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VETERINARY MEDICINE SERIES
No. 15

EPIZOÖTICS AND THEIR CONTROL DURING WAR

A Guide for Army, Government and Practicing Veterinarians

By

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With Thirty-Seven Illustrations

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AUTHOR'S PREFACE

In this book it is my object to describe in a condensed form all of the diseases of animals that occur and are of most interest in the present world war. It seems unnecessary to attempt to write a new book on infectious diseases, in view of the large number of excellent works already in print, but I learned from our experiences in the field how necessary it is for the practicing veterinarian to have conveniently at hand a small consulting book that contains every-day matters of importance, for it is next to impossible to carry the larger books. All of the observations that we have made while controlling and combating epizoötics during the years of the war, were most critically considered and are given in this book in their entirety. It is, of course, impossible to discuss in this brief work all the questions in connection with the diseases to be mentioned, and only such questions as relate to the most important diseases can be considered at the present time. This was taken into consideration even in the mere selection of the subjects to be discussed, and especially so in the individual chapters. Glanders assumes such an important rôle in the war, due to its having spread over such wide areas, that it would necessarily have to be given more space for consideration than diseases of less importance. Likewise, one can easily understand that the various diagnostic methods would be given particular attention. In the chapter on contagious pleuropneumonia of horses (influenza pectoralis) (*brustseuche*) is considered the advancement made in the treatment of this malady with arsenic, while facts that every veterinarian are supposed to know are discussed only

in a brief manner. In a similar way, only the important facts are considered in connection with other diseases.

Since the prime object in this book is to discuss the diseases of those animals used for transport purposes, namely, horses, I will devote the greater part to equine diseases. However, there are two contagious diseases discussed, both of which are almost exclusive cattle maladies, because cattle are also used for transport purposes as well as supplying the army with fresh meat; furthermore, because our experiences in past wars have shown us that cattle plague (rinderpest) and contagious pleuropneumonia (*lungenseuche*) always appear at that time. The risk of importing the extremely dangerous and easily transmitted disease, rinderpest, is greater at the present time because it is known that the Russian army, due to the scarcity of their meat supply, procure meat-producing animals from Mongolia and Manchuria, the chief sources of rinderpest.

In order to correspond with the first expressed idea to make this book solely a practical and brief work, almost all methods for research that require experts and well equipped laboratories, are in this case only briefly described and the reader is referred to more detailed textbooks for further information on this subject. Keeping in mind the rule that "preventing epizoötics is more important than controlling epizoötics," special attention is given to every known method which would assist in an early diagnosis or which would facilitate the prevention or eradication of infectious diseases. With the same object in mind there is described in the first or general section of the book the equipment of horse hospitals and depots as well as the laboratories for blood examination. Questions concerning disinfection and the most important disinfecting substances are also discussed in that part of the book.

I am cognizant of the fact that in this work I have not exhausted my subject, for in my attempt to be brief I was forced to limit the explanation in many cases—and, moreover, a subject of this kind never will be exhausted. It was also necessary to omit many discussions dealing with the subject at hand because they were of military interest in connection with the defense of the country. But, nevertheless, I hope to have succeeded in writing a book which will be helpful to the army veterinarian as well as the government and practicing veterinarian, because it is their duty to prevent the introduction of contagious diseases into the interior through transport and meat-producing animals and to combat existing epizoötics among the animals owned by the civil population.

Some of my experiences in past years and during the present war I utilized as guides in writing this book, while other valuable suggestions were given me by colleagues who are at the front. I also wish to thank Assistant Lange and Dr. Berge, both of my institution, who helped me in the proofreading, and Dr. Lütje, who contributed some very illustrative drawings. I am also grateful for the courtesy shown by the publisher of the original German edition, who showed such unusual ability in reproducing illustrations and publishing this work.

I believe that in dedicating this little booklet to my honored former teacher, the senior master of veterinary medicine, Professor Dr. Schütz, I could not dedicate it to a more worthy individual, for we are indebted to him and thank him for the great amount of work he has done in research on the infectious diseases of animals.

