

intestinal glands were enlarged, and more or less decomposed ; and there was also enlargement of the liver.

There were other farms intervening between the source of pollution and the drinking place of the cattle on this farm, but there does not seem to be any record of illness on these farms.

While not personally acquainted with the neighbourhood, I understand that this farm was about a mile and a half below the creamery, and that the stream also received sewage from the town. If these facts are correct, it does seem strange that other cattle should escape, and that creamery effluent should be considered more harmful than town sewage.

Total Ammonia in Analyses.

| | <i>Grs. per gall.</i> |
|---|---------------------------|
| Maybole Case | ·088 |
| Falkirk Case (drinking place) | 2·19 |
| " " (above pollution) | ·093 |
| Netherburn Case | ·406 |
| | <i>Parts per million.</i> |
| Irish Case | ·62 |
| " (above drinking place) | ·85 |

To those who believe that chemical analysis is quite satisfactory, and that there is any ratio between the ammonia present and the clinical symptoms, the above table should prove interesting.

In the Maybole Case ·088 grains per gallon caused general wreckage and abortion, while in the Falkirk Case the normal condition of the burn prior to pollution showed ·093 grains per gallon, and of this the cattle drank without any bad effects.

I am attempting to get the analyses of streams of which the cattle have drunk for years without causing illness, and if I am successful I think they would prove an interesting sequel to this article.

The following is typical, in my opinion, and I can vouch for its accuracy. A farmer's cattle drank of water containing farm and house sewage, and showing total ammonia to the extent of 2·19 grain per gallon, same as in the Falkirk Case, and remained healthy. On being put into another field, the waters of which ran past two cottages (neighbours), they turned ill. The analyses of these streams are respectively, total ammonia ·015 and ·021.

ECHINOCOCCOSIS IN THE DOMESTICATED ANIMALS.¹

By M. A. MARTIN, Veterinary School, Toulouse.

SINCE the publication of the classic works of Professors Neumann and Railliet, echinococcosis has been the subject of a large number of investigations which have yielded important biological and pathological results. I therefore thought it would prove interesting to enumerate, in a general review of the subject, the most recent

¹ Translated from the "Revue Vétérinaire," Nos. 10 and 11, 1907.

additions to our knowledge, and to describe the various forms of the disease.

Echinococcosis is due to the development, in the viscera and tissues of animals or men, of the cystic form of two species of parasitic tæniæ inhabiting the intestine of the dog and cat. The cyst, in other words the echinococcus (also called a hydatid), is a bladder of varying size, which usually assumes one of two forms, occurring either as a unilocular echinococcus, in which each hydatid is surrounded by a connective-tissue cyst proper to it, or as a multilocular or alveolar echinococcus, characterised by a single fibrous connective-tissue sheath containing cavities in which the hydatids are lodged. Unilocular echinococci originate in one of two ways; they are either produced directly from a hexacanth embryo, in which case they are termed primary, or from the cells of an already existing cyst, being then spoken of as secondary.

These three forms of echinococci produce three different pathological conditions, which we shall examine in succession: viz., primary unilocular echinococcosis; secondary unilocular echinococcosis; and alveolar echinococcosis.

I. Primary Unilocular Echinococcosis.

Unilocular echinococcosis is due to the development of the *echinococcus polymorphus* Diesing (*echinococcus veterinorum Rudolphi*) which represents the cystic stage of the *tænia echinococcus* von Siebold. This tænia lives in the small intestine of the dog. Dévé has succeeded experimentally in causing it to live in the cat, and it seems possible that this carnivore may often harbour the parasite.

The tænia echinococcus is a little worm from 2.5 to 5 mm. in length, formed of three or four segments. It becomes adherent to the intestinal mucous membrane by the four suckers and the double crown of twenty-eight to fifty hooks with which its head is furnished. The larger of these hooks measure from 22 to 30 μ , the smaller 18 to 22 μ . The last segment is also the longest, and when mature is full of eggs. In consequence of its small size, this worm is usually overlooked. It assumes the form of a little yellowish filament floating in the intestinal liquid or in the water with which the (opened) intestine may have been washed. The eggs are passed with the fæces of the dog or cat, and, if conveyed to the food or drinking water of men or animals, may easily be swallowed. The embryos then break through their protective shell, traverse the walls of the digestive tract, enter a capillary blood vessel or lymphatic, and are distributed in the viscera or tissues, in which they produce characteristic bladders. These bladders in turn if swallowed by a dog again give rise in its intestine to the tænia echinococcus. As a result of the investigations of von Siebold, Küchenmeister, van Beneden, Leuckart, etc., the life conditions have for long been known.

The echinococcus polymorphus is found in a large number of animals. It has been seen in man, in some varieties of monkey, in the dog, cat, mongoose, bear, panther, rabbit, mouse, squirrel, horse, ass, zebra, ox, sheep, goat, camel, dromedary, elk, giraffe, antelope, pig, giant kangaroo, and in the turkey. It is specially common in the ox, sheep, pig, horse, and in man.

It may be found in all the organs. Those chiefly affected are the liver; then, in their order of frequency, the lung, kidney, spleen,

heart, serous membrane, muscle, bone, nerve-centres, walls of the intestine, lymphatic glands, etc. These various organs may all be attacked at the same time.

(A) DEVELOPMENT.

The echinococcus develops very slowly. Its growth has been followed by Leuckart in the sucking pig. A month after the administration of ripe segments of the *tænia echinococcus*, Leuckart discovered beneath the serous coating of the liver little nodules 1 mm. in diameter. Each of these contained a young spherical solid echinococcus surrounded by a connective-tissue envelope. At the end of two months the echinococci had doubled in size and were full of liquid. Their wall was already differentiated into a thick lamellated cuticle and an internal granular layer. Towards the fifth month they had attained the size of a hazel nut, but showed no special growth in their interior. Their structure was quite characteristic. Removed from the cysts, they exhibited the appearance of spheroidal vesicles of jelly-like consistency with a thick whitish translucent wall. This wall was formed of two layers. The external layer or cuticle was sometimes 1 mm. in thickness, whitish or whitish-yellow in colour, and formed of a large number of concentric lamellæ. It was thicker in fertile than in sterile echinococci. When divided, the fragments immediately rolled up on themselves. Chemically, it consisted largely of chitin charged with calcareous salts, such as the carbonate, phosphate, and sulphate of lime (in young vesicles). It was permeable to fluids, which passed through it by osmosis. The internal layer, which was closely attached to the cuticle and was thinner (0.12 mm.—20 to 25 μ only, according to certain authors) has been termed the germinal or parenchymal membrane. Under the microscope it presents the appearance of a kind of plasmodium, containing little nuclei, without distinct cellular outlines, distributed throughout a colourless protoplasmic substance. This substance appeared to be formed of a network of thin closely-intertwined filaments, the nuclei being situated at the points where the threads crossed. This germinal membrane is the most active portion of the echinococcus, and contains a large quantity of glycogen, as shown by the brownish-yellow colour produced by treating it with iodised gum. This glycogenic reaction only appears in living cysts, whether in process of supuration or not.

