauschbrand of the Germans, is a rapidly fatal, infectious disease of young cattle, associated with external swellings which emit a crackling sound when handled. This disease was formerly regarded identical with anthrax, but investigations by various scientists in recent times have definitely proved the entire dissimilarity of the two affections, both from a clinical and a causal standpoint. The disease is produced by a specific bacillus, readily distinguishable from that causing anthrax. (Pl. XXVIII, fig. 4.) Cattle between 6 months and 2 years of age are the most susceptible. Sucking calves under 6 months are rarely attacked, nor are they so susceptible to inoculation as older animals. Cattle more than 2 years of age may become affected, but such cases are infrequent. Sheep and goats may also contract the disease, but man, horses, hogs, dogs, cats, and fowls appear to be immune.

Like anthrax, blackleg is more or less restricted to definite localities. There are certain pastures upon which the disease regularly appears in the summer and fall of the year. As to any peculiarities of the soil nothing is definitely known. Some authors are inclined to regard moist, undrained, and swampy pastures favorable to this disease, but these theories will hardly hold, as it is found in all kinds of soil, in all altitudes, at all seasons of the year, and under various climatic conditions. It occurs in this country from the Atlantic to the Pacific and from Mexico to Canada, but it is more prevalent in the Western and Southwestern States. In Europe it exists in France, various parts of Germany, in Belgium, Norway, Denmark, Italy, and in the Alps of Switzerland. In Africa it occurs in Algeria and to some extent in Natal and bordering countries. In South America it prevails quite extensively throughout Argentina. Cattle in Cuba and Australia also suffer.

Cause.—The cause of the disease is a bacillus resembling in some minor respects the anthrax bacillus and differing but little from it in size. It also possesses the power of forming within itself a spore. In Plate XXVIII, figure 4, this is represented as an uncolored spot located in one end of the rod, which is enlarged so that the rod itself appears more or less club-shaped. What has already been stated concerning the significance of the spore of the anthrax bacillus applies equally well to these bodies. They resist destructive agents for a considerable time, and may still produce disease when inoculated after several years of drying. This fact may account for the occasional appearance of blackleg in stables. In order to meet the requirements for the development of the spores, which takes place only in the absence of the atmosphere, it is necessary that the wound be very small and deep enough to penetrate the subcutaneous tissue.

Several observers have found this organism in the mud of swamps. By placing a little of the mud under the skin, the disease has been produced.

Since the disease may be produced by placing under the skin material containing the specific bacilli and spores, it has been assumed that cattle contract the disease through wounds, principally of the skin, or very rarely of the mouth, tongue, and throat. Slight wounds into which the virus may find access may be caused by barbed wire, stubbles, thorns, briers, grass burs, and sharp or pointed parts of feed. Infection by way of digestive tract is also probable.

Symptoms and lesions.—The symptoms of blackleg may be either of a general or of a local nature, though more frequently of the latter. The general symptoms are very much like those belonging to other acute infectious or bacterial diseases. They begin, from one to three days after the infection has taken place, with loss of appetite and of rumination, with dullness and debility, and a high fever. The temperature may rise to 107° F. To these may be added lameness or stiffness of one or more limbs, due to the tumor or swelling quite invariably accompanying the disease. After a period of disease lasting from one to three days the affected animal almost always succumbs. Death is preceded by increasing weakness, difficult breathing, and occasional attacks of violent convulsions.

The most important characteristic of this disease is the appearance of a tumor or swelling under the skin a few hours after the setting in of the constitutional symptoms described above. In some cases it may appear first. This tumor may be on the thighs (hence "blackleg," "black quarter"), the neck, the shoulder, the breast, the flanks, or the rump; never below the carpal (or knee) and the hock joint. It more rarely appears in the throat and at the base of the tongue. The tumor, at first small and painful, spreads very rapidly both in depth and extent. When it is stroked or handled a peculiar crackling sound is heard under the skin; this is due to a collection of gas formed by the bacilli as they multiply. At this stage the skin becomes dry, parchment-like, and cool to the touch in the center of the tumor. If the swelling is cut into, a frothy, dark-red, rather disagreeable-smelling fluid is discharged. The animal manifests little or no pain during the operation.

As it is frequently desirable to know whether the disease is anthrax or blackleg, a few of the most obvious post-mortem changes may here be cited. The characteristic tumor with its crackling sound when stroked has already been described. If after the death of the animal it is more thoroughly examined, it will be noted that the tissues under the skin are infiltrated with blood and yellowish, jelly-like material and gas bubbles. The muscular tissue beneath the swelling may be brownish or black, shading into dark red. (Pl. XLII.) It is soft, easily torn and broken up. The muscle tissue is distended with numerous smaller or larger gas-filled cavities, often to such extent as to produce a resemblance to lung tissue. Upon incision it does not collapse perceptibly, as the gas cavities are not connected with one another.

In the abdomen and the thorax bloodstained fluid is not infrequently found, together with bloodstaining of the lining membrane of these cavities. Blood spots (or ecchymoses) are also found on the heart and lungs. The liver is congested, but the spleen is always normal in appearance.

Differential diagnosis.—Among the features of this disease which distinguish it from anthrax may be mentioned the unchanged spleen and the ready clotting of the blood. It will be remembered that in anthrax the spleen (milt) is very much enlarged, the blood tarry, coagulating feebly. The anthrax carbuncles and swellings differ from the blackleg swellings in not containing gas, in being hard and solid, and in causing death less rapidly.

It is difficult to distinguish between the swellings of blackleg and malignant edema, as they resemble each other very closely and both are distended with gas. Malignant edema, however, generally starts from a wound of considerable size: it usually follows surgical operations, and seldom results from the small abrasions and pricks to which animals are subjected in pastures. Inoculation experiments on guinea pigs, rabbits, and chickens will generally disclose the differences between the three diseases above, as all these species are killed by the germ of malignant edema, only the first two species by the anthrax bacillus, while the guinea pigs alone will succumb to the blackleg infection. Hemorrhagic septicemia may be differentiated from blackleg by its affecting cattle of all ages, by the location of the swelling usually about the region of the throat, neck, and dewlap, by the soft, doughy character of the swellings without the presence of gas bubbles, and finally by the characteristic hemorrhages widely distributed throughout the body. Other means of diagnosis, which have reference to the specific bacilli, to the inoculable character of the virus upon small animals, and which are of decisive and final importance, can be utilized only by the trained bacteriologist and veterinarian.

Treatment.—In this disease remedies have thus far proved unavailing. Some writers recommend the use of certain drugs, which seem to have been beneficial in a few cases, but a thorough trial has shown them to be valueless. Others advise that the swelling be opened by deep and long incisions and a strong disinfectant, such as a 5 per cent solution of carbolic acid, applied to the exposed parts, but this procedure can not be too strongly condemned. As nearly all those attacked die, in spite of every kind of treatment, and in view of the fact that when these tumors are opened the germs of the disease are scattered over the stables or pastures, thus becoming a source of danger to other cattle, it is obvious that such measures do more harm than good and should be put aside as dangerous. Bleeding, nerving, roweling, or setoning have likewise some adherents, but the evidence indicates that they have neither curative nor preventive value and therefore should be discarded for the method of vaccination which has been thoroughly tried and proved to be efficacious.

Prevention.—The various means suggested under "Anthrax" to prevent the spread or recurrence of this disease are equally applicable to blackleg, and hence do not need to be repeated here in full. They consist in the removal of well animals from the infected pasture to a noninfected field, the draining of the swampy ground, the burial or burning of the carcasses to prevent the dissemination of the germs over vast areas through the agency of dogs, wolves, buzzards, or crows, the disinfection of the stables and the ground where the animals lay at the time of death, and, if possible, the destruction of the germs on the infected pastures. One of the most effective methods for freeing an infected pasture from blackleg is to allow the grass to grow high, and when sufficiently dry to burn it off. One burning off is not sufficient to redeem an infected pasture, but the process should be repeated several years in succession. This method, however, is in many instances impracticable, as few cattle owners can afford to do it, and the only means left for the protection of the animals is vaccination.

Immunization by vaccination.—Three French veterinarians, Arloing, Cornevin, and Thomas, were the first to discover that cattle may be protected against blackleg by inoculation with virulent material obtained from animals which have died of this disease. Later they devised a method of inoculation with the attenuated or weakened blackleg spores which produced immunity from natural or artificial inoculation of virulent blackleg germs. Their method has undergone various modifications both in regard to the manufacture of the vaccine and in the mode of its application. Kitt, a German scientist, modified the method so that but one inoculation of the vaccine was required instead of two, as was the case with that made by the French investigators. The vaccine formerly prepared and distributed by the Bureau of Animal Industry combined the principle of Arloing, Cornevin, and Thomas, and the modification of Kitt.

By vaccination we understand the injection of a minute amount of attenuated—that is, artificially weakened—blackleg virus into the system. This virus is obtained from animals which have died from blackleg, by securing the affected muscles, cutting them into strips, and drying them in the air. When they are perfectly dry they are pulverized and mixed with water to form a paste, smeared in a thin layer on flat dishes, placed in an oven, and heated for six hours at a temperature close to that of boiling water. The paste is then transformed into a hard crust, which is pulverized and sifted and distributed in packages containing either 10 or 25 doses. This constitutes the vaccine, the strength of which is thoroughly tested on experiment animals before it is distributed among the cattle owners.

This vaccine, which is in the form of a brownish, dry powder, is mixed with definite quantities of sterile water, filtered, and by means of a hypodermic syringe the filtrate injected under the skin in front of the shoulder of the animal. The inoculation is usually followed by insignificant symptoms. In a few cases there is a slight rise of temperature, and by close observation a minute swelling may be noted at the point of inoculation. The immunity conferred in this way may last for 18 months, but animals vaccinated before they are 6 months old and those in badly infected districts should be revaccinated before the following blackleg season.

The effect of the vaccine prepared by this bureau in preventing outbreaks of the disease and in immediately abating outbreaks already in progress was highly satisfactory, and it is not to be doubted that thousands of young cattle were saved to the stock owners during the 25 years in which the vaccine was distributed.[1] More than 47,000,000 doses were sent out during this period, and from reports received it is safe to conclude that more than 40,000,000 were actually injected, whereby the percentage of loss from blackleg has been reduced from 10 per cent, which annually occurred before using, to less than one-half of 1 per cent per annum. With these figures before us it is plain that the general introduction of preventive vaccination must be of material benefit to the cattle raisers in the infected districts. Moreover, there is every reason to believe that with the continued use of blackleg vaccine in all districts where the disease is known to occur, and an earnest effort on the part of the stock owners to prevent the reinfection of their pastures by following the directions given, blackleg may be kept in check and gradually eradicated.

Immunization against blackleg is now frequently accomplished by the use of the so-called blackleg aggressin and blackleg filtrates.

NECROTIC STOMATITIS (CALF DIPHTHERIA).

[Pl. XLIII.]

Necrotic stomatitis is an acute, specific, highly contagious inflammation of the mouth occurring in young cattle, and characterized locally by the formation of ulcers and caseo-necrotic patches and by constitutional symptoms, chiefly toxic.

This disease has also been termed calf diphtheria, gangrenous stomatitis, ulcerative stomatitis, malignant stomatitis, tubercular stomatitis, and diphtheritic patches of the oral mucous membrane.

History.—During the last few years farmers and cattlemen in this country, especially in Colorado, Texas, and South Dakota, have increasingly noted the occurrence of enzootics of "sore mouth" among the young animals of their herds. Instead of healing, like the usual forms, of themselves, these cases, if untreated, die. Careful study of some of them has resulted in their identification with cases

[1] The distribution of Government blackleg vaccine was discontinued July 1, 1922.

Haines del.

ZEESE-WILKINSON CO. INC., N. Y.

SECTION OF MUSCLE FROM A BLACKLEG SWELLING.

a, GAS BUBBLES.

b, CAVITIES DUE TO GAS FORMATION.

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NECROTIC STOMATITIS (CALF DIPHTHERIA).

reported in 1877 by Damnann, from the shore of the Baltic; in 1878 by Blazekowic, in Slavonia; in 1879 by Vollers, in Holstein; in 1880 by Lenglen, in France; in 1881 by Macgillivray, in England; and in 1884 by Löffler, who isolated and described the microorganism which produces the disease. Bang obtained this organism from the diphtheritic lesions of calves in 1890, and Kitt likewise recovered the bacillus from similar lesions of the larynx and pharynx of calves and pigs in 1893.

Etiology.—The cause of necrotic stomatitis, as demonstrated by Löffler and since confirmed by other investigators, is *Bacillus necrophorus*, often spoken of as the bacillus of necrosis. This organism varies in form from a coccoid rod to long, wavy filaments, which may reach a length of 100 μ; the width varies from 0.75 μ to 1 μ. Hence it is described as polymorphic. It does not stain by Gram, but takes the ordinary anilin dyes, often presenting, especially the longer forms, a beaded appearance. A characteristic of the organism, of great moment when we come to treatment, is that it grows only in the absence of oxygen, from which fact it is described as an obligate anaerobe.

Very few organisms exhibit a wider range of pathogenesis. According to clinical observation to the present time, *Bacillus necrophorus* is pathogenic for cattle, horses, hogs, sheep, reindeer, kangaroos, antelope, and rabbits. Experimentally it has been proved pathogenic for rabbits and white mice. The dog, cat, guinea pig, pigeon, and chicken appear to be absolutely immune. It is not pathogenic for man.

The importance of this bacillus is far beyond even its relation to necrotic stomatitis. Besides this disease it has been demonstrated as the causative factor in foot rot, multiple liver abscesses, disseminated liver necrosis, embolic necrosis of the lungs, necrosis of the heart, in cattle; gangrenous pox of the teats, diphtheria of the uterus and vagina, in cows; diphtheritic inflammation of the small intestine of calves. Among horses it is the agent in the production of necrotic malanders, quittor, and diphtheritic inflammation of the large intestine. In hogs it has caused necrotic or diphtheritic processes in the mucous membrane of the mouth, necrosis of the anterior wall of the nasal septum, and pulmonary and intestinal necrosis, accompanying hog cholera. Abscesses of the liver, gangrenous processes of the lips and nose, and gangrenous affections of the hoof have all been caused in sheep by this organism.

Pathology.—The principal lesions in necrotic stomatitis occur in the mucous membrane of the mouth and pharynx. The alterations may extend to the nasal cavities, the larynx, the trachea, the lung, the esophagus, the intestines, and to the hoof. The oral surfaces affected are, in the order of frequency, tongue, cheeks, hard palate, gums, lips, and pharynx. In the majority of cases the primary infection seems to occur in the tongue. (Pl. XLIII.)

Infection takes place by inoculation. Some abrasion or break in the continuity of the mucous membrane of the mouth occurs. Very likely the origin may be connected with the eruption of the first teeth after birth, or, in animals somewhat older, the entrance of a sharp-pointed particle of feed. Gaining an entrance at this point, the bacilli begin to multiply. During their development they elaborate a toxin, or poisonous substance, which causes the death, or necrosis, of the epithelial, or superficial, layer of the mucous membrane and also of the white blood cells which have sallied forth through the vessel walls to the defense of the tissues against the bacillary attack. This destruction of the surface epithelium seems to be the essential factor in the production of the caseous patch, often called the false membrane. From the connective-tissue framework below is poured forth an inflammatory exudate highly albuminous or rich in fibrin-forming elements. When this exudate and the necrosed cellular elements come in contact, the latter furnish a fibrin ferment which transforms the exduate into a fibrinous mass. This process is known as coagulation necrosis, and the resulting fibroid mass, containing in its meshes the necrosed and degenerated epithelium and leucocytes, constitutes the diphtheritic or false membrane. Did the process cease at this point it would be properly called a diphtheritic inflammation, but it does not. A caseating ferment is supplied by the bacilli, and this, acting upon the fibroid patch, transforms it into a dry, finely granular, yellowish mass of tissue detritus resembling cheese.

Frequently this caseous inflammation results in the formation of one or more ulcers with thickened, slightly reddened borders, surmounted by several layers of this necrosed tissue. The floor of the ulcer is formed by a grayish-yellow, corroded surface, under which the tissue is transformed into a dry, friable, or firm cheesy mass. In the tongue this may progress to two fingers' thickness into the muscular portion; in the cheek it may form an external opening, permitting fluids to escape from the mouth; upon the palate it frequently reaches and includes the bone in its destructive course; upon the gums it has produced necrosis of the tooth sockets, causing loss of the teeth. In the advanced forms, caseous foci may be seen in the lung and in the liver and necrotic patches observed on the mucous membrane of the gastrointestinal tract.

Symptoms.—Necrotic stomatitis is both a local and a systemic affection. Primarily it is local. The local lesion is the caseo-necrotic patch or ulcer developed as a result of the multiplication of the bacilli at the point of inoculation. The general affection is an intoxication, or poisoning, of the whole system produced by a soluble toxin elaborated by the bacilli.

The stage of incubation is from three to five days. The first symptoms noted are a disinclination to take nourishment, some drooling from the mouth, and an examination of the mouth will show on some portion of its mucous membrane a circumscribed area of infiltration and redness, possibly an erosion. The latter gradually extends in size and depth, forming a sharply circumscribed area of necrotic inflammation. It may measure anywhere from the size of a 5-cent piece to that of a silver dollar or even larger. It has the appearance of a corroded surface, under which the mucous membrane or muscular tissue seems transformed into a dry, friable, or firm cheesy mass. It is grayish yellow in color and is bordered by a zone of thickened tissue slightly reddened and somewhat granulated. The necrotic tissue is very adherent and can be only partially peeled off. It is homogeneous, cheesy, and may extend two fingers' depth into the tissues beneath. The general symptoms are languor, weakness, and slight fever. In spite of plenty of good feed the calf is seen to be failing. It stops sucking, or, if older, altogether refuses to eat. The temperature at this time may be from 104° to 107° F. The slobber becomes profuse, swallowing very difficult, opening of the mouth quite painful, and a most offensive odor is exhaled. The tongue is swollen and its motion greatly impaired. Sometimes the mouth is kept open, permitting the tumefied tongue to protrude. One or more of the above symptoms direct the attention to the mouth as the seat of disease; or, having noticed the debility and disinclination to eat, an examination of the animal may show a lump under the neck or swelling of the throat or head. The following extract from a letter is characteristic:

> I noticed my calves beginning to fail about the first week in December, but could not account for it, as they were getting plenty of grain and hay. My attention was first attracted by a swelling under the neck of one of the calves. I cast the animal and found that it was feed that had collected and the animal couldn't swallow it. I removed it, and in so doing noticed a large ulcer on the tongue and a very offensive odor. This was the first knowledge I had of anything being wrong with the calves' mouths. They may have been sick for some time before this.

Out of a herd of 100 belonging to this man, 70 were affected, and the letter emphasizes the insidious character of the onset.

The general affection at this time manifests itself by dejectedness, extreme weakness, and emaciation, constant lying down, with stiffness and marked difficulty in standing.

The disease frequently extends to the nasal cavities, producing a thin, yellowish, or greenish-yellow, sticky discharge which adheres closely to the borders of the nostrils. Their edges also show caseous patches similar to those in the mouth. Sometimes the nasal passage is obstructed by great masses of the necrosed exudate, thus causing extreme difficulty in breathing. When the caseous process involves the larynx and trachea there result cough, wheezing, and dyspnea, together with a yellowish mucopurulent expectoration.

When life is prolonged three or four weeks, caseous foci may be established in the lung, giving rise to all the signs of a bronchopneumonia. Many of these cases are associated with a fibrinous pleurisy. The invasion of the gastrointestinal tract is announced by diarrheal symptoms. This disease principally attacks sucklings not more than 6 weeks of age, but calves 8 and 10 months old are frequently affected, and several cases in adult cattle have been reported to this office.

In its very acute form many of the cases run their course in from five to eight days. In these the local lesions are not strongly marked, and death seems due to acute intoxication. In other enzootics the majority of the affected animals live from three to five weeks. These are cases that occasionally present the pulmonary and intestinal symptoms, and sometimes develop also caseo-necrotic lesions in the liver.

Ordinarily cases show no tendency to spontaneous cure. Left to themselves they die. On the contrary, if taken in hand early, the disease is readily amenable to treatment. In the latter event the prospects of recovery are excellent.

Differential diagnosis.—Necrotic stomatitis may be differentiated from foot-and-mouth disease by the fact that in the latter there is a rapid infection of the entire herd, including the adult cattle, as well as the infection of hogs and sheep. The characteristic lesion of foot-and-mouth disease is the appearance of vesicles containing a serous fluid upon the mucous membrane of the mouth and upon the udder, teats, and feet of the affected animals. In necrotic stomatitis vesicles are never formed, necrosis occurring from the beginning and followed by the formation of yellowish, cheesy patches, principally found in the mouth. Mycotic stomatitis occurs in only a few animals of the herd, chiefly the adult cattle, and the lesions produced consist of an inflammation of the mouth and lips and of the skin between the toes, followed in a few days by small irregular ulcers in the mouth. This disease appears sporadically, usually in the early fall after a dry summer, does not run a regular course, and can not be inoculated.

Prevention.—Prophylaxis should be carried out along three lines:

(1) Separation of the sick from the healthy animals.

(2) Close scrutiny and thorough disinfection once or twice daily for five days of the mouths and nasal passages of those animals that have been exposed.

(3) Complete disinfection of all stalls and sheds.

The disease appears to break out in winter and hold over to spring. It is conceivable that exposure to cold might so disturb the normal circulation of the oral tissues as to make the mucous membrane an excellent location for the causative factor of the disease. There is another possibility, however, which bears on the third line of prophylaxis. The so-called diphtheritic inflammations of the vagina and uterus in cows are caused by the same organism that induces necrotic stomatitis. A European writer has recently pointed out the almost constant relation of such attacks to previous occurrences of foul foot or foot rot in the same or other cattle on the place.

In all likelihood, in such cases, the stalls and sheds are the harborers of this germ. It is possible that many of these outbreaks have some relation to preceding cases of the above-mentioned diseases and the greater use in winter of the stalls and sheds, thus harboring the *Bacillus necrophorus*.

Treatment.—The treatment consists almost solely in careful and extensive cleansing and disinfection of the mouth and other affected surfaces. The mucous membrane of the mouth should be copiously irrigated with a 4 per cent solution of boracic acid in warm water at least twice daily. As exposure to oxygen kills the bacilli, one need have no fear about disturbing or tearing off the caseous patches or necrotic tissue during irrigation. The irrigation of the sores should then be followed by the application with a brush or rag on a stick of a paste made with 1 part of salicylic acid and 10 parts of water, or the affected areas may be painted with Lugol's solution of iodin (iodin, 1; potassium iodid, 5; water, 200). Frequent injections of 1 per cent carbolic-acid solution into the mouth make an excellent treatment. The internal administration of 2 grams of salicylic acid and 3 grams of chlorate of potassium three times a day has also proved to be very beneficial when accompanied with local antiseptic treatment.

