# A PRACTICAL GUIDE

TO

# MEAT INSPECTION

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(WALLEY)

FIFTH EDITION

RE-WRITTEN AND ENLARGED

BY

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*WITH NUMEROUS ILLUSTRATIONS*



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# PREFACE TO THE FIFTH EDITION

THE present Edition differs but little from the preceding one. The entire text, however, has been carefully revised, and numerous minor alterations, necessitated by recent pathological and bacteriological discoveries, have been made. The short chapter on Meat Poisoning has been entirely rewritten.

*November* 1909.

# PREFACE TO THE FOURTH EDITION

In preparing the Fourth Edition of this book, the original intention of the Editor was to follow on the lines usually adopted in such an undertaking.

After various attempts, however, he saw that it would be impossible to carry this out with any success, and he decided to rewrite and enlarge the whole book.

Those who were acquainted with the former editions of Walley's "Meat Inspection" will hardly recognise the Fourth Edition as a direct lineal descendant. Nevertheless the Editor wishes to acknowledge that the new edition is indebted to the old for much useful information, and that he himself must ever remember with gratitude the valuable personal instruction on the subject of Meat Inspection which he received from the late Professor Walley.

In order to perform the higher duties of a Meat Inspector— the Editor is of opinion that veterinary surgeons should not condescend to what might be called the policeman's part — a considerable knowledge of Comparative Pathology, including those branches of the subject termed Bacteriology and Parasitology, is necessary. It must be understood, however, that in no sense does the Editor claim for the Fourth Edition that it is a text-book of Pathology, Bacteriology, or Parasitology. His object has been to introduce just so much of each as is necessary to enable the veterinary student to understand the nature of the morbid changes with which he is likely to meet in the abattoirs. To keep the book within reasonable limits, it has been assumed that the reader has already passed through a course of Comparative Pathology and Comparative Anatomy, for only those who have taken out a full course of veterinary instruction are fitted to undertake the higher branches of Meat Inspection.

The veterinary student must not assume, however, that with the termination of his college course he has acquired all the knowledge necessary for the inspection of meat. There is certainly a great deal more that can only be learned at the abattoir and in the laboratory, but he is much further on towards the acquirement of this knowledge than those who have not had the benefit of a veterinary education.

For the section entitled "Statutory Provisions," etc., the book is indebted to D. Winter Robb, Esq., S.S.C., Edinburgh; and the Editor wishes further to acknowledge the great assistance which Mr. Robb has given him in the reading of proof-slips and sheets. The chapter on "Food Poisoning" has been kindly contributed by Ralph Stockman, Esq., M.D., F.R.C.P.E., Regius Professor of Materia Medica, University of Glasgow. For the final reading of the sheets, the book is indebted to J. M'Fadyean, Esq., M.B., C.M., B.Sc., Principal, R.C.V.S., London, who very kindly offered to superintend this part of the work on the Editor's departure for South Africa. To Messrs. Riddock and Thomson, Veterinary Inspectors to the City of Edinburgh, the Editor owes his best thanks for the many specimens with which they have supplied him. The illustrations marked "Neumann" are from Dr. Fleming's translation of Neumann's *Parasites of the Domesticated Animals*, and they are made from blocks kindly supplied by the publishers, Messrs. Ballière, Tindall, & Cox, London.

A large number have also been copied from Leuckart's *Parasites of Man*, through the kindness of the publisher, Mr. Young J. Pentland, Edinburgh. The illustrations marked M'Fadyean have been copied, with kind permission, from the *Journal of Comparative Pathology and Therapeutics*. *The Veterinarian* has been good enough to lend Fig. 13 (Tubercle

of pig's muscle, p. 102), which was originally made from a photograph by the Editor. Professor Muir of Glasgow has kindly supplied the negative for the illustration of the pseudo-tuberculosis bacillus. Mr. Frazer, Optician, Edinburgh, has been kind enough to lend the woodcuts of apparatus. The remainder of the illustrations, unless specially marked, are from photographs of specimens in the possession of the Editor, taken either by himself or by Mr. J. Paterson, of the R.C.P. Laboratory, Edinburgh.

On the subject of Meat Inspection there is often room for difference of opinion, and the procedure in this or that abattoir is frequently based on use or wont. The Editor would like to say that his aim has not been to lay down the law, but rather to show the lines upon which a rational opinion may be formed.

In conclusion, the Editor sincerely hopes that he has not omitted to thank any one who has given him assistance.

STEWART STOCKMAN.

*March* 1900.

NOTE.—Owing to my absence abroad, it was found necessary to delay the publishing for several months.—S. S.

*May* 1901.

# CONTENTS

## DISEASES OF THE BLOOD



## BACTERIAL DISEASES



## DISEASES CAUSED BY ANIMAL PARASITES



## UNCLASSED DISEASES

# LIST OF ILLUSTRATIONS

## PLATES



## FIGURES

# MEAT INSPECTION

## INTRODUCTION

### HISTORICAL

#### The Development of Meat Inspection[1]

In approaching this subject, much of which is buried in religious antiquity, I do not mean to pose as a biblical scholar. One may, however, be allowed to take at least an amateur's interest in the customs of early civilisation in the East, whence have emanated many of the rules devised for the health of our souls, and some of those elaborated for that of our bodies. Moses undoubtedly learned much concerning hygiene from the Egyptians during the Captivity; indeed, he had great opportunity, for we are told that at his instance the land was visited by ten plagues in the space of about twenty-five days. Many medical writers, however, have credited Moses with a knowledge of pathology and hygiene far in advance of his time; but I am bound to confess that the evidence brought forward in favour of Moses' highly scientific attainments is often shadowy, to say the least of it. Moreover, in the writings of some of the most distinguished scholars, one finds that the supposed medical aspect of the

[1] Presidential Address delivered by the Editor to the Scottish Microscopical Society, Philosophical Institution, Edinburgh, 1899.

laws relating to animals—the subject that concerns us at present—is hardly discussed. It is often asserted in medical books that the pig was excluded from consumption in the Levitical laws because it was known to Moses that swine-flesh was often measled (as we now call it), and might infect human beings with tapeworm. It is unlikely that Moses was the originator of the laws referred to; there were lawgivers and traditions before his day, and it is in the evolution of these traditional ideas that the explanation of the laws relating to the flesh of animals seems to lie.

The portion of Leviticus which deals with the subject was compiled by the writer of the Law of Holiness somewhere about eight hundred years or more after the death of Moses; but the writer was not the originator; he did little more than record the traditional laws, which before his time were perpetuated and probably modified by the practices of generations. Once the laws were written, of course, their development would be checked. It might be argued that the successors of Moses applied the laws relating to animals for medical reasons; but nobody would credit such a suggestion, because all the evidence indicates that they had a religious significance; they are, in fact, part of the ritual.

The solution of the question hangs on the origin of the idea of uncleanness as applied to animals. Robertson Smith, in his "Burnett Lectures" (1888–89), traces in a most interesting way the evolution of ideas which men held regarding their relation to animals. I wish here to state that I am indebted to his works for a great deal of information.

In the earlier days, when ritual was of the most primitive kind, there was a time when an animal's life was held sacred on account of the kinship which was supposed to exist between men and gods and beasts. Animals were only slaughtered for a sacrificial meal, in which the god was supposed to partake along with his worshippers. This seemed to justify the slaughter. As the desire for animal food increased, however, the sacrificial character of the slaughter was relaxed, except with regard to certain species of animals which were held peculiarly sacred. They were deemed so because of their supposed kinship with families of men, and their relationship to the god.

At the present day one finds it hard to understand how any family of human beings could foster the idea of their relationship to the pig, or consider the species divine. (Although nobody denies evolution, great difference of opinion comes in when we attempt to determine from what we are evolved.) Once the latter relationship was established in men's minds, however, the former would become much easier to accept. There is plenty of evidence to show that such beliefs were held and acted upon in the days of early paganism, and that the traditional ceremonies survived long after the reason for them had been discredited. Even now, savage totem tribes exist in Africa, and it is hinted by some authorities that their ideas may have originally come from the same source as those of the Semitic races. It is to be observed that the animal held sacred was not always of the same species. In Egypt it was the dog, especially at Cyanopolis (Anubis was worshipped as the representative of the dog). Of fish, the eel was held sacred to the Nile by the Egyptians (Herodotus, ii. 72); it was unclean to the Jews. The Hindoos regard the cow as sacred; the Shin caste of Dards abhor it. The Kaffir used the ox, as we do a sheep-dog, to herd and protect flocks.

Besides the supposed relation of animals to gods, there was another reason why certain of them were to be avoided, viz. that they were associated with the presence of dreaded spirits. In the *Book of the Dead* (Birch's translation) we find that the Egyptians considered the pig unclean because the demon Set appeared in that form (Hastings' *Dictionary of the Bible*, article "Food"). Herodotus (ii. 47) hints at a reason, but says it would be unbecoming to mention it. Herodotus frequently makes this excuse for not referring to religious matters.

We see, then, that among the ancients restrictions were put on the use of certain animals for two reasons—first, on account of holiness, *i.e.* the relationship to gods; and, second, because of ill-disposed spirits dwelling within them, *i.e.* uncleanness. The two, however, own a common root idea, and, as Robertson Smith points out, the law of clean and unclean in Levitical legislation almost meets that of holiness, since uncleanness was considered hateful to God. An unclean person could not approach the sanctuary.

In time of famine and on special occasions, the totem was slaughtered and eaten by its human relations, but with many lamentations and apologies, which must have done much to soften the blow. Similarly, sacred and unclean animals were eaten when food was scarce; and on specially solemn occasions they were employed for mystic sacrifices to certain gods whose names were associated with the species of animal. In the latter cases the whole community took a hand, and they shared the responsibility of the animal's death, as we to-day share the responsibility of a capital sentence with the judge through our representatives on the jury. When the Syrians besieged Samaria, the beleaguered inhabitants were so short of food that an ass's head was sold for fourscore pieces of silver (2 Kings vi.); but the ass neither parteth the hoof nor cheweth the cud. That even human flesh was eaten under the same circumstances, we learn from 2 Kings vi. 29 and Lamentations iv. 10. Herodotus tells us (ii. 47) that the Egyptians periodically sacrificed pigs to Isis (the goddess of the moon) and to Bacchus. Pigs also were sacrificed to Demeter, the Greek representative of Isis, and to Ceres, the Roman one, to whom the first temple was vowed by Postumius Albinus, 496 B.C. It was a moot point with the Greeks whether the Jews abhorred or worshipped pigs (*i.e.* whether these were unclean or holy). In Crete, pigs were sacred, and not ordinarily eaten; so also was it in Syria. In the Levitical sin-offering the fat was burned at the altar, and the remainder of the flesh was eaten by the priests or burned outside the town. Reasoning from what took place among other peoples, Robertson Smith concluded that this was done in order that there might be no chance of laymen being rendered unclean by coming in contact with anything so holy, for holiness and uncleanness were looked upon as contagious, *i.e.* were capable of spreading from things to men and from men to others. The more ancient beliefs were that a man who ate unclean beasts, or the totem, would be visited by boils, ulcers, and swellings. Herodotus, however, tells us that the Egyptians considered all diseases to be caused by demons entering the patient; and it is easy to understand how men would fear and shun unclean animals in which demons were supposed to be resident. From this it may well be asked, were not these ideas founded on actual cases of transmission of diseases from animals to man—tapeworm from pig's flesh, for example? In the case of the Jews, I think not, because perfectly harmless animals and things were regarded as unclean, while ox flesh, which in the East is often measled, was not prohibited. It is stated, however, as a *sine quâ non*, that all sacrificial animals must be free from blemish, and, in the light of our present knowledge of pathology, this might be, and often is supposed to have had a hygienic bearing. I would point out, however, that deformed animals (without disease) were also excluded, and that the same rules applied to the sacrificial beasts which were not eaten. The inference is, rather, that a second-rate article would not be accepted by the god. Robertson Smith explains that "without blemish" meant that the sacred life was normally embodied in the animal, and I think that this idea persisted long after the intensely sacrificial idea of slaughter had disappeared, owing to the increasing desire for a flesh diet. Indeed, it persists to-day, for the Rabbi still performs a religious inspection of the carcases. No one can deny that these rules would have the same effect as the inspection performed by Christians for hygienic reasons. The question is, however, did they arise with the ancients from hygienic motives? After a perusal of the writings of some distinguished biblical scholars, and those of ancient travellers like Herodotus, I have concluded that they did not. Moreover, if any such idea did exist, it does not appear in the teaching of Christ (*vide* Matt. xv. 11): "There is nothing from without that entereth into him that can defile him," etc. This was in reply to those who held out for traditional worship by the law.

Paul characterised as doctrines of devils the commandments to abstain from meats which God created (1 Tim. iv.). It is true that the weak-kneed Christians in Antioch and Syria were told to abstain from blood and things strangled; but that was a diplomatic stroke to make things easier for them (Paul, 1 Cor. viii. 1).

The Levitical law demands that the blood be poured out, and the same idea is at the bottom of the injunction to abstain from the flesh of strangled animals and those torn by beasts. I do not think, however, that any one denies the religious significance of these prohibitions: the blood is a thing too holy for men to touch. All doubt on the subject is dispelled in Leviticus xvii. 11, 12: "For the soul of all flesh is in the blood," etc. In verse 12, even the stranger must not partake of blood, presumably because of the supposed contagious nature of uncleanness. In Deuteronomy xiv. 21, it was allowed to sell to the stranger the flesh of an animal "that had died of itself." If the Jews who practised this considered that such flesh was hurtful to health, they were certainly not of a Christian disposition, although the same reproach might be attached to our present irregular system of inspection. Animals considered likely to be seized in an efficiently inspected abattoir are sent to the many places where the inspection is performed by retired stone-masons, plumbers, and others of the same class. The prohibition against eating the caul fat and that of the kidney seems to have originated from similar ideas. We pour out the blood now, because bled meat keeps better and is less repulsive. The carcases of animals which have been trampled to death (suffocated) by others in railway trucks—these carcases come too frequently into our abattoirs—are seized, because they are considered unmarketable.

Curious ideas concerning the toxic properties of blood were abroad in ancient times. Psammenites, king of Egypt, came by his death through being forced to drink bull's blood (Herodotus, iii. 15). Themistocles (449 B.C.) is reported to have committed suicide by drinking the blood of a bull. King Midas is said to have had a similar end (Strabo). The idea probably originated in Egypt, where male kine were held sacred. Pliny (23–79 A.D.), quoting from Nicander (185–135 B.C.), prescribes radishes (? cabbage) as an antidote to bull's blood (Pliny, xx. 13); and in xxxi. 47, a combination of nitrum and laser is recommended. In Book xi. 91, he says that bull's blood coagulates and hardens the most speedily of all, and hence it is so particularly deadly when drunk. Again, we are told that bull's blood is reckoned among the poisons, except at Ægira, where the Priestess of the Earth took a draught of bull's blood when about to foretell coming events (xxvii. 41). Here the supernatural connection is still retained. Pliny also tells us that he-goats' blood was used for sharpening instruments; the rust that forms makes them sharper than any file can.

Paulus Ægineta (seventh century A.D., *De Re Medica*, Libra Septem, v. 54, Adams) writes: "If the blood of a newly-killed bull be drunk, it brings on dyspnœa and suffocation, obstructing the passages about the tonsils and the parts concerned in deglutition with violent spasm." I have been told that ladies in South America drink warm defibrinated blood to improve the complexion. Out of curiosity I have myself tasted bull's blood, so I may be considered a living protest against the want of veracity in the statements of the ancients. A good case can be made out even for the view that there was a religious meaning in the injunction against the use of putrefying flesh; but I am quite willing to credit Adam with the ability to appreciate what appealed to him through his senses.

I have often heard it said by irresponsible persons—indeed, the saying is not limited to a small circle—that Jews enjoy to-day a greater freedom than other people from tuberculosis owing to their observance of the laws relating to animal flesh; —some will even assert that the communicability of this disease from animals to human beings was suspected by Moses.

Putting aside altogether the fact that animal flesh is one of the smallest factors in the spread of tuberculosis, the Jews to-day enjoy no such immunity from this plague of civilisation. That they met with tuberculosis in cattle I quite believe, but I do not think that a strong case is made out by those who quote Leviticus xxii. 22 as proving its existence. The verse referred to prohibits offering animals with running sores—running sore is the rendering given in the most recent English translation (The Polychrome Bible, "Leviticus," by the Rev. R. S. Driver, D.D., and the Rev. H. A. White, M.A., 1898). I should prefer to rest my opinion on the fact that the lungs are examined by the Rabbi before the animal is passed as free from blemish.

In the Gemara (fifth century A.D.) there are references to lesions which must have been tuberculous.

Let us return now to the measled pig, for he is the chief witness for the defence.

In warm climates, fresh (*i.e.* not preserved) pork seems often to be the cause of serious internal disturbance of a kind that would be quite intelligible to the most primitive mind,—even children are able to co-relate the sequence of events which follow upon certain repasts. At the present day it is forbidden in some places to slaughter pigs for food during the hot season —for example, in Spain, Greece, Monaco (Morot).

It is unlikely, however, that Moses ever had the opportunity of studying the effects of pork, measled or healthy, on human beings, because the pig is one of the most ancient of the taboos. We gather from the writings of Aristophanes (444–380 B.C.) that measles was known to the Greeks in his time (*The Knights*, Hickie's Aristophanes, vol. i. p. 70: "And, by Jove, we will put a skewer into his mouth in cook's fashion, and then draw out his tongue from within, and examine his inside well and manfully, while he gapes, if it be pimply ").

Herodotus (ii. 38) tells us that at Memphis kine were sacred to Epaphus. The priest pulls out the tongue and examines it to see if it is pure as to the right marks. Herodotus again (iii. 28) tells us that the calf Apis must have on its back the figure of an eagle in white against the black ground of the coat, and on the tongue a black mark in the form of a beetle.

I find in Smith's *Classical Dictionary* that the mark on the tongue is said to be like the insect cantharus. The latter is not the least like measles; besides, it had to be present at birth, and measles is never found then. There are no grounds, therefore, for supposing that Apis was a measled calf.

Tapeworms were known in Hippocrates' time (460 B.C.), probably long before him; but according to Leuckart they were chiefly the variety *T. saginata* (ox infection). Hippocrates, however, states that pork is a healthy and nutritious food (Celsus). Bladder-worms or measles were described by Aristotle (384–327 B.C., Arist. *Hist. Animal.* viii. 21); but it was not until the end of the seventeenth century that their animal nature was suspected (Redi, 1683). Aristotle also mentions flat-worms (*ibid.* v. 17).

The connection between the bladder-worms (measles) and the tæniæ, however, was not thought of until 1760, when Pallas wrote on the subject; and it was only in 1854 that Küchenmeister experimentally established that pork measles (*cysticercus cellulosæ*) was the cause of *tænia solium* in human beings.

The evidence derived from the history of comparative pathology, then, renders it still more doubtful that the Levitical laws had a hygienic origin.

The probable frequency of bladder-worms in the pig would have prevented many of these animals from being regarded as "without blemish." It is difficult to believe, however, that the species was tabooed on this account; for the bovine animal, a species not proscribed, was frequently the host of bladder-worms.

Spencer (*De legibus Judæarum*, cap. xxxi.) discusses the ideas of several ancient writers on this subject. Most of their opinions, however, are purely speculative, and they are not backed up by evidence.

The Koran (Mohammed, 570–632 A.D.) contains many restrictions on the use of animal flesh, which, with a few exceptions, are similar to those imposed by the Jewish doctrines. It is forbidden to eat that which hath died of itself, blood, things strangled, flesh of animals torn by wild beasts, and swine-flesh ; but it was no crime to eat such things in time of famine (Sale's Koran, chap. ii. p. 18, chap. v. p. 73, chap. vi. pp. 90, 100, chap. xvi. p. 205). In chapter vi. pp. 101, 102, the precepts of idolaters regarding certain flesh are condemned. Presumably they were wrong because those who held them were not of the faith. The other restrictions seem to have been founded on ancient prejudice. Certainly no mention is made of a hygienic reason in the Koran.

Let us now examine the evidence furnished by tuberculosis. It was not until 1865 that Villemin demonstrated that tuberculosis of animals and human beings could be transmitted by inoculation. Most of our present knowledge regarding this disease dates from Koch's discovery of the tubercle bacillus in 1882.

Still, tuberculosis in animals killed for human food engrossed the attention of hygienists in Europe in the eleventh century, as it does to-day.

The laws of the Church in the Frankonian part of Germany then forbade the use of flesh from tuberculous (?) oxen (Friedberger and Fröhner ; Fr. trans. Cadiot and Ries).

In 1363, letters patent of King John of France decreed against the use of tuberculous flesh (Morot, quoted by Moreau).

At Munich, in 1370, the sale of the flesh from tuberculous animals was forbidden ; other German towns followed the example of Munich (Friedberger and Fröhner, *op. cit.*).

The seventeenth century was marked in the various parts of Germany by the alternate enactment and abrogation of laws regarding the use of flesh from tuberculous animals.

In the early part of the century a relation was traced between tubercle and syphilis, and this led to a wholesale destruction of tuberculous carcases. In 1783, however, the Sanitary College of Berlin denied the supposed relationship, with the result that the embargo was removed. During this controversy on sanitary politics, Dr. Zweirlein publicly drank in the market-place of Brückenau a broth made of tuberculous material. I do not know if Zweirlein developed tuberculosis, —possibly he did not; but I know of a good many animals which have come by their death in this way, and it is beyond dispute that many human beings have died from ingestion of tubercle-infected material.

The Fifth International Congress of Veterinarians, held at Paris in 1889, voted almost unanimously for the total seizure of tuberculous flesh. The Sixth Congress, 1896, was much more moderate in its finding. To-day nobody denies the possibility of human beings contracting tuberculosis by eating infected material. The question is, under what circumstances is the flesh of a tuberculous animal likely to contain tubercle bacilli?

We know this pretty well now, but many municipal communities still prefer either to do without inspection or to condemn large quantities of harmless flesh rather than appoint an efficiently qualified Meat Inspector. I am of opinion that a code of laws dealing with this subject is necessary. I do not think it possible, however, to devise a workable code, unless it be on the most general lines. Such a one would fulfil all requirements if there were scientifically trained inspectors to interpret it. I hold that the veterinary surgeon is from his education the only one who at present is capable of doing this with equal justice to the butcher and to the public.

The Corporation of Edinburgh has reason to be proud of the part it has taken in the advancement of meat inspection. Not only has it acted as the guardian of a veterinary school, but it was the first municipal body to organise a qualified staff of Meat Inspectors, and it has been able to supply them to other towns, which are beginning to see the wisdom of appointing suitably educated officers.

The report of the Tuberculosis Commission (1898) says: "We may add that in the Edinburgh Public Slaughter House we witnessed meat inspection carried on more nearly on the enlightened system of the best continental abattoirs than it was our fortune to see in any other part of the United Kingdom. Here there are six Meat Inspectors, of whom four are veterinary surgeons, one has been a butcher, and one a cattle-salesman. We were very favourably impressed with the organisation, though the standard by which the meat of tuberculous carcases was judged appeared to us unnecessarily severe" (*Report*, p. 7, sec. 21).

I would like here to state that the present condition of things in Edinburgh is largely due to the advice given to the Corporation by the late Professor Walley, Principal of the Dick College.

Still, there is room for improvement. The booth system —the one in use in Edinburgh—is inferior to the central hall system; but, of course, this could not be changed unless new premises were being constructed. The inspectors, however, might be provided with a properly equipped laboratory in which to make their more particular examinations,—this could be done at very little expense; but no abattoir in this country is properly equipped for the purposes of meat inspection.

The importance of the microscope in meat inspection is too evident to require explanation, but it is worse than useless in the hands of the untrained.

The development of our use of salt with meat is intimately connected with that of man's civilisation and the evolution of his carnivorous habits. Purely carnivorous animals and men display no desire for sodium chloride, but as the wandering tribes began to settle on the soil, and eat vegetables, the desire for salt came. They even added it to their cereal offerings

(Leviticus). Bunge (*Physiological and Pathological Chemistry*, Lect. vii.) traces this desire to the amount of potassium swallowed by eaters of vegetables. Potassium, he says, causes the excretion of sodium chloride. According to Bunge, then, the craving for salt is a request by the tissues that this loss should be made good. Quoting Ditmar, he describes how the Russian Government failed to get the Kamtschadales to use salted instead of rotten fish from their silo pits. The Kamtschadales are ichthyophagous, and they positively loathe salt. The primitive vegetarian races, on the contrary, crave for sodium chloride. Mungo Park stated that the negroes on the coast of Sierra Leone would barter their wives for it (Bunge, *op. cit.*).

The question of our right to kill and eat animals is one of great antiquity. Even to-day the right is not unanimously admitted. We see the contrary view in the ancient idea of the "Golden Age," and at present it appears in a few conscientious abstainers from flesh.

At the Diipolia, when an ox was slain, the participators were tried for the offence. The blame was shifted on to the man who used the knife, but ultimately it was settled on the weapon, which was cast into the sea as a murderer. To-day, the doubting flesh-eaters quote Genesis i. 28 in justification of their act.

Personally, I eat meat twice daily, and I believe that the future is for the flesh-eating nations; but I strongly think that a great deal could and should be done to render the killing more humane. Every animal, large or small, should be stunned before being bled. I do not think that a desire for a small additional degree of lighter tint in the flesh is a sufficient reason for making an animal suffer great pain, nor do I admit that preliminary stunning makes any material difference in the amount of blood which can be extracted from the body. I have no intention of rousing public indignation by harrowing details, for I believe the object can be gained by a simple mention to the right authorities. I am aware, too, that many butchers pay due regard to the sensory nerves of the victims of slaughter; but I hold that in every abattoir the most humane method of slaughter ought to be enforced.

## STATUTORY PROVISIONS IN REGARD TO THE DUTIES OF MEAT INSPECTORS

It is a crime or misdemeanour knowingly to sell for human consumption meat which is unfit for that purpose; and if such a sale be made, and death ensue from partaking of the meat, the seller can be indicted for manslaughter. The statutory enactments have for their object the protection of the public by the detection and prevention of this crime. Unfortunately the regulations are not in identical terms for all parts of Great Britain and Ireland. There are separate general Statutes for each of the three kingdoms, and one for the Metropolis of London; but, besides, there exist many local Acts, the provisions of which are to be read as additional to the enactments in the general Acts. The medical officer of health, and the sanitary inspector or inspector of nuisances, in the exercise of the duties laid on them by these Acts, are under the supervision of the Local Government Boards of the respective countries, who have issued rules for their guidance.

The provisions of the Statute law with respect to meat inspection which apply to England and Wales, outside the administrative county of London, are contained in secs. 116–119 of the Public Health Act of 1875, and in certain sections of other Acts which are incorporated with it; and for Ireland, in secs. 132–135 of the Public Health (Ireland) Act, 1878. The provisions in both these Acts relating to the duties of meat inspectors are in similar terms. They empower any medical officer of health, or inspector of nuisances, at all reasonable times (even on Sundays) to inspect and examine any animal, carcase, meat, poultry, game, flesh, or fish exposed for sale, or deposited in any place for the purpose of sale, or of preparation for sale, and intended for the food of man,—the proof that the same was not exposed or deposited for any such purpose, or was not intended for the food of man, resting with the party charged; and if any such animal, carcase, meat, poultry, game, flesh, or fish appears to such medical officer or inspector to be diseased or unsound or unwholesome or unfit for the use of man, he may seize and carry away the same himself or by an assistant, in order to have the same dealt with by a justice, who may condemn it and order it to be destroyed. For the purpose of this inspection, power is given to the inspector of nuisances, the officer of health, or any other officer appointed for that purpose, in all *urban* districts, and in all *rural* districts to which the provision may be extended by the Local Government Board, at all reasonable times, with or without assistants, to enter into and inspect any building or place whatsoever used for the sale of butcher's meat, or for slaughtering cattle; and when the building in which the diseased animal or meat is believed to be kept is not such a place, a warrant may be granted by any justice to any such officer on complaint made by him on oath.

On the condemnation of the diseased animal or meat, proceedings may be taken against the person to whom the same belongs or did belong at the time of exposure for sale, or in whose possession or on whose premises the same was found, and he may be punished by fine or imprisonment. Any person obstructing an officer in the execution of his duty is liable to punishment.

The provisions of the Public Health (London) Act, 1891, which apply to the administrative county of London, are similar to those of the Act of 1875, with the undernoted exceptions. The medical officer or sanitary inspector may *without* a warrant enter any premises for the purposes of his inspection. Before proceedings can be taken against a party in England outside London, there must have been *exposure for sale* at the time of the seizure; but in London that is not necessary. In either case it has been decided by the Courts of law that personal knowledge of the party charged is not an element in the offence. Provision is also made for the punishment of sellers or consignors of diseased meat, when the same is seized in the hands of another party. The Statute also provides for affixing to the premises occupied by any person who has been convicted twice within twelve months of knowingly and wilfully committing an offence, a notice of such convictions.

The Public Health (Scotland), Act, 1897, contains the provisions relating to meat inspection for Scotland. The provisions offer considerable points of variance from the English enactments. It is provided that the medical officer or sanitary inspector, or *a veterinary surgeon approved for the purposes of the Act*, may at all reasonable times enter any premises within the district of the Local Authority (whether, it will be observed, they are premises for the sale of meat or a slaughter-house or not), or search any cart or vehicle, or any barrow, basket, sack, bag, or parcel, in order to inspect and examine, and may inspect and examine, any animal, alive or dead, or any article intended for the food of man which is exposed for sale, or deposited in any place, or is in course of transmission, for the purpose of sale or of preparation for sale, —the proof that the same was not exposed, etc., resting with the person charged; and he may seize and carry away the same in order to have it dealt with by a sheriff, magistrate, or justice. It is further provided that in the case of a living animal, the medical officer or sanitary inspector, unless he is himself a qualified veterinary surgeon, shall be accompanied by a veterinary surgeon approved as above mentioned. The police force have power to assist generally in executing and enforcing these enactments. If it appears to the magistrate that any animal which has been seized, or is liable to be seized, is diseased or unsound or unfit for the food of man, he shall condemn the same, and order it to be destroyed or so disposed of as to prevent it from being exposed for sale or used for the food of man.

It is further provided that the person to whom the animal belongs or did belong at the time of the sale, or exposure, or deposit, or transmission for the purpose of sale, or of preparation for sale, or in whose possession or on whose premises the same was found, shall be liable to a penalty, unless he proves that he and any person acting on his behalf did not know, and could not with reasonable care have known, that it was in such a condition. If the Court finds that a person knowingly and wilfully committed the offence, he is liable to imprisonment. There is a further provision that if such person proves that the animal or part thereof so condemned was, within a reasonable time prior to the seizure thereof, examined upon the premises where the animal was slaughtered, and passed by a veterinary surgeon approved as above provided, called in for the purpose, and who shall have granted a certificate in the terms provided in the Statute, he shall be exempt from penalty or imprisonment for the offence. To facilitate the obtaining of such a certificate from a veterinary surgeon, Local Authorities may appoint a place and time at which a veterinary surgeon shall attend for the purpose of examining any animal, alive or dead, and issue a certificate passing or condemning it in whole or in part. If the certificate is a certificate passing the animal, it shall set forth the name of the owner, the date and hour of examination, and such further particulars as the Local Authority may prescribe for the identification of the animal. A copy of any certificate shall forthwith be sent by the veterinary surgeon to the chief constable of the jurisdiction in which the examination took place, and the certificate itself shall be sent by the person selling the animal or carcase immediately after the sale, and not more than seven days from the date of the certificate, to the chief constable of the jurisdiction in which the sale of the animal or carcase took place. There is a penalty on a veterinary surgeon or any person contravening these enactments.

The Scotch Act also enacts that no carcase shall be submitted for examination unless as a whole carcase, including the thoracic and abdominal viscera, in such a manner that the examiner shall be readily able to satisfy himself that the organs are those of the carcase under inspection. As in the

London Act, provisions are made for the punishment of sellers or consignors of diseased meat seized in another party's hands, and for affixing to the premises of any person who has been convicted twice within twelve months of a notice of such convictions. Penalties are also imposed upon any person obstructing a medical officer, sanitary inspector, or veterinary surgeon in the performance of his duty.

It may be here observed that it is generally admitted that none of the Acts authorise the inspector to make any incision on any animal, carcase, or meat, without the permission of the owner.

With the exception of the provisions in the Scotch Act with regard to the veterinary surgeon, no special qualifications are required in persons employed as Meat Inspectors by the public health authorities.

It is well to mention here that, from the evidence laid before the Royal Commission on Tuberculosis of 1896, it appears that the great majority of diseased carcases, etc., are destroyed by voluntary arrangement between the inspector and the butcher, without the intervention of a magistrate.

There only remains to be noted the provisions of the Sale of Horse Flesh, etc., Regulation Act, 1889. It applies to the three kingdoms, and provides that all shops selling the flesh of horses, asses, or mules shall have an intimation to that effect affixed to them, and such flesh shall not be sold as other meat. Moreover, the medical officer, or other officer under direction of the Local Authority, may inspect any meat suspected to be the flesh of horses, asses, or mules which is exposed for sale as human food in any place other than such shop; and if it appears to be the flesh of any of these animals, he may seize it in order to have it dealt with by a justice or the sheriff. A warrant to enter any building other than such shop to search for meat suspected to be horse flesh illegally concealed, may be granted by a justice on sworn complaint by the medical officer or other officer; and the obstruction of such officer is created an offence.

# METHOD OF INSPECTION

It is advisable that animals intended for human food should be subjected to a veterinary inspection before slaughter. This method of procedure has many advantages. It would render possible the exclusion from the market of the carcases of animals which have been slaughtered on account of a disease which might render the flesh injurious without producing obvious alterations.

It would also enable the inspector to pass certain carcases which, in the absence of information concerning the condition of the animal during life, he might feel compelled to condemn in order to give the benefit of the doubt to the consumer. Further, the veterinary inspector would frequently be able to advise the proprietor against having his animal slaughtered when suffering from some transient affection which would almost certainly entail seizure of the carcase. In making an examination of a live animal, its temperature should be taken, and if symptoms pointing to disease of any special organ be observed, that organ should receive the special attention of the inspector after slaughter.

In large abattoirs it is only possible to carry on an adequate post-mortem inspection where the central hall arrangement is in use. Where slaughtering is carried on in several booths at the same time, it is obvious than an impossible number of inspectors would be necessary in order to see each carcase before the butcher has had time to remove diseased portions or to substitute the organs of one animal for another. The veterinary inspectors may have a corps of unqualified assistants who have received a training in the recognition of diseased organs. These assistants will be able to draw his attention to departure from the normal, but they should not be allowed to condemn or pass abnormal flesh and organs.

When the post-mortem inspection is being carried on, as it should be, during the process of dressing, the inspector is almost bound to examine the organs in the order they are exposed by the butcher. He will first obtain a view of the subcutaneous tissues, and the superficially placed organs, like the udder, during the skinning process; but while the animal is being bled he may make an examination of the feet. He will next see the peritoneum, the stomachs, the intestines, and the spleen as the abdomen is cut open. The pelvic viscera can be best examined after removal, but a preliminary examination may be made while the intestines are being removed. The lymphatic glands attached to all the organs should receive particular attention. The liver can also be examined at this stage; but a better view can be obtained of the organ after its removal from the body. This is done after the intestines have been cut out and the skinning process completed. As a carcase is being elevated at the posterior end, the chest is opened. The thoracic organs should be first examined *in situ*, as abnormal adhesions may be present. The examination of the head and the organs attached to it may be left to the last. When the nature of a lesion in any organ is not apparent to the naked eye, portions should be removed for a further examination in the laboratory, which should be attached to every abattoir. In this case, both the organs and the carcase from which they have been removed should be carefully marked, otherwise confusion is likely to occur.

After the carcase is dressed, the condition of the pleura and peritoneum may be further examined. The kidneys can also be examined when the carcase is hung up. The superficially placed glands, such as the prepectoral, lumbar, suprasternal, and supramammary, if present, should be incised.

The colour and condition of the flesh should be noted at those parts where the muscular tissue has been exposed. The bones of the vertebral column should also be examined. The condition of the flesh itself can hardly be judged until about twelve hours have elapsed since slaughter; but if the inspector is doubtful about how the carcase will turn out, he should detain it for further inspection. A proper opinion of the flesh can only be formed from the examination of a freshly cut surface. The superficial layers, which have been exposed to air, may be of a rosy colour, although the flesh beneath is very dark and repulsive in appearance.

It often happens that a carcase which the butcher expects to be condemned is carelessly dressed.

The condition of the carcase in fat should also be observed. The flesh of emaciated animals is likely to be tough, fibrous, and flavourless. It is likely to be innutritious, but the degree of emaciation which calls for seizure is difficult to lay down.

When a carcase is sent into the abattoir after being dressed, the inspector has less chance of finding traces of disease. He should make a particularly careful examination of the serous membranes and lymphatic glands. If the pleura has been stripped and the glands of the chest region removed, the carcase should be condemned. A carcase should not be mutilated without the consent of the inspector. In stripped carcases one will often find tubercle in the prepectoral glands. It is advisable that when a carcase is sent in dressed the organs, with the exception of the bowels, should accompany it. It would be difficult to manage this, however, in the case of dead meat imported from abroad, for healthy organs could always be substituted for diseased ones; and it would, of course, be impossible to leave the most important organs *in situ*. It is hardly possible to subject imported meat to an adequate inspection, but it might be made a condition that such meat should be accompanied by reliable evidence that it had been passed by responsible inspectors appointed by the Government of the exporting country.

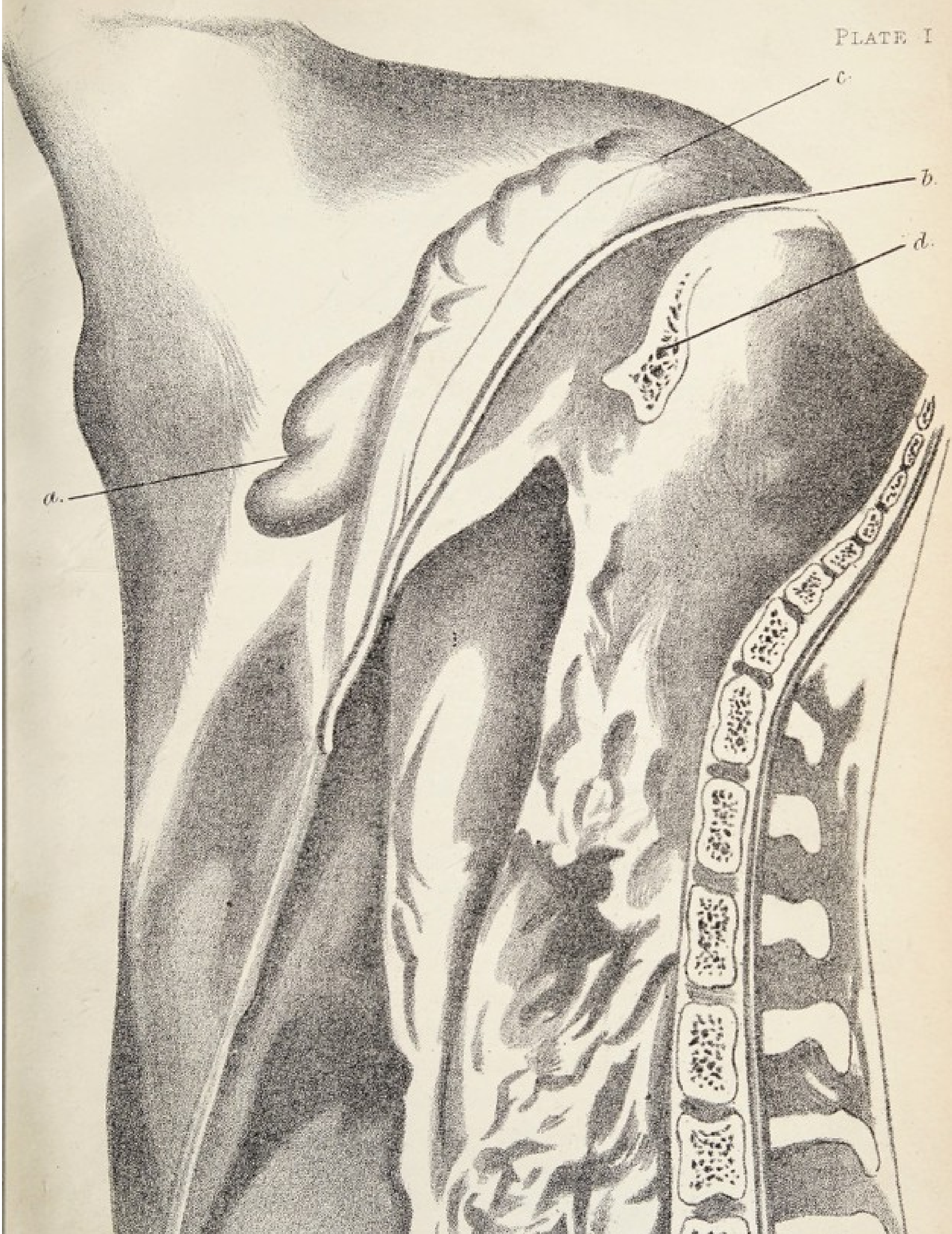
The skinning process is sometimes performed in calves by blowing air under the skin through a small puncture. The hole is closed and the inflated part is struck with the hand in order to drive the gas along under the skin. The subcutaneous tissues are generally emphysematous when this method of skinning has been practised. The butcher should not be allowed to inflate the skin from his lungs, but there is no reason why an insufflator should not be used.

The knives which have been used to dress the carcase of an animal suffering from a contagious disease should be sterilised before being employed again ; it should be the duty of the inspector to see to this. It is very necessary in the case of a knife employed to cut out tuberculous organs from a carcase which is likely to be passed. This knife should on no account be used on other parts of the carcase. The best method of sterilising instruments is to boil them in water, and arrangements for doing this should be at hand in the slaughtering hall.

*Frozen meat* has usually a diffusely red colour when thawed, owing to the hæmoglobin being dissolved in the fluids and permeating the tissues. This is especially the case when the thawing process has been conducted too rapidly. When a joint has been frozen and thawed several times, as may happen with unsold meat in a butcher's shop, one often finds that the flesh shows gelatinous-looking areas.

*Chilled meat* (*i.e.* meat kept at a few degrees above freezing-point) has also a bright red colour. The tissues are less altered than when they have been actually frozen.

*Salted* or *pickled meat* should also be carefully inspected. When the process has been improperly carried out the flesh may decompose. It becomes moist, slimy, and mouldy on the surface. A steel trocar or tryer may be inserted into the substance of the flesh, and examined for traces of a putrefactive odour on withdrawal. If the inspector has good reason to suspect that the preserved meat is decomposing he should cut into the deeper layers around the bone, for it is




Hind Quarter of Bullock.

*a.* Scrotal fat.
*b.* Penis.
*c.* Retractor muscle of Penis.
*d.* Pelvic bone.

there that the best evidence can usually be obtained. The meat which has been salted has sometimes been bad from the first. Flesh preserved by such chemical agents as boracic and salicylic acids should not be allowed into the market, as these agents may have an injurious action on human beings.

### DIFFERENCES IN CARCASES, FLESH, AND ORGANS REFERABLE TO SPECIES, SEX, AND AGE

It is possible to tell a good deal about species, sex, and age by an examination of the dressed carcase. The student of comparative anatomy will have little difficulty in determining the species and sex when dealing with an entire carcase.

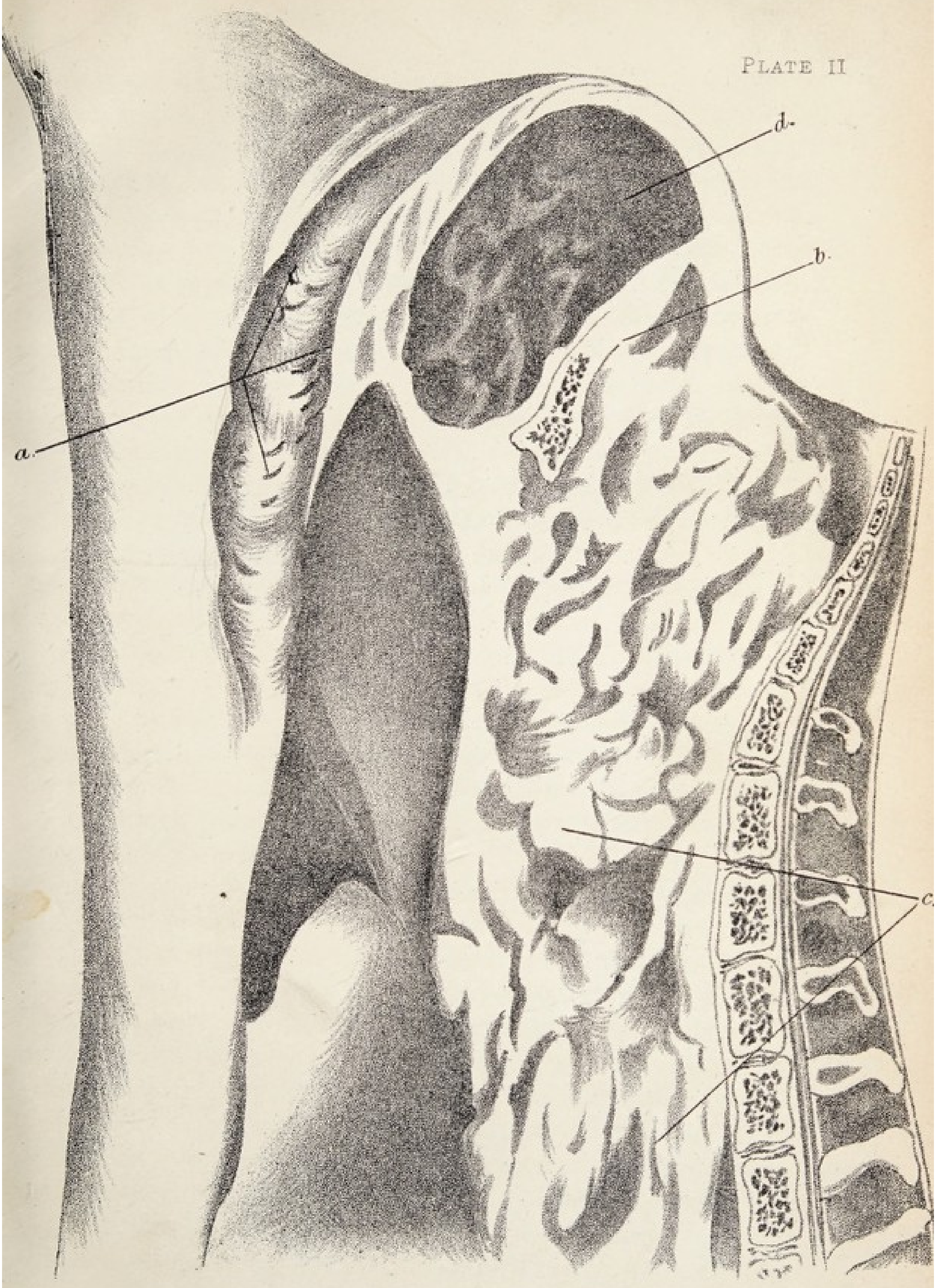
His task, however, will be more difficult when the carcase has been cut up for the market, for it must be remembered that a minute examination of the bones will not always be possible. The question of age is, of course, best settled by an examination of the teeth.

In the absence of the head, however, one can form an approximate idea of the age from the condition of the bones and flesh.

*The carcases of bovine animals.*—The carcase of the bull shows great muscular development in the regions of the shoulders, the neck, and the hind quarters. The neck is thicker than that of the ox, the heifer, or the cow. When one looks at the posterior surface of the dressed carcase, one sees at the junction of the neck and back a figure resembling the head of Napoleon. This appearance is due to the marked development of the panniculus muscle, and it is just as well seen in the bullock. The penis is seen on the left side of the abdomen, or if the organ has been removed a furrow is left. The retractor penis muscle is well developed, and the erector penis is exceedingly prominent. The joints are larger than in the female. The anterior part of the ischio-pubic symphysis is very well developed. It forms a distinct tubercle. The line of the symphysis is distinctly curved, and at its posterior part it forms an acute angle with the line of adipose tissue which runs round the inner aspect of the thigh (Plate I.). In the bullock the quarters are not so well developed. They are less rotund. The penis and the retractor muscle are less prominent than in the bull, and the erector muscles are atrophied. The anterior tubercle of the pubis is smaller than in the bull. The scrotal fat is distinctly prominent and nodulated.

In the female the quarters are still less rotund than in the bullock. In the cow the posterior line of the hind quarters is usually concave, the subcutaneous covering of adipose tissue is poorly developed, and the angles of the haunch are prominent. In young fat cows, however, the muscular development may be equal to that of the heifer. The female pelvis is broader than that of the male, but the anterior tubercle of the pubis is poorly developed. The floor of the pelvis is less curved than in the male, and the internal fat of the thigh is in a sense concentric with it (Fig. 1). In the female the udder is present, or the marks of it are left when it has been removed. These marks in the cow extend from the inguinal region to a considerable distance along the abdominal wall. They are triangular in shape, with the apex directed forward. The fat at the base of the udder is often fairly well developed, and the supramammary lymphatic glands are large. In the heifer the mammary gland is poorly developed. It is surrounded by a layer of fat, and the gland tissue is whiter in colour than that of the cow.

In animals of the bovine species the bones of the lower row of the carpus are two in number. In young animals the cartilages covering the articular surfaces are blue or rosy, but as the animal advances in years the colour becomes white. Up to the age of three years it is possible to cut through the ischio-pubic symphysis with a knife. After three years the junctional cartilage becomes osseous. Up to the age of four years the costal cartilage at the ninth rib can be cut through with comparative ease. At the age of five this is difficult,




Hind Quarter of Heifer.

*a.* Udder, very small, surrounded by fat.
*b.* Section through pelvic bone.
*c. c.* Sacro-lumbar (or kidney) fat—kidney removed.
*d.* Sections through muscles of haunch.

and at six it is almost impossible to sever them with a knife. According to the observations of Bunge, the line of junction between the superior spines of the dorsal vertebræ and their summits is cartilaginous up to the sixth year. A very thin line of cartilage may even persist up to the eighth year in the first four or five vertebræ. From the sixth year to about the twelfth the separation is marked by a red line, but after this all trace of a separating line has disappeared. These changes in the bones, however, are greatly influenced by the breed and the feeding. As a general rule, the osseous tissue of the bodies of the vertebræ becomes denser with age, and the intervertebral discs get thinner.

The left kidney of the ox is floating, the right is fixed.

*The carcase of the horse.* — There is little chance of a horse's carcase being mistaken for that of an ox. The neck of the horse is longer, and the bodies of the cervical vertebræ are more elongated.

The bones of the horse's limbs are longer than those of the ox, and the lower row of the carpus is made up of three or may be four bones. The sternum is cariniform, and the line of the ischio-pubic symphysis is almost straight. Moreover, the horse has eighteen pairs of ribs, while the ox has only thirteen pairs. The ribs of the horse are much narrower than those of the ox.

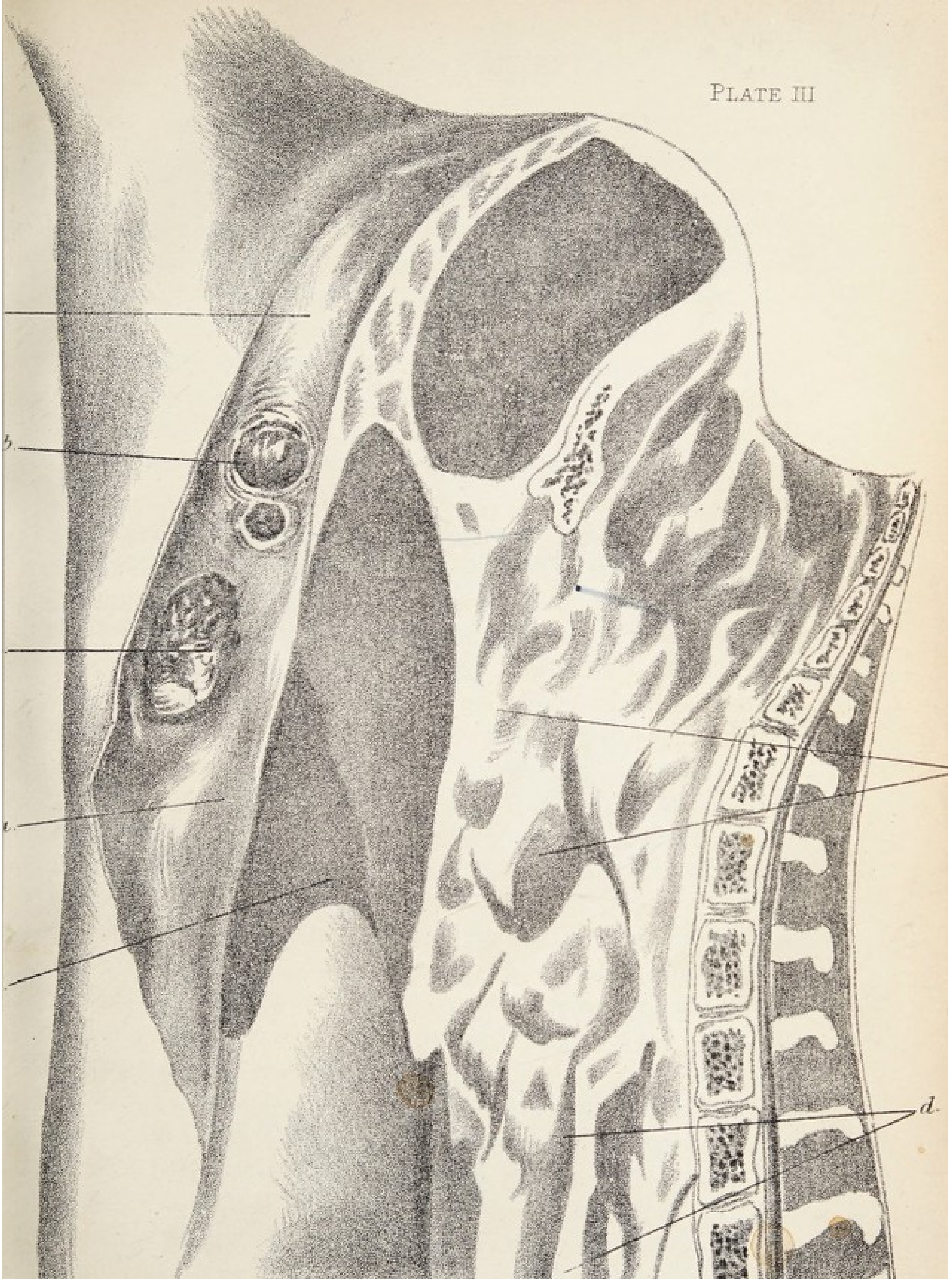
*The carcases of the sheep and goat.*—The carcase of the sheep is only likely to be mistaken for that of the goat. Both have thirteen ribs. In fat sheep the external covering of adipose tissue is well developed; in the goat it is practically absent. The neck, body, and quarters of the goat are longer than those of the sheep. The carcase of the former might be described as being long and lean. Moreover, the transverse lumbar process of the goat is curved in a downward direction.

*The carcase of the pig* usually has the head attached, and its characters are so distinctive that no mistake should arise. The pig has fourteen ribs. The neck is very short. In the dressing process the skin of the pig is not removed: the carcase is scalded and scraped. The subcutaneous fat is very white and soft, but it is only seen where the abdomen is cut open, unless an incision be made into the other parts.

*The muscular tissue in the healthy ox* should be of a florid hue in adult animals; it is brighter in young animals up to about eighteen months old, and darker in hue after the age of six. In certain positions—the limbs, for example—the flesh should be almost free from intermixture with fat; in others its connective tissues should be so infiltrated or intermixed with that substance as to give it a distinctly mottled or marbled appearance on section. This appearance is very well seen in the longissimus dorsi between the sixth and eighth ribs. The flesh should be of firm or slightly elastic consistence, tolerably dry after being exposed for a short time to the atmosphere, and *rigor mortis* (death stiffening) should be marked,—in other words, the carcase should "set" or "firm." Immediately after slaughter the flesh is brownish red and flabby. It sets in about twelve hours. It should possess a pleasant, sweet aroma, and should exhale, when exposed to the action of heat, a savoury odour. The graining of the muscles on transverse section should be fine. It is coarser in the muscles of the neck and sternum than elsewhere. In old cows, but more especially in the bull, the flesh is stringy and darker in colour. *Bull flesh* has an odour *sui generis.*

The flesh of the calf is always pale red in colour, and not very firm in consistence. The fat resembles tallow. The colour of the flesh will depend largely upon whether the animal has or has not been bled prior to slaughter, but the custom now is to bleed calves. In the *newly born or unborn calf—slink veal* of the butchers—the flesh has a watery, gelatinous appearance, and the fat resembles tallow which has been macerated for some time in water. The lungs of a still-born calf are collapsed. Calf flesh possesses a distinctive odour. While it is, by some manufacturers, largely substituted for chicken in the manufacture of ham, chicken, and tongue, other substitutions for veal are rarely practised. It is as well,

PLATE III




Hind Quarter of Cow.

*a a.* Site of udder—removed.
*b. b.* Deep inguinal or mammary lymphatic glands.
*c.* Site of sacro-lumbar group of glands.
*d.* Site of lumbar (kidney) group of glands.
*e.* Spot opposite to which (on the outside of the flank) the superficial flank group of glands are situated.

however, to note that the flesh of a large dog has a close resemblance to that of the young calf, and when the head, with the legs as far up as the knees and hocks, have been removed, the one carcase may be easily mistaken for the other. In the calf the joints are much larger than in the dog; and the carcase of the dog always exhales a distinctively *canine odour*.

The flesh of very young animals has a laxative effect on human beings. It should not be allowed into the market. Few calves, however, come into the abattoir for slaughter before the age of five weeks. The flesh of calves soon becomes sour.

The fat of bovine animals varies in colour from white to straw-colour and yellow. It is whiter in colour usually in young bulls, and in animals fed on corn or grass, than in bullocks or cows, or in animals fed on rich cakes, in which it is sometimes of a tolerably deep yellow, as it is in certain breeds of cattle, *e.g.* the Jerseys and Guernseys. In cooking, a loss of from 20 to 30 per cent. takes place in the case of yellow fat; consequently (according to Capt. Stacpole) officers charged with the duty of purchasing fresh meat for the army are directed to avoid it when the flesh is markedly yellow. It should be firm, have a suety taste, and a slightly greasy feel.

The connective tissue should glisten on exposure, and be tolerably moist, but there should be no draining of water from its meshes. It is most abundant in parts where the skin is loosely attached, *e.g.* the flanks, under the shoulder, the abdomen, and at the breast or brisket.

*The muscular tissue of the horse* is much darker in colour than is that of the ox. It is coarser in texture, and its odour is less pleasant. The flesh of the ass and mule is more finely grained than that of the horse. The fat is always of a yellowish colour, softer than is that of the ox, and it has a rather unpleasant, sickly taste. This want of consistence is due probably to the fact that it contains a large proportion of olein. After the lapse of a few days—the length of time depending upon the amount of watery vapour in the atmosphere and the condition of the animal when slaughtered—horse flesh contracts a peculiar sickly odour, and it sticks to the fingers.

When the operation of "boning" has not been performed, there should be little difficulty in distinguishing between a joint cut from the carcase of an ox and one from that of the horse. The bones of the horse are, relatively, much larger than are those of the ox. They contain more fatty matter, which is of a semi-fluid consistence. The processes usually situated at the extremities (the epiphyses and the apophyses) are better developed and more numerous, and those bones which are indirectly connected with the skeleton, the floating bones, as the cap of the stifle (patella), are much more pronounced in form and size. The ulna (or elbow bone) of the ox is much larger than is that of the horse—it articulates, in fact, with one of the bones of the knee (the cuneiform); but the corresponding bones of the hind leg (the fibulæ), as also the splint bones of both fore and hind legs, are usually absent in the ox, or, if present, are rudimentary.

The flesh of the horse contains a larger amount of glycogen than that of other animals, and the presence of this substance is a means of identifying horse flesh. Hasterlik and Niebel have described a method of estimating the amount of glycogen in flesh. Trotter, employing the method followed by Niebel, found that the amount of glycogen present in the flesh of oxen and sheep was nil. In that of the pig it varied from 0 to ·26 per cent. In various samples of horse flesh the amount of glycogen was from ·9 to 1·85 per cent. For the estimation of glycogen the method recommended by Pflüger may be employed. It is as follows:—The tissue is extracted with an alkaline solution containing about 3 per cent. KHO. To this 10 grms. of KI per 100 c.c. are added. This keeps the proteids in solution when the glycogen is precipitated by the addition of ½ to 2 vols. of 96 per cent. alcohol. After precipitation the mixture is filtered, and the glycogen is retained by the filter paper, the weight of which is known. The precipitate is washed with the following solution: KHO – 3 grms., KI – 10 grms., Water – 100 c.c. Free KHO to between ·4 and 2 per cent. (over and above that combined with the proteid) must be present. The precipitate (glycogen) is next washed with 50 per cent. alcohol, then with pure alcohol. Finally, the paper with its contents is dried in an oven until the weight is constant. The difference between the original dry weight of the filter paper and that of the dried paper and precipitate represents glycogen.

A less exact but simpler test for glycogen in flesh is that introduced by Brautigam and Edelmann, which has been further simplified by Courtoy and Coremans.

Fifty grammes of minced flesh are boiled in 200 grammes of water for from fifteen to thirty minutes. After cooling, the broth is filtered. A portion of this fluid is put into a test-tube, and a few drops of the following solution are slowly added: iodine, 2 parts; iodide of potassium, 4 parts; water, 100 parts. The tube should be held up to the light when the first drops are added, and a faint tinge of violet will be seen in the broth if glycogen be present.

Courtoy and Coremans say that if the broth does not become of a distinct brown colour the flesh under examination is not horse flesh. The brown colour should disappear when the broth is heated to 80° C., and reappear on cooling.

When the colour taken is a deep violet, starch is present. In such a case they advise the addition of twice its volume of acetic acid to the broth before testing. They also say that glycogen is absent from the masseter muscles of the horse.

When the flesh of one animal has been substituted for that of another, in such materials as mince and sausage, the fraud may be detected by what is termed the precipitin tests. This depends upon the fact that when muscle juice is repeatedly injected into an animal of a different species a substance (precipitin) is formed in the blood of the animal so treated which will cause a perceptible precipitate in a solution of that particular muscle juice. As applied to the detection of horse flesh the procedure is as follows :—With intervals of a few days expressed sterile juice from horse flesh is injected under the skin or into the peritoneum of a rabbit. After two or three weeks of such treatment the rabbit is bled, and the blood serum is collected in a sterile condition and preserved in the dark, ready for use. When the occasion arises, the suspected flesh has some of its juice extracted with water, and the solution is filtered until it is perfectly limpid and transparent. To a portion of this solution in the test-tube a small quantity of the specific rabbit serum is added. The formation of a precipitate or haziness in the mixture indicates that the suspected meat actually contained horse flesh.