The liquid contained in the vesicle is without colour, or is slightly yellow, clear, of low specific gravity (1009 to 1015), neutral, rarely alkaline or acid, and is not coagulated by heat. Along with traces of albumen it contains a large proportion of chloride of sodium (8 per 1000), small quantities of succinate of soda, and lime and a little glyucose and inosite. Some observers have also found in it, though not as regular constituents, cholesterin, leucine, and tyrosine. This liquid is normally sterile, but forms a good culture medium for pathogenic microbes (Viñas).

The liquid from the cysts also contains a toxic substance belonging to the group of toxalbumins, as shown by Mourson and Schlagdenhauffen. Under normal conditions the stratified cuticle checks the diffusion of this toxin and its passage into the blood, but, should the

hydatid cyst be ruptured accidentally or during operation, the toxin, which flows into a serous cavity like the peritoneum or pleura, is said to be absorbed, and, passing into the general circulation, to produce very grave results. It is stated that the urticaria, which in man frequently follows the rupture of a hydatid cyst of the liver, is due to this cause. This question of the toxicity of the hydatid liquid is, however, strongly controversial. Debove and Achard state that the entrance of the hydatid liquid into the peritoneal cavity in man is followed by peritonitis, which proves fatal in a few days or hours, or, in less grave cases, is accompanied by fever, urticaria, dyspnoea, vomiting, etc. The degree of toxicity is believed to depend on the age of the echinococcus, the most recent being the most dangerous. Roy, observing aseptic precautions, produced death in a few hours by injecting hydatid liquid into the abdominal cavity in the guinea-pig. On the other hand, Drago, Perroncito, and Joest declare that the liquid from the cysts when injected under the skin, into the peritoneal cavity, or into the veins in guinea-pigs, rabbits, or dogs, produces no pathogenic action, and therefore contains no toxic principle. Systematic injection of experimental animals with this liquid is not followed by the production of a specific precipitating serum, and the blood serum of animals affected with echinococcosis possesses no precipitating action on the hydatid liquid (Joest).

Careful consideration of the clinical facts, however, especially in man, forbids our accepting any such positive conclusions. Ghérardini, after a very exhaustive investigation of this question, is drawn to the conclusion that the liquid from the echinococcal cysts does not contain any special hydatid venom, and that the peritonitis, suppuration, and intoxication symptoms which follow the rupture of a non-suppurating cyst should be attributed to true infections due to microbes latent in the cyst, and capable of resuming, under certain circumstances, their full activity and virulence. Unfortunately, direct bacteriological examination of the various clinical cases has not been made, and Ghérardini's hypothesis awaits confirmation.¹ As to the outbreaks of urticaria, they are due, according to Ghérardini, to poisoning by a principle which is not a constant specific product of the echinococcus, but a substance pre-formed in the organism which succeeds in penetrating into and accumulating in the interior of the cyst. Discussion is far from ended on this point, for, whilst, after the numerous clinical observations, one cannot dispute the toxicity of the hydatid liquid, its importance should not be exaggerated. The study of secondary echinococcosis has thrown a strong light on the subject, and shown that numerous cases of rupture of a hydatid cyst have passed unnoticed in man.

The development of the echinococcus may become arrested at this stage. The growth is then sterile, and is termed an acephalocyst (Laennec). But fresh growths often develop within it. The internal surface of the germinal membrane at first exhibits little granulations arranged in more or less closely-packed groups. These granulations increase in size, become excavated and lined with a thin non-lamellated membrane, finally becoming transformed into vesicles,

¹ The contents of the cysts may not be sterile. Griglio, who examined forty-two echinococci from the lungs or liver of recently killed cattle, pigs, and sheep, found bacteria in thirty-five. In order of frequency these were: the staphylococcus pyogenes albus and aureus, sarcinae, proteus vulgaris and mesentericus, bacillus coli, and the bacillus pyocyaneus.

connected with the germinal membrane by a short pedicle. These are the proligerous vesicles, in which are developed, by a process not yet fully explained, the scolices or heads of the *tæniæ*. The scolices vary in number from five to fifteen, or even thirty-four, in a single proligerous vesicle, and are not always developed to the same degree. They are connected by a pedicle to the wall of the proligerous vesicle, but this pedicle frequently becomes broken and the scolices then float freely in the cavity of the vesicle. When completely developed the scolices present the appearance of little, more or less rounded, bodies, between 0.19 mm. in length and 0.16 mm. in diameter; the pole opposite the pedicle exhibits a depression formed by the invagination of the head on itself; on the sides are the suckers, in the depths a double crown of hooks resembling those of the adult *tænia*, but somewhat shorter; around the periphery of the head are arranged a considerable number of calcareous corpuscles. The proligerous vesicles often burst, and the scolices, isolated or united by threads to the *débris* of the proligerous vesicle, are scattered throughout the liquid of the hydatid.

When the liquid of a fertile echinococcus is left at rest in a glass a greyish deposit forms at the bottom. This material has received the name of hydatid sand. In examining the elements of which this sand is composed, one notes proligerous vesicles or their *débris*, scolices invaginated or evaginated or in various phases of evagination, others in process of development; some may be in the vesicular stage and in process of cystic metamorphosis, others undergoing involution or already dead.

Dévé distinguishes two varieties of echinococcic scolices of very different significance. The first, which he terms ortho-scolex, are clear and refractile, contain numerous calcareous corpuscles, are ovoid and regular in form, with a thick cuticle and strong pedicle, and are sometimes connected by threads of tissue to the *débris* of their proligerous vesicle. They possess suckers, a very clearly marked rostrum, and hooks of regular form firmly affixed to the head. They are strongly formed, are of great vitality, and are rich in glycogen. The others, termed meta-scolex, are dark in appearance, granular and yellowish, irregular in form, smaller in size, always detached from their proligerous vesicle, without a refractile cuticle, and with few or no calcareous corpuscles. Their suckers and rostrum are difficult to identify. The hooks are irregular and easily detached. They appear extremely fragile, and never contain glycogen. These two types, which occur as frequently in the hydatid cysts of animals as of men, usually coexist in a single proligerous vesicle, but in very varying proportions, and are unaccompanied by intermediate forms. Dévé regards the meta-scolices as atypical, without vitality, and without power of development. The ortho-scolices are the only important elements, and the only ones interesting from the biological point of view. Nevertheless, the meta-scolices may, from a medical point of view, have a certain degree of importance, especially in man; for, in consequence of their hooks being distributed in the hydatid liquid, they furnish the practitioner with an unmistakable diagnostic factor.