MALIGNANT CATARRH.

Malignant catarrh, or infectious catarrhal fever, is an acute infectious disease of cattle preeminently involving the respiratory and digestive tracts, although the sinuses of the head, the eyes, and the urinary and sexual organs are very frequently affected. It is relatively rare in this country, being more common on the continent of Europe. Outbreaks have occurred, however, in Minnesota, New York, and New Jersey. So far the causal agent of the disease has never been isolated, and inoculation experiments with the view of artificially reproducing the disease have proved negative in every case. In spite of the foregoing statements the consensus of opinion of eminent investigators points to malignant catarrh as being of specific origin; that is, due to some form of microorganism the contagious character of which is poorly developed. This accounts for the slow transmissibility of the disease from one animal to another. In fact, malignant catarrh is a type of that class of affections scientifically known as miasmatic diseases; that is, they remain stationary in stables with damp floors, low ceilings, poor ventilation, and bad sanitary conditions in general. Such places furnish a favorable seat of propagation for the infective material, and it will remain active for a long time, causing the loss of a few animals each year. One European veterinarian reports an instance in which the disease remained for 25 years on the same farm, attacking in all 225 animals, with a mortality of about 98 per cent.

The disease is most common in late winter and early spring, at all altitudes, and has a special preference for young, well-nourished cattle, although older animals are not immune. The time between the entrance of the infective principle into the body of the animal and the appearance of the first symptoms is relatively very long, averaging, according to German investigators, from 20 to 30 days. Fortunately, it is not a disease which spreads to any great extent or which causes severe losses, and hence legislative enactments do not seem to be necessary for its restriction.

Symptoms.—These are extremely variable according to the point of localization of the lesions. It is usually ushered in with a chill, followed by a marked rise of temperature (104° to 107° F.). The head droops, the skin is hot and dry, and the coat staring. Quivering of the muscles in various parts of the body is frequently observed. Marked dullness of the animal, passing, according to some observers, into an almost stupefied condition later on, is quite common. The secretion of milk stops in the beginning of the disease, and loss of flesh, invariably associated with the disease, is extremely marked and rapid. The lesions of the eyes may best be likened to moon blindness (periodic ophthalmia) in horses.

There is first an abundant secretion of tears, which run down the face. The lids are swollen and inflamed, and indeed this may be so marked as to cause involuntary eversion, exposing the reddened conjunctiva to view. Sunlight is painful, as is shown by the fact that the animal keeps the eyes continuously closed. This inflammation may extend to the cornea, causing it to assume a slightly clouded appearance in mild cases or a chalky whiteness in more severe affection. Cases of ulceration of the cornea followed by perforation and subsequent escape of the aqueous humor, leading to shrinking of the eyeball and permanent loss of sight, have been recorded, but these are relatively rare, although slight inflammation of the deeper structures of the eye (iris) are more frequent. In mild cases this inflammation may undergo complete resolution, but more frequently permanent cloudliness of the cornea, either diffuse or in spots (leucoma), is the result. The mucous membrane of the mouth, nose, sinuses of the head, throat, and lower respiratory passages are also involved. It is first catarrhal in character, but soon a false or diphtheritic membrane is formed, with the production of shallow ulcers. There is dribbling of saliva from the mouth and discharge from the nose, at first watery, becoming thicker and mixed with blood and small masses of cast-off croupous membrane, causing a very fetid odor. These croupous areas when they form in the throat, larynx, or windpipe, may lead to narrowing of the passages, with consequent difficult breathing and even suffocation. Various respiratory murmurs may also be heard, caused by the to-and-fro movement of mucus and inflammatory deposits along the air passages. There is also inflammation of the horn core with consequent loosening of the horn shell, and the horns are thus readily knocked off by the uneasy, blind sufferer. The animal may refuse all feed from the time of the initial rise of temperature, or in less severe cases, and especially when the lesions of the digestive tract are not so marked, the appetite may remain until the disease is well advanced. Constipation is quite common at the commencement of the attack, followed by diarrhea and severe straining, the evacuations becoming very soft, fetid, and streaked with blood. Cases of the evacuation of desquamated patches of diphtheritic membrane from the intestinal mucosa 6 to 9 feet in length have been reported. The kidneys and bladder are usually inflamed, the urine being voided with difficulty and the animal evincing signs of pain. Inflammatory elements, as albumen, casts, etc., may be seen on examination of the urine. In cows the mucous membrane of the vestibule is congested, swollen, and may contain ulcers and an excessive quantity of mucus. Abortion during advanced pregnancy is not infrequent, following a severe attack. In connection with these various symptoms there may be much uneasiness on the part of the animal, leading in some cases to madness and furious delirium, in others to spasms and convulsions or paralysis. A vesicular eruption of the skin may occur, seen principally between the toes and on the inside of the flank and in the armpits, with subsequent loss of hair and epidermis.

Like other infectious diseases, malignant catarrh pursues a longer or shorter course in accordance with the severity of the attack. In acute cases death is said to take place three to seven days after the appearance of symptoms. Recovery, if it occurs, may take three or four weeks. According to statistics, from 50 to 90 per cent of the affected animals die.

If animals which have died of this disease are examined, in addition to the changes of the mucous membrane of mouth and nasal cavities referred to above, shallow ulcers in these situations will be found occasionally. These necrotic processes may pass beneath the mucous membrane and even involve the underlying bony structure. In severe cases membranous (croupous) deposits are found in the throat. Similar deposits have been found upon the mucous membrane of the fourth stomach and intestine, which is always inflamed. There is more or less inflammation of the membranes of the brain, kidneys, and liver, and some fatty degeneration of the voluntary muscles. In countries where rinderpest occasionally appears it may be difficult to distinguish between it and malignant catarrh, owing to a general similarity of the symptoms. The principal points to be observed in differentiating between the two are the very slight transmissibility of the latter as compared with the intense contagiousness of the former, and the tendency of malignant catarrh to run a more chronic course than rinderpest, which usually results fatally in a very few days. Only a trained veterinarian who takes into consideration all the different symptoms and lesions of both diseases should decide in such cases.

Treatment.—There is no specific treatment for this affection. Copious blood letting in the earliest stages has been highly recommended, however, as this has a tendency to deplete the system and lessen the exudation of inflammatory products. Antiseptic washes, such as 4 per cent boric-acid solution to the eyes and Dobell's solution applied to the nose and mouth with ice poultices over the crest of the head and frontal region, have also proved efficacious. Calomel should also be given in 1-dram doses twice a day for three days, and in severe cases, involving the respiratory tract, a powder containing ferrous sulphate, quinin, and subnitrate of bismuth, given twice a day, will be found beneficial. At the same time it must be remembered that much greater success is to be looked for in the preventive treatment. This consists in the removal of the healthy from the infected animals (not vice versa) and thorough cleaning and disinfecting of the contaminated stables. If the floors are low and damp, they should be raised and made dry. If this can not be done, place a layer of cement under the stable floor to prevent water from entering from below. The stable should be well ventilated and the soil in the pastures thoroughly drained. If this is carefully carried out, the contagion should be destroyed and the danger of the reappearance of the disease in a great measure lessened.

MALIGNANT EDEMA.

Malignant edema, also termed gangrenous septicemia, is an acute, inflammatory disease of domestic and wild animals, resulting from the introduction of a specific organism into the deep connective tissues of a susceptible animal and proving fatal in many instances within 24 to 48 hours. The disease may be inoculated from one animal to another, but only by inserting the virus deeply below the skin. It is infrequently met with in cattle, but may follow operating wounds, as roweling, castration, and phlebotomy, which have become infected with septic matter, soil, or unclean instruments. In the pathological laboratory of the Bureau of Animal Industry the organism has also been obtained from the infected muscles of a calf that was supposed to have died of blackleg, and, as a result, all blackleg virus is thoroughly tested before it is made into blackleg vaccine in order to exclude the malignant-edema organism. The essential cause of malignant edema is a long, slender, motile, spore-bearing bacillus, resembling the bacillus of blackleg, and which can develop only in the absence of the atmosphere. Unlike the bacilli of anthrax and blackleg, which are confined to certain districts, this organism is widely distributed and found in ordinary garden soil, foul water, and in the normal intestinal tract of the herbivora. It may be brought to the surface of the soil by growing plants, rains, winds, or burrowing insects and rodents. In animals that have succumbed to the disease the germ is confined to the seat of infection, but a few hours after death it may migrate through the blood channels to other parts of the body. The bacillus may attack man, horses, asses, goats, sheep, pigs, cats, dogs, and poultry. Adult cattle, although refractory to experimental inoculation, suffer from natural infection, while calves are susceptible to both these methods of exposure. (Kitt.) The introduction of the bacillus into abrasions of the skin and superficial sores rarely does any harm, because the germ is quickly destroyed by contact with air. If, however, the organisms are inserted deeply into the subcutaneous tissues of susceptible animals, they quickly develop, producing a soluble poison, which is the fatal agent.

In lamb-shearing season, or after docking or castration, the mortality is higher among these animals because of wounds inflicted at such times. The application of antiseptics to wounds thus made will reduce the percentage of deaths to a minimum.

Symptoms.—Usually the first symptoms are overlooked. In the early stages the animal appears listless, disinclined to move about, and lies down in shady and quiet places. If forced to move about, the hind legs are drawn forward with a peculiar, stiff, dragging movement, and there may be slight muscular trembling over all the body, which becomes more intense as the disease progresses. When driven, the animal shows signs of fatigue, ultimately dropping to the ground completely exhausted. Breathing becomes fast and painful, with frequent spasmodic jerks.

The pulse is quick and weak and the temperature is 106° to 107° F. An edematous, doughy, and painful swelling appears at the point of infection. This tumefaction spreads more and more, and crackles on pressure. In case of an open wound, a fetid liquid and frothy discharge is observed. The center of the swelling may appear soft and jellylike, while the margin is tense, hot, and painful. The symptoms increase rapidly, resulting in coma and death.

Lesions.—After death the fat and subcutaneous tissues surrounding the infected area are infiltrated with a yellow gelatinous material containing an orange-colored foam, due to the presence of gas bubbles.

The muscles at this point are friable, spongy, and of a uniform brownish tint, dissociated by gas and with a blood-tinged exudate. This gangrenous tissue, when present before death, can be removed without pain to the animal. The intestines are generally normal, but, together with the peritoneum, they may be inflamed, and the lungs are usually the seat of an edema. The spleen, liver, and kidneys retain their normal appearance, in marked contrast with anthrax.

Differential diagnosis.—Unlike blackleg, this disease never appears as an epizootic but in isolated cases. It may also be differentiated from the former by the history of a recent parturition or surgical operation, by the presence of an external injury at the site of the swelling accompanied with a fetid liquid discharge, and the gangrenous appearance of the tumefaction. Man is susceptible to malignant edema, but not to blackleg. Malignant edema may also be easily differentiated from anthrax in that the blood and spleen are normal in appearance, while in the latter disease the blood is dark and of a tarlike consistency, and the spleen appears swollen, injected, and softened. The local tumor in malignant edema contains gas bubbles, which are absent in anthrax swellings. Inoculation experiments of guinea pigs, rabbits, and chickens will also disclose the differences among the above-mentioned three diseases, since all these species are killed by the germ of malignant edema, only the first two species by the anthrax bacillus, while the guinea pig alone will succumb to the blackleg infection.

Treatment.—Treatment is chiefly surgical and consists in laying the infected areas wide open by free incision, followed by a liberal application of a 30 per cent solution of hydrogen dioxid and subsequently a 5 per cent solution of carbolic acid. Usually the disease when observed has advanced to such an extent that medicinal interference is without avail. Preventive treatment is by far the most desirable, and consists, essentially, in a thorough disinfection of all accidental and surgical wounds, the cleansing of the skin, and the exclusion of soil, filth, and bacteria during surgical operations of any nature. Sheds, barns, and stables should receive a thorough application of quicklime or crude carbolic acid wash after all rubbish has been removed and burned. All dead animals should be burned or deeply buried and covered well with quicklime.

SOUTHERN CATTLE FEVER (TEXAS FEVER, TICK FEVER).

[Pls. XLIV–XLIX.]

This disease, which is more commonly known as Texas fever, and sometimes as splenetic fever, is a specific fever communicated by cattle which have recently been moved northward from the infected district; it is also contracted by cattle taken into the infected district from other parts of the world. It is characterized by the peculiarity among animal diseases that the animals which disseminate the infection are apparently in good health, while those which sicken and die from it do not, as a rule, infect others.

It is accompanied with high fever, greatly enlarged spleen, destruction of the red blood corpuscles, escape of the coloring matter of the blood through the kidneys, giving the urine a deep-red color, with a yellowness of the mucous membranes and fat, which is seen more especially in fat cattle, by a rapid loss of strength, and with fatal results in a large proportion of cases.

This disease has various names in different sections of the country where it frequently appears. It is often called Spanish fever, acclimation fever, red water, black water, distemper, murrain, dry murrain, yellow murrain, bloody murrain, Australian tick fever, and tristeza of South America.

The earliest accounts we have of this disease date back to 1814, when it is was stated by Dr. James Mease, before the Philadelphia Society for Promoting Agriculture, that the cattle from a certain district in South Carolina so certainly disease all others with which they mix in their progress to the North that they are prohibited by the people of Virginia from passing through the State; that these cattle infect others while they themselves are in perfect health, and that cattle from Europe or the interior taken to the vicinity of the sea are attacked by a disease that generally proves fatal. Similar observations have been made in regard to a district in the southern part of the United States.

The northern limits of this area are changed yearly as a result of the dissemination or eradication of the cattle tick along the border, but the infected area has gradually decreased, owing to the successful endeavors pushed forward to eliminate the ticks.

It was the frequent and severe losses following the driving of cattle from the infected district in Texas into and across the Western States and Territories which led to the disease being denominated Texas fever. It is now known, however, that the infection is not peculiar to Texas or even to the United States, but that it also exists in southern Europe, Central and South America, Australia, South Africa, and the West Indies.

When cattle from other sections of the country are taken into the infected district they contract this disease usually during the first summer, and if they are adult animals, particularly milch cows or fat cattle, nearly all die. Calves are much more likely to survive. The disease is one from which immunity is acquired, and therefore calves which recover are not again attacked, as a rule, even after they become adult.

When the infection is disseminated beyond the permanently infected district, the roads, pastures, pens, and other inclosures are dangerous for susceptible animals until freezing weather. The infection then disappears, and cattle may be driven over the grounds or kept in the inclosures the succeeding summer and the disease will not reappear. There are some exceptions to this rule in the section just north of the boundary line of the infected district. In this locality the infection sometimes resists the winters, especially if they are mild.

In regard to the manner in which the disease is communicated, experience shows that this does not occur by animals coming near or in contact with one another. It is an indirect infection. The cattle from the infected district first infect the pastures, roads, pens, cars, etc., whence the susceptible cattle obtain the virus secondhand. Usually animals do not contract the disease when separated from infected pastures by a fence. If, however, there is any drainage or washing by rains across the line of fence this rule does not hold good.

The investigations made by the Bureau of Animal Industry demonstrate that the ticks which adhere to cattle from the infected district are the only known means of conveying the infection to susceptible cattle. The infection is not spread by the saliva, the urine, or the manure of cattle from the infected district. In studying the causation and prevention of this disease, attention must therefore be largely given to the tick, and it now seems apparent that if cattle could be freed from this parasite when leaving the infected district they would not be able to spread the malady. The discovery of the connection of the ticks with the production of the disease has played a very important part in determining the methods that should be adopted in preventing its spread. It established an essential point and indicated many lines of investigation which have yielded and are still likely to yield very important results.

Nature of the disease.—Texas fever is caused by an organism which lives within the red blood corpuscles and breaks them up. It is therefore simply a blood disease. The organism does not belong to the bacteria but to the protozoa. It is not, in other words, a microscopic plant, but it belongs to the lowest forms of the animal kingdom. This very minute organism multiplies very rapidly in the body of the infected animal, and in acute cases causes an enormous destruction of red corpuscles in a few days. How it gets into the red corpuscle it is not possible to state, but it appears that it enters as an exceedingly minute body, probably endowed with motion, and only after it has succeeded in entering the corpuscle does it begin to enlarge. Plate XLV, figure 4, illustrates an early stage of this blood parasite. The red corpuscle contains a very minute, roundish body which is stained blue to bring it into view. The body is, as a rule, situated near the edge of the corpuscle. Figure 5 illustrates an older stage in the growth of the parasite, in fact the largest which has thus far been detected. It will be noticed that there are usually two bodies in a corpuscle. These bodies are in general pear-shaped. The narrow ends are always toward each other when two are present in the same corpuscle. If we bear in mind that the average diameter of the red blood corpuscles of cattle is from $\frac{1}{4000}$ to $\frac{1}{5000}$ inch, the size of the contained parasite may be at once appreciated by a glance at the figures referred to.

The various disease processes which go on in Texas fever, and which we may observe by examining the organs after death, all result from the destruction of the red corpuscles; this destruction may be extremely rapid or slow. When it is rapid we have the acute, usually fatal, type of Texas fever, which is always witnessed in the height of the Texas-fever season, that is, during the latter weeks of August and the early weeks of September. When the destruction of corpuscles is slower, a mild, usually nonfatal, type of the disease is called forth, which is only witnessed late in autumn or more rarely in July and the early part of August. Cases of the mild type occurring thus early usually become acute later and terminate fatally.

The acute disease is fatal in most cases, and the fatality is due not so much to the loss of blood corpuscles as to the difficulty which the organs have in getting rid of the waste products arising from this wholesale destruction. How great this may be a simple calculation will serve to illustrate. In a steer weighing 1,000 pounds, the blood in its body weighs about 50 pounds, if we assume that the blood represents one-twentieth of the weight of the body, which is a rather low estimate. According to experimental determination at the bureau station, which consists in counting the number of blood corpuscles in a given quantity of blood from day to day in such an animal, the corpuscles contained in from 5 to 10 pounds of blood may be destroyed within 24 hours. The remains of these corpuscles and the coloring matter in them must be either converted into bile or excreted unchanged. The result of this effort on the part of the liver causes extensive disease of this organ. The bile secreted by the liver cells contains so much solid material that it stagnates in the finest bile canals and chokes these up completely. This in turn interferes with the nutrition of the liver cells and they undergo fatty degeneration and perish. The functions of the liver are thereby completely suspended and death is the result. This enormous destruction of corpuscles takes place to a large extent in the kidneys, where a great number of corpuscles containing the parasites are always found in acute cases. This accounts largely for the blood-colored urine, or red water, which is such a characteristic feature of Texas fever. The corpuscles themselves are not found in the urine; it is the red coloring matter, or hemoglobin, which leaves them when they break up and pass into the urine.

Symptoms.—After a period of exposure to infected soil, which may vary from 13 to 90 days, and which will be more fully discussed under the subject of cattle ticks as bearers of the Texas-fever parasite, the disease first shows itself in dullness, loss of appetite, and a tendency to leave the herd and stand or lie down alone. A few days before these symptoms appear the presence of a high fever may be detected by the clinical thermometer. The temperature rises from a normal of 101° to 103° F. to 106° and 107° F. There seems to be little or no change in temperature until recovery or death ensues. The period of high temperature or fever varies considerably. As it indicates the intensity of the disease process going on within, the higher it is the more rapid the fatal end. When it does not rise above 104° F. the disease is milder and more prolonged.

The bowels are mostly constipated during the fever; toward the end the feces may become softer and rather deeply tinged with bile. The urine shows nothing abnormal during the course of the disease until near the fatal termination, when it may be deeply stained with the coloring matter of the blood. (Hemoglobinuria; see Pl. XLV, fig. 3.) Although this symptom is occasionally observed in animals which recover, yet it may generally be regarded as an indication of approaching death. The pulse and respiration are usually much more rapid than during health.

Other symptoms in addition to those mentioned have been described by observers, but they do not seem to be constant, and only those described above are nearly always present. As the end approaches emaciation becomes very marked, the blood is very thin and watery, and the closing of any wound of the skin by clots is retarded. The animal manifests increasing stupor and may lie down much of the time. Signs of delirium have been observed in some cases. Death occurs most frequently in the night.

The duration of the disease is very variable. Death may ensue in from three days to several weeks after the beginning of the fever. Those that recover ultimately do so very slowly, owing to the great poverty of the blood in red corpuscles. The flesh is regained but very gradually, and the animal may be subjected to a second, though mild, attack later on in the autumn, which pushes the full recovery onward to the beginning of winter.

In the mild type of the disease, which occurs in October and November, symptoms of disease are well-nigh absent. There is little if any fever, and if it were not for loss of flesh and more or less dullness the disease may pass unnoticed, as it undoubtedly does in a majority of cases. If, however, the blood corpuscles are counted from time to time a gradually diminishing number will be found, and after several weeks only about one-fifth or one-sixth of the normal number are present. It is indeed surprising how little impression upon the animal this very impoverished condition of the blood appears to make. It is probable, however, that if two animals kept under the same conditions, one healthy and the other at the end of one of these mild attacks, are weighed, the difference would be plainly shown.

Pathological changes observable after death.—In the preceding pages some of these have already been referred to in describing the nature of the disease. It is very important at times to determine whether a certain disease is Texas fever or some other disease, like anthrax, for example. This fact can, as a rule, be determined at once by a thorough microscopic examination of the blood. The necessary apparatus and the requisite qualifications for this task leave this method entirely in the hands of experts. There are, however, a considerable number of changes caused by this disease which may be detected by the naked eye when the body has been opened. Put together they make a mistake quite impossible. The presence of small ticks on the skin of the escutcheon, the thighs, and the udder is a very important sign in herds north of the Texas-fever line, as it indicates that they have been brought in some manner from the South and have carried the disease with them, as will be explained later. Another very important sign is the thin, watery condition of the blood, either just before death or when the fever has been present for four or five days. A little incision into the skin will enable any one to determine this point. Frequently the skin is so poor in blood that it may require several incisions to draw a drop or more.