In a similar manner sera which contain specific precipitins for the flesh of other animals may be obtained. Needless to say, the method is not one which the ordinary Meat Inspector can be expected to employ.

The organs of the horse most largely substituted for the edible organs of the ox are *the tongue*, *the heart*, and *the liver.*

*The tongue of the horse* is broad at its free extremity, while that of the ox is pointed, and in the latter its upper surface is rough and bristly, owing to the large filiform papillæ. The circumvallate papillæ are more numerous in the tongue of the ox than in that of the horse. In that of the former animal they are arranged in two rows. If, as frequently happens, the bone of the tongue (the *os hyoides*) has been left *in situ*, it will be found that while in the ox it is composed of nine segments or parts, there are only five in the horse ; that the body of the bone is of an angular shape in the ox, and its spur process is short and conical. The epiglottis (a cartilage frequently left on the tongue) is, in the horse, thinner and more pointed than in the ox.

*The heart of the ox* is more pointed (conical) than that of the horse, and the fat in the furrows on the external surface is usually in greater quantity, whiter in colour, and firmer in texture ; moreover, at the base of the former, there exists a bone (the *os cordis*) which is not found in the latter.

*The livers of the ox and sheep.*—They are made up of a continuous mass or lobe, with one small lobe at the upper and posterior part, while in the horse there are three distinct lobes —the right, left, and middle—with a supernumerary lobe. In the former animals a *gall bladder* is attached to the posterior surface; in the horse it is absent. *The liver of the pig* has five lobes, and the lobules are distinctly mapped out on its surface, while in the *dog* this organ is made up of two lobules—right and left.

*The kidneys of the ox and the calf* are lobulated—*i.e.* separated into lobes or divisions—and elongated; those of the dog, the pig, and the sheep are simple and oblong in shape. While the left kidney of the horse is oblong, the right is heart-shaped. *The kidney of the pig* is flatter on its surfaces than is that of any other animal.

*The flesh of the sheep* is of a less florid hue and finer in the grain than is that of the ox, but in the old ram it is often of a tolerably pronounced colour, and very tough. Even between the flesh of the old ewe or wether and that of the young animal there is a marked contrast in this respect. The fat is always very firm (suety) and white in colour, and both flesh and fat exhale a more distinctive odour than that given off from the carcase of the ox. The fat, too, is more evenly distributed over the back and sides of the carcase, and the muscular tissue is seldom found to be marbled with fat, except in the longissimus dorsi.

Occasionally the flesh of the sheep is tainted with the flavour of wool. This, it has been variously explained, is due to the skin being left on the back of the carcase for some time after death; to the carcase being enveloped in the skin; and to the intestines and stomach being allowed to remain for too long a time in the abdomen.

*The flesh of the goat* is, in adult animals, much darker in colour than is that of the sheep, and the fat is less abundant; but, although the fat on the body is small in quantity, there may be equally as much fat on the loins in the former as in the latter. When newly dressed, and when subjected to the action of heat, the flesh of the goat gives off a distinct "goaty" odour; it has also a "goaty" flavour. The marbled appearance is not seen in the flesh of goats.

The substitution of the flesh of the goat for that of the sheep, or of the kid for that of the lamb, is a matter of much less importance than are some of the substitutions carried out as between other animals.

*The flesh of the pig* is, in young animals, pale in colour, and even in adults it is of a comparatively lighter hue than that of either the ox or the sheep. It is also less firm to the touch; the fat is more unctuous to the feel. It forms a deep smooth layer all round the kidneys and under the skin of the back and sides—the latter constituting the "panniculus adiposus" of the comparative anatomist. A slight odour is always detectable, and this becomes very pronounced in *old boars,* as does also the "brawny taste." Both the odour and taste are retained—the former, in fact, is increased—on cooking. The flesh of the pig is not substituted for that of other animals; but inasmuch as large boars are frequently skinned, and the flesh is of a deep red colour, the carcase, on a superficial view, is not at all unlike that of an old ram. The anatomical differences, however, are very marked.

It is scarcely possible to cut through the skin of an old boar, so hard and fibrous does it become.

## METHODS OF PREPARING TISSUES FOR MICROSCOPICAL EXAMINATION

It is not intended in this section to deal minutely with the histological methods of examination. The scope of the volume will hardly admit of it, and there are many excellent text-books which treat of the subject. There is no doubt that the intending Meat Inspector ought to serve an apprenticeship in the laboratory in order to qualify himself for his future work; but, as there are many who have not had the opportunity of doing this, the Editor ventures to hope that the few simpler methods described in this section will not be considered superfluous.

Tissues which are to be examined microscopically may be cut into thin sections on the freezing microtome in the fresh state, or after they have been fixed and hardened. Thinner and better preparations can often be obtained by the embedding method; but a good deal of practice is necessary before one learns to execute the different manipulations satisfactorily. For the ordinary purposes of diagnosis, the freezing method will be found to meet most of the requirements of the Meat Inspector.

### The Freezing Method

As already said, a tissue may be cut in the fresh state or after it has been hardened.

*Method of dealing with fresh tissues.*—As a general rule, the softer tissues cannot be cut in the fresh state with very satisfactory results.

The very cellular parts usually fall out of the section, and the latter is apt to split up into shreds when the cover-glass is applied. Moreover, it is impossible to free fresh tissue sections from air-bubbles, or to dehydrate them with good results, when they require to be mounted in balsam. Nevertheless, one can often by the fresh method obtain preparations which are quite good enough for purposes of diagnosis. It is better not to attempt to cut large sections of fresh tissue, as these are very difficult to manipulate. Half an inch square will be found a convenient size for the block of tissue which is to be cut. The block is placed on the plate of the microtome, which has previously been smeared with a thick layer of gum solution.[1] The object of the gum is to firmly fix the block on the plate after freezing, but it should not be put all over the tissue, as in the case of hardened specimens, for fresh sections smeared with gum are difficult to separate from each other without tearing.

The tissue is next frozen by the ether spray to the required hardness. It is afterwards cut into thin sections with a razor

[1] The B.P. Mucilage suits very well.

on a tripod, or with one of the plane knives supplied with the microtome.

It is advisable to wet the upper surface of the knife before commencing to cut, as the sections then tend to stick to it. When a number have accumulated on the surface of the blade, they should be gently wiped off with the finger into a basin of clean water. The best sections are then picked out with a mounting needle, and placed in another basin of water, from which they are mounted on a slide. It is needless to say that all the manipulations should be performed in the gentlest manner possible, to avoid tearing the sections.

A very useful method of dealing with soft tissues in the fresh state is to harden them for one hour in a 10 per cent. solution of formalin before cutting. The tissue should be cut into small blocks of the size above described before being immersed in the hardening solution. Firm sections can be obtained from fresh brain tissue that has been treated in this way. Lung tissue which is not airless will float on the surface of the fluid ; and in order to ensure the penetration of the latter, the blocks must be made to sink.

If only a few sections are required, it saves time, and it is convenient, to begin cutting before the block has been frozen to the top. When the lower part is quite rigid, one shaves off the still flaccid top portion until one comes to a part that is sufficiently hard to be cut in thin sections. Failure from over-freezing, a common fault of the novice, is avoided by adopting this plan. The necessary degree of hardness is soon learned by practice. When a tissue on the microtome chips under the knife, it is generally due to over-freezing. If it cuts with a rough surface or tears, it has not been sufficiently frozen.

Teasing or splitting up into fine shreds with needles is a quick and convenient method of obtaining preparations of tissue-like muscle. It is also sometimes useful in separating parasites from the tissues in which they are embedded.

The tissue to be teased should be placed in a few drops of glycerine or water on an ordinary slide, and there manipulated.

The shreds may be further improved for microscopical examination by compressing them under a cover-glass with or without previous staining. Tissues like the above may also be examined after they have been squeezed between two ordinary glass slides, or between two glass plates made for the purpose. An apparatus of the latter description, such as is used in the Berlin abattoir for examining the muscles of pigs for trichinæ, will be found useful. The pressure is obtained by means of two screws placed one at each end of the plates, and the upper slab is ruled into compartments, which are numbered in such a way that the figures will appear normal when looked at through the microscope.

*Fixing and hardening.*—Tissues that have been properly fixed give a much truer picture when examined under the microscope. The object is to fix the cells by putting them in contact with some agent that will coagulate their albumin before it has undergone post-mortem changes. It is almost needless to say that tissues to be properly fixed must be placed in contact with the agent before physiological death has taken place. The sooner the tissue is fixed after the death of the animal the better.

Some of the preparations in common use, such as corrosive sublimate in saturated solution, and formalin, all fix in a comparatively short time. They are to be recommended for the more delicate work. Müller's fluid is a useful hardening agent, especially for brain tissue. Methylated spirit, a useful and expensive agent for hardening tissues, is not sufficiently fixative for the finer histological work. It is very suitable, however, for tissues that do not require to be examined by the more delicate methods, and will in most cases fulfil the requirements of the Meat Inspector. Commercial formalin diluted to one fourth, *i.e.* 10 per cent. formalin, is the strength generally used of this agent.

The tissues to be hardened should be cut into as small pieces as one can conveniently work with, and this should be done with a sharp knife or razor. The aim is, of course, to avoid tearing the tissues and to get the fluid to penetrate the mass as quickly as possible. If corrosive sublimate or formalin be used for fixing, the tissues should be changed into alcohol after twenty-four hours, and the alcohol itself should be changed every day for at least three days. Ordinary tissues require to remain in Müller's fluid for a fortnight or three weeks, and they should have about ten times their bulk of fluid. It is often necessary, however, to leave brain and spinal cord in the fluid for a much longer time. In all cases it should be changed frequently during the first week. Tissues hardened in Müller, however, do not stain well with picro-carmine. When spirit is used as the hardening reagent, it is generally sufficient to change it every day for the first three days. On the fourth day the tissues will be ready; but most tissues can remain in spirit indefinitely without undergoing deterioration. It is advisable to dilute the spirit with one-third of its volume of water if the tissue is very fibrous; this prevents over-hardening.

Calcified tissues of course require to be decalcified before cutting. They are usually hardened at the same time.

*Preparation of hardened tissues for cutting into sections.*—If the tissue is to be cut on the freezing microtome, a piece of convenient size is taken from the hardening fluid and washed in running water for an hour or more. The object is to wash out as much of the hardening reagent as possible. After washing, the piece is placed in a gum and syrup freezing mixture for at least twenty-four hours. Hardened tissues, however, may be left in gum indefinitely, so long as the mixture remains free from moulds. The reason for using the gum mixture is that it does not freeze into crystals, which would tear the tissues. When the tissue is properly impregnated, it is put on the plate of the microtome, surrounded by mucilage, and frozen. One may begin to cut sections when the surrounding mass of mucilage is frozen to the top. The sections cut are wiped off into a basin of clean water. If the sections are not over delicate, they may be put into spirit after a short soaking in water, and then transferred to another basin. This treatment causes the sections to spread out quickly, and gets rid of air-bubbles, but it may ruin delicate sections. The latter if left in water for a longer time will part with most of their air-bubbles and gum in the water.

*Mounting.*—The sections are taken singly and floated on to a glass slide, on which they are spread out with care. They may be stained on the slide or before mounting. When ready to receive the cover-glass, a few drops of a mounting solution, Farrant's medium—or Canada balsam, according to the previous treatment of the section — are dropped on and the cover-glass is applied. Care must be taken to avoid getting air-bubbles between the section and the cover-glass. Sections stained on the slide with picro-carmine or alum-carmine are mounted in Farrant after the superfluous stain has been drained off.

When hæmatoxylin or the bacterial stains are to be employed, the sections are placed in a watch-glass containing the dye, and they must be dehydrated before mounting in balsam. The sections, after they come out of the stain, are washed in water or in some decolorising mixture, until they take the required tint. They are then transferred to spirit for about three minutes ; from spirit they are placed in absolute alcohol for about the same time, or until thoroughly dehydrated. When this is accomplished they are transferred to some clarifying reagent, such as clove oil or xylol, out of which they are taken by means of a copper lifter, and spread out on a clean dry slide. They should be allowed to drain for a short time before the balsam is put on.

*Embedding method.*—When one has to examine very delicate tissues or those containing softened centres, it is advisable to supply them with a supporting framework of celloidin or paraffin before cutting. Before embedding, the block of tissue should be thoroughly dehydrated in absolute alcohol. When it has previously been preserved in spirit, twenty-four hours will generally be found sufficient, if the alcohol be changed once or twice. For purposes of diagnosis, however, it can be dehydrated in a much shorter time—one hour—by frequently changing the alcohol, or by using a Soxhlet tube. The larger the block of tissue, the longer will it take the embedding mass to permeate.

*Celloidin method.*—Before going into celloidin, the tissue should be thoroughly soaked in a mixture of alcohol and ether. From this it is placed in a 4 per cent. solution of celloidin in equal parts of alcohol and ether. It is left in this for about a week, and then transferred to a 10 per cent. solution of the same. When the tissue is thoroughly permeated—the time required varies—it is taken out with forceps and waved in air for a few minutes until a membrane forms on the outside. It is then hardened in 80 per cent. alcohol for a few hours, after which it may be cut on a freezing or other microtome. If the freezing microtome be used, the block is first soaked in water, wiped and fixed on the plate by a thin layer of mucilage. The razor should be wetted with 80 per cent. alcohol. Purposely, nothing has been said of staining in bulk, as the Editor does not think it advisable to multiply the methods here detailed. He has already expressed the opinion that an intending Meat Inspector should serve a short apprenticeship in the laboratory.

*Paraffin method.*—When the dehydrated tissues are to be embedded in paraffin, the Editor has found the cedar-wood oil method to give the best results. From the alcohol, the blocks of tissue are placed in a bath containing commercial cedar-wood oil, which is kept on the top of the paraffin bath for several hours ; one hour is sufficient for the quick method to be afterwards described. They are then transferred to a bath of paraffin whose melting-point is 45° C. They are kept in this for about two hours, during which time the paraffin is changed at least twice. Next they are placed in a bath of paraffin whose melting-point is about 50° C., and they may remain in this for from two to twelve hours. They should remain in the hard paraffin as short a time as is consistent with thorough penetration. If the tissue be left in too long it becomes cooked and hard. When sufficiently permeated, the blocks of tissue are taken out carefully with forceps, and placed in a metal or paper mould containing melted paraffin of the same hardness. When the surface of the paraffin has solidified sufficiently, the mass is rapidly cooled by placing the mould in cold water. The rapid cooling prevents the paraffin from crystallising. When cold, the paraffin can be shaken out of the mould, after it has been warmed around the sides.

The paraffin block is then planed smooth at its edges with a knife, and fixed on the carrier of the paraffin microtome by heat. It is advisable before cutting to dip the block in soft paraffin which has been melted. This facilitates the formation of ribbons. Mr. Patterson of the R. C. P. Laboratory, Edinburgh, tells me that he often hardens, embeds, and cuts all in one day the specimens sent for diagnosis. They go for one hour into spirit, one hour into absolute alcohol, and for the same time into cedar-wood oil. They are then put for two hours into soft paraffin, which is twice changed, and from this are transferred to hard paraffin for an hour before being placed in the mould.

The paraffin baths are kept in ovens heated by water maintained at a temperature slightly above the melting-point. Each oven should be fitted with a thermo-regulator.

*Manipulation of paraffin sections.*—One or several sections in ribbons are laid out in a basin of water heated nearly to that of the melting-point of the paraffin. In this the sections are spread out, and they can easily be floated on to the slide. It is advisable to coat the slides with a very thin layer of albumin, as it makes the sections stick faster. A stock of albuminised slides can be kept ready. When the sections are mounted, they are dried in a stove over night. For the quick method they can be dried over the flame; but this is not advisable, unless time is a great consideration. When dried, the slides are washed in turpentine to take out the paraffin, the turpentine is washed out with absolute alcohol, and this again with spirit. From the spirit they may be transferred into water, or they may be stained straight away. If corrosive sublimate has been used for fixing, it should be dissolved out of the tissue before staining. To do this the slides are washed for about five minutes in Gram's solution of iodine, and then in spirit, until the iodine is removed. After staining, and decolorising if necessary, the sections are thoroughly dehydrated in spirit and absolute alcohol. They are then clarified in turpentine, and mounted in balsam.

*Cover-glass preparations.*—This method of examination is very useful when dealing with fluids. A platinum wire, which has been looped at one end and fixed in a metal carrier by the other, is sterilised in the flame. When cool, it is dipped in the fluid to be examined, and the fluid is then rubbed over a cover-glass. The material may be further spread out by placing another glass on the top, pressing the two together, then sliding them apart. The latter procedure is necessary with thick liquids. It is sometimes possible to make a good film by simply rubbing the glass over the surface of the tissue. The glasses are left film side upwards under a bell-jar until dry, or the drying may be hastened by holding the glass above a small Bunsen flame. When dry, the cover is taken with a pair of forceps, held with the film side upwards, and passed three times through the flame to coagulate the albumin and fix it on the glass. After this it may be stained, decolorised, dehydrated over the flame, and mounted in balsam. Care must be taken not to scorch the film. Instead of fixing by heat, the films may be placed in some fixative solution or vapour.

In examining hard nodules, some tubercles for example, it is better to mince the tissue in water on a glass-slide and make the film from the emulsion.

The following stains and preparations will be found to meet most of the demands of the Meat Inspector :—

*Decalcifying fluid.*—Take a 10 per cent. aqueous solution of nitric acid and saturate it with picric acid. The time necessary for decalcification varies considerably. The fluid should be freely supplied and frequently changed.

*Müller's fluid.*—Bichromate of potash 2 parts, sulphate of soda 1 part, water 100 parts. The bichromate should be pulverised, and the water should be heated.

*Gum-freezing mixture* (Cole).—(1) Dissolve 1 lb. of loaf-sugar in 1 pint of boiling water; (2) dissolve 4 oz. of gum acacia in 6 oz. of water. For soaking the tissues before cutting, take three parts of No. 1 and five parts of No. 2. This mixture can be kept in stock by adding 5 grs. of carbolic acid for each ounce. For the more delicate tissues, take four parts of No. 1 and five of No. 2.

*Picro-lithia-carmine.*—Dissolve 1·25 grms. of carmine in 50 c.c. of a saturated watery solution of lithium carbonate; filter, and add slowly 100 c.c. of a saturated watery solution of picric acid. The quantities must be measured exactly. For purposes of diagnosis this is a very useful method of staining the tissues. The specimen is stained on the slide for about three minutes, the surplus stain is run off, and Farrant's medium is used for mounting the cover-glass.

*Borax carmine* (Grenacher).—Take of carmine 1 grm., borax 2 grms., distilled water 200 c.c. Specimens stained by borax carmine can be dehydrated and mounted in balsam.

*Ehrlich's acid hæmatoxylin.*—Take of hæmatoxylin 2 grms., water, absolute alcohol, and glycerine 100 c.c. each, glacial acetic acid 10 c.c.; dissolve the hæmatoxylin by rubbing it up in a mortar with the water, pour into a bottle, add the glycerine and alcohol, and then saturate with alum. The mixture is exposed to light, and occasionally to air, until it becomes dark red in colour, when it is ready for use. Fine histological preparations can be obtained with this hæmatoxylin, and it does not overstain. Sections are left in the stain for not less than three minutes. They are then washed in alkalinised water until they take a blue colour. Before dehydrating, they may be contrast-stained with eosin or Congo red. To stain with eosin, the sections are put for about two minutes in ½ per cent. solution, or the clove oil may be tinged

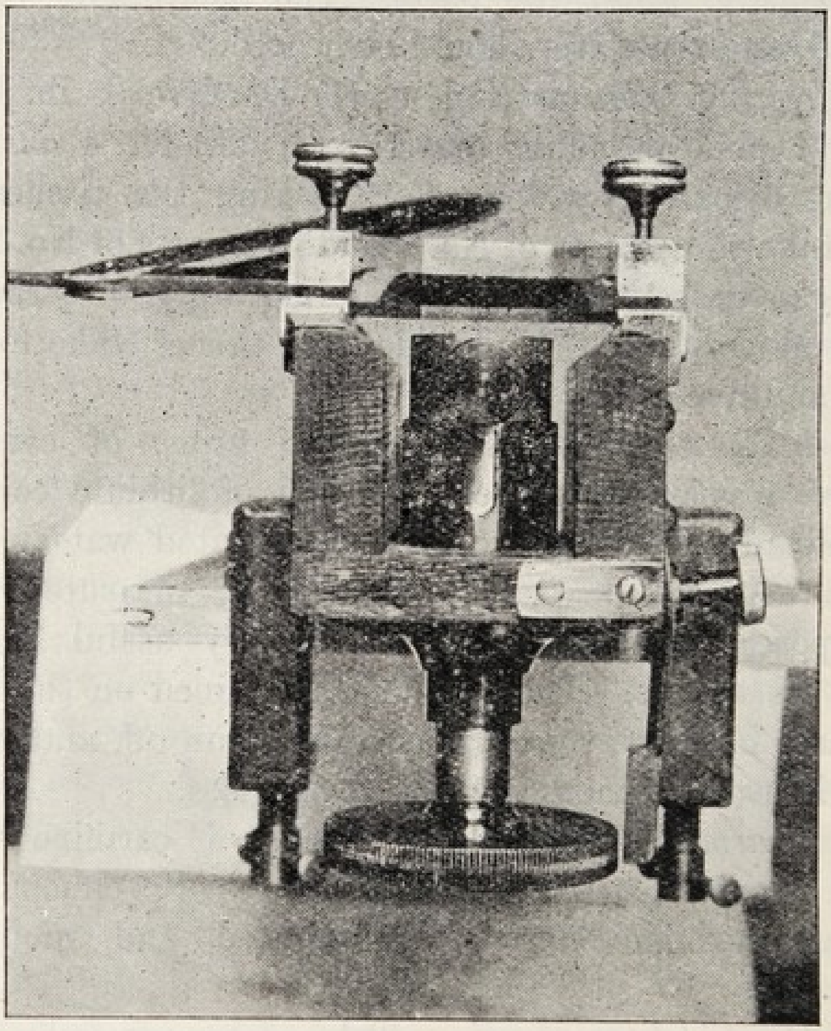


FIG. 1.—Cathcart freezing microtome.

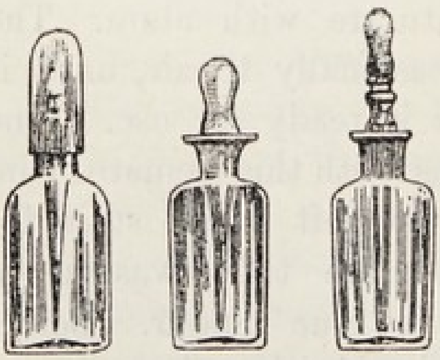


FIG. 2.—Reagent bottles fitted with pipettes.

FIG. 3.—Forceps for holding cover-glasses.

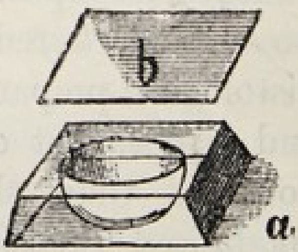



FIG. 4.—*a* and *b*, Staining dish, and cover for same.

with a solution in absolute alcohol if they have been cut on the freezing microtome. Congo red is used in solution of 1 to 1000. It must not be left on for much more than two minutes.

*Ziehl-Neelsen's carbol-fuchsin.*—Dissolve 1 grm. of fuchsin (basic) in 100 c.c. of a 5 per cent. solution of carbolic acid in water, and add 10 c.c. of absolute alcohol.

Like the other bacterial stains, this should be filtered before use. Its action is hastened by warming, but care must be taken not to put sections into the stain, if it be hot enough to shrivel them. Preparations stained for the tubercle bacillus are decolorised in a 20 per cent. aqueous solution of strong acid (sulphuric). Diluted to one-third with water, it is a suitable stain for cover-glass preparations of some of the other bacteria. The latter should be stained for three minutes, and then decolorised in a basin of water with a few drops of acetic acid added. To avoid a precipitate, it is advisable to dip the covers in alcohol before applying the stain. Tubercle preparations are taken back and forward from the acid to water until they show a very pale pink tint. The tissue cells can be contrast-stained by dipping for two or three minutes in one of the methylene-blue preparations, but methylene-blue, if left on too long, may wash out the fuchsin from the bacteria.

*Plaut's method.*—This can be used for tubercle, but it is better suited for the actinomyces clubs.

The stain is carbol-fuchsin. The decolorising fluid is spirit saturated with picric acid. The sections go from the decolorising fluid into clean spirit.

*Kühne's carbol-blue.*—Dissolve 1·5 grms. of methylene-blue in 100 c.c. of 5 per cent. aqueous solution of carbolic acid, and add 10 c.c. of absolute alcohol.

*Löffler's blue.*—Take of a saturated alcoholic solution of methylene-blue three parts, and add one part of 1 to 10,000 aqueous solution of caustic potash.

*Carbol-thionine-blue* (Nicolle).—Take of a saturated solution of thionine-blue in 50 per cent. alcohol, 10 c.c., and add 100 c.c. of 1 per cent. solution of carbolic acid in water.

Sections or cover-glasses stained by the blue preparations should be decolorised in water, which may be acidulated or not. If it be found that alcohol removes too much of the stain, the specimen can be dried on the slide in the stove and clarified in xylol or turpentine before mounting.

*Gram's stain.*—Take of aniline water (water saturated with aniline oil and filtered) 10 c.c., absolute alcohol 1 c.c., saturated solution of gentian-violet in alcohol 1 c.c. This stain should not be made up in large quantities, as it does not keep. Sections and cover-glasses are left in the stain for five minutes. They are then transferred to the following solution, until they become black—say three minutes.

*Iodine solution.*—Take of iodine 1 part, iodide of potassium 2 parts, water 300 parts. The superfluous colouring matter is washed out afterwards with spirit and absolute alcohol.

# GENERAL PATHOLOGICAL CONDITIONS

In this section have been placed those processes which are known in pathology as degeneration and infiltration. The neoplasms will also be dealt with here, as they are not of sufficient interest to the Meat Inspector to merit a special section.

## INFILTRATIONS

The materials which may infiltrate a tissue are: fat, calcareous particles, and several pigmented substances derived from the blood or from an extraneous source.

### Fatty Infiltration

With the exception of the liver, fatty infiltration is seldom seen in the organs, but the various storehouses for fat, such as the mesentery, become enormously enlarged in fat stock. A fatty liver is enlarged. On section, its tissue is less firm than that of a normal organ, and it is yellow in colour. To the fingers it feels greasy. According to the Editor's experience, fatty infiltration of the liver in cattle is mostly associated with cirrhosis caused by flukes. In this case the organ is very firm externally, but its substance is easily broken down. The microscope shows that the liver cells contain refractile oil droplets. They are distended, and the nucleus is often displaced, but it takes up the nuclear stains.

*Inspection.*—There is no reason why organs which are infiltrated by fat should be withdrawn from the market, unless cirrhotic changes be present as well.

## Calcification

Infiltration by calcareous material usually occurs at the seat of degenerated tissue, such as a tubercle. Many of the seats will be mentioned in connection with the various diseases. Cattle and sheep from the Argentine Republic sometimes show calcareous infiltration of the lungs. The Editor has received a specimen of this kind from the late Mr. Duguid, who obtained it from an ox slaughtered at Deptford. The affected portions resembled pieces of calcified sponge. Calcified tissue is very hard; it grates under the knife when cut, and stony particles of a grey or black colour are seen on the surface of section.

*Inspection.*—It is almost unnecessary to say that calcified tissues should be seized, unless the number of particles is trivial.

## Infiltration by Pigment

*Hæmatoidin.*—Hæmatoidin is a derivative of blood pigment. It occurs at the seat of injuries which have been followed by extravasation of blood. It is one of the substances which gives rise to the discoloration of tissue which follows upon a bruise.

*Lutein.*—This is yellow pigment which is found in the corpora lutea of the ovary. Sometimes the ovaries of cows are quite fibrous, and their tissue is universally infiltrated by lutein.

*Melanin.*—Melanin is a brownish-black pigment, which occurs in granules. It is a normal constituent of the body, but it sometimes accumulates in pathological growths, such as neoplasms—melanomata, melanotic sarcomata. Melanotic fibromata are by no means rare in oxen. In these also, but more especially in young calves, melanotic patches may be found under the skin, on the membranes, and in the organs, such as the spleen, the liver, and the lungs. The patches vary from mere specks to the dimensions of a half-crown piece or larger. This condition is sometimes spoken of as "melanosis." The general condition of the animal may be quite good. Melanin is soluble in hot liq. potassæ.

*Bile.*—Jaundice is the name given to pigmentation of the tissues by bile. It arises in the course of catarrhal affections of the bile ducts, or of the duodenum when the orifice of the main duct becomes obstructed. The bile is absorbed into the circulation, and it pigments the tissues. The colouring matter of the bile in herbivorous animals is biliverdin, which is very nearly related to the bilirubin of the carnivora.

The pigmentation is well seen in the adipose tissues and serous membranes, but its intensity varies greatly. All the tissues, with exception of the muscles, may be of a deep yellow colour, or only a faint tinge may be discerned in those which normally approach the white. A yellow colour of the fat is not always attributable to bile; it may have been due to the feeding. In old cows the fat is often very yellow in colour, the tint being due to a lipo-chrome. In bad cases of jaundice the muscles are of a dark brown colour. If any doubt exists as to the nature of the pigments, Gmelin's or Pettenkofer's tests may be applied.

*Post-mortem discoloration.*—When an animal has been dead some time before the viscera have been removed, local patches of discoloration are often present. These are due to staining with bile which has oozed through the gall bladder, and to decomposition of the blood owing to gases set free from the fermenting mass of ingesta in the intestines. This takes place more rapidly, of course, in hot weather than in cold.

The changes are seen in the abdominal region. Bile stains the tissues a greenish-yellow colour, and the decomposition changes render them green or even black. The latter colour is due to the formation of sulphide of iron by the action of $H_2S$ on the iron of the blood. The spleen, owing to the amount of iron it contains, frequently becomes black, although the other organs are almost unchanged. In sheep one of the first parts to show the green colour is the kidney fat.

*Soot.*—Extraneous pigments in the form of soot or carbon may be found in the lungs and the adjoining lymphatic glands.

The Editor has seen the lungs of a cow almost black with carbon. The animal had wandered into a bed of soot deposited in a field.

*Inspection.*—Tissues containing an abnormal pigment must be looked upon as unmarketable. It will seldom be necessary to seize the whole carcase, however, except in some cases of jaundice. In severe cases of jaundice the aspect of the flesh is very repulsive. Moreover, it is often flabby, and its flavour is altered. Total seizure should be applied to carcases of the latter description. Bile, however, is not a poison, and one would not be justified in seizing a carcase on account of a faint yellow tinge in the membranes.

The exact degree of pigmentation which calls for seizure must be left to the judgment of the inspector, for it cannot be defined.

## DEGENERATION

One understands by degeneration that the cell albumin is converted into some other substance, such as fat.

### Cloudy Swelling

This is a condition in which albuminous granules appear in the cells or fibres of an organ. The changes in a cloudy organ are not very apparent to the naked eye, but the microscope shows that the cells are swollen, and their nuclei are somewhat obscured by the presence of numerous dark granules having a peppery appearance.

*Inspection.*—Cloudy swelling is a symptom of certain systemic troubles, such as arsenical poisoning or bacterial affections, which must lead to the whole carcase being condemned. If the carcase is fit to pass, however, it is unlikely that a cloudy condition in an organ would ever be noticed, unless one was looking specially for signs of poisoning (*see* Alterations due to Drugs).

## Fatty Degeneration

In fatty degeneration the cell albumin is converted into oil. This change is met with in liver cells, renal epithelium, and muscle fibre.

An organ in which fatty degeneration is the only change is usually smaller and softer than normal. Its colour is yellow—reddish-yellow in the case of the heart and liver—and its consistence may be quite pulpy.

With the microscope one sees that some of the cells have disappeared. Many of the remaining ones contain small oil droplets, and the nuclei are lost in some cases. The disappearance of the nuclei by conversion into oil enables one to distinguish this condition from fatty infiltration. The oil droplets can be stained black with perosmic acid, ·5 per cent.

In cattle and sheep, fatty degeneration is frequently found in the liver as a complication of cirrhosis. In this case the organ is enlarged.

*Inspection.*—Organs in a state of fatty degeneration should be regarded as unmarketable. Their appearance is often repulsive, and the change may have been due to some serious trouble, such as poisoning by arsenic or phosphorus. Moreover, when one buys liver one expects that it will contain no more than the physiological amount of fat.

## Amyloid Disease

This is a condition in which the organs become invaded by a waxy-looking material. The spleen, the liver, and the kidneys are the commonest seats of the change ; but it is almost unknown in animals of the abattoir. It is sometimes met with, however, in the livers of tuberculous fowls. An amyloid organ is enlarged, usually firmer than normal,[1] and presents a pale, smooth, and wax-like surface on section. In the spleen, however, the Malpighian bodies may project (Sago spleen).

[1] The amyloid liver of the horse is sometimes pulpy.

The microscope shows the material to be present in the capillary walls, the middle coat of small vessels, and the connective tissues. The cells do not contain it, but they may be fatty.

*Inspection.*—Amyloid organs should be seized.

## Necrosis

Necrosis is the death of a part of the body. The condition will be again referred to (*see* Bacterial Necrosis). The dead tissue is white in colour, and is usually separated from the healthy parts by a more or less abrupt line. Its albumin has passed from the fluid to the solid state; it is coagulated and firmer than normal. The microscopic appearances are described in the chapter on Bacterial Necrosis.

Dead tissue which is in communication with the external air is apt to putrefy. The dead part softens under the action of microbes. It becomes livid in colour, and gives off a stinking odour (moist gangrene).

*Inspection.*—Necrotic tissue should not be allowed into the market. If moist gangrene has set in, the flesh may be fevered. In this case the carcase will be unmarketable. If the effects of putrefaction are purely local the diseased area should be removed, with a wide margin, before the rest of the carcase is passed. Particular attention should be given to the lymphatic glands in the neighbourhood of the slough.

## NEOPLASMS

It is not necessary to describe all the neoplasms in detail. They are new growths of what might be called pathological tissue, and as such are unfit for human food. The benign neoplasms, although they may be multiple, do not reproduce themselves in remote organs. Those most frequently met with in the abattoir are the fibrous tumour and its varieties—myxoma and melanoma, lipoma, and, more rarely, the myoma. The fibromata are found in connection with the skin, and not infrequently in the uterus. In the latter situation they may reach an enormous size. Their

FIG. 5.—Section through an intestinal lipoma, showing the strangulated bowel at two places (nat. size).

structure is that of white fibrous tissue, but myxomatous areas are often present. The melanotic fibroma is found on the skin, most frequently in red oxen. The myoma, which is composed of non-striped muscle cells, is sometimes found in connection with the uterus of the cow or the sow. It is usually of large size, and may show calcareous areas.

The lipomata have the structure of adipose tissue. They are sometimes found under the skin or in the abdominal cavities of the ox. Fig. 5 is a section of a lipoma which weighed about 50 lb. Two portions of the bowel are seen passing through the mass.

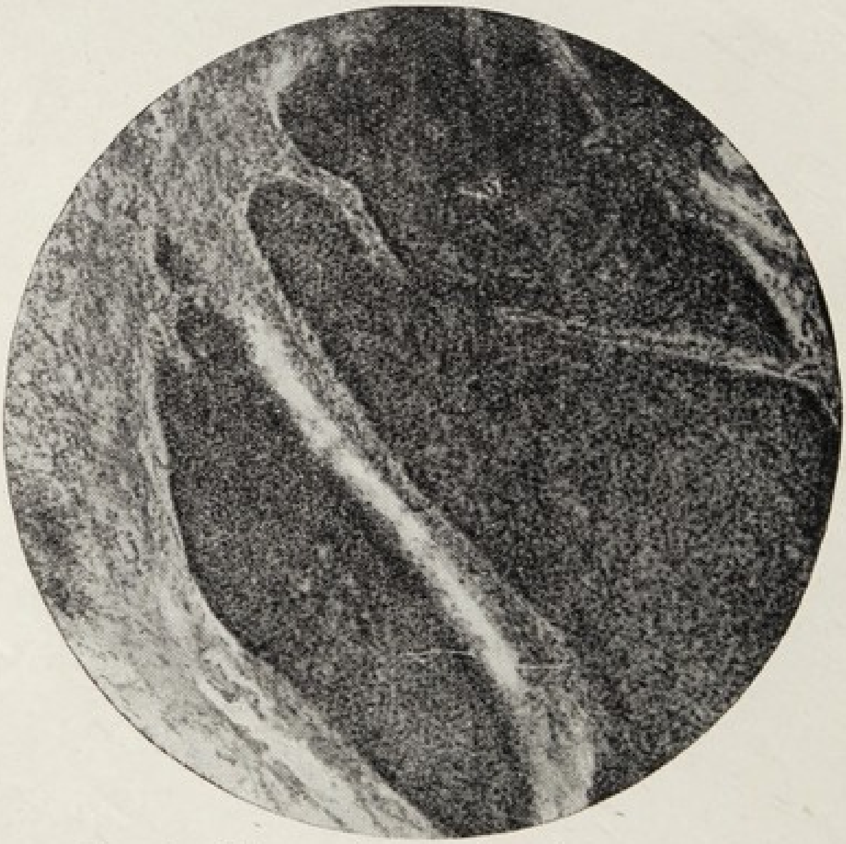


Fig. 6.—Microscopical section of a carcinoma (Reichert, obj. 3).

The malignant neoplasms are of more importance, as secondary metastatic growths may invade the internal organs after the manner of an infective disease. It should be mentioned, however, that the malignant tumours do not always display the same tendency to become generalised in animals as in human beings. There are three chief forms, viz. Sarcoma, Carcinoma, and Adenoma.

*Sarcoma.*—The sarcoma is a neoplasm composed of embryonic connective tissue cells, which may be either round or spindle-shaped. The elements tend to remain embryonic, but occasionally the mass of cells has a fibrous capsule. The spindle-cell variety is always mixed with round cells. Giant cells are almost unknown. Round cell sarcomata are seen in connection with the skin and mucous membranes. The Editor has on several occasions found multiple round-cell sarcomata in the kidney of the ox.

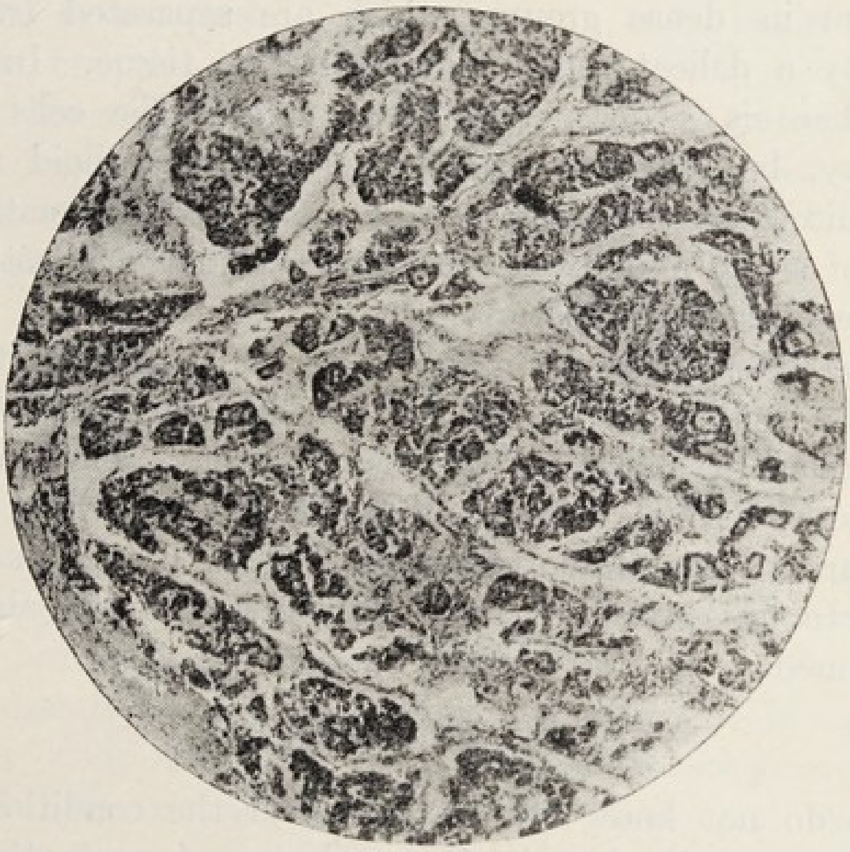


Fig. 7.—Microscopical section of an adenoma in the liver of an ox (Reichert, obj. 3).

The spindle-cell variety is found usually in connection with bones, particularly those of the jaw in the ox. In one case observed by the Editor in a cow, the inferior maxilla and several other bones, including the ilium, were the seats of these neoplasms. Some of the bones were quite fibrous in the region of the growth.

*Carcinoma.*—A cancer consists of a mass of epithelial cells embedded in vascular connective tissue (Fig. 6). They are uncommon in cattle and sheep, and rare in the pig.

The tumours are usually found on the skin, on mucous membranes, in the liver, and frequently in the lymph glands in communication with these structures.

*Adenoma.*—The adenomata are made up of fibrous tissue and epithelium arranged like a gland (Fig. 7). The acinous arrangement is the commonest. Sometimes the cells are in dense groups, which are separated from each other by a delicate strand of connective tissue. In another form there is a distinct acinous space. The cells are not secretory, but the acini sometimes contain colloid material. The Editor has met with several cases of adenomata in the livers of sheep and oxen, and one case in the intestines and mesenteric glands of a sheep.

*Inspection.*—Experimental evidence is against the idea that the malignant neoplasms can be conveyed either by inoculation or ingestion of the growths. The carcase of an affected animal, however, may be emaciated and unfit for the market when important organs have been invaded, and the actually invaded parts or organs must always be condemned.

## FEVERED FLESH

We do not know all the causes of the condition termed fever or pyrexia, but in the majority of cases the rise in temperature is due to the presence of poisons, usually of bacterial origin, in the circulation.

During fever the metabolism is increased in the tissues throughout the body. The muscles provide a good deal of the fuel for the increased combustion. The organs and muscles may be in a condition of cloudy swelling, but the latter are frequently darker than normal in colour, and show small hæmorrhages in their substance.

It does not necessarily follow that the flesh will be dark in colour because the temperature was high at the time of death; but it often happens that the fevered animal, being near the point of death before coming into the abattoir, does not bleed well, and its flesh appears darker than normal.

To the mind of the Meat Inspector the term "fevered flesh" generally conveys the idea that the muscles are very dark in colour, and albuminous or soapy to the touch. Flesh of this description is repulsive, but the exact degree of darkness which should exclude it from the market is impossible to lay down. Some latitude must be left to the inspector, but the greatest caution ought to be observed in passing "fevered" carcases, and they ought to be condemned without hesitation when the organs are not available for examination, and there is reason to suspect that the animal was slaughtered while *in extremis.*

## WOUNDS

Trivial wounds unaccompanied by septic changes hardly call for notice.

It sometimes happens, however, that an animal gets badly injured during transit. The injuries may consist of multiple bruises, or a limb may be fractured.

A bruise is accompanied by extravasation of blood under the skin and into the tissues. The muscles around a fractured bone are also infiltrated by blood, and the fibres are usually lacerated. The dark red condition of the flesh might, at first sight, lead one to suspect black quarter; but in the case of fracture the broken bone and the absence of emphysema will be sufficient to determine the diagnosis.

Counter-irritants, such as mustard, applied to the skin, may sometimes produce very marked lesions. It is usually in the region of the chest that mustard is applied. The subcutaneous tissue is swollen and infiltrated by lymph, which issues as yellow droplets from the injured surface.

*Inspection.*—Suppurating and gangrenous wounds are dealt with elsewhere.

When an animal has been badly injured, even if the wound be not septic, the flesh throughout the carcase may be very dark in colour. It often presents an unbled appearance, and it generally fails to set firmly. Under these circumstances it should be considered unmarketable.

When the effects of the injury are purely local, the carcase may be passed after the discoloured portions have been removed.

A large portion of a carcase may have to be condemned, owing to the effects of a severe counter-irritant applied to the skin. As these agents, however, are generally employed in the treatment of inflammatory diseases, there may, in this case, be a good reason for condemning the whole carcase.

## Rupture of the Œsophagus

When unsliced turnips are fed to oxen, it sometimes happens that a portion of the root becomes impacted in the œsophagus. During an attempt to force the obstructing body onwards with a probang, the œsophagus may be ruptured. This usually occurs in the thoracic portion of the organ. After an accident of this kind the animal has to be slaughtered.

The subcutaneous tissues in the region of the neck become emphysematous, owing to gases which have penetrated from the rumen. A small quantity of ingesta is found in the chest cavity, and the pleura may show signs of septic inflammation. The flesh is soft and watery. It has a dirty red colour, and gives off a distinct aniline oil or turnipy odour. It may also have a somewhat sour smell. These changes are particularly well seen in the intercostal flesh. The odour is apparently due to aromatic agents absorbed from the fermenting mass in the rumen.

*Inspection.*—The flesh of a choked animal, as it is popularly called, is particularly repulsive on account of its appearance and smell. Even if the animal has been slaughtered before pleurisy has set in, the condition of the flesh will render the carcase unmarketable.

The odour is best observed when a fresh cut is made into the substance of the muscles.

## SUFFOCATION

Sheep are very often suffocated by being trampled on by their companions during transit in overcrowded railway trucks or in market-pens. The Annual Report of the Chief Sanitary and Market Inspector shows that in 1898 fifty-one carcases of sheep were condemned at the Edinburgh abattoir on account of alterations due to suffocation.

In an animal dead from suffocation the subcutaneous surface will be found to have a generalised red colour, which arises from fulness of the capillary vessels. The lungs are congested. The flesh does not set firmly. It is dark red in colour ; indeed, it may not have been bled.

*Inspection.*—Carcases presenting the above appearances are unmarketable.

## FATIGUE

If an animal has been fatigued by a long journey on foot, it should not be slaughtered until it has recovered from the effects of the march. Rest is all the more necessary when the animal has been lamed during the journey.

During unwonted exertion, waste products of a poisonous nature—creatine, creatinine, etc.—accumulate in the muscles. These substances cause temporary alterations in the appearance and composition of the flesh, and they may give rise to fatigue fever. The flesh of an animal killed soon after a fatiguing journey does not set firmly. It is often very dark in colour and sticky to the touch. It has all the characteristics of fevered flesh. Moreover, it is tough, and difficult to digest when cooked. Animals landed from a long sea voyage often show œdema of the parts which have come most in contact with the hard decks. This is best observed in the pectoral muscles.

The bodies of animals which have been hunted to death enter soon into *rigor mortis*, which passes off quickly. Small hæmorrhages are often found in the muscular tissue.

*Inspection.*—The flesh of fatigued animals is usually unmarketable from its appearance alone. It has also been credited, however, with giving rise to serious symptoms of poisoning in individuals who have partaken of it.

Several oxen, which had been newly imported, broke away from the railway station at Paris, and were chased for a considerable distance. Some of them died of fatigue. Redon injected from 1 to 15 c.c. of their serum into the veins of three rabbits, with the result that the animals all died in from five hours to two days.

Such observations are of course interesting, but they have little bearing on the effects of the flesh when ingested. They do not even furnish conclusive evidence that the serum of fatigued animals is specially nocuous, for the serum of a normal animal, if injected into one of a different species, may cause death.

Pleindoux has observed that the flesh of bulls killed in the arena putrefies very rapidly. Fournol stated that broth made from the flesh of fatigued animals soon became sour and putrefied, the explanation being that the products of tissue disintegration ferment more quickly than the tissues themselves.

### ALTERATIONS IN THE FLESH PRODUCED BY DRUGS

It not infrequently happens that animals which have been under medical treatment are sent to the abattoir, the owners preferring to slaughter them rather than take the risk of their dying.

Some of the drugs they have been receiving may have produced alterations in the flesh ; or it may be that the animal has been poisoned.

The volatile drugs, such as ether, turpentine, carbolic acid, creasote, camphor, and the aromatics, may give an odour to the flesh.

If an animal be killed while in physic, especially in the case of saline purgatives, the flesh may be soft and watery, owing to a hydræmic condition of the blood. When an animal has been poisoned it seldom happens that the inspector is furnished with a history of the case. He may, from an ordinary examination, suspect poisoning, but in the absence of a history it might require a laborious chemical analysis to enable him to give a decided opinion.

The metallic and irritant poisons produce gastro-enteritis. The alimentary membrane in this case shows patches of congestion, which are sometimes hæmorrhagic. Such lesions, however, may arise from other causes; they are not pathognomonic of poisoning by any special drug. The odour of the intestinal contents, as in the case of carbolic acid, creasote, and phosphorus, in combination with the lesions, may enable one to make a correct diagnosis.

There are some poisons, however, such as arsenic, which are odourless in the tissues. There are others which cause no definite lesions, such as strychnine. Phosphorus, arsenic, and strychnine are cumulative poisons; that is to say, they are stored up in certain organs—in the liver, for example. The first two cause fatty changes in the organs; but death may have supervened before extensive fatty degeneration has had time to take place. The only apparent changes in the case of strychnine are those of asphyxia.

As is the case with the ingesta, the liver of an animal poisoned by phosphorus gives off a more or less pungent odour, which is intensified by heating the material under examination. Every odour is intensified by raising the temperature. If, in the case of phosphorus, the warming process be conducted in a dark room, the characteristic luminous appearance will be seen. When the poison is lead or arsenic one may find pieces of lead-foil and masses of dry lead or arsenical paint in some part of the alimentary track. They are occasionally found in the rumen of the ox, for example.

*Inspection.*—In acute cases of poisoning the flesh is usually fevered; often it has an unbled appearance. The changes present in the tissues and organs are usually so marked that the carcase would be condemned as unmarketable, irrespective of the cause. In a number of fowls poisoned by phosphorus, however, the Editor found a strong odour in the ingesta and liver, and yet the flesh was practically normal in appearance. In poisoning by strychnine it has been shown that the flesh contains the drug.

Lewin poisoned fowls, which are very resistant, by administering strychnine in doses of ·2 grm. The flesh was given to dogs in portions of 125 grms. The first meal made the dog ill; the second gave rise to fatal convulsions.

One must admit, then, that the flesh of animals poisoned by strychnine is unfit for consumption; but there will be nothing to arouse the inspector's suspicions unless he has seen the animal during life.

In cases of chronic poisoning by arsenic or lead, the animal is emaciated and the organs are usually fatty. The flesh may be watery and anæmic in appearance, but it is not always markedly altered. The fate of the carcase will usually be decided by its condition, for the inspector can hardly be expected to diagnose poisoning unless he has obtained a history of the animal and has seen it during life. As arsenic enters into the composition of some sheep-dips and ointments, one is helped to a decision by the state of the skin and the presence of diseased conditions against which this drug is employed.

In cases of chronic poisoning it is doubtful whether these metallic poisons are ever present in sufficient quantity to cause serious harm to an individual who may partake of the animal's flesh, for under ordinary circumstances he will only consume a small portion. If it be known, however, that the animal has suffered from poisoning by arsenic or lead, the consumer should have the benefit of the doubt, even if the flesh be marketable in appearance. The degenerated organs should, in any case, be dealt with as indicated with regard to cases of fatty degeneration.

### THE INFLUENCE OF THE FOOD

The influence of certain food-stuffs on the flesh and fat is undeniable, but exaggerated ideas of their effect are entertained by many farmers.

The flesh of young animals fed exclusively on milk is soft and white. It becomes darker and firmer as they begin to eat grass and meal.

The fat of animals which have been forced on maize or cake may be yellow and wanting in consistence. The colour is due either to lipo-chromes or to a high proportion of olein, and the want of consistence is caused by the latter substance. As regards the reputed influence of maize on the fat, it should be mentioned that the adipose tissue of American oxen is white and firm, although maize enters largely into their diet.

It is known from the experiments of Lebedeff and Munk, that if starved dogs be fed on sheep fat they store it directly, without waiting to transform it into dog fat. The fat deposited under these circumstances has a melting-point of about 40° C., whereas the normal fat of the dog is semi-fluid at 20° C. When colza oil was used, the fat deposited melted at 23° C. It contained 82·4 per cent. of oleic acid, while normal dog fat gives about 65 per cent. of this substance. Erucic acid, a constituent of colza oil, was also present. When linseed oil was given to the starved animals, the fat deposited remained fluid at 0° C. These experiments offer a possible explanation of the conflicting statements which have been made with regard to the influence of certain food-stuffs on the fat of animals, viz., that it depends largely on the condition of the animal when first put on the diet.

The fat of animals fed on distillery grains is said to be yellowish in colour. Rancid cakes give a special odour to the flesh. Turnips accentuate the cow odour of the flesh of cows; and when the animal has been choked it has a marked turnipy smell (*see* RUPTURE OF THE ŒSOPHAGUS).

In Scandinavia many of the cattle are ichthyophagous. Their fat is oily, and it both tastes and smells fishy. The same thing may be sometimes observed in poultry from Shetland; and the flesh of rabbits which feed on kelp-manured ground has a similar flavour. It is also very noticeable in ptarmigan. This flavour disappears if the fish diet be withheld for about three weeks before slaughter.

The flesh of birds fattened on hemp-seed is yellow and oily. When the diet of pigs has been largely carnivorous, the flavour of the flesh is coarse, and the lard is soft.

*Inspection.*—Unless there be a distinct rule bearing on these cases in this or that abattoir, the inspector can hardly interfere if the departure from the normal be purely one of flavour. If the carcase be otherwise of good quality, it would be difficult to justify its seizure on account of slight alterations in colour or odour which cannot be attributed to any pathological condition.

The Editor is of opinion that flesh which has an abnormal and markedly distasteful odour should be considered unmarketable, because the purchaser is not likely to discover it until the joint is served at the table. It is then too late to return it to the butcher.

## POST-MORTEM CHANGES IN FLESH

DEAD flesh, as every one knows, begins to alter almost immediately. In the majority of slaughtered animals in this climate, the albumin of the cells throughout the body has become solid in about twelve hours. The carcase, however, may "set," to use the popular expression, in less than twelve hours. The after-changes are due to the action of ferments, most of which are bacterial in origin. The rapidity with which the flesh becomes altered depends on the temperature, the character of the invading microbes, and the condition of the animal at the time of death. It is well known that a moderately high temperature is favourable to bacterial life, and that bacteria are ubiquitous. One may temporarily arrest their growth by keeping the temperature at a few degrees above freezing-point; but as soon as the chilling process ceases bacterial life again becomes active. If a flesh storehouse is not provided with a means for keeping the temperature low enough to arrest the growth of microbes, the dust should be laid with some cheap antiseptic fluid, such as a solution of permanganate of potash. Such agents as chloride of lime and carbolic acid are unsuitable, as they may give an odour to the flesh. The meat should also be protected from blue flies by clean muslin coverings. The maggots of these flies aid the penetration of microbes, and they are one means by which germs are brought in contact with the flesh. Meat which has been improperly bled does not keep so well as that from which most of the blood has been removed. The explanation seems to be that when an albuminous fluid is left in the vessels, microbes from the surface are able to spread more quickly into the centre of the flesh. Most of the post-mortem alterations in flesh come under the head of Putrefaction.

## PUTREFACTION

Putrefaction is a decomposition of organic substances caused by microbes. The bacteria of putrefaction are innumerable. Indeed, any microbe which is able to grow on dead meat may help in the putrefactive process. The germs invade the flesh from outside sources, or they may penetrate the tissues from the intestines if the latter are left too long in the body. In animals that have died from disease, bacteria may have penetrated from the intestine and been distributed throughout the body during the last hours of life. The influence of certain disease processes on the keeping properties of the flesh will frequently be referred to in the chapters on Diseases. In the first stages of putrefaction the aerobic microbes grow most abundantly; but as these use up the oxygen the anaerobes also multiply. In the putrefying material a constant struggle for existence goes on between the different kinds of bacteria, and some of them, after a more or less short period of existence, are crowded out.

In the decomposition process, various products, such as leucin, tyrosin, butyric acid, indol, scatol, and a host of other substances, are formed by reduction and chemical combination. Gases, such as O, H, and N, are set free, while others—$H_2S$, $CO_2$, $NH_3$—are formed by combination. Many of the products are aromatic, and give off special odours. Some of them are poisonous.

Certain of the bacteria are chromogenic in character, that is to say, they give rise to various coloured substances during their growth; but this function depends on the nature of the organic medium as well as on the species of microbe. Others render the medium luminous, but this will be referred to later.

The poisonous products are the ptomaines or basic alkaloids, and the albumoses or toxalbumins.

Most of the latter, which are perhaps the most poisonous, are destroyed by a temperature of 150° F. Many of the ptomaines remain active after being heated to 230° F. Those which are formed in the first stages are not particularly poisonous.

It is unnecessary to speak here of the action of these substances on the system, as this subject will be dealt with in the chapter on Meat Poisoning.

Putrefying flesh is softer and more fluid than the normal. Its colour varies from dark green to black, the latter colour being due to the formation of sulphide of iron. It is often emphysematous owing to gases liberated by the bacteria, and a putrefactive odour is given off The character of the latter depends on the nature of the aromatic substances formed, and that again depends on the species of the microbes. It is a mixture of smells, but that of $H_2S$ often predominates. Sometimes the odour is sour, and that of some well-known substance, such as butyric acid, may be very evident.

*Inspection.*—The general custom is to seize all putrefying flesh. Its poisonous properties will be dealt with in another chapter.

The flesh of game and deer, however, is often eaten when in an advanced state of decomposition, and there are some individuals who like even their mutton to be a little high, to use a popular expression.

The microbic products exercise a peptonising influence on the tissues, which renders them tender. The aromatic substances, moreover, give the flesh a flavour to which many individuals are partial. Nevertheless, it should not be permissible to sell putrefying flesh of any kind. The buyer who prefers to eat rotten flesh may keep his purchase until its condition is to his taste. If any accident should follow, the responsibility will then rest on himself. The method of labelling game or venison with the date on which the animals were slaughtered, too evidently lends itself to fraud to be worth discussing.

Thorough cooking will certainly destroy the microbes and most of the albumoses, which are their most poisonous products; but the flesh might happen to be served in a half-cooked condition.

Every one knows, of course, that the contents of the posterior bowel consist of putrefying organic material, which is usually excreted before the process has gone far enough to produce toxic symptoms. That, however, hardly justifies a wholesale introduction of microbes and their toxines into the alimentary track, for we know that colic follows when the fermentation process is unduly activated, and that cases of poisoning have arisen from the ingestion of putrefying flesh. Moreover, abnormal fermentation processes, such as the butyric, may be set up in the human stomach by the introduction of special microbes. These processes give rise to various forms of dyspepsia. We know also that some pathogenic bacteria, such as the bacillus of malignant œdema, exist in the intestines of most animals without doing any harm. Nobody, however, would care to swallow material which contained these microbes, even supposing that the risk of being infected by way of the alimentary track is not great.

## PHOSPHORESCENT MEAT

Phosphorescent rays are sometimes given off from dead meat, either in the cooked or raw state. This is observed in dark chambers, and it depends on the formation of phosphorus, which is brought about by certain microbes. The phosphorescence appears in about forty-eight hours, and it lasts for about a week, if the flesh does not become putrid. As soon as putrefaction is established the luminous appearance is lost. The best known microbes which cause phosphorescence in flesh are the *Micrococcus pflugeri* (Ludwig) and the ***Photobacterium*** *sarcophilum* (Dubois).

The first is a micrococcus which measures about 1 $\mu$ in diameter. The second is a short bacillus measuring from

1 to 1·5 $\mu$ in length. The luminous phenomena are most active when the flesh is kept at a temperature somewhat below 20° C. It may still be evident at −3° C., or even at a lower temperature, but it begins to disappear above 30° C.

*Inspection.*—The bacteria of phosphorescence are not pathogenic; indeed, the luminous condition often indicates that putrefaction is not advanced. Under these circumstances there is no necessity for interfering with flesh on account of this condition.

## MOULDY FLESH

The surface of a carcase may become covered by greyish, greenish, or black coloured moulds. These appear as a powdery

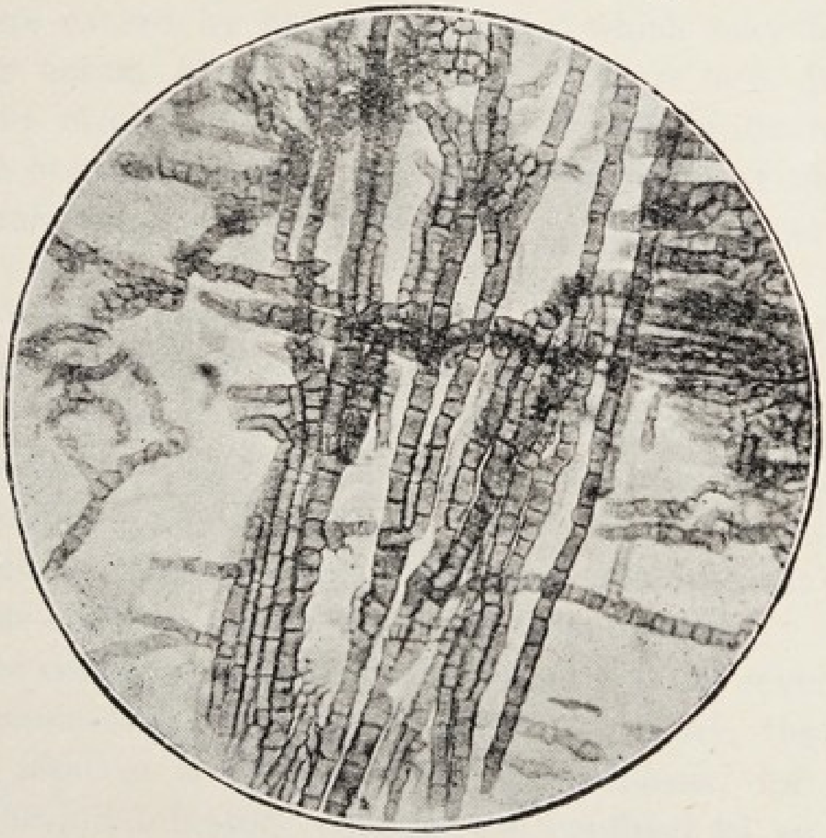


FIG. 8.—Microphotograph of a section from a black mucor spot, showing the mycelium (Henderson).

or downy layer, or as well-defined spots. What would commonly be called "mouldy" flesh is usually putrid, but superficial black spots, formed by the mycelium of various species of mucorini, are frequently met with on carcases that have for a long period been kept under cold storage, and are free from any trace of putridity. The flesh, if it be not in the dried condition, is usually putrid.