The vital resistance of the scolices, that is to say, the ortho-scolices, is very considerable. According to Sabrazès, Muratet, and Husnot, the scolices still show movement at a temperature of 31° C. as long as fifty-

six hours after the extraction of a hydatid cyst. These movements disappear at about 27° C., but are revived and become more marked at 37° and 40° C. Three days after collecting the liquid movement was again seen on warming, whilst when removed from the liquid, which was becoming putrid, to sterile bouillon, to physiological saline solution, to slightly acid gastric fluid, and to mucous and biliary fluids, the scolices retained their vitality and power of movement after being warmed for ten hours. In normal urine, pus from a case of putrid suppuration, and in a saturated salt solution, they retained their vitality for five hours. Dessication and immersion in a 10 per cent. solution of formalin rapidly killed them. Dévé has shown that, contrary to generally received views, the scolices long resist the action of bile, but that 1 per thousand sublimate solution and 1 per cent. formalin solution destroy them in five minutes. These observations are of importance in connection with the prophylaxis of echinococcosis.

The proligerous vesicles do not constitute the only method of multiplication of the echinococcus, which may form secondary or daughter vesicles. These are sometimes included within the mother vesicle which has given birth to them, sometimes situated outside. The former are termed endogenous or internal vesicles, and the echinococci which they present have received the name of echinococcus altricipariens (Küchenmeister), or echinococcus hydatidosus (Leuckart). They are particularly common in man, but have also been seen in the pig, horse, ox, and sheep. The second are termed exogenous or external, and the echinococci, echinococcus scoleci-pariens (Küchenmeister), or echinococcus simplex or granulosus (Leuckart). Although seen in man, they are specially common in ruminants and pigs. They usually remain of feeble proportions, and may escape observation.

The origin of these daughter cysts has been the subject of numerous investigations, the results of which have quite upset the views hitherto accepted. It was formerly believed, on the authority of Kuhn, Davaine, Leuckart, and Moniez, that they were developed between the cuticular layers at the expense of the germinating cells contained within the cuticle; these cells were supposed to undergo proliferation, forming a cellular mass which became excavated by a central cavity, whilst at the same time it developed a reticulated cuticle; the daughter vesicle thus formed, which possessed all the characteristics of the mother vesicle, distended the wall of the latter, and made its way outwards or inwards, depending on the conditions of development. But in 1862, Naunyn, who was preceded by Bremser and Eschricht, and followed by Rasmussen and Küchenmeister, disputed this method of development, and declared that the daughter vesicles developed from the proligerous vesicles and from the scolices. This theory, accepted somewhat later by Leuckart, was not usually admitted in France; but the more recent experiments of von Alexinsky (1898 to 1899), and of Dévé (1900 to 1902), have entirely confirmed it. The proligerous vesicles, when about to become transformed into daughter vesicles, develop a cuticle on their external surfaces, the scolices they contain become disintegrated, and their parenchyma forms on the internal surface of the cuticle a germinal membrane. The scolex which is about to produce a daughter vesicle

increases in size, whilst on its internal surface appears a fine network, which serves as a support to little granulations. These increase at the periphery of the vesicular scolex, and eventually form a germinal membrane. The cuticle of the scolex becomes thickened, and assumes a lamellated appearance. The central network finally disappears, and the hooks, thrust towards the periphery, form in the granular layer a little irregular body, which is the indication of the origin of a daughter vesicle. Dévé has also seen endogenous daughter vesicles developed at the expense of cells of the germinal membrane (in a human cyst); at the expense of cells not yet differentiated, contained in a proligerous cyst, in a sheep; and also at the expense of daughter vesicles already produced by the destruction or adhesion of their walls, as had already been described by Naunyn.

The daughter cysts, therefore, may originate in very varying ways. Nevertheless, when once produced they possess the same structure and the same future. According to Dévé, only the exogenous vesicles are formed in the thickness of the cuticle; the endogenous vesicles, on the other hand, are produced by one of the different methods described above.

The daughter vesicles produced by any of the methods indicated may in their turn give rise to vesicles of a third order of development, either internal or external. These are termed secondary daughter cysts. Daughter cysts and secondary daughter cysts are capable of producing internal proligerous vesicles, in which the heads of *tæniæ* may be detected, but, like the mother vesicles, they may also remain sterile and form acephalocysts.

The details into which I have just entered are not only interesting from a zoological standpoint, but are of very great importance from the point of view of pathology. They enable us to understand and interpret a special form of hydatid disease which has long been studied, namely, secondary echinococcosis. This will be discussed later.

The fertility or sterility of echinococci vary in different species of animals, and according to the organs affected. In the ox the proportion of fertile to sterile echinococci is as 24 to 76; in the pig as 80 to 20; in the sheep as 92·5 to 7·5; and in the horse as 38·9 to 61·1.

Turning now to the lung and the liver, we find in the ox 51·5 per cent. of fertile echinococci occur in the lung as compared with 76 per cent. in the liver. It also seems that in the pig age has some influence on the fertility of the parasite—in pigs aged more than two years, 50 per cent. are fertile; in those below this age, 87 per cent. Sex, bodily condition, and health are without influence on the fertility of the echinococci (Lichtenheld). The largest number of sterile echinococci are found in the ox. Hoefnagel and Reeser carried out a series of investigations at the abattoir of Utrecht, and came to almost identical conclusions.

Hydatids may attain very large dimensions, some being as large as an apple or a man's fist; in exceptional cases echinococci as large as a child's head have been seen. They may exist for very considerable periods; in man Courty saw one in the iliac region which had been in existence for thirty-seven years, and in the horse Raymond described one which persisted for seven years.

The echinococcus invades all the viscera and all the tissues, and

although it is most commonly localised in certain organs such as the liver and lung, a considerable number of cases of generalised echinococcosis are recorded, in which hydatids were distributed throughout the whole body. Localised infestation may be discrete, consisting only of a few vesicles, or very massive, with an extraordinary number of parasites: as many as 2300 have been counted in an ox's lung, and 2600 in the same animal's liver, and even these numbers are below the truth.

The striking feature in most recorded cases of echinococcosis is the absence of symptoms; very serious lesions pass unperceived during the animal's life, and the majority of the most interesting cases are only found on *post-mortem* examination or are chronicled in the records of slaughter-houses. Perhaps this is in part due to the shortness of life in our domesticated animals, the greater number of which are sacrificed early for meat; the lesions not having sufficient time to disturb the function of the infected organ, the clinical symptoms pass unnoticed. Nevertheless disturbance, indicated by varying symptoms, affects the organs invaded. The lesions and symptoms so produced we shall now examine, passing in review the localisations of the hydatid parasite and the various symptoms of echinococcosis.

I.—Echinococcosis of the Liver.

Hydatid cysts of the liver are very common in herbivorous animals and in the pig; they are also seen in dogs and cats (Neumann). Sometimes they occur singly, but often coexist with cysts of the lung or other organs. They develop both on the surface and in the depths of the parenchyma of the liver, and their presence may produce very extensive lesions.