Hannover, September, 1915. H. Miessner.

WAR HORSES

All unoffending, unsuspecting, led,
They come—patient, resistless, dumb—
To swell the heaps of nameless dead.
—Ever Holmes.

TRANSLATOR'S NOTE

The aim and scope of this book have been described in the author's preface, so that it is hardly necessary to dwell further on these phases.

The very favorable comment that has been passed on Miessner's *Kriegstierseuchen und ihre Bekämpfung* by American veterinarians familiar with the German language, caused the publisher and translator to come to the conclusion that American veterinarians might profit materially from an English translation of the book.

When Dr. Miessner wrote this book the world war had been in progress approximately one year. His connection with a German regiment of artillery during this time gave him ample opportunity to study the war from a veterinarian's viewpoint and to see the need of a concise treatise on animal plagues and their control. The magnitude and seriousness of this war make it absolutely imperative that we protect all of our resources and particularly our food and transport animals. The obvious necessity of this should stimulate all veterinarians to thoroughly familiarize themselves with animal plagues and their prophylaxis so as to be in a position to render all possible assistance to curb any outbreak of disease that might endanger the lives of our animals.

While translating this book it was always my object to adhere as closely as possible to the original text, but my aim throughout was to reproduce the ideas expressed rather than the style of the author. Those familiar with translating idiomatic expressions will appreciate the difficulty of this task.

No changes were made in the order of the subject matter from that in the original text. Some references to certain military regulations enforced in Germany were omitted for the obvious reason that they would not be of any essential value to the veterinarian in this country. All illustrations which appear in the original text have been reproduced.

The subject matter in the appendix has been included in this volume with the object of presenting in a compact form the experiences of a few American veterinarians who have been connected directly or indirectly with the world war. No originality is claimed for this portion of the book, the contents being made up of excerpts taken from the American Journal of Veterinary Medicine, due credit being given in each instance.

I wish to acknowledge my particular indebtedness to Dr. C. A. Zell, Assistant Director, Research Department, The Abbott Laboratories, for the valuable assistance rendered by him in the preparation of this translation. Acknowledgment is also due to Dr. J. H. Achard, of the Editorial Staff, American Journal of Clinical Medicine, for his kind and helpful suggestions. Acknowledgment is also due to the publishers who proved themselves most courteous and helpful in many ways in the preparation of this book.

Chicago, July, 1917. A. A. Leibold.

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PART ONE

HORSE HOSPITALS AND HORSE DEPOTS

PROBLEMS OF HORSE HOSPITALS AND DEPOTS

It is an obvious necessity that the army be supplied with horse hospitals and horse depots, maintained in the interests of the health of horses and the prevention and combating of infectiou diseases. Opportunity must be given to the fighting and marching army divisions to ship behind the battle fronts for treatment their sick horses, as well as those horses that are unable to travel. For this horse hospitals must be provided. In order to meet the demand at all times, army divisions must also be given opportunity to replace rapidly any horses that have either died or become sick. With this object in view, horse depots should be placed near the front, which will supply a great number of serviceable, healthy horses, destined for the front. It has been proved expedient to separate entirely the horse hospitals from the horse depots, in order to prevent any infection of horses at the depots through the medium of sick horses which have been returned from the troops, and in that way keep these horses at the depots serviceable and free from disease. Since the very sick horses or horses otherwise made unfit for war purposes are sent back home, suitable hospitals should be made available for these returning animals. In a like manner horse depots should be arranged at home and in the army corps in order to receive healthy horses destined for the front.

Besides caring for those animals showing external disease, it becomes the duty of the horse hospitals and depots to combat all possible infectious diseases with the best available methods, special attention being directed to glanders. Since many of the hospital horses that are

useless for war purposes, are returned to the civil population, proper preventive measures are carried out at the hospitals to preclude the spread of a communicable disease to the horses of the civil population; and, on the other hand, it becomes the problem of the depots to prevent the transmission of diseases from horses from home to the army horses of the fighting troops.