The changes in the internal organs, as found on post-mortem examinations, are briefly as follows: The spleen, or milt, is much larger than in healthy animals. It may weigh three or four times as much. When it is incised the contents or pulp is blackish (see Pl. XLIV, fig. 1), and may even well out as a disintegrated mass. The markings of the healthy spleen (fig. 2) are all effaced by the enormous number of blood corpuscles which have collected in it, and to which the enlargement is attributable. Next to the spleen the liver will arouse our attention. (See Pl. XLV, fig. 2.) It is larger than in the healthy state, has lost its natural brownish color (fig. 1), and now has on the surface a paler, yellowish hue. When it is incised this yellowish tinge, or mahogany color, as it has been called by some, is still more prominent. This is owing to the large quantity of bile in the finest bile capillaries, and as these are not uniformly filled with it the cut surface has a more or less mottled appearance. This bile injection causes in many cases a fatty degeneration of the liver cells, which makes the organ appear still lighter in color.

In all cases the gall bladder should be examined. This is distended with bile, which holds in suspension a large number of yellow flakes, so that when it is poured into a tall bottle to settle fully one-half or more of the column of fluid will be occupied by a layer of flakes. If mucus is present at the same time, the bile may become so viscid that when it is poured from one glass to another it forms long bands. The bile in health is a limpid fluid, containing no solid particles.

If the animal during life has not been observed to pass urine colored with blood or red water, the bladder should be opened. This quite invariably, in acute cases, contains urine which varies in color from a deep port wine to a light claret. In many cases the color is so dense that light will not pass through even a thin layer. (Pl. XLV, fig. 3.) The kidneys are always found congested in the acute attack. The disease exerts but little effect on the stomach and intestines beyond more or less reddening of the mucous membrane; hence an examination of them may be safely omitted. The lungs are, as a rule, not diseased. The heart usually shows patches of blood extravasation on the inside (left ventricle) and less markedly on the outer surface.

We have observed jaundice of the various tissues but very rarely. It has been observed by some quite regularly, however.

During the hot season about 90 per cent of the susceptible mature animals from a noninfected district die, but later, in the cool weather, the disease assumes a milder type, with a consequent decrease in the number of deaths.

The cattle tick, Margaropus annulatus, as the carrier of Texas fever. (Pls. XLVI, XLVII, and XLVIII.)—The cattle tick is, as its name indicates, a parasite of cattle in the southern part of the United States. It belongs to the group of Arthropoda and to the genus *Margaropus* (or *Boophilus*), which is included in the order Acarina. Its life history is quite simple and easily traced from one generation to another. It is essentially a parasite, attaching itself to the skin (Pl. XLVIII) and drawing the blood of its host. It is unable to come to maturity and reproduce its kind unless it becomes attached to the skin of cattle, whence it may obtain its food.

The eggs laid on the ground after the female has dropped from the host begin to develop at once. When the embryo is fully formed within the shell it ruptures this and gains its freedom. The time required from the laying of the eggs to their hatching varies considerably, according to the temperature. In the laboratory in the heat of midsummer this was accomplished in about 13 days. In the late fall, under the same conditions, it required from four to six weeks. The larva after emerging from the egg is very minute, six-legged, and is just visible to the naked eye. (Pl. XLVI, fig. 3.) If these larvæ are kept on a layer of moist sand or earth in a covered dish, they may remain alive for months, but there is no appreciable increase in size. So soon, however, as they are placed upon cattle growth begins.

On pastures these little creatures soon find their way on to cattle. They attach themselves by preference to the tender skin on the escutcheon, the inside of the thighs, and on the base of the udder. Yet when they are very numerous they may be found in small numbers on various parts of the body, such as the neck, the chest, and the ears. (Pl. XLVIII and Pl. XLIX, fig. 1.)

The changes which they undergo during their parasitic existence were first studied by Dr. Cooper Curtice, of the Bureau of Animal Industry, in 1889. The young tick molts within a week, and the second or nymphal stage of the parasite's life is thus ushered in. After this change it has four pairs of legs. Within another week another molt takes place by which the tick passes from the nymphal to the sexual, or adult, stage. Impregnation now takes place, and, with the development of the ova in the body, the tick takes an increased quantity of blood, so that in a few days it becomes very much larger. That the rapid growth is due to the blood taken in may be easily proved by crushing one. The intestine is distended with a thick, tarry mass composed of partly digested blood. When the female has reached a certain stage of maturity she drops to the ground and begins to lay a large number of eggs, which hatch in the time given above.

The life of the cattle tick is thus spent largely on cattle, and although the young, or larvæ, may live for a long time on the ground in the summer season, they can not mature except as parasites on cattle and horses. We have purposely omitted various details of the life history, including that of the male, as they are not necessary to an understanding of our present subject—Texas fever. How this is transmitted we will proceed to consider. Before the enforcement of the Federal quarantine southern cattle sent north during the spring and summer months carried on their bodies large numbers of the cattle ticks, which, when matured, would drop off and lay their eggs in the northern pastures. After hatching, the young ticks would soon get upon any northern cattle which happened to be on the pasture. So soon as they attached themselves to the skin they inoculated the cattle, and Texas fever would break out a week or more thereafter. For many years there had been a growing suspicion that the cattle tick was in some way concerned in the spread of Texas fever, and the facts which supported this supposition finally became so numerous and convincing that a series of experiments was inaugurated by the Bureau of Animal Industry which served to show that the tick is abundantly able to carry the disease to a herd of healthy cattle, and, in fact, is probably the only agent concerned in the transmission of the disease from southern cattle to susceptible northern animals.

Injurious effects of cattle ticks.—Unfortunately many cattle owners who have always been accustomed to see both ticks and ticky cattle on their farms are not inclined to attach much importance to these parasites, and, as a rule, through lack of appreciation of their damaging effects, placidly consider them as of little consequence. That ticks may be detrimental to their hosts in several ways has probably not suggested itself to these stockmen, who are most vitally affected, and it therefore seems necessary to emphasize the fact that, in addition to their relation to Texas fever, they may also be injurious to cattle as external parasites. While the power of transmitting Texas fever is undoubtedly the most dangerous property possessed by the cattle tick and is the principal cause for adopting stringent measures looking to its complete eradication, nevertheless there still remain other good reasons for the accomplishment of this achievement. These secondary objections to the presence of ticks on cattle consists in the physical harm they do to the host aside from the production of the specific disease of Texas fever. True, a few parasites may remain on cattle indefinitely without causing any noticeable effect, but it is not uncommon to notice bovine animals on pastures with their hides heavily infested with these pests. In such cases it can readily be seen that the continuous sucking of blood causes more or less impoverishment of the circulation. The animal must therefore be fed more in order to meet the demands of the parasites in addition to the ordinary needs of the host. If the ticks are removed from the body, the bites inflicted are often distinguished by small, inflamed or reddened areas somewhat swollen, with perforations of the skin which may allow the entrance of various kinds of disease germs, and showing that more or less irritation of the hide is produced by these parasites. This condition, together with the loss of blood, frequently induces an irritable state and evidence of uneasiness commonly known as "tick worry," which results in the loss of energy and other derangements of the animal's health. It may in some cases, especially in hot weather, become so pronounced that the animal will lose flesh in spite of good pasturing, thereby reducing the vitality and rendering it more susceptible to the inroads of disease. Moreover, if the infestation of ticks is not controlled, the cattle may be so reduced in condition that growth is retarded, and, in the case of young animals, they may never become fully developed, but remain thin, weak, and stunted—a condition that has been termed "tick poverty"—and easily succumb to other diseases as a result of lowered vitality. In milch cows this debilitating influence of the numerous ticks is shown in a greatly reduced milk supply. This should not appear strange when it is considered that some animals harbor several thousand of the bloodsucking parasites. If these parasites are crushed, it will be found that their intestines are completely filled with a dark, thick mass of blood abstracted from the animal host and containing nutriment that should go to the formation of milk, flesh, and the laying on of fat. In some rare cases the large number of bites on a limited area of skin may be followed by infection with pus-producing organisms, giving rise to small abscesses which may terminate in ulcers. The discharge from these sores, or in some cases the mere oozing of blood serum through the incision made by the mouth parts of the ticks, keeps the hair moist and matted together, and the laying and hatching of fly eggs in these areas give rise to infestation with destructive maggots, causing ulcers and other complications that require medical treatment. These statements regarding the secondary injurious effects of cattle ticks also apply to those ticks which have been previously spoken of as harmless so far as Texas fever is concerned, and, in fact, to all external parasites. Therefore, it is just as important to eradicate the cattle ticks for reasons other than those associated with Texas fever as it is to exterminate lice, fleas, and other vermin. Furthermore, cattle ticks, aside from the losses sustained by their purely parasitic effects, are the greatest menace to the profitable raising and feeding of cattle in the South, because they are an obstacle to cattle traffic between the infected and noninfected districts.

Loss occasioned by cattle ticks.—The economic aspect of the tick problem is unquestionably of the greatest practical interest, since the fundamental importance of all the other questions which surround it depends upon the actual money value involved. A careful and conservative estimate made in 1916 placed the annual loss caused by the ticks in the United States at $40,000,000, and indicated that the ticks also lowered the assets of the South by an additional $33,000,000. The principal items in these losses are set forth below.

It is well known that those animals coming from an infected district and sold in the "southern pens" of northern stockyards bring about one-half a cent less per pound than the quoted market price.

The handicap that is placed on the southern cattle raiser as a result of this decrease in value of his stock will average at this figure $3 per head, allowing an individual weight of 600 pounds for all classes of animals. This decreased value reacts and fixes the valuation of all cattle which remain in the infected territory, thereby reducing the assets of the cattle industry of that section. In addition there is a very great loss from the decrease in flesh and lack of development of southern cattle occasioned by the parasitic life of the ticks from without and by the blood-destroying and enervating properties of the protozoan parasites from within.

The presence of the tick among the cattle of the South not only lessens the value of the cattle on the hoof but causes the gradings of hides that have been infested with ticks as No. 4 quality. The same hide, if free from tick marks, would grade No. 2. The difference in price between these two grades of hides is 3 cents a pound. As the hide of a southern steer weighs about 42 pounds, the presence of the tick in the hide causes a loss in the hide alone of more than $1.26 a hide. It has been shown that the cost of tick eradication is only about 50 cents a head, so that if the counties make a systematic campaign to eradicate the tick, the increase in value of the hide alone would pay for the cost of tick eradication and leave the farmer a net profit of about 76 cents a hide.

The shrinkage in the milk production of cattle harboring many ticks will average 1 quart a day, which in the aggregate is a heavy loss. The damage resulting to the southern purchaser of northern purebred or high-grade cattle is another item of no small moment. About 10 per cent of all such cattle taken into the South die of Texas fever, even after they are immunized by blood inoculations, and about 60 per cent of them succumb to Texas fever when not so treated. As they are usually very expensive animals and of a highly valued strain of blood, the loss in certain cases is excessive and in others almost irreparable, owing to the possible extinction of some particular type especially selected for the improvement of the herd.

Another instance in which it is difficult to figure the injury done by the ticks is in the case of death of nonimmune cattle in the tick-free pastures of the South. Such animals are as susceptible to Texas fever as nonimmune northern cattle, and inasmuch as there is in many States only one out of every four farms infested with ticks, the cattle on the remaining farms will in many cases contract Texas fever when exposed to the fever tick. These losses can scarcely be computed, as the death rate depends so much on the season of the year when exposure occurs and on the age of the animal affected. However, the deaths among such cattle are considerable, although this fact is little appreciated or understood by many outside the infected area.

On rare occasions a small outbreak of Texas fever occurs north of the quarantine line as a result of improperly disinfected cars, of unscrupulous dealers breaking the quarantine regulations, or of some accidental condition. Such damage, however, is slight, but should be considered in summing up the loss occasioned by the fever tick.

The advertisement which a breeder obtains and the sales which are made by having his stock in the show ring are usually lost to the cattle raiser in the infected area who aspires to display his animals in the North, as they are barred from most of these exhibitions. On the other hand, the southern farmer is not given an opportunity to see and be stimulated by the fine specimens of northern cattle which might be shown at southern stock exhibits, for the reason that the danger of contracting Texas fever is too patent to warrant such exposure. A heavy expense is incurred by the Government and the States in enforcing the regulations that apply to the quarantine line.

Another loss which is indirectly sustained by the southern cattle industry through increased freight rates is the cost, to the railroad companies, of cleaning and disinfecting the cars that carry cattle and in providing separate pens for them at various places.

These statements are sufficient to indicate that the loss to the quarantined section from the cattle tick is something enormous. Such a series of encumbrances as those recorded could be carried by the cattle industry of no other section of the country than the South, whose excellent pastures, rich soil, and salubrious climate are the only reasons for its ability to overcome such obstacles in meeting the competition of the West; and it is the inherent capacity of the South for greatly increasing its herds and enlarging its pasture lands that makes the actual loss even secondary to the potential loss from restrictions necessitated by the presence of the cattle tick. This potential loss may be described as the difference between the value of the cattle industry of the South to-day and the extent to which this industry would be increased if farmers and ranchmen were assured that their lands and cattle would not become infested with fever ticks. Could this assurance be given, the beneficial effects would extend over the entire country, because the market of the northern breeder would thereby become greatly extended.

These appalling losses and annual sacrifices of the cattle raisers of the infected district can be entirely effaced, and this at a small proportionate cost; for, with enthusiastic stockmen, satisfactory State legislation, sufficient money, and a corps of trained inspectors, the cattle tick may be exterminated, and every dollar expended in this work will be returned many times during each succeeding year.

Tho so-called period of incubation.—After the young ticks have attached themselves to cattle the fever appears about 10 days thereafter in midsummer. When the weather is cool, as in autumn, this period may be a little longer. The actual period of incubation may be shorter, for if blood from a case of Texas fever is injected into the blood vessels of healthy cattle the fever may appear within five days. When cattle graze upon pastures over which southern cattle have passed, the time when the disease appears varies within wide limits. When the animals have been put upon pastures immediately after southern cattle have infected them with ticks, it may take from 30 to 60 days, or even longer, before the disease appears. This will be readily understood when we recall the life history of ticks. The southern cattle leave only matured ticks which have dropped from them. These must lay their eggs and the latter must be hatched before any ticks can get upon native cattle. The shortest period is thus not less than 30 days if we include 10 days for the period of incubation after the young ticks have attached themselves to native cattle. When the infection of pastures with ticks has taken place early in the season, or when it is cold, the period is much longer, because it takes longer for the eggs to hatch.

If native cattle are placed upon pastures which have been infected with ticks some time before, the disease will appear so much sooner, because the young ticks may be already hatched and attack the cattle at once. It will be evident, therefore, that the length of time between the exposure of native cattle on infected fields and the appearance of the disease depends on the date of original infection, and on the weather, whether cold or hot. When native cattle are placed upon fields on which young ticks are already present, they will show the fever in 13 to 15 days if the season is hot.

The fever appears before the ticks have matured. In fact, they are still small enough to be overlooked. In any case very careful search should be made for them in those places which they prefer—the thighs, escutcheon, and udder. After the acute stage of the fever has passed the ticks begin to swell up and show very plainly. (Pl. XLVI, figs. 6 and 7.)

Prevention.—It is generally accepted that if southern cattle are entirely free from that species of tick known as *Margaropus annulatus* they can be allowed to mingle with the most susceptible animals without danger. Furthermore, it has been learned from the study of the life history of the cattle tick and by observation that this tick infests pastures only transiently, never permanently, and will not mature except upon cattle or equines, that its extermination is possible, and that the disease it causes may be prevented. Therefore the various methods with these results in view should be directed toward the destruction of ticks on cattle as well as their eradication from the pastures.

METHODS OF ERADICATING THE TICKS.[1]

In undertaking measures for eradicating the tick it is evident that the pest may be attacked in two locations, namely, on the pasture and on the cattle.

In freeing pastures the method followed may be either a direct or an indirect one. The former consists in excluding all cattle, horses, and mules from pastures until all the ticks have died from starvation. The latter consists in permitting the cattle and other animals to continue on the infested pasture and treating them at regular intervals with agents destructive to ticks and thus preventing engorged females from dropping and reinfesting the pasture. The larvæ on the pasture, or those which hatch from eggs laid by females already there, will all eventually meet death. Such of these as get upon the cattle from time to time will be destroyed by the treatment, while those which fail to find a host will starve in the pasture.

Animals may be freed of ticks in two ways. They may be treated with an agent that will destroy all the ticks present, or they may be rotated at proper intervals on tick-free fields until all the ticks have dropped. The method most generally used is dipping the cattle in a solution of arsenic. The pasture-rotation method is not only more complicated, but the necessary tick-free fields are seldom available.

DIPPING.

The dipping vat is the best and cheapest means of applying the tick-destroying solution. The great advantage of dipping over spraying and applying remedies by hand lies in the fact that thoroughness of the treatment is practically assured.

When eradication is undertaken, all the cattle, and also the horses and mules if they harbor ticks, are treated regularly every two weeks during the part of the year that the temperature is favorable to treatment, until the ticks have disappeared. The purpose of the treatment is to destroy all ticks that get on the animals before they have had a chance to mature and drop, thus preventing them from reinfesting the pasture, farm, or range. If the treatment used were absolutely effective in destroying each and every tick on the animals treated there would be no renewal of the infestation after the treatment is begun. The cattle would act simply as collectors of ticks which would be destroyed regularly by the treatment applied every two weeks. It is probable, however, that in most instances, either because of the lack of efficiency of the dip or imperfect application, or because of failure to dip all cattle systematically, some ticks escape

[1] Only a general outline of methods of eradication will be given here. For detailed information, including directions for the construction of dipping vats and for the preparation of dips, the reader is referred to Farmers' Bulletin 1057, which may be obtained free upon application to the Department of Agriculture, Washington, D. C.

treatment and reproduce, thus prolonging the time that otherwise would be required for eradication.

If ticks apparently disappear from the cattle after they have been under treatment for some time, the dipping should not be discontinued until a number of careful inspections show that the cattle are free of ticks. If ticks continue on cattle until cold weather and then finally disappear it should be borne in mind that in all probability eradication has not been accomplished and that there may be engorged females, unhatched eggs, and inactive seed ticks on the farm or range, and that even if the cattle should remain free of ticks during the winter they may become reinfested the following spring. In any case in which ticks disappear from the cattle and treatment is discontinued, the cattle should be watched very carefully for ticks until ample time has elapsed to leave no doubt that eradication has been accomplished.

As a general rule it has been found that if dipping is begun in March and systematically and thoroughly done, all cattle being dipped every 14 days until November, complete eradication will be secured. In dipping, each animal should be completely covered by the dip. To prevent any animals from going through the vat without becoming wet all over, a man, provided with a forked stick, should be stationed at the middle of the vat to shove under those that have not been completely submerged.

Dipping is the only really satisfactory method of treating animals for ticks. In cases of emergency, however, or where there are not cattle enough within a radius of several miles to warrant the construction of a vat in which all the cattle of the community may be dipped, spraying may be advisable. In spraying animals the work should be done with great thoroughness and every portion of the body treated. An animal can not be sprayed properly unless it is tied or otherwise held, nor can good results be obtained unless the hair and skin are thoroughly wetted.

Preparation and use of arsenical dips.[1]—After experimenting for many years to discover a practical method for dipping cattle to destroy ticks without injury to the cattle, the Bureau of Animal Industry has developed a very satisfactory arsenical dip. Two formulas are given for homemade dips, one known as the "S-B" (self-boiled) and the other as the boiled dip. The former is the one usually employed.

The S-B dip.—The formula calls for two stock solutions, arsenic stock and tar stock, which must not be mixed except in the diluted dipping bath.

[1] For fuller information see Farmers' Bulletin 1057, from which the directions here given are mainly derived.

Arsenic stock requires the following materials ready to hand before starting:

	Pounds.
Caustic soda	4
White arsenic	10
Sal-soda crystals	10

There should be also some means for heating the solution in case, as sometimes happens because of impure materials, lack of skill, or some unforeseen circumstance, the heat created by mixing the materials should be insufficient to dissolve all the arsenic.

In a 5-gallon kettle or metal[1] pail place the 4 pounds of caustic soda, add 1 gallon of cold water, and stir with a stick until the caustic soda is practically all dissolved. Without delay begin adding the white arsenic, in portions of a pound or two at a time, as fast as it can be dissolved without causing the solution to boil, stirring all the time. If the liquid begins to boil, stop stirring and let it cool slightly before adding more arsenic. The secret of success is to work the arsenic in fast enough to keep the solution very hot—nearly but not quite at the boiling point. The result should be a clear solution, except for dirt. If the liquid persistently remains muddy or milky, it may be because the operation has been conducted so fast that much water has been boiled out and sodium arsenite is beginning to crystallize, so add another gallon of water and stir. If the solution does not then clear up, the caustic soda must have been very low grade, and the undissolved substance must be arsenic. In that case, put the kettle over the fire, heat nearly, but not quite, to boiling, and stir. As soon as the solution of arsenic is complete, dilute to about 4 gallons, add the sodium carbonate, and stir until dissolved.

Cautions.—It is necessary to avoid splashing. Hence never work hurriedly; stir deliberately and regularly; do not dump in the arsenic and sal soda, but carefully slide them in from a grocer's scoop held close to the side of the pail and to the surface of the liquid. Perform the whole operation in a well-ventilated place and avoid inhaling steam.

After the solution has become cold add water to make it to exactly 5 gallons,[2] mix well, let settle, and draw off into containers which can be tightly corked or otherwise closed. Jugs or demijohns are best, but tin cans will serve if occasionally inspected for leaks which may occur after a time through the action of the solution upon the solder of the can.

Tar stock is prepared thus: In a large metal pail dissolve three-fourths of a pound of caustic soda in 1 quart of water, add 1 gallon of pine tar, and stir thoroughly with a wooden paddle until the mix-

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[1] The chemicals employed have no effect upon iron. They will, however, actively corrode zinc, tin, or solder; hence a soldered pail must be watched for leaks and is far inferior to a seamless pail, stamped from a single sheet of iron. A tinned pail is preferred to a galvanized one, but a plain iron seamless pail or an iron kettle should be obtained if possible.

[2] Best done by previously determining by measurement the depth of 5 gallons of water in the kettle. Set the kettle exactly level and mark the depth on a stick held vertically on the center of the bottom.

ture, which at first looks streaked and muddy, brightens to a uniform, thick fluid somewhat resembling molasses. Test it by letting about a teaspoonful drip from the paddle into a glass of water (a glass fruit jar or a wide-mouth bottle will do) and stirring thoroughly with a sliver of wood. It should mix perfectly with the water. Globules of tar which can be seen by looking at the glass from underneath and which can not be blended with the water by repeated stirring indicate that more caustic-soda solution is needed. In that case make up more caustic-soda solution of the same strength and add it, not more than a pint at a time, with thorough stirring, until the desired effect is produced.

