Original Articles.

THE RELATION OF ANIMAL LIFE TO HUMAN DISEASES.*

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WHEN we speak to-day of the relation of animal life to the diseases of mankind, we mean the infectious processes, for the thought that animal life may have some influence in the production of other than infectious diseases is so remote that it need not be considered at present.

Medical literature abounds in references to the possibilities for harm lurking in the infectious diseases of animals, and in nearly every great epidemic animal diseases have been reported as precursors or attendants. Bold inferences have been drawn from mere relations in time and space and fanciful theories have had their day, such as the one that bovine tuberculosis was human syphilis in the cow.

The close association of man with domestic animals was a sufficient reason for unfounded inferences as well as certain true deductions. From the time that man became agricultural in the dim, uncertain past, animals have been his close associates. This relation, still very intimate in agriculture, is less so with the growing urban population of the world. But even in our densely populated cities we come in contact with dogs, cats, mice, rats and birds in our homes and with horses on the streets. Everywhere are consumed the flesh and dairy products of cattle, the flesh of sheep, swine and horses and of many varieties of game, both mammals and birds, of fishes and mollusks. We are beset by insect pests which parasitize upon our skin and draw our blood. In short, almost every one of the great divisions of animal life has one or more representatives which play some rôle in directly benefiting or injuring human beings.

With the beginnings of bacteriology, the relation of animal life to human disease gradually emerged from a fog of possibilities and suppositions, and each year has brought greater clearness and definition. Some old views are being abandoned, or at least greatly circumscribed, and new ones opened to investigation.

That the pathological relations between man and animals should be manifold and diverse naturally follows from the great diversity among the animals themselves. If we endeavor to group the human diseases associated with animals, we find three main divisions:

1. Diseases common to man and animals.
2. Human diseases accidentally carried by animals or animal products.
3. Diseases resulting from a complex and intimate relation between man and some insect on the one hand, and some microscopic parasite of both on the other.

The diseases which are generally spoken of as

common to man and animals may be still further separated into two classes:

1. Diseases belonging to some animal species and occasionally transmitted to man, such as glanders, anthrax, foot-and-mouth disease, rabies, trichinosis and echinococcus disease.

2. Diseases belonging to both animal and man, such as the bubonic plague and those due to certain tapeworms.

It is of interest to note that there are, in fact, no strictly human infectious diseases which are occasionally transmitted to animals spontaneously. There are human infections which can be inoculated into animals, and this practice is largely made use of in the study of certain human diseases by the experimental and comparative method, but infection in the normal way by simple contact or cohabitation is unknown. It might appear to some that vaccinia in the cow is an exception to this general rule. It is now quite generally accepted that vaccinia had its origin in smallpox grafted upon the cow, and this theory is in closest accord with what we know of vaccinia, on the one hand, and of infectious diseases in general on the other. But even in this case the disease is an inoculation-disease, implanted on the udder by the hands of the milker. The disease germ undergoes profound changes and remains permanently modified. As regards bubonic plague, in which the play of the infection between human beings and rats seems to be perfectly free, so that we might say that the infection belongs equally to man and to rats, there is still some doubt as to the original source of the virus. Some authorities claim, and with much reason, that the plague is a disease of rats primarily. This view is not supported by R. Abel, who, after a painstaking examination of the literature dealing with the black death of the Middle Ages was unable to find any references to rats.

This scarcity of diseases common to man and animals is most probably due to the gap existing between man and the animals he has domesticated. A much closer physiological relationship exists between man and the higher apes. This has recently had a rather striking confirmation in demonstrations of blood relationship by the precipitin test and the inoculability of syphilis upon the highest apes. It is of the utmost importance to man that so few infections may pass between him and the higher animals. If we were compelled to share only a fraction of the infectious diseases belonging to the domestic animals, the progress of sanitation would make it necessary for us to get rid of such animals entirely, otherwise the control of these diseases would be impossible.

The second group of infections carried by animals or animal products is largely due to incomplete sanitary progress. The transmission of diseases by milk is at best a result of uncleanness in the handling of this product, and up to the present we are not aware of any specific infection of the cow carried to man in milk unless it be the microbe of foot-and-mouth disease, and rarely

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the bacillus of bovine tuberculosis. The diseases carried by milk are chiefly of human origin, and the milk is simply a favorable vehicle. It is possible that the future may unearth certain infections belonging to the cow other than those mentioned which may make trouble in the human subject, but at present we do not know them. There are known cases of actinomycosis of the udder, but their relation to this disease in man seems problematical, to say the least.