Lesions.—The appearance of the liver is changed, the organ being considerably increased in size and weight. In the ox the liver, which normally weighs 5 kilogrammes, may attain a weight of 50, 75, or even 79 kilogrammes. In the pig, the normal weight of whose liver is 2 kilogrammes, the viscus may weigh 25 or even 55 kilogrammes, and in the horse as much as 20 kilogrammes (Liénaux). The liver is bosselated and irregular on the surface, which exhibits whitish, rounded, fluctuating swellings indicating the vesicles; these are separated by islands of hepatic tissue, which are sometimes reduced to mere narrow tracts, in which the cells have been thrust to one side, compressed, or completely replaced by fibrous tissue. Around each mother vesicle is formed a connective-tissue cyst, the structure of which varies with the fertility or sterility of the echinococcus, but is independent of the species of parasite.

If the echinococcus is fertile the cyst is formed of an internal layer surrounded by a fibrillar connective-tissue stratum rich in cells. If the hydatid is sterile it consists of an internal layer of giant cells and an external connective-tissue layer rich in cells. In the horse the walls of the cyst surrounding a sterile echinococcus are formed of fibrillated connective tissue with cells. The cyst wall varies in thickness, sometimes attaining 6 or even 10 mm. Its external surface is in contact with the hepatic tissue; its internal is smooth, brilliant, and seldom adherent to the vesicle, which can readily be removed. The walls contain a few blood vessels, and sometimes send sclerotic prolongations into the neighbouring tissue. The external daughter cells may

remain within the same cyst as the mother cell, which then becomes somewhat larger, or they may form special depressions, in which they lodge. These diverticula either remain in communication with the primary cyst, or the channel connecting them becomes contracted and atrophied, so that the two separate.

On section, the liver has a cavernous appearance, and presents numerous rounded, irregular cavities of widely varying size, from which spurts forth the hydatid liquid, containing daughter vesicles, proligerous vesicles, and detached scolices. Each of these cavities is lined with the membrane of the echinococcus, and exhibits proligerous vesicles, still adherent, on its internal surface. The walls of the cavities are in contact or are separated by islands of hepatic tissue, whose cells are compressed, thrust back, and atrophied. In this way the escape of bile is sometimes interrupted, and the liver presents a yellowish icteric colour. Sometimes the walls of vessels have become ulcerated, and the cyst pours its contents into them; it may thus communicate with the biliary canals. Cases of this kind are fairly numerous in man, and the condition has also been seen by Eppler in a cow. On the surface of the liver the peritoneum and Glisson's capsule are thickened, and adhesions may occur between the liver and the diaphragm, stomach, or intestine. Sometimes the vesicles accumulate around the portal vein, which they compress; circulation within the vessel is then impeded, the blood plasma transudes, accumulates in the peritoneal cavity, and gives rise to ascites.

As they grow old, echinococci undergo changes which often result in their destruction. The wall of the cyst becomes still further thickened, its internal surface loses its brilliant appearance, and between it and the vesicle is deposited one or more layers of caseous material. The liquid of the vesicle transudes through the wall and becomes mixed with this substance; the germinal membrane becomes softened and undergoes fatty degeneration; eventually the hydatid yields to compression, its walls fall in, and the cavity finally disappears. The secreted material gradually becomes still thicker, hardens, assumes the consistence of gum mastic, and undergoes calcification. By this time no more of the echinococcus remains than some fragments of the lamellar cuticle and of the hooks, which resist destruction and can be detected by microscopic examination.

Secondary infection sometimes occurs and the cavity and cyst then become filled with a purulent liquid. Calcification may also extend to the walls of the cyst itself, especially in the horse. One then finds in the liver (particularly in Germany and Italy) little nodules, the size of a pin's head, a millet seed, sometimes even a pea, which are sharply defined, firm to the touch, isolated or confluent, distributed throughout the mass of the organ or located beneath Glisson's capsule and completely calcified. These lesions, which the Germans term in the aggregate *chalicosis nodularis*, have in certain cases been brought about by an echinococcus becoming arrested in one of the branches of the portal vein (Kitt, Olt, Hartmann, Casella). Olt has found in these calcified nodules young echinococci of .1 to 1 mm. in size, recognisable by the remains of the cuticle. In exceptional cases the nodules are so numerous that the liver is transformed into a block as hard as stone.

Symptoms.—In the ox the symptoms of echinococcosis are vague and often pass unnoticed. When the liver is severely invaded and the disease well advanced, appetite becomes irregular and the animal loses condition. The liver having increased in size, pressure and percussion over the last four ribs on the right side cause pain and reveal more extensive dullness than usual. The conjunctiva is sometimes icteric, and diarrhoea sets in.

In certain cases examination by the rectum reveals the enormous size of the liver. Sometimes the disease produces cachexia, but most commonly it causes no visible disturbance and is not discovered until *post-mortem* examination. Eosinophilia has been noticed in echinococcosis. It is not constant, and, as it accompanies almost all parasitic diseases, it does not constitute a symptom of any great importance.

In the sheep hydatid disease of the liver produces the same vague assemblage of symptoms. The animal shows weakness and dullness, and, during the last stages of the disease, cachexia. As a general rule the symptoms are mistaken for those of distomatosis, which often coexists with echinococcosis.

In the pig discrete infestation causes no noticeable disturbance, but when hydatids are present in the liver in great numbers they produce severe changes, the most frequent indication of which is to be found in ascites. The abdomen increases in size, the abdominal cavity contains a large quantity of liquid which can be detected on palpation, the animal cannot stand, and severe wasting accompanies voracious appetite. The pulse, temperature, and respiration are normal (Lucas). In some subjects icterus is one of the dominant symptoms.

In the horse the disease does not produce any precise signs.

When the contents of the hydatid cyst become infected the symptoms differ from those of true echinococcosis: peritonitis, either acute and generalised or localised in the right anterior region, sets in, perihepatitis occurs, with adherence of the liver to the posterior surface of the diaphragm, to the hypochondriac region, to the gastric compartments, or even to the abdominal wall, and is indicated by exceptional tenderness of the right hypochondriac region, and by respiratory symptoms due to immobilisation of the diaphragm.

Sometimes there is no apparent disturbance, but the patients waste from day to day and, in some cases, become cachectic. Under other circumstances there is hypertrophy of the entire liver, excessive tenderness in the right hypochondriac region, progressive loss of appetite with acute thirst, uncontrollable diarrhoea, and fever. In a fortnight to three weeks, and sometimes in less time, the patients are carried off by septic intoxication, by generalised purulent infection, or by septicæmia (Moussu).

Diagnosis.—On account of the uncertain significance of the signs, the diagnosis of ordinary echinococcosis or of suppurative echinococcosis is difficult, and sometimes impossible. On *post-mortem* examination the lesions are easy to recognise, although old caseated and calcified cysts may resemble lesions of tuberculosis; but the continued existence of neighbouring hydatids in a good state of preservation, the absence of true recent tuberculosis, and of lesions of the lymphatic glands, soon put one on the right path. The

presence of fragments of the lamellated cuticle, and especially of hooks, can be detected microscopically, and decide the diagnosis. The two diseases very often exist in the same animal. In the horse calcified nodules in the liver, due to echinococci, may give rise to suspicion of glanders, but in that disease the liver is never the first organ invaded, and lesions will be found in the lung or in the nasal cavities. On the other hand, the lymphatics are never attacked in echinococcosis. Finally, calcification of glanderous centres is quite exceptional.