*Inspection.*—Since mouldy flesh is usually putrid as well, it should be seized. There is not the same necessity, however, for dealing rigorously with dried flesh, such as hams, when moulds are present on the surface. Indeed, it is very difficult to keep them quite free from moulds. On the other hand, refrigerated carcases must be considered unmarketable when extensively covered with black mucor spots.

# INFLAMMATORY DISEASES

THE diseases consigned to this chapter are those which are generally referred to as sporadic inflammation by clinicians. Many of them are believed to be caused by saprophytic microbes, which have managed to gain a footing in an organism whose natural resistance has been weakened by disease. Some are caused by animal parasites, which may be assisted in their action by microbes; while others are due to the effects of mechanical or chemical irritants. Inflammation of a septic or putrid type is due to the microbes of suppuration or putrefaction gaining access to an inflamed or abraded tissue.

The inflammatory condition is characterised by vascular congestion and the appearance in the tissues of material exuded from the vessels. The exudate contains a great many leucocytes, a variable amount of fibrin, and sometimes a considerable number of red cells. When the disturbance is located in a mucous membrane the exudate may contain numerous epithelial cells—catarrhal inflammation.

If the cause be a specific one, which acts on several organs at the same time, or in a progressive manner, the affection usually receives a special name—tuberculosis, for example. When the inflammatory changes are confined to an organ or to contiguous organs, such as the lungs and pleura, they receive names which signify that the organ is inflamed—pleuritis, for example. If a simple inflammation become septic, however, metastic lesions may be found in remote organs. The specific diseases will be described in special sections; mammitis and septic metritis have been classed with them. The others, which are of interest to the Meat Inspector, will be dealt with here.

## PNEUMONIA

This term is applied to inflammation of the lungs.

*Lesions.*—Two forms of pneumonia are met with—Broncho-Pneumonia and Lobar Pneumonia.

In broncho-pneumonia the inflammation is of the catarrhal type. The vast majority of the cases met with in the animals of the abattoir are due to Strongyli (*see* HOOSE). The lesions seldom cause alteration in the flesh.

In lobar pneumonia the lung tissue over a large area is solid, airless, and sinks when put into water. The pleura may also be inflamed. The consistence of the lung approaches that of the liver, hence it is said to be hepatised.

On section, the surface of the solid part is of a dirty grey and red colour. It has a distant resemblance to a piece of unpolished red granite. At a later stage, when softening of the exudate is taking place, the grey colour is more marked, and a thin pus-like fluid exudes from the cut surface.

The microscope shows that the consolidation is due to the presence of an exudate in the alveoli. The walls of the latter are swollen and infiltrated by cells. The exudate consists mainly of fibrin, with a variable number of leucocytes and red corpuscles.

Gangrene may supervene on pneumonia, or the changes may be of a septic type from the first (*see* GANGRENE and SEPTIC METRITIS).

## PLEURISY

The terms pleurisy and pleuritis indicate that the pleura is inflamed.

The extent of the lesion may be limited to a small patch corresponding to the surface of an abscess in the lungs, the diaphragm, or a lymphatic gland. It may correspond to an area of pneumonia, or it may extend over the greater part of the pleura on each side, while the lungs are little altered.

In the initial stage the membrane is congested in certain parts. It soon becomes swollen, grey, and opaque, however, owing to the appearance of a fibrinous exudate in its substance and on its surface. A turbid and albuminous fluid containing many white cells is present in the chest cavity, but the amount is variable, and may be almost imperceptible.

The exudate on the surface coagulates and forms a false membrane, which may establish a temporary adhesion between two parts of the pleura. If the disease has become chronic, permanent adhesions are formed by proliferation of the fibrous tissue in the two surfaces.

After rupture of the œsophagus or penetration of a foreign body from the second stomach in cattle, a putrid form of pleurisy is often present. The exudate in this case is usually dry and cheese-like, and it gives off a putrid odour (*see* SUPPURATIVE DISEASES, and RUPTURE OF THE ŒSOPHAGUS).

## PERITONITIS

Peritonitis is inflammation of the peritoneum. With the exception of a few traumatic cases and the tuberculous forms, it mostly occurs in cattle and sheep as the result of extension of an inflammatory process from the uterus, and it is of the septic type. The latter, however, may also arise from perforation of the bowel or bladder.

*Lesions.*—The changes consequent upon peritonitis are analogous to those of pleurisy. The septic form will be described later (*see* SEPTIC METRITIS).

## PERICARDITIS

Inflammation of the pericardium in animals of the abattoir arises almost always from traumatism, or as a complication of another disease.

*Lesions.*—They are similar to those seen in other serous membranes. In cattle the commonest cause is the penetration of a foreign body from the second stomach (*see* SUPPURATION IN THE HEART). The heart wall is usually implicated to some extent—Myocarditis.

## ENDOCARDITIS

Inflammation of the internal lining of the heart is most frequently seen in pigs. It is referred to in the section on Swine Erysipelas. In sheep and oxen the lesion is very rare.

Nodular vegetations are found on the valves, and the cusps are distorted.

## NEPHRITIS

Nephritis means inflammation of the kidney. It may appear as a complication of certain infectious diseases, such as swine fever; but it may also arise independently from the penetration of microbes to the kidney by way of the urino-genital track, or from the administration in poisonous doses of irritant drugs, such as turpentine, which are excreted by the kidneys.

*Lesions.*—The changes may be either acute or chronic in type. They may be confined principally to the lining of the tubules—*Catarrhal* or *Tubal Nephritis*—or they may be located in the intertubal tissue—*Interstitial Nephritis*. Finally, the inflammatory process may result in the formation of pus in the kidney substance, and the nephritis is then termed *suppurative* or *purulent*.

Acute tubal nephritis is seldom seen in the abattoir, but the acute interstitial form is by no means rare in pigs, and a good many chronic cases are met with in cows.

In the acute forms the kidney is congested. The Malpighian bodies are prominent, the surface of section is mottled, and the consistence of the tissue is sometimes pulpy.

In the chronic forms the capsule is often adherent; the organ is paler, harder, and sometimes smaller than normal, owing to contraction of new tissue. The surface may be irregular. Large hæmorrhages may be found in the substance of the organ. In the tubal variety the microscope shows that the epithelial cells are desquamating, and a catarrhal exudate, mixed with leucocytes, red blood cells, and albumin, is present in the tubules. Some of the lining cells are cloudy, or fatty.

In the acute interstitial form the intertubal tissue is infiltrated by leucocytes, and in chronic cases a considerable amount of new fibrous tissue is formed. The latter obliterates many of the tubules and vessels.

If a tubule be blocked by exudate or new tissue, its proximal part may become dilated into a cyst by the accumulation of urine. Should the ureter become occluded, the whole kidney may become cystic; that is to say, the kidney substance undergoes atrophy owing to the pressure of the accumulated fluid. The purulent type of nephritis has two principal forms, viz., pyæmic nephritis and pyelo-nephritis. The former is characterised by the formation of numerous small or miliary abscesses in both kidneys, and mainly in the cortical layer. The starting-point of such abscesses is the arrest in the capillaries of pyogenic bacteria which have been circulating in the blood. In the second form, or pyelo-nephritis, either one or both kidneys may be involved; the abscesses are generally fewer but larger than in the pyæmic form, and they are mainly situated in the medullary layer. The suppuration is determined by bacteria which have gained the pelvis of the kidney (by way of the ureter, from the bladder), and from that point have invaded the kidney substance.

## OSTEITIS

Osteitis is inflammation of bone. It is usually accompanied by periostitis, and masses of new bone may be formed. The affection runs a chronic course, and the muscles around the bone may be implicated. The muscles in the immediate neighbourhood may show lesions of chronic myositis. The results of suppurative osteitis are referred to under SUPPURATION.

*Inspection in the case of Inflammatory Diseases*

Acute inflammatory diseases are always accompanied by elevation of the temperature, so that the carcase may have to be condemned on account of the fevered condition of the flesh. In chronic cases the flesh may be of good appearance, but the affected parts should all be removed before the carcase is allowed into the market. It may even be necessary to strip off the pleura. When the inflammation has been septic in character, the flesh is usually of bad appearance if the affected area is at all extensive. It is dark in colour, flaccid, soapy to the touch, and, in addition, is apt to putrefy rapidly. Under such circumstances the carcase should be seized.

In cases of chronic endocarditis and nephritis the whole carcase may be dropsical, but one is sometimes surprised to find how extensively diseased these organs may be without the production of alterations in the flesh.

# DISEASES OF THE BLOOD

FOR want of the necessary information for forming a more correct classification, certain pathological conditions have been classed as diseases of the blood. It must be understood, however, that the alterations in the blood arise from ill understood, though sometimes perfectly apparent, changes in important organs.

## ANÆMIA

This term in its widest sense means deficiency in any constituent of the blood, but it has come to have a more restricted meaning. One generally understands by anæmia that the red cells are below the normal number — *Oligocythæmia*, or that the hæmoglobin is deficient. These conditions can only be diagnosed with certainty by examining the blood of an animal during life, or while it is being bled. The hæmocytometer is necessary for counting the red blood corpuscles,[1] and the hæmoglobinometer for estimating the hæmoglobin.

It will not be necessary for the inspector to make such minute observations on the blood, however, as he is only concerned when the flesh is altered. The severe or pernicious form of anæmia in animals is caused only by blood parasites (*see* PROTOZOA); but a milder variety, which corresponds to

[1] The Editor has made a considerable number of observations on the blood of apparently healthy cattle and sheep, and he finds that the average number of red cells per cubic millimetre is six millions in cattle and nine and a half millions in sheep. The hæmoglobin of bovine animals average 68 per cent. (lowest 55 per cent.) on Von Fleischl's scale, and that of sheep 58 per cent. (lowest 52 per cent.).

chlorosis of human pathologists, is met with as the result of some chronic diseased condition.

The flesh of truly anæmic animals is paler than normal, flabby, watery, and emaciated. Small punctiform hæmorrhages are sometimes present in the muscles and on the serous membranes. The cachectic condition produced by certain parasites, such as the liver fluke, is usually put down to anæmia; but there are no observations sufficiently definite to show that this view is pathologically correct. In cases of this kind, however, the exact pathological condition is of secondary importance to the Meat Inspector; for he should seize emaciated and watery carcases whether the cause be anæmia or not.

## LEUCOCYTHÆMIA

This is a disease in which the white cells of the blood are permanently increased in number, the increase being accompanied by enlargement of the lymphatic glands or the spleen, and by alteration in the bone marrow. All these organs may be simultaneously altered.[1]

In some of the bacterial diseases which run a chronic course, and in pregnant females, the leucocytes are slightly increased in number, but the glands throughout the body are not enlarged. The cause of leucocythæmia is still unknown, but there is a tendency to regard it as a bacterial disease.

*Animals affected.*—Leucocythæmia is rarely seen in the animals used for human food, although, according to the Editor's experience, it is not a very rare disease in dogs. Only one or two cases have been described in cows and pigs. Human beings sometimes suffer from this disease.

*Lesions.*—Changes may be present in the bone marrow, the spleen, the lymph glands, and the organs. The marrow

[1] Pseudoleukæmia is a condition in which the lymph glands are enlarged without any marked increase in the number of white corpuscles. So far as the Editor is aware, this disease has not been observed in the animals of the abattoir.

is regarded as the most constant site of lesions. Clinicians speak of a *myelogenous* form in which the abnormalities are seen mainly in the marrow, a *lymphatic* form in which the lymph glands are the principal organs diseased, and a *splenic* variety in which the spleen is enlarged. Combinations of the foregoing are also recognised. Thus we hear of *Lymphatico-splenic* and *Spleno-medullary leucocythæmia.* These are all manifestations of the same disease, the blood-forming organs being the seat of disturbance. The flesh is very pale in colour, and it may show hæmorrhages.

Blood.—The blood is lighter in colour than normal; in very bad cases it looks like a mixture of blood and pus. White clots are present in the heart. The blood gives off a peculiar sickly odour. It coagulates slowly, and the buffy coat is very distinct. On examining the blood under the microscope, the white cells are found to be more numerous than normal, and the octahedral crystals of Charcot and Leyden appear. If the white cells be counted during the life of the animal,[1] it will be found that they are increased absolutely and relatively to the red corpuscles. The proportion of white to red in leucocythæmia may be as high as 1 to 12.

Lymphatic glands.—The glands throughout the body are enlarged, it may be to three or four times the normal size. Small groups of glands, which usually pass unnoticed, stand out prominently. On section, their substance has the consistence of brain tissue, and a creamy fluid exudes from the surface.

The microscope shows the glands to be packed with lymphocytes.

Spleen.—The spleen may be enlarged to several times the normal. In a case observed by the Editor in a horse, the spleen weighed nearly 80 lb. The capsule is much thickened.

[1] A special hæmocytometer pipette is necessary for this operation. The number of white cells in the blood of a healthy animal varies according to the time of day at which the examination is made. The Editor has seldom found them to exceed 12,000 per cubic millimetre in the ox or sheep. The proportion of white to red is 1 to 900 or 1 to 1100.

On section, the consistence is pulpy, and the colour is that of crushed strawberry. In some cases the Malpighian bodies stand out prominently like large grains of sago, but in others they do not appear to be altered.

The microscope shows that the non-striped muscle cells in the capsule and trabeculæ are increased in number. The substance of the organ is densely infiltrated with leucocytes. When the Malpighian bodies are enlarged they are found to be similarly infiltrated, and they may merge into each other.

There is no likelihood of this lesion being mistaken for anthrax. The absence of the tarry appearance of the pulp, which is characteristic of the anthrax spleen, is of itself a sufficient distinction.

Bone marrow.—If a long bone be split longitudinally, the red marrow appears of the same colour as the blood. Cover-glass preparations show that the white cells are exceedingly numerous, and many nucleated red cells may be seen.

The other internal organs may show no macroscopic change, but the microscope often reveals the presence of many small collections of leucocytes in their substance. These might easily be mistaken for small abscesses or miliary tubercles; probably they are bacterial in origin. In the liver the capillaries may be so dilated that they can be seen with the naked eye as light red streaks.

*Inspection.*—In most cases the condition of the flesh and the contained glands would warrant the withdrawal of the carcase from the market. If it be true that leucocythæmia is a bacterial disease, the microbes must travel all over the body, because lesions of a kind are found in most of the organs. Keeping in mind the fact that human beings suffer from the disease, the Editor is of opinion that total seizure should be applied in all cases, whatever be the condition of the flesh. It is but right to state, however, that attempts to transmit the disease to animals by experimental methods have failed, or given only doubtful results.

# BACTERIAL DISEASES

Although several of the bacterial diseases are common to man and animals, it does not follow that they are likely to be transmitted to human beings through the medium of butcher meat.

In a book on "Meat Inspection," the most suitable arrangement of the bacterial affections would be to divide them into two classes, viz., those which are transmissible from animals to man, and those which are not. Unfortunately, this classification is not possible, because it sometimes happens that the name of a disease of human beings has been applied to one, or maybe more than one, totally different affection in animals.

The Editor, after many unsuccessful attempts, has had to abandon the idea of such an arrangement. The reader will observe that in the following pages the bacterial diseases first described are those which are characterised by actual lesions, and that those caused by moulds have been included. The specific bacteria of some of the affections have not as yet been isolated, but nobody doubts that the diseases are bacterial in origin.

## TUBERCULOSIS

Tuberculosis is a contagious disease caused by the growth of the tubercle bacillus in the tissues.

Since 1882, when the tubercle bacillus was isolated from the lesions by Koch, and shown by him to be the cause of tuberculosis, the disease has been the subject of many valuable papers and a great deal of controversy. The identity of the disease in human beings and animals, and the possibility of the one infecting the other, render of the first importance those points in the pathology of tuberculosis which concern the Meat Inspector. It is not advisable in a volume of this kind to report the many sharp and lengthy discussions from which have emanated our present ideas regarding the duties of a Meat Inspector when dealing with a tuberculous carcase. The object will be rather to state and explain these ideas, avoiding controversial subjects so far as one may in a treatise on meat inspection.

*Animals affected.*—Although some species and certain individuals of the same species are undoubtedly less susceptible to the disease than others, none possesses an absolute immunity. In judging the relative susceptibility of different individuals or races to tuberculosis, it is difficult to estimate how much of this is due to inherent or acquired conditions of the system, and how far opportunity of contracting the disease is responsible for the so-called predisposition. By far the greatest factor in the spread of tuberculosis is certainly the relative frequency of the tubercle bacillus in close proximity to animals.

Without the *bacillus tuberculosis* the disease cannot be contracted even by the most weakly animals ; but, given its presence in a dwelling or in the body of a companion, the strongest is not absolutely free from the danger of infection. The disease is most frequent in our more domesticated races of cattle, but it spreads, though with less rapidity, in those living in a more natural state of existence, if the bacillus once gains a footing in some member of the herd.

If one may judge from the frequency of occurrence, the human species must be placed in the first rank of susceptibility.

Of the domesticated animals the disease is most prevalent in cattle. Cows are much more frequently its victims than oxen, but that is to be attributed largely to the hygienic conditions under which the former live, and to the fact that their term of life is usually longer. Calves are seldom found to be tuberculous at the age when they enter the abattoir. The disease is still more infrequent before that age, notwithstanding the fact that so large a proportion of cows are affected. Congenital tuberculosis in the calf is rare, rarer even than tubercle of the uterus in the cow, on which it may be safely assumed to depend. The truth is that few of the abattoir calves have had time to be infected since they saw the light of day, and that the custom which exists in many parts, of removing them almost immediately from their mothers, renders the chance of infection very small. Sufficiently representative statistics to convince one of the rarity of tuberculosis in calves will be found below. They are an insurmountable argument against the theory of hereditary transmission of tuberculosis. There are others equally strong, but it would be out of place to discuss them here.

Next to the ox in point of frequency comes the pig, but the proportion of pigs found in the abattoirs to be tuberculous is far inferior to that of cattle.

Tuberculosis in the sheep and goat is very rare in this country, so rare that the number affected is negligible.

In the birds of our farms and covers, tuberculosis is by no means uncommon. Indeed, the disease is very prevalent, and on some hen-runs its ravages amount almost to a holocaust.

The following statistics from abattoirs in different parts of the world give some idea of the prevalence of tuberculosis in the different animals used for human food.

It is to be remarked, however, that such abattoir statistics as are available in this country give a very inadequate idea of the number of tuberculous cattle. The rules relating to the passing of the carcases of tuberculous animals are more stringent in some places than in others, and in a great number of towns there is practically no inspection. This is especially the case where private slaughter-houses exist.

It is to the less inspected abattoirs that many of the suspected animals are purposely sent, and the inhabitants of the towns concerned have themselves to blame for any evil consequences if they do not compel their city fathers to afford them protection by providing adequately qualified Meat Inspectors.

In Edinburgh, for example, where the inspection is adequate, about one hundred cows are sent out weekly from the byres to be sold in the market, and although all are meant for slaughter, less than one-fourth of them find their way to the city abattoir. The others are sent away, a goodly number to certain places where the inspection is notoriously inadequate.

## STATISTICS FROM ABATTOIRS

Mr. Riddoch, M.R.C.V.S., Chief Veterinary Inspector, has kindly furnished the Editor with the following statistics of animals condemned for tuberculosis in the Edinburgh abattoir during the years from 1893–97 :—

| Year. | Kind of Animal. | Total Number Slaughtered. | Condemned for Tuberculosis. |
|---|---|---|---|
| | | | Per cent. |
| 1893 | Cattle (exclusive of cows) | 28,261 | ·046 |
| ,, | Swine . . . . . | 3,809 | ·026 |
| ,, | Calves . . . . . | 6,852 | — |
| 1894 | Cattle (exclusive of cows) | 28,976 | ·034 |
| ,, | Swine . . . . . | 5,335 | ·075 |
| ,, | Calves . . . . . | 7,061 | — |
| 1895 | Cattle (exclusive of cows) | 30,137 | ·046 |
| ,, | Swine . . . . . | 6,248 | ·224 |
| ,, | Calves . . . . . | 6,923 | — |
| 1896 | Cattle (exclusive of cows) | 30,161 | ·073 |
| ,, | Swine . . . . . | 7,295 | ·150 |
| ,, | Calves . . . . . | 6,224 | — |
| 1897 | Cattle . . . . . | 29,125 | ·410 |
| ,, | Cows . . . . . | 2,162 | 4·718 |
| ,, | Calves . . . . . | 5,756 | ·017 |
| ,, | Swine . . . . . | 7,458 | ·040 |
| 1898 [1] | Cattle . . . . . | 30,722 | ·023 |
| ,, | Cows . . . . . | 1,936 | 6,404 |
| ,, | Calves . . . . . | 5,371 | ·037 |
| ,, | Swine . . . . . | 6,218 | ·064 |

[1] Taken from report of the Chief Sanitary Inspector.

Through the kindness of Dr. Williamson, Chief Sanitary Inspector, the Editor has been allowed to prepare the following statistics from the books of the Edinburgh abattoir. They deal with the cases of tuberculosis in bovine animals observed during the year ending November 1899.

Out of 1312 cows slaughtered, 129 were condemned on account of tuberculosis (*i.e.* 9·5 per cent.). About 2 per cent. of the tuberculous cows are passed for food. This would bring the total number of affected cows up to, say 150, or 11·4 per cent.[1]

Tuberculous lesions were found in the udder in 23·3 per cent. of the tuberculous cows.[2]

From these numbers it would appear that the proportion of dairy cows with tuberculous udders is 2·6 per cent. (total number examined, 1312). The Editor thinks, however, that 2·6 per cent. is in excess of the truth—first, because the veterinary inspectors are very strict in dealing with suspicious cases of udder disease in the city byres ; and, secondly, because most of these cases find their way to the city abbatoir, as nobody will buy them in the market, owing to the apparent disease of the udder and their want of condition. A good number of the other cows sold in the market go to towns where inspection of meat is less strictly performed. Many of these are affected with the disease, although their udders are healthy. If they were all slaughtered in Edinburgh the proportion of tuberculous udders in tuberculous cows would be less. The proportion of tuberculous cows with uterine lesions was 3·3 per cent., and it is interesting to know that only one case of congenital tuberculosis has been observed during the last five years. The average number of calves slaughtered is about 6000 yearly. The subjoined table shows the distribution of

[1] No record is kept of the tuberculous carcases passed, but, judging from experience, the above is a fair estimate of the number of cows. Of course the proportion of tuberculous carcases of the young beasts passed will be higher.

[2] Most of the doubtful cases were referred to the Editor, who submitted the udders to a microscopical examination before pronouncing on the nature of the lesion.

the tuberculous lesions in the various organs of bovine animals ; 95·2 per cent. of the cases were met with in cows :—

| | Per cent. | | Per cent. |
|---|---|---|---|
| Lung | 93·4 | Spleen capsule | 21·1 |
| Pleura | 80·0 | Pericardium | 5·8 |
| Bowel and mesenteric glands[1] | 65·6 | Kidney | 5·1 |
| Peritoneum | 61·3 | Uterus of cows | 3·3 |
| Liver | 54·0 | Bones | 1·4 |
| Udder of cows | 23·3 | Ovary of cows | 1·5 |

[1] Ulcers were found on bowel in 2·1 per cent. of these.

The proportion of acute miliary cases was 6·5 per cent. of the tuberculous. It is interesting to note this, because such a small proportion, relatively to the number of udder cases, makes it difficult to believe that the mammary gland is invaded only by way of the blood stream.

*The microbe.*—The microbe is a rod-shaped bacillus, measuring commonly about 3·5 $\mu \times$·3. The rods are either straight or curved, and they are rounded at their ends. When stained they often show a number of clear refractile spaces in their protoplasm. They are found among the cells of the tubercle or inside the giant cells. Some of them occur singly, others are arranged in clumps or rosette form. They can be stained well by the Ziehl-Neelsen method or by that of Ehrlich. Gram's method is also suitable. It is worth while noting that the bacilli are sometimes present in very small numbers in the lesions. It may be necessary to mince up a nodule on a slide or cut sections of the tissue in order to demonstrate them. In a few cases their presence can only be revealed by inoculation.

*The identity of tuberculosis in man and animals.* — Although Villemin in 1865 demonstrated that tuberculous material from men or cows could produce tuberculosis in rabbits if inoculated under the skin, it was not until after the discovery of the bacillus of Koch that the contagious nature of the disease and its identity in human beings and animals began to be generally recognised.

Koch himself, as the result of his earlier investigations into the etiology of tuberculosis, regarded the bacilli found in the lesions in man and the lower animals as identical, but at the Congress for the study of tuberculosis, held in London in 1901, he espoused the view that the bacilli which are the cause of human tuberculosis are different from those which cause the disease of the same name in cattle. The investigations which have since been carried out in this and other countries, and notably those conducted by the Royal Commission on Tuberculosis appointed in 1901, appear to have established the following facts :—

The bacilli which are the cause of bovine tuberculosis (bovine type) tend to form meagre growths on artificial media (dysgonic), and are intensely pathogenic by inoculation to cattle, especially calves, and also to rabbits and guinea-pigs. In a variable proportion of cases of human tuberculosis, mainly those having their starting-point in connection with the alimentary canal or its associated lymphatic glands, the lesions contain bacilli identical in all respects with bovine bacilli. It therefore seems impossible to doubt that such human cases result from infection with bacilli derived from tuberculous lesions in cattle or other animals.

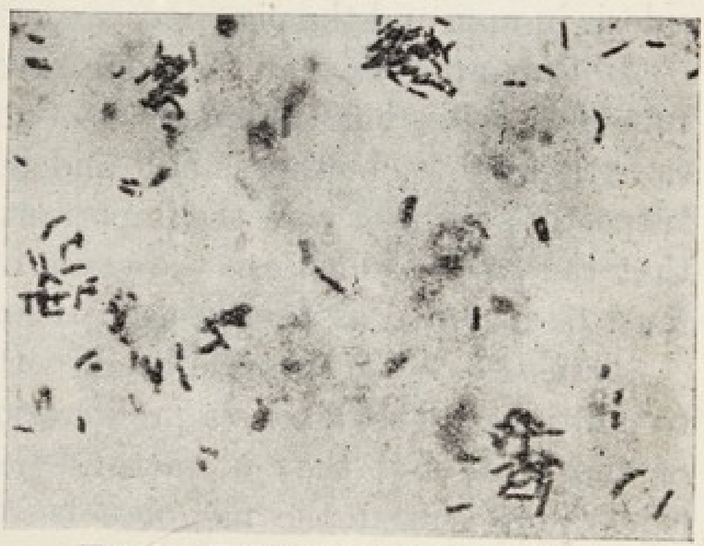


Fig. 9.—Tubercle bacillus. ×1000.
(Bovine)

In the majority of cases of human tuberculosis the lesions contain bacilli which differ from those found in cattle in that they grow more luxuriantly on artificial media (eugonic), and are only feebly pathogenic when inoculated into cattle or rabbits (so-called human type). In a small proportion of cases the bacilli found in human lesions present characters more or less intermediate between the bovine and the common human type.

In tuberculosis of the pig the bacilli present are generally of the bovine type, but occasionally they appear to be identical with those which are the cause of tuberculosis in birds. In tuberculosis of birds (avian tuberculosis) the bacilli present certain cultural differences which distinguish them from the mammalian (human and bovine) types, and they are also characterised by being highly pathogenic for the fowl and only feebly pathogenic for any of the domesticated mammals. They are, however, infective by inoculation to the rabbit, and bacilli of this type have been found present in cases of tuberculosis in man and the pig.

It thus appears that there are several varieties or types of tubercle bacilli, but the question of the precise relationship of these types to each other is still undetermined. From the Meat Inspector's point of view the important fact in this connection is that the bacilli which are the cause of tuberculosis in animals must be regarded as dangerously pathogenic for human beings.

*Lesions.*—When tubercle bacilli settle in a tissue, they begin to multiply. They excite a proliferation in the fixed tissue cells of the part, and they attract the leucocytes towards them. The result is that the microbes become surrounded by cells, which are apparently bent on destroying the invaders. This is the commencement of the so-called tubercle, and it first makes itself evident to the naked eye as a greyish-white speck about the size of a millet-seed. Every tubercle, then, is a miliary one to start with.

The tissue cells may triumph over the bacilli and prevent further mischief, but in a very large number of cases—one cannot say in what proportion—the result is not so fortunate.

Usually the miliary tubercle continues to increase in size, and bacilli are carried to adjacent parts, where they start fresh tubercles. These adjacent tubercles coalesce and the growth assumes the proportion of a nodule. During the growth of the bacilli they elaborate certain products, some of which cause the cells to undergo a cheese-like or caseous degeneration.

The nodules commonly vary in size from a pea to a nut, but caseous areas of much greater extent may be formed from confluence. The smaller nodules consist of a yellowish centre of caseous material and a firmer greyish periphery, which is sometimes fibrous. The consistence of the caseous material varies from that of thick pus to that of ordinary cheese, but the less purulent tubercles are often infiltrated with gritty calcareous matter. More rarely the tubercles assume the form of small grey fibrous nodules about the size of a hemp-seed. The latter form is sometimes seen in the lungs of pigs and oxen. The nodules are found throughout the infected organ in numbers varying from two or three to many hundreds.

When tuberculous lesions come under the eye of the pathologist, they are acute miliary or chronic nodular in form. By acute miliary tuberculosis one understands — first, that the tubercles in one or more organs are all of nearly the same size, viz. about that of a millet-seed ; secondly, that they are equally and densely distributed throughout the organ on the course of its capillaries.

When the lesions have the above distribution, the disease is said to be generalised ; that is to say, the bacilli have been in the blood stream, and consequently may have reached any organ in the body.

In the chronic or nodular form, the tubercles are not so numerous nor so densely packed in the organ. They are of different sizes or ages, and most of them are much larger than a millet-seed.

The microscope shows that in the earlier stages the tubercles consist of a few large epithelioid cells which have arisen from the fixed tissues, and some leucocytes are present.

The bacilli are so few that their presence may be overlooked, if only one or two sections be examined. About the tenth day, giant cells appear in the growth. These are large multinucleated cells. They have a homogeneous yellowish-looking centre and several nuclei towards the periphery. The giant cells are supposed to arise from fusion of several contiguous small cells, or from repeated division of the nucleus of one cell without a corresponding separation of the cell protoplasm.

In the older tubercles the giant cells are more numerous, yellow structureless patches of caseous material are seen, and a greater number of bacilli are present. Fibrous tissue may be

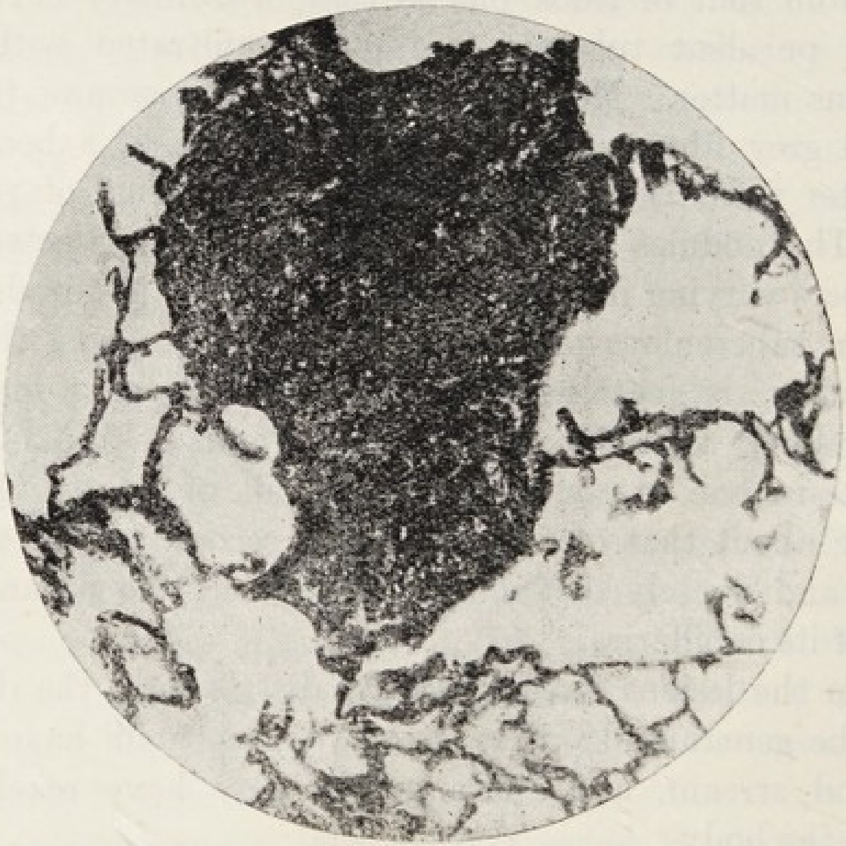


Fig. 10.—Tuberculous nodule in lung of cow (Reichert, obj. 3). The lung tissue around the nodule is emphysematous.

seen forming at the margin of the tubercle, or it may be completely encapsuled in a fibrous shell and infiltrated with salts.

When the preparation is suitably stained, the bacilli are seen singly or in clumps between the cells and inside the giant cells.

The above may be described as the typical appearance, if such an adjective can be applied to the structure of a tubercle.

More rarely the giant cells are absent from a tubercle, and the bacilli may be so few that very laborious searching with the microscope is necessary to find them. The amount of fibrous tissue in the latter cases is generally great ; there may be caseous centres in the still cellular parts, or degeneration may be absent.

In the tuberculous lesions of the fowl giant cells are generally absent.

*Pathognomonic character of the lesions.*—Strictly speaking, the only specific components of the tubercle are the bacilli. They may, however, be too few in number to be revealed by the microscope, and inoculation to animals would but little serve the purpose of the Meat Inspector.

In the absence of the bacillus, then, it is important to know what weight can be attached to the historical structure of the tubercle.

Martin has shown that materials other than tubercle bacilli, such as cheese, pepper, lycopodium seeds, cantharides, and mercury give rise to a similar formation when introduced experimentally into the tissues. Dead tubercle bacilli produce the same effect. Again, the embryos of the *Strongylus rufescens* give rise to somewhat similar tubercles in the lungs of sheep and goats.

In the lungs of pigs we meet with the same kind of lesions caused by the embryos of *S. paradoxus*.

What is to guide us, then, in forming an opinion of the character of the tubercle when the bacillus cannot be found ? There are several points of great importance in this respect, viz. :—

1. None of the other bodies produce caseation to the same extent as living tubercle bacilli.

2. The true tubercle is a progressive lesion, whereas the pseudo-tubercle remains local.

3. The species of the animal under examination ; true tuberculosis is rare in the sheep and goat.

4. The absence of other parasites capable of exciting the same kind of growth. The latter are chiefly the actinomyces in the ox and pig, the glanders bacillus in the horse, and the before-mentioned animal embryos in the sheep, pig, and goat.

Practically there is small chance of error when dealing with the ox and sheep, in this country at least. In the ox about 99 per cent. of tuberculous-looking lesions in the internal organs will be found due to the tubercle bacillus. In the sheep and goat an even larger proportion of the lung tubercles are caused by parasitic embryos.

Other important points in the differential diagnosis will be more easily dealt with when considering the disease in the different organs, and in the chapters upon other diseases with similar lesions.

*Tuberculosis in the different organs and the paths of infection.*—Primary infection takes place in the majority of cases by way of the respiratory or alimentary tracts. The difficulty of experimentally infecting animals by causing them to ingest tuberculous material is well known. The gastric juice destroys many of the bacilli before they can pass to the tissues. Nevertheless, positive results can be obtained by using large quantities, and cases of natural infection by way of the alimentary tract are too numerous to allow one to make light of this mode of incursion. The possibility of infection by subcutaneous inoculation, by way of the teats in the cow, and by the urino-genital tract, is undoubted, but the bacilli seldom enter the body ~~of~~ by those paths. The primary lesions, then, will be found mostly in the respiratory and alimentary tracts or in the glands which are in direct communication with them, for some post-mortem examinations leave a strong impression that tubercle bacilli may enter an organ such as the lung, and pass to the glands, without giving rise to any preliminary lesion of the organ they first came in contact with. That, at least, is the only feasible explanation one can give of such primary lesions as we find in the bronchial, mediastinal, and pharyngeal glands. In cases of congenital tuberculosis, however, the primary lesions are found in the liver or in the retrohepatic glands. Once the tubercle bacillus has gained a decided footing in a tissue, it by degrees infects neighbouring parts, and the related lymph glands are generally invaded in a comparatively short time.

Miliary Tubercle of Pleura.

Piece of lung—external view—with the grape-like masses of Tubercle connected together by fibrinous bands.


Portion of Inferior Border of Lung of Cow, showing—

*a. a. a.* Sessile Masses on the surface of the Pleura.
*b. b. b.* Pedunculated Masses growing from the Pleura at the extreme border—Dr. Crichton's festoons.

Lymphatic Gland (Bronchial) of Cow, laid open to show the deposition of caseous and calcareous Tubercle in its interior—mainly at its hilum—with detached smaller masses.

The tissues react to the presence of the bacilli by throwing around them a cordon of cells, which for a time impedes their further advance. In a time, however, commensurate with the activity of the bacilli and the resistance of the organism to it, the barrier is cleared, and fresh areas are invaded.

Suppose the bacilli to have established themselves on some lymph gland, they are arrested for such a time as the cells hold out, then they pass on and on until the last barrier which separates them from the main veins is cleared. Once in the veins, they pass through the right heart and commence their peregrination of the organs. The foregoing is probably the usual manner of generalisation, but there are other possibilities. A tubercle in the lung might penetrate a branch of the pulmonary veins and pour its bacilli into the left auricle (M'Fadyean), or a similar accident might happen to a vessel more remote from the heart. It is probable that an occasional bacillus will be carried into the circulation by the leucocytes, but it is also probable that in such small numbers they are not likely to give rise to distinct lesions. In any case, we need not fear a true blood stream contamination by this method. Given the bacilli in the right heart, it does not follow that they will take up their abode in every organ of the body. The majority of them are arrested in the capillary filter of the lungs, a comparatively small number passing through to the left heart. It is almost inconceivable that the microbes, when they reach the arterial circulation in considerable numbers, do not enter most of the organs, but for reasons ill understood they show little tendency to form a permanent settlement in some of them. It may be that the vessels of certain organs are less able to retain the microbes, that they have been arrested in too small numbers to produce a distinct lesion, or less probably, that they have found a soil unsuitable for their development. Be this as it may, the recent researches of M'Fadyean show clearly that in experimentally generalised cases of tuberculosis of the ox, even when very large numbers of bacilli are inoculated, well-marked acute miliary lesions may be present in the lungs, while other organs, such as the spleen, liver, and kidney, may not even show microscopic tubercles. Moreover, it is a notorious fact that the muscles are quite exceptionally the seats of tuberculous lesions, although they are often invaded by bacilli.[1]

The foregoing remarks are important to bear in mind when the inspector has to decide whether generalisation has taken place or not, but they are not to be interpreted as meaning that there would be no risk in eating the organs from a generalised case when these may show neither macroscopical nor microscopical lesions. Inoculation experiments on animals with the juice expressed from such organs have given many positive results, hence a certain amount of risk must be admitted, whatever be its degree.

The order in which the bacilli from a certain starting-point invade the different organs is of cardinal importance to the inspector. Unfortunately, however, the succession of events in one species can only be applied to others in a general sense, and this problem has not been the subject of the same amount of experimental investigation in all. Particularly is this the case in the larger animals, whose price has prevented them from figuring largely in experimental pathology. In the absence of the more positive information which one acquires from a large series of experiments designed with the above object in view, much of our information regarding the progression of the lesions has been gathered from post-mortem examination of natural cases. Where it is possible to form an opinion of the relative ages of the lesions in two or more organs, we may correlate our ideas and obtain fairly exact information regarding the order and manner of invasion. A careful consideration of the experimental information available will further assist us in coming to a conclusion.

Arloing, and more recently Delépine, have traced the progress of experimentally produced lesions in the guinea-pig.

[1] The Editor has on one occasion examined a cover-glass preparation of muscle juice, in which tubercle bacilli were abundantly present. This, however, is quite exceptional.

If a guinea-pig be inoculated in the thigh with tuberculous material, the lesion spreads unilaterally to the inguinal glands, then to the sublumbar lymphatic ganglia, next to the spleen and retrohepatic glands, from there to the liver, and next to the bronchial glands and lungs. Once the diaphragm is passed, the lesion no longer spreads in a unilateral manner. The bronchial glands and the lungs are affected, and the other glands on both sides of the body become tuberculous. The infection spreads later to the glands below the diaphragm on the side opposite to that inoculated. When the primary infection takes place at an anterior extremity (the base of an ear), the lesions follow a similar course in the opposite direction.

There would be a risk of error in applying *in toto* to other animals what takes place in the guinea-pig, since the lesions do not follow the same course in the rabbit. Moreover, there are some points regarding this manner of progression which require to be cleared up before drawing too sweeping deductions from it. It would be useless, however, to discuss these at present, but apparently the infection may spread along the lymphatic system in what seems to be a backward direction, according to our ideas of the direction taken by the lymph stream.

The experiments of G. Colin, performed on young oxen before those of Arloing on guinea-pigs, show that the course of invasion is much the same in the former animals as in the latter.

This chapter would hardly be complete without referring to the methods whereby the different organs may become secondarily infected. For convenience, the anatomical changes in each, in so far as they vary from the usual, will be described at the same time. To save repetition, the reader is referred to the description of the typical tubercle already given. He is reminded that any organ may be invaded by its blood supply and show the acute miliary lesion.

Blood.—The bacilli do not remain long in the blood; they are soon filtered off by the various capillary networks. The researches of Nocard, M'Fadyean, and Leclainche show that the blood loses its virulence in from four to twenty-four hours.

The later experiments of M'Fadyean, however, show that it may become virulent again owing to a fresh eruption of bacilli. It is impossible to establish the virulence of the blood except by inoculation.

The larynx, trachea, and lungs.—The larynx and trachea are probably infected by mucus from a diseased lung. They show ulcers on the mucous membrane. Notwithstanding the frequency of pulmonary lesions, the trachea and larynx are seldom affected with tuberculosis.

The lungs may be infected primarily by way of the bronchial tubes. They may also be invaded in a backward

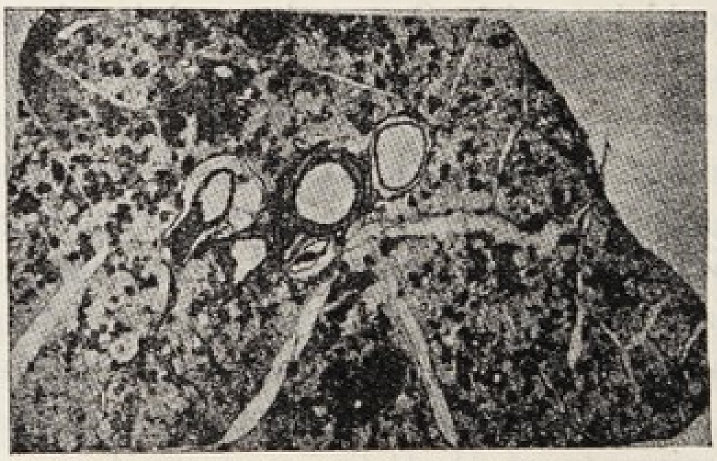


Fig. 11.—Section of lung, showing miliary tuberculosis (nat. size).—M'Fadyean.

direction from the bronchial glands. A healthy part of the organ may be infected from a diseased part by way of the lymphatics or by contaminated mucus passing into its bronchial tubes and alveoli.

The most common form of lesion is a tuberculous broncho-pneumonia. A variable number of caseous nodules are found in the parenchyma, or quite a large tract may be converted into a cheesy mass. Sometimes in the pig, less frequently in the ox, the tubercles are grey and fibrous, showing little tendency to become caseous.

An acute miliary lesion may have supervened on a chronic one. It is in the lungs that one finds the most distinct


External Surface of a Lobe of the Liver of a Hen, showing lesions of Tuberculosis.

*a.* Distended Capillaries of its Capsule.

embolic lesions, as, owing to their situation and vascular arrangements, they can hardly escape when bacilli get into the circulation. It is in the lung that one looks for evidence of generalisation having taken place. It is conceivable, however, that one may meet with cases in which generalisation has taken place so recently that the disseminated embolic lesions are not evident to the naked eye.

The Editor has met with several cases of advanced tuberculosis in which all the signs of multiple embolism, congestion of large capillary areas, and slight œdema of the lung tissue, were present. Such an appearance should be looked on with suspicion.

Lymphatic glands.—The different glands of the body are usually infected by the lymph stream from other glands in line with them or from affected organs drained by them. Attention has already been drawn to the possibility of the infection operating by the lymph paths in what is apparently a backward or centrifugal direction. For example, the pharyngeal and submaxillary glands may be infected by material taken in by the mouth or by mucus expectorated from a diseased lung, and a primary lesion in the pharyngeals may spread to the prescapular, prepectoral, and other glands of the part, or they may be all ultimately infected backwards from the pleura. The glands in the abdomen may be infected from the intestine or from the inguinal glands in a few exceptional cases outside those induced by experimental inoculation. Apparently, however, the former may in a backward direction infect the latter and the supramammary glands.

At first the gland becomes swollen and œdematous, and it may be in this condition for some time before macroscopical tubercles can be seen. Swelling and œdema of a lymph gland must always be regarded as suspicious in a tuberculous carcase. In the ox and pig the tubercles in the glands are often calcified.

Pleura.—The pleura may be infected from the glands of the chest or by direct extension from the lung itself. Once the disease is started in one part of the membrane, the bacilli may be carried to other parts by the lymph stream.

In the earliest stages a red slimy exudate covers the part and sometimes agglutinates the lobes or surfaces (false membrane). Distinct yellowish-looking tubercles appear at a later stage, and a good deal of new fibrous tissue is formed, which unites many of the nodules into one mass. In this way tuberculous masses of several inches thick may arise on the pleuræ. These formations are greyish in colour, moist looking, and when incised show numerous caseous and calcified centres.

Heart, pericardium, and vessels.—The pericardium is infected from the pleura or bronchial glands. From the parietal layer the disease may spread to the visceral and thence to the heart wall.

The Editor has recorded a case of tuberculous myocarditis in a cow, in which the parietal and outer surface of the visceral pericardium were healthy.

The lesions in the membrane are like those found on the pleura.

The heart muscle is generally invaded from without inwards. The muscular tissue is replaced by caseous nodules. In the above case recorded by the Editor, the walls of both auricles and ventricles were almost completely converted into a caseous and calcareous mass. The uninvaded tissue was represented by a strip measuring half an inch in breadth. The organ weighed 47 lbs. Tubercle of the heart wall, however, is not common.

Cases of tuberculosis in the larger vessels have been recorded. The Editor has met with it at the seat of experimental inoculation into the veins.

Liver.—The disease may spread from the peritoneal covering to the substance of the organ, but usually the tubercles do not extend very deeply in such cases. The organ may also be infected from the retrohepatic glands and by way of the portal blood from the spleen and intestines, when tubercles in these parts have penetrated a portal branch. In

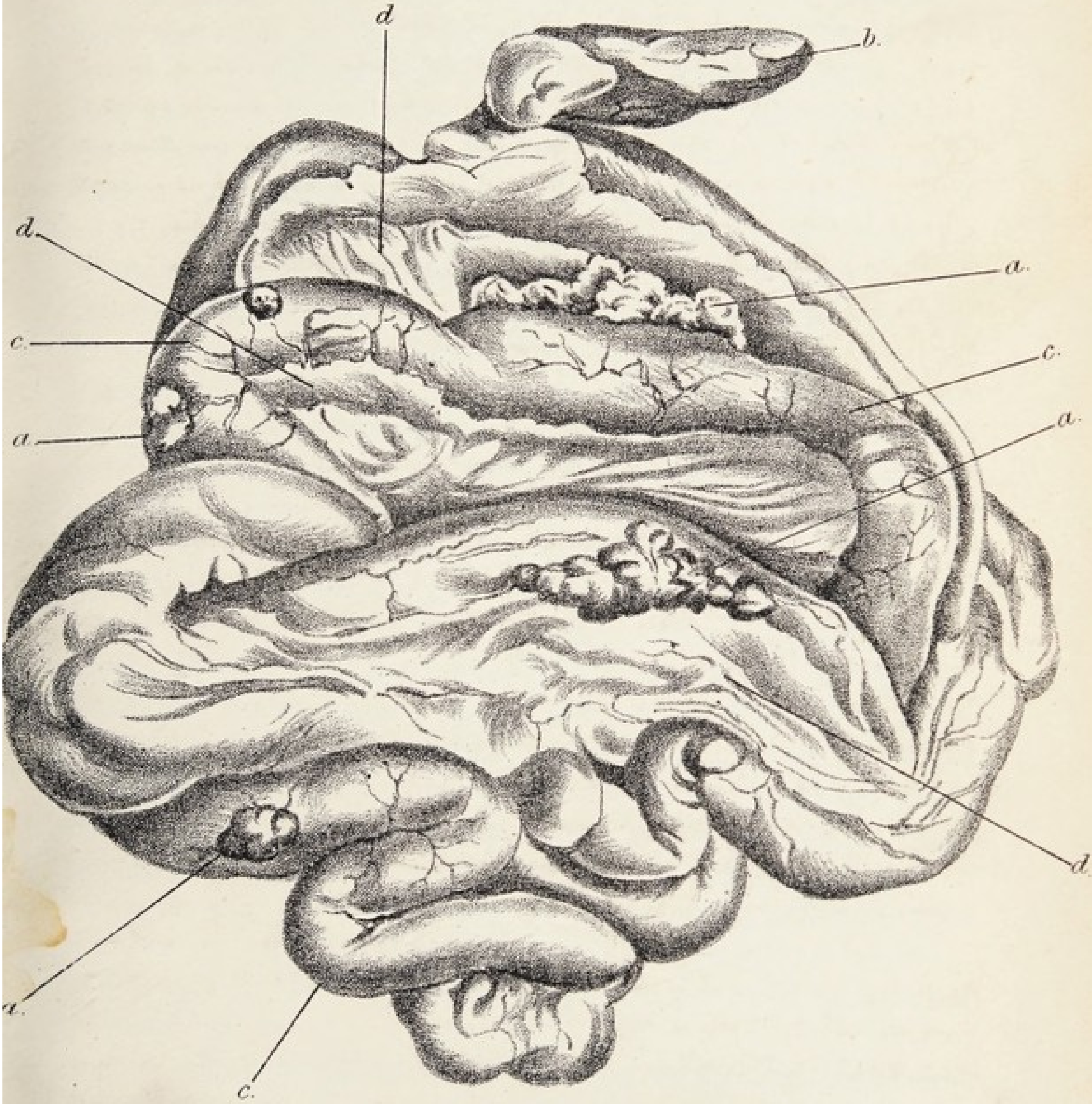



FIG. 19.—Coils of Intestines of a Hen, showing—

*a. a. a. a.* Sessile tubercular nodules in the Intestinal Walls.
*b.* A large pedunculated Tubercular Nodule.
*c. c. c.* Intestines.
*d. d. d.* Mesentery and Mesenteric Fat.

the fœtus the liver may be infected by way of the umbilical vein, which passes through the organ.

The organ shows tubercles of various sizes, which in the ox and pig are often very caseous. In the ox one sometimes finds the lesion in the form of an abscess, containing a fluid greenish pus and surrounded by a thin fibrous capsule. All such abscesses in the liver, of course, are not tuberculous, but the Editor has satisfied himself that many of them are. Cirrhosis sometimes accompanies the tuberculous lesions.

In the pig one may meet with a lesion of lymphatic origin so disseminated that it is very like an acute miliary tuberculosis. The tubercles, however, are of different ages. In tuberculous fowls the liver is almost always the seat of lesions. The tubercles vary in size from a pin head to a pea. They are often very caseous, but commonly enough the small ones are quite fibrous in consistence, easily enucleated, and difficult to break up. Amyloid material is often present at the margin of the tubercle in the fowl.

Spleen.—The spleen may be invaded from its lymphatic glands or from its peritoneal covering. Although tuberculous lesions on the peritoneal covering are not rare in the ox, the substance of the organ is seldom the seat of tubercles in adult subjects. The rarity of splenic lesions might almost be called a feature of tuberculosis in the ox. Even in generalised cases, macroscopic lesions are seldom found in the spleens of oxen, though they may be present in acute tuberculosis in calves.

In the pig, fowl, and horse, on the contrary, splenic lesions are common, and, from what has been said regarding infection, it follows that the organ may be invaded by other paths than its blood vessels.

The organ is enlarged. The lesion in the pig and horse may assume one of two forms. In the one form the tubercles show themselves as conical nodules, about the size of a marble, under the capsule. These nodules may be quite caseous, or hard and almost fibrous. In the latter case they are abruptly separated from the healthy tissue. In the other form the lesion is more diffuse, a good deal of new tissue is formed, and in this the tubercles are found.

Tuberculous nodules, sometimes of large size, are found in the spleen of the fowl. Usually they are fibrous and difficult to break down.

The stomach and intestines.—Infection of the stomach sometimes occurs when large numbers of bacilli are swallowed. This takes place when the mucus, laden with bacilli from a diseased lung, is expectorated into the pharynx and swallowed. As one might expect, tuberculous lesions on the mucous membrane are rarely met with. M'Fadyean records a case of tuberculous ulceration of the rumen, and one where the ulcers were on the mucous membrane of the abomasum in the cow. The Editor has met with one case of tubercle of the abomasum in the cow. No ulcers were present, but about half a dozen fibrous nodules the size of a swan-shot were found under the mucous membrane. Tubercle bacilli were found between the fibres.

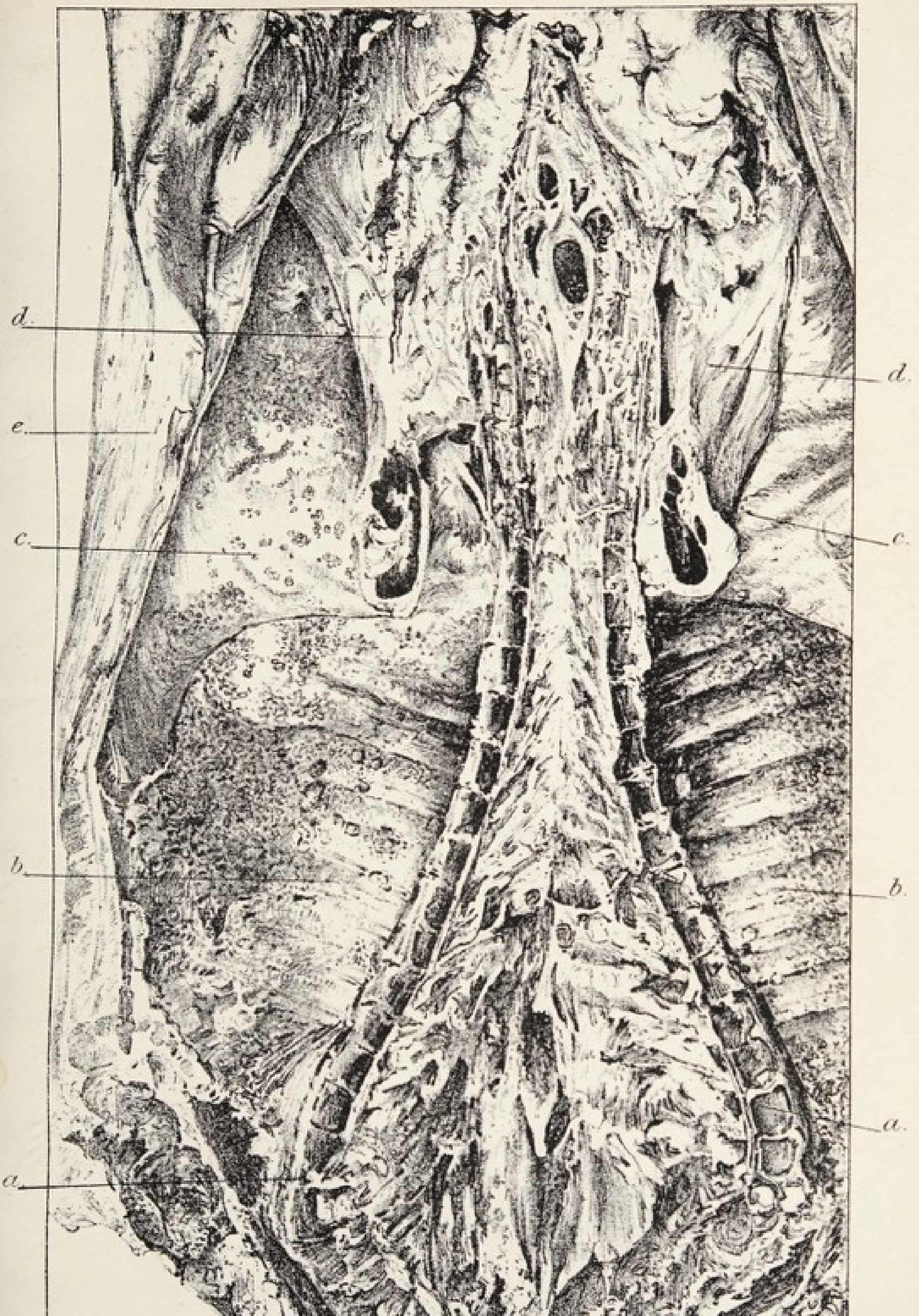
The intestines are infected by bacilli that have escaped the gastric juice. These bacilli have in cattle usually come from the lungs, but they may have been taken in from outside sources with the food; they may pass to the glands without provoking a lesion in the bowel. The lesions, when present, consist of crater-shaped ulcers, most commonly found at the level of Peyer's patches.

In the fowl the bowel is often the seat of tuberculous ulcers or nodules.

Peritoneum, mesentery, and omentum.—The peritoneum is infected from the bowel, from the mesenteric glands, or through the diaphragm from the pleura by the lymph vessels. According to M'Fadyean, the infection almost invariably takes place by one of the lymph paths.

The lesion is very like that on the pleura, and the same may be said of the mesentery and omentum.

Kidney.—Tuberculosis of the kidney is not common. Infection takes place by the lymph or blood streams,




Photograph of Abdominal and Thoracic surface of the Carcase of a Cow showing diffuse Nodular Tuberculosis of the Pleura and Peritoneum.

*a. a.* Section through Dorsal Vertebræ.
*b. b.* Thoracic Pleuræ. The dark spots representing the Tuberculous Nodules.
*c. c.* Peritoneum with Tuberculous Nodules.
*d. d.* Kidney Fat.
*e.* Flank.

In the ox one usually finds a large tuberculous nodule surrounded by fibrous tissues in one or two lobules. More rarely the lesion is acute miliary in character.

Uterus.—The uterus is also infected from the peritoneum by way of the lymph vessels, or possibly by the Fallopian tubes. The lesions are found in the horns or over the whole organ. They consist of caseous ulceration of the mucous membrane and fibrous thickening.

Ovary.—The ovary may be infected from the peritoneum. The organ is enlarged, fibrous, and shows the usual tubercles.

Testicles.—The testicles are seldom tuberculous. They may be invaded from the peritoneum or by way of the blood stream.

Mammary gland.—This organ is invaded by bacilli in the blood stream, or by those that have travelled along the lymph vessels from the supramammary lymph glands. It is possible that the gland may in exceptional cases be invaded by way of the teat.

In the case of an embolic invasion, tubercles are scattered through the organ ; but one does not expect to see so dense a crop of them as one finds in the lung, because the greater part of the bacilli have been removed from the blood by the latter organ.

Frequently only one quarter is the seat of disease, but all four may show tubercles. In the early stages the affected quarters are swollen ; latterly they become much enlarged and fibrous. Distinct tubercles are usually found in the organ, but in a considerable proportion of cases the naked-eye appearances are calculated to mislead the uninitiated.

In one form the acini seem to be plugged with yellow clots in certain areas. This appearance might be passed over as acute non-tuberculous mammitis, which it resembles. In the latter, however, the clots are whiter ; they are, in fact, coagulated milk. To be certain in these cases it is necessary to examine cover-glass preparations properly stained. In another form the chief alteration to the naked eye is cirrhosis of the gland. The Editor has met with several cases of chronic interstitial mammitis which would have been passed over as non-tuberculous had a microscopical examination not been made.

Nerve centres.—They are very seldom the seat of tuberculous lesions. The cord and its meninges may be invaded from a tuberculous vertebra.

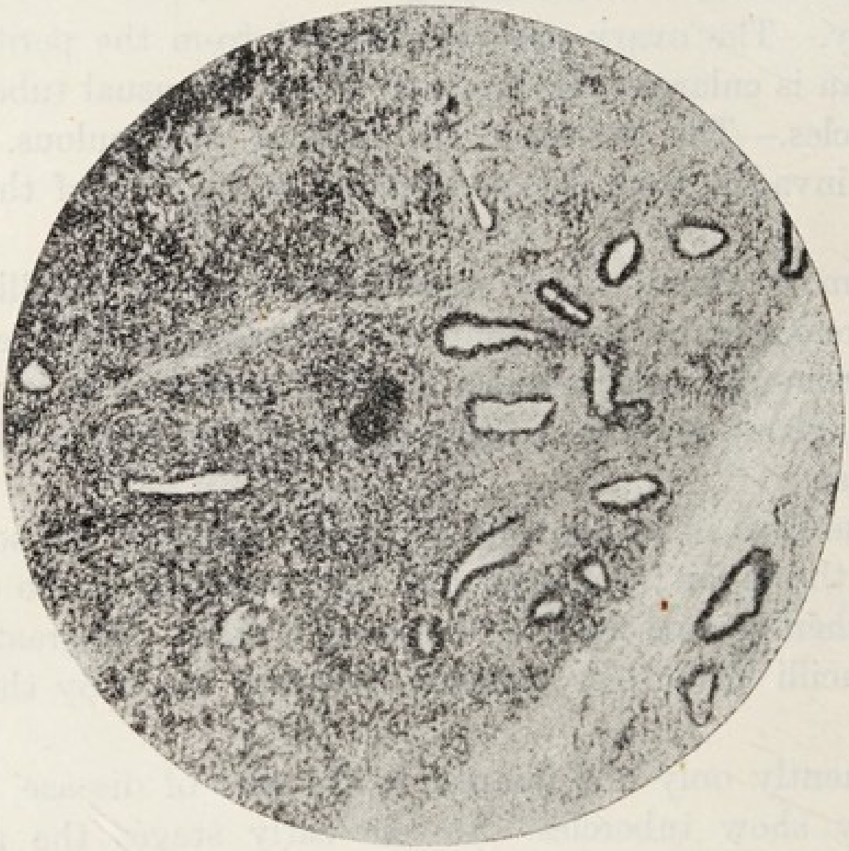


FIG. 12.—Microscopical section of a cow's udder affected with chronic tuberculosis (Reichert, obj. 3). Tuberculous elements and fibrous tissue have replaced the normal glandular tissue.