If an appropriate glass vessel for making the test is not at hand, take a little of the mixture between the fingers, then dip the fingers under water and try to rub off the tar. It should leave the fingers perfectly clean after a little rubbing with water. If an oily coating remains, more caustic-soda solution is needed. Such an extra addition of caustic soda will be required only in case of a very low-grade chemical or a very highly acid tar. The tar stock should be kept in closed containers, such as a pail with a friction top.

The quantity of S-B arsenic stock or of tar stock made in one operation can be varied as desired, provided the above-given proportions of the ingredients are adhered to. But one should attempt to work the S-B formula on a larger scale only after skill and experience have been acquired.

The boiled dip is less convenient than the S-B dip, but the final composition and effect of dipping baths prepared from the two are the same.

To make a 500-gallon bath provide:

Sal-soda crystals	24 pounds.
White arsenic	8 pounds.
Pine tar	1 gallon.

Put 25 gallons of water into a kettle or tank of from 40 to 50 gallons' capacity, heat to boiling, and add the sal soda. When this has dissolved add the white arsenic, then boil and stir for 15 minutes or longer, until the white arsenic has entirely disappeared. If intended for immediate use cool to 140° F. (by addition of cold water if desired), then pour in the pine tar in a thin stream while constantly and vigorously stirring the solution. Immediately empty the liquid into the dipping vat, which has already been three-fourths filled with water, and stir thoroughly.

All the utensils must be free from greasy or oily matter which would coat the arsenic and hinder its solution. The operation of boiling requires constant attention to avoid loss by foaming. Hard water may be used, but in that case considerable undissolved material, which, however, does not contain any arsenic, may be left after boiling.

For a stock solution to be kept on hand and used when needed add no tar, but after the solution has become cold make it up to 25 gallons, stir well, let settle, and draw off into containers which can be well closed. In this case the tar stock previously described is also required.

Diluting the dip.—First run water into the vat about three-fourths up to the dipping line, at which its capacity must be known. If tar stock is to be used the necessary amount will be one-third of a gallon for every 100 gallons of vat capacity. Measure it out, mix it with 2 or 3 times its volume of water and pour it along the surface of the water in the vat, stirring a little.

Every 100 gallons of standard-strength bath calls for $1\frac{3}{5}$ pounds white arsenic, which quantity is contained in four-fifths of a gallon of S-B stock or in 5 gallons of boiled stock. From these figures the quantity of arsenic or stock needed to charge the vat may be calculated. Or one may base the calculation on the following facts:

One pound of white arsenic will make $62\frac{1}{2}$ gallons of bath.
One gallon of S-B stock will make 125 gallons of bath.
One gallon of boiled arsenic stock will make 20 gallons of bath.

All solutions of arsenic are considerably heavier than water and if carelessly put into the vat they may plunge to the bottom and be difficult to mix. Therefore always pour the arsenic stock or a proprietary dip in a thin stream evenly along the vat except at the shallow exit end. Another precaution to be taken in handling proprietary dips is never to mix them first with small quantities of water, which may "break" them. Pour them directly into the water in the vat.

Finally, add water up to the dipping line and stir well. An excellent way to stir is by a pail tied to a rope. Sink it at the entrance end of the vat and haul it along the bottom to the exit. Then raise it, throw it back to the entrance end, and haul through again, repeating as many times as necessary but always hauling through in the same direction.

The standard-strength bath prepared as above contains practically 0.19 per cent arsenious oxid when fresh. After use oxidation may set in and weaken it, but it will not need to be strengthened so long as it tests not less than 0.175 per cent arsenious oxid.

To make up small quantities for spraying, to each 5 gallons of water measured out add first 2 fluid ounces (4 tablespoonfuls) of tar stock, and then $5\frac{1}{8}$ fluid ounces of S-B stock or $2\frac{1}{8}$ pints of boiled arsenic stock.

The standard strength of bath should be adhered to so far as possible because its effectiveness against ticks will effect eradication in the least time and with fewest dippings. But if time is not pressing it is sometimes best to begin with a lower strength, say 0.14 or 0.15 per cent, and gradually work up to full strength as the cattle become accustomed to the treatment. This is certainly a wise method for the individual cattle owner who is outside the area of cooperative work and who lacks aid and advice from experts. Weather conditions also need to be considered. Hot or moist weather is more trying to the cattle than cool or dry weather. The longer the time needed for the cattle to dry off after dipping, which of course primarily depends on the proportion of moisture in the air, the more liable they are to show blistering or other injury through the continued absorption of arsenic by the skin. The combination of heat and moisture is particularly bad, and under such conditions it may be desirable, unless other conditions prohibit, to use the bath somewhat weaker than standard strength. The following table shows the quantities of arsenic and stock solutions contained in 100 gallons of bath of different strengths, so that the quantities necessary to charge a vat of any size at any strength can be found by simple multiplication.

Composition of dipping baths.

Actual arsenious oxid.	Per 100 gallons of bath.			Actual arsenious oxid.	Per 100 gallons of bath.		
	White arsenic.	S-B stock.	Boiled stock.		White arsenic.	S-B stock.	Boiled stock.
Per cent.	*Pounds.*	*Gallons.*	*Gallons.*	*Per cent.*	*Pounds.*	*Gallons.*	*Gallons.*
0.05	0.42	0.21	1.3	0.15	1.25	0.63	3.9
.06	.50	.25	1.6	.16	1.33	.67	4.2
.07	.58	.29	1.8	.17	1.41	.71	4.4
.08	.66	.33	2.1	.18	1.49	.75	4.7
.09	.75	.38	2.3	.19	1.58	.79	4.9
.10	.83	.42	2.6	.20	1.66	.83	....
.11	.91	.46	2.8	.21	1.74	.87	....
.12	1.00	.50	3.1	.22	1.83	.92	....
.13	1.08	.54	3.4	.23	1.91	.96	....
.14	1.16	.58	3.6	.24	2.00	1.00	....

As dipping goes on the bath naturally needs replenishing, and its strength probably needs correction from time to time. Full directions on these points may be found in Farmers' Bulletin 1057.

Prepared dips.—Proprietary arsenical cattle dips appear now to have passed the experimental stage and to have become established as reliable and useful products. At any rate this can be said of the brands which have received permission for use in official dipping in place of the homemade dip. The formulas and standard samples of all such brands are in possession of the Bureau of Animal Industry and the manufacturers are required to guarantee that their products as placed on the market will be kept up to standard and that all requirements of the bureau will be observed. Like the homemade dip they all contain sodium arsenite as the active tick-killing agent. They do not all contain pine tar, because that substance is difficult to blend into a highly concentrated product, but they all contain some other substance or mixture of substances of such character and in such quantity as field trials have proved will produce the same effects.

They are not regarded as any more effective or any milder on the cattle than properly prepared homemade dips. None the less they are undoubtedly safer for general use because they offer decidedly fewer opportunities for making mistakes in the quantities used or in the operations gone through and also fewer chances for accidental poisoning or other injury from the handling of powerful chemicals. Whether their higher cost is sufficiently outweighed by these considerations is necessarily a matter for individual decision.

Precautions in the use of arsenic and arsenical dips.—The fact that arsenic is a violent poison is what renders it valuable, for the fever tick is hard to kill. But, like a keen-edged tool, it may be decidedly dangerous if ignorantly or carelessly handled. Three possibilities of danger must be kept constantly in mind; danger to oneself, danger to other persons, danger to animals.

The dry, powdered white arsenic should be kept in a tightly covered pail, plainly labeled. Paper bags are unsafe because they easily burst, and arsenic so scattered about looks harmless enough. In weighing or otherwise handling the arsenic avoid raising dust or breathing it in, if raised, and keep it off the skin and clothing. In mixing or boiling stock solutions work only in a well-ventilated place, and on the windward side of the kettle so that steam arising from it will not be inhaled.

The stock solutions are in some respects more dangerous than the original substance because the arsenic in them is already in solution and can act very quickly. If any gets on the skin or clothing it must be washed off without delay. Cattle must be kept away from such solutions or from anything that has been in contact with them, for cattle craving salt have been poisoned by licking the outside of leaky barrels and by licking the earth around dipping vats where a little concentrate had been carelessly spilled in charging the vat. All such poisoned earth must be removed, buried, and replaced by fresh.

The diluted bath is naturally much less dangerous, but no chances can be taken with it. No puddles from which animals may drink should be allowed to accumulate. The persons who do the dipping should not allow the skin or clothing to be wet by the dip any more or any longer than absolutely necessary. When spraying, the operator should see to it that neither he nor the animals inhale any of the spray.

When a vat is to be emptied the approved practice is to run the waste bath into a pit properly guarded by a fence, where it will gradually seep away under the surface and do no harm, provided only that seepage can not be carried to a well, stream, or spring from which any person or domestic animal may drink.

The symptoms of arsenical poisoning are rather variable and also depend on the size of the dose and the method of administration. If an animal sickens or dies shortly after dipping it by no means follows that arsenical poisoning or any other effect of the dipping is the cause. Very few cattle relative to the total number dipped have suffered undoubted arsenical poisoning and in most of the cases the cause could be traced to somebody's error or carelessness.

In regard to arsenical poisoning of human beings there is a standard antidote, which may be obtained at any drug store with directions for use. It should be kept on hand for emergencies. If the antidote is not at hand the poison must be removed from the stomach by encouraging repeated vomiting, and soothing drinks such as milk, white of eggs and water, or flour and water must be freely given meanwhile. A suspected case of arsenical poisoning must have the attention of a physician at the earliest possible moment, as sometimes the poison works very quickly.

Crude petroleum.—Various kinds of crude petroleum and emulsions of it have been used with more or less success in destroying ticks, but on account of the difficulty of obtaining suitable grades of oil and the liability of injury to cattle, their use has been practically abandoned.

Method of dipping.—The method usually adopted in dipping cattle is to construct a narrow swimming tank with a chute at one end for the entrance of the cattle, and a sloping exit at the other end when the cattle emerge after passing through the vat. (See Pl. XLIX, fig. 2.) A drip chute, or floor, is connected with the exit, where the excess of dip is allowed to drip off the animals and to drain into the vat. Plans and specifications for installing dipping plants may be obtained from the Bureau of Animal Industry, Department of Agriculture, Washington, D. C.

TREATMENT.

When Texas fever has broken out, all animals, the sick as well as the healthy, should at once be removed to a noninfected pasture. While this may not cut short the disease, it may save the lives of some by removing them from the possibility of attack by more young ticks. Removal from infected pastures likewise prevents a second attack, in October or early in November, which is caused by another generation of ticks. Sick native cattle infect with a new generation of ticks the pasture to which they are removed, but these usually appear so late that they have but little opportunity to do any damage; hence, sick natives do not, as a rule, cause visible disease in other natives.

It is of importance to remove all ticks, so far as this is possible, from sick animals, since they abstract a considerable quantity of blood and thereby retard the final recovery.

Medical treatment of the sick has generally been unsatisfactory, although in chronic cases and those occurring late in the fall beneficial results have followed. If the animal is constipated, a drench containing 1 pound of Epsom salt dissolved in 1 quart of water should be administered, followed by sulphate of quinin in doses of 30 to 90 grains, according to the size of the animal, four times a day until the system is well saturated with it. Tincture of digitalis one-half ounce and alcohol 2 ounces may be combined with the quinin, according to indications of individual cases. An iron tonic containing reduced iron 2 ounces, powdered gentian 4 ounces, powdered nux vomica 2 ounces, powdered rhubarb 2 ounces, and potassium nitrate 6 ounces will be found beneficial in the convalescent stage when the fever has run its course. This tonic should be given in heaping teaspoonful doses three times a day in the feed. Good nursing is essential in treating these cases, and the animal should be given a nutritious, laxative diet with plenty of clean and cool drinking water and allowed to rest in a quiet place. If the stable or pasture is infested with ticks, the animal should be placed in a tick-free inclosure to prevent additional infestation with these parasites and the introduction of fresh infection into the blood. Furthermore, all ticks that can be seen should be removed from the sick cattle, as they keep weakening the animal by withdrawing a considerable quantity of blood, and thereby retard recovery.

QUARANTINE REGULATIONS.

The sanitary regulations issued by the Department of Agriculture for the control of cattle shipments from the infected districts have for their initial purpose the prevention of the transportation of ticks from infected regions to those that are not infected, either upon cattle or in stock cars or other conveyer. They are based upon the fact that Texas fever is carried north only by the cattle tick, and the exclusion of this parasite from the noninfected territory has in every instance been found a certain method of excluding Texas fever. The regulations governing the movement of cattle from below the quarantine line are made yearly by the Secretary of Agriculture, and they

SOUTHERN CATTLE FEVER (TEXAS FEVER, TICK FEVER).

DESCRIPTION OF PLATES.

PLATE XLIV. Normal spleen and spleen affected by Texas fever.

Fig. 1. Spleen of an acute, fatal case of Texas fever. The narrow end of the spleen is here represented.

Fig. 2. Spleen of healthy steer. Though the latter animal weighed one-half more than the former, the weight of the diseased spleen (6⅝ pounds) was nearly three times that of the healthy spleen (2⅜ pounds).

PLATE XLV. Texas fever.

Fig. 1. The cut surface of a healthy liver taken from a steer slaughtered for beef.

Fig. 2. The cut surface of the liver in Texas fever.

Fig. 3. Appearance of the urine in an acute, fatal case of Texas fever.

Fig. 4. Red corpuscles, magnified 1,000 diameters, containing the parasite of Texas fever. This appears as a blue point *a* near the edge of the corpuscle. The blood was taken from a skin incision. The case was nonfatal and occurred late in the fall.

Fig. 5. Red corpuscles from the blood of an acute, fatal case, 20 hours before death. The Texas-fever microbes *a* are shown as pear-shaped bodies, stained with methylene blue, within the red corpuscles. The larger body on the right *b* is a white blood corpuscle, also stained with methylene blue. (Magnified 1,000 diameters.)

PLATE XLVI. The cattle tick (*Margaropus annulatus*), the carrier of Texas fever.

Fig. 1. A series of ticks, natural size, from the smallest, just hatched from the egg, to the mature female, ready to drop off and lay eggs.

Fig. 2. Eggs, magnified 5 times.

Fig. 3. The young tick just hatched (magnified 40 times).

Fig. 4. The male after the last molt (magnified 10 times).

Fig. 5. The female after the last molt (magnified 10 times).

Fig. 6. A portion of the skin of the udder, showing the small ticks. From a fatal case of Texas fever produced by placing young ticks on the animal. (Natural size.)

Fig. 7. A portion of the ear of the same animal, showing same full-grown ticks ready to drop off. (Natural size.)

PLATE XLVII. The cattle tick (*Margaropus annulatus*).

Fig. 1. Dorsal view of male. (Greatly enlarged. Original.)

Fig. 2. Ventral view of male. (Greatly enlarged. Original.)

Fig. 3. Dorsal view of replete female. (Greatly enlarged. Original.)

Fig. 4. Ventral view of same.

PLATE XLVIII. Portion of a steer's hide, showing the Texas-fever tick (*Margaropus annulatus*). (Natural size. Original.)

PLATE XLIX. Fig. 1. Tick-infested steer.

Fig. 2. Dipping cattle to kill ticks.

PLATE L. Facsimile of poster used to show the difference between cattle of similar breeding raised on a tick-free farm in one case and on a ticky farm in the other.

define the boundary of infected districts. The infected area as now determined is shown in maps issued periodically.

In consequence of the enforcement of these quarantine regulations, Texas fever has been practically prevented in the noninfected districts for several years, and little or no hardship has been caused to stockmen handling cattle from the infected areas. Prior to the adoption of these regulations the tick-infested district was rapidly extending northward, but since the quarantine line was established and rational regulations enforced it has gradually been moved farther south. This problem of still further reducing the infested area is of the greatest importance to the cattlemen of the South—in fact, to those on both sides of the line—and one which is receiving special consideration by this department as well as by many of the interested States.

TICK ERADICATION.

Systematic cooperative work by the Federal Government and the affected States for the eradication of the cattle ticks which transmit Texas fever was begun in the summer of 1906 under authority given by Congress in the appropriation act for the Department of Agriculture. The first Federal appropriation for the fiscal year ended June 30, 1907, was $82,500, and for the fiscal year 1908 an appropriation of $150,000 was made, then for several years $250,000, and this has been increased to $660,000 for 1922. Funds have also been provided by States and counties.

The original infected area amounted to 728,543 square miles. Of this territory there has been released from quarantine as a result of the work above mentioned 523,837 square miles (up to July 1, 1922). In other words, 72 per cent of the area has been freed from ticks in 16 years.

Great improvement has resulted from this work in the released territory. More cattle are being raised, and a better grade of breeding stock is being introduced; calves grow faster, and cattle put on flesh more rapidly during the grazing season and go into the winter in better condition because of the absence of the ticks; they can be marketed without quarantine restrictions, and higher prices are being obtained; dairy cows give a larger yield of milk; and values of farm lands are enhanced.

The difference between the prices realized for cattle from the tick-infested region and the prices of cattle of similar grades from above the quarantine line has ranged from $2.25 to $5 a head at the principal northern live-stock markets, without taking into account the improvement in quality and weight of cattle because of the eradication of the ticks. It can easily be seen that the extermination of the ticks means a large total annual increase in the prices obtained for southern cattle sold in northern markets. In addition to this, the increase in prices of cattle sold locally in the South would represent a large sum. This local increase has been found to amount to from $3 to $15 a head in territory freed from ticks. An agricultural official of one of the Southern States has reported that calves in the tick-free area bring double the prices that can be obtained for similar calves in the tick-infested region.

Heretofore it has been impracticable to improve the quality of southern cattle by introducing fine breeding animals from other sections, because such animals were liable to contract Texas fever and die unless protected by inoculation. Furthermore, it is impossible for animals to attain good growth and to thrive when they are heavily infested with ticks. With the eradication of the ticks, however, the southern farmers are enabled to introduce good breeding animals and to improve the grade of their stock.

There is no longer any doubt that it is entirely practicable to exterminate the ticks throughout the entire region, and the accomplishment of this result will be of tremendous economic advantage not only to the South but to the whole country. The rate of progress depends mainly on two factors—the amounts appropriated by the Federal and State Governments, and the cooperation of the people.

CHRONIC BACTERIAL DYSENTERY.

Chronic bacterial dysentery is a chronic infectious disease of bovines caused by an acid-fast bacillus simulating the tubercle bacillus and characterized by marked diarrhea, anemia, and emaciation, terminating in death.

This disease was observed in the United States for the first time by Pearson in Pennsylvania cattle, and later by Mohler in Virginia cattle, and in an imported heifer from the island of Jersey at the Athenia quarantine station of the Bureau of Animal Industry.

Pearson proposed the name chronic bacterial dysentery for this affection, and it has also been termed Johne's disease, chronic bacterial enteritis, chronic hypertrophic enteritis, and chronic bovine pseudotuberculous enteritis by various European investigators. The disease was first studied in 1895 by Johne and Frothingham in Dresden, but they were inclined to attribute to the avian tubercle bacillus the cause of the peculiar lesions of enteritis which they observed. In 1904 Markus reported this disease in Holland, and subsequently it was observed in Belgium, Switzerland, Denmark, and Great Britain.

Cause.—The bacillus, which has been invariably demonstrated in the intestinal lesions and mesenteric lymph glands in this disease, is a rod about 2 to 3 microns long and 0.5 micron wide. It stains more or less irregularly, like the tubercle bacillus, and moreover the similarity goes further, in that the organism is also strongly acid-fast, which facts led Johne and Frothingham to surmise that the disease was caused by avian tubercle bacilli. However, it has now been plainly demonstrated that the bacillus of chronic bacterial dysentery is readily distinguished from the latter organisms, for while it resembles the tubercle bacillus in form and staining qualities, no one has succeeded in growing it in culture media or in reproducing the disease by injecting experiment animals.

Symptoms.—Probably the first symptom noticed is that the animal is losing condition despite the fact that its appetite is good and the food nourishing. This is soon followed by a diarrhea which, while moderate at first, soon becomes excessive and may be either irregular or persistent, the feces being of the consistency of molasses and passed frequently. In the meantime the hair becomes dry and harsh and the animal falls off considerably in weight. The temperature, however, remains about normal. The appetite does not seem to be greatly impaired until the last few weeks of life, but nevertheless emaciation continues, the animal becomes more and more anemic, great muscular weakness and exhaustion are manifested, and death follows, apparently as the result of the persistent diarrhea and great emaciation. The disease may continue for four or five weeks or may last for a year, or even longer, before death intervenes.

Lesions.—The lesions observed on post-mortem are remarkably slight and are out of all proportion to the severity of the symptoms manifested. The disease appears to start in the small intestines, especially in the lower portion, where the lesions are usually the most marked, but it also involves the large intestines, including the rectum. The mucous membrane may alone be affected, although usually in the long-standing cases the submucosa is also invaded and the entire intestinal wall is then much thicker than normal and the tissue infiltrated with an inflammatory exudate. The mucous membrane or inside lining membrane is markedly wrinkled or corrugated, showing large, coarse folds with more or less reddening or hemorrhagic patches or spots on the summits of the ridges, especially noticeable in the large intestines. The mesenteric lymph glands are usually somewhat enlarged and appear watery on section. The other organs do not appear to be affected except from the anemia present in the later stages of the disease.

Differential diagnosis.—The principal disease with which bacterial dysentery may be confused is tuberculosis, but the application of the tuberculin test will readily diagnose the latter disease, while no reaction will be noted in case the injected animal is suffering with the former affection. The disease may also be mistaken for the parasitic affections resulting from stomach worms (verminous gastritis) and intestinal parasites, especially uncinariasis, but a microscopic examination of the feces is necessary in order to establish definitely the diagnosis.

Treatment.—As with all other forms of infectious disease, it is advisable to separate immediately the diseased and suspected cattle from the healthy animals. The feces passed by the former animals should be placed on cultivated soil where healthy cattle will not be exposed to them, as the bacilli producing the disease are readily found in such manure. The stalls, stables, and barnyards should also be thoroughly disinfected, as has been described under "Tuberculosis," in this chapter, special attention being given to those places which have been soiled by feces. The administration of medicines has thus far been quite unsatisfactory, although treatment should be directed toward disinfecting the intestines with intestinal antiseptics, such as tannopin in 1 dram doses twice daily, and strengthening the animal by the use of stimulants such as strychnin in half-grain doses given twice daily hypodermically. Salol, turpentine, or subnitrate of bismuth in a starch or wheat-flour gruel may also give temporary relief, but the diarrhea is likely to reappear and cause the death of the animal. In all cases the feed must be carefully selected to assure good quality, and should consist preferably of nutritious dry feed.