Treatment.—There is no treatment. On account of the deep-seated position of the liver one can scarcely hope to reach it in order to puncture or remove the cysts, and, although surgical intervention is fairly frequent in man, it does not appear practicable in the herbivora. Moreover, when the liver is invaded by an immense number of hydatids surgical intervention, even if possible, would be illusory, for it would be necessary to extirpate the liver. Prophylaxis alone is of importance.

II.—*Echinococcosis of the Lung.*

Echinococcosis of the lung is seen in ruminants, swine, and horses. It often accompanies echinococcosis of the liver. In oxen hydatid cysts of the lung are much more frequent than those of the liver, according to the statistics of the German abattoirs. The same appears true of sheep.

Lesions.—When invaded by echinococci the lung appears enlarged and collapses irregularly; its surface is bosselated and beneath the pleura bluish-white, semi-transparent, fluctuating vesicles are visible, varying in size between that of a pea and an apple, and surrounded by a connective-tissue cyst. Its weight in the ox may be increased from 3 kilogrammes to 20, 25, and even 27 kilogrammes. On section, hydatid liquid escapes, carrying with it the daughter vesicles contained in the cysts. Around the cysts the pulmonary tissue is compressed and atrophied, whilst at other points it preserves its normal appearance. Sometimes vesicles open into the bronchi, and the cavity then assumes a cavernous appearance. They may also rupture into the pleural cavities, and there distribute their contents (Sperling). In the lung the echinococcus undergoes changes similar to those seen in the liver; it becomes caseous, its membrane plicated, and the whole growth infiltrated with calcareous salts. It then resembles a tubercle, the magma only containing *débris* of the cuticle and a few hooks.

In the horse the wall of the cyst is frequently calcified. The lung sometimes contains calcified nodules which have been studied by Olt and Schütz and found to be due to the larvæ of nematodes. Some of these nodules, however, about the size of a pea, contain dead echinococci. They are distributed under the pleura and in the parenchyma, or are united in masses which feel hard and resist the passage of the knife. On section, the isolated nodules show a yellowish-white calcified centre surrounded by an envelope from .5 to 1 mm. in thickness. The whole growth may readily be enucleated, and then appears as a little, smooth sphere. The collections of nodules resemble calcified tubercles, and contain a hard, caseous material (Kitt).

Symptoms.—Pulmonary echinococcosis produces no functional disturbance except when the vesicles are large and exist in great numbers. The early symptoms consist in a feeble, wheezy cough, repeated at first at rare intervals, then more and more frequently, so that it occurs every five or ten minutes. At the same time respiration is accelerated and occurs in two efforts. There may be trifling fever. Pressure and percussion over the chest are not painful. Dulness may exist at certain points, but is less marked than in pleuro-pneumonia. Opposite the affected spots the vesicular murmur is suppressed, but in the healthy parts it is stronger and rougher, and is accompanied by blowing or bubbling sounds, and by intermittent bronchial râles during inspiration; finally, at the exact moment when respiration ceases a special characteristic sound is heard (cloc-cloc, Hartenstein). Dyspnoea occurs, sometimes gradually or after exertion or rapid trotting, even though of short duration. When the lung is extensively invaded by echinococci general disturbance, similar to that in echinococcosis of the liver, may be detected. Disease of the liver usually accompanies that of the lung (Neumann). When a cyst breaks into the pleural cavity severe disturbance may follow, such as dyspnoea, noisy respiration, and emphysema about the body (Sperling).

Diagnosis.—Although difficult, a diagnosis may be made. The disease is distinguished from tuberculosis by the gurgling sound, by difficult respiration occurring along with an otherwise good state of health, and by absence of swelling of lymphatic glands.

It is less easily differentiated from pleuro-pneumonia. However, the absence or relatively trifling character of the fever, the pulmonary sounds, and the slight tenderness of the chest wall assist in forming a correct opinion.

After death the differential diagnosis of echinococcosis of the lung is easy. The disease is distinguished from tuberculosis by the presence of intact hydatids, by the persistence of fragments of the cuticle and of hooks in the degenerated cysts, by the absence of recent tubercle and of lesions of the lymphatic glands. In the horse one can distinguish the parasitic nodules from those of glanders by their calcification, the ease with which they can be enucleated, the absence of recent glanders centres, etc.

Treatment.—This is illusory. The best line to adopt is to slaughter those animals which are least affected.

III.—*Echinococcosis of the Heart and Blood Vessels.*

Echinococcosis of the heart is commonest in oxen, very rare in horses (only one case has been reported) and pigs (three cases).¹ Professor Neumann dealt with these localisations of the echinococcus in an article published in the *Revue Vétérinaire* in 1905. Since then five other cases in the ox have been described, but they do not add anything to what was already known on the subject.²

Lesions.—It sometimes happens that the liver and lungs are affected simultaneously with the heart. In three cases only was the

¹ According to the figures given by Lichtenheld, 3·2 per cent. of the cases of echinococcosis in the pig, and 1·3 per cent. of the cases in the sow, are due to parasites in the heart (in reality he saw this once in twenty-seven pigs examined and once in fifty-eight sows).

² Hydatid cysts of the heart are very frequent in certain countries. In Roumania Démétrian observed over thirty-five cases in a year, and the condition was present in 2·2 per cent. of the animals slaughtered. He does not give details, and it is probable that they do not modify Neumann's conclusions which are summarised in this chapter.

heart alone affected. Sometimes the external appearance of the heart is normal, but almost always it appears changed in form over the point where the parasite is lodged, being enlarged and the surface bosselated, or exhibiting only a local change of form due to the projection of the cyst. The latter is almost always intact, though rupture is possible and may be accompanied by tearing of the endocardium or of the wall of the heart, which in these cases is often extremely thin. Intrapericardial hæmorrhage then occurs, but in the majority of cases the cyst is intact. It is lodged in the wall of the heart and projects into one of the cavities. In the majority of instances only one echinococcus is present in the heart, though cases have been reported where two, three, four, and five have been observed. In one case the myocardium was riddled with them. The size of the parasite varies. Some are no larger than a grain of millet or a pea; more frequently they are as large as a hen's or even a turkey's egg; sometimes as a man's fist or even a child's head. They may be fertile or sterile; some undergo degeneration and are in part calcified. The cardiac tissue also suffers change, its fibres being thrust aside or compressed. The hydatid is only covered at its most prominent point by a thin layer of myocardium, not exceeding in thickness a sheet of paper; in other cases it is in contact with the endocardium, and may even project a considerable distance into one of the cavities of the heart. The myocardium undergoes fatty degeneration or thinning, and becomes pale and flabby. Thickening of the endocardium has been noted.