The brain, according to M'Fadyean, is most likely to be invaded from diseased glands at the base of the skull.

The lesions take the form of a miliary eruption on the pia mater, or of caseous tuberculous masses in the substance.

Bones.—Tuberculosis in bones is not common in the lower animals. They are probably invaded mostly by the lymph stream or from neighbouring lymph glands by contiguity.

The bones most commonly affected are the vertebræ and the ribs. The Editor has met with it in the submaxilla of the ox.

In the vertebræ the lesion is in the form of a tuberculous caries. The jawbone becomes swollen, softened, and necrotic.

Muscle.—The muscles are often invaded by tubercle bacilli entering through their blood vessels, but muscular lesions are of the rarest. Probably, when lesions occur, the bacilli have

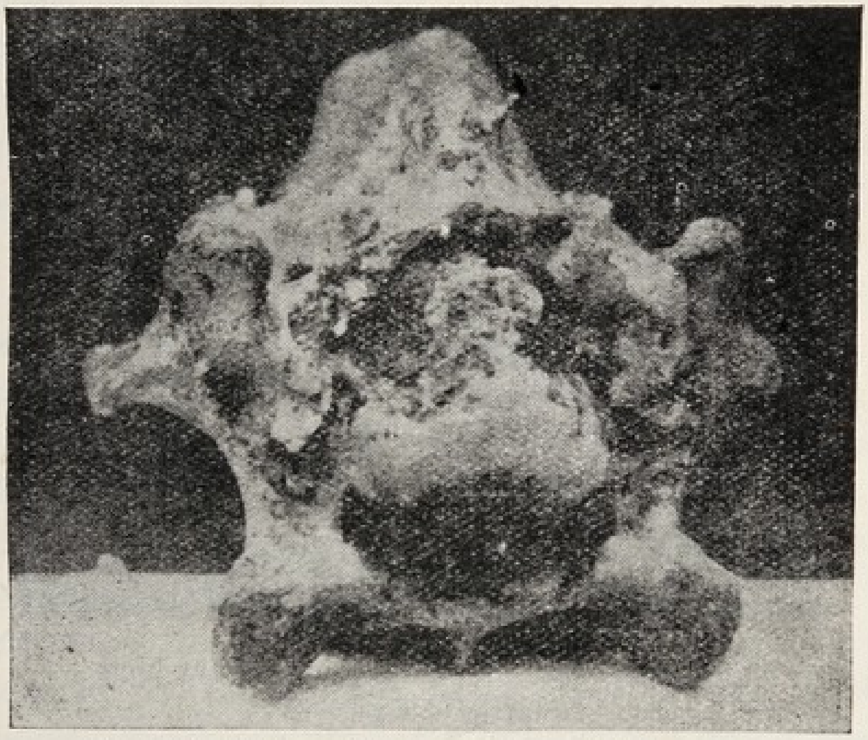


FIG. 13.—Tuberculous vertebra.—M'FADYEAN.

travelled backwards from the nearest lymph glands, when the latter are in a state of advanced tuberculosis.

In two cases of muscular tuberculosis in the pig—one in the arm, the other in the hip—observed by the Editor, the glands draining the muscles were almost completely caseous.

The lesion takes the form of a chronic interstitial myositis. The section is rather like that of a mammary gland affected with cirrhosis. Pale yellow centres, many of them calcified and surrounded by a fibrous ring, are seen in the muscle.

One or two cases of tuberculosis have been recorded in the tongue of the ox. The lesion may be either limited or disseminated. The organ is probably invaded by its lymph stream; local inoculation appears improbable. One or two hard fibrous nodules are found in the substance, or there may be a considerable number. The superficial ones become ulcerated, and there may be a great deal of new tissue formed in the organ. The lesion, especially in the disseminated form, is very like that of actinomycosis. A microscopic examination is necessary to establish the diagnosis.

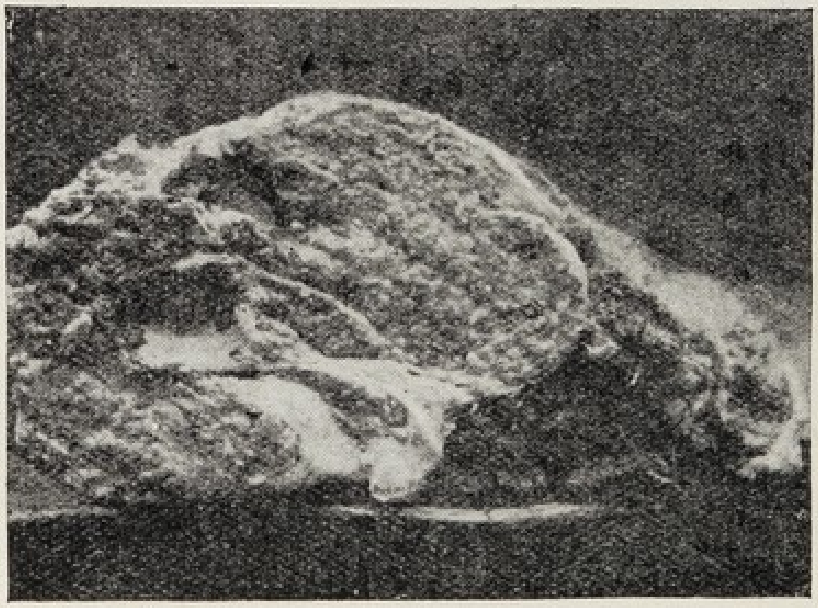


FIG. 14.—Muscular tuberculosis in the hind quarter of a pig.—V.

Skin.—In animals the skin seldom shows tuberculous lesions. Probably it is infected in every case by local inoculation. Sometimes tuberculous fibrous tumours are found under the skin of the ox.

The Editor has met with several cases of cutaneous tuberculosis in the subtarsal and subcarpal regions of the ox. One or more limbs may be affected, usually the fore ones; only in one case were all four diseased.

The lesion extends from the pit of the heel to just below the carpus or tarsus. The subcutaneous tissue is much increased, and there may or may not be abscesses on the course of the swelling.

*The danger arising from the ingestion of tubercle-infected butcher meat.*—Long before the discovery of the tubercle bacillus—as far back as 1839—Malin reported cases of infection in dogs by way of the alimentary tract. The subject, however, received little consideration until nearly thirty years later, when the work of Chauveau and that of Gerlach appeared. The large number of confirmatory experiments and the observations since collected make it impossible to doubt that tuberculosis can be contracted by ingestion of infected tissue. Ingestion, however, is not the easiest method of infecting an animal with tuberculosis. In the majority of cases a large number of bacilli must be swallowed before a positive result is obtained. That the bacilli can penetrate by way of the buccal and pharyngeal mucous membrane seems certain. It has already been mentioned that tuberculous lesions on the gastric mucous membrane are rare, but as they are not unknown, one must admit the possibility of invasion by way of the stomach. Straus and Wurtz showed that tubercle bacilli resist the action of the gastric juice for eighteen hours. Stern has demonstrated that the intestinal juices have no effect on them.

Apart from the experimental evidence, which has already been referred to, the number of cases of natural infection in which bowel lesions are present prove beyond doubt that under certain circumstances penetration by way of the intestinal mucous membrane is not difficult. As already mentioned, a relatively large number of bacilli are necessary to experimentally infect healthy animals by this method; but it seems probable that, if the mucous membrane be not intact, a smaller quantity would suffice.

Since the possibility of infection by ingestion is undeniable, the important question to the Meat Inspector comes to be, under what circumstances do the conditions obtain which are likely to render meat dangerous? This question has already been dealt with in great part in the paragraphs on infection of the organs. It remains only to indicate what experiment has taught us regarding the extent of the danger. It is unnecessary to describe in detail the results obtained by the large number of experimenters who have investigated this subject. The plan of operation has been the same in all.

Animals have been fed on flesh from tuberculous carcases, or inoculated with the juice expressed from the muscles. In those cases in which the experimenters were careful to avoid all chance of the juice or flesh being contaminated from outside sources, the number of positive results obtained with ox flesh is exceedingly small, notwithstanding the fact that in many cases the carcases supplying the material for experiment were those of animals affected with generalised tuberculosis. Nocard and M'Fadyean have both shown that the bacilli disappear from the muscles in a very short time after a large number of bacilli have been injected into the blood stream. The second series of experiments by Kastner call for remark, for he obtained twelve positive results out of fourteen guinea-pigs. Kastner, however, does not say that the cases from which he obtained the flesh were not those of generalised tuberculosis, nor does he mention the regions of the body which supplied the muscle. He says that the flesh used was from confiscated carcases.

Nobody desires to pass for food the flesh of generalised cases, but in localised cases the region experimented with is worthy of consideration. It is unlikely that any one who has followed the recent work on this subject will deny the probability of the bacilli being in the muscles in the neighbourhood of localised lesions, especially if the latter be in the glands. Thus Galtier found that in a tuberculous cow muscle from the thigh was non-virulent, while that from the shoulder gave a positive result. Veyssière and Humbert obtained two positive results with the psoæ muscles of a tuberculous cow; but every one knows that the glands in the lumbar region are often diseased. In a case of tuberculosis of the pig, in which the anterior glands and some of the muscles of one fore-limb showed marked lesions, the Editor failed to obtain a positive result in four guinea-pigs inoculated with juice expressed from the muscles of the hind quarters. The experiments performed with the flesh of animals other than the ox are much fewer in number, but the proportion of positive results has been larger.

Working with the flesh of the sheep (generalised case), Gerlach obtained two positive results in two pigs experimented on by the ingestion method.

By inoculating the muscle-juice of the pig to two rabbits Toussaint obtained two positive results, Gunther and Harms two positive results with four rabbits, and Gerlach two positive out of four rabbits inoculated.

Peuch had three positive results with three rabbits inoculated with the muscle-juice of a fowl dead of tuberculosis.

*Inspection.*—There are no uniform rules regarding the inspection of tuberculous carcases in this country. It is evident, however, that any procedure adopted by Meat Inspectors must be based on a comprehensive knowledge of the pathology of the disease. In the foregoing sections the pathological points of interest to the inspector have been dealt with. It remains now to point out a line of procedure deduced from them.

All authorities agree in condemning affected organs, lesions, and emaciated carcases, whatever be the degree of tuberculosis. The other cases that one seeks to exclude from consumption are—(1) those in which generalisation has taken place, for the muscles may then be assumed to contain bacilli ; (2) those in which the glands embedded in the muscles are invaded, although the tuberculosis is still local. The difference of opinion comes in when we have to determine what constitutes evidence of generalisation, and under what circumstances the glands of a given region may contain the bacilli, because it has already been explained that they may do so without showing any macroscopic tubercles.

Signs of generalisation.—In the ox, generalisation is not common ; it occurs more frequently in pigs, and it is always secondary to a local lesion.

When an acute miliary lesion is present in any organ, unless it be in the liver only, generalisation may be assumed to have taken place. To the inspector the important point about generalisation is, of course, that the bacilli are likely to be in the muscles and their glands. When the bacilli enter a vein or small artery, they go to the right heart and thence to the lungs, where most of them are retained. One could imagine that, when an artery is penetrated, the bacilli might be arrested in its capillary branches and give rise to embolic lesions in the organ supplied. In the latter case, however, the most important result of contamination of the blood stream—the presence of bacilli in the muscular system—does not follow. As a matter of fact, an analogous condition may be produced in the liver, when bacilli enter a branch of the portal vein.

True generalisation, then, means that the bacilli have in one of the ways before mentioned passed into and out of the left heart. One or two cases are reported where tubercles were found on the aorta. The blood stream might, of course, be contaminated from such lesions.

The evidence of post-mortem examinations goes to show that in the majority of cases, at least, the bacilli which reach the left heart do so by passing through the pulmonary capillaries. Since a large number are retained in the lung, it is that organ which furnishes us with the most constant proof of generalisation.

The task of the inspector is more difficult when dealing with carcases which are in the second category ; that is, when he has to determine in a case of localised tuberculosis whether the glands of this or that part are likely to contain bacilli. It is out of the question to expect to have a corps of inspectors sufficiently large to make a searching examination of all the glands in the neighbourhood of tuberculous lesions. One must try rather to proceed along the lines of a fair and practicable compromise, but the benefit of a doubt must always be accorded to the consumer. Under a system of this kind, a good deal of harmless flesh will be withdrawn from consumption, but the expense of inspecting it minutely would amount to more than the value of the meat.

From what has been said regarding infection of the different organs and the progress of the lesion, it follows that tubercle may spread from the peritoneum to the sublumbar and inguinal glands. Tuberculosis of the peritoneum, then, will entail seizure of the carcase posterior to and including the diaphragm. When tuberculous lesions exist on the pleura or in the anterior glands, the fore part of the carcase, including the diaphragm, will be condemned.

The second Royal Commission on Tuberculosis, in their report published in 1898, issued the following recommendations regarding the carcases of tuberculous animals :—

"C.—TUBERCULOSIS IN ANIMALS INTENDED FOR FOOD.

"6. We recommend that the Local Government Board be empowered to issue instructions from time to time for the guidance of Meat Inspectors, prescribing the degree of tubercular disease which, in the opinion of the Board, should cause a carcase, or part thereof, to be seized.

"Pending the issue of such instructions, we are of opinion that the following principles should be observed in the inspection of tuberculous carcases of cattle :—

| | |
|---|---|
| "(*a*) When there is miliary tuberculosis of both lungs<br>"(*b*) When tuberculous lesions are present on the pleura and peritoneum . . . . .<br>"(*c*) When tuberculous lesions are present in the muscular system, or in the lymphatic glands embedded in or between the muscles . .<br>"(*d*) When tuberculous lesions exist in any part of an emaciated carcase . . . . . | The entire carcase and all the organs may be seized. |
| "(*a*) When the lesions are confined to the lungs and the thoracic lymphatic glands . . .<br>"(*b*) When the lesions are confined to the liver .<br>"(*c*) When the lesions are confined to the pharyngeal lymphatic glands . . . . . .<br>"(*d*) When the lesions are confined to any combination of the foregoing, but are collectively small in extent . . . . . . . . | The carcase, if otherwise healthy, shall not be condemned, but every part of it containing tuberculous lesions shall be seized. |

"In view of the greater tendency to generalisation of tuberculosis in the pig, we consider that the presence of tubercular deposit in any degree should involve seizure of the whole carcase and of the organs.

"In respect of foreign dead meat, seizure shall ensue in every case where the pleuræ have been 'stripped.'"

These recommendations, if adopted, are calculated to reduce to the vanishing-point any risk which people run of contracting tuberculosis from eating the flesh of tuberculous animals. They will also considerably lessen the hardship inflicted on the butcher in those places where the inspection resolves itself practically into total seizure. In the present state of our knowledge it would be hardly possible to issue instructions much less general in character, but if the inspector be a properly qualified man, with a knowledge of pathology, he will have little difficulty in applying them rationally.

No part of the stomach or intestines should be passed for the manufacture of tripe, haggis, or sausages, when lesions exist in the abdominal organs.

The Editor has on one occasion found a tuberculous thickening on a piece of dressed tripe.

Inspectors should impress on butchers the necessity of cleansing their knives which have been employed to cut lesions, before they again use them for dressing purposes.

## JOHNE'S DISEASE

The first case of this disease was recorded by Johne and Frothingham in 1895, and since that date the disease has been found to have a wide distribution in Europe. As M'Fadyean [1] has shown, it is comparatively common in England. As the principal symptoms of the disease are diarrhœa and wasting, it is often mistaken for tuberculosis while the animals are alive. It has not been met with in any of the domesticated animals except the ox, and all attempts to transmit it experimentally to such laboratory animals as the guinea-pig and rabbit have failed.

[1] *Journal of Comparative Pathology and Therapeutics*, March 1907.

*The bacillus.*—The cause of the disease is a bacillus which resembles the tubercle bacillus so closely that the two cannot be distinguished by morphological characters. It is also impossible to distinguish between them by staining reactions, as they are both equally acid-proof. That they are distinct, however, is indicated by the specific character of the lesions in Johne's disease, and by the fact that the bacillus of the latter disease cannot be cultivated artificially, and cannot be successfully inoculated into the guinea-pig or rabbit, both of which are readily infected with the tubercle bacillus of cattle. In cases of Johne's disease the bacilli are usually present in enormous numbers in the wall of the diseased bowel, and in smaller numbers in the mesenteric and colic lymphatic glands. They have never been detected in any of the other organs or tissues of the body.

*Lesions.*—In advanced stages of the disease the animal is much emaciated, and there is usually evidence of diarrhœa about the tail and buttocks. The only lesions ascribable to the bacillus are found in connection with the intestines and their lymphatic glands. The latter are usually a little enlarged, and their tissue is œdematous. In the small intestine the mucous membrane, especially in the ileum, is thickened and shows a peculiar coarse corrugation or wrinkling, frequently without any marked congestion. In the large intestine the thickening of the mucous membrane is not so great, but congestion is more pronounced.

It is important to notice that in an uncomplicated case there is no naked-eye evidence of caseation or calcification, and no appearance of tubercle formation, in either the bowel wall or the glands. Microscopic examination of the intestinal wall shows that the thickening of the mucous membrane is due to a diffuse formation of a new tissue which closely resembles that of young tuberculous growths, since it is composed of epithelioid cells and occasional giant cells. This new tissue, which is also found in the villi, has little or no tendency to necrosis, or caseation, or calcification.

*Diagnosis.*—In any case in which Johne's disease is suspected in a slaughtered animal, the above-described alterations in the bowel should be looked for, and, after the bowel has been thoroughly washed, scrapings from the mucous membrane should be stained with carbol-fuchsin, decolorised with 25 per cent. sulphuric acid, counter-stained with methylene-blue, and searched for acid-proof (red-stained) bacteria.

Fig. 15.—Photo of mucous membrane of ileum from a case of Johne's disease, showing the coarse wrinkled appearance (about half nat. size).

Scrapings from the tissue of the mesenteric glands may be stained and examined in the same way.

As a rule there is no difficulty in finding the bacilli in scrapings from the mucous membrane when it is obviously thickened. Like tubercle bacilli, the bacilli of Johne's disease have a tendency to form groups or clumps.

*Inspection.*—The fact that it has hitherto been found impossible to transmit the disease to other animals than cattle creates a presumption that the human subject is not susceptible to it. When the carcase is emaciated, total condemnation is justified on that ground alone; but should the disease be detected at an early stage, before there has been any notable loss of condition, the carcase may be passed. The intestines and their glands ought, of course, to be seized and destroyed.

## ACTINOMYCOSIS

Actinomycosis is a disease due to the actinomyces.

*Animals affected.*—The disease is most commonly met with in the ox. The pig in this country is much less frequently affected. One or two isolated cases have been recorded in the sheep and horse. Man may also be attacked.

*The actinomyces.*—The parasite is usually found in animals in the form of colonies, known as the ray fungus. That, however, is not the only form.

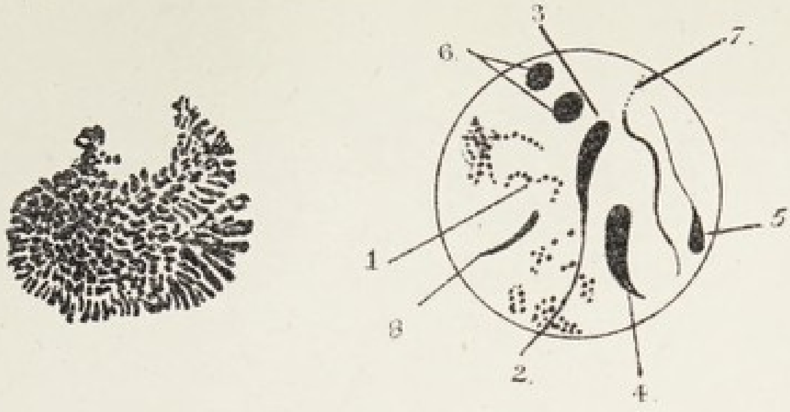
In an earlier stage the colonies consist of coccus forms, which are sometimes arranged in chains, and of bacillary and thread-like elements. The actinomyces is not a good parasite, —in the tissues it tends to lose its vitality, and it then assumes involution forms (clubs). The ends of the filaments swell into club-like bodies, and the colonies assume the form known as the ray fungus. The threads radiate from a centre, and when a section is made of a ray-fungus colony in the tissues it has an appearance which has been aptly enough compared to the capitulum of a daisy. The central threads, however, are usually degenerated.

It is of interest to the inspector to know that the parasite is usually found in the above degenerated form in animals, because in that state it cannot be inoculated to others.

The club forms can be well seen without any previous staining, but they can be nicely stained by Plaut's method. The other elements stain by Gram's method.

*Lesions.*—Most frequently the lesions appear as greyish, firm nodules about the size of a barley grain. On cutting into these, one sees a small greenish-yellow centre of softer material. This softened centre, however, may be absent; it may be as large as a threepenny-piece and quite caseous; sometimes it is brownish-yellow in colour, and very like a tuberculous nodule. It is seldom purulent in the liquid sense. The lesion, again, may take the form of a fibrous tumour known as an actinomycoma. Many of the latter show no softened centres whatever, and it is only on making a microscopic examination that the true nature of the growth is discovered. These tumours are generally found growing from the buccal mucous membrane or on the skin of the ox. An important point about the actinomycosis lesion is, that it is almost always associated with a considerable fibrous proliferation in an organ; and this is one point of distinction between it and tuberculosis. Histologically the nodules consist of leucocytes, epithelioid cells, and in the older cases a more or less fibrous periphery. There may or may not be giant cells present; they are never so numerous as in the tubercular nodule. One or two colonies of the parasite are found embedded in the cells; but when the nodule is large they, along with the cellular centres, generally fall out of sections cut on the freezing microtome. Calcareous granules are sometimes present.

Actinomycosis of the organs, and infection.—Primary infection usually takes place by way of the alimentary tract, and it is due to the ingestion of contaminated fodder. The parasite apparently reaches the tissues through wounds in the mucous membrane of the mouth. It may also occur from inhalation of contaminated dust, or the parasite may penetrate the mammary gland by way of the teats. Any external wound may serve as a port of entrance. The fibrous tumour (known as scirrhous cord), which is found on the end of the spermatic cord of the ox, is caused by the entrance of the actinomyces by the wound of castration. Once in the tissues, the infection




Actinomycosis organism.

1. Colony of clubs (ray fungus).
2. Isolated coccus elements, rods, threads, and clubs (M'Fadyean).


Fowl Diphtheria.

Head of Hen, with mouth open, showing—

*a.* False membrane.
*b.* An ulcerous area.

may travel by way of the lymph stream to neighbouring parts; but, on the whole, the lesion tends to remain local. Generalisation is almost unknown in animals.

The organ most frequently affected in the ox is the tongue, but commonly enough the lesions are found in the bones of the jaw and the muscles of the cheek in contact with the bones. The pharyngeal glands are also pretty frequently affected. The other organs, such as the lungs, liver, bowel, mammary gland, etc., may show lesions. In the pig, muscular actinomycosis is said to be fairly common in some parts of Germany; but if we exclude the cases in which the tongue and the cheek muscles are affected, the lesion must be of rare occurrence in this country. The parts most often diseased in the pig are the tongue, tonsils, and mammary gland. The infrequency of generalised lesions is probably explained by the feebly parasitic propensity of the actinomyces. Only one or two cases of generalisation have been recorded. The lesions were situated in the lungs, liver, glands, and muscles.

Tongue.—The tongue is increased in size, and very fibrous if the disease has existed for any time (wooden tongue). The nodules are found on the sides and dorsum, usually about the upper third of the organ. Generally they are confined to the more superficial parts. The larger nodules on the surface tend to ulcerate and give rise to a superficial sore. Fibrous tumours may be found in connection with the lips and palate.

Oesophagus, stomach, and intestines.—These organs may be infected directly by ingested material, but actinomycosis lesions are rarely found in them. The lesion is in the form of ulcers and nodules which often attain to considerable size.

Liver and other abdominal organs.—In this country these organs are seldom found affected, and little is known about the manner of invasion. Probably the liver is invaded by way of the portal vessels from the bowel. The nodules, when present in the liver, are softened in the central part and fibrous at the periphery. The organ is also cirrhotic.

Lungs.—The lungs are infected directly by the inhalation of contaminated dust. Once a lesion is started, the other parts may be invaded much in the same manner as in the case of tuberculosis, except that widespread actinomycosis lesions are very uncommon. The nodules are usually discrete, fibrous at their periphery, and separated from each other by a considerable stretch of lung tissue. In some cases, however, certain areas show many soft and confluent nodules, similar to what one finds in tuberculous broncho-pneumonia.

Serous membranes.—They are not often invaded. Nodules

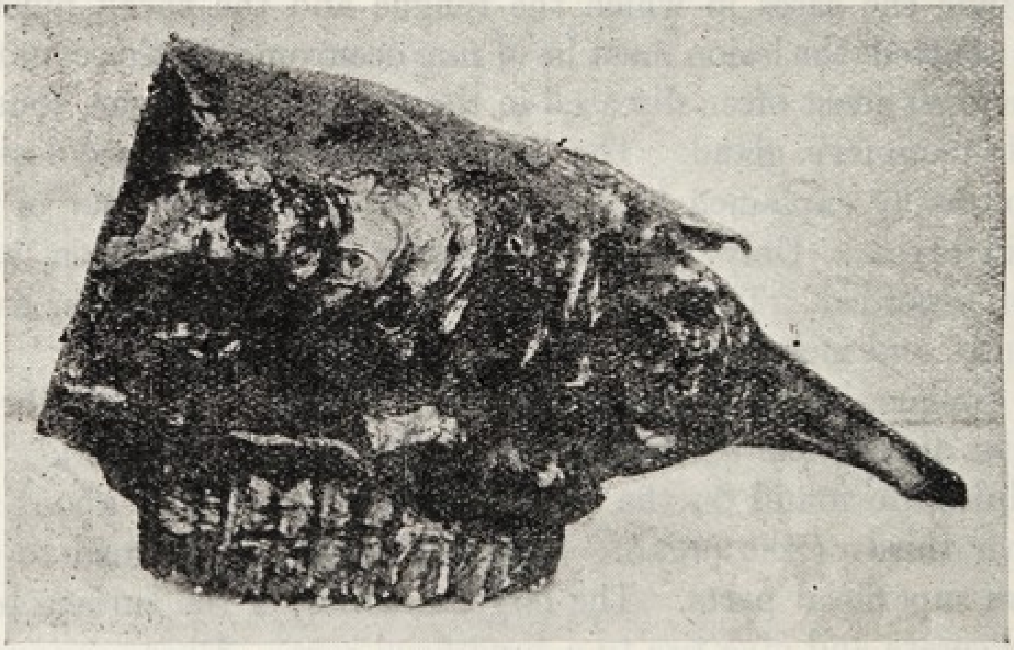


Fig. 16.—Superior maxilla of ox, actinomycosis.

varying in size from a small pea to a nut are found on their surfaces.

Bones.—The bones most frequently affected are the superior and inferior maxillæ. They are invaded primarily through wounds into the alveoli, or secondarily by way of the lymph stream from lesions in the mouth or on the cheeks. The bodies of the vertebræ and the ribs are also sometimes attacked,—probably the infection is in their case by the lymph stream from a diseased gland.

The bones are swollen, carious, and rarefied. The bones of the jaw are often perforated by cloacæ, from which pus issues. The tissues round about are swollen and show nodules.

Glands.—They are infected from lesions in the neighbourhood. At first they are enlarged and œdematous, but show no macroscopic nodules. Later they are much increased in size, and show softened centres.

Muscles.—When lesions exist in the muscles, infection has probably taken place from the skin or glands by the lymph stream. Infection by the blood stream is rare. The intermuscular fibrous tissue is much increased at the expense of the muscle fibres; softened centres—cold abscesses—are seen in the new tissue.

Skin.—The lesion is in the form of a fibrous tumour, which sometimes suppurates. In the metacarpal and metatarsal regions of the ox the actinomyces may cause a lesion similar to those described under tuberculosis.

Mammary gland.—The situation of the lesions in the gland points usually to an invasion by way of the teats. The lesion is more common than one generally admits. In three of four cases examined by the Editor, the nodules were situated in one quarter, and they were most numerous towards the base of the teat. In the fourth case the whole gland was more or less invaded.

The gland is very cirrhotic and difficult to cut.

The nodules are so like those of tuberculosis, that a microscopical examination is necessary to establish the diagnosis. The hardness of the gland, the situation of the nodules, and the absence of lesions in other organs should always make one suspect actinomycosis.

The Editor has met with one case of mammary actinomycosis (cow) in which tuberculosis was present in the internal organs.

*Inspection.*—The records of comparative medicine do not furnish us with any proof that actinomycosis is communicated from animals to human beings. The state of the parasite as it is usually found in animals renders it unlikely that the disease in man is ever due to ingestion of butcher meat. Still one must admit a possibility of infection in this way, and even the least æsthetic would hardly care to eat parts containing the lesions.

The carcase will be seized in entirety when there are lesions in several parts of the muscular system and when it is much emaciated, as it may be in the ox if the tongue and jaws are diseased. If the flesh be of good quality, the carcase may be passed after the parts containing lesions have been removed.

## GLANDERS

This is a contagious disease caused by the bacillus of glanders —the *Bacillus mallei*.

*Animals affected.*—Glanders is almost exclusively a disease of the horse tribe, and on this account it is of secondary importance to British Meat Inspectors. Human beings certainly contract the disease ; but it must seldom happen that they do so by eating glandered flesh or organs.

Bovine animals are absolutely refractory to glanders. If virulent material be injected under the skin of an ox, the only result is a small abscess, which remains local. According to Peuchu, sheep can be inoculated locally. They may even be affected with clinical glanders after inoculation, but they never take the disease naturally.

Pigs never contract glanders by the natural methods of infection, and they are almost absolutely refractory to experimental inoculation.

Goats have been infected by cohabitation with glandered horses (Nocard). The dog shows only a local lesion after inoculation ; but the cat may die of glanders under the same circumstances.

*The microbe.*—The bacillus is rod-like, and measures from 3 to 5 $\mu$ by about 1. Many of the rods when stained show a number of small and closely set uncoloured parts, which give the bacillus a granular appearance. The extremities of the rod are rounded. They may be stained by Löffler's or Kuhne's blues ; diluted carbol-fuchsin also suits very well. Cover-glass

Group of Glanders Ulcers on Inner Surface of Anterior and Upper Part of Nostril of Horse.

preparations should be washed in water only, as the bacilli are not very retentive of the stains. Preparations can be obtained from the soft material of the nodules; but, except in acute cases, the microbes are very few in number, so few that it is seldom possible to demonstrate their presence with the microscope.

*Lesions.*—The lesions are in the form of nodules situated on the mucous membranes and in the parenchyma of organs (glanders), or they may appear in the superficial lymphatics and on the skin (farcy). Of the internal organs, the lungs and their covering are most frequently the site of lesions; indeed, the nodules are often confined to the lungs. The superficial lesions are found most often on the Schneiderian mucous membrane covering the septum nasi, and on the skin.

Septum nasi.—The nodules here are in the form of small papules about the size of a lentil-seed. There may be only a few isolated ones, or they may be present in groups which often merge into each other. They consist of dense collections of leucocytes like miliary abscesses. The membrane softens and gives way over the papule, and an ulcer is left. The ulcers are about the size of a split-pea; their edges are irregular and slightly raised. Large ulcerous patches of an inch or two in length may be formed by confluence of the smaller ulcers. A mucopurulent discharge, usually odourless, issues from the membrane. Similar patches of ulceration are sometimes found on other parts of the respiratory passages.

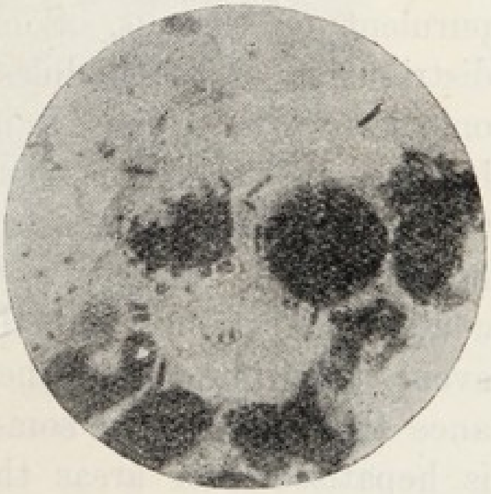


Fig. 17.—*Bacillus mallei* in pus (oil immersion, $\frac{1}{12}$).

Lymph glands.—The glands in the neighbourhood of the lesions are often swollen. This is seen especially in the submaxillary lymphatics, but they seldom suppurate in the ordinary sense of the word, although their enlargement is due at first to accumulation of leucocytes. After a time new fibrous tissue is formed, and the gland becomes hard. Necrotic patches may be found in the gland substance. The bronchial glands are seldom increased in size.

Lungs and pleura.—The pleura covering the superficial nodules in the lung is often thickened, but a large extent of its surface may be swollen and opaque. The thickening is at first due to distension of the lymph spaces ; but in cases of long standing it is due to the formation of new fibrous tissue. The lungs show nodules in their substance, some of which feel hard and shot-like. The appearance of the nodules changes somewhat with their age. The younger ones are in the form of greyish or yellowish specks, varying in size from that of a pinhead to that of a split-pea. They are usually surrounded by a red zone. The older ones range in size from a pea to a nut. Their peripheral part is fibrous, and the central part is either purulent or caseous. Sometimes they are calcareous. The distribution of the nodules is very irregular. There may be only two or three present in one lung, or there may be over a hundred in the two portions. The latter characters help one to distinguish glanders from pulmonary tuberculosis in the horse ; for in the latter case the lesion is almost always an acute miliary one, and the tubercles are so numerous and evenly distributed that they give to the lungs a solid appearance throughout. In some cases of glanders the lung tissue is hepatised over areas the size of one's hand. The solidified parts are of a dirty-white colour, and the interlobular septa are much widened. In acute cases both lungs may be almost completely hepatised. The latter form is commonly seen in the ass, but it is rare in the horse.

In chronic cases there is frequently a considerable amount of new fibrous tissue formed under the pleura and in the lung substance.

The microscope shows that the youngest tubercles begin as a collection of leucocytes. These look like miliary abscesses, and they obscure the alveolar walls. The capillary vessels of the air cells round about them are crammed with white cells, and the alveoli contain a fibrinous material and leucocytes. At a later stage, round and angular epithelioid cells are found outside the central part, and one or two giant cells may be seen (M'Fadyean, Schütz). The giant cells, however, are not so numerous as in the true tubercle. The air cells at the

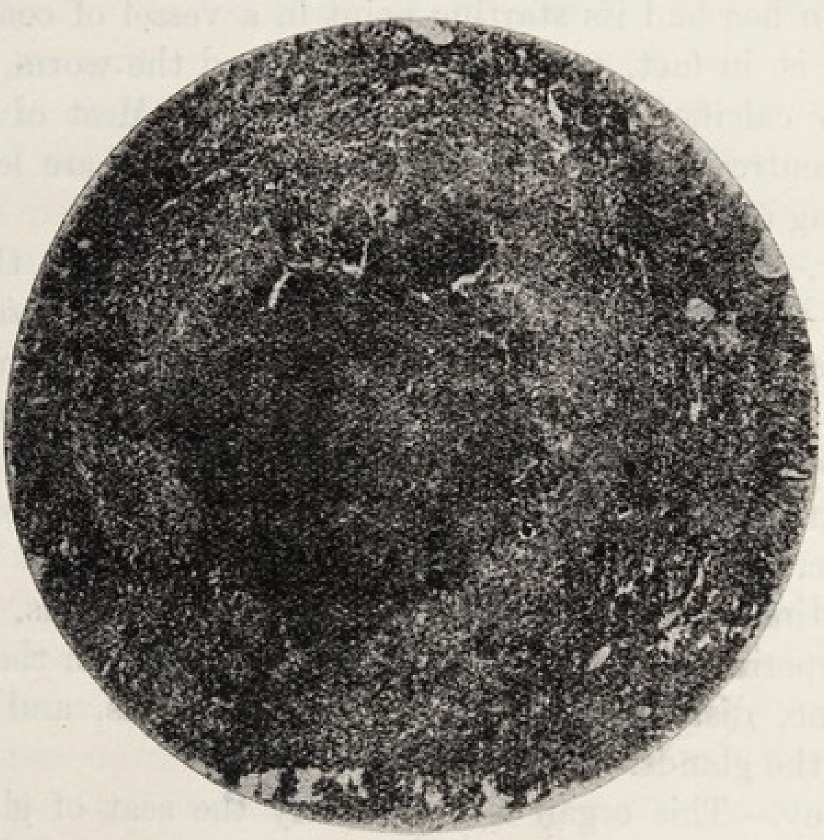


FIG. 18.—Microscopical section of chronic glanders nodule.—M'FADYEAN.

outermost part of the nodule contain a croupous exudate—fibrin, leucocytes, and red cells.

In the oldest nodules the central part is necrotic. It consists of disintegrated cells and chromatin particles (chromatotexis); it is sometimes calcareous. The peripheral part is fibrous.

In the large hepatised areas the alveolar vessels are distended by leucocytes, and their cavities contain a dense fibrinous exudate.

The walls of the smaller bronchial tubes in the neighbourhood of the lesion are densely infiltrated by round cells, and their epithelium is in a state of catarrh.

In the lungs of the horse, circumscribed fibro-cellular nodules, which are caused by a worm, are sometimes found. They are about the size of a pea. These might be mistaken for glanders tubercles. The microscope, however, shows that the lesion has had its starting-point in a vessel of considerable size. It is, in fact, a chronic arteritis, and the worm, which is generally calcified, can sometimes be seen. Most of the cells in the centre are still intact; many of them are leucocytes containing coarse granules which stain with eosin.

Liver.—The liver is seldom the seat of lesions in the horse. It may, however, show a few nodules varying in size from a mere speck to a pea. In the liver of a lion which died of glanders the Editor found innumerable miliary abscesses of microscopic size. They contained the *bacillus mallei.*

Spleen.—The spleen may show nodules like those found elsewhere.

Intestines.—They are seldom the seat of lesions. Schütz, in his experimental cases, found miliary nodules in the mucous membrane, distension of the lymphatic vessels, and enlargement of the glands.

Kidney.—This organ is very rarely the seat of glanderous lesions. Nocard, however, has recorded two cases of glanderous abscesses in the kidney. In one of the cases the other lesions were found in the bowel and mesentery; the lungs were intact. Lesions have also been described in the testicles, in the heart, and in the bones. In the latter situation glanders bacilli give rise to caries and sometimes to an abscess. The lesions have been oftenest described in connection with the vertebræ and ribs.

Skin (Farcy).—It is usually the skin of the limbs that is affected, but similar lesions may occur on other parts of the body. The nodules generally start in the subcutaneous tissue, and they elevate the skin over areas about the size of a threepenny piece. The skin at the summit becomes softened and yellowish in colour. It gives way, and a thick lymph-like fluid or pus is discharged. These ulcers are most numerously present on the inner surfaces of the limbs. The lymphatic glands and vessels are swollen; the latter stand out on the surfaces. The subcutaneous tissue is distended by lymph, and the affected limb is much thickened.

*Inspection.*—The question as to whether the muscles of glandered animals are virulent or not has not been submitted to the same amount of exhaustive investigation as it has in the case of tuberculosis; the necessities of the case have not demanded it. The horse is practically the only domesticated animal which naturally contracts glanders, and the disease is much less prevalent than tuberculosis of the bovine race. Moreover, the quantity of horse flesh used for human food is relatively small, and the value of the carcase is such that total seizure inflicts no great hardship on the owner. The blood of glandered horses, even in acute cases, seldom contains the bacilli in sufficiently large numbers to render it dangerous, and, so far as we know at least, the flesh itself has seldom been found virulent. Still, the glands may contain bacilli, and manipulation of the carcase is not unattended with danger.

Menagerie animals have been known to contract the disease by eating the flesh of glandered horses; but it is by inoculation of the external parts that human beings are infected.

The provisions of The Glanders or Farcy Order, 1894, sec. 17, fairly meet the case. They compel total seizure and destruction of every part of a horse, ass, or mule that was diseased at the time when it died or was slaughtered.

## DISEASES CHARACTERISED BY SUPPURATION

Suppuration is a condition produced by the growth of pyogenic or pus-producing bacteria in the tissues of a living animal.

Suppuration, when it occurs in some organs of the body, receives a special name, which in a text-book of medicine, or even in one of pathology, would entitle the affection in each organ to a special chapter. The Editor is of opinion, however, that in a book on meat inspection the morbid conditions characterised by suppuration can be more conveniently and briefly dealt with in one chapter.

*Animals affected.*—Suppuration may occur in any of the domesticated animals; it is, in fact, of everyday occurrence.

*The microbes.*—Several microbes which really give rise to the formation of pus, such as the tubercle bacillus and the bacillus of glanders, are not usually classed with the micro-organisms of suppuration, because the diseases caused by the former have received special names.

The most widely distributed pyogenic microbes are the *Streptococcus of strangles*, the *Staphylococcus pyogenes aureus*, the *Staphylococcus pyogenes albus*, and the *Streptococcus pyogenes.* It is usually to the effects of the latter organisms that the term suppuration is applied. In pus of a bluish colour, a special chromogenic microbe—the bacillus of blue pus or *Bacillus pyocyaneus*—is also found. The microbes can be seen in preparations made from the pus. They stain well by the methylene-blue methods.

*Lesions.*—It seems probable that the bacteria can at first penetrate only a damaged tissue, but a very small injury is often sufficient. A primary lesion may be found in connection with a superficial wound, or it may arise in any organ—lung, vagina, urethra, bladder, uterus, etc.—in direct communication with the external air. In the tissues the microbes by the products of their metabolism attract a large number of leucocytes around them; the tissue becomes fatty and liquefied. In this way a cavity is formed which contains a fatty albuminous fluid of varying consistence. The liquid, which consists of *liquor puris* and white cells, is called pus; the lesion is called an abscess. A suppurative inflammation may be established in a membrane, and if the membrane bound a cavity a large amount of pus accumulates therein. Thus we may meet with a collection of pus in the chest—*pyo-thorax*; in the pericardium—*pyo-pericardium*; or in the uterus. An abscess generally increases until the tissue which separates it from the external air or a cavity is liquefied, then its contents are evacuated. The deeper-seated ones, however, and those in internal organs, often become surrounded by a fibrous capsule which limits their extension. The fluid, again, may be absorbed, and the solids left as a dry caseous mass, which sometimes becomes calcified. Abscesses vary in size from a pin's head—miliary abscess—to anything in reason. The lesion may and often does remain local, but the infection may spread by the lymph stream to the neighbouring glands; or a vessel may become implicated in the suppurative process, its wall perforated, and the blood stream contaminated. In the latter case the bacteria enter the circulation, and are arrested in the capillaries of internal organs, where they provoke abscesses. This condition, in which the blood stream has been contaminated by the pus germs, is called *Pyæmia*. The affected organs may show only a few abscesses; or their whole substance may be crowded with yellow miliary ones of the same age. The latter lesion resembles acute miliary tuberculosis, for at first the contents of the abscesses are not fluid. It also resembles the early lesions of glanders, and those of nodular parasitic pneumonia in sheep.

It is almost impossible by a mere microscopic or histological examination of an organ to distinguish between the three lesions in their initial stage, so alike are they. Glanders, however, does not affect the ox, and is practically never seen in the other animals slaughtered in our abattoirs. In the case of miliary tuberculosis, chronic lesions which are easy to recognise as tubercles will be found in some other part. A bacteriological examination may aid one in making the diagnosis; but it may be disappointing, because the tubercle bacillus is often difficult to find in very young lesions. The presence of staphylococci or streptococci is evidence in favour of suppuration, but it is not conclusive, as there might be a mixed infection.

Histologically an abscess consists of a dense collection of leucocytes. There are no giant cells present, but their absence is not by any means conclusive evidence that the lesion is not one of tuberculosis, although their presence would justify the conclusion that the case is not one of ordinary suppuration. What has been said above is of importance only as regards the use of the flesh, for there can be no doubt about the advisability of seizing the affected organs. When multiple miliary abscesses are present throughout an organ, unless it be the liver alone, and when abscesses are found in two or more organs which do not communicate naturally or accidentally with the outside air, nor with each other by any path other than the blood vessels, one may fairly conclude that the microbes have been in the blood stream, although they may not have entered in large numbers. The nodular disease in the lungs of sheep will be fully described in another section.

### Suppuration in the Organs

All the organs may be invaded by way of the blood stream in the case of pyæmia.

Lungs and pleura.—The lungs may be infected from without, or from an abscess of the throat by way of the bronchial tubes. They may also be invaded when a foreign body penetrates from without, or from the second stomach in cattle. The latter accident is fairly common in town cows, and the foreign body is generally a sharp piece of wire or wood. When suppuration arises from the latter cause, the pus is fœtid. A blackened track generally marks the course that the body has taken; and the lungs, besides showing abscesses, become emphysematous from the gases entering. In cases of some standing, the connective tissue about the wound is much increased.

In the lungs of sheep affected with nodular (parasitic) pneumonia, the Editor has frequently met with true abscesses of about the same size as the larger parasitic nodules. These abscesses are generally multiple, irregularly distributed, encapsuled, and contain a greenish-coloured pus, but no parasite. The sheep are usually fat, and of healthy appearance.

The pleura may be infected in the same way as the lung —by the passage of a foreign body, or by an abscess from the latter organ evacuating its contents into the chest cavity; pyo-thorax or empyema is the result. The thoracic glands are infected from the lungs and pleura.

Heart and pericardium.—Suppuration in these organs is in the majority of cases caused by a penetrating body from the second stomach. Abscess in the heart wall, however, is very uncommon even in pyæmia. The changes are usually those of chronic septic myocarditis. The heart muscle is hypertrophied, and its wall is the seat of chronic myocarditis. The epicardium is covered by a dense false membrane, and it is often adherent to the parietal layer of the sac. A variable amount of fœtid purulent material escapes when the pericardium is incised. Sometimes a vast collection of blood-stained pus is present in the serous cavity.

Liver.—The liver may be invaded through a wound due to a foreign body passing from the second stomach of the ox. The lesion is not rare as a consequence of the latter accident. Under these circumstances the peritoneal surface of the organ is covered by a false membrane, which unites it firmly to the diaphragm. The second stomach will also be found much thickened at the injured part, and adherent to the diaphragm and superior portion of the liver. The organ in newly-born animals is sometimes invaded by way of the umbilical vein, which passes through it (*see* NAVEL-ILL AND JOINT-ILL). In the latter case the abscesses are usually multiple. In adult oxen, abscesses in the liver from other causes are not by any means rare. The organ is probably invaded by way of the portal blood from a suppurating focus or catarrhal lesion in the bowel; but this question requires further investigation. The lesion often complicates that of distomatosis, and it is also possible that the microbes have been carried from the bowel by the parasites. It has been already pointed out, however, that some hepatic abscesses are due to the tubercle bacillus. If an abscess has been superficially placed, one sees an inflammatory or a purulent area on the peritoneal surface of the diaphragm where the abscess has been in contact. This may be seen in the carcase despoiled of its viscera.

Spleen.—In pyæmia, of course, the spleen is likely to be invaded, but, that excepted, abscess of the spleen is exceedingly rare in animals. It is difficult to explain the origin of isolated abscesses in the organ, but possibly they are caused by the arrest of a few leucocytes carrying microbes. The latter lesions cannot be taken as evidence of pyæmia in its full sense.

Stomach and intestines.—Abscesses in these organs are rarely met with in animals. When present, the probability is that the germs have gained entrance to their tissue by means of wounds on the mucous membrane. An abscess in the wall of the alimentary tube may burst into the peritoneum and cause suppurative peritonitis.

Kidney.—The kidney is frequently invaded in the course of pyæmia, and then both organs are affected (*see* JOINT-ILL). The miliary abscesses in this case are most numerous in the cortex, because the glomerular capillaries arrest the microbes. They are also present, however, in the medulla. The organ is enlarged, and in cases of some standing contains a good deal of new fibrous tissue. The capsule is adherent. The kidney may also be invaded by way of the ureter when suppuration is present in some other part of the urino-genital tract, such as the vagina, urethra, or bladder. In this case—suppurative pyelo-nephritis—the abscesses are at first most evident in the medulla, but after the process has gone on for some time the whole organ is invaded, and it is difficult to say from an examination of it alone how infection has taken place. If only one kidney is affected, one may conclude that the invasion has taken place by the ureter. Both kidneys, of course, might be simultaneously invaded by way of the ureters; but in the case of a blood stream infection a primary focus will be found elsewhere in the shape of a softened clot or an abscess.

Udder.—The udder is usually invaded through a wound into its subcutaneous tissue, or by way of the teats. In the former case a single abscess is the usual result; but in the latter, multiple abscesses are formed throughout the quarter, and may burst externally.

Uterus and ovaries.—The uterus is invaded usually by way of the vulva and vagina. When suppuration occurs it is almost always as a sequel of parturition. Pus collects in variable amount in the uterus, and frequently becomes putrid. The microbes sometimes grow up the clots in the vessels until the patent branches are reached, and in this way pyæmia may be established (*see* SEPTIC METRITIS).

Bones.—It is not rare to find suppuration in the bones, and the marrow is certain to be invaded in the course of pyæmia. A single bone may be infected from a neighbouring abscess or by way of a penetrating wound from without. The extremities of the bone are where the abscess mostly forms. The bone becomes much swollen, and its substance is perforated by cloacæ, through which pus escapes to the exterior. In some cases the pus collects under the periosteum, stripping it off from the bone, and as a consequence the latter undergoes necrosis. In other cases the microbes eat into the bone, as it were, from without. No abscess is formed, but necrosis takes place in small particles. This condition, which is called caries, can be brought about by other microbes than those of suppuration. It is generally seen in connection with the vertebræ, and is well exemplified in some cases of poll-evil of the horse, when the occipital bone and the atlas become implicated. The affected part of the bone has an eroded appearance; it is irregular, and there is often a considerable loss of substance. When the bone marrow is invaded from without—infective osteo-myelitis—pyæmia follows, because the microbes easily gain access to the circulation owing to the naturally delicate condition of the vessel walls in the marrow. In pyæmia from other sources the condition of the marrow affords us very useful information. It is congested, and contains the microbes. If the animal has lived long enough, purulent centres will be found.

## Navel-Ill and Joint-Ill

The first of these terms is applied to a septic condition of the umbilical wound in newly-born animals. The wound does not heal, but continues to discharge. Even after it has closed up an abscess may form in the subcutaneous tissue. Navel-ill in the majority of cases leads to the far more serious condition termed "Joint-ill," or "Umbilical Pyæmia." The pyogenic microbes extend along the clots in the umbilical vessels. In this way they reach the liver, where multiple abscesses are soon formed, and the general circulation, whereby the other organs of the body are invaded. The pyæmic condition is well established, and often proves fatal about the third or fourth week of life; that is to say, before the age when the young enter the abattoir. Some of them, however, hang on for a considerable time longer, and are sent to the abattoir in the hope that something may be made out of them.

*Animals affected.*—All young animals are liable to contract the disease. It is sometimes seen even in children. It is met with most frequently, however, in foals, calves, and lambs, animals whose umbilical wounds are often left to take care of themselves.

*Lesions.*—The lesions are, of course, those of pyæmia. Abscesses are found in the liver, the spleen, the kidney, the lungs, and sometimes in the muscles. In some cases, however, the symptoms seem due to intoxication, as no distinct abscesses are observable. The joints, particularly the hocks and knees, are swollen. On cutting into them, one finds the synovial membrane congested or opaque—synovitis; the cavity contains a turbid fluid, but it is rare to find true pus. Microbes may be found in the joint fluid.

*Inspection in the case of suppurative diseases.*—Although there is no evidence to show that suppuration or pyæmia can arise in human beings from the ingestion of food containing pyogenic germs, it is generally believed by medical men that food of this description — milk, for example —may be the cause of sore throat, or of serious bowel disturbance, such as catarrh and diarrhœa.

When superficial abscesses exist, and the neighbouring glands are healthy, it will only be necessary to seize the affected part and the altered tissue round about it. It will generally be found that the tissues in the neighbourhood are infiltrated with fluid, and that they are in an unmarketable condition. The rest of the carcase, however, is usually quite fit for the market, and no harm can result from passing it. When the local glands are also diseased, the whole of the region concerned should be seized. The fate of the other parts will, of course, depend on their appearance.

In some of the finest-looking beasts encapsuled abscesses are often found in some of the internal organs—the liver and lung, for example. It is a debatable point whether these abscesses are of hæmatogenous origin or not; but if they are, very few bacteria can have entered the blood stream, and the condition is not a pyæmia in its full sense. Only the affected organs need be seized.

When the suppuration is local but very extensive, as one sometimes finds in the uterus, the chest, and the peritoneum, the flesh is fevered and œdematous. It does not set, and in the majority of cases is quite unmarketable. In the case of the uterus the pelvic tissues are infiltrated with blood; sometimes they are gangrenous and give off a stinking odour (*see* SEPTIC METRITIS). Flesh from cases of the latter description putrefies rapidly, and is always of very bad aspect. It should not be allowed into the market. Cows with a foreign body in the heart or lungs often live for a considerable time, even when the heart lesions are very marked. If serious febrile symptoms have been present just before death, the flesh is fevered, soapy to the feel, and in some parts œdematous. In addition, putrefactive changes are often present in the tissues and organs of the chest.

A carcase presenting the above appearances will, of course, be treated as unmarketable, because the flesh has not only a repulsive aspect, but is also prone to rapid putrefaction. In a few cases in which the septic changes are less marked, the flesh is normal and apparently fit for the market. It may, however, be necessary to order the pleura to be stripped off. Before giving his final decision, the inspector should satisfy himself as to the condition of the flesh and local glands by making incisions in a manner that will least disfigure the carcase. When pyæmia exists, the whole carcase should be seized. It is not always an easy matter to convince oneself of the presence or absence of pyæmia, but an inspector with a training in pathology will know that it is never a primary condition, that it is most likely to be connected with navel-ill, a septic clot in one of the blood vessels, or suppuration in the marrow. A microscopic examination of an organ in the fresh state does not require much time, and it may reveal the presence of multiple disseminated abscesses, although little alteration is observable by the naked eye.

## BOTRYOMYCOSIS

Botryomycosis is a disease caused by the *Micrococcus ascoformans*, and characterised by the formation of pus and of fibrous tissue in the parts invaded.

*Animals affected.*—The horse is most often affected with this disease, but cases have been reported in the ox and pig.

*Lesions.*—Czokor has recorded a case of interstitial mammitis in the cow due to this parasite. Lesions similar to those found in the horse have been described in the pig, viz. scirrhous cord, and chronic interstitial myositis affecting the muscles of the thigh.

The new tissue crushes out the essential elements, and the organ is converted into a fibrous mass. In this new tissue softened centres are found, or there may be cavities containing an albuminous fluid of a brown colour. This fluid when examined on a slide shows to the naked eye some yellow sand-like grains. These are colonies of the parasite. When stained by Löffler's or Kühne's blue, and examined with the microscope, they appear as irregular masses of cocci, sometimes surrounded by a membrane.

*Inspection.*—The carcase may be passed after the affected parts have been removed.

## MAMMITIS

### Inflammation of the Mammary Gland

This is an affection of the udder which may arise from more than one species of microbe penetrating by way of the teat. It may, or may not, be accompanied by severe systemic disturbance.

*Animals affected.*—All females in lactation may suffer from mammitis, but it is chiefly in the milch cow that we meet with it in the abattoir. It is occasionally seen in the heifer, but in this case it is of the suppurative type. The goat also suffers. Nocard has described a gangrenous mammitis in ewes; but so far as the Editor is aware, the disease has not been recorded in this country.

*The microbes.*—Nocard has described a form of mammitis in milch cows which is due to a small streptococcus (*Mammite streptococcique des vaches*). The cocci have a diameter of 1 $\mu$. They are found in the milk and in the acini. They stain well by the methylene-blue preparations.

The Editor has repeatedly found streptococci and other microbes in the contents of the acini of affected udders.

He has also been able to assure himself that these microbes were the cause of the disease; but he has never had the opportunity of experimentally proving that any individual species was alone responsible for it.

The microbe of the gangrenous mammitis described by Nocard is a small micrococcus arranged in zoogloea masses. It stains by the methylene-blue preparations and by Gram's method.

*Lesions.*—In the disease described by Nocard there is a catarrhal inflammation of the acinal membrane. The lesions run a chronic course from the first; new fibrous tissue is formed, first at the base of the teat, then it spreads gradually through the gland. There is no systemic disturbance.

In a form of mammitis frequently met with in this country the disease starts with an acute stage. It is seldom fatal, but one sometimes gets an opportunity of making a post-mortem examination of the gland in the abattoir even in the acute stages. Cows suffering from chronic mammitis are often sent for slaughter, as it does not pay to keep them for the production of milk. The disease may be confined to one quarter, or it may affect all four.

In the acute stages the affected quarters are swollen and the skin of the teats is tense. On section, the gland tissue is pink in colour; the contents of the acini are creamy and blood-tinged. If the latter material be examined microscopically after staining, it will be found to contain leucocytes, epithelial cells, red blood corpuscles, and various microbes. In some forms of mammitis the contents of the acini are serous and stinking. In others they are filled with thick pus of a yellow colour, and there may even be large abscesses in the gland substance. In still another form the acini contain greyish or yellowish clots of coagulated milk.

The explanation of these variations lies in the different properties of the microbes which are capable of setting up mammitis.

It should be mentioned, however, that in a normal gland which has been exposed for some time in the post-mortem room, the milk in the acini becomes clotted. This condition has been already referred to in the chapter on Tuberculosis (p. 99). A microscopical examination of the gland will reveal the true state of affairs. When any of the above forms have existed for some time, as is frequently the case, the gland is enlarged and firmer than normal, owing to the formation of new fibrous tissue. On section, the graining of the fibrous parts is coarser, and the new tissue by its contraction renders the remaining gland substance more prominent in certain parts. The Editor has already stated that many of the cases of chronic interstitial mammitis which have come under his notice have turned out, on microscopical examination, to be due to the tubercle bacillus, although the microscopic appearance did not in the least justify such a conclusion.

The histological changes in mammitis are conclusive. In the acute stages the acinal walls are swollen and densely infiltrated with round cells. The spaces contain many leucocytes, some red corpuscles, and a fair proportion of desquamated epithelial cells. A few microbes are discovered in some of the acini. In the chronic stages the acini are compressed by new fibrous tissue. In some lobules they are more widely separated from each other than in the normal gland; they may be obliterated altogether by the new growth (Fig. 12). The changes observed in one part of the same quarter may be acute, while those seen in a neighbouring region are of a chronic nature. The supramammary lymphatics may be normal, but in the purulent and stinking forms they are enlarged and œdematous.

The flesh of the carcase is darker than normal, and shows the alterations produced by fever, if the animal has been killed in the acute stage. When the latter is past, no alteration is discoverable in the flesh. In the stinking form, however, the flesh may have a faint but unpleasant odour, and it is liable to putrefy quickly.

The appearances of mammitis caused by the tubercle bacillus and the actinomyces have been described in special chapters.

*Inspection.* — In all cases the diseased gland and its lymphatics should be removed and destroyed. The fate of the carcase will of course depend on its appearance. If the proprietor has been so ill-advised as to have his animal slaughtered during the acute stages, the flesh will be dark in colour, sticky, and it may not set firmly. These faults may be present to such an extent as to render the carcase unfit for the market. In the fresh condition there is nothing about the flesh which is likely to injure the consumer; but carcases of this kind which would be accepted in one market would be rejected on account of their appearance in another. The inspector, however, should exercise greater severity when dealing with cases of putrid mammitis, for the flesh under these circumstances may putrefy rather rapidly. If it gives off any disagreeable odour it should be condemned.

## SEPTIC METRITIS

This is an inflammatory affection of the womb which is due to bacteria penetrating by way of the genital organs. It is accompanied by severe systemic disturbance, due to absorption of the bacterial products.

In this chapter the Editor has included the disease known as "malignant parturient fever" in ewes. He does not intend to convey the idea, however, that all the affections here included are one and the same,—they are only to be regarded as in the same category; but it would be impossible to treat them separately, owing to the state of our knowledge concerning their pathology. For the purposes of a book on meat inspection, this arrangement is quite suitable.

*Animals affected.*—All parturient animals are liable to such disorders. In the city abattoirs the disease is seen mostly in cows. Affected ewes are seldom sent in alive, but their carcases may be forwarded after being dressed. Sows in this condition seldom arrive in the abattoir either dead or alive, but certain sequelæ of the affection, in the form of abscesses, may be found in some members of this species, which have been slaughtered long after the last parturition.

*The microbes.*—The different species of microbes found at the seat of disease are very numerous, but it has not yet been shown that any one of them is solely responsible for the disease; indeed, it is more likely that several act in concert. Some of them are pyogenic, others are putrefactive.

*Lesions.* — The lesions vary greatly. It may be that the disturbance has been caused by a retained piece of the placenta, which has begun to putrefy. In this case the uterus is not properly retracted. Its cavity contains a small amount of a thick, reddish-brown fluid, which has a disagreeable odour. The cotyledons are congested and pulpy in appearance. The flesh is fevered.

In other cases the uterine walls are thickened and œdematous. The mucous membrane is congested, and the cavity of the organ contains a considerable quantity of sanious pus, which smells abominably.

The pelvic tissues in such cases are discoloured by extravasated blood, and peritonitis is often present. The lips of the vulva are often tense and œdematous, and the œdema may even extend to the perinæum. In some cases the uterus contains unaltered pus, and when the *os uteri* has become closed the distended organ may contain a gallon or two of that material.

If the condition has existed for some time, abscesses may be found in the pelvic tissues; there may even be a purulent pyelo-nephritis present, but that is a rare lesion. The microbes often cause softening of the clots in the uterine vessels, and they may spread along them until the circulation is reached. In the latter cases a species of septicæmia results, or embolic lesions may arise in the different organs. The serous membranes and lungs very often show lesions.

In cows which have recently aborted, the uterus often contains a brownish, syrupy, odourless fluid. The organ is more flaccid than it should be, but no marked changes are visible to the naked eye on its mucous membrane, nor are any signs of systemic disturbance visible in the flesh.

Serous membranes.—They are often ecchymosed. Sometimes the peritoneum becomes infected from the uterus, and shows lesions of putrid inflammation. A dirty grey false membrane is present, and the fluid contained in the cavity is stinking. The pleura and pericardium may show similar changes, but these have usually had their starting-point in the lungs.

