

was found to be a bowel affection, but there was at the same time tuberculosis of the lungs and kidneys.

In the left lung a bean-sized caseous abscess; scattered through the lungs, near their surface, whitish-yellow nodules varying in size from a millet-seed to a lentil, and showing purulent softening towards their centres. Numerous just visible tubercles in both kidneys. Tubercle bacilli present in masses.

On the 17th October 1890 I obtained for examination the organs removed from a jackal (*canis aureus*), which had died from a hæmorrhagic enteritis, and I found also present tuberculosis of the pleura, lungs, and mesenteric glands.

Diaphragmatic pleura beset with numerous small nodules, which partly by confluence form diffuse plate-like growths. In the middle lobe of the right lung some hepatised parts; the entire posterior lobe is condensed, traversed by developing caverns; above and close to the main bronchus of the same lung a caseous nodule quite as large as a bean. Scattered through the lungs single scarcely visible tubercles. In the diseased parts of the lungs masses of tubercle bacilli. In the mesenteric glands a bean-sized, calcified, white nodule, in which not a few granular tubercle bacilli are recognised.

Further, tuberculosis has been observed here some time ago in various other carnivorous animals—in bears (six or seven of these died from phthisis cavernosa), two lions, a royal tiger, a black panther, and a jaguar.

During recent years a number of observations have been made showing that poultry are with difficulty affected with human tuberculosis, and, on the other hand, that avian tuberculosis is not easily communicated to rabbits. Something similar appears to be the case with tuberculosis of the carnivora. Rabbits appear very resistant towards subcutaneous inoculation with the same. However, I have as yet so few observations in this direction to reason upon that I refrain from drawing any further conclusion from them.

## CALCAREOUS DEGENERATIONS IN THE HORSE.

By FRED SMITH, M.R.C.V.S., F.I.C., Professor in the Army  
Veterinary School, Aldershot.

IN 1885 I described in the *Quarterly Journal of Veterinary Science in India* a series of remarkable degenerative changes occurring in the viscera and limbs of horses in India, which I designated calcareous degeneration. The limited circulation of the periodical in question, and the importance of the subject as an addition to our pathological knowledge, warrant me in bringing it before the notice of the profession in this country.

By calcareous degeneration I understand the conversion of certain tissues into lime. Such changes are not unknown in tumours, but the wholesale conversion of tissue into lime, such as I will have to record, is, I believe, quite an undescribed feature in pathology. Had such extensive changes only occurred in one or two cases, one would be inclined to regard the condition as a pathological *rara avis*; but the

observations made in this paper are deduced from a very large number of *post-mortem* examinations, extending over several years.

Certain tissues and organs of the body are liable to this change in different degrees, and according to my experience the liability to become affected is in the following order:—Liver, Lungs, Intestines, and Joints. The changes in each of these will therefore be separately described.

I may at once say that I am not aware of any symptoms which point to calcareous degeneration of these organs, nor, with the exception of the joints, do they interfere with nutrition, or apparently with the comfort and well-being of the animal. It is only on *post-mortem* examination that we become acquainted with these remarkable changes.

*The Liver.*—The liver in a state of calcareous degeneration may or may not be enlarged; the lime is seen in the form of white bodies, the size of sago, studded over the surface and throughout the substance of the organ, or in pieces the size of a pea or less, speckled here and there over the entire liver, and found as frequently in its substance as on the surface. A small part of the liver or the whole organ may be so infected; it is common to find that not a square inch of liver tissue is without a deposit, and I have seen livers so infected and the structure so entirely destroyed, that a pin could not be placed in the organ at any part of its surface or substance without impinging on one of the calcareous deposits (Fig. I.). However badly the liver may be affected, we always find the deposit in nodular pieces, the intensity of the process depending upon the number of nodules collected together. I have seen livers with only one or two small sago deposits, and many others as badly affected as above described.

The nodule is peculiar; it is yellowish white in colour, generally of stony hardness, encapsuled, readily removed from the capsule by the point of the knife, often irregular on its surface with projections growing out here and there, at others spherical or oval, and quite smooth. A section is made with extreme difficulty, and a nucleus darker and harder than the periphery is seen.

Small nodules by running into each other form large ones, but it is not uncommon—even in acute calcareous degeneration—for the nodules or deposits, though crammed so closely together that hardly a speck of healthy liver structure remains, to still maintain the size of grains of sago.

The liver is rigid in acute cases, and cuts with extreme difficulty; in slighter cases every deposit cut through imparts a gritty feeling to the knife; the fingers passed over the organ have an irregular feel imparted to them. The colour of the organ depends upon the intensity of the change; where as much as a square inch of the liver can be seen without a deposit the colour may be normal, in worse cases the cells are swollen and the central vein congested; in the most advanced state of the disease, where but little liver substance is left, what can be seen is of a pink or flesh colour.