In the majority of cases the hydatid projects either externally or into the interior of the heart, sometimes both externally and internally; occasionally, where the parasite has developed in one of the partition walls, into two neighbouring cavities. The cavity invaded by the cyst is reduced to an extent dependent on the volume of the latter.

An interesting fact has been noted in regard to the seat of the cysts. They are found in the walls of the ventricles and auricles, in the inter-ventricular partition, and in the inter-auricular partition, but are especially frequent in the left ventricle, and are more than three times as common in this position as in the right ventricle. This peculiarity is probably due to the method of distribution of the coronary arteries in the ox; whilst the right coronary artery is very small, the left is five or six times as large, and of itself supplies two posterior thirds or left portions of the heart with blood, whilst the right only supplies the anterior third. The greater lumen of the left coronary artery therefore would render it easier for the embryos to invade the portion of the heart supplied by it (Neumann).

The number of observations regarding pigs and horses are so few as to be insufficient for any general conclusions.

Symptoms.—Sudden death appears the most common termination in echinococcosis of the heart. In the ox it may occur under the most varying conditions. The animals die suddenly in the byre, at grass, whilst ruminating, in leaving or returning to the byre, in returning from the drinking trough during or after work, and often without ever having shown any sign of disease. Sometimes death is preceded by sudden severe tympanites, asphyxia, and difficulty in respiration; but these are symptoms not peculiar to this condition, and, in fact, we know of no symptom which can certainly be referred

to the presence of one or several echinococci in the heart. The mechanism of sudden death is easy to understand when it is due to the rupture of a cyst and to tearing of the heart. When these conditions are wanting we may imagine that the atrophy or destruction of a large portion of the contractile fibres of the heart imposes so severe a strain on the organ that it finally determines asystole and death (Neumann). Nevertheless, echinococcosis of the heart is not always fatal, and oxen sometimes continue their normal method of life even with an enormous cyst in that region.

Diagnosis is impossible, and treatment useless.

Echinococcosis of the vessels is very rare. Bollinger has found hydatids in the wall of the aorta near its bifurcation and in the wall of the posterior aorta in horses. Goubaux described a case of sudden death in a horse from rupture of the aorta, near its origin. The walls of the vessel contained three little sterile cysts. After rupture of a hydatid cyst its contents may be discharged into the lumen of a vessel, and daughter vesicles may bring about the formation of emboli. Eppler has seen such on the internal surface of branches of the portal vein fixed in position by fibrous tissue.

IV.—Echinococcosis of the Bones.

Echinococci are the only animal parasites which one finds in bones. They have rarely been seen in domestic animals, a fact perhaps largely due to the insufficiency of investigation and to the short life of the animals, which forbids the parasite bringing about sufficient change to determine the appearance of symptoms. A dozen cases are known—two in the horse and ten in the ox—all observed by Prof. Neumann, and a thirteenth described by M. Morot, also relating to an ox, and published shortly afterwards by Mr Henry. One of these cases was produced by a multilocular echinococcus, thus reducing to twelve the cases of unilocular echinococcosis in bones.

In the horse the parasite has been met with twice in a flat bone—once in the inferior maxilla (Vachetta) and once in the ilium (Colin). In the first case the hydatid had produced a swelling of the left branch of the inferior maxilla as large as a turkey's egg, soft towards its lower part, and fluctuating. Puncture was followed by the escape of an opalescent liquid and of a few vesicles. By enlarging the opening about thirty daughter vesicles, together with the mother vesicle, were removed. The hydatid was sterile. In Colin's case the parasite formed an enormous swelling in the sub-lumbar region, and this reappeared after two partial removals. It extended towards the ilium, in the diploë of which hydatids were found. The two layers of bone were thrust apart, and formed the walls of an excavation as large as a child's head, around which the areolæ of the spongy tissue were dilated. There appeared to be no irritation of the periosteum in the neighbourhood, even at the extreme points of the lesion.

In the ox the reported cases of hydatid cysts in bones have always been found on autopsy or by butchers when sawing bones in the slaughter-house. They may be classified as follows: Long bones, six cases (femur three, tibia one, humerus two); short bones, three cases (dorsal vertebræ two, cervical vertebræ one); flat bones, one case (ilium). The external appearance of the bone seldom indicates the

presence of a parasite. Sometimes, however, the osseous tissue is ulcerated and the echinococcus has invaded neighbouring tissues. In the long bones the medullary cavity is considerably enlarged around the hydatid, the bone-marrow is thrust aside and destroyed, the spongy tissue is atrophied, and in some cases has even completely disappeared. The cavity thus produced is often lined with a firm, whitish connective-tissue membrane, within which is lodged the echinococcus. Sometimes one only finds a single vesicle, sometimes a large number. They vary in size from a pea to a hazelnut, and may either be fertile or sterile.

V.—Echinococcosis of the Nerve Centres.

Veterinary medicine only contains a few recorded cases of echinococcosis of the brain. These may be divided as follows: Horse seven cases, ass one case, ox four cases, dog three cases. The symptomatology is vague, and does not enable us to arrive at an exact diagnosis. In the horse there are attacks of vertigo or of coma, immobility, depression, sometimes paresis or paralysis, dilatation of the pupil; in the ox complete dulness and insensibility to external impressions—preceded or not by vertigo—difficulty in moving, the animal striking against objects when walking, sometimes paralysis. There may be generalised trembling. The frontal region is sometimes sensitive, the pupil is greatly dilated, and hæmorrhage into the retina occasionally occurs. In the dog the symptoms are equally vague. Boschetti has seen difficulty and pain in moving the head. The animal had a drawn appearance about the face, and at last was incapable of drinking or eating. Another dog showed nothing whatever abnormal. Titta mentions circus movements and stupidity; the head was held high and inclined towards the left.

The echinococcus may be located at one of many different points—in the meninges, in the frontal lobe, in the occipital lobes, in the cerebellum, or in the lateral ventricles (cow, dog). Usually the writers only mention one vesicle, sometimes two, in one case (dog) five; and their size varies, some being as large as a pigeon's egg, some as a billiard ball. They may be fertile or sterile. Around the parasite the brain substance is compressed and softened, and the meninges congested; sometimes the vault of the cranium is thinned by the pressure of the vesicle (cow).

VI.—Echinococcosis of the Serous Membranes.

This localisation is rare, though cases have been seen in the ox, pig, dog, and horse of echinococci lodged in the pleura, peritoneum, or pericardium. Sometimes the lung and liver are simultaneously and severely invaded, and it may appear as though the case were one of secondary echinococcosis. It is, however, quite evident that primary echinococcosis of the serous membranes occurs, and that the embryos of the *tænia echinococcus* may develop in these cavities.

The pig has furnished the majority of observations, the vesicles having been seen in the peritoneum, pleura, and pericardium. In the peritoneal cavity, in Kühnau's case, were very numerous echinococci, which had set up fibrous peritonitis. The appearances resembled tuberculosis of the peritoneum, but microscopic examination showed the condition to be due to dead echinococci. All the

organs were invaded, and numerous dead echinococci were fixed to the epicardium.