Lungs.—Very often in the cow the lungs are the seat of a lobar pneumonia which is putrid in character. Large areas of lung are completely hepatised. Serous fluid oozes from the surface of section, and a putrefactive odour is given off. The appearance of the section is almost characteristic; it somewhat resembles that of contagious pleuro-pneumonia.

On section, the interlobular septa appear to be much broader than the normal, owing to distension of their lymph spaces. The lobules are of a dull red colour, but they have many greyish specks scattered through them.

The microscope shows that the alveolar contents consist mainly of leucocytes and red cells. Several species of microbes can be obtained from the lung.

*Inspection.*—In the majority of cases of septic metritis the flesh is fevered. Sometimes it has an iridescent appearance, which is well seen when the carcase is ribbed. Frequently it happens that the animal does not bleed well. In the latter case the flesh is very dark, and the superficial parts are discoloured by streaks of blood.

On these grounds alone the carcase might be condemned as unmarketable, for its appearance is very repulsive; but there are still more serious objections to the indiscriminate use of the flesh from such carcases as human food. There is often strong evidence—embolic lesions, septic pneumonia —that the blood stream has been contaminated by noxious germs, and the flesh tends to putrefy quickly. Cases of the latter description call for total seizure. The uterus, however, may occasionally contain unaltered pus, while the only other lesions seen are slight congestion of the pelvic tissues, with the presence not infrequently of an abscess in their substance. Signs of systemic disturbance are absent; there is no evidence of embolic lesions, nor is the flesh fevered. In the opinion of the Editor, the latter cases should be dealt with in the same way as local suppuration (*see* p. 129).

## DIPHTHERIA

The term Diphtheria is applied in veterinary pathology to diseases characterised by superficial necrosis and the appearance of a false membrane on or about the fauces. This application is as unfortunate as it is loose, for not only does it leave undifferentiated by name diseases whose only point of similarity is a symptom, but it is apt to lead one to suppose that human diphtheria may have its origin in animals, which is probably not the case.

The bacillus of human diphtheria has special characters of its own, and nobody has yet reported a disease in animals that corresponds in its lesions and systemic symptoms to human diphtheria. The existence of the latter disease in animals is rendered still more doubtful by the fact that they are exceedingly sensitive to the paralysing toxin of the true diphtheria bacillus.

### Diphtheria of Birds

This disease has been described as occurring in all the birds of the farm, including pigeons, and in game. It is doubtful whether human beings are ever attacked by it.

*The microbe.*—Various bacteria have been identified as the cause of the disease. Probably the very minute organism (one-fifth of a micron in size) described by Bordet is the real offender.

*Lesions.*—Tough yellow false membranes are found on the conjunctivæ and on the mucous membranes of the mouth, pharynx, nasal cavities, and larynx. Sometimes the lower parts of the respiratory and alimentary membranes become infected from the upper, and similar lesions appear on the mucous linings of the bowel and bronchi.

On pulling off the dense exuded material, a raw red surface is exposed. Sometimes the disease assumes an acute or septicæmic form. In the latter case one finds congestion of the organs, especially the spleen, and small patches of necrosis in the liver.

*Inspection.*—Apart from the risk of transmission to man of avian diphtheria, the possibility of which hardly seems to be established, the birds are usually emaciated, and therefore unfit for human food.

## Calf Diphtheria

In this country the disease is also known as malignant or ulcerative stomatitis of calves.

*The microbe.*—The disease is caused by the necrosis bacillus, the organism which is responsible for a variety of necrotic lesions in cattle, sheep, and horses (*vide* Multiple Disseminated Necrosis of Liver).

*Lesions.*—Grey necrotic patches covered by an exudate are found on the buccal and pharyngeal mucous membrane.

The necrosis may have spread to the respiratory or alimentary membranes, or it may have been inoculated at the feet.

*Inspection.*—The disease tends to remain local, in the sense that the infection does not become generalised. Seizure of the lesions is all that is necessary if the flesh be of good quality.

## ASPERGILLOSIS

This is the name given by continental authors to lesions caused by the *Aspergillus fumigatus* in the bodies of animals.

*Animals affected.*—Probably all animals are susceptible to aspergillosis, but the disease has most frequently been met with in man and birds. It has been seen in fowls, ducks, geese, turkeys, and pigeons. Lucet has very fully described a case of aspergillosis in the cow, and along with Thary he has recorded one in the horse.

*The Aspergillus fumigatus.*—This parasite belongs to the class of moulds. It is found in the form of spores, or tube-like filaments which are partitioned. The spores are spherical bodies, measuring about 4 $\mu$ in length. The latter are numerously present in the blood stream and organs in acute cases. The filaments are found most abundantly on the surfaces of membranes, such as the pleura, the peritoneum, the bronchial membrane, and that of the air-sacs in birds.

In the air passages the parasite attains its fullest development. Cover-glass preparations show that it consists of filaments (*hyphæ*) felted together into a mass (*mycelium*). From the mycelium spore-bearing hyphæ arise. The masses are of a grey-green or brown colour. Occasionally the parasite assumes the appearance of the ray fungus in the tissues (Laulanie). The spores can be seen in cover-glass preparations made from the blood and organs in acute cases. They can also be found in sections of the affected organs. In the more chronic lesions of the organs a few filaments can be seen, but they seem to disappear from the oldest nodules.

The parasite can be stained by Gram's method and by carbol-thionin blue.

*Lesions.*—Acute cases are marked by hæmorrhagic lesions of the septicæmia type. This was the form observed by Lucet in the cow and the horse. Hæmorrhages are present under the skin, in the muscles and internal organs. The serous membranes are ecchymosed, and the cavities contain blood-tinged fluid.

In chronic cases nodules may be found in any of the organs—the lungs, the liver, the spleen, the kidney, the bowel, and even in the muscles. These nodules vary in size from a pin-head to a pea. They are greyish in colour, and the older ones are of fibrous consistence. They are very like some forms of true tubercle. Histologically the youngest nodules are composed of leucocytes. Giant cells may be found at a later stage, and fibrous tissue is formed at the periphery of the oldest nodules. The presence of the parasite has been already referred to. When the membranes are invaded, an exudate is present, and masses of filaments may be found on its surface. This is well seen in the bronchial tubes and in the air-sacs of birds. On the peritoneum of the goose, Lucet has described plaques of exudate about the size of a three-penny-piece.

*Inspection.*—It is difficult to experimentally infect animals with the *Aspergillus fumigatus* by the ingestion method. In experiments in which the results were positive, lesions were found in the lungs, but not in the bowel (Lucet, Renon). It is possible, then, that infection took place by way of the trachea from the mouth. Local lesions should of course be removed, but it will be unnecessary to condemn the carcase except in acute cases.

## BACTERIAL NECROSIS

There are several varieties of bacteria which cause local death in tissues. For example, the bacillus of diphtheria and the tubercle bacillus have this action. The lesions to which this chapter is consecrated, however, are only of local importance; that is to say, the causal agents remain in the regions where they have been arrested, and no systemic disturbance occurs, other than that which follows upon partial destruction of an organ. It may, of course, be serious enough, if the destroyed part be a vital one.

*Animals affected.*—It seems probable that necrosis of tissue may be caused in every species of animal by certain microbes, whose effects are almost entirely confined to the invaded parts. In most cases, however, these microbes can only act on tissues already injured by other bacteria, or on those which have had their vitality impaired by other influences, such as mechanical injury. Thus Bang attributed to a widely disseminated micro-organism, which he called "the bacillus of necrosis," the necrotic lesions of the bowel which are seen in swine fever. The same microbe has been found in necrotic areas in various parts of the bodies of other animals—for example, on the coronet of the ox, in the lungs, and in the liver. The bacillus of diphtheria in calves is the same organism. M'Fadyean has described a bacterial necrosis in the livers of oxen and sheep; and the cause of the former, at least, is a micro-organism morphologically identical to the others. The microbes present in the lesion of the sheep were different.

Bacterial necrosis of the liver is comparatively common in oxen slaughtered at the Edinburgh abattoir. The Editor meets there with at least half a dozen cases every year, and he has several times received affected livers from various parts of the country. He has never met, however, with a case in the sheep. The necrotic lesions described by Schmorl about the head and anterior mucous membranes of rabbits are apparently due to the same bacillus; but in this form the disease is of little importance, since it was confined to the animals of an experimental institution. Hamilton has described this bacterial necrosis in the liver of a donkey. It is not to be understood, however, that necrosis is always bacterial in origin. It may occur from injuries and interference with nutrition without the intervention of microbes.

*The microbe.*—The bacillus of necrosis, the most important to the Meat Inspector, assumes more than one form. The elements are composed of rods measuring 3 to 4 $\mu \times \cdot 8$, and long unsegmented threads from 40 to 100 $\mu$ in length. Coccus forms are also described, but it is not clear that they constitute a form of the same microbe. Cocci only were present in M'Fadyean's case in the sheep, and in the lesions of the donkey's liver described by Hamilton.

The micro-organism is apparently saprophytic in character, and can only exceptionally become pathogenic without the aid of a predisposing influence, such as a mixed infection.

The elements stain best by Kühne's or Löffler's methods, but in the well-developed lesions it is exceedingly difficult to put them in evidence. M'Fadyean obtained his best preparations by staining sections of fresh (unhardened) livers containing recent lesions. The microbes are found just outside the dead area.

*Lesions.*—Necrotic tissue is much paler than normal, and it is firmer owing to coagulation of its albumin. On the surface of the body it becomes white, dry, and leathery.

Liver.—Disseminated necrosis is the name given by M'Fadyean to the bacterial lesion in the liver of the ox. In 95 per cent. of the cases observed by the Editor the necrosis was accompanied by fatty infiltration of the liver tissue, and by cirrhosis due to the presence of flukes in the bile ducts.

The organ in such cases is much enlarged. It is firmer than normal, and the section is of a yellowish-red colour. The liver, however, may show no other change than that of multiple necrosis. Under the capsule and in the substance of the organ, pale greyish or yellow areas are seen, which in shape approach the circular. They are firmer than the normal liver tissue, from which they are abruptly marked off by an irregular line. The areas on the surface are hardly raised above its level. In size they vary from that of a pin's head to that of a walnut. Sometimes two neighbouring patches have come into contact and formed a figure of eight. Their number varies from one or two to several dozens.

Under the microscope the liver structure is beyond recognition in the dead parts, except in the most recent lesions. In these the cell outlines can be dimly seen. The protoplasm of the dead cells is granular. Their nuclei do not take up the nuclear stains, but those of a few leucocytes can be made out. The line of separation from the normal tissue is marked by a dense collection of phagocyte cells whose nuclei stain deeply. Many of the liver cells in other parts are infiltrated by fat, and some are replaced by fibrous tissue, but the latter lesions have no direct connection with the necrosis.

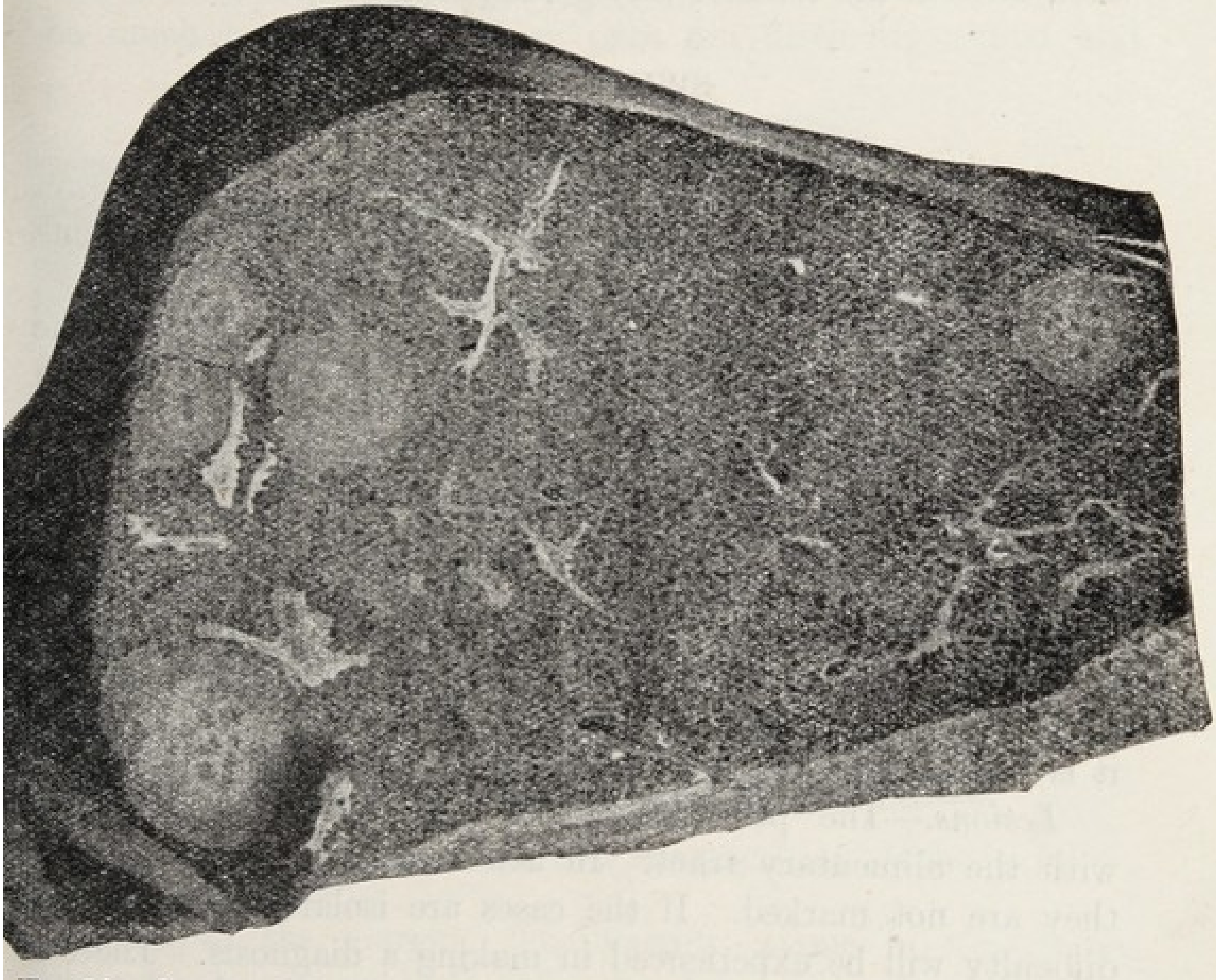


FIG. 19.—Section of the liver of an ox, showing the lesions of bacterial necrosis. —M'FADYEAN.

*Inspection.*—There is no direct evidence to show that any harm would follow if a human being were to partake of organs showing the above lesions; but, according to Schmorl, the necrosis bacillus, aided by the microbes of suppuration, sometimes retards the healing process of wounds in man. The damaged organs, then, might possibly occasion trouble if used for food. Necrosis, however, no matter what the cause be, renders the affected parts unfit for sale, and on this account alone the inspector is justified in seizing them. In the case of the liver, the whole organ should be seized. As the lesions to all intents and purposes remain local, no harm can result from passing the carcases after they have been removed. Such carcases are often of very good quality.

## SWINE FEVER

### Hog Cholera (America)

A contagious disease of swine, peculiar to the porcine species, and caused by an ultravisible microbe.

It is characterised by an erythematous eruption on the skin, the formation of ulcers in the alimentary tract, and in the acute stages by intoxication.

*The microbe.*—For a number of years a bacillus which can in all acute cases be cultivated from the blood or organs of diseased pigs was accepted as the cause of swine fever, but, as was first discovered by de Schweinitz, the actual cause belongs to the class of ultravisible viruses. The so-called "swine fever bacillus" is therefore only a secondary invader, though it is possibly the cause of the bowel lesions.

*Lesions.*—The principal lesions are found in connection with the alimentary tract. In acute cases of short duration they are not marked. If the cases are isolated, considerable difficulty will be experienced in making a diagnosis. There is generally a purple discoloration on the skin of the hocks, the ears, and the under surface of the abdomen. The alimentary mucous membrane shows areas of congestion, maybe in the pharynx, the stomach, and the small or large intestines.

The congested parts vary in colour from a reddish tinge to a hæmorrhagic colour, and in size from a pin-head to a large area. Sometimes in the early stages there are patches or areas of diphtheritic inflammation in the posterior portion of the small intestine, in the cæcum, and the colon.

The most characteristic lesion, however, is the swine fever ulcer. The action of the bacillus is to produce necrosis of the tissues. This necrosis begins as a small diphtheritic (necrotic) patch about the size of a split-pea, and it spreads outwards in a circular manner. The necrotic patch is by and by cast off, leaving an ulcer. The ulcers commonly vary in size from that of a threepenny-piece to that of a shilling, but they may be much larger. The larger ones are distinctly raised and

FIG. 20.—Swine fever ulcers in large intestine of pig.—M'FADYEAN.

rounded at the margin. The necrotic tissue in the centre generally becomes black from the formation of sulphide of iron. The ulcer may heal, leaving a cicatrix. This ulceration seldom extends beyond the muscular coats, and perforation of the bowel is very uncommon. In old cases the intestinal wall becomes thickened, and ulcerating nodules may be found projecting into the tube. The commonest site of the ulcers is the large bowel, particularly the cæcum in the region of the ileo-cæcal valve. They are also very often found in the colon, and they may extend right back to the rectum. In the small intestine they are sometimes found at the posterior part. Rarely are they seen in the stomach, and it is exceptional to find them on the upper surface of the tongue or on the mucous membrane of the cheeks.

The histological examination of the lesions shows that at the seats of diphtheritic inflammation the epithelial cells are dead. Many of the glands have lost their epithelial lining, and they contain a multitude of different microbes. The glands of the abdominal cavity, and frequently those of other regions, are congested (strawberry glands). Sometimes they show necrotic patches. The cavity may contain an excess of fluid.

Liver.—The liver may show nothing more than cloudy swelling of its cells, but sometimes the organ is the seat of a multiple necrosis, a lesion which resembles that of tuberculosis.

According to M'Fadyean, "swine fever bacilli" are found in the necrotic areas.

Spleen.—The spleen is usually normal, but occasionally one finds necrotic patches on its substance.

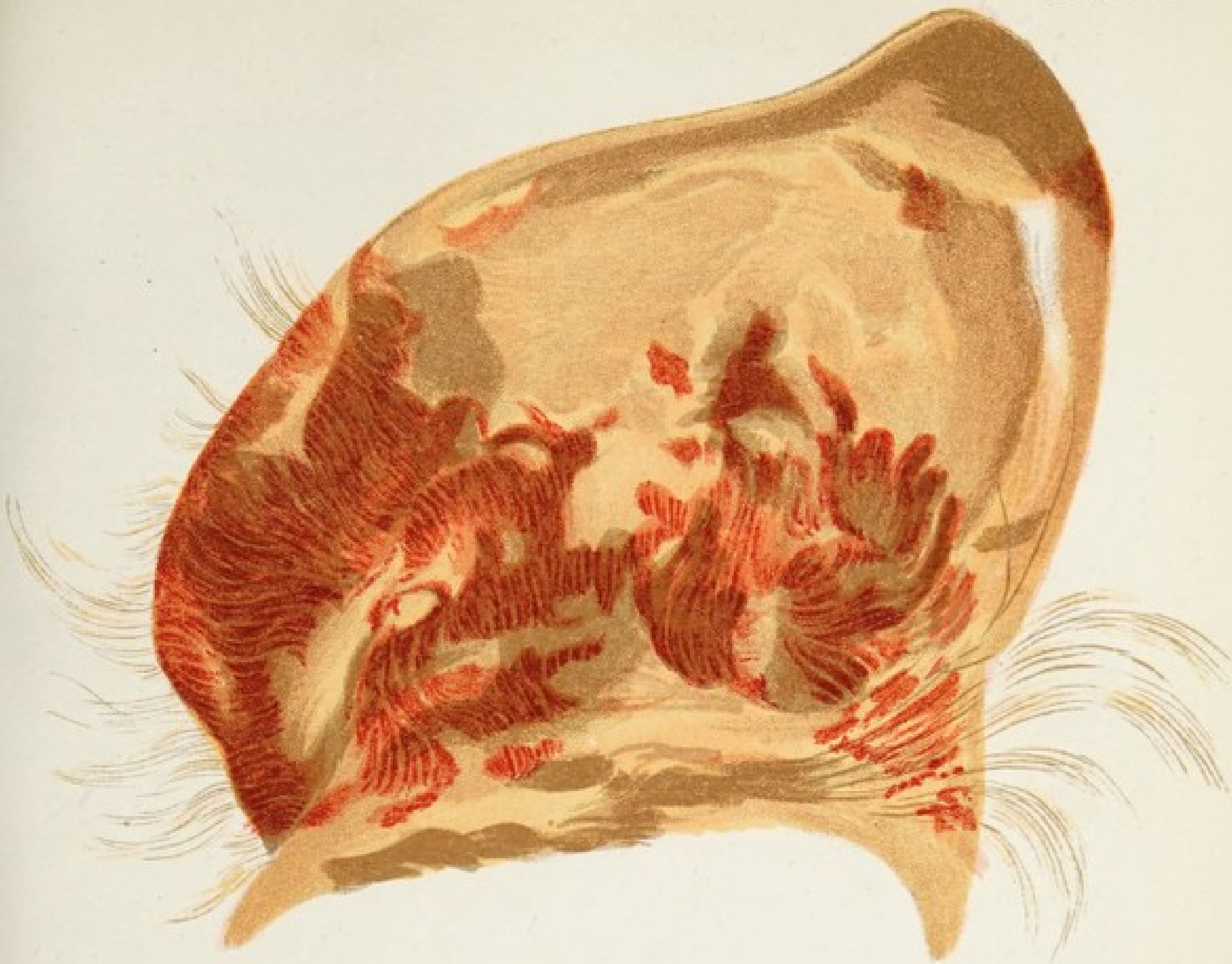
Kidneys.—The kidneys may be normal, but numerous small hæmorrhages are often found in the substance, and occasionally a large amount of coagulated blood is discovered in the pelvis. Parenchymatous inflammation has also been described.

Lungs and pleura.—In cases of swine fever the lungs are often found to be consolidated. The pleura is sometimes inflamed, and the chest may contain fluid. The pneumonia may be either lobar or lobular, and according to M'Fadyean it is in most cases a complication due to the action of saprophytic germs (so-called swine-plague bacteria) on an enfeebled organism. The Editor has seen many cases in which the lung lesions were due to strongyli (*S. paradoxus*). In some cases true swine fever necrotic lesions are present in the lungs.

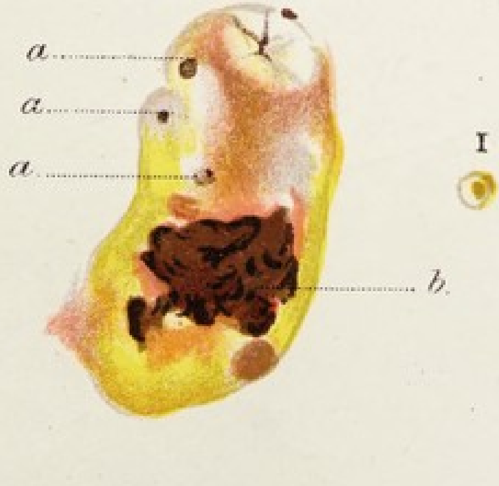
Heart.—The muscle of the organ is very little altered, but petechial hæmorrhages may be found on its membranes.

*Inspection.*—As this disease is not communicable to

PLATE X



External surface of Ear of Pig, showing discolouration seen in Swine Fever.




Ileo-cæcal Valve of young Pig, showing plugged Gland Follicles *a*, *a*, *a*, and one Ulcer at base *b*.

1.—A detached plug.

human beings, the inspection resolves itself into a question of what is marketable and what is not. The carcases of pigs killed in the earliest stages often set firmly and present no abnormal appearance. Such carcases might be passed without detriment to the health or fastidiousness of the consumer. When the disease is developed, however, small hæmorrhages may be found under the skin and in the muscles; the flesh is fevered, flabby, and often œdematous. The usual practice is to seize carcases of the latter description as well as those which are emaciated. Pouchet and others have reported cases of poisoning in human beings from eating the flesh of pigs killed while suffering from swine fever, but it is very far from certain that the swine fever was actually to blame.

*Application of Contagious Diseases of Animals Act.*—The Swine Fever Order of 1894 (sec. 7) forbids the utilisation of the flesh as food, by requiring the carcase of a pig affected with or suspected of swine fever at the time of its death to be destroyed. Suspected does not apply here to animals which have been killed and found healthy, although they have been in contact with the sick.

## SWINE ERYSIPELAS

This is a disease peculiar to swine, and caused by the entrance into the body of the bacillus of *Swine Erysipelas*, or *Rouget du Porc* of the French veterinarians.

On the continent of Europe swine erysipelas is described as virulent and contagious, but that description does not suit the disease as we meet with it in this country. Here it is not at all common. Moreover, nearly all the cases which have been recorded have occurred sporadically. In the acute or septicæmic forms the disease is characterised by fever, intoxication, and gastro-enteritis. In the more chronic forms a rash appears on the skin, and vegetations frequently form on the cardiac valves.

*Animals affected.*—The disease is met with mostly in adult pigs; young animals up to about four months are said to possess a marked degree of immunity.

*The microbe.*—The microbe is a fine rod-like bacillus, measuring about 2 $\mu \times \cdot 3$. It is rounded at the ends, non-motile, and stains equally throughout. It stains by the methylene-blue preparations and by Gram's method. It is found in the blood in small numbers, but preparations are best made from the spleen, the lymphatic glands, or bone-marrow.

*Lesions.*—In acute forms, where death has supervened in a few hours, there may be no skin eruption (*Rouget blanc*). Usually, however, there is a reddish or violet rash on the same regions as in swine fever. This rash is sometimes spot-like.[1] In recovering cases the skin over the part may slough. Under the skin and in the muscles one finds small hæmorrhages.

The muscles are usually paler than normal in the parts where there are no hæmorrhages. They are often flaccid, œdematous, and soapy to the feel, if the pig has died or been killed in the acute stages. The fat, too, does not set firmly.

Stomach and intestines.—The gastric and intestinal membranes are swollen and congested. In the region of Peyer's patches the engorgement is specially marked. No distinct ulcers are found, but the membrane may show abrasions. The peritoneum shows ecchymoses, and the abdominal cavity may contain an excess of fluid.

Spleen.—The spleen is engorged and softened. This

[1] In twenty-one cases diagnosed as urticaria of swine, Jensen found the bacillus of swine erysipelas in the skin lesions. In some of the cases vegetations were present on the cardiac valves, and in others the bacilli were found in the spleen. Jensen says that many of the Danish veterinary surgeons look upon urticaria of swine as a contagious disease. It would be interesting to know if similar bacilli are present in the lesions of the skin in cases of urticaria of swine in this country, in which swine erysipelas in its virulent form is rarely met with.

lesion might easily raise a suspicion of anthrax, but in swine erysipelas swelling of the throat is absent. The bacteriological examination of the spleen-pulp will in most cases put the diagnosis beyond doubt.

Liver.—The liver may be little altered, or it may be engorged.

Kidneys.—The kidneys often show multiple small hæmorrhages in their substances.

Glands.—The glands are swollen and congested.

Lungs.—In the acute stages the lungs are congested. The chest cavity may contain an excess of fluid, and the serous membranes show ecchymoses.

Heart.—In the more chronic form, such as that met with in this country, vegetations form on the cardiac valves, and all the results of valvular disease may follow. The valves on the left side are most frequently affected. The lesion is caused by the bacillus of swine erysipelas, which may be demonstrated in the superficial layers of the vegetations.

*Inspection.*—This disease is communicable to man by inoculation, but experience indicates that there is no risk of infection through ingestion of the flesh of diseased pigs. It must not be forgotten, however, that the bacillus invades the blood stream, so that the flesh may be and often is virulent so far as the pig is concerned. There is a possibility of fresh centres of the disease being established in piggeries by the uncontrolled sale of pork from affected pigs; for, as every one knows, the parings from the kitchen and the flesh factories often find their way into the pig's pail. The authorities, however, would be acting *ultra vires* if on the latter grounds they withdrew the flesh from the market, since the Board of Agriculture has as yet applied no restrictions.

If the animals have been slaughtered in the initial stage of a less acute attack, the flesh may be quite marketable. Ostertag, however, says that it is liable to putrefy quickly, and advises that the time which has elapsed since slaughter be taken into account before the flesh is passed. In this country, of course, one would have no guarantee that the flesh would pass immediately into consumption after it left the abattoir. In the later stages of the disease the flesh is fevered, and shows hæmorrhages into the tissues. Such carcases are unmarketable. When the heart lesion is all the evidence that remains, the carcase is usually fit for human food, unless there be marked emaciation. In the absence of the viscera one may with advantage make a bacteriological examination of the bone-marrow.

## SWINE PLAGUE

A contagious disease of pigs, with pneumonia as a nearly constant accompaniment, was first described in Germany, and named Schweineseuche (to distinguish it from Schweinepest, or swine fever). Recent investigations have made it probable that the disease, as an independent, contagious affection of swine, has no real existence, the cases which have been included under that head being cases of swine fever with pneumonia as a complication. In every country a considerable proportion of the animals affected with swine fever develop pneumonia, with more or less extensive hepatisation of one or both lungs, and in the great majority of such cases the lung lesions contain, and are apparently caused by, minute bacteria of the fowl cholera type. These bacteria are apparently normal inhabitants of the mouth and air passages in pigs, but in animals whose general powers of resistance have been weakened by an attack of swine fever they may invade and multiply in the lung tissue and thus cause pneumonic complications (see p. 146).

## CONTAGIOUS PLEURO-PNEUMONIA OF CATTLE

A contagious disease peculiar to the ox, and characterised by inflammatory changes in the lungs and on the pleuræ.

*The microbe.*—The causal microbe of this disease has been the object of much fruitless search.

According to Nocard, it is so small that one can just see it as a refractile point when the highest magnifying powers are used. He obtained cultures of this almost infinitesimal object by inoculating a special medium, which was then enclosed in collodion capsules and inserted into the peritoneal cavities of rabbits. After several weeks' incubation in this way he was able, by inoculating the culture under the skin of oxen, to produce local lesions similar to those caused by injection of the virulent lymph obtained from natural cases.

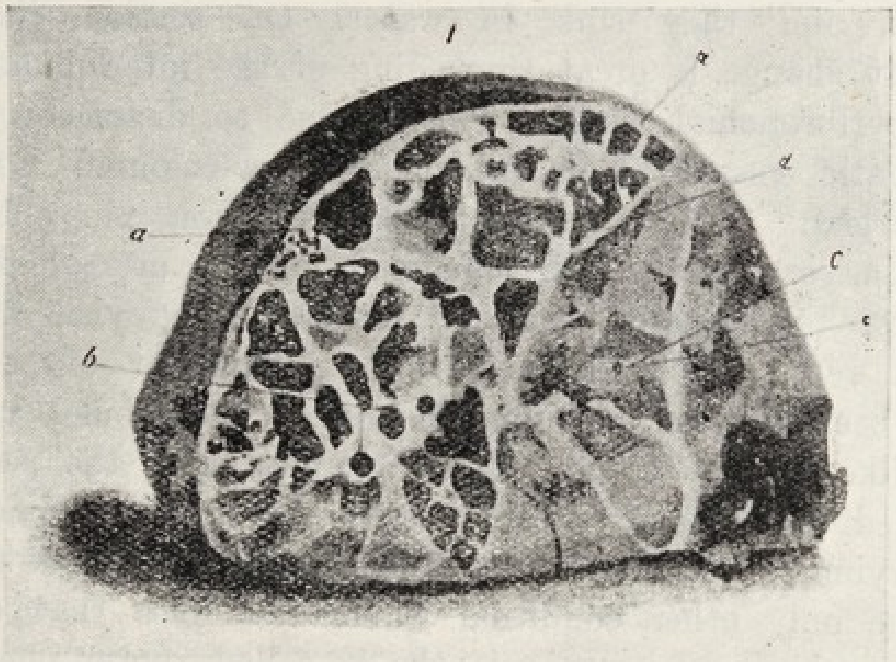



Fig. 21.—Section of lung showing the lesions of contagious pleuro-pneumonia.—Walley.

*a*, Subpleural tissue distended by lymph.
*b*, Dilated veins in interlobular septa.
*c*, Interlobular tissue.
*d*, Consolidated lobule.

*Lesions.*—They are almost entirely confined to the chest organs, although one may occasionally meet with local cutaneous swellings and arthritis. The tissue in front of the chest is often œdematous. On opening the chest one often finds a considerable amount of greyish turbid fluid inside. The pleura in certain parts is opaque, thickened, and covered with a dense false membrane of a yellowish colour. The two surfaces may be adherent. Pericarditis may be present. The glands are swollen and œdematous.

The lung lesion varies in extent. There may be only a small area affected, or the greater part of both lungs may be consolidated. Emphysema is present in the still open parts, and there may be areas of hæmorrhagic infarction. The consolidated areas stand out prominently; they are airless, and they sink in water. On section the most evident change is great thickening of the interlobular septa and peribronchial tissue. This is due to distension of the lymphatic vessels, from which a straw-coloured lymph is discharged. The smaller tubes are often plugged by a fibrinous exudate. The hepatised lobules are of different colours. Some are brick red, others are greyish-yellow or greyish-red, and when a very large number of red cells have been thrown out into the alveoli the lobules are dark red, like venous blood. These changes give the section a marbled appearance. In old cases one finds necrosed areas of varying size, which are often encapsuled by fibrous tissue.

The only other condition which resembles that of contagious pleuro-pneumonia is the so-called septic pneumonia seen in recently calved cows. In the latter cases, however, the marbling is not so distinct, the septa are usually less distended, the straw-coloured lymph is absent, the tissue is very œdematous, and it usually stinks. The microscopic appearance is less characteristic than the macroscopic. The interlobular, peribronchial, and perivascular lymphatics are much distended. The septa are invaded at their margins by round cells, but only in the very chronic cases does one find fibrous proliferation.

The contents of the alveoli vary. Those near the septa contain a great deal of fibrin, but very few cells. Others contain leucocytes, red cells, and fibrin in varying proportion; a few detached epithelial cells may be present. In the very red-coloured lobules and the areas of hæmorrhagic infarction, one finds a dense collection of red blood corpuscles. Some of the blood vessels contain clots. Perhaps the most characteristic feature of contagious pleuro-pneumonia is the amount of fibrin present in the exudate. In the other forms of pneumonia one seldom finds much fibrin.

*Inspection.*—It is unlikely that pleuro-pneumonia will ever again gain a serious footing in this country, if the present regulations continue to exist. During the ravages of the disease the slaughter order was mercilessly applied, and one had ample opportunity of observing the flesh in all stages of the malady.

In the acute stages the flesh is fevered and soapy. It does not set well. When a large area of lung is consolidated, and when there is much fluid in the chest or pericardium, the flesh is œdematous and flabby. This condition is seen well at the anterior and lower part of the chest, and this led to the term "wet goat" being applied to the disease by Edinburgh fleshers.

In the above conditions the flesh is unmarketable. When the disease has reached the chronic stage, and the lesions are not great in extent, the flesh is normal in appearance, and may be passed if the carcase is not emaciated. The universal rule in Edinburgh was to pass carcases when the flesh showed no departure from the normal. The affected portions of the pleuræ were removed by stripping. In bad cases, the portion of the fore-quarter contiguous to the pleuritic lesion, or even the whole quarter, was retained.

## FOOT AND MOUTH DISEASE

### Eczema Epizootica

A contagious and inoculable disease, characterised by fever and the appearance of a vesicular eruption on different parts of the body.

*Animals affected.*—All animals may be infected, but the disease is mostly seen in those whose flesh is used for human food. The ox is most frequently attacked, the sheep and pig suffer less often. It is transmissible to man.

*The microbe.*—As was first shown by Löffler and Frosch, the infecting agent is not retained in the pores of a porcelain filter, and thus belongs to the class of ultravisible viruses.

*Lesions.*—The lesions are found chiefly in connection with the mucous membrane covering the pad and tongue, on the skin between the digits, around the coronet, and at the base of the supernumerary digits. In the cow the skin of the

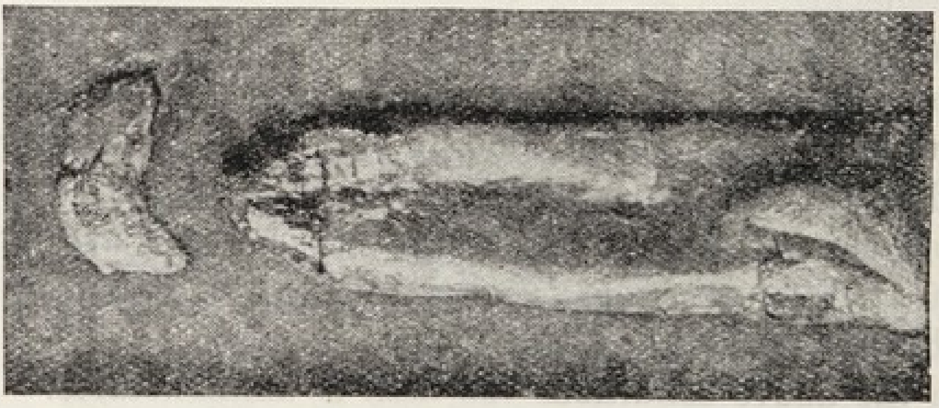


Fig. 22.—Tongue and pad of ox, showing the lesions of foot and mouth disease.

udder and teats is a favourite seat of the eruption. The eruption may, however, appear on any mucous membrane; for instance, on the alimentary or bronchial, or on the parts of the body where the skin is thin.

In the earlier stages the part is swollen and congested; later a vesicle, commonly about the size of a florin, appears. One usually finds, however, that the vesicle has burst. The remains of the membrane, white and bleached looking, covers a raw red sore. Often the cutaneous sores are suppurating, and in old cases the hoof may be separating from above downwards. In the more severe cases there may be abscesses in the lungs and liver, pneumonia, and lesions on the stomach and bowel.

In all stomachs there may be patches of congestion, and even ulceration. The small bowel may also be congested and ecchymosed. In very bad cases all the appearances of septicæmia are present.

*Inspection.*—There is no case on record of foot and mouth disease having been contracted by human beings through eating the flesh of affected animals, although there is a slight danger of the butcher being inoculated through wounds. Most of the recorded cases of transmission have been due to drinking milk contaminated by the virus, but they are few in comparison with the number of cows attacked during an outbreak. The present regulations of the Board of Agriculture would debar affected animals from being moved to the abattoir; but in former times many were slaughtered for food. The carcases of these animals were usually of good quality, and quite marketable after the parts containing lesions had been removed.

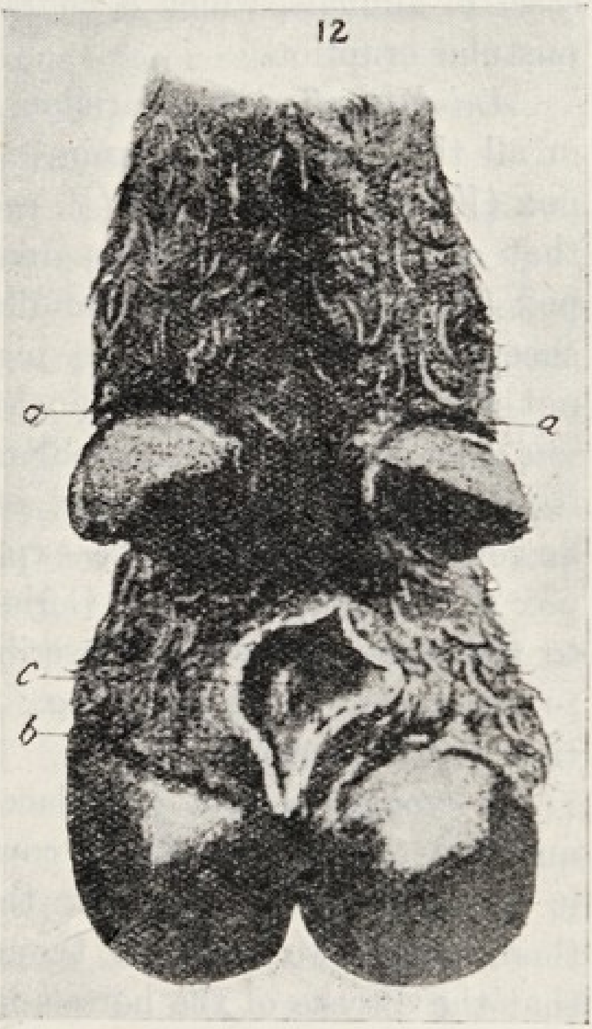



FIG. 23.—Foot of ox affected with foot and mouth disease.—WALLEY.

*a*, Raw surface at base of supernumerary digits.
*b*, Horn beginning to separate.
*c*, Ruptured vesicle.

In cases of a malignant type, and in those in which the temperature has been high, the flesh is fevered, and the carcase is like that of an animal which has suffered from septicæmia. A carcase of this description would call for seizure apart altogether from the disease under discussion.

## VARIOLA

### Pox

The term Variola is applied to a class of contagious diseases of animals, which is characterised by fever and a vesico-pustular eruption.

*Animals affected.*—Variolous diseases have been described in all the domesticated animals, and even in poultry. Horse pox (*V. equina*), cow-pox (*V. vaccina*), the pox of the goat and that of the camel, are apparently the same disease. Sheep-pox (*V. ovina*) is a different disease, which is peculiar to the sheep. The variola of the pig (*V. suilla*) is rare, and has not been the subject of much study. Trasbot considers it *une maladie propre.* Friedberger and Fröhner state that it originates from small-pox of man. It is worthy of note, however, that pigs can be experimentally infected with cow-pox (Chauveau), and that Gerlach has communicated *V. suilla* to the goat. The cases described as variola in poultry seem to have been due to *gregarinæ* ; fowls are refractory to inoculation with the vaccine virus.

It would be out of place to discuss the much-vexed question of the identity of cow-pox with small-pox of man ; it is sufficient to say that the bulk of evidence points to them being two different though neighbouring diseases, and that the disease of the horse's legs, characterised by elephantiasis and seborrhœa, has usually nothing to do with horse-pox, although the horse-pox eruption on the limbs may end in a somewhat similar condition.

*The microbe.*—No specific infecting agent has as yet been demonstrated to be the cause of variola in any animal, and recent experiments indicate that the virus is ultravisible.

*Lesions.*—Vaccinia is a benign disease. It is not now commonly met with except in certain parts in England. In the cow the eruption is met with mainly on the teats and udder ; the mucous membranes and the skin of the body are seldom the seats of lesions; a generalised eruption is exceptionally met with. In the male the eruption appears on the scrotum. In the calf it is found on the muzzle. In the pig the eruption occurs on the snout and the mammæ; sometimes it is generalised.

On the skin it begins by redness and swelling. This is followed usually by a papule about the size of a lentil, which becomes vesicular at its summit, then bursts. A thick yellow or blood-tinged lymph exudes and forms a brownish crust. This is the so-called pustule. The discharge, however, is not pus in the popular sense, unless the organisms of suppuration have gained access to the wounds. The eruption in its dry stage consists of a central scab, slightly raised, and a peripheral bluish-looking ring of new epithelium. The skin outside this is usually of a rosy tint. On the thinner mucous membranes the eruption is more vesicular in character. By mechanical irritation the pustules may have been converted into large sores.

*Inspection.*—It is by direct inoculation that man contracts vaccinia. Variolous cases seldom come into our abattoirs, nor is much inspection called for in connection with them. The blood and lymph are not virulent, unless they be taken from the lesions. Moreover, the virulence is easily destroyed by heat. The flesh is usually of good aspect, and may be passed after the parts showing the eruption have been removed. This is generally done in the natural course of dressing.

## Variola Ovina

This disease calls for special remark, for although Great Britain has been free from it since 1862, the disease still exists in countries from which mutton may be imported. Some breeds of sheep suffer but little from an attack; others are fatally affected. The eruption appears generally on the external mucous membranes and on the parts of the body where the wool is thin. The papules vary in size from a lentil to a sixpenny-piece; they are flat and hard. In malignant cases the alimentary and respiratory membranes are ecchymosed, the glands are congested, and all the signs of septicæmia are present. The lungs often show patches of consolidation, they may even be gangrenous.

*Inspection.*—*V. Ovina* is not transmissible to man. Attempts to experimentally infect human beings have failed (Nocard). Bosc and Pourquier, however, communicated to the Moscow Congress of 1897 a supposed case of transmission to a woman by the accidental inoculation of sores on the hands.

In malignant cases the flesh is fevered, and small hæmorrhages are found under the skin and on the serous membranes. The carcase is of bad aspect and does not set well. Such carcases are unmarketable, and should be condemned. In the milder cases the flesh is usually good, and may be passed after the lesions have been removed.

## CATTLE PLAGUE

### Rinderpest

Cattle plague is a contagious eruptive fever caused by an ultravisible virus.

*Animals affected.*—Oxen are by far the most frequently attacked. Sheep and goats are less often the victims of the disease. Some races of pigs (Chinese) are susceptible to inoculation, and they also take the disease naturally. Wild ruminants are susceptible, and, according to Leblanc, the camel may suffer from rinderpest. Man, the horse, and the dog are immune.

As was first shown by Nicolle and Adil-Bey, the causal agent may pass through the pores of a Berkefeld filter, and must therefore be classed with the ultravisible microbes.

*Lesions.*—The characteristic lesions of cattle plague are localised on the mucous membranes, especially on that of the alimentary tract. Sometimes there is an eruption on the skin. In the mouth one finds patches of intense congestion and desquamation. They are particularly evident inside the lips, at the posterior part of the mouth, and in the fauces. The first three stomachs of the ruminant may show patches of congestion. The abomasum towards the pylorus shows hæmorrhagic patches, and there may be erosions and an exudate on its mucous surface.

In the small intestines the mucous membrane is intensely inflamed, and a diphtheritic exudate is present in patches at certain parts. Peyer's patches and the solitary glands are swollen and congested. In the large intestine, particularly in the cæcum, one finds the mucous membrane swollen and congested. In the rectum the mucous membrane is intensely red, and the redness is broken by lines of greyish exudate (zebra markings). The liver is swollen and cloudy; its gall-bladder is distended. The spleen is not enlarged. The kidneys may be normal or they may be congested.

The glands are often hæmorrhagic. The serous membranes are ecchymosed. The blood in the veins is of a purple colour, and the microscope shows the leucocytes to be increased in number, while the red cells are distorted—poikilocytosis. The respiratory membrane may also show congestion and ecchymoses. The lungs are often congested and emphysematous. The above lesions are not all constant. According to Verney, the most constant lesions are inflammation of the nasal cavities and abomasum, ecchymoses on the mucous membrane of the cæcum, and zebra markings on the rectum.

*Inspection.*—The flesh in the advanced stages presents a magenta hue; it may be of a mahogany colour, or very dark red. It gives off a special odour. In the earlier stages it is not much altered, but notwithstanding this the majority of experts are unanimous in condemning such flesh as an article of human food; and here, as in the case of rabies and anthrax, the Legislature has decreed its absolute destruction.

## MALIGNANT CATARRH OF THE OX

### Malignant Catarrhal Fever

This is a disease characterised by inflammation of the mucous membranes of the eyes, the anterior parts of the respiratory passages, the mouth, and the bowel. In severe cases symptoms of intoxication are also well marked. The disease is presumably of bacterial origin, but it is usually sporadic in character, and has no great tendency to spread from animal to animal. Sometimes, however, it assumes enzootic characters among animals subjected to bad hygienic surroundings. Thus it is seen to affect a large number of beasts which have come a sea voyage and been battened down between decks.

*Animals affected.*—The disease is said to be peculiar to the ox, but sheep certainly suffer, though less frequently, from a very similar affection, which has not as yet been the subject of special investigation.

*The microbe.*—According to Leclainche, the disease of the ox is due to a microbe of the *Bacillus coli* type. The *B. coli* is an oval rod rounded at its extremities, and measuring from 2 to 3 $\mu \times 1$. It stains with the methylene-blue preparations, but does not take Gram. The *B. coli* is a harmless inhabitant of the intestines of many animals, but under certain circumstances it is believed to acquire pathogenic characters. It is but right to say, however, that the name *B. coli* is often applied simply to designate the type of organism, just as one speaks of the fowl cholera type. The original catarrhal symptoms of the disease become complicated at a later stage, owing to invasion of the tissues by other microbes, such as those of suppuration.

*Lesions.*—In mild cases, and in the early stages, one finds congestion of the Schneiderian membrane, a croupous exudate on its surface, and a discharge around the nostrils. The conjunctiva is also red and swollen. The membranes of the mouth, the larynx, pharynx, and bowel are congested. In advanced cases the membranes of the nasal cavities, the sinuses, and the larynx are ulcerated and suppurating. The discharge exhales an abominable odour. The deeper parts of the respiratory passage seldom show alterations, but the lungs may be the seat of emphysema. The alterations in connection with the eyes are marked; the organs may show signs of keratitis, iritis, and hæmorrhage into the anterior chamber. The buccal membrane on the lips, the gums, and base of the tongue shows small superficial erosions. The mucous membrane of the stomachs and bowel is inflamed and ecchymosed.

Peyer's patches are often markedly affected. The contents of the tube are tinged with blood. The glands are swollen and congested. The kidneys are also congested, and the urine contained in the bladder may be blood-tinged. A pustular eruption on the skin has also been noticed. The other alterations are those of a septicæmic type of disease—ecchymoses on the serous membranes and small hæmorrhages into the muscles.

*Inspection.*—No bad effects are known to have followed in human beings from ingesting the fresh flesh of animals affected with this disease. If the animals have been killed in the early stages their flesh is not much altered, and it may be passed. It should be remembered, however, that such flesh is liable to putrefy quickly.

In advanced cases the flesh is fevered, and it shows small intramuscular hæmorrhages. In such cases it is repulsive, and should be considered unmarketable.

## Malignant Catarrh of the Sheep

In sheep, especially hill sheep, a disease characterised by somewhat similar lesions to those seen in the above affection is met with. The lesions, however, are more suppurative in character, and the animals become affected although they are living in the open. In the absence of information regarding the cause of this affection, one would hardly be justified in saying that it is identical with the malignant catarrh of the ox. It looks as if an ordinary catarrh of the pituitary membrane had become converted into a suppurative one by the access of pyogenic germs.

The membrane in bad cases is ulcerated. Small abscesses are found on the face in the neighbourhood of the nostrils, and sometimes on the bare parts of the body (auto-inoculation). The animals lose condition, and in bad cases are much emaciated.

*Inspection.*—Unless the carcases are emaciated they may be passed with safety after the affected parts have been removed.

## ANTHRAX

### Splenic Fever; Splenic Apoplexy; Cumberland Disease (Australia); "Loodianah" Disease (India); Malignant Pustule and Woolsorter's Disease in Man

Anthrax is a disease caused by the anthrax bacillus.

*Animals affected.*—Human beings are susceptible to anthrax, and they usually contract it by handling animals or their products.

Oxen and sheep are the domesticated animals most frequently attacked by anthrax. The pig and horse contract the disease less frequently. The rabbit and guinea-pig are also susceptible, but the fowl is refractory to inoculation, except under circumstances only realised in experiment.

*The microbe.*—When examined in preparations made from the organs or blood while they are fresh, the bacillus appears in the form of stiff motionless rods, measuring from 4 to 10 $\mu$. They can be seen in unstained preparations. When stained by methylene-blue, one sees a coloured central rod of protoplasm bounded by a clear area, which only takes up the stain at its outer margin. Unless a very high magnification be used, the ends of the rod appear to be square cut; but in reality they are concave. The bacillus does not sporulate in the body, but at summer temperatures spores are formed when anthrax blood is exposed to the air.

The bacillus stains well by most of the aniline dye preparations and by Gram's method. When gentian-violet is used, however, the membrane is not differentiated from the rod protoplasm, and the bacillus looks thicker. The bacteria of putrefaction which invade the tissues from the bowel several hours after death have often been mistaken for those of anthrax (see *Inspection*).

*Lesions and infection.*—Animals may be infected through

FIG. 24.—Anthrax bacilli from blood (Leitz, oil immersion. $\frac{1}{12}$).

wounds, or by way of the alimentary and respiratory tracts. The path of infection, however, is not of great interest to the Meat Inspector, for no matter how the microbe has gained a footing, it finds its way into the blood stream in a comparatively short time.

Animals may arrive in the abattoir sick of anthrax; they may have died on the way, or their carcases may come in dressed from other places. This is one of the dangers of the foreign meat trade. As might be expected, the lesions present will be somewhat different in each case.

The lesions found in connection with anthrax are of the hæmorrhagic septicæmia type. The local reaction of the tissues and cells is almost absent. The bacteria, however, plug many of the capillaries, and lead to congestion of the organs and hæmorrhages into their tissues.

If the animal has been brought in dead, there is often a bloody discharge from the anus and nostrils. Under the skin one sometimes finds an œdematous swelling, which is due to infiltration of the tissues by a yellowish or blood-tinged fluid. The latter is not common in cattle, but in affected horses and pigs it is the rule to find œdema in the region of the throat. Under the skin one finds small hæmorrhages.

The flesh is paler than normal, except where hæmorrhage has taken place; some time after death it has a salmon colour. The embedded glands are hæmorrhagic. The internal organs and glands are all congested, and may show numerous hæmorrhages. The latter are well seen on the omentum. The serous cavities sometimes contain a reddish fluid, and their membranes are ecchymosed. The blood is dark and tarry looking.

The spleen is usually much enlarged; it may even be ruptured. The pulp is more fluid than normal, and has a tar-like appearance. Enlargement of the spleen in cases of sudden death is considered almost diagnostic of anthrax. Under all circumstances, where there are no other lesions to account for it, the enlargement should be looked on with great suspicion. In exceptional cases, however, the spleen is normal in size. When the animal has come in sick and been bled the congestion is not so well marked, and in the case of a carcase sent in dressed many of the important indications have been removed.

*Inspection.*—No part of an animal that has died or been killed during an attack of anthrax should be allowed into the market. All parts of the animal ought to be destroyed, and the greatest precautions should be exercised by those whose duty it is to handle them. When dealing with a fresh case, there will seldom be any difficulty about arriving at a correct diagnosis. If the spleen is enlarged, a cover-glass preparation of the pulp will show hundreds of bacilli. They are fewer in cases in which the spleen is normal, but, so far as the Editor's experience goes, a few can always be found. In cases which have been dead some time before the inspector makes his examination, especially if the season be hot, the anthrax organism is mixed with others. Some of the latter resemble it sufficiently to deceive the inexperienced into mistaking an ordinary case of post-mortem putrefaction for anthrax. The bacilli found in the former condition, however, are usually larger and thicker, and their ends are rounded or pointed.

These putrefactive germs crowd out the anthrax rods, so that a time arrives when it is impossible to say if there are any present. In such cases it is advisable to examine blood from capillaries equally far removed from the two sources of foreign microbes, viz. the external parts and the intestines. The Editor's experience has been that a small artery may contain no anthrax bacilli, although the case is one of anthrax. The kidney, owing to its vascular arrangement, and the bone-marrow are good organs to examine; one may even resort to sections of the former.

When dealing with a dressed carcase, the difficulties are greater. The suspicions of the inspector will be aroused by the appearance of the flesh, and probably by the ecchymosed condition of the pleuræ and peritoneum, if they have not been stripped off. He should then cut into the muscles to look for hæmorrhages, and he should examine the blood. The Editor is of opinion that carcases in dispute should be detained in cold storage until experimental inoculation has decided the case.

The Anthrax Order of 1895, sec. 7, requires that the carcase of an animal which at the time of its death was affected with or suspected of anthrax shall be destroyed. "Suspected" refers to animals that have died.

## MALIGNANT ŒDEMA

### Traumatic Gangrene

This is an inoculable disease caused by the bacillus of malignant œdema (Koch), the *Vibrion septique* (Pasteur). It is characterised by intoxication, and by gangrene of certain parts.

*Animals affected.*—Malignant œdema is very rarely seen

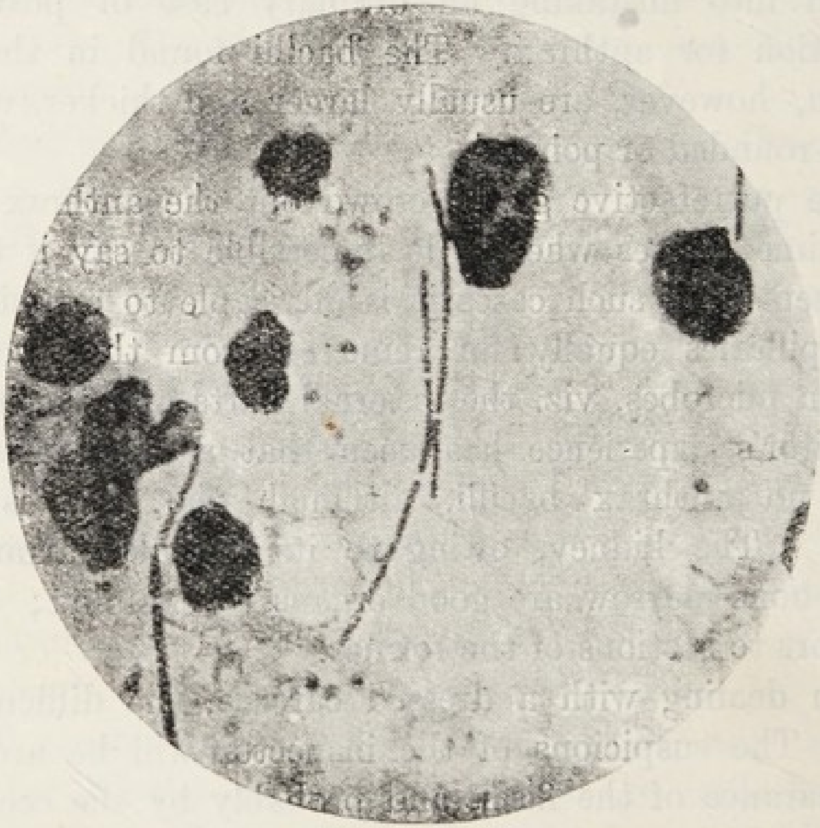


Fig. 25.—Bacillus of malignant œdema from subcutaneous fluid. ×1000.

in animals. It is said to be most frequently met with in the horse. Cases have also been reported in the sheep, ox, and pig. These animals certainly suffer sometimes from diseases similar in character to malignant œdema, but convincing evidence is still wanting that these are caused by the vibrio. Animals, with the exception of the cow, can all be experimentally inoculated. The cow, however, is said to contract the disease naturally.

*The microbe.*—The microbe is found in the œdematous fluids under the skin and in the cavities. It seems only to invade the blood in numbers as death approaches: it is an anaerobe. In preparations made from the fluids of cavities it presents itself in the form of long threads and of rods rounded at the ends. The rods measure 4 to 5 $\mu \times 1$. They are motile, and the threads can be seen to cross the field with a twisting motion. When the fluid from the tumours is examined some threads are found, but the rods are more numerous. Many of them are distended by clear spores, which give them a spindle or knob-like appearance.

This microbe might be confounded with the anthrax bacillus, or even with the black-quarter microbe. The anthrax bacilli, however, are generally abundant in the blood, and they are square at the ends. They are not motile, nor do the segments of the threads ever attain the length of some of those seen in the malignant œdema filament. The black-quarter bacillus does not form long threads, nor is it so thick as the other.

*Lesions.*—The lesions consist of superficial œdematous swellings which are soon followed by gangrene and emphysema of the part. The underlying muscles are not so dark as in the case of black-quarter, and if an odour is given off it is putrefactive.

The internal lesions are not important. The membranes are ecchymosed, and the spleen may be slightly enlarged, but not to the same extent as in anthrax.

In the cow the lesions are said to be those of septic metritis with emphysema and gangrene of the pelvic tissues; but it is by no means certain that all such cases are due to the vibrio.

*Inspection.*—The bacillus soon invades the tissues after death. The attempts to infect animals by ingestion have given negative results; and it is well known that the bacillus exists in the intestines of healthy animals. Nevertheless, infection is theoretically possible if a wound exists in the anterior part of the alimentary tract. The carcase is generally unmarketable on account of the fevered condition of the flesh, which soon putrefies.

Total seizure is justified for the above reasons.

## BLACK QUARTER

### Black Leg ; Striking ; Black Spauld (Scotland) ; Murrain ; Quarter-Ill

Black Quarter is an inoculable disease due to the entrance into the tissues of the black-quarter bacillus.

The disease is characterised by intoxication and by the appearance of emphysematous tumours in certain muscles and under the skin.

*Animals affected.*—The disease is seen mostly in young oxen between the ages of five months and four years, but younger and older animals are not absolutely immune. Sheep and goats also contract the disease readily enough. One or two cases have been reported in the pig and horse. Man and the fowl are immune.

*The microbe.*—The bacillus can only be demonstrated by the microscope in preparations made from the affected muscles and the œdematous fluids. In the freshest state it is in the form of rods measuring from 4 to 8 $\mu$, rounded at the ends, and staining equally throughout. In unstained preparations it is motile, if protected from the air.

Some of the rods occur singly, others are joined end to end in twos and threes. This is the form usually found in the fresh fluid from cavities. In preparations made from the muscles the form of the bacilli varies. Some of them are distended by a clear unstained spore in the centre or at the extremity ; others, without being swollen, stain unequally. In this way the rod may become spindle- or racquet-shaped.

It stains by Kühne's or Löffler's method, but not by that of Gram.

*Lesions.*—The principal lesions are local ones. They are found in the region of the fore and hind quarters. The bacilli come to rest in the intermuscular tissues, where they grow and set free gases which distend the skin and dissect apart the muscle fibres. On cutting into the swelling, gas escapes. The subcutaneous and intermuscular tissues are infiltrated by a bloody serosity. The muscles of the part are dark red in colour, and their fibres look stringy. They give off a rancid odour (butyric acid), which becomes very marked when the tissue is heated. In the sheep the local tumour may be almost imperceptible. Histologically examined, many of the muscle fibres are hyaline and broken across. The glands of the part are often hæmorrhagic. The cavities sometimes contain more fluid than in health. Some of the internal organs are congested, and the muscular ones may show the usual lesion. It may be found in the heart, for example.