The surface of the organ is usually first affected; from here the change extends to the ligaments, which become rigid, and by this time the deeper parts of the gland are affected. The deposit is seen around the blood-vessels, and even beneath the lining membrane of them.

The bulk of the organ may or may not be increased, but the liver

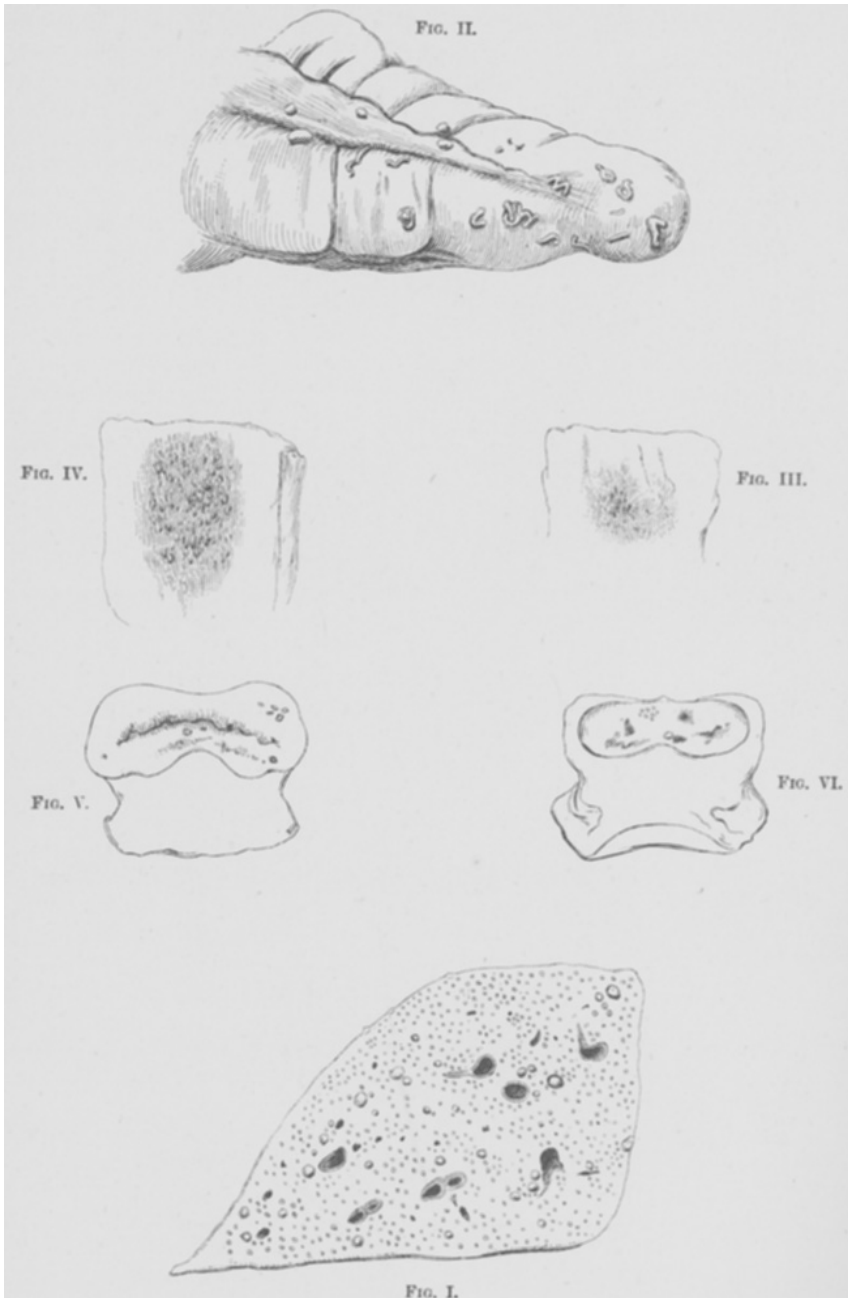
*JOURNAL OF COMPARATIVE PATHOLOGY AND THERAPEUTICS.*

FIG. I.—Section through a liver affected with calcareous degeneration (drawing considerably reduced). The vessels are the shaded areas; the lime deposits—both large and small—are scattered throughout the substance of the organ.

FIG. II.—Portion of cæcum showing the sub-peritoneal deposits of vermicelli form.

FIG. III.—Portion of the internal surface of left ventricle affected with calcareous degeneration.