Beltramelli found two hydatids the size of hazel nuts with proligerous vesicles in a portion of the cæcal mesentery from a pig. Lisi counted sixty vesicles in the left side of the thorax in a sow whose left lung was crammed with echinococci.

During a period of six months Vamos saw two cases of pericarditis due to echinococci in the pig. In both cases the pericardium and epicardium were covered with a layer of false membranes 2 to 5 mm. in thickness. The thickened connective tissue contained greyish, transparent, sterile echinococci, varying in size from the head of a pin to a hazel nut, some encapsuled, some open. The myocardium also presented some cysts. In one of the animals there were only a few vesicles in the liver.

Morot has published one case in a cow in which the hydatid cysts were situated between the pleura and the internal surface of the ribs. He has often seen vesicles as large as peas on the surface of the parietal pleura.

On the right costal pleura, near the sternum, de Benedictis saw a zone 4 inches in diameter formed by nodules and vesicles, varying in size between a pea and a nut. The small vesicles were calcified, the others full of liquid containing numerous scolices.

On the costal pleura and pericardium Görig found several dozens of echinococci, varying in size between a hazel nut and a fowl's egg, with broad bases or pedicles, which were most common towards the insertion of the diaphragm. Some were intact; others had undergone various forms of degeneration. There were numerous cysts in the lung and in the liver.

In the horse Liénaux has published a remarkable case of echinococcosis of the pleura and lung. Almost the whole surface of the serous membrane was covered with hydatids.

In the dog the first reported case is due to Hartmann (1694). The peritoneal cavity of a dog contained so large a number of vesicles as to fill several buckets. The vesicles varied in size between a nut and a fowl's egg. Some were free and others adherent to the peritoneum covering the diaphragm, stomach, mesentery, and bladder. Only the liver, however, had been penetrated. However much Hartmann may have erred regarding the nature of these vesicles, the truth is beyond question.

In a case of ascites Reimann found an enormous number of echinococci in the peritoneal cavity; they extended into the pelvis and vaginal sheath and around the testicles, weighing in all 8872 grammes. Some were free and others adherent to the mesentery or epiploon. The majority varied in size between a hazel nut and a fowl's egg. The smallest was as large as a pea, the largest as a man's fist. They contained numerous scolices, but many acephalocysts were also seen.

Some of these cases were probably due to secondary echinococcosis. We shall return to the point.

VII.—Echinococcosis of the Muscles.

The muscular tissue is rarely the seat of echinococci. Only a few cases are reported in the horse, pig, and ox. The majority refer to the horse. Echinococci have been found in an abscess of the tem-

poral fossa (Kirkman); between the wall of the thorax and the attachment of the diaphragm (Goubaux); in the region of the ribs, where they formed a swelling which continued for seven years and healed after having several times been tapped (Raymond); below the transverse processes of the second to the fifth lumbar vertebræ of an old horse which had suddenly gone lame: at this point was a large swelling weighing 4 kilogrammes 556 grammes, bosselated on the surface, resembling a sarcoma, and containing thousands of agglomerated echinococci. The large and small psoas muscles on the right side had lost almost all their muscular fibre. The transverse processes of the second, third, and fourth lumbar vertebræ were attacked, and the swelling had extended above them and come in contact with the inferior surface of the lumbar muscles. It had also invaded the spinal canal by dilating the inter-vertebral foramen, and had thrust aside the meninges and the spinal cord (Georges).

In four other cases echinococci were situated in the upper parts of the hind limb between the anus and the ischium, where they formed a swelling from which hydatids were removed by incision through the rectum, there had been frequent attacks of colic (Villate); in the muscles of the lumbar region, where they extended almost into the ilium, the swelling which they formed returned after two partial removals (Colin); in the muscles of the internal surface of the quarter in considerable quantity (2 litres) (Broquet and Mégnin); in an enormous purulent swelling, extending from the left kidney to the upper margin of the ilium, in a horse which had been killed on account of his poor general condition—in the pus floated hundreds of echinococci, either intact or degenerated. This multilocular pocket extended into the deep layers of the muscles of the thigh, and into the anterior and posterior crural region (Ranvier and Dehors). Finally, Johnne found a vesicle in one of the psoas muscles (Friedberger and Fröhner), and Blanchard has described simple cysts in the crural muscles.

In the pig, de Benedictis, whilst making sections in the right forearm region in search of cysticercus cellulosæ, found in the upper portion of the extensors of the fore-arm an acephalocyst the size of a fowl's egg. Penescu, in a four-year-old pig, found echinococci in most of the large collections of muscles.

Dupuy in 1825 described the case of a two-year-old sow suffering from paraplegia, which, on *post-mortem* examination, showed echinococci in several of the muscles of the back, loins, and quarters, as well as others in the liver, lung, and kidneys.

In the cow Morot found hydatid cysts under the pleura, and covered by a thin layer of the fibres of an internal intercostal muscle. Rieck has seen some in the large pectoral muscle.

VIII.—Other Localisations of the *Echinococcus*.

In addition to the localisations we have just passed in review, hydatids are found in other organs.

Spleen.—Echinococci have been found in this organ in the ox, pig, sheep, horse, and dog. They seldom seem to affect the health of their hosts, even though they attain considerable dimensions. Porro mentions the case of an ox in whose spleen was a fertile cyst weighing more than 500 grammes. Tabusso has described a much more

interesting case in the dog. The animal was in very bad condition, showed swelling of the abdomen, alternations of constipation and diarrhoea, could only move slowly and with pain, and suffered from feebleness of the heart's action. It was killed, and on *post-mortem* examination a large, dirty-white, bosselated swelling, entirely covering the abdominal viscera, was found adhering to the hypertrophied and elongated spleen. It weighed 1800 grammes, measured 25 cm. by 10 cm., and was formed by the union of cysts, varying in size from a pigeon's egg up to that of a fowl. These cysts were echinococci which had undergone partial caseous and calcareous degeneration; they contained invaginated and evaginated scolices.

Lymphatic Glands.—Cysts are very rare in the lymphatic glands. They have been described by Hoefnagel and Reeser, who saw two cases of echinococcosis in the mesenteric lymphatic glands in the pig, and by Dévé, who saw a case in three of the tracheo-bronchial lymphatic glands in a sheep. Each was hypertrophied, bosselated, and on section appeared excavated with cavities the size of a grain of hemp, a pea, or a hazel nut, containing a clear liquid. These cavities had become polyhedral by compression, and were separated by thin divisions infiltrated with lime salts. They were lined with a sterile hydatid membrane and communicated between themselves. The parasite, therefore, was an echinococcus of the scoleci-parous type, that is to say, a type which proliferates exogenously. The liver of the sheep was very extensively invaded, and the lungs each contained a dozen swellings of the same type. There were no cysts in the cellular tissue of the mediastinal or lymphatic vessels.