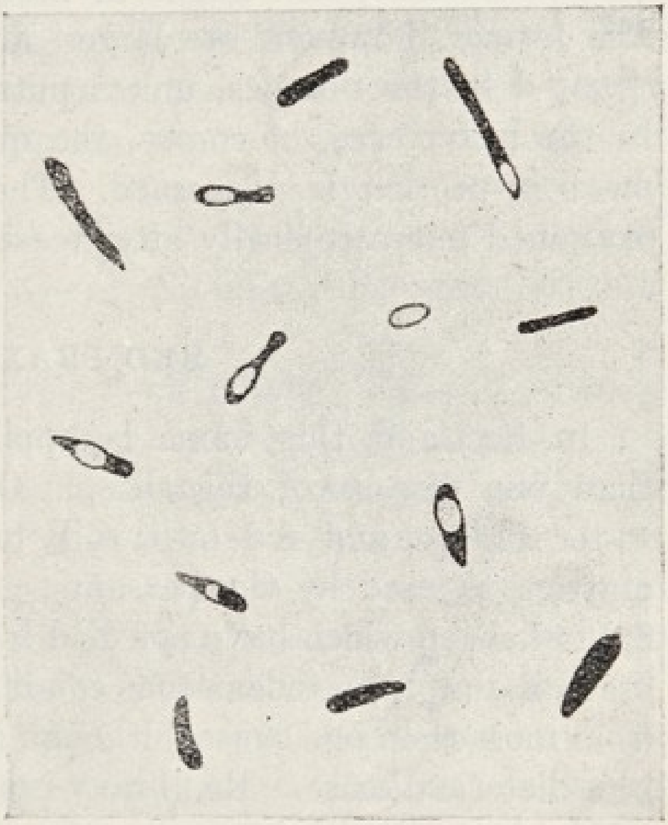


Fig. 26.—Black-quarter bacilli from muscle of sheep (× 2000). The oval body near the centre of the group is a free spore.—M'Fadyean.

*Inspection.*—The disease is not communicable to man, and the flesh has been often consumed by human beings without ill results. Nevertheless, total seizure in an abattoir is justifiable, because the flesh has often a rancid odour, and putrefaction begins in a very short time. It is seldom, however, that one meets with cases of black-quarter in the abattoirs; but the carcase of an animal killed during an attack may be sent in dressed. It may then be necessary to decide whether the lesion is of traumatic origin, as may be stated by the proprietor.

One will, of course, look for bacilli in the lesions. A piece of the suspected muscle should be heated gently, when a rancid odour will be given off in the case of black-quarter. Some of the putrefactive microbes are rather like the black-quarter bacillus, and might at first sight be mistaken for it. The former, however, are larger, and they are not so deeply situated in the muscles, unless putrefaction is well advanced. In the latter case, of course, the question is settled so far as meat inspection is concerned. The diseased muscle can be examined microscopically after teasing on a slide.

## RED BRAXY

In Scotland this name is applied very loosely to more than one disease of the sheep. One speaks particularly of water braxy, and red or turnip braxy, but the term braxy mutton, as used by the peasants, generally means simply the flesh of sheep which have not died by the hand of man. Water braxy is simply an œdematous condition, which may have arisen from more than one cause, although it is generally considered to be a dietetic disease. Red braxy is a specific disease, and seems to be identical with bradsot, or brasot, which is very prevalent in Iceland and in some parts of Norway. In its character this disease very much resembles black-quarter, and the two have often been confounded. It is advisable that veterinarians should reserve the term braxy for the specific disease.

The disease is prevalent in the north of Scotland and in some parts of England — Cumberland. According to the writings of the early part of the 19th century, it had then a much wider distribution in Scotland than it has to-day. The deaths amounted to as many as 35 per cent. of the flock in some places. The disease was well known in various parts of the Lowlands; but it has to a large extent disappeared as the land became improved. Braxy is almost identical with black-quarter in its clinical, bacteriological, and morbid anatomical characters.

*Animals affected.*—The disease is met with most commonly in young sheep towards the back-end of the year. Animals above the age of three years are seldom attacked. The calf and pig are not refractory to experimental inoculation, but one does not hear of them being infected naturally. In the *Quarterly Journal of Agriculture* (No. 50, 1838), Mr. J. Carmichael, who had evidently great experience of braxy, describes a case in a mountain deer. The disease can be experimentally inoculated to fowls and pigeons, which are absolutely immune to black-quarter. The effect of the virus on these birds constitutes one of the chief differences between the two diseases.

*The microbe.*—Nielsen, and more recently Jensen, describe the microbe of bradsot as a sporulating bacillus, measuring 2 to 6 $\mu \times 1$, and resembling in appearance the bacillus of black-quarter. In fact the only difference seems to be in its pathogenic effect on animals. It stains in the same way as the latter microbe. Preparations are best made from the fluid of the cavities and the œdema in the wall of the fourth stomach.

*Lesions.*—They are very like those of black-quarter. The subcutaneous and muscular tissues are infiltrated by a sanguineous œdema ; gas is also present. The serous cavities contain a reddish fluid. The walls of the stomachs, particularly the fourth, and the intestines are infiltrated by a sanguineous fluid. The flesh exhales a special odour.

*Inspection.*—On account of the odour and discoloration of the tissues the flesh is unmarketable, but it is not harmful to human beings, unless putrefaction has set in. This occurs very rapidly. In infected districts large quantities of braxy mutton are consumed by the peasant population after salting or smoking ; but, inasmuch as the curer is unable to distinguish between anthrax and the former disease, this practice is not devoid of danger.

An interesting note in a paper by Mr. Cowan (*Highland*

*and Agricultural Soc. Reports*, 1861) is as follows :—" In some places of Argyllshire, large quantities of braxy mutton are salted, dried as hams, and sold into the towns, where by many it is considered a delicacy. From the quantities of it consumed in particular localities, there is no doubt that it is a cause of bowel disorders, impurity of the blood, and skin diseases." In a footnote the editor of the journal remarks that the price obtained for the flesh, which was in much request, made farmers less anxious to get rid of the disease from their farms.

With regard to the flesh being a cause of skin disease, it is interesting to remember that " itch " (scabies), the classic reproach to the Highlands, was said to be of dietetic origin. A continued diet composed largely of salted meat is not conducive to health, especially if the flesh has begun to putrefy before being put into the pickle.

## TETANUS

### Lock-Jaw

An inoculable disease, caused by the bacillus of tetanus, and characterised by tonic spasms of the muscles.

*Animals affected.*—Of the domesticated animals the horse is the most susceptible to tetanus. The disease is rare in the ox, but it may be met with in cows after parturition. Occasionally it is met with in calves (umbilical tetanus). Sheep and goats are more frequently attacked than oxen. A considerable number of cases appear in certain districts in newly born lambs and in those that have been castrated. The pig is susceptible, but does not often contract the disease. Fowls are refractory. Man is susceptible.

*The microbe.*—The bacillus of tetanus is found at the seat of inoculation, which is generally a suppurating wound. After death, a few bacilli invade the blood (Sanchez, Toledo). The rod measures about 6 $\mu$. It is rounded at the ends, and when the microbe is sporulating one extremity shows a knob, or maybe a clear space (drumstick bacillus). The rods occur singly or in twos and threes joined end to end. In preparations made from the wound other microbes are present.

*Lesions.*—The bacillus acts solely by its toxins; the lesions found are not due directly to it. Thus there may be pneumonia when foreign bodies have passed down the trachea during a spasm of the glottis; in the muscles there may be signs of small hæmorrhages having occurred. A

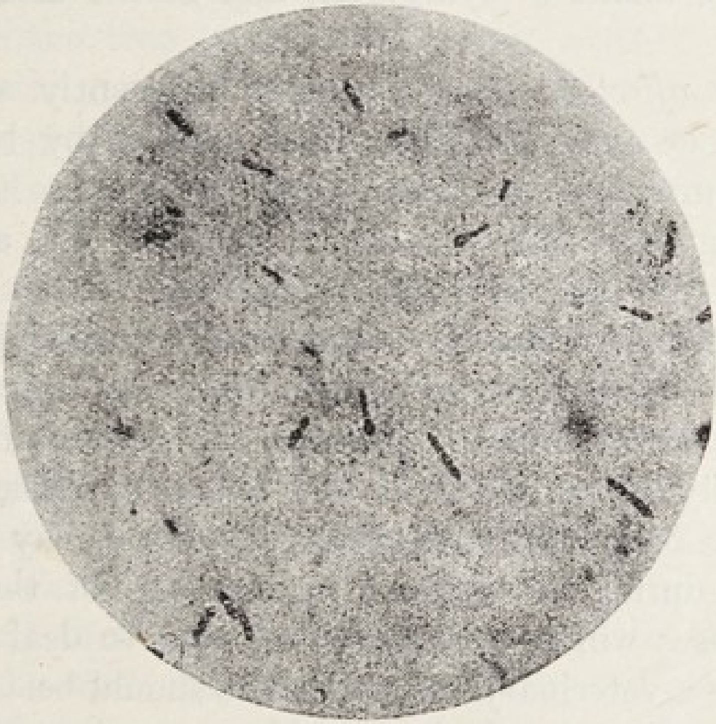


FIG. 27.—Tetanus bacillus (sporulating) (Reichert, oil immersion. $\frac{1}{12}$).

histological examination of the latter organs often reveals hyaline degeneration of some of the fibres.

*Inspection.*—Tetanus is not at all likely to be transmitted to man by ingestion. Animals do not develop tetanus even when virulent material is ingested; indeed, the bacillus exists in the intestines of many healthy animals. The comparatively small chance of recovery may induce the owner of an animal to slaughter it at the outset of the attack. The flesh of such animals, if it set properly, may be passed as harmless and marketable when the wounded tissue has been removed. In the later stages, however, the flesh does not set, and the muscles are altered in the manner described above. Such carcases are not dangerous, but they are unmarketable.

## RABIES

Rabies is a disease communicated to animals by the inoculation of an undetermined virus. The disease is characterised by maniacal symptoms, and in the later stages by paralysis.

*Animals affected.*—The dog most frequently suffers from rabies, but he may inoculate other animals by biting them. These in turn may inoculate each other, but it is mainly by the dog that the disease is spread. All animals are susceptible, but the fowl seldom becomes rabid after being bitten. In man the disease is known as hydrophobia.

*Lesions.*—There are no lesions that can be said to be pathognomonic of rabies. Indeed, the post-mortem appearances usually leave one in doubt, unless the history of the animal is known. The symptoms of rabies may develop in an animal during its sojourn in the pens of the abattoir; but such cases will be comparatively easy to deal with if the inspector be a veterinary surgeon, as he should be.

On the other hand, it may happen that the animals have been sent in for slaughter on account of having been bitten by a mad dog. The owner may have advised the authorities, or he may not; but if a number of bitten animals come in for slaughter, it will be as well to get their history. The fact of the animals not being fat should arouse suspicion.

If the animals have come in soon after the accident, the wounds will be apparent. If the symptoms have developed before death, there will often be self-inflicted wounds present. In sheep and cattle the latter are generally found about the head.

In the carnivora the wounds are found on the tongue and in the mouth. The pharynx may be congested. A like condition is found in the salivary glands. The stomach may contain foreign material of all descriptions, or only a quantity of brownish-coloured blood-tinged mucus. The alimentary mucous membrane is congested and ecchymosed at places. The serous membranes also show ecchymoses. The respiratory membrane may be similarly congested and ecchymosed. The nerve centres and the meninges are also congested.

In ruminants the appearances are practically the same, except that the true stomach is usually empty, and wounds in the mouth are less frequent. According to Nocard and Roux, the urine present in the bladders of animals dead of rabies contains in about 30 per cent. of cases a large amount of sugar.

*Inspection.*—Rabies is not a disease likely to be contracted by ingestion, even if the material swallowed be virulent; still, a theoretical danger exists, despite the absence of confirmatory evidence. The greater danger, however, is to the man who manipulates the carcase; and he should be warned against the chances of accidental inoculation if a post-mortem has to be made.

The parts that have been found to contain the virus are the brain, the cord, the salivary and lachrymal glands. Less frequently the nerves are virulent; they are most likely to be so towards the centres; the virus seems to spread both to and from the centres along the nerves. More rarely the kidneys, the suprarenal, pancreatic, and mammary glands have been found virulent. It is worthy of note that the nerve centres and the saliva have been found virulent two or three days before the appearance of any appreciable symptom (Nocard and Roux). The muscles are never virulent of themselves, but the nerve trunks of the part may be.

It appears from the above considerations that total seizure will be necessary in all cases when the symptoms have developed.

When dealing with the carcases of animals slaughtered on account of having been recently bitten by a mad dog, it will be sufficient to seize the head and the parts in the neighbourhood of the bites.

### FOWL CHOLERA

This is a contagious disease of birds, usually of the septicæmia type, and caused by the fowl cholera bacillus.

*Animals affected.*—All birds are susceptible, but barn-door fowls suffer most frequently. The rabbit is also very susceptible. Birds and rabbits are most often attacked by the disease in its acute or septicæmic form. The less susceptible animals, such as horses and ruminants, are either not affected by experimental inoculation, or they show only a local abscess. They never contract the disease spontaneously. Human beings are refractory.

Fowl cholera is not a common disease in Great Britain.[1] Klein, however, has described a somewhat similar disease in fowls, due to the *Bacillus gallinarum.* This was met with in England and Ireland. The same authority also investigated the well-known "grouse disease," and stated that it was due to a bacillus of the fowl cholera type. M'Fadyean has described an epizootic pneumo-pericarditis in turkeys, which was caused by a similar bacillus. The two latter, however, are not communicable to the fowl. The Editor has also described a form of septicæmia which carried off a large number of tuberculous fowls. The latter was also due to a bacillus of the fowl cholera type.

*The microbe.*—The microbe of fowl cholera is a small, oval bacillus, measuring $1\ \mu \times \cdot 25$. When coloured preparations of the bacilli are looked at longitudinally, the poles and margins appear deeply stained, and they enclose a clear, uncoloured space in the centre. This appearance, however, is not confined to the bacillus of fowl cholera; it constitutes

[1] Professor M'Fadyean has informed the Editor that he has frequently met with the disease.

a morphological type to which several microbes belong. When the microbes are looked at perpendicularly they resemble cocci. The bacillus can be stained by Löffler's or Kühne's blues. Preparations can be obtained from the blood, the œdematous fluids, and all the organs. The microbes are also present in the discharges, though not in a state of purity.

*Lesions.*—In most cases death takes place in from twelve to forty-eight hours. A few, however, linger on for a week or two, then die emaciated.

A yellowish foam is present about the beak, and signs of diarrhœa are seen around the anus. In the subcutaneous tissues one finds small hæmorrhages. The muscles are very pale in chronic cases. The internal vessels are all congested, and so are many of the organs.

Blood.—The blood is very dark in colour.

Lungs and pleuræ.—The lungs are congested; the pleura is ecchymosed.

Heart and pericardium.—The pericardium is ecchymosed, and the cavity contains a light straw-coloured fluid, which soon coagulates when the sac is opened. The heart muscle and endocardium show ecchymoses.

Liver.—The liver is swollen, and in some cases it shows small necrotic areas of a yellowish colour.

Spleen.—The spleen is usually much swollen, but it may be normal.

Intestines and peritoneum.—The peritoneal cavity contains a fibrinous fluid.

The intestinal mucous membrane is congested and ecchymosed; in some parts a greyish exudate is present. The tube contains a fluid which is grey and blood streaked.

*Inspection.*—It is unlikely that fowl cholera will be met with by the Meat Inspector; neither is he likely to see the diseases described by Klein, nor that of turkeys investigated by M'Fadyean, except perhaps in the poultry markets. The flesh of birds dead from those affections is unmarketable, for it is often flaccid, and shows small hæmorrhages. It may happen, however, that when a hen-run or cover gets infected, the proprietor may decide to kill off for sale as many birds as possible. A number of birds, then, that have been killed in the early stages may be sent into the market. If the birds are not emaciated, and if the flesh is not disfigured by hæmorrhages, there is no reason why it should be withdrawn from consumption, since none of the diseases here mentioned are communicable to human beings. Birds which have not been shot or had their necks drawn, should arouse suspicion; but, of course, it is easy enough to draw the neck after death.

A bacteriological examination of the heart blood might give the inspector a clue to the cause of the lesions. The Editor would point out, however, that in his experience bacilli of the fowl cholera type, which may in no way be connected with the animal's death, are not infrequently present in the heart blood of fowls. They have probably invaded the blood from the intestines after death, for, as every one knows, the entrails of the slaughtered fowls are not immediately removed.

## DIARRHŒA IN YOUNG ANIMALS

### White Scour

Diarrhœa in young animals is brought about by the action of the several species of bacteria which cause lactic acid, acetic acid, and butyric acid fermentations.

The products of these bacteria irritate the gastro-intestinal mucous membrane, and a catarrhal condition is set up. According to Jensen, diarrhœa in young calves at the teat is due to a bacillus which resembles the *bacillus coli* (*see* Malignant Catarrh). The latter form is sometimes complicated by septicæmia; that is to say, the bacteria invade the blood stream.

*Animals affected.*—Diarrhœa of the above nature may be seen in all young animals, but it is principally with calves and lambs that the Meat Inspector is concerned.

Sometimes the calves' carcases are sent to the abattoir after having been bled; it would hardly be worth while sending in a lamb's carcase.

*Lesions.*—The mucous membrane of the abomasum shows slight congestion. A similar condition is found on certain parts of the bowel. The posterior bowel contains a sticky white material, which has a sour smell. The flesh is paler even than normal; it is flabby and usually œdematous. If the trouble has existed for a day or two the body is emaciated.

*Inspection.*—Flesh of the above description is considered unmarketable owing to its watery and emaciated condition. Nocard states that numerous observations show that veal of this description may be the cause of serious gastro-intestinal disturbance in human beings. He explains that this is probably due to bacteria contained in the flesh. Evidently he refers to the form in very young calves, which may end in septicæmia. The flesh of animals so young as that, however, may cause intestinal disorder, even if the animal has not suffered from diarrhœa.

## DERMATOMYCOSIS

This term is applied to diseases of the skin caused by parasitic moulds.

The principal forms are those popularly known as ringworm—*Tinea tonsurans* and *Favus.*

### Tinea tonsurans

This form of the disease is caused by the *Trycophyton tonsurans* (Malmsten). It is frequently seen in cattle, but rarely in sheep and pigs. Man may be infected from animals by contact.

*The parasite.*—The parasite, when taken from the lesions, consists of filaments and spores. The former are partitioned, and show occasional branching. They measure from 4 to 6 $\mu$ in diameter, and some of them break up into chains of spores at one extremity. The spores are ovoid bodies measuring from 2 to 4 $\mu$ in length. They are arranged in chains or masses, and are generally much more numerous than the filaments.

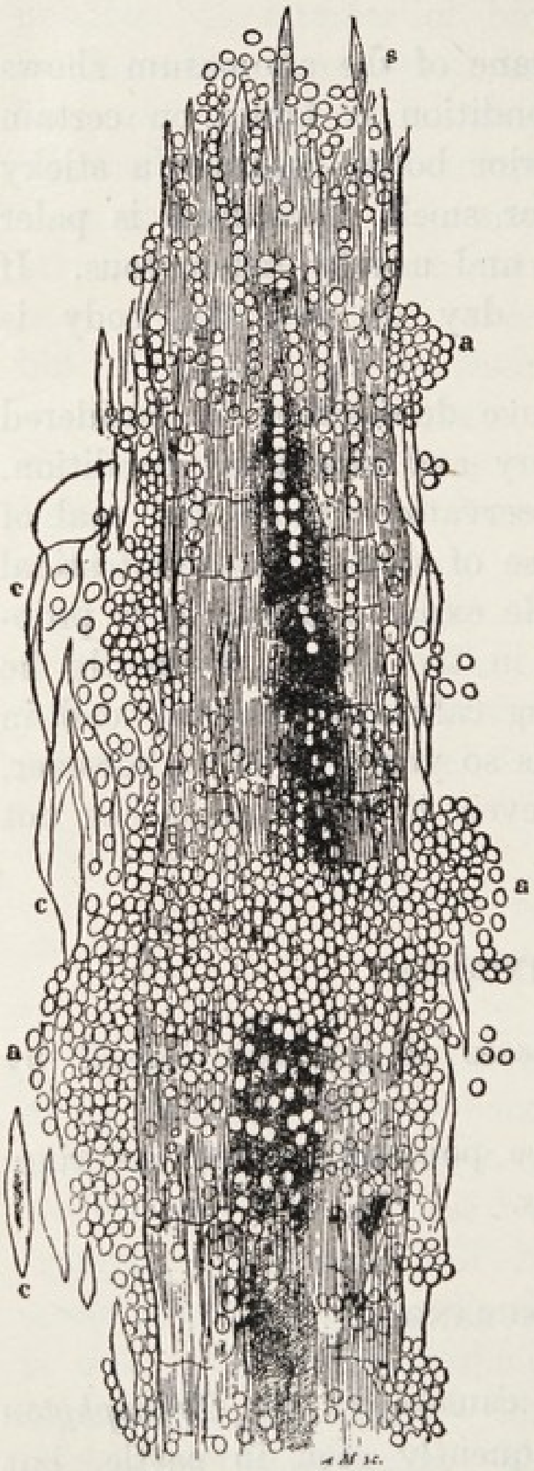



Fig. 28.—Hair of horse, showing the trycophyton parasite. — Neumann.

Preparations are obtained from scrapings taken off the affected patches, and from the roots of diseased hairs. The material should be first cleared in a 40 per cent. solution of caustic potash, and then mounted in glycerine. No staining is necessary.

It is by no means certain that all cases of trycophyton ringworm are caused by the tonsurans, for some of the parasites show distinct differences on artificial culture media. This question, however, need not be discussed, as its bearing on meat inspection is insignificant.

*Lesions.* — In cattle the lesions are most frequently found about the head and neck; but they may appear on any part of the body. In the older animals, the upper eyelid, the base of the horns, and the neck are favourite seats. In calves the lesions are often found around the mouth. Dry crusts of a greyish colour appear on the skin. They may reach the thickness of half an inch, and the hairs are destroyed. If some of the remaining hairs be pulled out from the affected area, it will be seen that in some cases the roots are surrounded by a greyish sheath. The microscope shows the latter to be made up of spores.

If the denser crusts be pulled off, the skin is found to be red and bleeding underneath. There may also be pus present. The skin in the neighbourhood of the crusts is wrinkled. In another form of the disease the lesions start about the flanks, croup, and sides of the chest. The hair is at first erect in small patches. Later, it falls off, leaving a bald patch which often reaches the size of a five-shilling piece, and is limited by a circular zone of congestion.

In sheep the wool is matted in small patches on the neck, chest, shoulders, and back, and greyish crusts appear on the skin.

*Inspection.—See* FAVUS.

## FAVUS

The Meat Inspector is only likely to meet with this form of ringworm in fowls. It has several times been met with in caged rabbits; but, so far as the Editor is aware, no outbreak has been reported in a warren.

*The parasite.*—The parasite is a mould—the *Achorion schönleinii.* The elements of the fungus are very like those of trycophyton; so much so, that the differential diagnosis cannot be made by a microscopic examination alone. As a rule, however, the filaments are much more numerous than in trycophyton, and the breaking up of the threads into chains of spores is more frequently observed. Slight differences of form and biological character observed in parasites from favus lesions render it probable that all are not due to the achorion.

*Lesions.*—In the fowl the lesions are mostly found on the comb and wattles, but they may also appear on the body. Greyish circular crusts appear on the skin. They vary in size from a pin-head to a threepenny-piece, and consist of felted masses of filaments (mycelia). At first they are cupped or depressed in the centre. As the patches become confluent, however, this appearance is lost, and the skin is covered by irregular crusts of a greyish colour. When the neck and body are invaded, the feathers are powdery, and many of them have fallen out. A mouldy, mouse-like odour is given off. The birds are frequently emaciated.

*Inspection.*—It is by contact with the diseased surfaces and hairs that human beings contract ringworm from animals. Many cases of transmission, both of trycophyton and favus, have been recorded. It is therefore necessary to warn those who have to handle the carcases of the danger of infection, and it is advisable that all affected fowls be kept out of the market.

In the larger animals, however, the lesions will be removed with the skin, and it will not be necessary to seize any part of the carcase, unless the deeper structures have been injured by rubbing, or by the application of severe irritants.

# DISEASES CAUSED BY ANIMAL PARASITES

## PROTOZOA

Several members of this group of animal parasites are found in the blood, muscles, and internal organs of animals used for food. With the exception of the coccidia, we cannot regard them as parasites transmissible from animals to human beings through the medium of animal flesh. The evidence in favour of even the coccidia being so transmitted is slight.

### Texas Fever or Redwater

This is a disease which is of world-wide occurrence, but in the British Isles it is now rare in many countries, and is chiefly seen in animals grazed on moor or other rough pasture.

*Animals affected.*—The disease is seen in cattle only.

*The parasite.*—The parasite, which has been classed with the Protozoa, has been named *Piroplasma bigeminum.* It is found free in the blood or contained in the red corpuscles.

The parasites usually present themselves as clear bodies of a pear-shape. They measure from 2 to 4 $\mu$ in length, by 1·5 to 2 $\mu$ at their broadest part. Some of them show a small dark point like a nucleus in the swollen end. In fresh blood (uncoagulated) preparations the free parasites show amœboid movements at the body temperature. The pear-shape is not the only form; some are spherical. The latter are especially met with in animals affected by the disease in its chronic form. The red cells contain one, two, or more parasites, and they are most abundantly present in blood from the kidneys, spleen, and liver. Cover-glass preparations made from the blood can be stained by eosin and methylene-blue, or by methyl-violet.

*Lesions.*—Ticks are often present on the affected animals; it is through the agency of the former that the disease is spread. In the acute stages the animals are very anæmic. The red blood cells may have fallen greatly below the normal (normal in ox=6,000,000 per cubic mm.). Many of the corpuscles contain parasites—others are distorted (poikilocytosis). Small hæmorrhages are found under the skin and in the internal organs. The latter are engorged with blood. The spleen is enlarged—maybe to twice its normal size. The kidneys are also congested, and their tubules are sometimes crammed with brownish granules of pigment derived from the blood (pigmentary infarction). The bladder may contain reddish-coloured urine. The flesh may be fevered.

FIG. 29.—Red cells of ox containing the parasites of Texas fever.—SMITH.

The post-mortem appearances in the acute form of the disease resemble those of anthrax, but the absence of the *Bacillus anthracis* from the blood and congested organs suffices to differentiate Texas fever from the former.

In chronic cases the animals are much emaciated and very anæmic. The spleen is usually more or less enlarged, but congestion of the other organs is not usually present. The hæmoglobinuria symptoms are generally absent.

The flesh is paler than normal, but it may show signs of small hæmorrhages.

*Inspection.*—Nothing is definitely known about the effect on human beings of the flesh of animals which have suffered from redwater. One may reasonably argue, however, that any deleterious action would have been traced, did it exist; for in some parts of the world the disease is very common, and the flesh of affected animals must frequently have been eaten by human beings.

The carcases of the affected animals are often unmarketable on account of their poor condition and watery appearance, or the presence of hæmorrhagic discolorations and signs of fever.

## Sarcosporidia

The parasites of this class are found embedded in the tissues. They are the *Psorospermiæ utriculiformes.*

*Animals affected.*—Sarcosporidia are frequently found in all the animals of the abattoir, but apparently they seldom cause much trouble to their hosts.

They are more commonly met with in the flesh of animals in poor condition; but fat animals are by no means exempt. Pigs are often the harbourers of these parasites, and in trichinosis countries muscular psorospermosis frequently coexists with the former disease. Cobbold stated that it was the exception not to find them in the flesh of cattle which had died of cattle-plague. They are also frequently found in the muscles of healthy cattle. They have been found by Cobbold in sheep. Out of 900 sheep examined by Morot, over 30 per cent. were found to harbour sarcosporidia. These parasites have also been frequently found in the flesh of goats, deer, fowls, and rabbits. Lindemann has recorded a case of psorospermosis in the heart of a man; but this is quite an exceptional observation. Leuckart states that they have never been found in the muscles of human beings.

*The parasites.*—There are two principal varieties of the utriculiformes, viz. the *Sarcocystis* and the *Balbiania.*

The sarcocysts are found in the muscle fibres. They vary greatly in size. The smaller form, which is known as the *Sarcocystis meischeri* — Rainey's corpuscles — measures from 2 to 3 mm. × ·08 – ·3 mm. This is the form most frequently found in the pig, and it requires the microscope for its identification. When a preparation of affected muscle is examined with the microscope, the sarcocysts, if viewed longitudinally, appear as cigar-shaped bodies, which are bounded by a membrane showing a fine cross striation. Pressure disintegrates the membrane, and in this case it may appear ciliated. The cyst contains a number of kidney-shaped bodies, which are looked upon as spores (Fig. 30).

In sheep, large sarcocysts—*S. tenella*—measuring $\frac{3}{5}$ in. × $\frac{1}{8}$ in.,

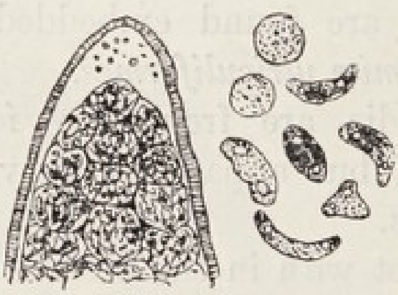


FIG. 30.—Extremity of one of Miescher's tubes with its contents. At the side are the kidney-shaped bodies, much enlarged.

FIG. 31.—Falciform corpuscles from the *Balbiania gigantea* × 850.—RAILLIET, NEUMANN.

are also met with. Bertram found 182 sheep affected out of 185 (Ostertag).

The *Balbianiæ* are larger as a rule than the sarcocysts. On account of its size this parasite has been called the *B. gigantea.* It varies in dimensions from a barley-grain to the kernel of a hazel-nut. It is surrounded by a membrane, and the internal cavity is partitioned into spaces, which contain a number of bodies of a crescent shape—falciform corpuscles (Fig. 31). If the cysts be ruptured, a milky juice exudes, which on microscopical examination is found to contain the before-mentioned corpuscles.

*Lesions.*—The alterations seen in the flesh depend to a large extent on the number of parasites present. When the muscles are infested in a moderate or medium degree by the small sarcocysts, no macroscopic changes are present. The flesh may appear perfectly normal to the eye, but the microscope shows the psorosperms in the muscle fibres. The latter are dilated, and the parasites are surrounded by the sarcous substance, which they have pressed out under the sarcolemma (Fig. 32).

Some of the invaded fibres have undergone hyaline degeneration. The cysts sometimes become calcified. They then appear to the eye as calcareous specks of a greyish colour. The number of parasites present varies greatly. In healthy-looking beef from different animals, Cobbold estimated them at from 100 to 2000 in an ounce, and in the heart of a sheep, a portion of which he ate, there were about 1000 to the ounce.

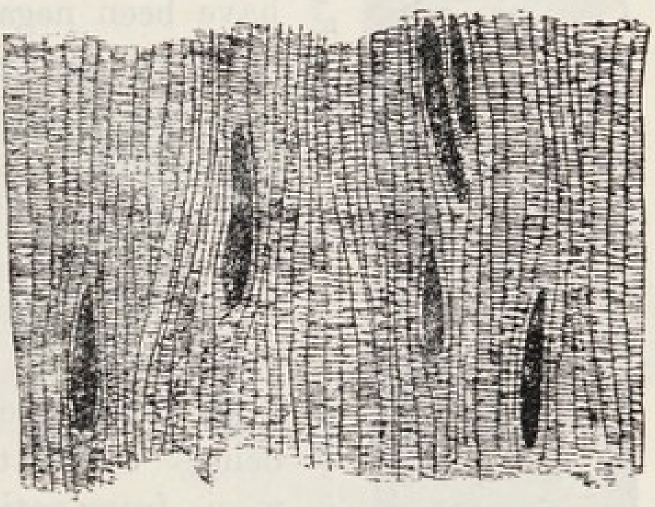


FIG. 32.—Rainey's tubes, enlarged about 40 diameters.

In cases of severe infestation, alterations of an inflammatory and œdematous character have been described in the muscles; but it is not certain that these are due to the parasites, for other pathological conditions sufficient to account for the appearance of the flesh are often present.

When the larger sarcocysts are present, as in the sheep, one sees greyish elongated cysts against the red colour of the muscles.

The *Balbiania* is found oftenest in sheep, but oxen, pigs, goats, and deer are also frequently infested by it. They are generally situated in the connective-tissue structures. The œsophagus is the favourite habitat, but they are also found in the tongue, the muscles of the pharynx, those of mastication, and those of the neck, trunk, and thighs. They are occasionally found under the serous membranes. Out of 900 sheep examined by Morot, 272 had cysts in the œsophagus (Fig. 33). Excepting the presence of the cysts, the tissues are little altered.

Fig. 33.—Œsophagus of sheep, showing the *Balbiania gigantea*.—Railliet, Neumann.

*Inspection.* — Many feeding experiments with infected flesh have been conducted on animals, the results of which have been negative. Leuckart, however, observed sarcocysts in a pig which he had fed on infected flesh; but he could not assure himself that infection had not taken place in some other way. As already stated, Cobbold ate a portion of a badly infested sheep's heart, and he experienced no ill effects.

If there be any chance of human beings contracting muscular psorospermosis from eating affected flesh, it must be a very small one, for, notwithstanding the frequency with which these parasites exist in animals of the abattoir, the condition is practically never met with in human beings.

Flesh containing microscopic sarcocysts, then, may be passed unless their presence be associated with alterations which render it unmarketable. In the case of carcases containing parasites of macroscopic size, the *Balbianiæ* for example, only the affected parts need be seized, if the flesh be otherwise normal. The same procedure may be adopted in dealing with cases in which a large number of calcified parasites are present.

## Coccidiosis

This term is applied to diseases caused by *Coccidia.* The disease is also referred to as psorospermosis.

*Animals affected.*—The species which most frequently harbours coccidia is the rabbit, but these parasites are by no means rarely found in cattle and sheep. Man is also said to suffer from coccidiosis.

*The parasites.*—The coccidia are an order of the Sporozoa.

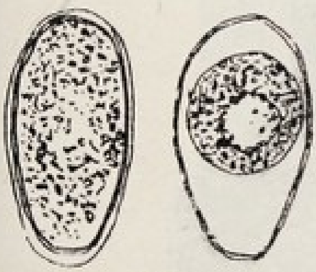


Fig. 34.—Adult *Coccidia* from the liver.

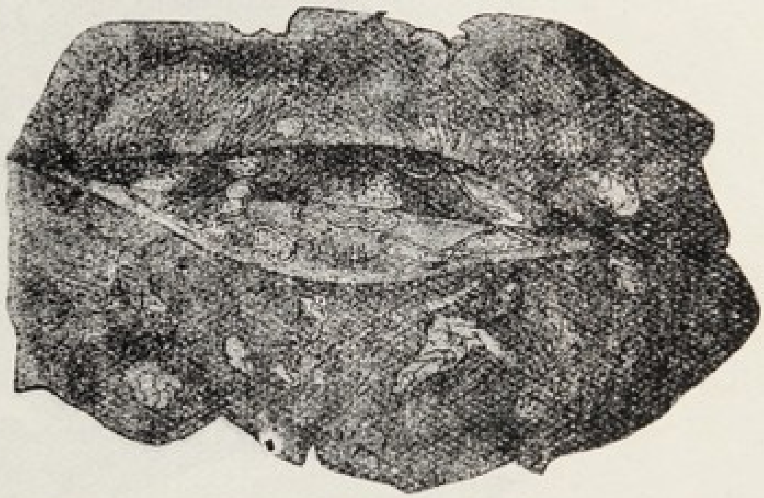


Fig. 35.—Liver of rabbit with *Coccidium* nodules.

The best known species is the *Coccidium oviforme* of the rabbit. It infests either the bile ducts or the intestine. Coccidia also occur in the intestine of cattle, sheep, and poultry.

The adult *C. oviforme* from the bile ducts is ovoid, and measures from 30 to 40 $\mu \times 14$ to 20 $\mu$. It is surrounded by a membrane with a double contour.

In some the contents of the cell are separated from the wall, and appear as a round mass in the centre; in others the cell contents are granular (Fig. 34).

In some of the epithelial cells the parasites are much smaller, 1·5 to 2 $\mu$.

*Lesions.*—In the majority of cases the lesions are confined to the liver or bowel, but owing to interference with absorption and metabolism the body may be very emaciated.

Liver.—It is chiefly in the rabbit that the liver is the seat of disease. The organ is enlarged. Greyish-white nodules are seen on its surface and in its substance, varying in size from a millet-seed to a hazel-nut. These nodules are dilated and thickened bile ducts which contain coccidia. Some of the nodules are dense and cheese-like in appearance. These might be mistaken for tuberculous nodules, but

Fig. 36.—Cross-section of a *Coccidium* nodule, slightly enlarged. The contents have been for the most part washed out.

their situation in the bile ducts and the presence of coccidia will dispel all doubt as to the true nature of the lesion (Fig. 35).

If a section of the liver be examined microscopically, one finds that the walls of the dilated bile ducts are thickened by fibrous tissue. Many of the lining cells are invaded by parasites, and some of them are shed. At certain parts of the duct nodules having a papillomatous structure project into the lumen (Fig. 36).

Intestines.—The intestinal lesions depend on the extent of infestation and the duration of the disease.

In the early stages, nothing would be noticed unless a microscopic examination were made. The epithelial cells would then be found to contain refractile bodies which often displace the nucleus.

In more advanced cases areas of congestion are visible to the naked eye, and in the sheep reddish nodules about the size of a small pea are found on the mucous membrane at various parts of the bowel. These nodules contain coccidia,

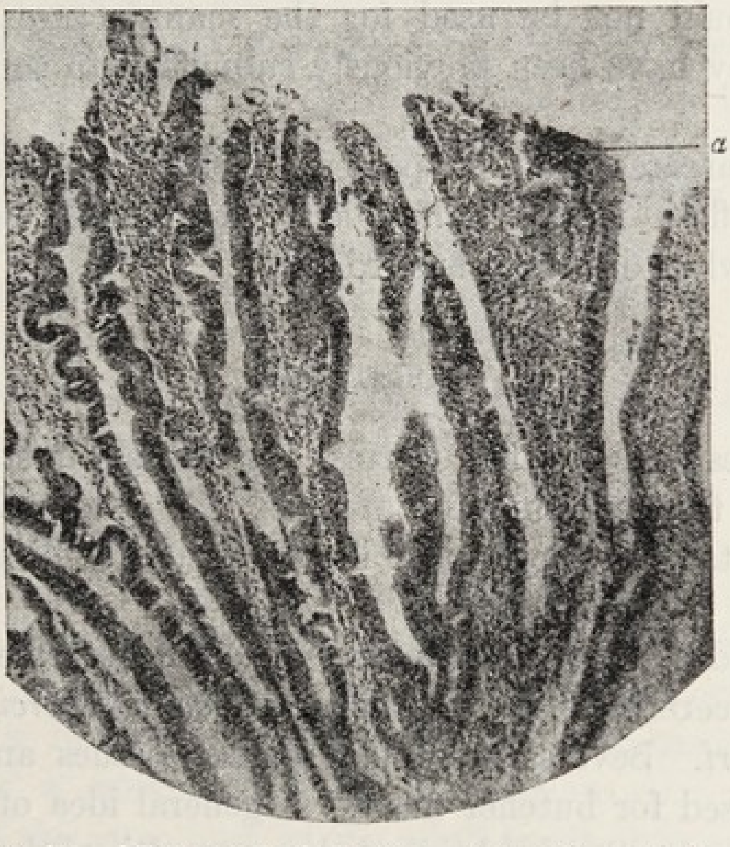



Fig. 37.—Microscopical section of lamb's intestine affected with psorospermosis. The psorosperms are seen at *a*.—M'Fadyean.

and they are sometimes ulcerated. On examining microscopic sections of the bowel, the nodules are found to consist mainly of distended Lieberkühnian glands and adenoid tissue. The glandular epithelium is in a state of active proliferation, and many of the cells contain the parasites. The villi included in the tumours, and those of the congested areas, are enlarged. Their epithelial covering is thickened at some parts; at others it is in a state of catarrh (Fig. 37).

*Inspection.*—Cases of hepatic and intestinal coccidiosis are said to occur in human beings; but it is likely that infection takes place through the medium of vegetable food or water, rather than by ingestion of affected organ.

The organs most frequently affected, viz. the liver of the rabbit and the intestines of other animals, are not likely to be eaten by human beings. To avoid all risk, however, they should be seized and destroyed. The intestines of affected sheep should not be used for the manufacture of sausages, unless they have been previously submitted to some sterilising process.

The carcases may be passed, if they are not emaciated, and the flesh is not flabby and œdematous, as sometimes happens when diarrhœa has existed.

## CESTODES

The cestodes are flat worms. In the adult state they are found in the intestines of animals, but they pass an intermediate stage of encystment in the tissues of different species of hosts.

The adults are the tæniæ, and the intermediate forms which concern the Meat Inspector are the *cysticerci*, *echinococci*, and *cœnuri*. Several are found in the tissues and organs of animals used for butcher meat. A general idea of the method of infection will be obtained by consulting the section on Measles. The cystic forms must be dealt with in particular. The tæniæ may be discussed *en bloc*, as they all frequent the intestines.

### Measles

This is a condition caused by the presence of certain bladder-worms—cysticerci—in the organs and flesh of animals.

*Animals affected.*—The ox and the pig are the animals whose flesh most frequently contains cysticerci. It is by eating diseased beef and pork that human beings become harbourers of tape-worms in the majority of cases. Cysticerci have occasionally been found in the tissues of sheep.

There seems to be little doubt that some of these were *Cysticercus cellulosæ.* Olt and Bongert found the latter in the muscles of one animal of this species, and Ostertag gave it as his opinion that certain calcareous nodules found in the hearts of three sheep were degenerated *C. cellulosæ.* These observations, however, are exceptional.

The goat has on one occasion been infected experimentally with the measles of the ox by Zenker, but this animal hardly requires mention in a section on measles, unless it be to say that it does not suffer naturally. The cysticercus of the pig has been found a few times in deer and monkeys.

Man and the dog sometimes harbour the *C. cellulosæ* in their flesh and organs. The latter observation, of course, has more bearing on the objects of food supervision than on the actual inspection of meat.

*The Parasites.*—Measles arises from different forms of parasites, although they all belong to the common class of cestodes. From the researches of Von Siebold, Küchenmeister, Leuckart, Cobbold, and others, we know that the bladder-worms, be they cysticerci cœnuri, or echinococci, are all immature or intermediate forms of different tæniæ or tape-worms. As a general rule the bladder or cystic forms do not occur in the same host as the adult tæniæ, but an exception to this rule is sometimes found in the case of the *C. cellulosæ,* which is occasionally met with in the muscles and organs of human beings, the hosts of the mature tape-worm or strobila. It is with the measles-producing cestodes, however, that we are concerned at present; the others will be dealt with elsewhere. As already mentioned, the animals chiefly affected with measles are the ox and the pig, two of the most important victims of our carnivorous habits. The parasite of the ox is known as the *C. bovis*; that of the pig as the *C. cellulosæ.* Measles of the sheep is usually due to the *C. tenuicollis,* but inasmuch as its strobila, the *Tænia marginata* of the dog,

13

never inhabits the intestines of man, the Editor thinks it better to preserve the symmetry of arrangement by leaving its description to the next section of this volume.

CYSTICERCUS BOVIS (Cobbold).

This is the cystic form of the *T. saginata* (Goeze) or *T. mediocanellata* (Küchenmeister), which inhabits exclusively the intestines of man. The size of the true cysts varies from a hemp-seed upwards, according to the stage of their development; but they are seldom larger than a pea. They have occasionally, however, been found to measure as much as $\frac{3}{5}$ of an inch in length.

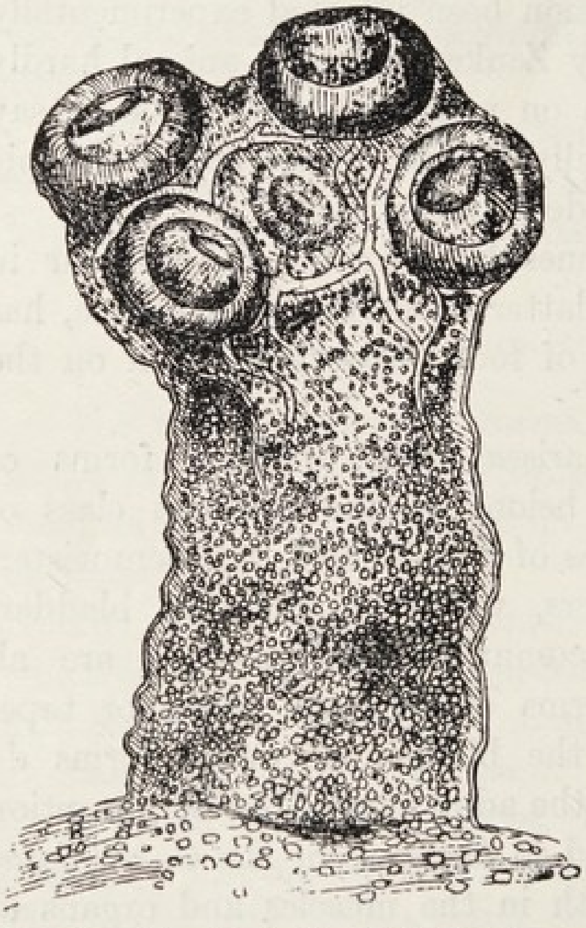


Fig. 38.—Evaginated head of *Cysticercus Tæniæ saginatæ*. ×30.

The cyst (Fig. 41) is a delicate membranous sac, spherical or elliptical in shape, and of a greyish colour. It contains fluid. At one point on its wall a small nodule about the size of a hemp-seed is seen. This contains the head or scolex of the tape-worm. It is enclosed in a chamber of the caudal vesicle, which seems to be formed by an involution of the membrane.

The cysticerci as a class are monosomatic and monocephalic; that is to say, only one chamber is formed, which contains a single scolex. In some cysts the development is arrested, and no head is formed (acephalocyst). If a fresh cyst be gently pressed on each side of the nodule, the scolex can be evaginated and examined under the microscope (Fig. 38). The size of the scolex is slightly under 1 mm. ($\frac{1}{25}$ in.). Under a low-power lens it is seen to be tetragonal in shape. As is common in tape-worm heads, four suckers are seen around the head, if it be looked at from above; if viewed laterally, only two can be seen.

It differs from most of the other tape-worm heads in being devoid of hooklets, hence it is sometimes called the unarmed tænia (*T. inermis*). The rostellum, too, is quite rudimentary; it is represented by what looks like a frontal sucker. These characteristics are of great importance in distinguishing this parasite from the *T. solium* and others which are of less consequence to the Meat Inspector but may nevertheless be found occasionally in muscle—*Cysticercus tenuicollis* and *Echinococcus veterinorum*, for example. About the head and the constricted part termed the neck, a large number of small calcareous particles are found, but this also applies to many other scolices.

### CYSTICERCUS CELLULOSÆ

This is the cystic form of the *T. solium* (Rudolphi), which has its habitat in the intestines of man only.

The cysts are elliptical, and very like those of the *C. bovis*. When the contained head is evaginated, however, and examined under the microscope, it shows many points of difference (Fig. 39). The head is more spherical in shape, and slightly smaller (·6 to ·8 mm.) than that of the ox parasite. In front there is a well-developed rostellum, which carries a double circlet of from twenty-four to thirty-two hooklets. The rostellum, however, if retracted, may not appear prominent. The hooks are composed largely of inorganic material (silica). On this account they resist degenerative processes for a longer time than the organic parts, and may be found long after the latter have disappeared; but the inorganic structures may themselves be removed before the cyst has undergone complete degeneration. The hooks measure from 110 to 180 $\mu$. Confusion might occasionally arise between this parasite and the *Echinococcus veterinorum*, but a microscopic examination of the cyst and its contents will at once dispel all doubts.

The characteristics of the parasites which may be mistaken for those of measles will be described in the next section.

*Infection of human beings and animals.*—When human beings ingest the flesh of animals containing living cysticerci of the species under consideration, the scolices are freed from their envelopes by the gastric juice, and the corresponding tape-worms develop in the intestines. Similarly, when animals

Fig. 39.—Bladder-worm from the pig, after the digestion of the bladder. × 20.

Fig. 40.—Larger (anterior) and smaller (posterior) hooks of *Tænia solium*. × 280.

swallow food which has been soiled by human fæces containing the eggs or ripe proglottides of the tape-worm, they become infected with measles. The eggs of the *T. saginata* give rise to the *C. bovis*, and *vice versâ*. Those of the *T. solium* give rise to the *C. cellulosæ*.

The above facts have been proved by abundance of observation and experiment on men and animals. Von Beneden first experimentally infected pigs with the ova of *T. solium*; Küchenmeister experimented successfully on criminals with the *C. cellulosæ*; and many others have since recorded similar experiments. The evidence regarding the *C. bovis* and *T. saginata* is equally conclusive.

In Southern and Eastern countries, where sanitation, as applied to men and animals, is in a backward state, tape-worms are commonly found in men. Owing to the uncivilised habits of the latter, the eggs are forced, as it were, on the unthinking beast, and they are returned to the human host in a more mature form.

In India the habits of the lower castes have resulted in the widespread distribution of *C. bovis* in the ox and *T. saginata* in man. The same is true of many other primitive countries, in which the history of tape-worms is lost in antiquity. Mr. Macfarlane, M.R.C.V.S., Government Veterinary Inspector in Malta, has recently informed the Editor that measles is very common in the cattle imported into Valetta from Tunis and Barbary—especially from the latter country.

Measles of the pig is also very commonly met with in Malta. The recent discussions raised in the *Soc. Cent. de Med. Vet.* by M. Morot of Troyes, show that measles of the pig is well known in Southern France. Morot also points out the necessity of carefully inspecting the cattle imported into France from Algeria, as Mr. Macfarlane does for those coming into Malta from the same quarter of the world.

The recent returns of the Board of Agriculture show that in 1897 we imported from foreign countries and British possessions 3,010,387 cwts. of fresh beef, and 347,617 cwts. of fresh pork. It is only just to the consumer and to the British butcher that this flesh should be subjected to a more adequate inspection than at present. The farther animals are removed from human beings, actually and metaphorically, the less frequently will tæniasis and measles occur. In the more enlightened countries, however, they are still too common. In native French cattle and swine measles is often seen. In Germany measles is by no means rare. In some parts the proportion of affected animals is very high. Reissmann, quoted by Ostertag, states that in Berlin, from 1892 to 1897, the percentage of beef measles increased steadily from ·188 per cent. to ·396 per cent. in bulls, from ·147 per cent. to ·401 per cent. in oxen, and from ·124 per cent. to ·322 per cent. in cows: possibly the examination became more searching. The records of measly beef from the Prussian abattoirs show a large increase of cases during the last six years: 567 in 1892; 2629 in 1897 (Ostertag). In Saxony 47 cases were recorded in 1893 and 299 in 1897. These numbers do not represent a large percentage when one takes into account the number of animals slaughtered, but they show what careful inspection has brought to light, and the necessity for supervision by competent officers. Some of the German abattoir returns show considerably over 1 per cent. of cases. In America we have no reason to believe that the *C. bovis* is rare; Stiles examined 297 tape-worms, all of which turned out to be *T. saginata*. Ward, on the other hand, states that the *T. solium* is very uncommon in America; but that has little bearing on the frequency of measles in a country where meat is eaten well cooked. In Prussia the percentage of measly swine slaughtered was ·067 in 1896; in Saxony, ·017; and at the Berlin abattoir, ·074. It is worth noting, however, that the distribution is very unequal; the percentages are very much higher in some abattoirs than in others.

In Britain no statistics on the frequency of measles are available. There is no doubt, however, that it exists in British swine. In the past few years the Editor has met with several cases, and others have been reported by practitioners. Our sanitary arrangements, and the conditions under which our animals live in most parts of the country, at least, are calculated to render small the chances of infection by human fæces. We know, however, that sewage grass is freely used for cows in some towns, and that in many rural districts swine have plenty of opportunity to indulge a coprophagous inclination. In countries like our own, where some control is exercised over the hygienic surroundings of animals, they seldom have the opportunity of swallowing an enormous number of tape-worm eggs. Possibly that explains why we hear so little about measles from our abattoirs. It is not customary to look specially for the disease, consequently the presence of a few cysticerci in certain muscles may easily escape observation.

There is no reason why certain human tæniæ should not in a short time be stamped out of existence in civilised lands. It is related of the Abyssinian that he regards his tape-worm as one of his most cherished possessions; but fortunately no such obstacle to stamping out these parasites can exist here, even in the mind of the man who refused to forbid his pig the house on the ground that it paid the rent.

The fact that human beings are sometimes infected with the cystic form of the *T. solium* only concerns the Meat Inspector in that it makes this form of tæniasis the more to be feared. It is believed that a man harbouring the *T. solium* in his intestines may become infected with the *C. cellulosæ*, if the worm be displaced in such a way that it deposits its eggs in the stomach. This, however, is not the only method of human infection by the cysticercus, but the reader may be spared an indelicate explanation, since this part of the subject belongs to the province of the physician.

FIG. 41. — *Cysticercus Tæniæ saginatæ*, embedded in the muscle. Nat. size.

*Lesions of ox measles.*—In the tissues the cysticerci excite a proliferation and become surrounded by a delicate adventitious cyst of fibrous tissue. The latter is practically of the same size as the parasitic cyst, on the outer surface of which it is moulded. The cysts vary in size from that of a dried pea to that of a small bean, and their appearance is that already described. The bladders which have been ruptured are, of course, smaller. If the cyst be enucleated from the tissues a cavity is left. The duration of life of the parasite in its intermediate host is limited. According to Cobbold, degenerated cysts only are found about six months after infestation; but of course the latter may have occurred at different times, so that living and dead cysticerci may be found in the same beast. The necrosed cysts are usually shrivelled up. They are about the size of a hemp-seed, of a yellowish or greenish-yellow colour, and are frequently calcified. Cobbold and Morot have both pointed out that in some of them a purulent-

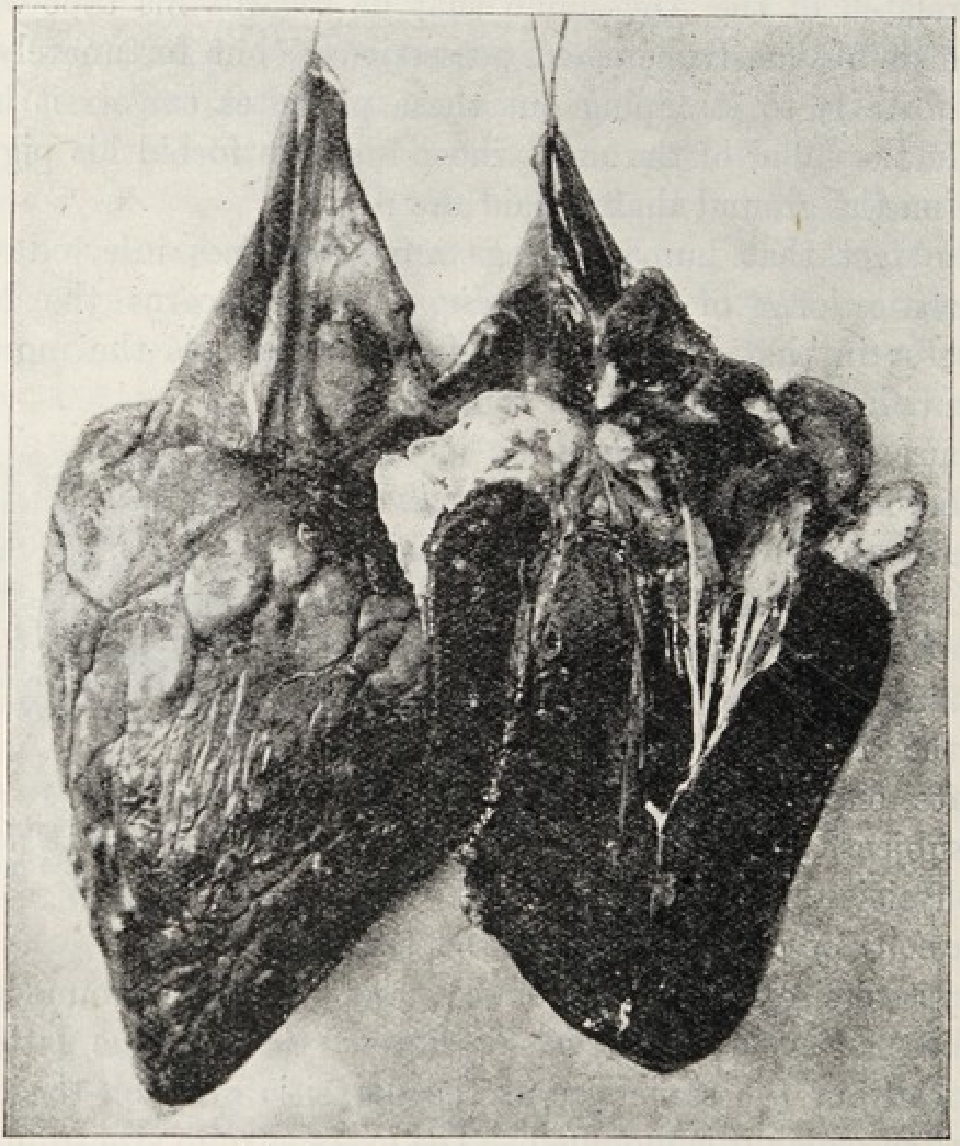


Fig. 42.—Measles in heart of ox.
*(From a photograph by Mr. Macfarlane, M.R.C.V.S., Malta.)*

looking material of a greenish or yellow colour may be found between the true cyst and its capsule, which is evidence that the degenerative process is invading the cyst from without inwards. This is important to know, because the inspector by using the microscope may hope still to find some trace of the scolex inside the cyst, although degeneration may have commenced. Where it is advanced, Ostertag states that the calcareous corpuscles of the parasite can still be found.

The favourite seats of the bladder-worms are the root and frænum of the tongue, the muscles of mastication—pterygoids and masseter muscles—and the heart. They are often enough,

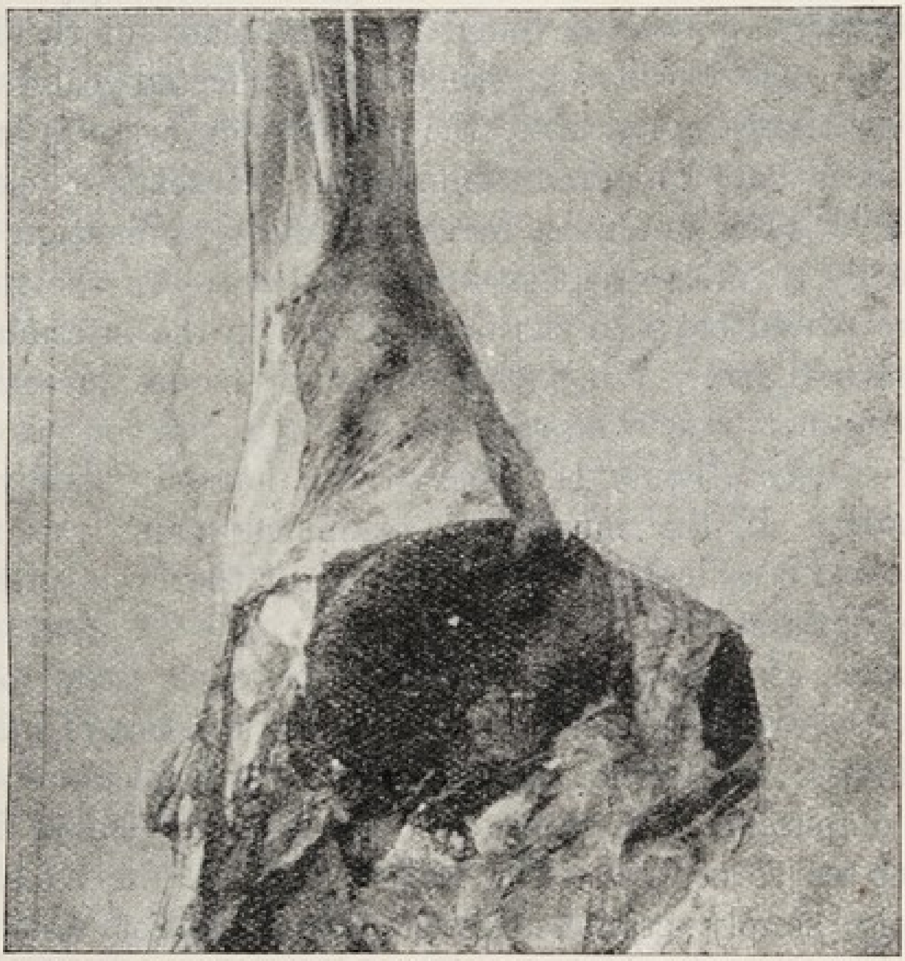


Fig. 43.—Measles in the hind quarter of an ox.
*(From a photograph by Mr. Macfarlane, M.R.C.V.S., Malta.)*

however, present in the muscles of the shoulder, haunch, and other regions.

With the exception of the heart, the cysts are seldom found in internal organs. Adipose tissue is almost always free from them. Morot, however, lately recorded a case of pulmonary cysticercosis in the ox, and referred to another case reported by Mejer.

The number of cysts is very variable. It depends on the quantity of eggs swallowed. Dr. Joseph Flemming counted as many as 300 in a piece of the psoas muscle weighing one pound. This, however, was in India, where the conditions are such that an animal may swallow thousands of eggs. In cases of experimental infection, for which enormous numbers of eggs were used, the flesh and organs were simply infested with bladders. Leuckart found them in many of the lymph glands in one of his experimentally infected calves. In civilised countries, however, the number of cysts is usually small, and they are often confined to the seats of election. To discover them one must make a careful examination of the muscles by a series of longitudinal incisions. In the muscles they are seated between the fasciculi and in the intermuscular connective tissue. When only a few cysts are present, the muscle is not much altered to the eye. When they are numerous the tissue is paler than normal, flabby and œdematous. If the muscle be examined under the microscope, the fibres in the neighbourhood of the cysts present a hyaline appearance.

*Lesions of pig measles.*—The commonest seats of the *C. cellulosæ* are the tongue, the heart, the muscles of mastication, those of the neck, the chest, and the muscular portion of the diaphragm. They are also found pretty often in the liver and nerve centres. The Editor has seen the liver of an Irish pig simply crammed with them. Morot has lately recorded a case of splenic cysticercosis of the pig. As in the ox, a generalised distribution seems to depend on infection by a large number of eggs. The subcutaneous fat is usually free from cysts, but this is by no means an absolute rule. The lymph glands may be invaded in bad cases. The appearances of the flesh and the changes undergone by the parasites are practically the same as in beef measles, but, of course, the contents of the cysts differ from those of the latter. There may only be one or two bladders present in an animal, but they are usually much more numerous in the pig than in the ox, because of the many opportunities given the former to indulge the coprophagous appetite. It is said that the bladder-worms live for a longer time in the pig than in the ox.