The agency of oysters and other shellfish is precisely similar to that of milk. These animals are not known to be afflicted with any parasitic or bacterial diseases dangerous to man, but they act apparently as more or less passive agents in bringing back to us the human infections consigned to sewage. Since both shellfish and milk are dealt with in detail in another section of the program, I content myself by referring to them thus briefly.

The common house fly is still another agency whose field of activity remains to be more accurately determined. It has not been wholly neglected, for the work of Nuttall, Alice Hamilton, F. W. Lord and others have each in another way contributed important data convicting or exonerating this insect of certain practices. It still needs more detailed study, not only in the adult, but in the larval stage, in order that measures pointing to the restriction of breeding may be more widely known and applied.

We may safely affirm that the common fly is a passive carrier of infectious agents, and that it is not a true secondary host of any human infections, as is the case with certain species of mosquitoes, ticks and the tsé-tsé fly of Africa. These are all species which draw blood, and this gives them the opportunity to act as intermediate hosts of certain well-known pathogenic organisms. Nevertheless, the flies which abound near and in human dwellings are fit objects of study for the sanitarian. A better knowledge of their functions may lead to more adequate measures for the prompt collection of refuse in which they breed than is now possible in large cities, owing to public indifference.

As regards the kind of infections carried by house flies, we must at present assume that they may carry on or in their bodies all kinds of infections, though the danger of such infections is greatly diminished by the inability of these flies to pierce or lacerate the skin. The chief danger lies in the contamination of foods consumed raw or of foods sterilized by cooking, to which flies have access after this process is completed. In this regard, as in so many others, the sterilization of foods by cooking and subsequent protection is a most valuable safeguard, and all practices favoring the consumption of foods raw or even partially cooked should be frowned upon by sanitary science unless some very well supported arguments are presented in opposition.

The diseases of mankind, transmitted by insects acting as necessary intermediate hosts are of world-wide importance. Malaria, yellow fever, sleeping sickness, filariasis, and perhaps other still

imperfectly known infectious diseases, are inoculated by insects, and they are the ones which make the tropics such forbidden territory for the immigrant from temperate climates. Not only he himself, but the domestic animals he brings with him, are destroyed by the same or similar living agencies. To this group of diseases I shall only refer in passing, for they have been so widely discussed in recent years as to have become familiar even to the laity.

Perhaps that group of human diseases which is transmitted by the well known domesticated animals and their products is still uppermost in our minds when we speak of animal diseases in their relation to the public health. It is these diseases which crop out sporadically in the practice of physicians and which often remain unrecognized because of their rarity and irregular course. It is the same diseases in animals upon which the practice of veterinary medicine is built and which have made it such an important adjunct to the health officer. It is to these diseases that I wish to devote the remaining pages of this communication.

Inasmuch as the object of investigating animal diseases is to find means of controlling and suppressing them if possible, I must point out before discussing this group of infections one great practical difficulty. In the group of diseases carried by insects, ticks and rats, there can be no question at present that the extermination of these carriers is to be aimed at. We know of no useful functions carried on by mosquitoes, flies and rats which we cannot dispense with. But the group of domesticated animals which may transmit to us certain of their diseases is most useful to us. The essentials of our dietary in health and disease are derived from domesticated animals. They yield many other valuable industrial products. Among them are our companions and load bearers. We have a double problem before us, to protect human lives and to promote the welfare of our animals as well. Hence the conflicting counsels in the suppression of the transmissible diseases and the need for conservatism.

The significance of animal parasites, overshadowed by the bacteria since the beginnings of bacteriology, is now gradually being recognized. Fortunately, only a small number of human parasites are also the property of our domestic animals. Among these the most important are the *Tænia echinococcus*, that formidable and very small tapeworm of the dog, the beef and pork tapeworm and trichina. The occasional discovery of other animal parasites in man need not concern us here. As regards *Tænia echinococcus*, it is well known that the cystic stage invades man and is a dangerous guest. It is found occasionally in our abattoirs in swine, but it is fortunately rare at present. It is far more common in Europe, and its presence in man not infrequently demands surgical interference.

Of the other parasitic diseases due to animals, trichinosis is the only one of considerable importance. Thorough cooking of pork products

is known to render it harmless, but in spite of this cases are discovered now and then, and H. U. Williams has found at autopsies nearly 5% of the bodies examined harboring trichinæ. This figure cannot be made general, since the individuals autopsied belong largely to the lower stratum of society.