Kidneys.—Echinococci may also develop in the kidney. The internal surface of the cyst is often reticulated and its cavity traversed by bands which render it multilocular. The surface or substance of the wall is frequently calcified; sometimes it appears partially ossified over varying areas. The atheromatus deposits compress the hydatid, which is flattened and degenerated. The cyst may open by fissures on the surface of the kidney or into the pelvis (Rayer). Hydatids have been described in the kidney of the pig and horse, and of ruminants, especially of sheep. Varnell has described a case in a sheep, one of whose kidneys was completely destroyed, and the other of which only retained traces of its gland tissue. The organs were as large as a child's head and were full of cysts, varying in size between a pea and a fowl's egg. Cadéac and Malet have described a remarkable case of echinococcosis of the kidney in a horse. Here also the renal substance had disappeared at several points, and the cyst was amalgamated with the fibrous sheath of the kidney. Finally, these parasites have been met in the kidneys of a sow by Dupuy, in the kidney of a dog by Perroncito, and in the right kidney of a zebu by the same writer.

Suprarenal Capsule.—In a six-year-old ox which was suffering from pulmonary tuberculosis, and whose liver was severely invaded by hydatids, Fumagalli found the right suprarenal capsule entirely occupied by an echinococcus cyst.

Uterus and Udder.—Hydatid cysts of the uterus and udder have several times been described. In two cases of extensive echinococcosis in the cow the uterus was very large and deformed by parasites which occupied its walls (Szanto). A vesicle the size of a

foal's head was seen in a mare's uterus by Mettam. In Réhmet's case a cow's udder was riddled with numerous nodules, giving rise to suspicion of tuberculosis, but on incision hydatids the size of a hazel nut up to that of a fowl's egg were found. The largest cysts contained daughter vesicles; the scolices were absent or were degenerated, and the glandular tissue had not undergone change. There were no echinococci in any other organ; but the lung was the seat of tuberculosis. Stending saw an echinococcus the size of a pigeon's egg in the left anterior quarter of a cow's udder, and Gurin in the udder of a bitch.

Pancreas.—In very rare cases echinococci have been seen in this organ, but without their presence appearing to have any influence on the health of the host.

In exceptional instances hydatid cysts have also been found in other tissues or organs, such as the walls of the intestine (Szanto), the peritoneal and subperitoneal connective tissue (cow; Szanto), in the adipose tissue of the base of the heart (ox; de Benedictis). No organ and no tissue is free from the possibility of hydatid invasion.

(B) ETIOLOGY AND GEOGRAPHICAL DISTRIBUTION.

The essential factor in the production of echinococcosis is the presence of dogs harbouring in their intestines the *tænia echinococcus*, whose eggs, passed along with the *fæces*, enter the digestive tract of animals along with food or drink. The embryos, set at liberty by the action of the digestive fluids, pass through the walls of the intestine, and may develop at any point in the animal body.

It follows that echinococcosis is almost as widely distributed as the dog itself. In Continental Europe, Mecklenburg and Eastern Pomerania are most severely infested. In certain districts 25 to 50 or even 65 per cent. of the oxen, 75 per cent. of the sheep, and 5 to 8 per cent. of the pigs are affected. In these countries man necessarily suffers from the disease more severely than elsewhere. In the other parts of Northern Germany the disease is also very frequent, and in Southern Germany echinococcosis is, according to Bollinger, the endoparasitic disease commonest in ruminants, tuberculosis and distomatosis alone excepted. The Russian statistics are very similar to those of Germany. According to Gurin, in certain governments 81·2 per cent. of the oxen, 50 to 60 per cent. of the sheep, 60 to 70 per cent. of the pigs, and 19 per cent. of the calves are affected. The disease is also frequent in the horse, the returns from Uralsk placing the figure at 40 per cent. In other countries of Europe echinococcosis, whilst less common than in Germany and Russia, is by no means rare.

Iceland is the classic country of the echinococcus, dogs being extremely numerous. There is said to be one dog to every three or five inhabitants, and 30 per cent. of them suffer from *tænia echinococcus*. Men, dogs, and cattle live in close promiscuity, and the hydatid cysts, which are very frequent in the human species, are even more so in animals. When cattle are slaughtered the viscera are thrown away without being burned, dogs eat them, contract the *tænia*, and continue to disseminate the germs of the disease.

In North Africa, Tunis is also infested in a very high degree. Vidal declares that animals whose liver is completely free of the parasite are very rare.

In Australia echinococci are almost as common as in Iceland. In British India, where dogs are very common, 70 per cent. of the ox tribe suffer from echinococcosis of the liver. In the Argentine Republic, particularly in the province of Buenos Aires, hydatid cysts of the liver and lung are very frequent—40 per cent. of the ox tribe, 60 per cent. of the sheep, and 70 per cent. of the pigs, suffering from them. On the other hand, they are rare in Brazil, Chili, and Peru. They are also very rare in the United States.

(C.) PROPHYLAXIS.

If curative treatment of echinococcosis is impossible in the domestic animals, prophylaxis is very important. It is necessary to prevent dogs and cats contracting the *tænia echinococcus*. Dogs which frequent abattoirs or private slaughter-houses are most exposed to infestation. The admission of dogs to slaughter-houses should therefore be forbidden. Dogs should never be fed with viscera containing, or suspected of containing, hydatids. All viscera infested with echinococci should be seized and burned, because we now know that the scolices are endowed with very much greater powers of resistance than was formerly believed. Finally, it is desirable periodically to administer to dogs a course of anthelmintic medicine to rid them of the *tæniæ echinococci* which they may be harbouring in the intestine. The prophylactic measures must be applied to the carnivora. It is useless to attempt to prevent herbivora and swine from swallowing the embryos of the *tænia*. This is an absolute impossibility. If applied to the dog these measures would be highly efficacious, and it is desirable that they should be generally carried out, for it must not be forgotten that in man echinococcosis is a serious disease, the frequency of which stands in direct relationship to its occurrence in animals, and that in protecting the latter from the disease we are protecting ourselves.

COMPENSATION PAID FOR THE SEIZURE OF MEAT AND THE SLAUGHTER OF ANIMALS ON ACCOUNT OF TUBERCULOSIS IN FRANCE.¹

By H. MARTEL, D.Sc., Chief of Veterinary Service of Paris and
of the Department of the Seine.

IN France, since 1898, the State has granted compensation to the owners of tuberculous animals. The indemnity in the case of meat seizure and animal slaughter on account of tuberculosis is provided in accordance with articles 36 and 52 of the law of the 21st June 1898. Article 36 of the law in the rural code provides for slaughter, upon the order of the Mayor, of animals of the bovine species duly certified to be affected with tuberculosis; article 52 of the same law

¹ Translated from "*L'Hygiène de la viande et du lait*," July 1907, by John F. J. Sykes, M.D., D.Sc., M.O.H., St. Pancras, London.