NAGANA.

Nagana, also called tsetse-fly disease, is an infectious fever occurring chiefly in horses and cattle, characterized by alternating paroxysms and intermissions and produced by a specific flagellate protozoan (*Trypanosoma brucei*) in the blood. It is probably transmitted from animal to animal solely by the bites of the tsetse fly. This insect is something like a large house fly, and when it settles on a diseased animal. sucks the blood and infects its proboscis, it is enabled on biting a second animal to infect the latter by direct inoculation. This disease is found throughout a large portion of central and southern Africa, along the low-lying and swampy valleys. It has never occurred in the United States, nor is it known to be present in the Philippines, but its relation to surra and the possibility of its appearance in one of our island dependencies are the reasons for including a few remarks at this time.

Symptoms.—The chief symptoms in addition to the fever, which is usually about 104° to 105° F., are the muscular wasting, progressive anemia, and loss of power, together with the edema most marked about the head, legs, abdomen, and genital organs. The urine is yellow and turbid, and occasionally contains albumin and blood. There is paralysis of one or both of the hind legs, difficult urination and defecation, labored breathing, discharge from the eyes and nose, extreme thirst, and gradual extension of paralysis to other parts of the body. The disease runs a chronic course, lasting from three to six weeks in horses, and from one to six months in cattle. Besides these animals, the mule, ass, buffalo, antelope, hyena, camel, and dog contract the disease naturally, and sheep, goats, cats, and small laboratory animals succumb to artificial inoculation.

Lesions.—The spleen and lymphatic glands are enlarged. There are sero-fibrinous exudates in the body cavities, the liver is enlarged and engorged, heart flabby, and a catarrhal condition is present in the respiratory passages. Pathological changes occur in the spinal cord. The finding of the trypanosoma by microscopic examination of the blood will be conclusive evidence for diagnosis.

Treatment.—Treatment has not proved satisfactory. Quinin, arsenic, methylene blue, and other drugs have been used, but without success. Endeavors thus far made to produce immunity from this disease have likewise been unavailing.

CATTLE FARCY.

This is a chronic disease of cattle occurring in France and the island of Guadeloupe, West Indies. It is characterized by caseating nodular swellings, first of the skin and afterwards of the superficial lymphatic vessels and glands, finally proving fatal within a year by extension to the viscera. The swellings rupture and discharge a purulent yellowish fluid, which contains the causative organism. This affection, called farcin du bœuf by the French, resembles cutaneous glanders or farcy of horses, but is caused by an entirely different organism, the streptothrix of Nocard. Moreover, cattle are immune from glanders, and for this reason the name, unfortunately applied to this disease, should not lead to any confusion with the cutaneous glanders or farcy of horses. Although the disease has been described as occurring only in Guadeloupe and France, the possibility of its occurrence in American possessions warrants its mention in this chapter.

Treatment.—Treatment consists in making incisions into the swellings and syringing them out with 2 per cent compound cresol solution. The cavities may then be packed with cotton, soaked in 5 per cent zinc-chlorid solution. The swollen lymphatics may also be bathed or covered with cloths wrung out in this solution.

OTHER INFECTIOUS DISEASES.

The following are also infectious diseases of cattle, a discussion of which will be found in previous chapters:

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Contagious abortion	167
White scour of calves	261
Infectious ophthalmia (pink eye)	345

ANIMAL PARASITES OF CATTLE.

By B. H. Ransom, Ph. D.,
Chief of Zoological Division, Bureau of Animal Industry.

The animal parasites of cattle comprise more than a hundred different species, belonging to various groups of the animal kingdom. Fortunately not all these parasites occur in this country—many are uncommon, and many are comparatively harmless. Some forms, however, occur frequently, and some are of distinct importance to the American stockman on account of the damage for which they are responsible. It is these parasites particularly which will be referred to in the present article, and although some forms are discussed which are rare or apparently of little economic importance, most of the minor and unusual parasites and species not found in this country have been omitted from consideration.

FLIES.[1]

Of the various species of flies which infest cattle some are injurious on account of the annoyance, pain, and loss of blood due to their bites, and sometimes also on account of diseases or parasites which are thus transmitted from the blood of diseased animals to that of healthy cattle, while others, which in the winged adult state do not bite, are injurious because they live parasitic on cattle during their larval stages.

Remedies for flies.[2]—Most remedies used for protecting cattle from the attacks of flies have to be applied frequently, and few, if any, will keep flies away for more than a day or two following their application. The numerous proprietary fly repellents to be found on the market are usually more expensive, and often less efficacious than homemade mixtures.

At the Minnesota experiment station rancid lard 1 pound and kerosene one-half pint, mixed thoroughly until a creamy mass forms, was found to give excellent results as a fly repellent, lasting for two or three days, when rubbed not too thickly with a cloth or with the bare hand over the backs of cows. Mixtures of cottonseed oil and

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[1] Further information may be found in a very full report on "Insects Affecting Domestic Animals," issued as Bulletin 5, new series, of the Bureau of Entomology of this department.

[2] Further information on fly repellents may be found in Bulletin 131 of the Department of Agriculture.

pine tar containing from 10 to 50 per cent of the latter substance were found by investigations in the Bureau of Animal Industry to have a marked repellent action against flies when applied lightly every day. A too free application of tar mixtures and other preparations containing phenols is liable to cause poisoning; hence care should be observed in this regard.

Jensen (1909) recommends the following formula, which is said to protect cows for a week:

Common laundry soap	1 pound.
Water	4 gallons.
Crude petroleum	1 gallon.
Powdered naphthalin	4 ounces.

Cut the soap into thin shavings and dissolve in water by the aid of heat; dissolve the naphthalin in the crude oil, mix the two solutions, put them into an old dasher churn, and mix thoroughly for 15 minutes. The mixture should be applied once or twice a week with a brush. It must be stirred well before being used.

THE STABLE FLY (STOMOXYS CALCITRANS).[1]

This fly very closely resembles the house fly, but, unlike the latter, it is a biting fly. It is common about stables and often enters dwellings, especially in cloudy weather. According to Noé, it is the agent of transmission of a parasitic roundworm of cattle (*Setaria labiato-papillosa*, see p. 529). This fly has been shown capable of transmitting anthrax from diseased to healthy animals, and under some conditions it may transmit surra, a disease caused by a blood parasite which affects horses, cattle, and other livestock.

The annoyance suffered by cattle and horses from stable flies is much lessened if the stables are darkened.

The screening of doors and windows, however, is preferable, as ventilation is not interfered with as it is in darkening stables. For milk cows coverings made from burlap (double thickness), including trouserlike coverings for the legs, may be used when the flies are very numerous and troublesome. One of the fly repellents mentioned above may be applied to cattle to protect them from stable flies. The Hodge flytrap fitted to the windows of dairy barns is a useful means of destroying stable flies. The United States Bureau of Entomology has found that a mixture of fish oil (1 gallon), oil of pine tar (2 ounces), oil of pennyroyal (2 ounces), and kerosene ($\frac{1}{2}$ pint) is fairly effective for a short time when applied lightly, but thoroughly, to the portions of animals not covered with blankets. The risk of poisoning with tar mixtures as already mentioned should be borne in mind in using this remedy. Care should be taken to apply it lightly.

The stable fly breeds in moist accumulations of straw, chaff, cow or horse manure, and various fermenting vegetable substances. The

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[1] For further information consult Farmers' Bulletin 1097.

débris collecting in and under outdoor feed troughs, and the remains of straw stacks are favorable breeding places for the stable fly. Under the most favorable conditions about three weeks are required for development from the egg to the adult stage.

The proper care of straw and the proper disposal of stable manure are very necessary in the control of stable flies. Straw stacks should be carefully built so as to shed rain, and loose straw or chaff should be scattered or burned. Straw not required for winter feed should be promptly disposed of by burning or scattering and plowing it under. Stable manure should be hauled out and scattered at regular intervals, preferably every three days, and the vicinity of stables should be kept free from accumulations of straw and hay that may become wet and serve as breeding places for the stable fly.

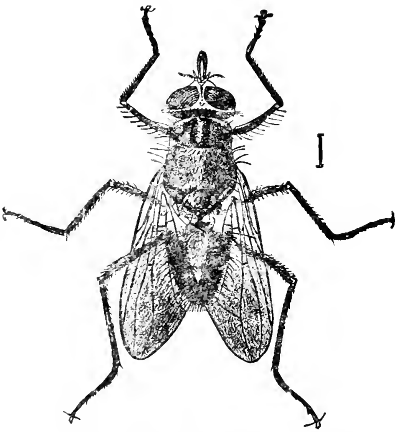


Fig. 1.—Hornfly (*Lyperosia irritans*) in resting position. Enlarged. (From Bureau of Entomology.)

THE HORNFLY (LYPEROSIA IRRITANS).[1]

This fly, now found nearly everywhere in the United States, was introduced into this country from Europe about the year 1885. Hornflies have the habit of clustering about the base of the horn (fig. 2), whence the name by which they are popularly known. They do not damage the horn, and congregate there only to rest.

In view of the general practice of dehorning cattle, the name hornfly is less distinctive than it once was. Moreover, hornflies rest on other parts of the body as well as the horns.

When resting, their wings are held down close to the body (fig. 1); when feeding, their wings are held out nearly at right angles, ready for flight. They puncture the skin and suck blood, usually attacking the upper parts of the body, particularly those which are out of reach of the animal's head or tail. Unlike most flies, they remain on the animal more or less constantly, day and night. Owing probably to the irritation and annoyance caused by these flies, cattle often do not thrive as they should during seasons when the flies are numerous. The hornfly has also been charged with transmitting diseases, such as anthrax.

[1] For further information consult Circular 115 of the Bureau of Entomology.

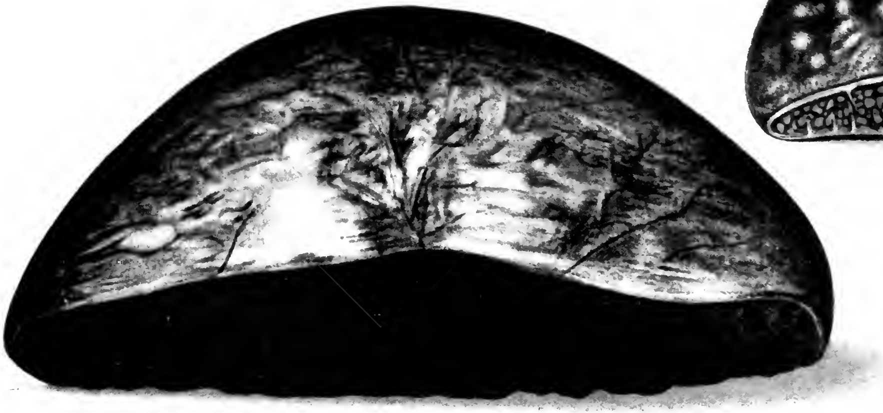


Fig. 1

Fig. 2

Haines del.

ZEESE-WILKINSON CO., INC., N.Y.

NORMAL SPLEEN AND SPLEEN AFFECTED BY TEXAS FEVER.

Fig. 1. SPLEEN OF AN ACUTE, FATAL CASE OF TEXAS FEVER.

Fig. 2. SPLEEN OF HEALTHY STEER.

Fig. 1

Fig. 3

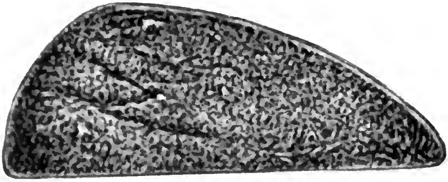


Fig. 2

Fig. 4

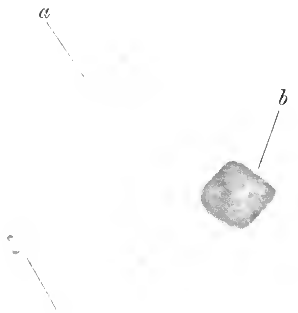


Fig. 5

ZEESE-WILKINSON CO., INC., N.Y.

TEXAS FEVER.

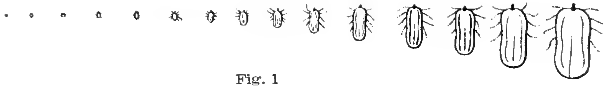


Fig. 1

Fig. 2

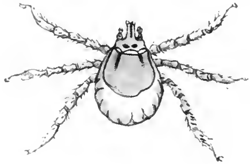


Fig. 3

Fig. 4

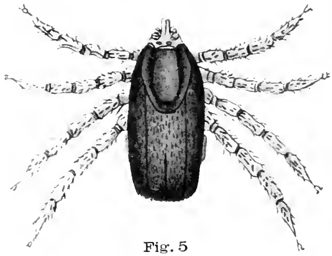


Fig. 5

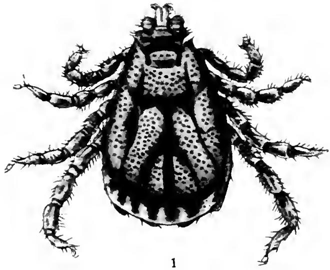
Fig. 6

Haines del.

Fig. 7

ZEESE-WILKINSON CO., INC., N.Y.

THE CATTLE TICK (MARGAROPUS ANNULATUS), THE CARRIER OF TEXAS FEVER.



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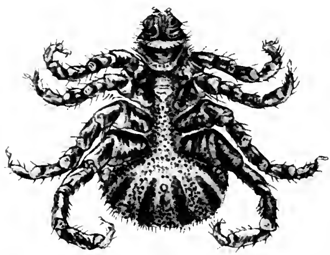

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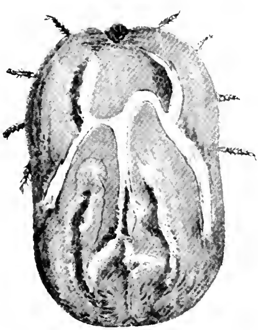

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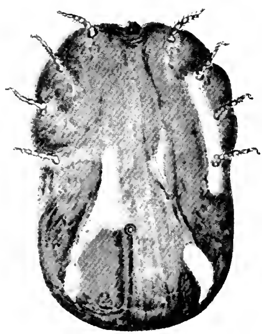

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ZEESE-WILKINSON CO., INC., N.Y.

THE CATTLE TICK (MARGAROPUS ANNULATUS).

Figs. 1 and 2 DORSAL AND VENTRAL VIEWS OF MALE.

Figs. 3 and 4 DORSAL AND VENTRAL VIEWS OF REPLETE FEMALE.

(GREATLY ENLARGED.)

Portion of a Steer's Hide, Showing the Texas-Fever Tick (Margaropus annulatus) of the United States. Natural Size. Original.

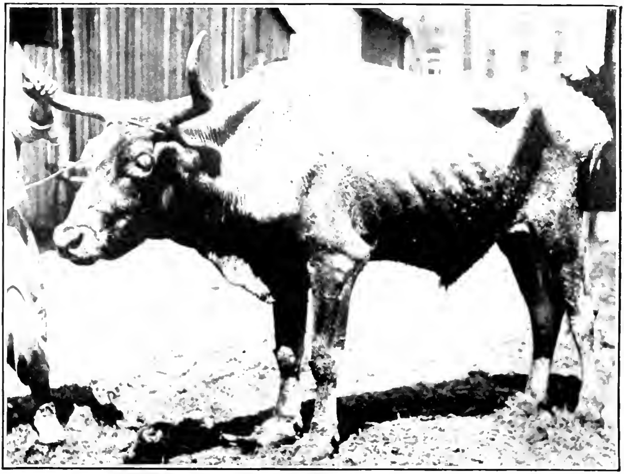


FIG. 1.—TICK-INFESTED STEER.

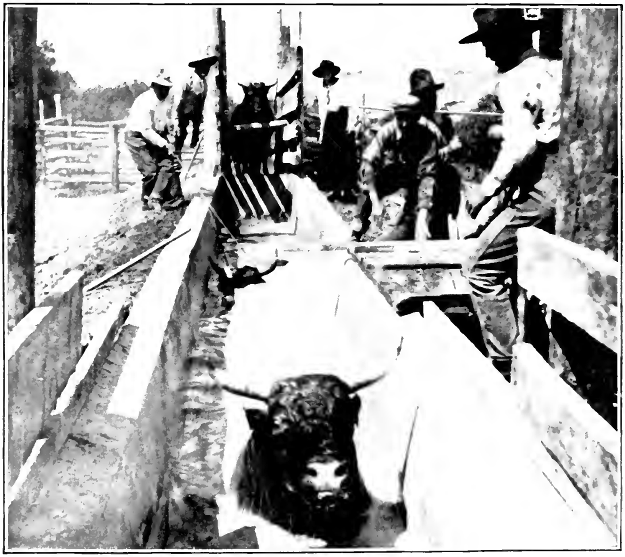
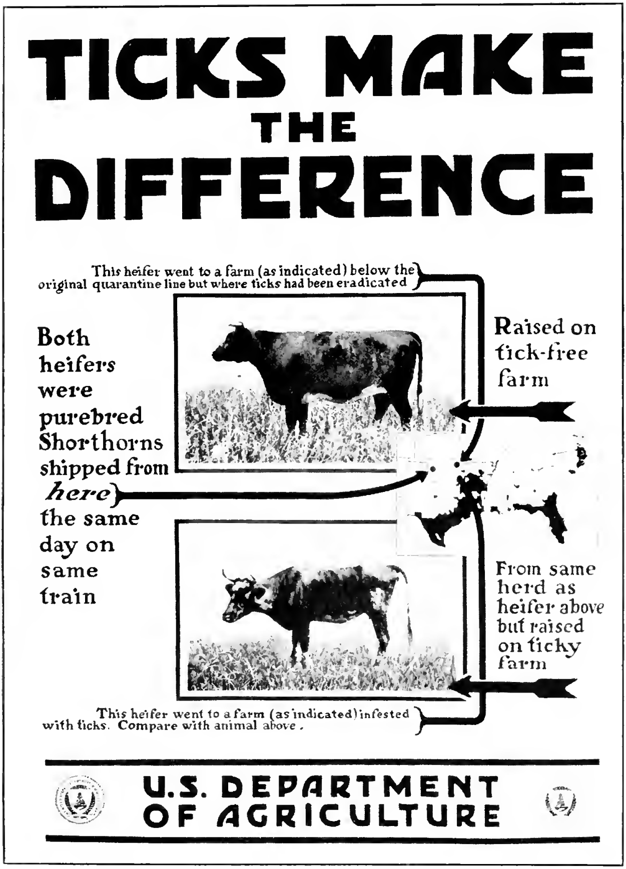


FIG. 2.—DIPPING CATTLE TO KILL TICKS.



FACSIMILE OF POSTER USED IN TICK ERADICATION WORK.

The fly lays its eggs in freshly dropped cow manure. They hatch in about 24 hours, and the larvæ or maggots in four or five days develop to the pupal stage, which lasts a week or 10 days. From the pupal stage the mature fly emerges. The entire process of development from the deposition of the egg to the appearance of the mature fly therefore may be completed in two weeks, or even in a shorter time. To protect cattle from attacks of the hornfly they may be treated with one of the remedies mentioned above (p. 502). Dipping cattle in a vat provided with splashboards set at the proper angle destroys most of the hornflies present on the animals. Unless the splashboards are used all but a few of the flies succeed in escaping as the cattle plunge into the bath and later return to them. Scattering the droppings of cattle with a shovel, or with brush dragged over pastures, in order to insure the rapid drying of the manure and consequent de-

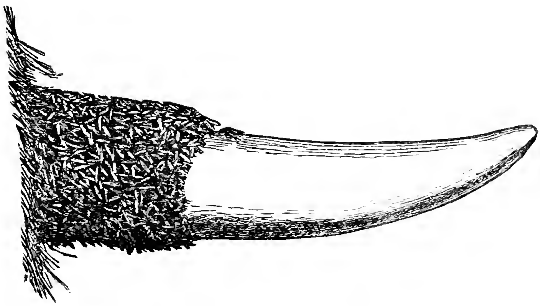


FIG. 2.—Hornflies (*Lyperosia irritans*) on cow horn. (From Bureau of Entomology.)

struction of the larvæ, is, when practicable, an efficient means of reducing the number of these flies.

BUFFALO GNATS.

These small flies, also known as black flies, are about one-eighth of an inch long and have a characteristic "humped" back (fig. 3). They breed in running water and appear in swarms during spring and summer, often in enormous numbers, causing great annoyance to stock and human beings, on account of their bites and their entrance into the eyes, nose, mouth, and other openings of the body. Their bites appear to be poisonous, and in seasons especially favorable to the gnats heavy losses of horses and cattle often occur.

Buffalo gnats are more troublesome in bright, sunny weather than when it is cloudy, and animals which have not shed their winter coats suffer more from their attacks than those with smooth coats. Cattle kept in darkened stables are not molested. The application of one of the fly repellents already mentioned (p. 502) may help to protect animals from buffalo gnats. The burning of smudges is also a useful means of protecting stock from the attacks of these flies.

SCREW WORMS.[1]

Screw worms (fig. 4) are the maggots of a fly (*Chrysomyia macellaria*), so called from their fancied resemblance to a screw. The adult fly (fig. 5) is about one-third of an inch long, with a bluish-green body, red eyes, and with three dark longitudinal stripes on the back (thorax). Attracted by odors of decay, it deposits its eggs, 300 to 400 at a time, in cuts, sores, castration wounds, etc. The crushing of a tick on the skin commonly results in screw-worm infection at that point. The eggs hatch in a few hours and the larvæ or maggots, or so-called screw worms, begin to burrow into the flesh and continue burrowing and feeding from three to six days, after which they leave the wound and crawl into the earth, there transforming into the quiescent pupal stage. This stage is completed in three to fourteen days. The mature flies then emerge from the pupal envelope and are soon ready for egg laying. From two to three weeks are therefore required for the entire life cycle, although under certain conditions it is possible for the fly to undergo its full development in as short a time as seven days, and on the other hand as long as a month is often required.

FIG. 3.—Buffalo gnat. Enlarged. (From Bureau of Entomology.)

Besides cattle, the screw-worm fly attacks sheep, horses, dogs, and man. In the case of hogs it is generally the ears which are affected. The fly also breeds in dead animals, and all carcasses should therefore be buried deeply or burned. The complete destruction of all dead animals by burning has been found by the Bureau of Entomology to be by far the best method of controlling screw worms.