Trichinosis in swine affords an illustration of the fact that we are occasionally willing to make sacrifices in the interest of foreign trade which we would not make for the general welfare. Owing to the demands of the German government, there has been built up an extensive system of inspecting animals, including pork for trichinæ, destined for export. This inspection is not designed to protect the American consumer but only the foreign customer. It is, however, highly probable that a considerable amount of the inspected meat is consumed in this country.

The system has undoubtedly done much good in calling attention to the necessity of inspecting all animals destined for food and all meat products. It has trained many men to recognize disease, and has been an educational factor of no mean influence. Yet it may well be questioned why our central government should pay the cost of inspection under the conditions under which it is made, rather than the packer, is as the case in the German system.

From the standpoint of public health, perhaps in recent years the most notorious of the infectious animal diseases is bovine tuberculosis. Identified by Koch in his celebrated work of nearly a quarter century ago in its etiology with human tuberculosis, this affection became a target for nearly every one who was endeavoring to fight the human disease. The human carriers of bacilli were for the time being forced to the background by the energy and the money spent in destroying infected cattle. To-day we know that the tubercle bacilli found in cattle can be readily distinguished from the tubercle bacilli found in the human disease with certain relatively rare exceptions. For in some forms of the human disease, notably in tuberculosis of the mesenteric glands, bacilli are now and then detected which are at present indistinguishable from those of cattle. Human and bovine tuberculosis can no longer be regarded as identical, however, and it remains for us to study most thoroughly those isolated cases in which bovine bacilli are found, in order that we may know the conditions which favor such invasion.

Bovine tuberculosis for obvious reasons must remain a proscribed disease, both in the interest of man, cattle and other domestic animals. There must be no backward step in the movement to restrict this disease, although opinions will differ as to the means by which the disease is to be controlled.

When the crusade against bovine tuberculosis started, it was proposed to destroy all animals which give a positive tuberculin reaction. This drastic method is happily laid to rest and a more conservative and less costly procedure has taken its place. In the hands of individual owners, the

old method may still score a triumph by completely eliminating tuberculosis from a given herd after a certain number of months or years.

The complete eradication of bovine tuberculosis is made difficult by the existence of mild, latent types of the disease which may recover. These react towards tuberculin as vigorously as the more advanced, clinically defined cases. In the destruction of animals, attention has been therefore diverted from tuberculin as a guide, and the effort has been to eliminate only those animals which discharge tubercle bacilli. The mere presence of a tuberculous focus within the body does not mean danger to man and cattle. It is only when tubercle bacilli are being discharged from the udder, the lungs, the uterus, or the skin that the environment is imperilled. It may be urged that the methods for detecting bacilli in the secretions and excretions are inadequate and require time, but this is no reason for destroying immense numbers of cattle apparently well. It is rather a challenge for veterinary medicine to devise and improve methods for rapid as well as more accurate diagnosis.

If bovine bacilli easily infect man, it is strange that the army of people employed in cow stables who are exposed, just as the cows themselves are, to bovine tubercle bacilli coughed up, should not yield a larger number of tuberculous patients. Possibly in the early years of life the mucous membranes are more easily invaded than in adult life. This harmonizes with the fact that the cases in which bovine bacilli were found were largely children.

The study of tuberculosis in Japan by Kitasato has amply demonstrated that human tuberculosis may flourish where bovine tuberculosis is almost unknown among native cattle, and where cows' milk forms a negligible part of the diet of infants and children. Even in that country the proportion of cases of tuberculosis starting in the digestive tract was found to be as high as in milk-consuming countries where bovine tuberculosis is common.

A most timely and efficient aid in the warfare upon bovine tuberculosis is the movement for cleaner milk gradually gaining strength. Whatever can be done to reduce the number of bacteria in milk will indirectly aid the work against tuberculosis. For clean milk means a normal or nearly normal udder. It means that discharges from the uterus will be detected and these are frequently due to tubercular processes. The demand for clean milk will eradicate all emaciated or sickly animals, many of which are tuberculous. In short, the crusade against dirty milk calls attention to all those defects which a cow shedding tubercle bacilli is likely to exhibit, and we may rest content that this movement will, at least for the present, meet the demands for milk free from tubercle bacilli.

Tuberculosis among other domestic mammals, such as dogs, cats and swine, is derived from either bovine or human sources. The tubercle bacillus of birds possesses certain differential characters which distinguish it from mammalian

bacilli, even after years of cultivation. The disease in mammals other than cattle is of subordinate interest to the sanitarian, but it should not be wholly lost sight of, and it needs further study before its significance can be definitely estimated.