FIG. IV.—Portion of the aorta, the lime deposits being distinctly seen in the substance of the wall.

FIG. V.—Inferior surface of the os corona; the long streak across the centre represents the erosion of the cartilage and the swollen and fringed condition of the edge of it. Lime deposits are seen to the right, both above and below.

FIG. VI.—The upper articular surface of the corona, showing erosion of the cartilage; a group of lime deposits is seen at the centre and upper part, and a single large deposit is seen below this and to the right.

generally weighs more than normal. I have seen cases where marked atrophy of the liver substance had taken place, the lobes being as rigid as leather ; in others the liver is swollen and enlarged, the maximum weight registered being 56 lbs.

On microscopical examination it is found that the deposit takes place generally between the lobules, and at first it is slight, but, as additions to the surface of the deposit occur the liver cells disappear, either as the result of pressure or actual conversion into the growth. The latter is distinctly seen to be made up of a dark nucleus, the external layers of which, arranged in a concentric manner, are fibrous-looking, studded here and there with small cells, probably of the connective-tissue variety, and constitute the capsule of the growth. If a drop of HCl be added, the specimen is obscured by the bubbles of gas given off.

The deposits occurring in the interlobular tissue produce by their presence sufficient irritation to cause an increase in the connective tissue of the same, and, therefore, cirrhosis. If a very thin section of the organ be examined the deposits are found to consist of minute granules, which are no doubt granules of lime. These granules are the first to be deposited ; as they increase in bulk by addition to their surface they take on the appearance described above, with the formation of a capsule derived from the interlobular tissue. In the examination of a section it is not uncommon to find granules of lime scattered here and there throughout the interlobular tissue, which are no doubt the nuclei of future growths.

I am not quite clear as to whether the deposit of lime ever takes place in the hepatic lobules themselves. I have seen sections which have inclined me to take this view. By far the most common way is for the growth to occur in the interlobular tissue, and the lobules are forced out of existence by this growth in the interlobular space.

*The Lungs.*—I have given the lungs the second place in my list, but I am doubtful whether they or the intestines should have precedence.

Calcareous degeneration of the lungs shows itself by the organs being studded all over with nodules which are generally much larger than those found in the liver.

The anterior and upper portion of the lungs is more affected than the lower and posterior parts.

As mentioned in connection with the liver, there may be only one or two deposits on the lungs or the surface of both lungs may be covered with them. The diseased part is elevated, each nodule distinctly seen under the pleura, and surrounded by a pink areola. The surface of the lung I believe to be more commonly affected than the deeper portions.

The lung deposit is about the size of a pea or bean. It first shows itself as a blotch of a deep maroon colour with sharply circumscribed edges, in the centre of which the deposit may be detected, the latter being at this stage soft and whitish ; this now increases in size, becoming of stony hardness, and the maroon discoloration gradually fades, leaving nothing but a pink areola around the deposit, which may now be the size of a bean. The deposit, as in the liver, is enclosed in a capsule, the centre of the growth being darker and harder than the periphery, and the latter is irregular on its surface.

The deposit formed in the lung either remains in the condition described, or else it undergoes change, and produces local irritation of

the lung tissue, which becomes swollen and inflamed, and allows a small quantity of pale sero-purulent fluid to escape on section. This secondary change is by no means unusual, and is very interesting, as nothing of the sort is seen in the liver.

*The Intestines.*—Calcareous degeneration of the intestines shows itself in the large bowels—generally the cæcum towards its apex, often the colon, rarely the small intestine, and then only to a trifling extent.

The deposit is either sub-peritoneal or sub-mucous; in the former the masses are very singular, arranged almost like a coiled worm, the coiling being irregular, and the patch about the size of a sixpence; the deposit is exceedingly hard, stands out from the bowels, and shines through the peritoneal covering as a yellowish-white body (Fig. II.). Sometimes the coats of the bowel over circumscribed areas are as rigid as leather.

I have seen the colon and cæcum affected throughout the whole length by calcareous degeneration; in the former bowel it is generally limited to the course of the colic vessels, and the deposits here met with are like beans, and are probably converted lymphatic glands. I have also seen the arteries of the colon converted into rigid tubes from lime deposit in their coats and surrounding tissue; this change was not the result of parasitic invasion but of the deposition of lime.

In the submucous form of degeneration nodules can be felt beneath the muscular coat; they are largish deposits, about the size of a bean, freely movable, excessively hard, and they produce on the mucous surface of the intestine a peculiar form of ulceration. The ulcer, no matter how large the deposit, is seldom larger than the head of a big pin, its surface is covered by a small yellowish black slough, which is generally found partially separated from the ulcer, and is readily removed with the point of a knife; surrounding the ulcer is a pink areola of variable width. The pink colour can also be seen on the mucous membrane where no slough exists, but where one will shortly occur.