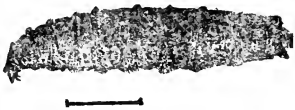


FIG. 4.—Screw worm (larva of *Chrysomyia macellaria*). Enlarged. (From Bureau of Entomology.)

Treatment for screw worms.—For proper treatment an animal suffering from screw worms should be caught and thrown. Chloroform is then poured into the wound, taking care that it penetrates thoroughly into all the burrows of the screw worm, if necessary using a slender stick or a small bunch of twisted hay as a probe. The animal should

[1] For further information consult Farmers' Bulletin 857.

be held for several minutes in order to insure the continued action of chloroform. Instead of chloroform, gasoline may be used, and carbon tetrachlorid is said by some authorities to give good results. Finally, the dead or dying maggots may be removed with forceps, the wound washed with a weak carbolic or cresylic acid solution, and painted with pine tar to reduce the chances of further attack by flies. Finally the wound should be dressed with a carbolic or cresylic ointment to promote healing and thus prevent further infection, or the wound may be painted with pine tar. Dipping in the arsenical dips used for destroying cattle ticks is a convenient method of treatment if many animals are involved.

GRUBS, WARBLES, BOTS.

Ox warbles are whitish or, when full grown, dark-colored grubs or maggots that develop from the eggs deposited on the hairs of cattle by certain flies known as warble flies. In the United States there are two species of ox-warble flies, technically known as *Hypoderma lineatum* and *Hypoderma bovis*. These flies somewhat resemble bees in their general appearance, but like all flies have only two wings.

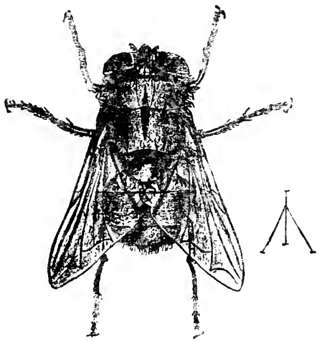


FIG. 5.—Screw-worm fly (*Chrysomyia macellaria*). Enlarged. (From Bureau of Entomology.)

The first named, *H. lineatum*, is commonly called the heel fly and is more generally distributed over the United States than the other species. The tail has a distinctive reddish-orange color and the legs are rough and hairy. This fly commonly deposits its eggs about the coronet, whence the name of heel fly, and on the fetlocks, knees, and hocks. When cattle are resting, eggs are deposited along the line of contact of the body with the soil. Cattle are frequently indifferent to the activity of this fly in depositing its eggs. Commonly 8 to 10 eggs, sometimes as many as 14, are attached to a single hair.

In the United States the other warble fly, *H. bovis*, has been found only in the North (New England, New York, Pennsylvania, Maryland, Michigan, Iowa, Missouri, and Washington) and has not yet been found in the Southern States. The tail is orange-yellow, lighter in color than that of the other species, and the legs have but few hairs. This fly commonly deposits its eggs on the outside of the hind quarters and above the fetlocks when the animals are moving, or lower down if they are quiet. Cattle are usually much disturbed by the activity of this fly and not infrequently appear terror stricken. The eggs are attached singly, one egg to a hair near its base.

The eggs of the warble flies hatch as a rule in about a week, the time varying with local conditions. The young warble is about 1 mm. ($\frac{1}{25}$ inch) long. It crawls to the base of the hair and burrows into the hair follicle. The entrance of the larvæ frequently causes sudden appearance of swellings. The larvæ of *H. bovis* in entering the skin

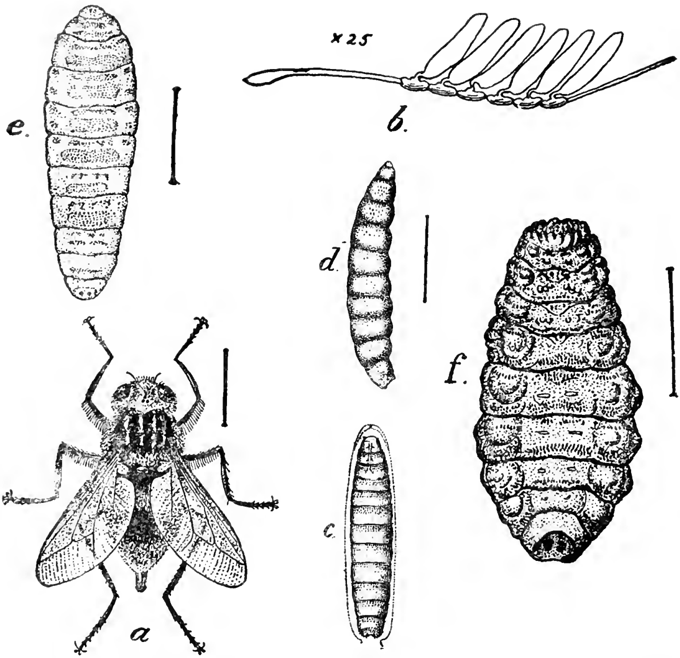


Fig. 6.—The warble fly (*Hypoderma lineatum*): *a*, adult female; *b*, eggs attached to a hair, × 25; *c*, larva as seen in egg; *d*, larva from esophagus of an ox; *e*, later stage of larva from beneath the skin of the back; *f*, larva at the stage when it leaves the back of cattle and falls to the ground—all enlarged (after Riley).

rarely cause a flow of serum or pus formation, but those of *H. lineatum* commonly cause a considerable flow of serum with pus formation resulting in a matting of the hair on affected areas of the skin. The warbles after penetrating the skin migrate through the body and ultimately reach the backs of the cattle, *H. lineatum* usually appearing there in northern latitudes about the middle of December and *H. bovis* about a month later. During their migrations, before they reach the back, the young warbles spend a considerable period in the walls of the esophagus, or gullet, and may be found in this location as early as August 15. During the fall and winter a large proportion of the gullets of cattle that are slaughtered are found to be infested with warbles, and are known as grubby gullets or weasands in the packing houses.

When the warbles first appear in the back they are about $\frac{3}{5}$ inch long. They cause swellings about the size of pigeons' eggs, each swelling having a small hole in the center, which has been punctured in the skin by the warble to enable it to breathe. Through this hole the warble leaves the back of the cow when it has completed its parasitic stage of development, at which time it measures nearly an inch in length.

The full-grown larvæ begin to leave the backs of the cattle early in the year, and in northern latitudes the last leave before the middle of July. After leaving the backs of the cattle they burrow into the ground, lie quiescent for about a month, and become transformed into mature flies. In northern latitudes the mature flies of the species *H. lineatum* may be observed during April and May, and those of the other species during June and July.

The damage caused by warbles includes injury to stampeding cattle frightened by the fly, decreased milk flow and diminished growth in infested animals, and injury to hides, the last item being especially serious.

Treatment.—The best method of control known at present is to extract the warbles from the backs of cattle and kill them. If they are almost ready to leave the cattle, they may be squeezed from the backs with the fingers. Forceps are useful in removing the warbles, but it is important to be careful in extracting warbles not to crush them, as the body juices of these parasites are sometimes poisonous to cattle if absorbed into their circulation. In the South herds may be examined in November or early in December and once a month during the next two or three months. In the North the first examination may be made six weeks to two months later, with two or, better, three following examinations at intervals of a month. If this procedure is carefully carried out there will be a noticeable diminution of warbles the following year, and if persisted in the warble can be almost if not completely eradicated. Where an entire community follows up the practice of removing and destroying warbles, the results are highly beneficial.

As a result of recent studies by various investigators it appears that the tiny grubs, newly hatched from the eggs, may gain entrance to the body by penetrating directly through the skin. Many observers, however, have held that the eggs or newly hatched larvæ are taken into the mouth by the cattle licking themselves. It is possible, as in the case of several other parasites, that both modes of infection may occur and that the larvæ may gain entrance to the body either by penetrating the skin or by being swallowed. From the evidence at present available it seems likely that the usual mode of entrance is through the skin. Irrespective of the mode of infection, the larvæ evidently wander extensively through the tissues of the body, developmental stages being found in considerable numbers in the wall of the esophagus during the fall of the year. They have also been found in the spinal canal and in various other locations. Finally, about January they appear beneath the skin of the back, forming the well-known swellings. The posterior end of the grub is near the small opening in the hide, through which the grub breathes and discharges its excrement, and through which, when its development is complete, it finally escapes. The anterior end of the grub is at the bottom of the tumor, where the mucus collects upon which it feeds. By spring or early summer the grub is full grown and forces its way out of the skin, falling to the ground, into which it burrows for a short distance and transforms into the pupal stage. In about a month the mature fly emerges.

It has lately been discovered that a second species of warble fly (*Hypoderma bovis*) common in Europe is of not uncommon occurrence in Canada and the northern part of the United States, whereas it was formerly supposed that the ox warbles of this country were all of the one kind. The general appearance, life history, and effects of the European species are much the same as those of the American form.

Grubs weaken cattle, cause them to fall off in flesh and milk, and decrease the value of the hide. The beef in the immediate vicinity of a grub becomes slimy and of a greenish color, and is known to the butchers as "licked beef."

The total loss to this country on account of the warble fly is estimated at $35,000,000 to $50,000,000 a year, at the least, and may amount to considerably more.

Treatment for warbles.—During the winter and spring examine the cattle for the presence of warbles. By passing the hand over the backs of the animals the swellings marking the location of the grubs may be readily found. Pressure properly applied to the swellings will cause the grubs to "pop out" if they have reached a late stage of development. They may be more easily removed by means of slender forceps inserted into the opening of the warbles, and a still more certain method of removing them, particularly if the lumps are still very small, is to cut into the swellings with a sharp knife or bistoury, after which they may be pressed out. Care should be taken to crush all grubs removed, so as to prevent the possibility of their further development and transformation into flies. In order that none may escape it is advisable to examine the cattle every two weeks during the late winter and spring, at each examination removing the grubs which have developed sufficiently to cause perceptible swellings.

Another method of treatment is to force grease or oil into the openings of the warbles, which kills the grubs. This method is less certain than that of removing the grubs, and has the further objection that the dead grubs remain beneath the skin.

Cattle may be treated during the summer with fly repellents (p. 502) to keep off the warble flies. The efficacy of repellents against these flies is probably, however, not very great.

In localities where the character of the cattle industry is such as to render practicable the systematic examination of cattle and the removal of the grubs—that is, where the herds are comparatively small and subject to the close supervision of the owners—it is possible, by the exercise of a little care and with very little effort on the part of the cattle owners, provided they work together, each doing his share by seeing to the removal of grubs from his own cattle, so that as few as possible survive to transform into flies, to reduce the number of grubs within one or two seasons almost, if not entirely, to the point of extinction.

Investigations not yet completed indicate that grub eradication may sometimes be accomplished by the use of arsenical dips, which are extensively used at the present time for destroying cattle ticks. (See p. 497.) It is possible that the destructive action of arsenical dips upon warbles is more or less dependent upon the fact that arsenic is stored up in small quantities in and upon the skin of cattle that are repeatedly dipped in arsenical dips. The arsenical dip appears to act, not upon the well-developed grub beneath the skin, but upon the eggs or the newly hatched larvæ, probably the latter. Accordingly the dipping of cattle to destroy grubs should be carried out during the fly season and repeated treatments should be given every two or three weeks, as in dipping cattle to eradicate ticks.

LICE.[1]

Cattle in the United States are commonly infested with three species of lice, two of them sucking lice (*Hæmatopinus eurysternus*, the short-nosed cattle louse, and *Linognathus vituli*, the long-nosed cattle louse), commonly known as blue lice, and one biting louse (*Trichodectes scalaris*), commonly known as the red louse.

[1] For further information see Farmers' Bulletin 909.

The blue lice (figs. 7 and 8) suck the blood of cattle and are more injurious than the red lice (fig. 9). Unless very abundant the latter cause little injury. If numerous they irritate and worry their host probably more by their sharp claws than by their bites, as their food seems to consist entirely of particles of hair and dead skin.

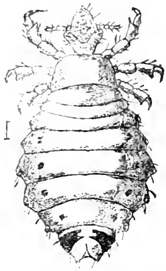


FIG. 7.—Short-nosed blue louse (*Hæmatopinus eurysternus*) of cattle. Enlarged. (From Bureau of Entomology.)

Cattle lice reproduce by means of eggs or nits (fig. 10) which they fasten to the hair. The blue lice infest chiefly the neck and shoulders; red lice, when present, may be found almost anywhere on the body, but are usually most numerous on neck, shoulders, and at the root of the tail.

On account of the itching caused by the lice, infested cattle rub against posts, trees, etc., and lick themselves, the hair sometimes coming out and the skin becoming thickened so that mange may be suspected.

Treatment for lice.—Cattle may be treated for lice by means of hand applications, spraying, or dipping. Dusting powders sold under various trade names are of value in helping to hold lice in check when the weather is too cold for dipping or spraying. The application of greases and insecticidal liquids by hand is fairly effective and practicable in cases in which there are only a few animals to be treated. The following remedies have proved effective when applied by hand, the treatment being repeated if necessary in about 16 days: (1) Cottonseed oil and kerosene, equal parts; (2) kerosene, ½ pint, mixed with lard, 1 pound; (3) crude petroleum; (4) any of the dips recommended for use in dipping, and diluted in the same proportions as for dipping. Oils or greases should not be used in very warm or very cold weather. The remedies mentioned may be applied with a brush or a cloth. They should be distributed in a thin, even coating over the surface of the body, taking care that there is no excess quantity at any point.

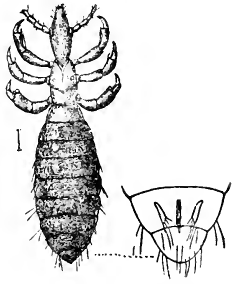


FIG. 8.—Long-nosed blue louse (*Linognathus vituli*) of cattle. Enlarged. (From Bureau of Entomology.)

In spraying, any of the dips recommended for lice, properly diluted, are applied by means of a spray pump over the entire body. Thorough wetting of the skin and hair is important, and a second treatment should be given 15 or 16 days later.

When a considerable number of animals are to be treated the most satisfactory method of destroying lice is by the use of a dipping vat.

Two dippings should be given 15 or 16 days apart. Dipping in the fall is good insurance against risk of loss from lice during the winter. All animals in the herd should be treated regardless of the number showing infestation. Either coal-tar-creosote or nicotin dips may be used. These are sold under various trade names. The directions for dilution given by the manufacturer should be carefully followed. As coal-tar-creosote dips do not mix well with all kinds of water, they should be tested with the water to be used for making the solution by mixing some of the dip in the proper proportions with the water in a clean and clear-glass bottle or jar. If an oily layer or mass of globules collects either at the top or the bottom of the mixture after standing an hour, the dip is not suitable for use with that kind of water. Imperfectly mixed coal-tar-creosote dips are liable to poison animals even when not used in stronger solutions than that recommended by the manufacturers, and are also likely to be inefficacious.

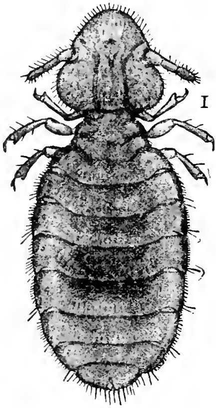


FIG. 9.—Red louse (*Trichodectes scalaris*) of cattle. Enlarged. (From Bureau of Entomology.)

The lime-sulphur dip, which is highly efficacious as a mange remedy, is of little value for destroying lice, especially blue lice. The arsenical dip used in tick eradication is a good louse remedy, but its use is not advisable on account of its poisonous nature, except under the supervision of capable persons who know how to use it and what precautions to take.

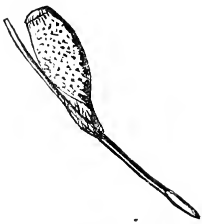


FIG. 10.—Egg of short-nosed blue louse (*Hæmatopinus eurysternus*) attached to a hair. Enlarged. (From Bureau of Entomology.)

MANGE, ITCH, SCAB.[1]

Cattle are subject to four kinds of mange, of which common mange or psoroptic mange is the most important.

PSOROPTIC MANGE.

Psoroptic mange of cattle is caused by small mites (fig. 11) which multiply rapidly and are spread from diseased to healthy cattle by bodily contact, or by pens, stables, railroad cars, etc., recently occupied by mangy cattle. The mites attack the skin and cause it to become thickened and covered with crusts and scabs, with a consequent loss of hair. Intense itching accompanies the disease,

[1] For a fuller discussion see Farmers' Bulletin 1017, issued by the U.S. Department of Agriculture.

and affected cattle are more or less constantly rubbing and licking themselves. Psoroptic mange commences at the root of the tail, or on the neck, or withers, and gradually extends over the back up to the head, over the sides, and may finally affect nearly the entire body except the legs. In serious cases the skin may become ulcerated; the animals are greatly weakened and emaciated, and finally die. By taking scrapings from the edges of scabby patches and placing them on a piece of black paper in a warm place the mites may be seen as tiny white objects crawling over the paper, more distinctly if a magnifying glass is used. Mange may be confused with lousiness, ringworm, or with any condition in which there is itching or loss of hair, but if mites are found there is no question of the diagnosis. The disease is worse during cold, wet weather. Mangy cattle when on good pasture during the summer often seem to recover, but in the fall the disease again appears in a severe form.

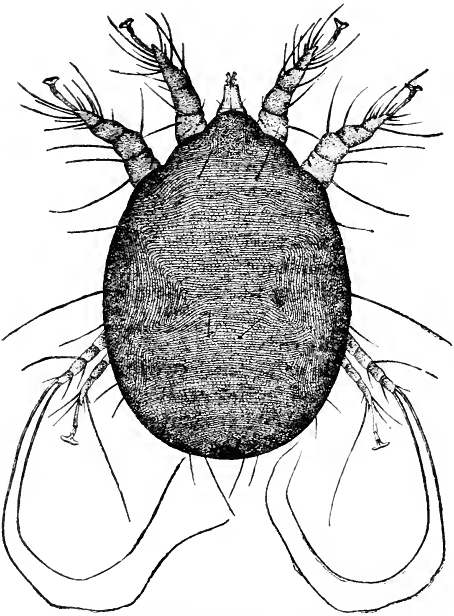


FIG. 11.—Mite which causes psoroptic scab of sheep. Enlarged about 100 times. The mite of psoroptic cattle mange is almost identical in appearance.

Treatment.—The most generally used and most satisfactory method of treating cattle mange consists in dipping the animals in a vat filled with a liquid of such nature that it will kill the parasites without injuring the cattle. Vats for dipping cattle are built of wood, stone, or concrete, and vary in length from 30 to 100 feet or more. They vary in width from 3 to 7 feet at the top and 1½ to 3 feet at the bottom, and the depth may be from 7 to 10 feet. A narrow chute through which the cattle are driven leads to one end of the vat, where a steep slide pitches the cattle into the dipping fluid, through which they swim, and climb out of the vat at the other end, which is built sloping and provided with cross cleats to give the animals a foothold. A draining pen with floor sloping back toward the vat is generally provided. The dip should be used warm, 100° to 105° F., and the cattle should be held in the vat for two minutes to insure thorough action of the dip. The head of each animal should be ducked at least once. Care should be taken that the vat contains a sufficient depth of fluid to swim the animals to be dipped. The dipping fluid may be heated from a steam boiler by pipes or hose, or water heated in large iron cauldrons or tanks may be used for charging the vat, and hot water with a proper quantity of dip added from time to time as the dipping fluid becomes cool.

If crude-petroleum dips are used, one dipping is usually sufficient, and the dip is used cold. Crude-petroleum dips are rarely used for common mange, but are of special value for sarcoptic mange, which is cured with difficulty by the ordinary dips. In the treatment of ordinary mange with lime-sulphur or nicotin dips two dippings are necessary, the second dipping being given 10 to 14 days after the first. The second treatment is necessary to kill the few parasites which sometimes escape at the first treatment, either in the egg stage or as fecundated females.

LIME-SULPHUR DIP.

The lime-sulphur dip is made in the proportion of 12 pounds of unslaked lime (or 16 pounds of commercial hydrated lime—not air-slaked lime), 24 pounds of flowers of sulphur, and 100 gallons of water.

Directions for preparing 100 gallons of dip.—Weigh out the lime, 12 pounds (or hydrated lime, 16 pounds), and sulphur, 24 pounds. Place the unslaked lime in a shallow, water-tight box similar to a mortar box, or some other suitable vessel, and add water enough to slake the lime and form a lime paste or lime putty. Sift into this paste the flowers of sulphur and stir well; then place the lime-sulphur paste in a kettle, boiler, or tank containing 30 gallons of water, the water being first heated nearly to the boiling point. Boil the mixture for two hours at least, stirring frequently; add water occasionally to maintain the original quantity. Allow the mixture to settle in the tank or draw the entire contents of the kettle or boiling tank into a large tub or barrel placed near the dipping vat and provided with a bunghole about 4 inches from the bottom, and then allow ample time to settle—from two to three hours or more if necessary. When fully settled, draw off the clear liquid into the dipping vat, taking care not to allow any of the sediment to accompany it, as the sediment is liable to render the dip unnecessarily caustic. The clear liquid thus obtained requires only the addition of sufficient clear warm water to bring the total up to 100 gallons. Flowers of sulphur must be used and the lime must be of good quality.

The dipping bath should be used at a temperature of 100° to 105° F., and for official dippings must be maintained at all times at a strength of not less than 2 per cent of "sulphid sulphur" as indicated by the Bureau of Animal Industry field test for lime-sulphur baths.

NICOTIN DIP.

The nicotin dip is made with sufficient extract of tobacco, or nicotin solution, to give a mixture containing not less than five one-hundredths of 1 per cent nicotin and 2 per cent flowers of sulphur. Sufficient nicotin would therefore be furnished for 96 gallons (about 800 pounds) of dip by 1 pound of a 40 per cent solution of nicotin. The formula for this dip would be: Nicotin, four-tenths of a pound; flowers of sulphur, 16 pounds; water, 96 gallons.

To calculate how much nicotin solution or extract of tobacco should be used for 96 gallons of water, divide the quantity of nicotin required in the dip by the proportion of nicotin in the extract. For example, suppose the nicotin solution contains 25 per cent nicotin, we have $0.40 \div 0.25 = 1.6$. Therefore in this case it would require 1.6 pounds of nicotin solution for the 96 gallons of dip. Or, if a tobacco extract is used, having, for example, 2.4 per cent of nicotin, the formula would be as follows: $0.40 \div 0.024 = 16.66$, and therefore 16.66 pounds would be required for 96 gallons of dip. Do not use any preparation the strength of which is not given on the outside of the package.