*Inspection.*—It will be seen from the above description of the lesions that the number of cysticerci found in animals varies within wide limits. The cases may be divided for the purpose of consideration into three categories. First, there may be a large number present throughout the body ; secondly, there may be a dozen or so ; thirdly, it may happen that only one or two apparently isolated parasites are found in the most favoured resorts. In the last two cases the inspector must make several longitudinal incisions into the flesh at the commoner seats of the parasite in order to detect it. In the first class of cases there is no question about the duty of the inspector. He should seize and destroy the whole carcase, for in addition to its infecting power, the flesh is pale, flabby, watery, and consequently unmarketable. In the second and third classes the question is rather more complex, for the carcase may be of good appearance. It does not follow that parasites will be present in the hind quarters, even when several have been found in the anterior muscles ; but one must always suspect it. To cut the carcase into pieces small enough to enable one to say that the whole has been examined and the affected parts removed, would be tantamount to total seizure, for its sale, in this country at least, would be spoiled. Its mutilated condition, however, would not prevent its being employed for the manufacture of sausages, and for this purpose it might be used if the examination proved satisfactory.

Thorough cooking kills the parasites. Perroncito has shown that they are destroyed by a few minutes' exposure to a temperature of 50° C. (122° F.). In some of the German abattoirs the carcases of measly animals considered fit for food are cut into suitable pieces and thoroughly cooked or sterilised before sale. No arrangements, however, are available for supervised cooking in our abattoirs, nor is it at all certain that an extensive market would be found for the material, however excellent it might be. Moreover, it has yet to be shown that measles exists in our animals to such an extent that the utilisation of suspicious carcases is a serious consideration. At the same time one must admit that no methodical system of examination for cysticerci is practised in our abattoirs, and any one acquainted with the method, or rather want of method, in vogue even in the best of them, will understand how easily the presence of a few parasites may be overlooked. Pickling renders the flesh harmless in about three weeks, but even a shorter time would suffice, since thorough cooking is necessary in order to extract the brine from meat of this kind. The owner of a carcase moderately measled but otherwise of good quality might be allowed to pickle the apparently healthy parts under the supervision of the authorities. He might also be allowed to make use of the fat or lard after it had been melted and strained through a fine sieve. In the absence of arrangements for carrying out the above prophylactic manipulations, or failing the assent of the proprietor to conform to them, the duty of the inspector should be to seize the whole carcase. The suggestions with regard to the destruction of cysticerci in flesh by prolonged cold storage appear to the Editor to be impracticable.

Those pigs which come in the third category, where only one or two cysticerci have been found by the ordinary method of examination, should, in the opinion of the Editor, be treated like those in the second. It is difficult to believe that an animal could have swallowed only a single egg. Indeed, it is much more likely that a proglottis containing many has been swallowed. The discovery of one cysticercus, then, argues the presence of others, although the method of examination may have failed to reveal them. In man the *T. solium* may give rise to such serious consequences that one cannot afford to be lenient. In dealing with cattle there is not the same call for severe measures. The *T. saginata* is certainly an inconvenience to its human host, but its cystic forms do not invade his muscles and organs. Accordingly, when a few cysticerci have been found at the seats of election in an ox, and exploratory incisions into the other parts have failed to disclose more, the apparently healthy portions might be put on the market in the fresh state. To destroy them altogether because there is a slight chance of an odd individual getting a *T. saginata* from eating the flesh seems to the Editor to be an exaggerated form of meat inspection. Moreover, the very fastidious can destroy the last element of risk by refusing to eat a joint that has not been cooked right into the centre. Were it customary in this country to sell meat with instructions that it must be well cooked before being eaten, one might apply the same rules to pork as to beef. To label a joint, however, would be at present to prevent its sale; and for reasons already explained, the consequences of putting measled pork on the market without warning might be irremediable. The same cannot be said of measled beef, although it is advisable that ordinary care be exercised to keep it out of consumption. When degenerated cysts are numerously present in ox flesh, be they calcified or not, the parts containing them should be considered unmarketable. If the degenerated cysts be not very numerous, the flesh might be passed after removal of the lesions; but one should always look for living parasites as well, since all of them may not have undergone degeneration.

In dealing with pork sausages, Schmidt-Mulheim recommends that they be digested in artificially prepared gastric juice, since it acts more slowly on the scolices and their hooklets than on the flesh particles. This, however, would be a laborious undertaking. It would be much better to take care that no flesh deserving to be condemned gets into the hands of sausage-makers. Lastly, it should be remembered that those who are working with measly flesh may by their fingers carry the scolices to their food.

### CYSTICERCUS TENUICOLLIS

This is the cystic form of the *Tænia marginata* which inhabits the intestines of the dog.

*Animals affected.*—The parasite may be found in all wild and domesticated ruminants, but it is most commonly met with in sheep. The reason for this is the important part that the dog plays in the herding of these animals. Young sheep are apparently much more easily infected than older animals. At the Edinburgh abattoir this parasite is only second in point of frequency to the *S. rufescens* of the sheep. The Editor has only on one occasion met with it in the pig.

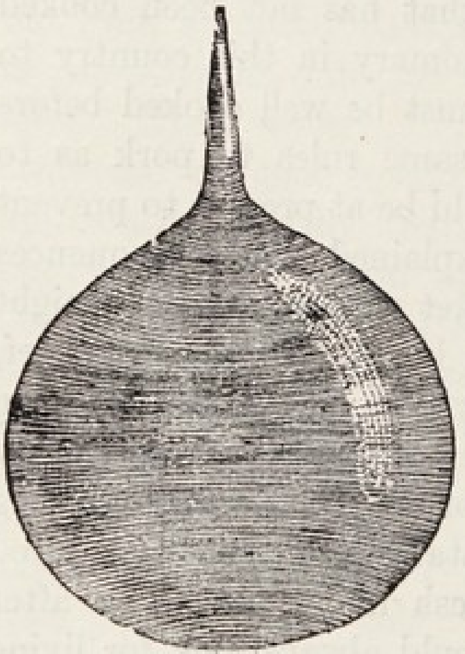


FIG. 44.—*Cysticercus tenuicollis.* —NEUMANN.

*The parasite.*—The size of the bladder-worm depends on its age and situation. In the serous cavities it may reach the size of a hen's egg, or even larger. In this situation the parasites are contained in adventitious sacs formed from the peritoneal tissue. They look like small water-bladders, and in some cases the serous covering is pulled down by the weight of the cyst, so that a constricted part is formed at the point of attachment. The true cyst (Fig. 44) shows an attenuated portion or neck, hence the name "slender-necked hydatid." The scolex is contained inside the neck, and can be evaginated by pressure.

As in the case of other cysticerci, only one head is present in each cyst. It may, however, be acephalous. In cases of experimental infection, the bladders have been found to have attained the length of from ·6 to 3·5 mm. in ten days. Leuckart states that seven weeks after infection they measured 15 mm. Their size, then, varies greatly. The heads are well developed in cysts of forty days' standing (Baillet), and in the fully developed cysts they possess a double row of hooklets. These are about the same length as, but more slender than, those of *C. cellulosæ*, a parasite for which this one might be mistaken. The roots of the hooklets of *C. tenuicollis* (Fig. 45) are also longer than those of the former, and the blades are less curved. The usually large size, the difference of habitat, and the long neck of *C. tenuicollis*, however, are in the vast majority of cases the best guides for distinguishing the one cysticercus from the other. It is not difficult to distinguish the parasite under consideration from the *C. bovis*, for the latter is unarmed.

*Lesions.*—The embryos when freed from the egg enter the

FIG. 45.—Hooklets of *Tænia marginata*. × 280.

blood vessels. In this way they may get to various parts of the body. They have been found in the liver, lungs, pleura, heart, pericardium, and muscles, but the peritoneum is by far the most frequent habitat. In this situation they may be found attached to the surface of the liver, or to the adipose tissue of the mesentery and omentum. The number found in one animal varies from one to a dozen or more. Sometimes they are shrivelled up and calcified. According to Leuckart and Baillet, most of the embryos gain the peritoneum by boring their way through the substance of the liver, which they reach by way of the portal vessels. Traces of their wanderings can be found in the form of greyish or blood-stained streaks; but they seldom develop in the organ. In passing through the serous covering they may give rise to severe peritonitis; but lesions of the latter description are seldom seen, except in experimental cases of infection, in which large numbers of eggs have been used. Still, Avéradère has reported an enzootic of cysticercosis which carried off fifteen out of thirty lambs aged three months. The lesions were those of acute peritonitis and pleurisy. The liver and lungs were crammed with young cysticerci, and some measuring $\frac{2}{5}$ of an inch were found in the peritoneal cavity.

In the lungs, only the early forms have been met with.

In the muscles and subcutaneous tissues of sheep, young forms have been observed—measles of the sheep (*C. ovis*)—and isolated adult cysts have been met with in a few cases. It is possible, then, that these cysts might also be found in the muscles of the pig, and be mistaken for *C. cellulosæ.* The latter parasite is also exceptionally met with in sheep. The differences already referred to between the cysts and scolices of the two parasites, added to those of situation in other organs, should prevent any mistake being made in the diagnosis of the muscle lesion. Degenerated cysts of *Cœnurus cerebralis* are sometimes present in the muscles and organs of young sheep (*see* CŒNURUS).

*Inspection.*—It is mainly with sheep that the inspector has to deal in this case. The affected animals are often in very good condition. In such cases the carcases should be passed after the affected organs have been removed. The latter should be destroyed, so that dogs may not eat thereof and become infected with *T. marginata.* When the carcases are emaciated, as occasionally happens, they should be dealt with according to the degree.

### CYSTICERCUS PISIFORMIS (Zeder)

This is the cystic form of the *T. serrata,* which inhabits the intestines of the dog. The cysticercus is found chiefly in the peritoneal cavities of hares and rabbits. It reaches its habitat in a way which is similar to that taken by the *C. tenuicollis.* In Scotland, rabbits are frequent harbourers of this parasite. The adult cysts vary in size from a pea to a nut, but most of them are of the former size. At one end the cyst shows a small firm nodule. This is the chamber containing the head. It may be retracted inside the chamber, or it may be evaginated (Figs. 46 and 47).

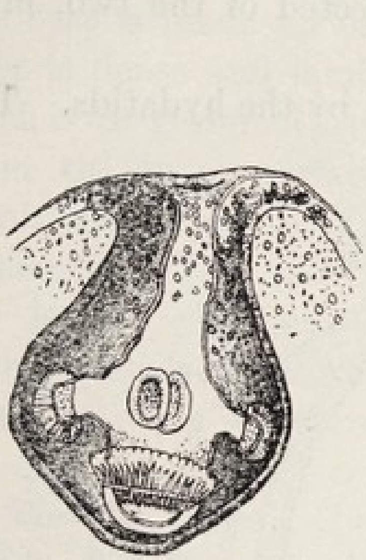


Fig. 46.—Head of *Cysticercus pisiformis* just mature. × 40.

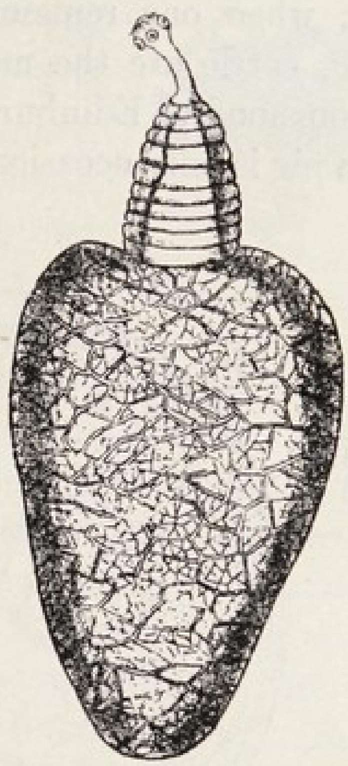


Fig. 47.—Head and body of *Cysticercus pisiformis* in completely evaginated state. × 19.

The head has a double row of hooklets, which are relatively much longer than those of other scolices.

*Inspection.*—In the interests of the dog, the affected organs should be destroyed. Affected rabbits are often very much emaciated, and quite unfit for the market; but, owing to the custom of selling them in the disembowelled condition, the cause can often only be surmised.

### Echinococcus veterinorum

This is the cystic form of the *T. echinococcus* of the dog.

*Animals affected.*—All the domesticated herbivora and omnivora may be infected by the hydatids of the *T. echinococcus*.

The parasite is also found in the organs of wild animals. It is by no means rare in human beings. Cattle and sheep are its most frequent hosts in this country ; but, strange as it may appear, when one remembers the relations of the sheep and the dog, cattle are the more often affected of the two, in the neighbourhood of Edinburgh at least.

The pig is only occasionally invaded by the hydatids. Their

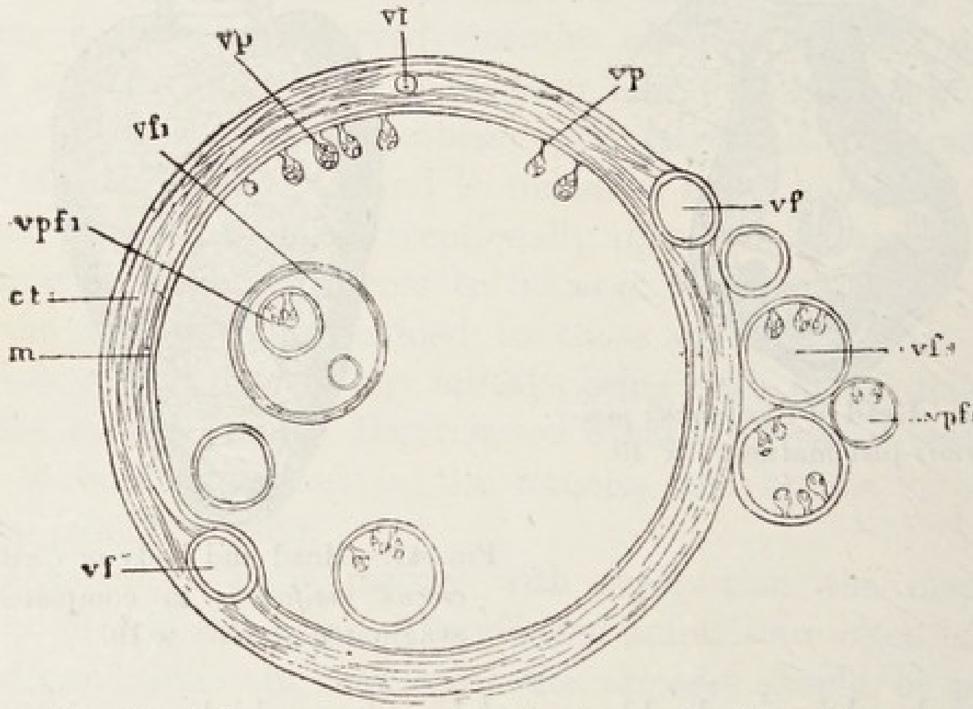



FIG. 48.—Diagram showing the development of daughter and granddaughter echinococcus cysts.—NEUMANN.

frequency, however, depends on that of *T. echinococcus* in the dog, so that the number of cases in this or that district will vary from time to time.

*The parasite.*—The *E. veterinorum* is polysomatic and polycephalic ; several chambers are formed, inside of which five, ten, or even more scolices are developed.

According to Leuckart, the echinococci are visible to the naked eye two months after reaching the tissues. They then measure about 1·5 mm. in diameter. The heads appear in about five months, when the bladders have a diameter of about $\frac{3}{5}$ of an inch. The size of the fully formed hydatid, however, varies according to the density of the tissues which enclose it, and is roughly from that of a walnut to that of a bantam's egg. The hydatid lies inside an adventitious cyst of fibrous tissue. The true cyst is made up of two layers. The outer is dense and laminated; the inner, which is the germinal layer, is membranous. From the inner surface of the internal membrane several proligerous vesicles are developed. The scolices develop inside the latter. In some cases daughter cysts arise from the mother vesicle, either exogenously or endogenously (Fig. 48). These have the same structure as the mother cyst; and even a third generation may form from them (granddaughter cysts). This is probably the explanation of the racemose forms of echinococci which are frequently present in the livers of cattle (Fig. 49).

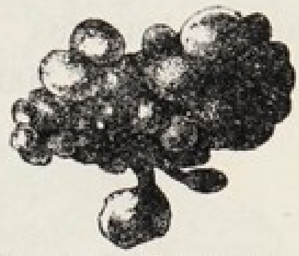


Fig. 49.—*Echinococcu racemosus.* Nat. size.

There is still another form of echinococcus cyst, which is exceedingly rare in animals in this country. This is the *E. multilocularis.* On section it consists of many small cavities about the size of a pea, and bound together by fibrous tissue (Fig. 50).

Fig. 50.—Section through an *Echinococcus multilocularis.* Nat. size.

The Editor has only met with one case of the latter class. It was present on the surface of an ox's liver, and was about the size of a hen's egg. Whether these are related to the racemose forms, which are fairly common, it is difficult to say. Both are acephalous, but the cavities of the racemose variety are often about the size of a hazel-nut, and they are separated only by a thick membrane. Degenerated cysts are commonly found, but these will be described with the lesions. According to the experience of the Editor, the apparently normal cysts met with in the livers of cattle often contain no heads. If a normally developed cyst be ruptured, and the fluid examined with a power of eighty, the heads will be distinctly seen (Fig. 51). Many calcareous particles are also present. The heads measure about 300 $\mu$ when fully extended, but the anterior

Fig. 51.—Scolices of the *Echinococcus veterinorum*. The head is evaginated in two of the scolices (Reichert, obj. 7).

end is often invaginated into the posterior part. Many bright calcareous particles are present in the scolices. When the anterior part is visible it shows a rostellum surrounded by a double row of hooklets. A high-power lens shows that the hooks are remarkable for their shortness.

*Lesions.*—By far the most common seats of the *E. veterinorum* are the lungs and liver. The hydatids have also been found in the spleen, kidney, pancreas, heart, aorta, serous membranes, brain, and in the medullary cavities of long bones. They have in a few instances been found in the muscles of the pig and the horse.

Their presence in organs other than the liver and lungs, however, is exceptional. Presumably the embryos travel by the blood vessels, but, as they are most likely to enter the

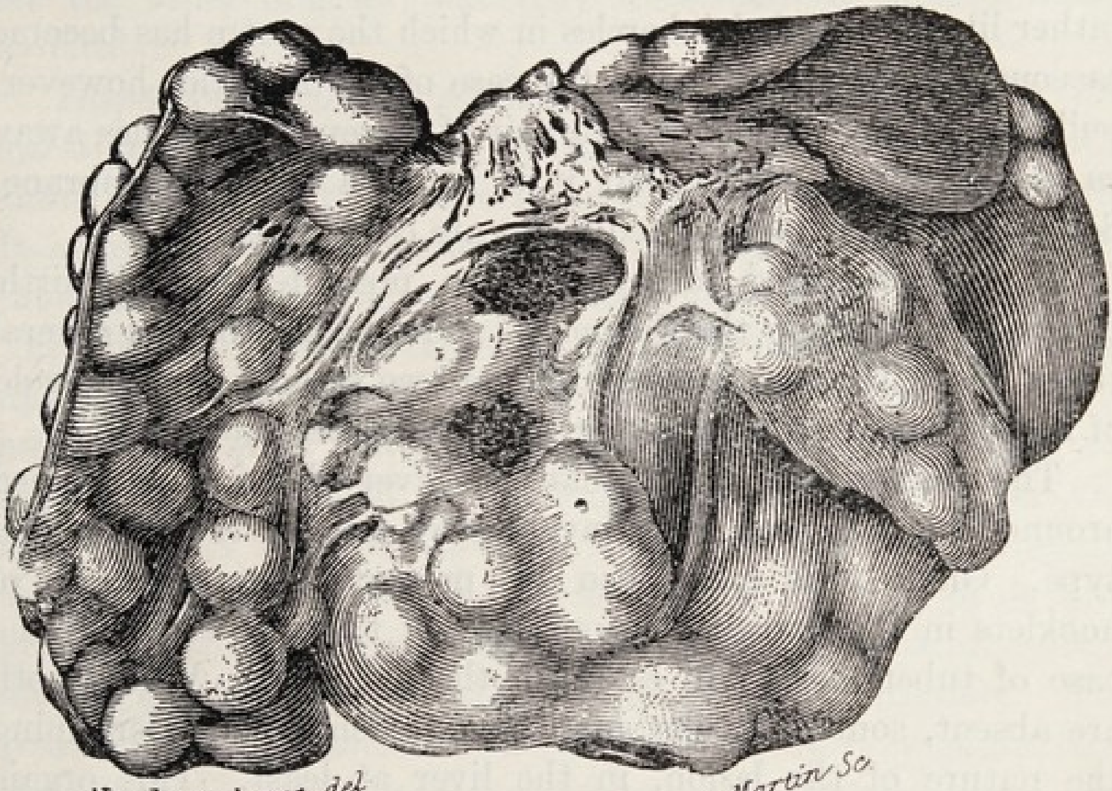



FIG. 52.—Liver of pig affected with *Echinococcus veterinorum*.—RAILLIET, NEUMANN.

portal branches from the intestines, the majority will be arrested in the capillaries of the liver.

Liver.—The number of parasites present varies from a single one to several hundreds. In the graver cases of infection the organ is enormously enlarged. Frequently it weighs over 100 lb. in the ox (normal, about 11 lb.). The bladders are seen on the surface and in the substance of the organ (Fig. 52).

The capsule over the vesicles which project from the surface is atrophied and opaque. In most of the cases examined by the Editor a very large number of the vesicles were degenerated. These are always more or less shrunken. They may contain fluid, or they may be dry. The true cyst is shrivelled up into a yellowish-coloured cheese-like material, which floats in the fluid, or adheres to the collapsed wall, when the fluid is gone. As many of these contain neither heads nor hooklets, it is probable that they were acephalous cysts ; but of course the hooks do not persist indefinitely. The dry cysts look rather like encapsuled tubercles in which the centre has become caseous. One can always in the case of the hydatid, however, pull the yellow part out with a pair of forceps. It comes away *en masse*, and one sees that it is really a folded membrane. Sometimes these degenerated forms are calcareous.

If undegenerated forms are also present, there is little difficulty in making the diagnosis ; but the Editor has several times met with cases in which one or two caseous cysts, devoid of hooklets, were present along with true tuberculous lesions.

The microscope shows that the liver tissue is atrophied around the cyst, and it is invaded by cells of the epithelioid type. Giant cells may also be present. The presence of hooklets in the parasitic lesions, and of tubercle bacilli in the case of tuberculosis will establish the diagnosis. Where both are absent, some difficulty may be experienced in determining the nature of the lesion, in the liver at least. This organ, however, is never the seat of primary tubercles, except occasionally in very young animals. Moreover, the centre of the parasitic lesion can be completely enucleated from the adventitious membrane, the inner surface of which is smoother, more regular, and usually thinner than the capsule of an old tubercle.

Lungs.—In the experience of the Editor, one almost never finds the lungs so seriously invaded as the liver. The number of hydatids present varies usually from one to six. When located at the surface they bulge out the pleura, which is usually opaque over the vesicle. Those in the substance of the organ can be felt to fluctuate and roll under the fingers. Occasionally a cyst in the neighbourhood of a bronchus will cause atrophy of the wall, and evacuate its contents into the tube.

Muscles.—The muscles are seldom invaded by the hydatids. One or two cases have been described in the pig. Lemke counted eighteen in a pound of pork. Megnin has reported a case of a Russian pig, in which the ilio-spinal muscle was crowded with cysts of the echinococcus. He did not see the other muscles, but they were said to contain many hydatids.

*Inspection.*—The *T. echinococcus* does not develop in the intestines of human beings, so that the presence of hydatids in animals does not constitute a direct source of danger to man. It is by the fæces of infected dogs contaminating water, vegetables, and possibly plates, that man is infected with this parasite. The affected organs of animals, however, should be seized and immediately destroyed. This is all the more necessary, since infection of dogs with the tape-worms constitutes a direct menace to the health of the human community. When the liver is badly infected the carcase is often emaciated, and the flesh is flabby and watery. Such carcases must be dealt with according to their appearance ; but in the absence of serious alterations in the flesh there is no need to interfere. The possibility of the muscles containing cysts is very slight, and their presence would not injure any one who ingested them.

## Cœnurus cerebralis

This is the hydatid form of the *T. cœnurus* of the dog. It is the cause of the disease known as "sturdy," or "gid."

*Animals affected.*—All ruminants may be invaded by this parasite. It is much more commonly seen in the sheep, however, than in any of the others. Young sheep up to the age of two years are apparently more liable to contract sturdy than older animals, but the latter are not exempt. We have no recent statistics concerning the frequency of this parasite, The affected animals are sent into our city abattoirs to be slaughtered in the spring of the year. As it is not customary for the inspectors to examine the brains of animals, it is likely that a good many cases pass unnoticed. The Editor has on two occasions obtained sheep's brains containing this parasite from a butcher's shop.

*The parasite.*—The *C. cerebralis* is polysomatic, but it is monocephalic. Two or three hundred chambers may be formed, but each contains only one scolex (Fig. 53).

In the brain, the cysts are as large as a pea about three weeks after infection (Baillet). The heads appear about the fortieth day, but the cyst is not mature until about the second month; even then some of the scolices are incompletely developed. The mature bladders are usually about the size of a small walnut, but they may be much larger. When extracted, one sees numerous grey specks, which are arranged in patches on the wall. These contain the heads.

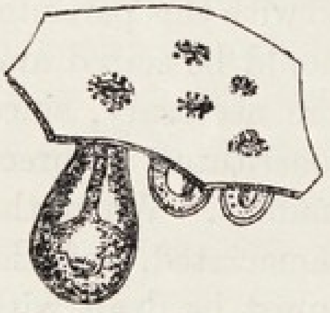


Fig. 53.—Heads of *Cœnurus*. × 25.

*Lesions.*—It is quite exceptional to find the cysts in an advanced state of development, except in the brain and the spinal cord. The former organ is the more common seat. Usually only one or two cysts are present, but as many as thirty in one brain have been recorded. The tissue around the cyst is destroyed.

When the bladders are large and superficially situated, even the bones of the skull may be thinned and softened, The carcases are often very much emaciated. The emaciation may be particularly evident in certain regions which have undergone atrophy in consequence of a spinal lesion. The embryos reach their habitat by way of the blood vessels, and during the first three weeks of their invasion traces of their wanderings in the brain can be seen in the form of red or grey streaks (Fig. 54).

The embryos certainly enter the other organs, but they have only in one or two isolated cases been known to develop in the subcutaneous tissue. In the other organs their development is checked at a very early stage, and the parasites degenerate. These degenerated forms are frequently met with in the tissues of lambs. The lesions produced by them are in the form of nodules, varying in size from a hemp-seed to a nut. The external part, which is fibrous, encloses a caseous material of a greenish-yellow colour. The nodules are sometimes calcified. Morot, who has repeatedly called attention to these nodules, has lately described a marked case of general infection. In a young sheep he found 68 nodules in the muscles of the abdomen and hind-quarters, 87 in the muscular tissue of the fore-quarters, 41 in the masseters, 2 in the muscles of the eye,

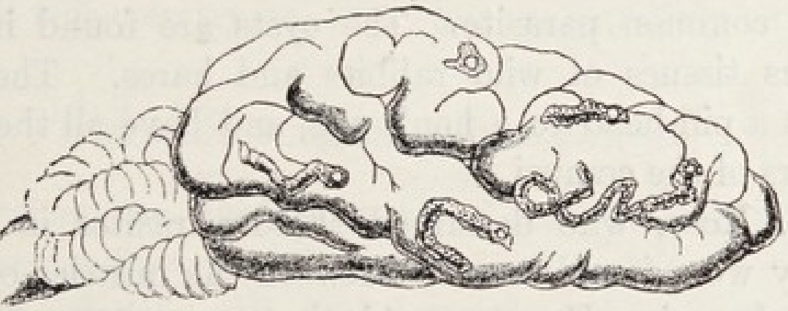


FIG. 54.—Brain of a lamb with passages of *Cœnurus*. Nat. size.

and 2 in the tongue. Similar nodules were present in the heart, the diaphragm, the kidneys, the pleura, and the peritoneum. In the brain there were several degenerated nodules, but also five small bladders containing a clear fluid. Railliet, to whom the tissues were sent, regarded the cysts as those of cœnuri.

Some difficulty might arise in distinguishing between young cœnuri in the brain and the measles parasites. Scolices would be present in the latter, however, when the bladders had reached the size of a hemp-seed, whereas they only begin to appear in the cysts of the former when they are about the size of a hazel-nut.

The degenerated cysts in muscle might easily be mistaken for those of measles in the same condition. The fact of all the nodules being caseous, however, would point strongly to the parasites being cœnuri; but a mistake regarding the identity of degenerated parasites would be of no consequence.

*Inspection.*—The parts showing lesions and the emaciated carcases are the only ones which require to be dealt with.

The heads should, of course, be destroyed if cœnuri be found in the brain. The presence of degenerated cysts in the tissues should make one suspect sturdy.

When the caseous nodules are numerously present in any part, it must be looked upon as unmarketable.

### Cœnurus serialis

This is the cystic form of the *T. serialis* of the dog, but it is not a common parasite. The cysts are found in the subcutaneous tissues of wild rabbits and hares. They vary in size from a pin-head to a hen's egg, and have all the structural characters of the cœnuri.

C. B. Rose, who described these parasites in 1833, said that they were found usually between the muscles of the loins, back, and neck. He also said that warreners puncture the vesicles and squeeze out the fluid before sending the affected animals to market.

### Tæniæ

The tæniæ most commonly found in the intestines of cattle and sheep in this country are the *T. expansa* and *T. denticulata.* The former worm is best known. They are both unarmed. The *T. expansa* may attain a great length, in some cases 20 ft. or more. The posterior segments are nearly an inch in breadth. The head, which shows four oval suckers, is continued by a narrow twine-like portion. The *T. denticulata* is shorter than the preceding. It is usually about 1 ft. in length, but it may be much longer. The head is made up of four globular suckers. The anterior part is thicker than that of the *expansa*, and the body has a denticulated appearance.

Tape-worms have been credited with giving rise to diarrhœa and anæmia in young oxen and sheep. It seems more likely, however, that the serious and sometimes fatal effects attributed to the tæniæ are really caused by small nematodes, such as the *Strongylus cervicornis* described by M'Fadyean in this country, and also found in calves by Gilruth in New Zealand. The intestinal parasites may give rise to severe gastro-enteritis, and be the cause of such marked emaciation and cachexia that the carcases of the animals are rendered unfit for the market.

## TREMATODES

The only trematodes which are of much importance to the inspector in this country are those known popularly as flukes.

### Distomatosis (Rot ; Fluke Disease)

These terms are applied to the diseased condition caused by distomata or flukes.

*Animals affected.*—All the domesticated animals may be invaded by flukes. Fluke disease, however, is only seen to any extent in sheep and cattle. The other animals are much less exposed to infection. A considerable number of cases have been recorded in human beings. In Scotland the disease is widely prevalent both in sheep and cattle. A large number of sheep carcases have to be condemned annually at the Edinburgh abattoir on account of this disease. It is most prevalent from December to March. The affection is rarely met with in pigs.

*The parasites.*—The two best-known flukes are the *Distomum hepaticum* and *D. lanceolatum.* The former is by far the most frequent in Scotland ; one hardly ever meets with the *lanceolatum.*

The *D. hepaticum* is like a miniature flat-fish (Fig. 55). It measures from 1·8 to 3 cm. in length, and from 6 to 10 mm.

in breadth. Its cuticle is of a brownish colour, being much lighter towards the centre than at the margins. It is studded with delicate bristles. An oral sucker, which communicates with a double alimentary canal, is situated at the anterior part of the head. The alimentary tubes show many lateral branches. A short distance behind the mouth on the ventral surface there is another pore. The parasite is hermaphrodite, and the male and female genital organs are placed just in front of the ventral opening. The eggs are of a brownish colour, and measure about 130 $\mu \times 70$ $\mu$.

In most cases the parasites are found only in the bile ducts, where many of them lay their eggs, or they may have passed to the intestines by way of the bile duct. They are occasionally met with, however, in other organs.

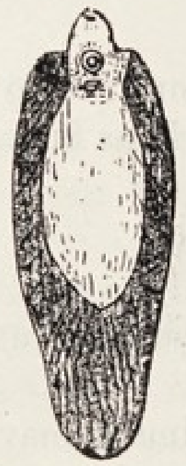


Fig. 55.—*Distomum hepaticum.* Nat. size.—Leuckart.

The *lanceolatum* is longer and narrower than the *hepaticum.* It measures from 4 to 9 c.m. × 2·5 mm. It is lance-shaped, and the body is devoid of bristles. The alimentary tubes are unbranched.

*Lesions.*—The bile ducts are the natural habitat of the flukes, and the chief anatomical changes are found in the liver. Isolated parasites, however, have been found in other organs, which they probably reach by way of the blood stream. They enter the vessels at a less mature and smaller stage of their parasitism. The Editor has many times observed them in the lungs of oxen.

Morot found 101 cases of pulmonary distomatosis in 2458 oxen (4 per cent.). Lung lesions have also been met with in sheep by Burke and Littlewood, and in the pig by Ruser.

Morot has recorded one observation of *D. hepaticum* in the intercostal muscles of an ox. He has also found the parasites encysted under the serous membranes of the same species.

Friedberger and Fröhner say that flukes are sometimes found free in the serous cavities.

Cocu has found a fluke in the right ventricle of a cow. Morot, Blanchard, and others have seen them located in the parenchyma of the liver. Lucet has seen the hepatic distoma in the spleen. They have also been met with in the portal vein and other vessels. The *lanceolatum* does not give rise to such marked lesions as the *hepaticum*. In China and Japan flukes are often found in the ducts of the pancreas in the ox and buffalo (Gomy). The pancreatic fluke, however, is a different species—*Dicrocollium pancreaticum*.

Liver.—The *D. hepaticum* gives rise to cirrhosis of the liver. It is no exaggeration to say that, in this country at least, the vast majority of cases of hepatic cirrhosis in animals is due to this parasite.

In the ox the organ is much enlarged. Its borders are rounded, and its surface is usually regular. Its consistence is much firmer than normal, and its colour is often yellowish from infiltration by fat. If the organ be cut, a jerky sensation is conveyed to the hand through the knife. Frequently a grating noise is produced as the knife passes through the calcified ducts.

Small areas, usually linear, of white fibrous tissue are seen on the surface of section. The walls of the bile ducts are much thickened; sometimes they are calcified. The ducts contain inspissated bile and mucus, which varies in colour from reddish-yellow to very dark brown. Parasites are generally found in the ducts along with calcareous scales, but it is sometimes difficult to find a single fluke. In the ox lesion the formation of cavernous blood spaces is almost invariably observed. These appear as dark purple areas under the capsule and in the substance of the liver. They are never found in the cirrhotic livers of sheep.

In the early stages the microscope reveals the presence of many fibroblastic cells in the neighbourhood of the ducts. Later, these cells are transformed into fibrous tissue which extends into the lobules and destroys the liver cells. In the fibrous tissue many new bile capillaries are seen

(Fig. 56). In some cases the remaining liver cells are infiltrated by fat globules.

The cavernous spaces look like distended vessels filled with blood. They consist of areas of dilated capillaries which are separated from each other by rows of liver cells (Fig. 57).

In sheep the enlargement of the organ is generally in the antero-posterior direction. On the posterior surface the large

FIG. 56.—Cirrhosis of liver, showing new tissue and bile capillaries.

ducts stand out prominently as white tubes, and usually contain large numbers of parasites.

Cirrhosis of the liver not traceable to the fluke is sometimes seen. These cases are supposed to be due to some error in diet. In Prussia, for example, a cirrhosis accompanied by fatty degeneration is often met with in sheep and cattle fed on yellow lupins. The disease has been called Lupinosis. It has already been mentioned that cirrhosis of the liver may occur in animals suffering from certain chronic bacterial diseases. In this country a form of fine cirrhosis is sometimes seen in the livers of oxen. The organ is enlarged and of a dark chocolate colour. On section the graining is fine, and it is difficult to make out the new tissue with the naked eye.

The interlobular form of cirrhosis, in which the new tissue is formed regularly between the lobules, is seldom seen in sheep

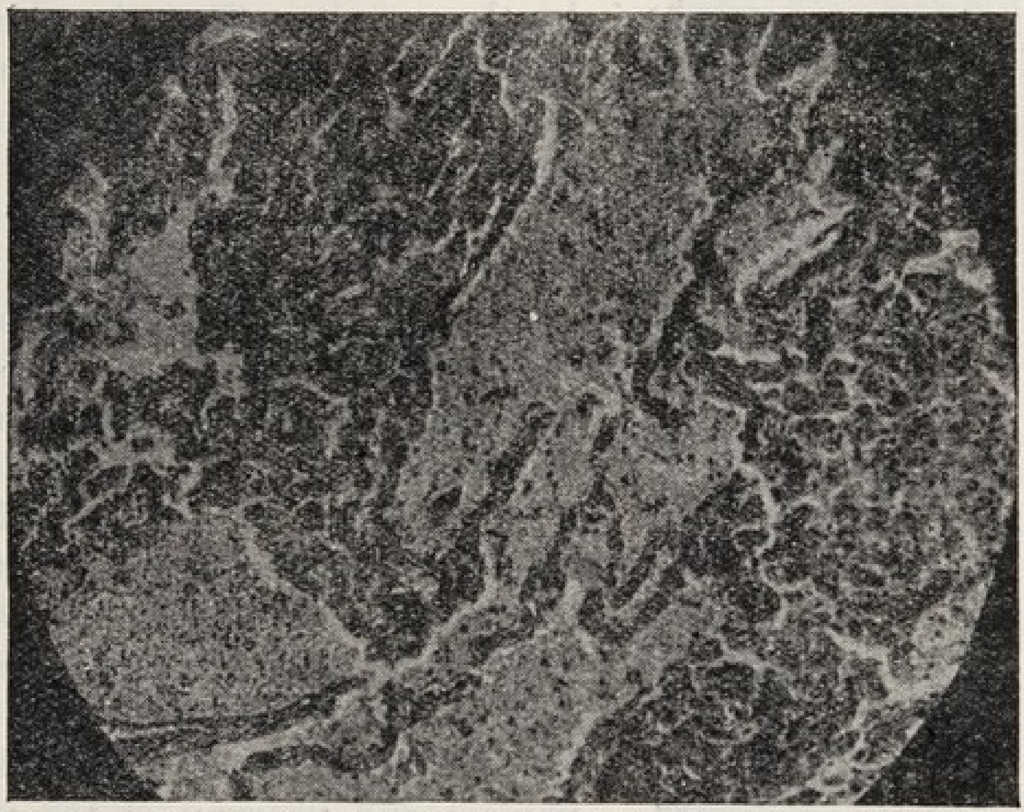


FIG. 57.—Microscopical section of the liver of an ox, showing cavernous spaces.

and cattle. It is, however, sometimes met with in the pig. It is almost needless to warn the inspector against mistaking the naturally well-marked lobulation of the pig's liver for cirrhosis.

As a general rule the carcases of young oxen which have suffered from cirrhosis of the liver are not emaciated. Sheep, however, are often reduced to skin and bone, as the saying is. The flesh of these emaciated animals is anæmic-looking, flabby, and watery. Frequently other parasites are discovered in their intestines.

Lung.—In the lung the parasite becomes encysted. A hollow tumour with fibrous walls is formed. The tumour can be seen on the surface of the lung, or felt in its substance. It is exceptional to find more than two present in the one animal. The tumour is about the size of a small walnut, greyish in colour, and the wall is often calcified. The cavity contains a dark brownish fluid of syrupy consistence. It probably consists largely of material excreted by the parasite. There is seldom more than one fluke in each cyst, but even that may have undergone degeneration, and disappeared.

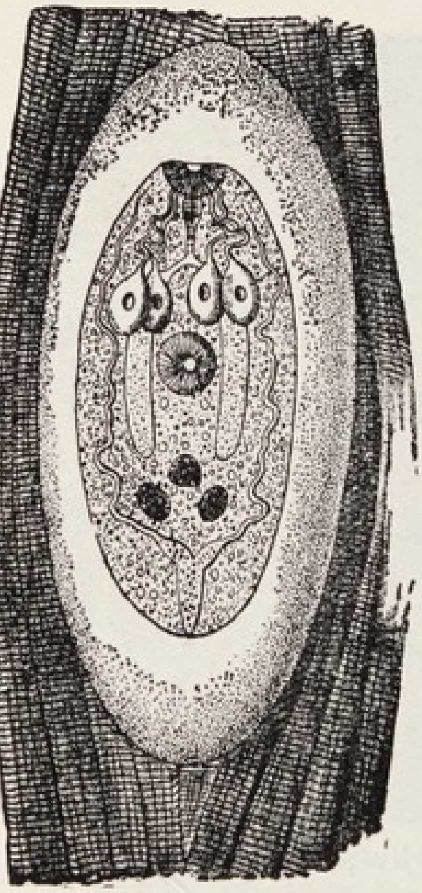


FIG. 58.—Larval distoma in muscle of pig.—LEUCKART, NEUMANN.

Serous membranes and muscle.—The parasites may give rise to small nodules immediately beneath the pleura and peritoneum, or in the deeper lying muscular tissue. The nodules are about the size of a haricot-bean. In the case of a cow observed by Morot, seventy-five nodules were present.

Dunker and Leuckart have described immature trematodes in the muscular tissue of the diaphragm and pharynx of the pig. They were contained in fibrous tissue capsules of an oval shape, and almost the size of a trichinous cyst (Fig. 58). The parasites were about half a millimetre in length, and they were motile when heated to the body temperature.

*Inspection.*—After the eggs of the fluke have been excreted from the bodies of animals, the embryos are hatched. The latter, however, must pass through several intermediary stages of existence in other hosts before they can infect animals or human beings with flukes. The disease, then, is not directly transmissible, but the affected organs, especially the liver, should be seized. Cirrhotic or fibrous livers are in all cases unfit for human food. Nevertheless, fluke livers can sometimes be found in butchers' shops. The carcase can be passed, unless the flesh be œdematous or too emaciated for the market.

### Bilharzia bovis

The *Bilharzia* is the name given to a species of trematode which was first found in the portal vein of a man in Egypt by Bilharz. The *B. bovis*, a similar parasite, was first discovered in the portal vein of a bull in Egypt by Sonsino. It has since been frequently observed in oxen and sheep in Eastern countries. It has been met with in Egypt, South Africa, and in India.

The sexes are distinct. The male *Bilharzia* of man measures from 11 to 14 mm. × 1 mm. The body is flat, of a grey colour, and dotted with papillæ. Like other trematodes, it possesses an oral and a ventral pore. The male carries the female in an elongated pouch (*canalis gynæcophorus*). The female is thread like, and measures from 15 to 20 mm. in length (Fig. 59).

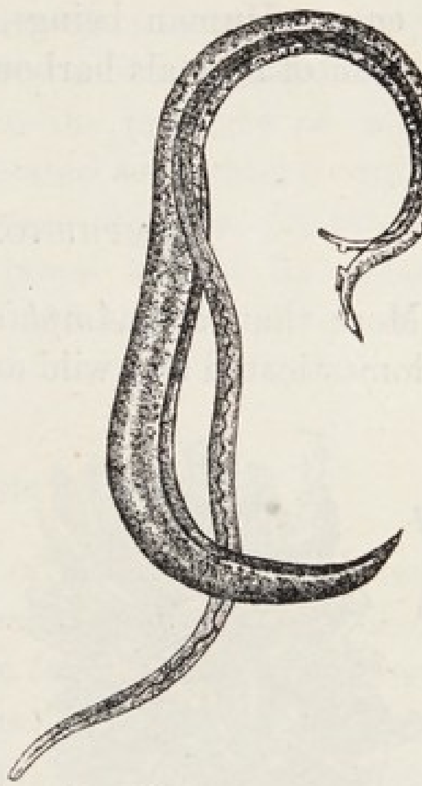


Fig. 59.—*Distomum hæmatobium*, male and female, the latter in the canalis gynæcophorus of the former.—Neumann.

The *Bilharzia* of animals does not differ materially in appearance from that of man, except that it is slightly larger.

The eggs of the *B. bovis* are spindle-shaped, and much drawn out at the extremities, one of which carries a pear-shaped body. They measure about 160 $\mu$ × 40 $\mu$.

The parasites are found in the veins, especially in those of the portal system. The eggs of the female are carried by the blood stream into the different organs, particularly the bladder and intestines.

*Lesions.*—The eggs are arrested in the capillaries. They may cause rupture with hæmorrhage, or they may give rise to the formation of small pin-head nodules. The latter are found chiefly in the large intestines and in the bladder. They contain eggs.

*Inspection.*—The researches of Harley and Sonsino show, at least, that animals cannot be infected directly by means of the eggs. Human beings, accordingly, incur no danger from the flesh of animals harbouring these parasites.

### Amphistoma conicum (Zeder)

More than one *Amphistoma* has been found as a parasite in domesticated and wild animals.

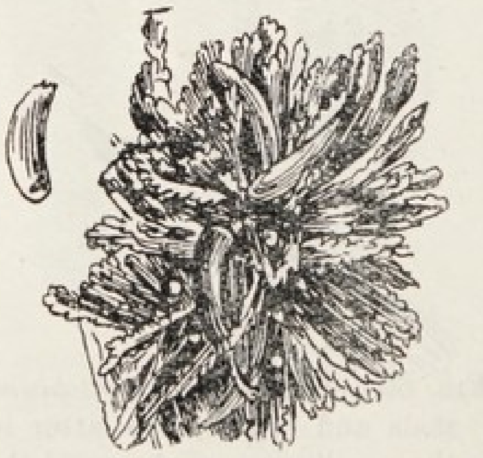


Fig. 60.—Portion of rumen of ox containing the *Amphistoma conicum.*—Neumann.

The *A. conicum* is a parasite of the rumen and reticulum of oxen and sheep. It is met with in Egypt, Australia, and India. Cobbold has given the name *A. tuberculatum* to a parasite found in the intestines of the ox in India.

The *A. conicum* is yellowish in colour, with a rosy tint in certain parts. It is ovoid, the narrow end being in front. It possesses a frontal pore, and it measures from 10 to 13 mm. × from 2 to 3 mm. at the broadest part.

These parasites are of little interest to the Meat Inspector.

## NEMATODES

The Nematodes are round worms. Many members of the order live as parasites in the bodies of animals. It is not necessary, however, in a book on "Meat Inspection" to enter into a description of every individual species. Only those which are of interest to the Meat Inspector need be dealt with here.

Gastro-intestinal nematodes, such as the *Strongylus contortus*, *S. cervicornis* (M'Fadyean), and several others, may be the cause of diarrhœa, anæmia, and emaciation in cattle and sheep. The lesions in the stomach and intestines, however, are of small importance. They seldom consist of more than local congestion, and would in the majority of cases be passed over were it not for an emaciated and watery condition of the flesh, which may render it unmarketable. A few cases of perforation or rupture of the bowel caused by ascarides have been recorded. Accidents of this kind will, of course, be followed by peritonitis.

## TRICHINOSIS

Trichinosis is a parasitic disease of man and animals caused by the *Trichina spiralis*. One speaks of a muscular and an intestinal form, but it is usually the former that is understood by the term trichinosis, or trichiniasis as it is sometimes written.

*Animals affected.*—Although the degree of susceptibility varies widely, almost all animals, with the exception of the cold-blooded species and birds, can be experimentally infected with muscular trichinosis. Positive results, however, have been obtained in cold-blooded animals by keeping them at a temperature of 30° C. (Goujon). In birds the intestinal form only can be produced. Rats are easily infected experimentally, and in trichinosis districts they are often trichinous. Only the carnivorous animals contract the disease naturally, as one might expect, from the fact that infection takes place in the vast majority of cases by ingestion of diseased flesh. It is with the pig only that the Meat Inspector need concern himself.

The pigs of this country are wonderfully free from the disease, if we are to judge from the rarity of cases in the large number of human beings who make pork a part of their diet. It is possible, however, that their immunity depends to some extent on the prejudice in favour of eating pig flesh after it has been well cooked. So far as the Editor is aware, the only parts likely to be eaten half-cooked are the pork fillets, and those portions which are made into sausages.

A large amount of fresh and cured foreign pork is, however, imported into this country from places where the disease is known to exist. The Board of Agriculture returns show that in 1897 we received from abroad 347,617 cwts. of fresh pork, and 6,967,996 cwts. that had been salted or cured.

The fresh pork certainly calls for a more satisfactory method of inspection than that at present in vogue, for by no stretch of the imagination could the examination be called adequate.

In some parts of America trichinosis seems to be pretty common in the pig, if we judge from the results obtained in France and Germany by examining imported hams and other forms of cured pork. This statement, however, is not intended to convey the idea that these cured products are likely to cause trichinosis in human beings. The facts brought to light by investigation are against such a conclusion; but this will be discussed more fully in the paragraph devoted to *Inspection*.

The examinations made in France and Germany showed that from 2 to 3 per cent. of the pork imported from America was trichinous. Chatin (p. 216, "Prophylaxis") states that out of 3444 cases of American pig products—hams, sausages, etc., examined at Havre in 1881, the number of cases containing trichinous flesh amounted to 14·66 per cent.; the proportion of pieces affected was to 2·3 per cent. Later statistics from Germany by Zurn (quoted by Ostertag) show that in 1891 the proportion of trichinous pork imported from America into certain towns varied from 1 to 8 per cent.

Official reports from America stated that 2·7 per cent. of the pigs examined were found trichinous in 1884.

The Annual Report of the Bureau of Animal Industry for 1898 states that out of 1,892,131 hog carcases, of which parts were submitted to microscopical examination, ·816 per cent. showed degenerated trichinous cysts, but no recognisable *trichinæ*. The number which showed recognisable *trichinæ* amounted to 1·036 per cent. Thus it would appear that the percentage of American pigs which at some time of their lives harbour living *trichinæ* is 1·852.[1]

In French pigs it is said that the disease has never been observed, although in some parts a large proportion of the rats are trichinous.

In German pigs the disease is not unknown, but, according to Ostertag, it is becoming less frequent. In Prussia, in 1896, the proportion of trichinosis found in slaughtered swine was ·021 per cent., against ·043 per cent. in 1892. In Saxony it was ·102 in 1896. In Berlin, from 1893–97, the proportion was from ·022 per cent. to ·028 per cent.

Small as these proportions may appear at first sight, the actual number of animals found diseased is by no means negligible ; for it must be remembered that many thousands of pigs' carcases were submitted to examination, and that one diseased animal may be the cause of trichinosis in a large number of human beings. The existence of trichinosis in German pigs, and the national partiality for raw or half-cooked swine flesh, cost Germany a large sum of money annually for meat inspection.

The disease has been met with in Sweden, Denmark, Holland, Belgium, and Russia. There is hardly a country in the world in which it has not at least been seen, although records

[1] Section 20 of the Regulations, dated 14th June 1895, orders all carcases showing recognisable *trichinæ* to be destroyed. The report further states that in 1897 the amount of examined pork exported to countries not requiring a certificate of microscopic examination was 161,303 lbs.

As Great Britain alone imported 6,855,856 lbs. of fresh pork from America, a great deal of it can never have been examined.

of its frequency are in most cases wanting. In Great Britain we know nothing about its occurrence in home pigs ; the disease has only been looked for on the few occasions when human beings have been so severely infested that marked clinical symptoms followed. It is worthy of note, however, that the Cumberland outbreak of 1871 in human beings was caused by the flesh of a pig which had been bred and fed at home. Moreover, trichinæ have frequently been found in the muscles of human corpses in our medical dissecting-rooms. It was owing to observations made in the dissecting-room of St. Bartholomew's Hospital in 1834, that Paget discovered the worm which was afterwards described and named by Owen.

*The parasite.*—The parasite belongs to the family of Trichotrachelidæ. It occurs in the same forms in men and in animals. The adult worms are found in the intestines only (intestinal trichinosis), but they give birth to embryos which penetrate to the muscles and organs. The females are more numerously present than the males. The latter measure from 1·4 to 1·6 mm. $\times 40\ \mu$. The worm is attenuated towards the cephalic extremity. It possesses an intestinal tube which ends at the posterior extremity in a cloaca. In the male the testicular tube opens into the cloaca, which is bounded by two small prolongations (digitiform appendages). The females measure 3 to 4 mm. $\times$ 60 $\mu$, and the appendages are absent. The female genital organs consist of an alternately dilated and constricted tube, which ends in a vulva towards the anterior extremity. The eggs are hatched inside the female, whose posterior portion is simply crammed with them. The part anterior to the uterus contains embryos. It has been reckoned that one female may give birth to as many as 15,000 young trichinæ. The latter at first measure about 100 $\mu \times 6$ at their broadest part. These embryos may be found in the host's intestines, if the contents be examined under a magnifying power of about 200. They migrate to various parts of the body. In the tissues they may reach the length of 1 mm. ; but the genital organs remain rudimentary until these larval forms are taken into the intestines of another host (Fig. 61).

*Infection of animals and human beings.*—When flesh containing living larval trichinæ is swallowed by a susceptible animal, the parasites are freed from their tissue connections by the gastric juice. They complete their development in the intestines ; the sexes copulate, and the females give birth to a brood of embryos about the sixth or seventh day after the flesh has been eaten. It is this second generation of embryos that gives rise to the intestinal symptoms, and migrates afterwards to other parts of the body. The latter they reach either by boring directly through the tissues, or by means of the blood and lymph streams after they have penetrated into the vessels. The embryos have been found in the blood stream by Zenker and others. The migrations last for about eight days, starting from the time the embryos are born.

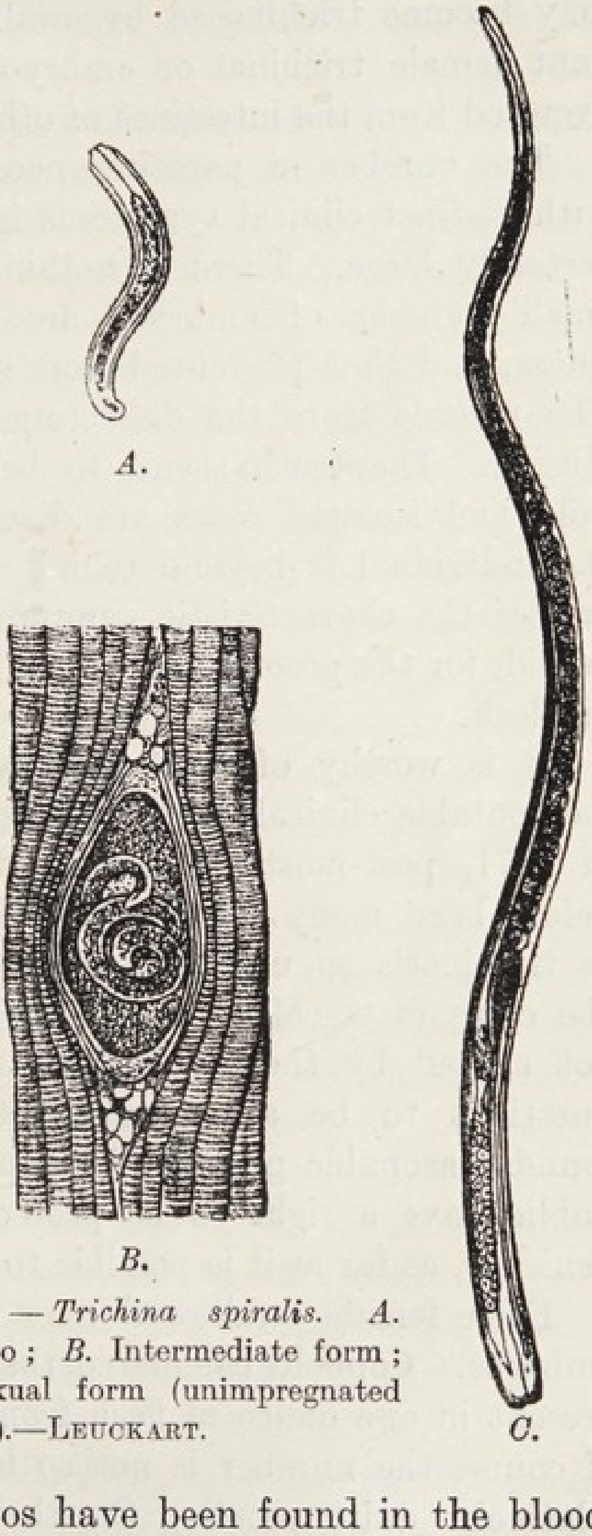



Fig. 61. — *Trichina spiralis. A.* Embryo ; *B.* Intermediate form ; *C.* Sexual form (unimpregnated female).—Leuckart.

Human beings are infested by eating the flesh of affected swine. Swine get the disease by eating trichinous rats and mice, or the flesh of their own kind. It is also possible that the pig may become trichinosed by swallowing food containing pregnant female trichinæ or embryos which have been recently excreted from the intestines of other animals.

The number of parasites necessary to produce trichinosis with distinct clinical symptoms is a debatable question ; it is certainly large. There is nothing to show, however, that a small number of embryos are destroyed by the digestive juices, and thus prevented from gaining their natural habitat. The records from the dissecting-rooms are against this conclusion. The truth seems to be that in human beings the mild and isolated cases are diagnosed only at a time when the individual is beyond telling whether he ever experienced any of the characteristic symptoms. The probability is that he did, for the proof is there that the parasites have penetrated his flesh.

It is worthy of note that, whereas the first cases with indisputable clinical symptoms were diagnosed in this country in 1871, post-mortem proof of the disease had forty years before been many times obtained. This inclines one to ask : Is trichinosis so uncommon as we think ; and are some of the cases of so-called muscular rheumatism in human beings not caused by the presence of a few trichinæ ? These are questions to be answered by the physician. If there be found reasonable grounds for replying in the affirmative, the public have a right to be protected from this bodily inconvenience, as far as it is possible to do so.

Each female swallowed may give birth to at least 1000 embryos. Cobbold calculated that there were 85,000 embryos present in one ounce of flesh from the Cumberland pigs ; but of course the number is not so large in all cases—it may be relatively quite small. On the assumption that half the number in the above case would develop into females capable of producing 1000 young, Cobbold estimated that three ounces of the underdone flesh would infest a human being with about 100,000,000 muscle trichinæ. This, he adds, would render the host very ill; but recovery would be possible. The above numbers are, of course, only to be accepted as computations.

*Lesions.*—The presence in the intestines of a large number of embryos gives rise to signs of severe irritation. At this stage the flesh, although not dangerous, may show the alterations due to fever. The regions most frequently invaded by the embryos are the muscular parts of the diaphragm, the muscles of the shoulder, loins, larynx, thigh, neck, tongue, cheeks, and intercostal muscles. The larvæ are often most numerously found at the points of insertion of tendons; the bony structures are said to arrest their further progress. Chatin states that the fat is often invaded by the larvæ, and that they are not infrequently found in the intestinal wall.

In the muscles the parasites are for the most part located in the intermuscular tissue; very occasionally do they, according to Chatin, invade the sarcolemma. At first they excite a proliferation in the tissues, and the parasites become surrounded by fibroblasts, which eventually form into fibrous cysts around them. These cysts measure about ·4 mm. × ·25 mm. Little can be seen by the naked eye until calcification of the cysts has taken place. Then they appear as small white specks, which are easily made out. Calcification, however, does not begin until several months have passed, so that one must depend entirely on the chance of a microscopic examination revealing the parasites during the earlier stages. With the microscope one can see at first a round-cell infiltration in the neighbourhood of the parasites. A little later, granules, which give the reaction of glycogen, can also be made out. The fibroblastic cells form into connective tissue which encapsules the larvæ. These cysts may be lemon-shaped or spherical. Usually each contains only one parasite, but as many as seven have been found in one cyst—*Kystes* *polytrichines* (Chatin). The worms are coiled up in the cysts, sometimes in S form, sometimes in figure of eight (Fig. 62). The muscle fibres around the cyst are atrophied; they may also show hyaline and fatty changes. Sometimes they are infiltrated with lime salts. Adipose deposits are frequently present in the intermuscular tissue near the cyst. The cysts may undergo degenerative changes. Even before the formation has assumed a definite structure, further development of the parasite may be checked; the region becomes infiltrated with brownish-yellow granules — pigmentary degeneration—which appear as specks in the tissue. When fully formed the cyst may undergo fatty degeneration, and eventually become calcified. These changes, however, are seldom seen until many months have passed.

FIG. 62.—Trichinosed pork. × 45.—LEUCKART.

The parasite may, on the other hand, die and become calcified soon after it has reached its habitat. At first it appears as a petrified image of the original, but later all trace of its shape is lost, and only a calcareous nodule marks the seat of its former existence.

In adipose tissue the further development of the parasites is often arrested, and a capsule is seldom formed around those which manage to exist.

In examining muscle for trichinæ, a magnification of 10 diameters is sufficient. Moreover, a low power is convenient, as it enables a large field to be examined. Small strands of muscle are cut in a longitudinal direction from the parts most frequently affected. These are laid out between wet slides or between the plates of a compressing apparatus like that described on page 35. The preparation is pressed until it is thin enough to let the light pass freely through it. Then it may be examined under the microscope. The muscle may also be teased out in water and examined on the plate of a dissecting microscope. If it be found necessary to decalcify the preparation before examination, one of the quicker acting fluids will be found most useful. Fatty tissue containing parasites may be fixed on an albuminised slide by heat, and when the water has been driven off the slide can be rinsed in turpentine to dissolve out the fat.

The parasites can be easily observed without resorting to methods of staining, but staining with ordinary reagents is sometimes useful in revealing the fact that the parasite is dead and undergoing degeneration. In the latter case they stain diffusely, whereas the living ones do not. The parasites are not always to be considered alive, however, because they do not stain. When killed by salt they retain their outward form, and the stains pick out certain parts only ; these correspond to preparations of tissues which have been fixed. A more certain method of determining whether the larvæ are alive or not is that resorted to by Colin. A small bird —a sparrow, for example—is fed with the trichinous flesh. Eight hours afterwards the bird is killed, and its intestinal contents are examined under the microscope. The larvæ, if alive, will be found moving about in the fluid. The movements are accelerated by gently heating the slide to 104°. When dead larvæ have been swallowed they are found in a half-digested condition.

Other degenerated and calcified parasites in muscle might be confused with trichinæ. Such an error, however, is only likely to be made in the case of calcified lesions, when the form of the parasites in question is practically lost. The consequences of a mistake of this kind would not be important, because the calcified parasites are dead. Encysted larvæ of distomata have several times been found in the muscles of swine (Fig. 58). It has also been stated in another part of this book that muscular actinomycosis is not unknown. Concretions of lime and crystals of tyrosin, of which the significance is unknown, are frequently found in the muscles of pigs. The tubes of Rainey (*see* "Psorospermosis of muscle") are often present alone or along with trichinæ in pig's muscles; but the former are nor encapsuled, and their appearance is very different.