I am perfectly positive on one point, viz., that the bowel changes are quite independent of any parasitic action, and I may say the same for all other parts of the body.

*The Joints.*—Calcareous degeneration of the joints was first brought to my notice by a peculiar case of lameness which came under my care some years ago.

B 49, 12th Royal Lancers, a mare twelve years old, was first treated by me on the 24th January 1881, for lameness of the near fore leg, which I diagnosed as ringbone. She was discharged cured on February 22, 1881. On December 24, 1881 she again became lame of the same limb, was once more treated for ringbone, and was discharged relieved on January 20, 1882. On June 17, 1882 she fell lame again of the near fore leg, and this time was treated for navicular disease, and was discharged relieved on September 18, 1882. She remained at slow work and continued lame, occasionally after a hard day's work being intolerably so for some days; during the period of comparative freedom from lameness she always "pointed" the near fore foot.

On June 25, 1883 she was taken for a severe gallop, and the following day was so intensely lame (simply bearing on the toe and not maintaining the same position for more than a minute or two), that I made

up my mind the navicular bone was fractured. She was destroyed on July 2, 1883.

*Post-Mortem Examination.*—On examining the abdomen, the intestines were found affected with calcareous degeneration. The small bowels contained two or three deposits, but the large ones were principally affected.

The calcareous nodules were found in three places, (*a*) beneath the peritoneum, (*b*) in the submucous tissue, (*c*) in the lymphatic glands of the bowels. The lymphatic glands of the colon and cæcum were with a few exceptions entirely affected. They were about the size of a bean, generally as hard as a bullet, and on their capsule could be distinctly noted vessels filled with a pale albuminous fluid. On making a section of the gland a central cavity was noted; the deposit was yellowish-grey in colour, irregularly round in shape, and roughened on the surface, from which proceeded prolongations which held it in its capsule. In consistence they varied, some being soft and cheesy, others quite hard. The pelvic flexure of the colon was principally affected in this process.

The appearance produced by the subperitoneal deposit was most peculiar. The apex of the cæcum at first sight seemed to be covered by white "warts." These were calcareous deposits, raised above the surface of the gut in some places as much as  $\frac{3}{16}$ ths of an inch. They were white, hard as stone, and seemed to be made up of worm-like masses coiled into a heap (Fig. II.); they were not surrounded by any sign of inflammation or disturbance of nutrition, but over various parts of the cæcum could be noticed vessels filled with the same albuminous or jelly-like material previously described as found in the capsule of the diseased lymphatic glands. We had another distinctive kind of subperitoneal deposit; it was found in three or four places about the size of a pea, and had the colour and appearance of jelly. I regret these were lost and never microscopically examined. I consider them to be an early stage of the deposit.

The submucous form of the disease was similar to the others; roundish hard bodies could be detected, many the size of a hazel nut, which pushed up the mucous coat and gave it the appearance of being full of small tumours; the deposits were freely movable, they produced no disease of the mucous membrane, which was in all respects healthy. I only noticed one deposit on the surface of the membrane; it was about the size of a pin's head, and looked like a small black slough, and when removed it left a depression which had an elevated margin and a red bottom.

In the large intestines thousands of nematodes worms existed, also many amphistomes, and in the cæcum five tænia were found close to the valve. One would have thought that these parasites would have affected the mare's condition, but she was always the fattest in the troop, and was found fat and well nourished internally.

The liver was about its natural size but contained calcareous deposits; one on the right lobe immediately beneath the peritoneum was worm-like, about 2 inches in length and  $\frac{1}{8}$  of an inch in breadth, shaped somewhat like those in the cæcum, which were, by-the-by, not unlike vermicelli. I have never before seen a long streak of calcareous matter of this shape in the liver.

*Heart.*—The internal surface of the left ventricle, the mitral valve,

and internal surface of the left auricle were of a greyish colour, due to a calcareous degeneration of the lining membrane (Fig. III.). The deposit looked rough but felt soft; the right side was healthy; the heart was hypertrophied, the aorta enormously hypertrophied and dilated, the walls rigid,  $\frac{1}{2}$  inch thick, and on the inner surface infiltrated with lime salts, which gave it a white colour and rendered it very rough (Fig. IV.); calcareous matter was noticed in the substance of the walls on microscopic examination.