In preparing these dips the nicotin solution and sulphur should be mixed together with water before adding them to the water in the dipping vat. On no account should the dip be heated above 110° F. after the nicotin solution is added, as heat is liable to evaporate the nicotin and weaken the dip.

For official dippings the dipping bath should be used at a temperature of 100° to 105° F. and at all times must be maintained at a strength of not less than five one-hundredths of 1 per cent nicotin as indicated by a field test approved by the Bureau of Animal Industry.

A homemade nicotin dip may be prepared as follows:

For each 100 gallons of dip desired, take 21 pounds of good, prepared tobacco leaves; soak the leaves in cold or lukewarm water for 24 hours in a covered pot or kettle; then bring the water to near the boiling point for a moment, and, if in the morning, allow the infusion to draw for an hour; if in the evening, allow it to draw overnight; the liquid is next strained (pressure being used to extract as much nicotin as possible from the wet leaves) and diluted to 100 gallons per 21 pounds of tobacco. This dip should be used as fresh as possible, as it contains a large amount of organic material which will soon decompose.

CRUDE-PETROLEUM DIPS.

Crude-petroleum dips, which are valuable for the treatment of sarcoptic mange, are not often used for the treatment of psoroptic mange or of chorioptic mange, oily dips being liable to injure animals, especially if they are moved rapidly soon after treatment, if they are exposed to bright sunshine, or if they become chilled. Besides unprocessed crude petroleum, processed petroleum from which the gasoline and other light hydrocarbons have been removed may be utilized in the treatment of cattle for mange, particularly sarcoptic mange. There are a number of proprietary brands of crude-petroleum dips on the market, consisting of processed crude petroleum with other substances added, mainly lighter oils to give the dip a suitable consistency. In dipping cattle in crude-petroleum dips fill the vat with water to within 1 foot or 18 inches of the dip line and then add the oil until the surface is flush with the dip line. The oil floats on the water, and as the animals pass through the vat their bodies become coated with oil.

CHORIOPTIC MANGE.

Chorioptic mange, due to a species of mite different from that causing common cattle mange, is confined almost entirely to the region at the root of the tail and if not treated may persist for years. The treatment is the same as for psoroptic mange.

SARCOPTIC MANGE.

Sarcoptic mange, frequently called "barn itch," is caused by a mite very similar to that which causes itch in human beings. It commonly affects the head and neck, but may also occur on various other parts of the body. Bulls are particularly liable to be affected with this form of mange. Cattle may become infected not only from other cattle, but also from horses, goats, dogs, sheep, and hogs. As a rule sarcoptic mange in any species of animal, if acquired from an animal of another species, is likely to run a short course and tend toward a spontaneous recovery.

The treatment likely to be most efficacious is that of dipping in a crude-petroleum dip, one treatment as a rule being sufficient. If lime-sulphur dip is used, four or five successive treatments, or even more, at weekly intervals, may be necessary before a cure is effected.

DEMODECTIC MANGE.

Demodectic mange, which is caused by a small parasite that lives in the hair follicles, causing pustules, especially on the neck and shoulders, occurs occasionally among cattle in this country and is of importance on account of the injury to the hide. When tanned, hides infested by this parasite are pitted, the pits, in some cases, being so deep that they form holes. No practicable treatment is known for this disease.

TICKS.[1]

About 10 species of ticks have been reported as parasites of cattle in the United States. The most common and most important is the species known as *Margaropus annulatus*, which transmits Texas fever. Information concerning this tick and Texas fever has been given elsewhere in this volume (p. 475).

The spinose ear tick (*Ornithodoros megnini*) is frequently found in the ears of cattle in the western part of the United States, and is of common occurrence also in the ears of horses, dogs, cats, etc.

When its parasitic stage of development is completed the ear tick leaves its host. Mating between the sexes occurs after the ticks have cast their skins following the abandonment of their host. They usually crawl up some distance from the ground and secrete themselves in cracks and crevices in trees, walls of buildings, etc., where the females deposit their eggs.

After the eggs hatch, the larval ticks, which emerge from them, when they succeed in finding a host, enter the ears and gradually develop to the stage at which they are ready to leave the host animal. The females may live several months, or even years, if they do not find mates. After mating they may deposit their eggs intermittently. Hatching of the eggs may occur as early as 10 days after deposition. The larvæ may live for 80 days without a host. The parasitic period has been observed to vary from about two to about seven months.

Treatment.—On account of their habits and great vitality and their occurrence in various kinds of animals besides cattle, complete eradication is a difficult problem. The only effective treatment known is to introduce directly into the ear passages a remedy that will kill the ticks. Later, of course, the cattle may become reinfested from exposure to infested ranges or inclosures. The following mixture, however, in addition to killing the ticks in the ears, will protect against reinfestation for about 30 days: Ordinary commercial pine tar, two parts; cottonseed oil, one part—in each case by volume. Animals to be treated are confined in a chute, and the mixture is injected into the ears with a syringe, after the wax and other débris in the ears have been cleaned out with a wire probe that has an eyelet at one end. Further information concerning ear ticks and the details of their treatment is given in Farmers' Bulletin 980.

[1] For a more complete discussion consult Farmers' Bulletin 1057, Bulletins 130 and 152 of the Bureau of Animal Industry, and Bulletins 15 (technical series), 72, and 106 of the Bureau of Entomology, all issued by the United States Department of Agriculture.

BLOODSUCKERS OR LEECHES.

These worms are sometimes taken up by cattle when drinking from ponds. They may attach themselves to the inner surface of the mouth or nose, and sometimes reach the upper part of the windpipe or of the gullet. Bleeding at the mouth or nose may be noticed, the membranes where the leech is attached are liable to be swollen and congested, and as a result of the loss of blood a condition of anemia may result.

Treatment.—If the worm can be reached it may be destroyed by cutting it in two with a pair of scissors, or it may be removed with forceps or with the fingers after wrapping a towel around the hand so that the worm can be held without slipping. Fumigation with tobacco or tar may cause the worm to release its hold if it can not be removed by other means. Ponds may be rid of infestation with bloodsuckers by the introduction of eels.

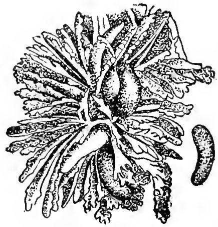


FIG. 12.—Portion of the wall of the first stomach with conical flukes attached.

PARASITES OF THE STOMACH.

The stomach of cattle consists of four compartments, of which the first and fourth are most likely to be the seat of parasitic infestation. The first stomach, or paunch, contains large numbers of minute parasites known as protozoa, which are too small to be seen with the naked eye. These small organisms apparently are in no way injurious. A species of fluke (*Paramphistomum cervi* or a closely related species) is occasionally found in North American cattle, especially grass-fed cattle, attached to the inner surface of the first stomach (fig. 12). This worm is about one-half inch long, and somewhat conical in shape; hence the name, conical fluke, by which it is sometimes known. Although this parasite has been accused of producing serious effects, it is generally considered harmless.

FIG. 13.—Twisted stomach worms (*Hæmonchus contortus*). Outlines showing natural size of male (above) and female.

Several species of roundworms may occur in the fourth stomach. Two of these are of special importance.

THE TWISTED STOMACH WORM (HÆMONCHUS CONTORTUS).

The twisted stomach worm (*Hæmonchus contortus*, figs. 13, 14, 15) is sometimes found in enormous numbers in the fourth stomach of cattle. Sheep, goats, and other ruminants may also be infested with it. Among the symptoms caused by this parasite may be mentioned anemia, loss of flesh, general weakness, dullness, capricious appetite, excessive thirst, and diarrhea. The anemic condition is seen in the paleness of the skin and mucous membranes of the mouth and eye, and in the watery swellings which often develop under the lower jaw ("poverty jaw"). If the fourth stomach of a dead animal is cut open and the contents carefully examined, the parasites, which are from $\frac{1}{2}$ inch to $1\frac{1}{4}$ inches in length and about as thick as an ordinary pin, may be seen, if present in any considerable number, actively wriggling about like little snakes.

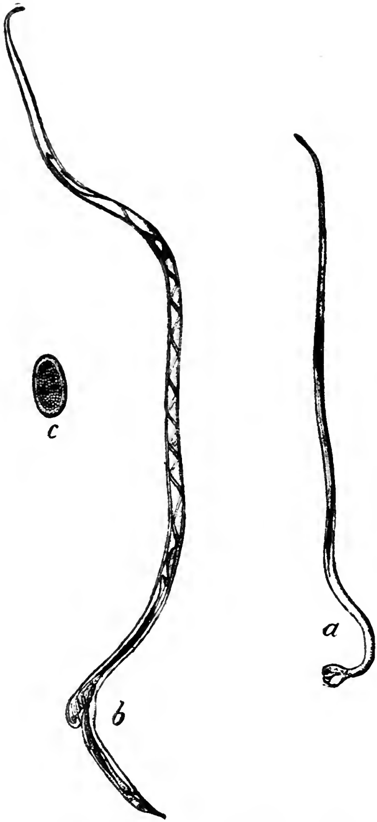


Fig. 14.—Twisted stomach worms (*Hæmonchus contortus*). Male (*a*), female (*b*), and egg (*c*). Enlarged.

Cattle become infected with these parasites by grazing on pastures on which infested cattle, sheep, or goats have grazed and scattered their droppings. The worms in the stomach produce a multitude of eggs (fig. 14*c*) of microscopic size, which pass out of the body in the feces. In warm weather these eggs hatch in a few hours. If the temperature is below 40° F., they remain dormant, and if below freezing, they soon die. The eggs are also killed by dryness; moisture, on the other hand, favoring their development. The larvæ which hatch from the eggs are microscopic in size, and, like the eggs, are, at first and until they have developed to a certain stage, very susceptible to freezing and drying. In very warm weather the larvæ complete their development, so far as they are able to develop outside the body, in two or three days. In cooler weather the time required for this development is longer, and at temperatures below 70° F. 10 days to several weeks may be necessary. The larvæ are then ready to be taken into the body. The eggs and early stages of the larvæ apparently do not develop if swallowed, and only the completed larval stage seems to be infectious. In this stage the larvæ migrate up grass stalks (fig. 15) or other objects, showing activity whenever the air is saturated with moisture; that is, during rains, fogs, and dews. When the air becomes dry and the moisture evaporates from the grass the young worms cease their activity, resuming their migrations when the air again becomes overladen with moisture. Larvæ which have developed to the infectious stage, unlike the eggs and early larval stages, are able to survive long periods of freezing and dryness. In two weeks to a month after the embryos are swallowed they reach maturity and begin producing eggs.

Preventive treatment.—Preventive measures are important. As moisture favors the development of the embryos, high sloping ground is preferable for pastures. If low ground is used, it should be properly drained. The pasture should not be overstocked. Burning over the pasture will destroy most of the young worms on the grass and on the ground, and this means of disinfection under certain circumstances may be very advantageously used. The herd should be changed to fresh pasture as often as possible. Cattle should be supplied with water from wells, springs, or flowing streams, preferably in tanks or troughs raised above the ground. To a slight degree salt serves to protect cattle against infection with internal parasites, and plenty of it should therefore be kept accessible.

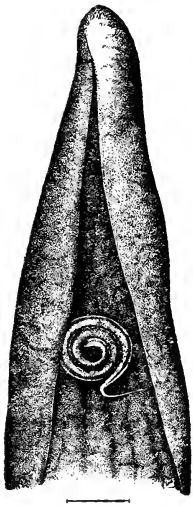


FIG. 15.—Larva of twisted stomach worm (*Hæmonchus contortus*) coiled on tip of grass blade. Enlarged.

Affected animals should be isolated from the rest of the herd in hospital pens or pastures. A plentiful supply of nourishing feed is an important factor in enabling cattle to withstand the attacks of stomach worms and other intestinal parasites. The stabling of cattle, with the maintenance of clean and sanitary surroundings and liberal feeding, will often stop losses from internal parasites, even though no medicinal treatment is given.

Medicinal treatment.—In dosing animals for stomach worms it is advisable to treat not only the animals which are seriously affected, but the rest of the herd as well, since the parasites with which they are infested will remain as a source of reinfection to the others. The cattle should be removed to fresh pasture after treatment, if possible.

The animals to be treated should be deprived of feed for 12 to 16, or even 24, hours before they are dosed, and if the bluestone treatment is used should receive no water on the day they are dosed until several hours after dosing. In drenching, a long-necked bottle or a drenching tube may be used. In case the former is used the dose to be given may be first measured off, poured into the bottle, and the point marked on the outside with a file, so that subsequent doses may be measured in the bottle itself. A simple form of drenching tube (fig. 16) consists of a piece of rubber tubing about 3 feet long and one-half inch in diameter, with an ordinary tin funnel inserted in one end and a piece of brass or iron tubing 4 to 6 inches long, of suitable diameter, inserted in the other end. In use the metal tube is placed in the animal's mouth between the back teeth, and the dose is poured into the funnel, which is either held by an assistant or fastened to a post. The flow of liquid through the tube is controlled by pinching the rubber tubing near the point of union with the metal tube. It is important not to raise the animal's head too high on account of the danger of the dose entering the lungs. The nose should not be raised higher than the level of the eyes. The animal may be dosed either standing on all fours or lying on the side.

The position on all fours is preferred by some authorities, who believe that more of the remedy is likely to reach the fourth stomach when the animal is dosed standing than when dosed in other positions.

Great care should be used in dosing to prevent the entrance of the liquid into the lungs, and in the preparation and administration of the remedy to avoid getting the solution too strong or the dose too large.

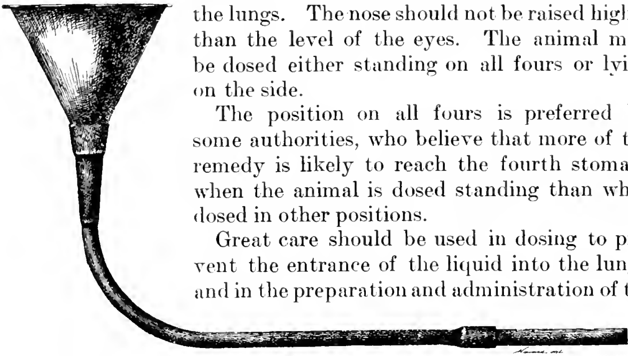


FIG. 16.—A drenching tube made from an ordinary tin funnel, a piece of rubber hose, and a piece of brass pipe.

Bluestone, or copper sulphate, has been extensively used in South Africa in the treatment of sheep and cattle for stomach worms and is recommended by the colonial veterinary surgeon of the Cape Colony as the best and safest remedy. To prepare the solution take 1 pound (avoirdupois) of pure bluestone, powder it fine, and dissolve in 9½ gallons of warm water. It is better first to dissolve the bluestone in 2 or 3 quarts of boiling water, then add the remaining quantity of cold water, and mix thoroughly. This solution may be given to cattle in the following-sized doses:

Calves	3½ to 4 fluid ounces.
Yearlings	6 fluid ounces.
Two-year-olds and over	12 to 16 fluid ounces.

In making up the solution only clear blue crystals of bluestone should be used. Bluestone with white patches or crusts should be rejected. It is especially important that the bluestone and water be accurately weighed and measured, and that the size of the dose be graduated according to the age of the animal.

The special value of medicated salts advertised under various trade names as preventives against worms is problematical. Commonly they contain little else than ordinary salt, the other substances being in such small quantity that their therapeutic effect is practically negligible. Definite evidence that they are more efficacious than plain salt is not yet available and their use is not recommended.

THE ENCYSTED STOMACH WORM (OSTERTAGIA OSTERTAGI).

This parasite is as thick as a fine hair and less than half an inch in length. It lives in small cysts in the wall of the fourth stomach (fig. 17) and is also found free in the cavity of the stomach. When numerous, these parasites cause a thickening of the stomach wall and disturb its digestive functions. The symptoms caused by this parasite are very similar to those produced by the twisted stomach worm. The life history of the encysted stomach worm is not known in detail, but it is undoubtedly very much the same as that of the twisted stomach worm. The same measures as recommended above for preventing infection with the twisted stomach worm should be used. Medicinal treatment would seem to be of little use, owing to the protected position in which the parasite occurs.

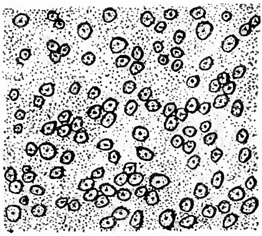


FIG. 17.—Piece of lining of fourth stomach, showing cysts of the encysted stomach worm (*Ostertagia ostertagi*).

INTESTINAL PARASITES.

TAPEWORMS.

Two species of tapeworms (fig. 18) are known to occur in the small intestine of American cattle. They sometimes grow to a length of several yards and to a breadth of three-fourths of an inch. Small portions of tapeworms, consisting of one or more segments, are occasionally seen in the droppings of infested cattle. The life history is not known, but the infectious stage is undoubtedly taken in with the feed or water, infection being spread by the eggs of the parasite contained in the feces of infested animals. The eggs are perhaps swallowed by some small creature (an insect, worm, or snail) which acts as an intermediate host, and which when accidentally swallowed by a cow while grazing or drinking carries with it into her stomach the infectious stage of the tapeworm.

Adult cattle do not seem to suffer much from infestation with tapeworms, but in calves these parasites may cause scouring and emaciation.

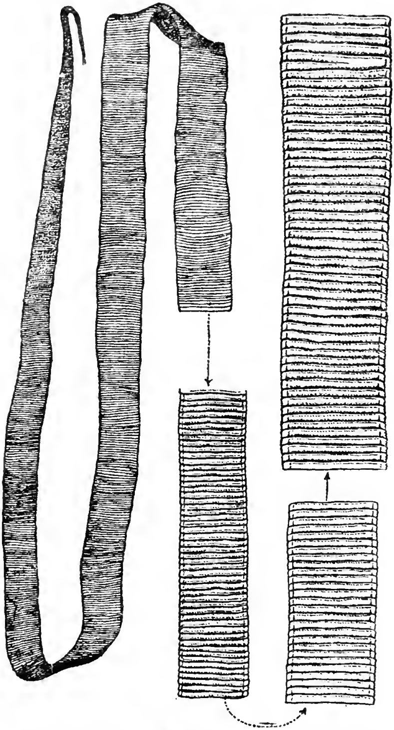


FIG. 18.—A tapeworm (*Moniezia planissima*) which infests cattle.

Treatment.—Medicinal treatment for tapeworms in cattle is usually unsatisfactory, but the bluestone treatment used for stomach worms and mentioned above (p. 522) sometimes expels tapeworms. Arsenic in doses of 1½ to 3 grains has been claimed to give good results in the treatment of calves for tapeworms. From results obtained at the Oklahoma Experiment Station in the treatment of tapeworms of sheep it would appear that the efficacy of the bluestone treatment against these parasites may be increased by the addition of tobacco. For use on cattle the bluestone and tobacco mixture may be prepared as follows: 13 ounces of snuff or powdered tobacco is soaked over night in about 8 gallons of water. To this decoction is added 1 pound of copper sulphate which has been dissolved in 2 or 3 quarts of boiling water. Sufficient water is then added to the mixture to make a total of 9½ gallons. The doses of this solution are the same as for the simple copper sulphate solution, described on page 522, namely:

Calves	3½ to 4 fluid ounces.
Yearlings	6 fluid ounces.
Two-year-olds and over	12 to 16 fluid ounces.

ROUNDWORMS.

A large roundworm (*Ascaris vitulorum*) measuring 6 to 12 inches in length, sometimes found in the intestines of cattle, especially calves, may cause inflammation and occasionally rupture of the intestine. Infection occurs through the swallowing of the eggs of the parasite in feed or water which has been contaminated with the feces of infested cattle.

A number of species of small roundworms, varying in size from an eighth of an inch to an inch or more in length, occur in the intestines. Of these may be mentioned the hookworm (*Bunostomum phlebotomum*) and the nodular worm (*Œsophagostomum radiatum*). The former is about an inch long and is found in the small intestine. The latter is somewhat smaller and is found in the cecum and large intestine. Hookworms, when numerous, may cause anemia and other symptoms similar to those caused by stomach worms (see p. 519). The injury to the mucous lining of the intestine from the bites of hookworms may cause severe inflammation, and affords an avenue of infection with the germs of various diseases. The adult nodular worms apparently do not attack the wall of the intestine, but derive their nourishment from the intestinal contents. Several species of small, very slender roundworms (Trichostrongylus), less than a quarter of an inch in length, sometimes occur in the small intestine and fourth stomach, and a severe gastroenteritis, or inflammation of the stomach and intestines, has been attributed to them. One species of small roundworm (*Cooperia punctata*) burrows in the wall of the small intestine and causes caseous nodules in the mucous lining. This parasite sometimes occurs in very large numbers in the intestines of cattle in certain sections of the country, and apparently does considerable damage.

Nodular disease of the intestine, due to young nodular worms which burrow in the intestinal wall during a certain stage in their life history, sometimes apparently produces serious effects, particularly in young cattle, but commonly has little or no perceptible influence on the general health. It, however, often renders the intestine unfit for use as sausage casings, and as it is widely prevalent among cattle the loss from this source is considerable. The greenish or yellowish nodules with cheesy contents are frequently mistaken by the inexperienced for lesions of tuberculosis.

The life histories of the various small roundworms occurring in the intestines of cattle, so far as they have been worked out, are very similar to that of the twisted stomach worm as described on page 519.

Treatment for intestinal roundworms.—The preventive measures are similar to those recommended in the case of the twisted stomach worm (p. 521). Medical treatment is generally not very satisfactory. According to the Oklahoma Experiment Station, the addition of 1 per cent of tobacco to the bluestone solution used in the treatment of stomach worms in sheep is effective in the removal of hookworms. The bluestone and tobacco mixture described on page 524 may be of value in the treatment of hookworms in cattle. It is asserted by one author that 2 or 3 drams of rectified empyreumatic oil in a mucilaginous emulsion, followed the next morning with a purgative of 1 to 1½ pounds of sulphate of soda, will expel the large roundworms (*Ascaris vitulorum*).

PROTOZOA.

A number of species of protozoa have been reported as parasites of the intestines of cattle. To one species has been attributed a serious disease of cattle in Switzerland known as red dysentery, but so far comparatively few cases of this disease have been recorded in America. It is probably more common than is generally supposed. Calves particularly seem most likely to be affected.

FLUKES IN LIVER AND LUNGS.