Another infectious disease which is now thoroughly disseminated over the entire civilized world and which is giving public health authorities considerable work to do is glanders among horses.

Glanders and tuberculosis have much in common. The underlying principles governing infection and dissemination through the body are nearly the same. From the standpoint of etiology there is, however, this important difference. There may at present be a reasonable doubt concerning the animal origin of any case of human tuberculosis, with the chances preponderatingly in favor of its human origin, because we have a tubercle bacillus fitted to the human species and one fitted to cattle. In glanders of the human subject there can be no doubt that it is of equine origin, for there is no human glanders independent of horses.

When we proceed to examine the statistics of human and equine glanders we are at once struck with its wide prevalence in horses and its very restricted occurrence in man, in spite of the intimate association of many human beings with horses continually discharging glanders bacilli. Glanders, so far as we know, is not conveyed to man except by direct inoculation or the infection of a wound. But even this cannot explain the restricted occurrence in man, for wounds and abrasions are common among those handling horses. Possibly some association of the glanders bacillus with septic organisms in the discharges from nose or skin of the horse may explain the occasional invasion of the bacillus.

In the struggle against this disease the same difficulties have arisen which surround tuberculosis in cattle. The mallein test reveals a certain number of mild, latent, non-infective cases which probably get well. What to do with such frequently very valuable animals is not easily decided. It seems to me that here also conservative measures should prevail, and that the methods of diagnosis should be applied to determine whether glanders bacilli are being discharged or not. If the animal is disseminating glanders bacilli it should be destroyed. If not, it should be inspected at intervals and the mallein test applied until the reaction is negative or nearly so.

Human anthrax is to-day associated with animal products, rather than with the infected animals. Hides, hair and wool carry the disease from far distant permanently infected countries into the heart of our large cities. Factories in which these products are utilized may infect streams and pastures, and thus create enzootic foci dangerous to cattle, horses and sheep. Such foci are known to exist in our country, east, west and south, and with a more intensive agriculture and a more distributed animal industry than now exists, an-

thrax may play a much more important part in our country than it does at present.

The anthrax bacillus differs essentially in its biological characters from the highly parasitic bacilli of tuberculosis and glanders. It survives in a resistant spore form, and is capable of carrying on an independent life in the soil. It must be attacked in two ways. Agriculture and public health must co-operate in preventing the formation of new enzootic foci and in circumscribing and suppressing those now in existence. The workmen in factories must be protected by a careful supervision of animal products coming from infected countries and their disinfection. All cases of anthrax in man should be studied with special reference to the source of infection.

Fortunately, surgery combined with the use of a promising anthrax serum may take away much of the danger of this disease. The improvements in protective inoculation of animals made by Sobernheim by injecting a protective serum with the culture are destined to cheapen the process and at the same time strengthen the immunity over and above what has hitherto been attained by the Pasteur vaccine.

There is still one other infectious disease for which human beings and animals appear to be equally susceptible. Rabies or hydrophobia is a disease which stands quite by itself in its etiology, mode of dissemination and species susceptible to it. Its causal agent remains unknown, though certain bodies within the cells of the brain have recently been found to have at least diagnostic importance. It is the only one of the infectious diseases of unknown etiology which is inoculable into a large series of animals. All the others are restricted to one or two, rarely three, different host species. It is also unique in this, that it is disseminated only by inoculation through a wound.

Rabies as an infectious disease belongs to the dog and the wolf. From them it passes to other mammals. Cats are also known to have conveyed it through their bite. In the dog and wolf the disease is perpetuated by this habit of inflicting wounds with their teeth. In other animals and in man the disease is not inoculated by them. The extermination of this disease in civilized communities depends upon the management of dogs. It would seem to be a comparatively easy thing to check and completely wipe out this disease, yet there are many obstacles to encounter. The fondness of the human being for the dog, which at least with us makes men and women impatient of any restriction placed upon canines, stands in the way. So does the laxity with which stray and ownerless dogs are dealt with. The variable and often long period of incubation of this disease makes it difficult to exercise sufficient control over exposed and suspected animals. There is, however, nothing to stand in the way of ridding our country of rabies if we really and earnestly desire to do so and make the necessary sacrifices.