*Inspection.*—Flesh containing living larval trichinæ, no matter what be the degree of infestation, should not be allowed into the market in the fresh state. If the pigs have been slaughtered during the intestinal stage—a contingency unlikely to arise—it must be left to the inspector to pronounce on the marketable quality of the flesh. Flesh containing a large number of calcified trichinous cysts, even if it be satisfactorily proved that the larvæ are dead, should be considered unmarketable, because one may reasonably object to eat flesh with numerous chalky nodules disseminated through it.

The larvæ are destroyed in a joint that has been thoroughly cooked; that is to say, when the flesh has assumed a greyish colour in its deepest layer. In such a condition the flesh might be sold, did custom admit of it in this country. It is hardly necessary to mention that joints are often served at our tables in a half-done condition. Although the irate husband may order away the offending dish, the tears of the wife may prevail, and result in the family partaking of half-raw pork. Vallin, experimenting on rabbits with trichinous flesh which had been exposed for twenty minutes to a temperature of 60° C., found that it was no longer harmful. A piece of flesh weighing 6 kilos. (13 lbs.) required four hours' boiling to get the above temperature in the centre; pieces over 6 kilos. in weight required five and a half hours, but in that time one-fourth of the original weight had been lost. Colin's results, obtained fifteen years before, were practically the same. Fjord stated the time necessary for hygienic cooking to be less than this —about twenty minutes per lb.—if the meat be put into boiling water. The exact time, however, is not of much practical importance. The cooking temperature kills the parasites, and if there be no red flesh left in the centre, harm will not result.

It has already been pointed out, however, that the domestic cook is far from being infallible, therefore the sale of trichinous pork must be controlled.

Pickling and smoking are sure methods of destroying the muscle trichinæ, provided the process be carried on for a sufficient length of time to enable the reagent to penetrate to every part of the flesh. One speaks of dry and wet pickling, but in reality there is only one method, for dry salt and nitre put over flesh absorb water from the atmosphere, and penetrate in saturated solution.

A great deal of discussion arose twenty years ago regarding the use of preserved American pork, which often contains larval trichinæ.

In 1881 the importation of American pork into France was forbidden. This embargo is still in force, although the Académie Royale de Médecine in the *séance* of 5th February 1884 voted that American fully-cured pork was not dangerous. In the discussion on M. Colin's paper, Proust pointed out that the dock labourers at Havre had for years eaten this cured pork in the raw state, yet no cases of trichinosis had been heard of. In Great Britain we have obtained the bulk of our preserved pork from America for many years. In 1897 we received from the United States 141,428 cwts. of salt pork, 3,592,635 cwts. of bacon, and 1,603,533 cwts. of hams, but no cases of trichinosis sufficiently severe, at least, to allow of diagnosis during life have been recorded. We do not submit the imported flesh to the detailed examination which it undergoes in Germany, therefore we have no reason to conclude that the material sent here is freer from trichinæ than that imported into the former country. Colin, in his paper of 1884, reported the results of his experiments with trichinous flesh which had been embedded in pickle or placed in brine—saturated salt solution. After three weeks the trichinæ at the depth of $1\frac{1}{5}$ in. from the surface were dead. In large hams the parasites might be alive in the deeper parts after fifteen days' salting. None were found alive in hams salted for two or three months. Colin concluded that six weeks' salting would be efficacious in the majority of cases. On the other hand, Chatin obtained several positive results by feeding guinea-pigs on American cured pork. Girard and Pabst have seen movements occur in the larvæ from cured pork after warming the slide to 42° C. The latter observations, however, do not show that curing does not kill the larvæ, but rather that the process is sometimes incompletely carried out. Along with these positive results many negative ones were obtained. The observation of Fourment, oft quoted, in which trichinæ were found alive in pieces of flesh which had been covered with salt for fifteen months, is of no value, for the salting was performed in dry air in a sealed tube.

It is well known in the history of trichinosis epidemics that people who ate fresh trichinous flesh suffered severely from the disease, while those partaking of the flesh of the same animal after salting were affected only slightly, or not at all. The evidence up to date is certainly not in favour of the wholesale seizure of cured pork when it contains trichinæ.

Improperly salted flesh soon goes wrong, and is therefore the less likely to be consumed by human beings. With sausages the conditions are different, for the contained pork is seldom properly salted throughout, and they are almost never cooked through and through. The Editor is of opinion that imported sausages should be subjected to a severe inspection, not only on account of trichinosis, but for other obvious reasons.

Should trichinosis be found in fresh pork, one could not in justice deny to the owner the right to sell it after it has been properly cured, seeing that we accept American cured flesh without any inspection.

### ASCARIDES

Different varieties of *ascaris* are found in the small intestines of calves (*A. vituli*), sheep (*A. ovis*), and pigs (*A. suillæ*). They are cylindrical worms, measuring from 4 to 10 in. in length. They are pointed at the extremities, and the body has usually the thickness of a quill. The integument is white or yellowish in colour, but red streaks can be seen underneath this outer covering. Large numbers of ascarides may be present in an animal without giving rise to any serious lesions. They are very common in pigs, and they usually frequent the small intestine. Vallisneiri of Padua, so long ago as 1712, drew attention to a peculiar odour given off from the flesh of calves which had harboured large numbers of ascarides in their intestines. Morot has recently observed the same kind of odour in the flesh of a calf whose intestines contained over one hundred ascarides. Laubion says that he has frequently had experience of the same condition in calves. The odour persists for days, and it is not removed by cooking. The flesh, moreover, has a peculiar taste. The odour is described as sourish (*aigrelette*). It has been known for a long time that the ascarides themselves give off a peculiarly pungent odour which in some individuals causes symptoms analogous to those of hay fever. It seems likely that the flesh becomes permeated by the same odoriferous agent, whatever it be.

*Inspection.*—Laubion reports that many individuals consume the flesh without suffering any inconvenience, while others are nauseated by the smell. Morot considers that the flesh of animals, when it exhales this odour in a marked degree, should be withdrawn from consumption or sold in *la basse boucherie.* Ascarides in the intestines excrete poisons which may cause serious trouble in animals, but more especially in human beings. The symptoms are those of nervous disorder, itching of the skin, and respiratory catarrh.

We do not know that ingestion of flesh of the above description has been the cause of serious trouble in any individual, but the Editor is of opinion that the abnormal odour is of itself a sufficient reason for considering the carcase unmarketable. The intestines which contain the ascarides and their eggs should in all cases be destroyed.

### ECHINORHYNCHUS GIGAS

This worm belongs really to the Acanthocephali. It inhabits the small intestines of the pig. It is never seen in

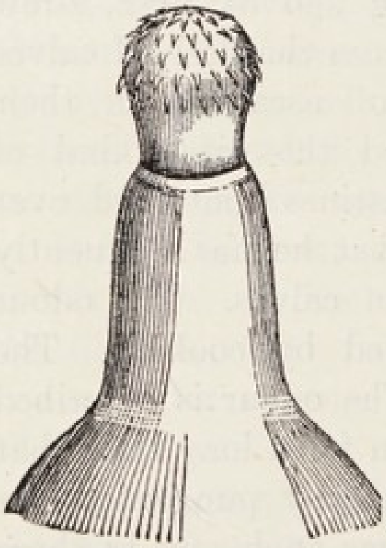


FIG. 63.—Head of *Echinorhynchus gigas*. × 10.—RAILLIET, NEUMANN.

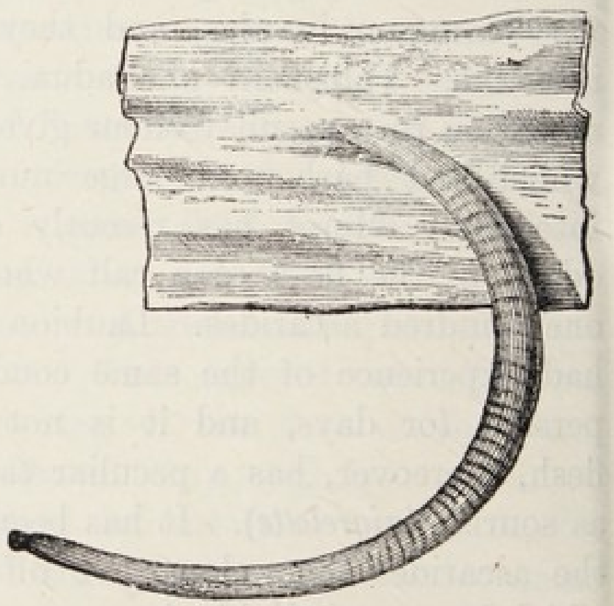


FIG. 64.—*Echinorhynchus gigas* (male) attached to the intestine.—RAILLIET, NEUMANN.

British pigs, but it may be met with in those imported from the United States. It is said to be frequently met with in German and French pigs.

The worm is cylindrical, but tapers towards the posterior extremity. Its colour is greyish, with sometimes a violet tinge. The male measures from $2\frac{1}{2}$ to $3\frac{1}{2} \times \frac{1}{5}$ in., and the female has a length of from 8 to 14 in. The head has a globular rostellum, which is armed with five or six rows of spines (Fig. 63).

*Lesions.*—The worms bury their heads deeply in the mucous membrane of the intestine. Small abscesses, of about the size of a hemp-seed, form at the seats of the wounds which they cause. These project on the serous surface, and give it a pearly appearance. The mucous and serous surfaces may show inflammatory patches. Sometimes the bowel is perforated, in which case peritonitis results. The carcases are often emaciated and dropsical.

*Inspection.*—The bowel may be useless for the manufacture of sausages, but the carcase need not be interfered with unless the flesh is so altered as to render it unmarketable.

### ŒSOPHAGOSTOMA COLUMBIANUM (Curtice)

This parasite in its adult state inhabits the intestines of sheep. It is frequently met with in some parts of America, but it is unknown in British sheep. The lesions caused by this parasite were often seen at the Edinburgh abattoir when sheep imported from America were slaughtered in the city. The male measures from 12 to 15 mm., and is provided with a caudal bursa. The females are longer—14 to 18 mm. The adults are found in the cæcum and the parts of the bowel posterior to it. When the embryos are hatched they burrow beneath the mucous membrane of the bowel, and give rise to nodules in which they undergo further development. The largest embryos in the nodules measure from 3 to 4 mm., and the smallest about ·7 mm.

*Lesions.*—As already stated, nodules are formed in the bowel. These are most numerous on the cæcum and posterior portions of the large intestine, but they may also be present in the small bowel. They range in size from a pin-head to a hazel-nut (Fig. 65). The smaller ones look like sacs filled with fluid, and a small globular body is found floating inside. If this internal cyst be opened, and its contents examined under the microscope, the embryo will be seen. The larger nodules contain a greenish-yellow cheesy material and larger parasites.

The oldest nodules are very hard; the central portion has dried up, and the embryos have in many cases departed. Sometimes the mucous membrane over the larger nodules undergoes necrosis, and ulcers result. Histologically, the earliest nodules are composed of round cells and embryos. Later, the central cells have undergone degeneration, and the peripheral part of the nodule has become fibrous (Fig. 65). The lesion is similar to an encapsuled abscess. The maturer embryos escape into the intestinal canal.

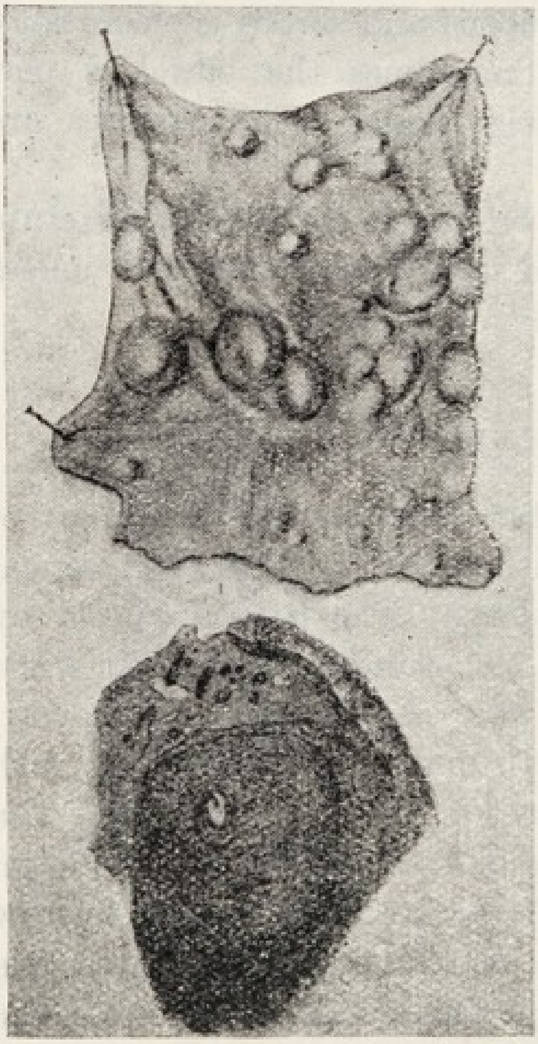


Fig. 65.—Lesions caused by *Œsophagostoma Columbianum*.—Curtice. (*a*) Lesions in bowel (nat. size); (*b*) microscopical section of nodule.

Degenerated nodules may also be found in the lymphatics of the omentum and in the liver.

*Inspection.*—The bowel is valueless for use as sausage skins; it should be destroyed.

The flesh is usually not of bad quality, but, when the bowel lesions are numerous, the carcase may be too emaciated for the market.

EUSTRONGYLUS GIGAS

This parasite—*the giant strongylus*—is very uncommon. Carnivorous animals are its usual hosts; but it has been found in the ox. The worm is round, of a reddish colour, and tapers towards the extremities. The male may reach the length of 12 ins., and the female 36 ins.

The worms are found in the renal pelvis. They destroy the kidney substance, which may be so hollowed out that it looks like a thin-walled cyst. Little is known about its systemic effects.

### STRONGYLI OF HOOSE

The term hoose is applied popularly to inflammatory affections of the lungs of ruminants and pigs, caused by strongyli. The parasites are most frequently seen in young animals.

*The parasites.*—In sheep and goats one meets with two parasites—the *S. filaria* and *S. Rufescens*, or *Pseudalius ovis pulmonalis* (Koch). The *S. rufescens* is the most common. It is of a reddish-brown colour, thread-like, and measures from 18 to 25 mm. ($\frac{3}{4}$–1 in.) in the male, and from 25 to 35 mm. (1–$1\frac{2}{5}$ in.) in the female. The females are oviparous, and the eggs as well as the hatched embryos are found in the lungs.

The eggs are elliptical, and measure about $90\ \mu \times 40\ \mu$. The length, however, depends to some extent on the pressure to which they have been subjected. They are of a brownish colour, granular, and the granules stain with eosin. The embryos are about 360 $\mu$ long. If examined in fluid, they move about actively with a twisting motion. In the quiescent embryo the posterior part is coiled on itself.

The *S. filaria* is white in colour. It is thicker and longer than the *rufescens*. The male measures from 3 to 5 cm. ($1\frac{1}{5}$–2 in.), the female may reach a length of 8 cm. ($3\frac{1}{5}$ in.). The female is viviparous. The embryos measure $540\ \mu \times 20\ \mu$.

The lung parasite of the ox is the *S. micrurus*. It is filiform and of a white colour. The male measures 4 cm. ($1\frac{3}{5}$ in.), and the female about 6 cm. ($2\frac{2}{5}$ in.). The latter is viviparous.

In the pig, hoose is caused by the *S. paradoxus*. This worm is also white and thread-like. The male measures from 20 to 25 mm., and the female from 25 to 40 mm. The female is either oviparous or viviparous.

*Lesions.*—The *S. rufescens* is the most common of the lung parasites, although the adult worms are seldom numerously present.

The lesions caused by it are present in the lungs of 99 per cent. of the yearling sheep killed in Edinburgh; but they are not all affected in the same degree. Old sheep are also affected, but not to quite the same extent. Probably lesions were present in the lungs of some of them in their youth, but have disappeared.

The lesions do not always take the same form. In yearlings the changes in the lung are almost always the same. The organ is somewhat firmer than normal. Its surface presents a blotched appearance; some patches are dark brown in colour, while others are of a pale pink. Nodules of a yellowish-white colour are seen both on the surface and in the substance of the organ, but more particularly in the former situation. The distribution is irregular. Some of them show a greenish (chlorotic) tinge. They are firm in consistence, and range in size from a pin-head to a marble, but the larger ones are only present under the pleura.

Although they have the appearance of being quite solid, they float in water. On section these large nodules look as if they were made up of several small ones. Some of the smaller ones may be calcified.

If a scraping from one of the larger nodules be examined under a low power of the microscope, it will be found to contain innumerable eggs and embryos. Portions of the adults containing eggs will also be seen. In some cases—usually in older animals—no nodules are present. The lungs, which are much solider than normal, show only a blotched appearance on the surface. On section the colour is a deep pink, and the surface feels slimy.

Immediately under the pleura in the darker areas the tissue is still more solid; it is collapsed. Scrapings from the superficial parts and smaller tubes show large numbers of eggs and embryos.

In yet another form, which is also seen most frequently in older sheep, the blotched appearance is absent. Both lungs stand out prominently, and a very large number of miliary nodules are regularly distributed through their substance. They are whitish in colour, or they may present a chlorotic hue. This lesion looks like the result of a blood stream invasion (Fig. 66).

The nodular forms are often referred to as pseudo-tuber-

Fig. 66.—Section of lung of sheep, showing a disseminated pseudo-tuberculosis (parasitic) lesion.

culosis, but it is advisable to qualify the term by the word parasitic to prevent confusion with the bacterial disease.

Histologically, the youngest nodules consists of a collection of leucocytes. The parasites are small in this stage, and they are absent from most of the sections. In the more advanced lesions many of the nodules show sections of a parasite coiled up in the centre (Fig. 67). Some of them are calcified. Cells with brightly staining nuclei are densely packed around the worm. Caseation may be present, but not nearly to the same extent as in a tuberculous nodule. Outside the central mass the cells are not so densely packed, and many of them are epithelioid in character. The inner zone is sometimes separated from the outer part by caseous patches, in which giant cells are present. The peripheral portion of the nodule is made up of large round or angular cells, and there may be young fibrous tissue. The lung tissue near the nodules is usually open. This lesion resembles that of true tuberculosis both in its macroscopic and microscopic characters, but the chief differential points have been already referred to (*see*

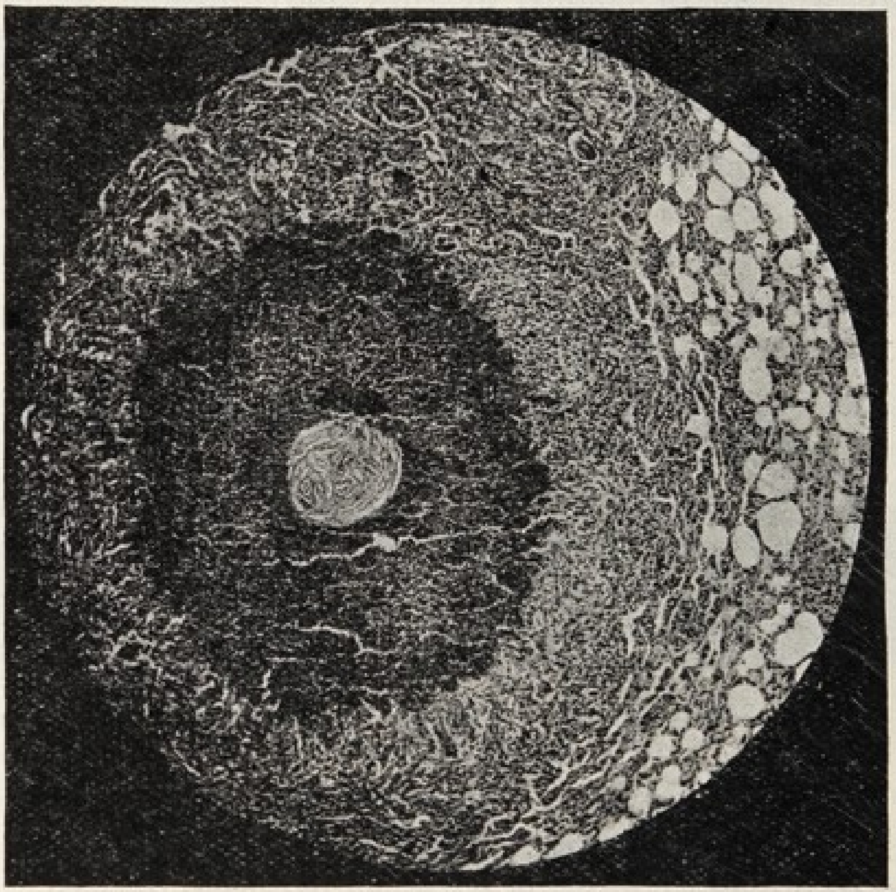


Fig. 67.—Lung of sheep showing the lesion of parasitic pseudo-tuberculosis. The centre of the tubercle contains sections of the parasite (Reichert, obj. 3).

Tuberculosis, *Pathognomonic Characters of the Lesion*). In sections of the large nodules one sees that the lung tissue over a considerable area is infiltrated with cells, and many eggs and embryos are present. Sections of older or even adult worms are also found, and a typical pseudo-tubercle is sometimes seen in the area.

In those solider parts in which there are no nodules, the air cells contain a catarrhal exudate—leucocytes and epithelial cells. Those towards the surface of the organ are collapsed, or they may contain eggs and embryos. Many of the eggs are segmenting, while others contain the embryo. The bronchial walls are infiltrated with round cells, and the lining membrane is in a state of catarrh (Fig. 68).

In several cases the Editor has found nodules and free

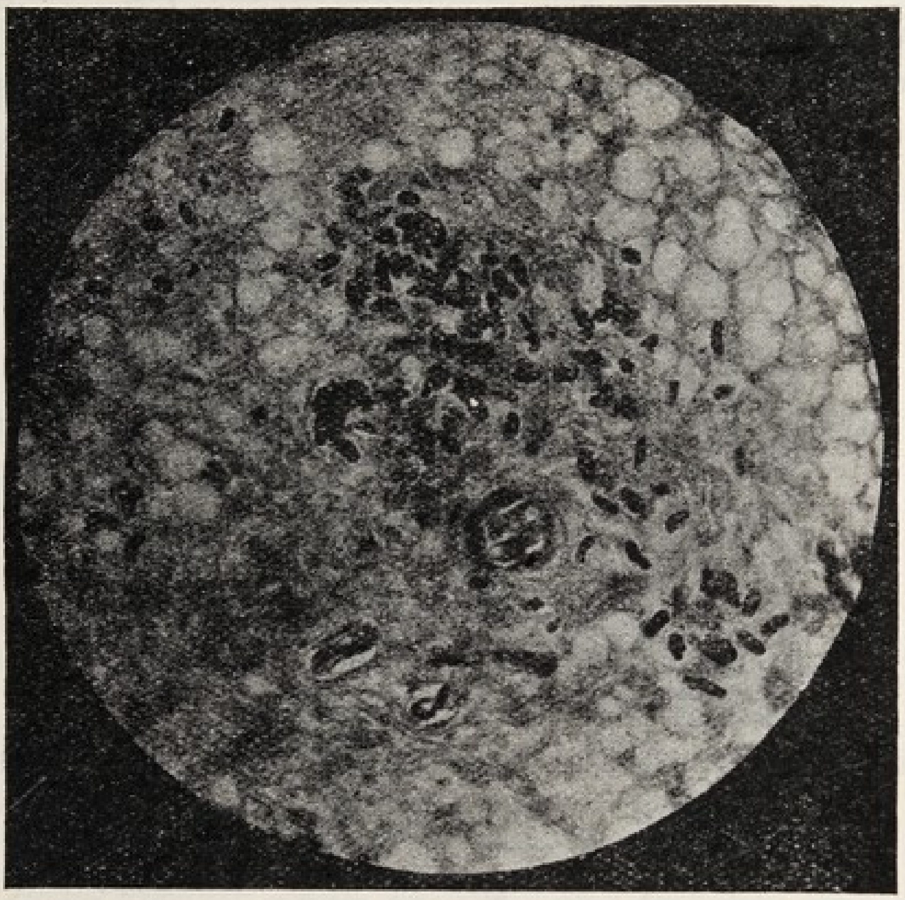


FIG. 68.—Lung of sheep, showing eggs and embryos of the *Strongylus rufescens* (Reichert, obj. 3).

embryos in the mediastinal glands. M'Fadyean has described still another form which the lesion may assume in very chronic cases. The lung becomes indurated by the formation of new tissue. Large areas are solidified and of a dirty white colour. The pleura is thickened, and the two surfaces may be adherent.

The microscope shows a great increase in the fibrous tissue of the organ. Many of the infundibula are distorted, and some of the smaller bronchi show papillomatous growths from their mucous membrane. The appearance of the section is very like that of an adenoma (Fig. 69).

The *S. filaria*, *micrurus*, and *paradoxus* are found in the bronchial tubes. No eggs or embryo are met with in the air cells, except occasionally in the case of the *paradoxus*. Nodular pneumonia has also been described in the pig's lung, but the lesion is rare.

Usually the lungs are consolidated in small patches, and


Fig. 69.—Microscopical section of sheep's lung, showing fibroid pneumonia caused by the *S. rufescens*. The papillomatous and adenomatous structure is seen at *a* and *b*.—M'Fadyean.

the tubes contain a quantity of frothy mucus. The parasites may be so numerous that they block the tubes, or only a few may be found in the terminal portions. In some cases the whole of both organs is moderately consolidated. Their colour is greyish-white all over, and on section the surface feels sticky.

The microscope shows a catarrhal exude in the air cells, and other signs of broncho-pneumonia. Some of the air cells are ruptured (emphysema).

*Inspection.*—Most of the young sheep and many of the older animals are in prime condition, notwithstanding the presence of parasitic lesions in their lungs. Sometimes, however, the flesh is fevered, or the carcases may be emaciated, watery, and consequently unmarketable. The fevered condition is usually due to an acute pneumonia, which has supervened on the parasitic disease; and, in the experience of the Editor, other parasites, which could account more satisfactorily for the emaciation, are often present. With regard to the lungs themselves, the practice in Edinburgh is to seize only those organs in which the lesions are numerous or widespread. Were the inspectors to seize every sheep's lung affected with parasitic disease, lights, as the butchers call them, would be hardly obtainable in the market.

## INSECTS

The parasitic insects are ectozoa, with the exception of the larval forms of the Pentastoma.

### Arachnidæ

#### MANGE; SCABIES; PSORIC ACARIASIS; SCAB IN SHEEP

Mange is a parasitic disease of the skin caused by different varieties of acari.

*Animals affected.*—Every animal, including man, may suffer from scabies. The parasites are not the same in all cases, although they belong to the same species. Therefore, it is customary to qualify the term "mange" by the class of acarus which gives rise to it. In the horse we meet with sarcoptic, psoroptic, and symbiotic mange, but not with the follicular variety. In cattle, sarcoptic mange is rare, but the symbiotic and psoroptic forms are pretty common in our town cows.

Follicular mange is rarely seen in cattle; but it is not unknown. Sheep are attacked most frequently by psoroptic mange, the symbiotic and sarcoptic forms are much less frequent, and the follicular variety has seldom been recorded.

The commoner mange of the pig is sarcoptic, but follicular scabies (*Demodex phylloides* of Czoker) has not infrequently been met with: Czoker found twenty-two cases in one herd. The goat occasionally suffers from sarcoptic mange, and the demodex has been found in one or two cases. Rabbits are very often affected with sarcoptic mange; the Editor has several times seen whole warrens attacked. Poultry harbour a goodly number of acari which do not cause mange, but they are also frequently the hosts of psoric sarcoptes. Man suffers from sarcoptic mange, and he is frequently infected by contact with animals.

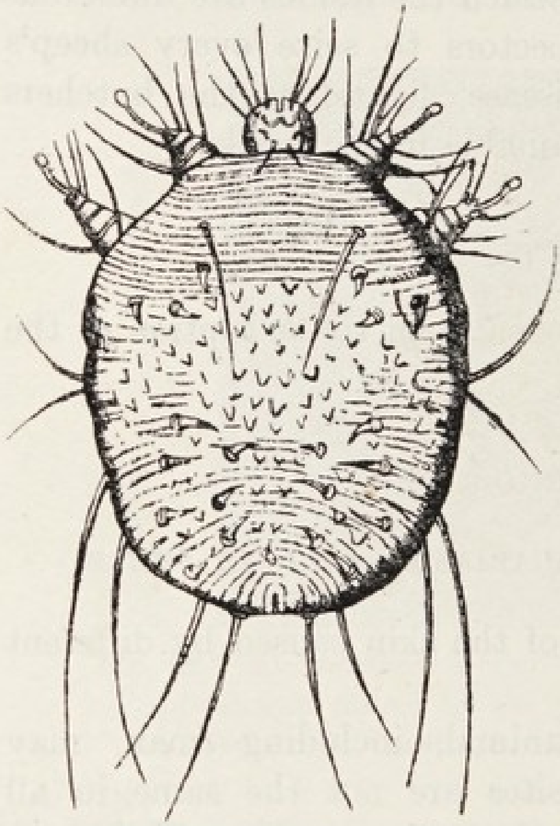


FIG. 70.—*Sarcoptes scabiei.*

*The parasites.*—With the exception of the demodex, they belong to the family Sarcoptidæ. Of the Sarcoptidæ there are three classes—the sarcoptes, the psoroptes, and the symbiotes.

In some of the classes there is more than one variety, but in a treatise of this kind it is only necessary to mention the general characters of each class. The Demodex belongs to the family Demodecidæ. All the mange acari are oviparous; most of them are invisible to the naked eye, but, with the exception of the sarcoptes, can be easily enough seen with a magnifying power of ten diameters. They have many common characters.

Sarcoptes.—The body is oval, the head is short, thick, and shaped like a horseshoe. In point of size they are the smallest variety, measuring ·2–·5 mm. The legs are very short; when the insect lies on its face they hardly project beyond the body. As in the other acari, the legs number eight in the adult, and six in the larva. They end in bell-shaped suckers or in claws and long hairs. The male sarcoptes has suckers on the first, second, and fourth pair of legs; the female has them on the first and second pair. The sarcoptes of the fowl, however, has suckers on all four pairs.

Psoroptes or Dermatodectes.—They are longer than the sarcoptes—·5–·8 mm. The head is long and pointed, and the legs project well beyond the body. Suckers are present on the first, second, and third pair of legs in the male, and on the first, second, and fourth pair in the female.

Symbiotes or Chorioptes.—They measure ·3–·5 mm. The breadth of the head is greater than its length, and it ends bluntly in front. The male has suckers on all four pairs of legs; the female has them on the first, second, and fourth pair.

Demodex folliculorum (Owen).—This parasite is very different from the others. The head is blunt at its anterior part, and seems to be in a piece with the thorax at its posterior. The thorax shows on its under-surface a longitudinal ridge (*sternum*), from which four transverse bands pass to each side. The latter, however, are absent in the young. The adults possess four pairs of legs, which are fixed on the thorax; the larvæ have only three pairs. The abdomen is finely striated across, and tapers towards the posterior extremity. More than one variety of demodex is recognised. The chief difference seems to be in the size, which varies from ·22 to ·24 mm. in length, and from ·2 to ·6 mm. in breadth (Fig. 71).

The parasites of mange can in most cases be discovered in scrapings taken from the affected parts with a blunt scalpel. The material may be examined in the dry state, or after the scales and hair have been triturated with *liquor potassæ* (solution, 1 in 20). By gently warming the dry material on the slide the sarcoptidæ are made to move;

the demodex is motionless. The Editor prefers the potash method, for by it the acari are more clearly seen, and many of them are set free from the epidermic crusts by which they are often surrounded. When the acari are scarce he adds plenty of potash solution, precipitates the solids in the centrifuge, and examines the residue. When looking for the demodex it is unnecessary to add any fluid. In cases which have been treated, and in some forms of sarcoptic mange, it is sometimes very hard to find a single acarus; but this is of less importance to the Meat Inspector than to the practitioner.

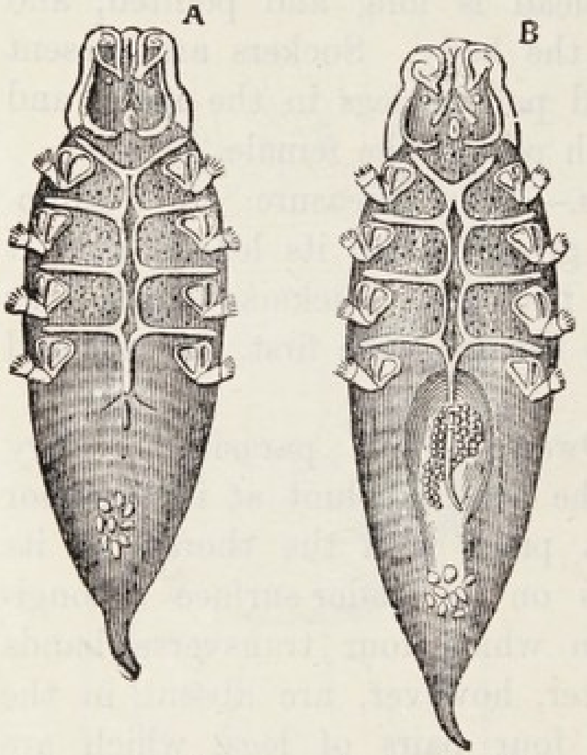


FIG. 71.—Demodex of pig. × 250.
A. Male ; B. Female.—NEUMANN.

*Lesions.*—Sarcoptic and demodecic mange are the most serious, because the parasites tend to burrow beneath the epidermis.

Sarcoptic mange is as a general rule found on the parts of the body where the hair is thin, especially about the head. It may, however, spread all over the body. In the sheep, the goat, the pig, and the rabbit, one finds grey furfur-like and honeycombed crusts of dry epidermis around the eyes and along the nose. In bad cases the whole face and head are covered. Fig. 72 is from the photograph of a case in a sheep which came under the Editor's notice. In the earlier stages, of course, the lesion is not so marked : there may be only slight depilation and a few papules or scabs. The surface below the crusts is red, and the latter contain a good number of parasites.

Two varieties of sarcoptic mange are met with in poultry ; scabies of the legs (*sarcoptes mutans*) and scabies of the body (*sarcoptes lævis*). In the former the legs become covered by thick greyish crusts; in the latter the chief symptom is falling out of the feathers. The skin underneath is little altered.

Psoroptic mange.—It generally occurs on the neck and body. In cattle it is seen more particularly on the neck, the croup, and the base of the tail. The lesions are seldom

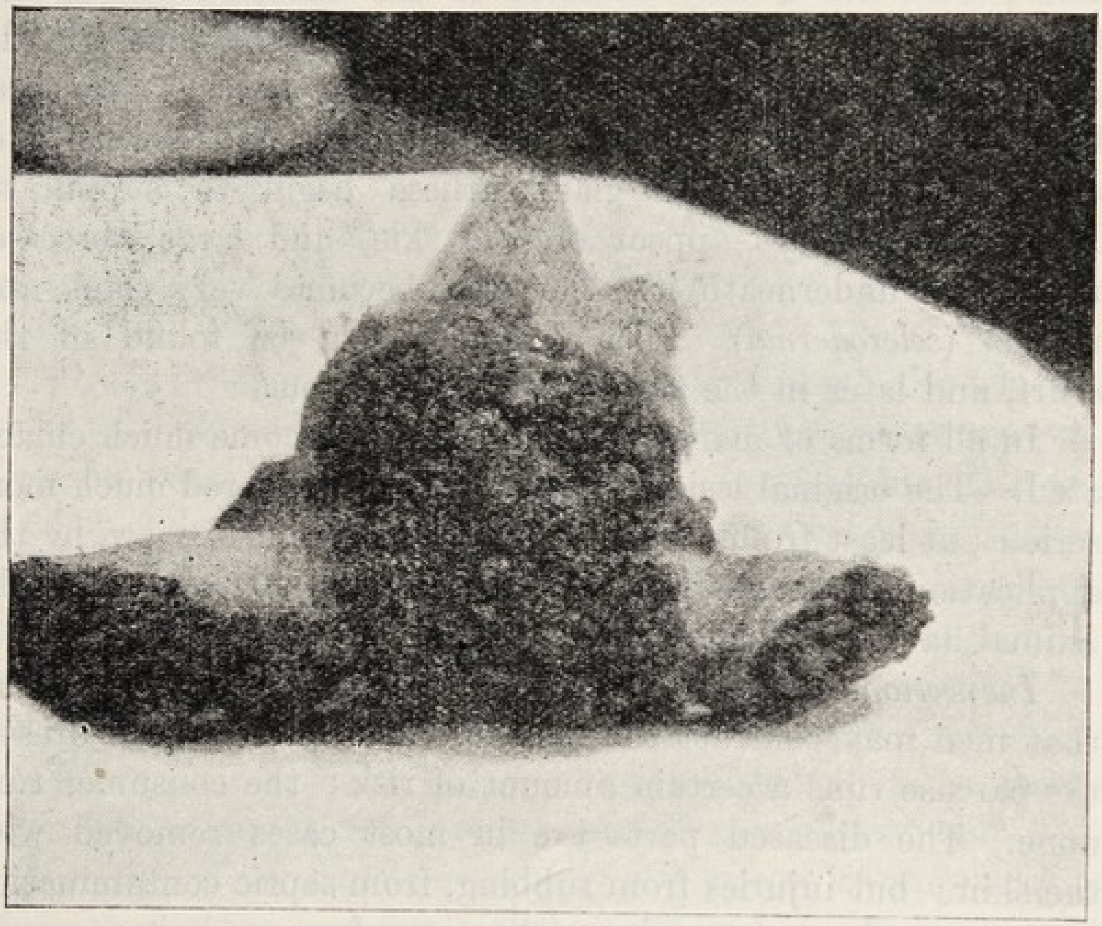


Fig. 72.—Sarcoptic mange on head of sheep.

serious. The hair over the affected parts is thin; the skin is scaly, and shows both papules and scabs. In the sheep the lesions are found on the shoulder, the back, and the croup, inside the thighs, and under the belly. Papules, scabs, and even pustules are present. The fleece is matted by the dried discharges, and it is easily pulled out. Raw sores of considerable extent are often present.

Symbiotic mange.—The lesions in this case are the least serious. There is often little more than an epithelial desquamation. It occurs mostly on the extremities, especially around the coronets in cattle and sheep. The symbiotes are sometimes present along with the psoroptes in mange of the croup in cows.

Follicular mange.—The Meat Inspector seldom meets with mange in this form; it is mainly seen in young dogs. The lesions are usually confined to the head, the neck, and the shoulder. The parasites invade the sebaceous glands. At first only depilated and desquamating patches are seen, but as the parasites increase in number and germs gain access to the inflamed glands these begin to suppurate. Numerous pustules appear on the skin, and large abscesses may form underneath it. The skin becomes very thick and rugous (*scleroderma*). The demodex can be found in the scurf, and later in the slimy blood-stained pus.

In all forms of mange the animal may become much emaciated. The original lesions may have been rendered much more serious, at least from the Meat Inspector's point of view, by the application of severe remedies to the skin, or owing to the animal having rubbed the sores.

*Inspection.*—It is by contact with skins of mangy animals that men may contract the disease. The butcher who dresses the carcase runs a certain amount of risk; the consumer runs none. The diseased parts are in most cases removed with the skin; but injuries from rubbing, from septic contamination of the wounds, or from the application of severe irritants, may be great enough to render the carcase unmarketable in whole or part. When the damage is local, the unsightly parts can be removed, and the remainder passed. It not infrequently happens, however, that in animals slaughtered after the application of a severe counter-irritant the flesh is very dark in colour, and does not set well. Such carcases are unfit for the market. It is possible that the carcases of sheep with raw sores on their skins, if the animals have been dipped in arsenical solutions shortly before death, might prove harmful to the consumer. Evidence, however, is wanting on this point, and it would always be difficult to get a correct history.

Emaciated carcases, of course, call for seizure, according to the degree.

### Bots or Warbles

These are larval forms of certain flies, two of which are of interest to the Meat Inspector, viz. *Hypoderma* or *Oestrus bovis*, and *O. ovis*.

During the summer months the female hypoderma lays her eggs on the skin of oxen, particularly about the regions of the back and flanks. When the eggs are swallowed the embryos burrow outwards and finally reach the subcutaneous tissues.

In the earlier stages they are club-shaped, and of a whitish colour. At the termination of the period of their parasitic existence the pupa case beneath the skin measures about 1 in. $\times \frac{1}{2}$ in. The capsules are elevated into circular ridges to the number of eleven, and show spines on the surface. In colour they are yellowish and speckled with brown.

The mature bot of the *O. ovis* is about the same length as that of the ox, but it is narrower and shows transverse markings of a brownish colour on the segments. The bot of the sheep has its habitat in the nasal cavities and sinuses of the head.

*Lesions.*—These parasites usually give rise to no appreciable lesions during the first few months of their parasitic existence. Little is noticed until the spring of the next year.

In the ox small fibrous nodules appear under the skin. These ultimately reach the size of a small walnut. Their summits are perforated by a hole from which pus exudes. Under the skin small hæmorrhages may be found, and sometimes there are collections of pus. On the other hand, the wound may have healed after the parasite has dropped out, and in this case only a cicatrix is left. The number of nodules varies from a single one to a hundred, or even more.

In the sheep the mucous membrane of the nasal cavities and sinuses is tumefied. Sometimes pus is present in the cavities, and there is a discharge from the nostrils.

*Inspection.*—In the case of the ox the lesions are for the most part removed with the skin. When small hæmorrhages or collections of pus are present, it may be found necessary to remove certain parts of the subcutaneous tissue and the panniculus before allowing the carcase to go into the market. In dealing with sheep, the head should be seized when there is evidence of catarrh of the membranes; otherwise the carcase is usually quite marketable.

## Maggots

These are the larvæ of certain flies, which are often deposited on wounds of man and animals.

According to Portchinsky, the larvæ of the *Sarcophaga magnifica* are most frequently found. Various members of the genus *Lucilia* deposit their eggs on abraded surfaces.

These larvæ measure about half an inch in length. They are of a greyish colour, wire-like, annulated, and actively motile. They irritate a wound or abraded surface, and cause the animals to rub the part against fixed objects. In this way a trivial wound may be converted into a large suppurating patch. In the hotter months, many sheep, especially young animals, are often seriously inconvenienced by these parasites. A common seat is the region of the anus after it has become excoriated by the discharges when the animals have suffered from diarrhœa.

The animals rub the abraded surface, which may ultimately extend over the croup.

The skin is swollen, and its surface is raw. Frequently the wound exhales a fœtid odour. The wool may have fallen off, or it may be matted by a dry purulent discharge. Sometimes the maggots even burrow beneath the skin.

*Inspection.*—The tissue underlying the sores may be so disfigured as to call for partial seizure. Unless emaciation is marked, as is sometimes the case, the rest of the carcase may be passed.

## Phthiriasis or Lousiness

All animals are liable to be invaded by lice. These insects live on the skin and produce a certain amount of irritation.

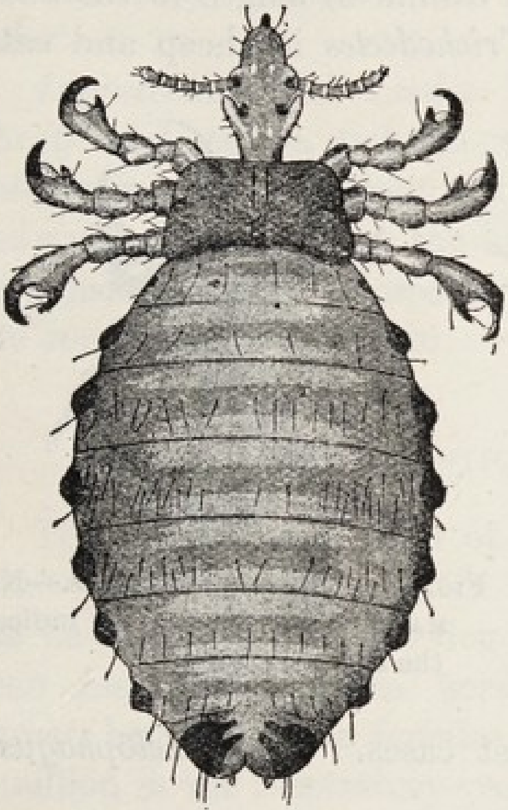


**Fig. 73.**—Female *Hæmatopinus eurysternus* of ox. × 20.—Neumann.

**Fig. 74.**—Female *Hæmatopinus tenuirostris* of ox. × 20.—Neumann.

The hosts may under these circumstances rub themselves and produce abrasions on the skin, and depilation. When lice are present on an animal in large numbers they may give rise to a certain amount of emaciation ; but it should be mentioned that animals in very poor condition, and those wasted by disease, frequently harbour large numbers of lice. They may sometimes be seen to swarm on cows in the last stages of tuberculosis. The lice of cattle belong to the genera *Hæmatopinus* and *Trichodectes.* Sheep are invaded by the *Trichodectes sphærocephalus* and by the *Melophagus ovinus* (ked), which is the commoner. The pig harbours the *Hæmatopinus suis.*

The large size of these insects would of itself enable one to distinguish them from the mange parasites in most cases; but of course there are many other distinguishing features, which may be seen on the subjoined figures (Figs. 73–76). The *Hæmatopinus* varies from 2·5 to 3 mm. in length in the ox, to 4 to 5 mm. in the pig. The *Trichodectes* in sheep and cattle

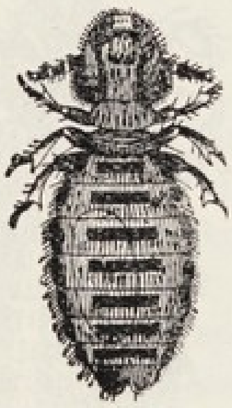


FIG. 75.—Female *Trichodectes scalaris* of ox. × 20.—NEUMANN.

FIG. 76.—*Melophagus ovinus.*—NEUMANN. The black line indicates the natural size.

measures over 1·5 mm. in most cases. The *Melophagus* is from 3 to 5 mm. long.

*Inspection.*—Lousiness of itself does not damage the flesh of animals, but emaciation may co-exist with the presence of the parasites, or there may be superficial sores. In the latter circumstances the whole or a part of the carcase may be rendered unmarketable; but it is seldom that the abrasions affect the underlying tissues to an extent which calls even for partial seizure.

### IXODIDÆ

The most important members of this group are the *Ixodes* or *Ticks.* They are temporary parasites on sheep and cattle and other vertebrates. They are much larger than the mange acari. The males measure about 3 mm. in length × 1·5 mm. The empty females vary from 4 to 8 mm. × 2·5 mm. When gorged with blood which they suck from their hosts the females may measure as much as 10 mm. × 6 mm. They are found on animals from May to October.

*Lesions.*—These parasites make small punctures on the skin in order to feed. Sometimes the wounds are transformed into pustules, but the deeper tissues are seldom affected.

*Inspection.*—The *Ixodes ricinus*, which is the common sheep and cattle tick in Great Britain, is pathologically interesting as the agent by which bovine piroplasmosis or redwater is spread, but the lesions for which ticks are directly responsible are of no importance to the Meat Inspector. They are removed with the skin.

### Pentastoma denticulatum or Tænioides

This is the larval form of the *Pentastoma tænioides.* The adult parasites are found in the air passages, particularly in the nasal cavities of the dog. They have on rare occasions been met with in the horse, the sheep, the goat, and in human beings. The females lay eggs to the number of half a million in the respiratory passages. The eggs are discharged on to the pastures, and in this way the food of herbivorous animals may be contaminated.

*Animals affected.*—It is principally with the larval forms that the inspector is concerned. These are found chiefly in oxen, sheep, and rabbits, but they have also been found in the horse, the cat, the deer, the goat, and in man. Apparently all animals may become infested if the opportunity occurs.

In this country the parasites are exceedingly rare, if we may judge from the number of times the presence of the adult has been recorded in the dog. The Editor has not met with a single case of the *denticulatum* in sheep or oxen slaughtered at the Edinburgh abattoir during the last seven years, and no cases have been recorded from other abattoirs. In some parts of the world, however, the parasite is comparatively common. Friedberger and Fröhner say that the pentastoma is frequently met with at Berlin and Munich. Babes has observed the *denticulata* very frequently in Roumanian cattle. In the United States it has been met with in two rabbits by Kilborne and Curtice.

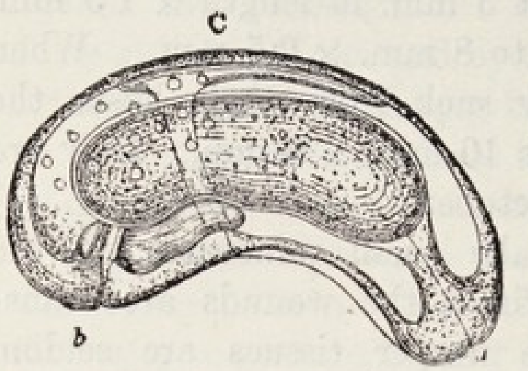


Fig. 77.—Pupa of *Linguatula tænioides* nine weeks old.—Leuckart, Neumann.

*The parasite.*—The immature parasite passes through several stages in the bodies of its intermediary bearers.

When the eggs are swallowed the embryos are set free in the intestines. These embryos measure 130 $\mu \times 60\ \mu$. They resemble acari in shape. The dorsal surface is convex and the ventral is flat. They have two pairs of legs, each of which ends in two claws. At their anterior part they are armed with a boring apparatus shaped like a spur. The embryos bore their way into the abdominal and thoracic organs, where they become encysted. In the cysts they lose their legs and boring apparatus, and become transformed into pupæ, measuring ·3 mm. × ·18 mm. During the next six months the larva undergoes several changes, which result in the form termed *Linguatula denticulata.* In this form it measures from 6 to 8 mm. It is shaped like an almond. The body is

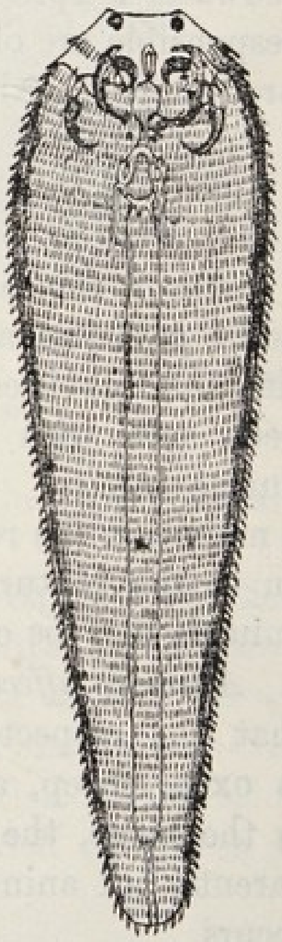


Fig. 78.—*Pentastomum denticulatum.*

denticulated at its margins, and is made up of from 80 to 90 rings. It has hooks on its anterior end. The digestive tube runs the whole length of the body. The genital organs are rudimentary (Fig. 78).

*Lesions.*—The embryos penetrate to the mesenteric glands, the liver, the lungs, and less frequently to the kidneys. At first there is little alteration in the organs, but the invaded ones becomes hollowed out by small cavities as the parasites develop. The neighbouring cavities become confluent, and form larger cysts. In this way a gland may undergo atrophy, and be converted into a small cyst containing nothing but a brownish fluid and larvæ. At first the invaded glands show to the naked eye only a few brownish coloured spots. They ultimately become fibrous, and may show tubercle-like areas. Many of the *denticulata* perforate the walls of the cysts and gain the peritoneal cavity. According to Leuckart, they may again pierce the other abdominal organs or migrate to the lungs (Fig. 79).

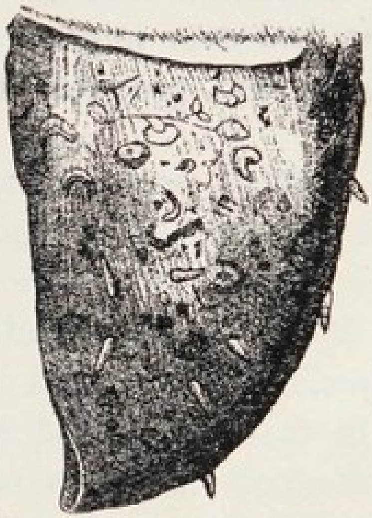


FIG. 79.—Lung of rabbit infected with Pentastomida.

The animals whose mesenteric glands are extensively invaded are often emaciated, and their flesh is pale, flabby, and œdematous.

*Inspection.*—Dogs are infected with the adult pentastoma by eating the organs of sheep and cattle containing the *denticulata.* The larvæ gain the nasal cavities by way of the nostrils or pharynx, and become mature. The adults have been so seldom found in human beings that we are almost bound to conclude that the risk of direct infection to man is very small. With regard to infection of human beings by the *denticulata*, Leuckart says that it takes place usually through infected dogs smelling or licking the hands. He also says that men are only invaded by small numbers of the larval parasites. There is nothing, however, against the supposition that human beings may be infected by using plates from which dogs have fed, or by eating garden vegetables upon which they have deposited the eggs of the parasite by sneezing.

The diseased organs should not only be excluded from the market, but they should be put beyond the reach of dogs by being immediately destroyed. Destruction of the organs will not only protect the dog from the pentastoma, but also human beings whom it might infect with the *denticulata.* There is no evidence to show that the *denticulata* ever migrate to the muscles. The carcase, then, may be passed, provided it is not emaciated or dropsical.

# UNCLASSED DISEASES

In this chapter will be described such diseases as Milk Fever, Louping-Ill, Rickets, and Osteo-Porosis, all of which are difficult to class on account of our ignorance of their pathology.

## Milk Fever

Milk fever, or parturient apoplexy, attacks cows immediately before or a few hours after parturition. The symptoms are those of coma, and are probably produced by bacterial toxines absorbed from the uterus. There are no post-mortem signs which are pathognomonic of milk fever. There may be congestion of the meninges, but this is present in other pathological conditions, such as the so-called stomach staggers, and poisoning by lead. The affected animal, being comatosed, is unable to rise. If she has been down for a day or two before slaughter, the tissues upon which she has been resting most of her weight will be œdematous and sometimes infiltrated with blood. This is well seen in the neighbourhood of the sternum and hips. The skin over these parts may even be necrosed (bed-sores).

*Inspection.*—So fatal is milk fever in some localities that the owner may elect to slaughter the animal on the first onset of the disease, in order that there may be a better chance of getting the carcase accepted.

It is seldom that cases of this kind come to the abattoir from city byres, for it is not customary for dairymen to keep pregnant animals. Most cases are sent in from the country as dressed carcases. If the animal has been slaughtered early, little or no change is observable in the flesh; no harm is likely to result from passing it. Indeed, it is often allowed into the market with the full knowledge of the inspector. In the later stages of the disease the animal does not bleed well. This shows itself by a fulness of the blood vessels, blood streaks in the tissues, and a general dark red appearance of the flesh. Moreover, as stated above, the regions on which the animal has lain are often damaged. Carcases of the latter description should be regarded as unmarketable, whether the cause of the condition has been milk fever, lead poisoning, or stomach staggers, all of which may give rise to such changes.

## Louping-Ill

This is a disease which is seen in sheep in certain parts of Scotland. It is most prevalent in the late spring. The disease is characterised by nervous symptoms. Very little is known about its pathology; but M'Fadyean has shown that several different conditions, such as an abscess in a vertebra and purulent meningitis, account for some of the so-called cases of louping-ill.

According to Williams, Greig Smith, and Hamilton, it is a bacterial disease; but no bacterium has yet been isolated which, from its action on animals, can claim to be called the microbe of louping-ill.

In what are generally said to be typical cases of the disease no important lesions are found in the internal organs, with the exception of the spinal cord. The meninges are congested, and a reddish fluid or coagulum is found around the cord. As the animals become paralysed and unable to move about in search of food, they become emaciated. Abscesses may be present under the skin or in the superficial muscles.

*Inspection.*—The flesh of animals killed at the outset of the disease may be of good enough quality.

After paralysis has set in it is emaciated, flabby, and œdematous. It should not in the latter circumstances be passed by the inspector.

### Rickets

The chief anatomical changes in rickets are located in the bones, but it is regarded as a constitutional disease. It is only seen in young animals. Those of the abattoir, with the exception of the pig, rarely suffer from it.

In what might be termed the acute stages, the bones are softer and more vascular than normal. The long bones are bent and their epiphyses are often swollen. Microscopical sections show that there is some disturbance in the region of the ossifying centres. The osteoblasts under the periosteum are increased in number, and calcification is proceeding irregularly in the cartilage of growth.

*Inspection.*—Animals during an attack of rickets are generally in poor condition. They are sometimes cachectic, and their flesh has a watery or anæmic appearance. The fate of the carcase should depend on the condition of the flesh.

### Osteo-Porosis

Osteo-porosis is an exceedingly rare disease in this country, but it seems to be met with more frequently in other parts of the Empire. Several specimens have been sent to the Dick College from India. The disease is seen mainly in horses, but it has also been described in oxen.

Its pathology is practically unknown; but it seems to be a systemic affection, although the bones are the seat of the chief anatomical changes.

The bones of the jaws are most frequently affected. They are swollen and brittle. The teeth become loosened. When the bones are boiled they have a worm-eaten appearance. Their tissue is markedly rarefied.[1]

*Inspection.*—The subjects of osteo-porosis are usually so cachectic and emaciated as to be unfit for the market.

[1] Osteo-malacia is the term given to another disease in which the principal changes are found in the bones. We are as ignorant of its true nature as we are of that of osteo-porosis. In osteo-malacia the bones seem to become decalcified. They can be bent in all directions, and can sometimes be cut with a knife.

# MEAT POISONING

In the widest sense of the term meat poisoning may be held to include all cases in which severe illness, more or less sudden in its onset, is caused by the consumption of meat (animal flesh or organs) containing some unwholesome ingredient.

In this sense illness attributable to chemical substances accidentally present in meat or added to it as a preservative might be regarded as an example of meat poisoning. In the more restricted application of the term, however, meat poisoning embraces only those cases of sudden and severe illness which ensue in human beings in consequence of the consumption of meat containing virulent bacteria or toxic bacterial products.

It was at one time very generally supposed, and it is still popularly believed, that certain alkaloidal substances (ptomaines) formed during the decomposition of meat and other albuminous materials by the bacteria of ordinary putrefaction possess highly poisonous properties, and that most cases of meat poisoning are caused by the presence of such ptomaines in the meat ingested. In other words, it was believed that the injurious meat was simply meat which had undergone putrefactive changes. This view can no longer be upheld. Meat which is invaded by the common putrefactive bacteria to the extent that it is recognisably putrid may, in consequence of its contained ptomaines, cause some gastric disturbance, but ptomaines cannot be held responsible for the serious and often fatal illness which is characteristic of meat poisoning in the narrower sense. There is, indeed, sufficient evidence to show that the ordinary putrefactive changes which occur in meat do not render it sensibly harmful to men or animals consuming it, and, on the other hand, the flesh which causes most serious meat poisoning may be entirely free from either the taste of the odour indicative of putrefaction.

The *Bacillus enteritidis* (Gaertner). In the great majority of cases of meat poisoning proper that have been submitted to bacteriological investigation the illness has been traced to this organism.

The bacilli vary in length from 2 to 4 $\mu$. Their ends are rounded and they are actively motile. They do not form spores, and are not stainable by the method of Gram.

The bacilli can be cultivated in all the common media. Gelatin is not liquefied, milk is not coagulated, and there is no formation of indol. Glucose and various other sugars are fermented, usually with abundant gas formation.

A strong toxin which resists the boiling temperature is formed in broth cultures.

The most important points to note in connection with the meat poisoning caused by Gaertner's bacillus are: (1) that, unless other bacteria (which have nothing to do with the illness) are present, the meat has no odour or flavour of putridity; (2) that the bacilli are highly pathogenic for human beings when introduced into the stomach; and (3) that the bacilli manufacture a powerful toxin which is not certainly or entirely destroyed even by the boiling temperature. It will thus be seen that when raw or underdone meat containing these bacilli is consumed the subsequent injurious effects may be due either to an infection (the ingested bacilli multiplying in the stomach and intestines and eventually invading the entire system), or to such an infection plus poisoning with the toxin already formed in the meat. On the other hand, when the infected meat is properly cooked immediately before consumption any illness which follows must be attributed to the toxin alone, since the bacilli are certainly destroyed at temperatures considerably below the boiling-point.

Much still remains to be determined regarding the habit and distribution of Gaertner's bacillus. There is reason to think that it is a rather widely distributed saprophyte, and that it is of common if not constant occurrence in the intestines and fæces of various animals. It is probable that in animals suffering from various diseases the bacilli may invade the body from the intestine in considerable numbers just before death, or that such an invasion may occur post-mortem when the carcase is not promptly eviscerated, but it is also possible that Gaertner's bacillus is sometimes the cause of serious and even fatal illness in some of the domesticated animals. At any rate, an all-important fact for the Meat Inspector to remember in this connection is that in a very striking proportion of outbreaks of meat poisoning inquiry has traced the illness to the consumption of meat from an animal which either died or was killed when at the point of death from some obscure disease, with in many cases diarrhœa for one of its symptoms. In other cases, however, there has been clear evidence to show that the animal from which the offending meat was derived was healthy, and that the meat acquired its dangerous properties subsequent to the act of slaughter, presumably as a result of external contamination with Gaertner's bacilli and multiplication of these throughout the meat substance.

The *Paratyphoid B. bacillus* and the so-called *swine fever bacillus* are believed to be occasionally the cause of meat poisoning in human beings, though they have been less frequently isolated from such cases than Gaertner's bacillus. The three organisms are not distinguishable by morphological or culturable characters, but they can be differentiated by agglutination tests.

The *Bacillus botulinus.*—This organism is the cause of a form of meat poisoning characterised by a train of symptoms quite different from those exhibited in outbreaks due to the *Bacillus enteritidis* of Gaertner. Whereas in the latter cases the principal symptoms point to severe gastro-intestinal disturbance (sickness, vomiting, diarrhœa, and collapse), in cases of so-called " botulism " the most striking and constant symptoms point to partial or complete paralysis of certain of the cranial nerves (ptosis, aphonia, dysphagia, etc.).

The bacillus is a cylindrical organism from 4 to 6 $\mu$ long and about 1 $\mu$ broad. It is a strict anaerobe, exhibits a rather feeble motility, and stains by the method of Gram. It secretes a very powerful toxin which is readily destroyed by heating at 80 to 100° C.

The bacillus itself appears to be devoid of pathogenic properties, and the symptoms exhibited in cases of " botulism " are entirely due to the toxin present in the meat substance. The contamination is always subsequent to slaughter, and it is especially such materials as sausages that are liable to become dangerous, because, given the contamination, the anaerobic bacilli are able to multiply and manufacture the toxin in the interior of the meat substance. Here again it is important to remember that cultures of this bacillus have no putrefactive odour.

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# INDEX