*Examination of the Near Fore Foot.*—On opening the navicular bursa synovia was found in excess but healthy in quality; on completely exposing the navicular bone, nothing was to be seen with the exception of a few points of calcareous degeneration in the fibro-cartilage, and some thinning of the latter on the central ridge. I thought the fibres of the tendon were split at one place, but I cannot be sure that this was not caused by the knife. On opening the pedal joint the articular cartilage covering the three bones, but particularly the os pedis and os coronæ, was found swollen, pulpy, and removed from the bones in long patches or strips; in some places white spots of calcareous deposit could be seen lying imbedded in the cartilage and fixed in the bone; at others (an early stage) the deposit consisted of small vesicular-looking spots, not unlike boiled sago, and corresponded exactly in appearance with the two or three gelatinous bodies found in the cæcum, and with the gelatinous contents of the vessels which coursed their way over the gut and the lymphatic glands, as before described.

Where the navicular and pedal bones articulate peculiar change had occurred, the articular cartilage being swollen, fringed, and raised up in patches; deposits could be seen beneath the cartilage. The fringed and swollen condition gave one an impression as if the navicular and pedal bones had articulated so tightly as to materially scrape up each other's articular cartilage into small heaps at the edge (Fig. V.).

The peculiarity of this condition of the joint was the apparent entire absence of inflammation; the erosion of cartilage was not attended by any sign of inflammatory action, in fact the joint was rather paler than usual, and section of the bones gave no indication of inflammation. On the inferior surface of the os coronæ almost complete removal of articular cartilage had occurred, extending completely across the bone, and corresponding to where it rests on the union of the two bones below; in some places simply the cartilage was removed, in others excavations extended into the bone (this was the exception). Lime deposits could be made out in the bone itself, and what was left of the articular cartilage was swollen, pulpy, and jelly like. The disease was not limited to the pedal joint; the pastern, fetlock, and knee of both limbs had suffered. There was no destruction of cartilage, however, above the knee; here the deposits in the articular cartilage were small just as they are in the liver, and some of them in the gelatinous sago-like early stage noted in the pedal joint. The peculiarity of the latter was that they were always in clusters of seven or eight.

I have described the *post-mortem* appearances of this remarkable case exactly as they were made at the time. It will be noted that the liver changes were nothing like so acute as I have observed in other horses, but, on the other hand, the bowel and joint disease was

intense ; it was on account of this latter that I have described the case in detail, for we have undoubted evidence of the distress it occasioned during life, and, further, the *post-mortem* appearances of the joint ; the changes in the latter, though remarkable, were by no means commensurate with the amount of lameness produced and the length of time it lasted.

It is also particularly interesting to note that the nutrition of the horse was not interfered with ; neither the intestinal parasites nor the calcareous degeneration of the major part of the viscera appeared to produce any disturbance.

There are certain places where I have never met with calcareous degeneration, viz., the spleen, pancreas, and kidneys. I have found lime deposits in muscles, in one case in particular, in which during life a large swelling had formed over the wing of the atlas. I found after the animal's death that the swelling consisted of a cavity containing lime ; it is probable that this had grown from the bone itself rather than from the muscle ; the latter formed a large sac for the deposit, and had practically disappeared.

*The Microscopical Appearance of the Joints.* — When articular cartilage is affected by calcareous degeneration, irritation of it is shown by an increase in its cellular elements, which become at the same time fatty ; the matrix of the cartilage, excepting in the neighbourhood of the deposit, is clear, but near the deposits it is silvery grey in colour, and so opaque as to obscure the cells and render the section very difficult of examination.

The lime deposits are shown as black masses, generally circular, and containing large bodies with a dark periphery and bright centre, these being the granules of lime. They are readily dissolved with effervescence on the addition of HCl, and leave behind a cavity containing *débris*. The cartilage surrounding these deposits is also infiltrated with lime deposits. In the fibro-cartilage of the navicular bursa the same black oval deposits are seen (the colour of course being due to absence of light), the lime deposit infiltrating the matrix of the cartilage surrounding the capsule in which all these bodies are contained.

I have met with only a few cases of calcareous degeneration of the joints causing lameness, and in all of them the deposits were confined to the pedal joint or navicular bursa. I have examined many joints, of apparently healthy animals, affected slightly with this peculiar degeneration, with changes in the articular cartilage, and yet producing no lameness. Such are common in the shoulder and fetlock joints. I have never seen calcareous degeneration of the joints in this country.

The most unsatisfactory part of the inquiry is the determination of the cause ; on this I have no opinion to offer. I presume there is some defective excretion of lime from the body, of which salt the horse excretes a considerable quantity in health, it being probably held in solution in the blood by the carbonic acid, but what can lead to its deposition I cannot conjecture.

I thought at one time that the disease was purely an Indian one, but I have met with slight calcareous degeneration of the liver and lungs of horses in this country.