There is another group of diseases having its source in the animal food supply which has

received considerable attention in European countries, and but little in our own. I refer to outbreaks known as meat poisoning, which are characterized by more or less severe and even fatal attacks of gastro-enteritis. The animal food involved has come from cows, calves, horses and swine. The bacteria found have, as a rule, been related to the hog-cholera or enteriditis group, and are perhaps identical with the recently discovered paratyphoid and paracolon groups of bacilli of man. There are, however, other bacteria involved in some of the outbreaks, notably the bacillus of botulism and *Proteus*. In Europe (England, Germany, Belgium, Norway, etc.), the diseases known as meat poisoning have occurred generally in an epidemic form, because the meat from a single animal is sold in a restricted locality, such as a village or small town. As the animal in most instances is raised and slaughtered in the same community, the source of an epidemic of gastro-enteritis is easily traced. In our own country it is far more difficult to trace the source of such diseases, because the meat supply comes from a distance, and parts of the same animal are scattered over a large territory.

The frequent occurrence of such epidemics in certain portions of Europe is in part due to the habit of eating meat raw. In England, however, outbreaks have been traced to meat preparations not sufficiently sterilized by cooking or baking. In our country the taste for very rare beef is not much more elegant than that of the German for raw spiced pork or beef.

With us, the rearing of cattle on a large scale in thinly populated territories has operated against the prevalence of diseases which might lead to food poisoning. There is no likelihood that this mode of raising animals will continue indefinitely. With a denser population in the western states we shall inevitably adopt the methods of European countries and we shall then have to cope with the same diseases. It is even probable that they do occur among us at present, but remain unrecognized. The various forms of gastro-enteritis known as ptomaine poisoning probably have in many instances the same etiology as cases of meat poisoning.

We are at present wholly unable to attach any precise significance to the many bacteria which live upon the mucous membranes of our domestic animals, such as various cocci and the varieties of colon bacilli, the streptococci and staphylococci of septic processes and the various anaërobic bacilli of the intestines. While we may not go far astray in claiming the harmlessness of most of them, there is still ample justification for more thorough comparative study of these micro-organisms, since there may be among them a small number of dangerous forms.

The experimental and comparative study of animal infections which has been going on for over twenty-five years, beginning with the earlier researches of Pasteur and Koch, has had far more influence in the development of sounder theories of disease and has led to many more notable discoveries in that large field of parasitism,

which shows its hand in almost every known malady, than most of us would be prepared to admit. The origin of new ideas and fruitful theories is almost never contemporaneous with their acknowledged discovery. Discoveries are often simple explosions of material suitably prepared long beforehand. Much of this material has been laboriously brought together during the investigations dealing with animal diseases. To it we owe above all a strengthening of certain principles and doctrines, among which the most important are the latency of certain infectious agents in the body and their persistence in certain diseases after recovery. The broader study of infection has also emphasized the mutual adaptation of host and parasite to one another leading to variations of immunity in the host and to specific variations of the parasite which circumscribe its power to invade other host species. Finally, it has thoroughly demonstrated the necessity for looking primarily to living beings, be they human or animal, as transmitters and disseminators of infection, and only secondarily to dead objects and fomites.

A CASE OF PYLORIC STENOSIS IN AN INFANT.

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JOHN G., the first child of healthy parents, was born April 7, 1905, after a normal labor. He was breast-fed and did very well for the first two weeks, there being no vomiting and the movements being normal. Vomiting then began and steadily increased. He was weaned on April 25, after which he was given Mellin's food for two days and then a weak, modified milk. The vomiting continued, however, and the bowels became constipated, the movements being small and green. He was admitted to the Infants' Hospital, May 5. Just before entering the hospital he passed a closed bib-pin about one inch long which had been missing for about two weeks. The onset of the vomiting coincided pretty closely, therefore, with the disappearance of the pin.

Physical examination: He was small and fairly nourished, but the circulation was rather poor and the skin somewhat dry. The fontanelle was small and depressed, the tongue dry and somewhat irritated. The abdomen was not distended, but examination was difficult as the muscles were held rather firmly; there was no definite spasm, visible peristalsis or tumor. Examination was otherwise negative. The weight was 2,870 gm.

The diagnosis of chronic gastric indigestion was made, with stenosis of the pylorus to be considered. The history of the passage of the bib-pin seemed pretty conclusive that two weeks previously there had been no stenosis of the pylorus.

Various sorts of food were tried. He was first given whey, 30 cc., 10 feedings; then a mixture containing fat 2%, sugar 5%, whey proteids .25%, casein .25%, lime water 5%, — 60cc. at a feeding and 8 feedings. The intervals were then lengthened to three hours, still giving 8 feedings in the twenty-four hours. The mixture was also peptonized for ten minutes before each feeding. Tube feeding was then tried. A few