Two species of flukes occurring in the liver and lungs are known to affect cattle in the United States. These parasites are flat, leaf-like worms; one of them, the common liver fluke (*Fasciola hepatica*, fig. 19), is less than an inch in length, while the other, the large American fluke (*Fasciola magna*, fig. 20), is considerably larger when full grown. In their life history these flukes depend on snails as intermediate hosts. At a certain stage of development the young flukes leave the snails, become encysted on stalks of grass (fig. 21), or fall into drinking water, and finally may be swallowed by cattle. Stiles writes as follows:

Fig. 19.—The common liver fluke (*Fasciola hepatica*).

Flukes may produce a serious, often fatal, disease, more especially in younger animals. The symptoms are somewhat similar to those produced by worms in the stomach. The first symptoms are generally overlooked, the disease not attracting attention until the appetite is diminished; rumination becomes irregular, the animals become hidebound, and the coat dull and staring. The staring coat is due to the contraction of the muscles of the hair follicles. The visible mucous membranes become pale, eyes become dull, there is running at the eyes, and the animal gradually becomes emaciated. As the disease advances the milk supply is lessened, fever appears, there is generally great thirst, but the appetite almost ceases; edematous swellings appear on the belly, breast, etc.; diarrhea at first alternates with constipation, but finally becomes continous. The disease lasts from two to five months, when the most extreme cases succumb.

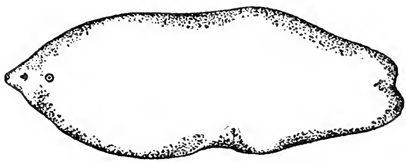


Fig. 20.—The large American fluke (*Fasciola magna*).

Most of the German cattle are said to be infested with liver flukes, but even when a large number are present the nourishment of the cattle is not disturbed. Thickening of the gall ducts, so that a so-called "Medusa's head" forms on the surface of the liver toward the stomach, appears in even well-nourished animals; even in cases of a cirrhosis of the liver it is seldom that any effect upon the cattle's health can be noticed, and so long as a portion of the liver tissue about twice the size of the fist remains intact, the nourishment of the animal may be comparatively good. It is rare that one sees a generalized edema in slaughtered cattle as a result of fluke invasion, and even in the heaviest infections of young cattle only emaciation is noticed.

Treatment.—Medicinal treatment is unsatisfactory. The disease may be prevented to a considerable extent by giving animals plenty of salt, and by introducing carp, frogs, and toads into infected districts; these animals destroy the young stages of the parasite and feed upon the snails which serve as intermediate hosts.

FIG. 21.—Portion of grass stalk bearing three encysted cercariæ of the common liver fluke (*Fasciola hepatica*). Enlarged.

The drainage of wet pastures and the avoidance of swampy lands for grazing purposes are important measures in the prevention of fluke diseases.

Railliet and others have recently recommended the application of lime to fluky pastures, having discovered that very weak solutions are destructive not only to fluke embryos but to snails. This application is to be made during the summer months at the rate of about 500 to 1,000 pounds of lime per acre. The same authors also recommend extract of male fern for the treatment of fluke disease. Moussu states that the average dose for cattle is 1 gram of the extract for each 10 kilograms of live weight; that is, 10 grams for a young animal weighing 100 kilograms (about 220 pounds) up to 50 grams as a maximum for large animals weighing 500 kilograms (about 1,100 pounds) or more. The extract is mixed with about 5 times as much non-purgative oil and the dose is administered each morning for five consecutive days two hours before the animal is allowed to feed after having been fasted over night. The extract of male fern used should have a guaranteed strength of 22 to 25 per cent of filicine and 3.5 per cent of filicic acid.

TAPEWORM CYSTS OF LIVER AND OTHER VISCERA.

Three kinds of tapeworm cysts are found in the viscera of cattle. One of these (*Multiceps multiceps*, or *Cœnurus cerebralis*) will be further referred to in the discussion of gid (p. 528). All these are the intermediate stages of tapeworms, which live when mature in the intestines of dogs, wolves, and other canines. The eggs of the tapeworms are scattered over the fields in the droppings of infested dogs or wolves, and when swallowed in food or water by cattle hatch out and the embryos migrate to the liver, mesentery, lungs, brain, or other organs, where they develop into cysts, variously known as hydatids, bladder worms, water balls, etc. When organs of cattle thus infested are eaten by dogs or wolves the cystic worms are also liable to be swallowed and then develop into mature tapeworms. To prevent cattle from infection with these parasites stray dogs, wolves, and coyotes should be killed wherever found, and dogs too valuable to kill should be kept free from tapeworms. As a precaution against infection with tapeworms, the viscera of cattle, sheep, or hogs should not be fed to dogs unless cooked.

Hydatids (*Echinococcus granulosus*) form tumors (fig. 22) of varying size (sometimes as large as 6 inches in diameter) in the

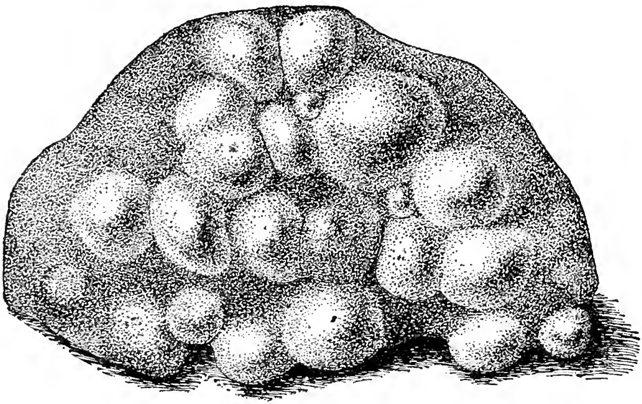


Fig. 22.—Hydatids (*Echinococcus granulosus*) in portion of hog's liver.

liver, lungs, and other organs. Their contents are liquid, resembling water. The presence of these parasites can not be detected in the living animal and there is no medicinal treatment for them. Organs containing hydatids should be destroyed by burning in order to prevent their being eaten by dogs. This is especially important, as dogs infested with the tapeworm stage of this parasite are a menace to human beings on account of the danger of infecting them with hydatids, which develop in man if the eggs of the hydatid tapeworm are swallowed.

Thin-necked bladder worms (*Tænia hydatigena*, fig. 23) are most commonly found attached to the mesentery and omentum. There is no medicinal treatment.

Gid.—Bladder worms (*Multiceps multiceps*, or *Cœnurus cerebralis*), which are occasionally found in the brain of cattle and cause gid, "turnsick," or "staggers," deserve mention, as they are rather common among sheep in the Northwest. As already alluded to, these worms are the intermediate stage of a tapeworm found in dogs, and their life history and the means of preventing infection have been briefly discussed above (see p. 527).

Cattle harboring this parasite show symptoms indicating an affection of the brain, walking or turning in circles, dizziness, uneven gait, impaired vision, etc.

Treatment consists in trephining the skull and removing the parasite, an operation which requires a skillful operator and is frequently unsuccessful. Unless the parasite is removed affected cattle almost invariably die.

TAPEWORM CYSTS IN THE MUSCLES, BEEF MEASLES.[1]

Small tapeworm cysts (*Tænia saginata*), about the size of a pea, found in the muscles of cattle are the larvæ of the common tapeworm of man. Cattle become infected from feed or water which has been contaminated by the feces of persons harboring the adult tapeworms, and human beings in turn become infected by eating raw or rare beef infested with the larval stage (measly beef).

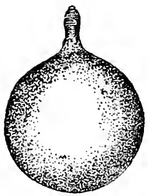


FIG. 23.—Thin-necked bladder worm (*Tænia hydatigena*) from abdominal cavity of a steer.

To prevent cattle from becoming infested with this parasite care should be taken that human feces are not placed where they will contaminate the feed or drinking water.

This parasite is very common in cattle in the United States, at least 1 per cent being infested. As a result considerable loss is entailed through condemnations of beef carcasses by meat inspectors, because of the presence of tapeworm cysts. All this loss could be avoided and the danger of tapeworm infestation in human beings from this source could be removed by the observance of proper precautions in disposing of human excreta. At the same time much sickness and many deaths from diseases (hookworm, typhoid fever, etc.) caused by soil pollution would be prevented, and farm life would be rendered much safer than under the poor sanitary conditions which are responsible for the high percentage of tapeworm cysts among cattle in the United States.

THREAD WORMS IN THE ABDOMINAL CAVITY.

Thread worms (*Setaria labiato-papillosa*) 2 to 4 inches long are frequently found in the abdominal cavity. They seem to cause little or no trouble. The embryos produced by these worms enter the

[1] For further information consult Bureau of Animal Industry Circular 214.

blood vessels. According to Noé, they are spread from one animal to another by stable flies (see p. 503), but this has not been definitely proved. The roundworms found occasionally in the anterior chamber of the eye (see p. 531) are perhaps immature forms of this species which have reached this location during their migration.

LUNG WORMS.

Lung worms (*Dictyocaulus viviparus*, fig. 24) in cattle are thread-like worms 2 to 4 inches long, found in the bronchial tubes and producing a condition known as verminous bronchitis. The life history of the parasite is not fully known, but infection is evidently derived through the medium of pastures where infested cattle have grazed. In the later stages of the disease the cattle cough, especially at night. Young cattle are more seriously affected than old animals.

Treatment for lung worms.—Various treatments have been advocated for lung worms, including fumigating with different substances and injections of remedies into the trachea by means of a large hypodermic syringe or by a special spraying apparatus, but none have been very successful from a practical standpoint. About all that can be done is to feed affected animals well and protect them from exposure, removing them from the pasture and keeping them in dry yards or stables maintained in a cleanly, sanitary condition.

FIG. 24.—Lung worm (*Dictyocaulus viviparus*) of cattle. Outlines showing natural size of male (above) and female.

The methods of prevention in general are similar to those described under the discussion of the twisted stomach worm (p. 521).

PARASITES OF THE BLOOD.

Certain flukes (*Schistosoma bovis* and related species) which live in the blood vessels (the large veins) of cattle in tropical and subtropical countries cause bloody urine and diarrhea, the feces being mixed with blood. These parasites have not yet been discovered in the United States, although the natural conditions are such in some parts of the country that they are liable to become established if introduced.

The embryos of *Setaria labiato-papillosa* (p. 529) which occur in the blood may be found by microscopical examination. They apparently cause no trouble.

The organism which causes Texas fever is a protozoan parasite (*Piroplasma bigeminum*) of microscopic size, which lives in the blood and attacks the red blood corpuscles. For a discussion of this parasite and the disease which it produces see page 476 of this volume.

Other parasites which live in the blood cause serious diseases known as surra and nagana (p. 500), but as yet neither of these diseases has gained a foothold in the United States.

PARASITES OF THE EYE.

Small roundworms, one-third to four-fifths of an inch in length, may occur in the ducts of the lacrimal glands. Several species all belonging to the same genus (*Thelazia*) are known. They sometimes escape from their usual location and may be found on the surface of the eyeball beneath the lids, or even in the eyeball. It has been supposed by some writers that the worms seen in the interior of the eyeball ("snakes in the eye") are immature stages of *Setaria labiato-papillosa* (see p. 529) which have gone astray from the normal course of their migration, but the correctness of this supposition is uncertain.

Worms in the eyes and lacrimal ducts may cause inflammation, in which case the eyes may be syringed with an antiseptic, such as a weak solution of coal-tar stock dip, and iodoform ointment applied if the condition is severe.

When worms are present in the eyeball itself, their removal depends upon surgical treatment, usually not advisable, as the worms in that location either cause but little trouble or disappear without treatment.

MYCOTIC STOMATITIS OF CATTLE.

By John R. Mohler, V. M. D.,
Chief, Bureau of Animal Industry.

INTRODUCTION.

Numerous letters have been received by this bureau in recent years relative to the existence of a disease affecting the mouths and feet of cattle in certain Eastern and Central Western States. Later reports indicate that the malady has made its appearance in the Southwest, where it has caused much alarm among the stockmen owing to its similarity to the foot-and-mouth disease of Europe. The disease, which is to be discussed under the name of mycotic stomatitis, has been carefully investigated by this department on various occasions, and it is with the view of giving the results of these clinical investigations as well as to assert its noninfectiousness and to differentiate it from the virulent foot-and-mouth disease, which it so closely simulates, that this article is prepared.

NAME AND SYNONYMS.

The name stomatitis signifies that there is present in the affected animals an inflammation of the mucous membrane of the mouth. This inflammation, which quickly develops into ulcers, is one of the principal and most frequently observed lesions. Mycotic stomatitis refers to that form of stomatitis which results from eating food containing irritant fungi. Thus the name not only suggests the cause of the disease, but also indicates the location of the earliest and most prominent symptoms. Other names which have been applied to this disease by different writers are sporadic aphthæ; aphthous stomatitis; sore mouth of cattle; sore tongue; benign, simple, or noninfectious foot-and-mouth disease; mycotic aphthous stomatitis; and sporadic stomatitis aphthosa.

CHARACTER OF THE DISEASE.

Mycotic stomatitis is a sporadic, or noninfectious, disease which affects cattle of all ages that are on pasture, but more especially milch cows. It is characterized by inflammation and ulceration of the mucous membrane of the mouth, producing salivation and inappetence, and secondarily affecting the feet, which become sore and swollen. Superficial erosions of the skin, particularly of the muzzle and of the teats and udders of cows, may also be present, with some elevation of temperature and emaciation.

CAUSE.

This disease, as its name indicates, results from the eating of forage containing fungi or molds. It is probable that more than one fungus is involved in the production of this disease, but no particular species has been definitely proved to be the causative factor. Several attempts have been made by the writer to determine the exact cause and also to transmit the disease to other animals by direct inoculation, but with negative results. Suspicion, however, has been directed by various observers to the Uromyces and the red and black rusts that occur on clovers. These fungi cause very severe irritation of the lining membrane of the mouth, producing sometimes a catarrhal, at other times an aphthous, and occasionally an ulcerous stomatitis. The fungus of rape, etc. (*Polydesmus excitiosus*), is very irritating to the mouths and feet of cattle, causing severe inflammation and in some instances producing symptoms that have been mistaken for foot-and-mouth disease. The fungi (Penicillium and Puccinia) found on grasses have also been credited with the production of stomatitis. The fact that this disease disappears from a locality at a certain time and reappears at irregular intervals would suggest the probability that certain climatic conditions were essential for the propagation of the causative fungi, since it is well known that the malady becomes prevalent after a hot, dry period has been followed by rain, thus furnishing the requirements necessary for the luxuriant development of molds and fungi. Owing to this fact the disease is observed in one locality during one season and in an entirely different section another year, but reappears in the former center when favorable conditions prevail. In this way the affection has occurred at irregular intervals in certain sections of both the United States and Canada.

SYMPTOMS AND LESIONS.

Among the first symptoms observed in mycotic stomatitis are inability to eat, suspension of rumination, frequent movements of the lips with the formation of froth on their margins, and in some cases a dribbling of saliva from the mouth. There is a desire to eat, and frequent attempts to take food are made, but prehension is very difficult. If, however, feed is placed on the back of the tongue, it is readily masticated and swallowed. If the mouth is examined at this time, it will be found red and hot, and exceptionally small blisters will be seen, which, however, quickly become eroded and develop into active ulcers varying in size from one-eighth to 1 inch in diameter. Where several ulcers have coalesced a large and irregularly indented patch is formed. These erosions are most frequently found on the gums around the incisor teeth, on the dental pad, inside the lips, and on the tip of the tongue, but they also occur on the cheeks, interdental space, and dorsum of the tongue. The ulcers have a hemorrhagic border, a depressed suppurating surface, and contain a brownish or yellowish colored débris, which is soon replaced by granulation tissue. As a result of this sloughing of the tissues and the retention of food in the mouth, a very offensive odor is exhaled. The muzzle becomes dry and parched in appearance, which condition is shortly followed by erosions and exfoliations of the superficial layer of the skin. Adherent brownish crusts and scabs form over the parts, and similar lesions are seen around the nostrils and external surface of the lips.

In some cases there are associated with these alterations a slight swelling and painfulness in the region of the pasterns, at times affecting the forefeet, at other times the hind feet, and occasionally all four feet. In a few cases the swelling may extend above the fetlock, but it has never been observed above the knee or hock. The skin around the coronet may occasionally become fissured and the thin skin in the cleft of the foot eroded and suppurated, but without the formation of vesicles. As a result of these feet lesions, the affected animal may assume a position with its back arched and the limbs propped under the body as in a case of founder, and will manifest much pain and lameness in walking. If it lies down, the animal shows reluctance in getting up, and although manifesting no inclination to move about, when forced to do so there is more or less stiffness and a tendency to kick or shake the foot as if to dislodge a foreign body from between the claws.

In some outbreaks the milch cows have slight superficial erosions on the teats which at times extend to the udder. The cracks in the skin are filled with serum and form brownish-colored scabs. The teats become tender and the milk secretion diminishes; in some cases it disappears. A similar tendency toward the formation of fissures and scabs on the skin of the neck and shoulders has manifested itself in a recent outbreak in Texas, and this feature was likewise noticeable in the disease when it occurred in Maryland and Virginia in 1889.

In mild cases only the mouth lesions may be observed, or these alterations may be associated with one or more of the other above-described symptoms, but in severe cases, where there is a generalized mycotic intoxication, one animal may show all these alterations. When the disease is well developed the general appearance of the animal is one of great lassitude, and it either stands off by itself with hind feet drawn under the body and its forefeet extended, or it assumes a recumbent position. Owing to the inability to eat and to the general systemic disturbance present, the animal loses flesh very rapidly and becomes greatly emaciated in the latter stages of the disease. The temperature and pulse are somewhat increased, the former 2 or 3 degrees, the latter to from 75 to 90 beats per minute. The fever is not lasting, and these symptoms are soon modified. The animal has an anxious look, and in a few cases there is a gastrointestinal irritation, the feces being thin, of a dark color, and of an offensive odor.

PROGNOSIS AND MORTALITY.

Mycotic stomatitis is not a serious disease, and in uncomplicated cases recoveries soon follow the removal of the cause and the application of the indicated remedies. In such cases complete restoration may take place within one week. In mild outbreaks a large percentage of the animals will recover without treatment, but that the disease is fatal is shown by the fact that animals which develop an aggravated form of the affection succumb if not treated. In such animals death occurs in 6 or 8 days, but the mortality in the serious outbreaks thus far investigated has been less than 0.5 per cent. The course of this disease is irregular and runs from 7 to 15 days, the average case covering a period of about 10 days.

DIFFERENTIAL DIAGNOSIS.

FOOT-AND-MOUTH DISEASE.

In examining a case of mycotic stomatitis it is important not to mistake it for foot-and-mouth disease, which has appeared in this country on six occasions only. This may be easily accomplished by taking into consideration the fact that in the contagious foot-and-mouth disease there is a rapid infection of the entire herd, as well as of any hogs and sheep that may be on the premises. It is also readily transmitted to neighboring herds by the spread of the infection from diseased animals, but it never occurs spontaneously. The characteristic lesion of foot-and-mouth disease is the appearance of vesicles containing serous fluid in the mouth and upon the udder, teats, heels, and coronary bands of the affected animals. Drooling is profuse, and there is a peculiar smacking sound made by sucking the affected lips.

Mycotic stomatitis occurs sporadically on widely separated farms, affecting only a few animals in each herd, and the lesions produced consist of erosions without the typical vesicular formations of foot-and-mouth disease. The failure of the vesicles, if any appear, to spread extensively in the mouth, the absence of these blisters on other portions of the body—notably the teats and udder, and characteristically the feet—together with the absence of infection in the herd, and the inability to transmit the disease to calves by inoculation, distinguish between this affection and foot-and-mouth disease. The erosions of the mouth are not so extensive and they heal more rapidly in mycotic stomatitis. The swelling of the feet and stiffness of the animal are also more marked in mycotic stomatitis.

ERGOTISM.

The lesions resulting from ergotism may be differentiated from those of mycotic stomatitis by the lack of ulcerative eruptions in the mouth and by the location of the lesions at the tips of the ears, end of the tail, or upon the lower part of the legs, usually below the knees or hocks. The lesions of ergotism do not take the form of ulcers or festers, but the end of the limb affected is diseased "in toto" and the eruption extends entirely around the limbs, followed soon afterwards by a distinct line of demarcation between the healthy skin above and the diseased below. The absence of suppurating sores between the claws and on the mucous membrane of the mouth, the knowledge that the lesion upon the limb in question extends uninterruptedly around it, and the presence of ergotized seeds in the hay or grain fed the animals should point conclusively to a diagnosis of ergotism.

FOUL FOOT.

In foul foot, or ground itch, of cattle, the inflammation of the skin and toes usually affects but one foot. It begins as a superficial inflammation followed by sloughing, ulceration, and the formation of fistulous tracts which may involve the tendons, bones, and joints. The mouth remains unaffected, and the presence of the disease may be traced to filth and poor drainage.

NECROTIC STOMATITIS.

In necrotic stomatitis (calf diphtheria) there is a formation of yellowish cheesy patches in the mouth without any lesions of the feet or udder. It affects sucking calves chiefly, and is caused by the *Bacillus necrophorus*.

TREATMENT.

The treatment of mycotic stomatitis should consist in first removing the herd of cattle from the pasture in which they have been running. The affected animals should, if it is possible, be brought to the barn or corral and fed on soft, nutritious food, such as bran mashes, ground feed, and gruels. A bucket of clear, cool water should be kept constantly in the manger, so that the animal may drink or rinse the mouth at its pleasure; and it will be found beneficial to dissolve 2 heaping tablespoonfuls of borax or 1 tablespoonful of potassium chlorate in each of the first two buckets of water taken during the day. If the animals are gentle enough to be handled, the mouth should be swabbed out daily with antiseptic washes, such as a 2 per cent solution of carbolic acid or a 1 per cent solution of compound solution of cresol or of permanganate of potassium, or 1 part of hydrogen peroxid to 2 parts of water. This should be followed by astringents, such as one-half tablespoonful of alum, borax, or chlorate of potassium placed on the tongue. Probably a more satisfactory method of administering the antiseptic treatment to a large number of animals would be to mix thoroughly 2 teaspoonfuls of pure carbolic acid every morning in a quart of bran mash and give to each affected animal for a period of five days. Range cattle may be more readily treated by the use of medicated salt placed in troughs accessible to the animals. This salt may be prepared by pouring 4 ounces of crude carbolic acid upon 12 quarts of ordinary barrel salt, after which they are thoroughly mixed. The lesions of the feet should be treated with a 2 per cent solution of carbolic acid, while the fissures and other lesions of the skin will be benefited by the application of carbolized vaseline or zinc ointment. If the animals are treated in this manner and carefully fed, the disease will rapidly disappear.

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