ARRANGEMENTS OF HORSE HOSPITALS AND DEPOTS

In order to prevent the spread of diseases, it is necessary that all horse hospitals and depots have three-room stables, each of which is separate from the others. Stable No. 1 serves to receive the incoming horses; stable No. 2 receives such horses as have been shown to be infected, and is comprised of three divisions in which are kept the—

(a) Glanders suspects.

(b) Strangles cases.

(c) Horses infected with other diseases—all being separated from one another.

Stable No. 3 is intended for those horses known to be absolutely free from infectious diseases and which are ready for distribution.

The stables must provide separate drinking troughs and mangers; in case this is not possible it becomes necessary to erect heavy partitions; and even individual nose-bags must be provided, for feeding and watering the horses in some instances.

All horses are to be examined for symptoms of glanders before they are given quarters. The glanderous horses should be killed immediately and not allowed to be placed in these stables. Every horse is to be given a serial number which is best done by cutting it into the hair, or burning it on the hoof or braiding a numbered card in the mane or tail. Before horses leave the hos-

pitals or depots they are to be subjected to the ophthalmic mallein test and, as far as possible, to the serodiagnostic tests.

Division Horse Hospitals

In order to relieve the fighting and marching troops of the severely sick horses and others unfit to travel, a hospital must be arranged in the neighborhood to care for such animals; *i.e.*, a division horse hospital. The division horse hospitals are to be made mobile since they must follow the troops, even though they follow at a slower rater of speed. It is therefore necessary that they send such animals, which require a long time to cure or those not fit to travel or to be used in war, to the corps or army horse hospitals in the rear.

Staff Veterinarian Ohm very kindly made some valuable suggestions to me by letter. According to him, all horses must be carefully marked so that those discharged from the division hospital as cured can be returned to the regiment and officers from which they came. In this way only, will the confidence in this arrangement be kept and strengthened and an early delivery of sick and other horses needing careful handling, be made possible. This is of special interest in order quickly to restore the horses and rapidly to make them serviceable again. It is necessary to inscribe the serial number of the hospital on the left side of the horse's neck by cutting the hair, and to renew the regimental brand on the left side of the cheek; in such cases, where horses belong to officers, a leather tag with the officer's name on it is braided into the tail. All horses placed in the receiving stable No. 1 are immediately groomed and well cared for; in the evening the ophthalmic mallein test is applied and blood is withdrawn for serodiagnosis. Horses found, by means of the biological tests, to be infected with glanders are immediately killed and buried accord-

ing to instructions. Horses that react doubtfully are subjected to further observation and examination by means of the usual methods in stable No. 2, division for glanderous suspects. In a similar manner the remaining horses are distributed to the different divisions of the stable, depending on the conditions from which the horses are suffering. Horses showing fever and suffering from an incurable external malady are killed and buried, whereas those that do not give evidence of having fever are sold to the slaughterer.

Horses which can not be used any longer by the troops, but which are still serviceable for farm work, must be immediately sent to the permanent horse hospitals and sold there.

Thoroughly experienced practicing veterinarians are selected for the horse hospitals; and, beside the commanding veterinarian, it is necessary to have one veterinarian to about every 100 horses.

Dietetic forage (bran, linseed oil cake, crushed oats, etc.) must be provided for the horses which are in poor physical condition or very sick.

Corps or Army Horse Hospitals

The corps or army horse hospitals afford a place to care for the sick horses and combat the infectious diseases according to the instructions given. Such animals, that are either difficult to cure or known to be incurable or unfit for war purposes, should be sent to the immobile hospitals at home.

The corps or army horse hospitals are to be equipped with a plentiful supply of modern veterinary operating apparatus such as the excellent portable collection arranged in a synoptical manner in a box offered by the Hauptner firm (Berlin).

These hospitals also have to supply suitable transport

ambulance wagons in order to get those horses which are unfit for travel from the division hospitals, or to take them to the nearest railroad station so they may be sent home.

It would also be useful to have a laboratory connected with the corps or army horse hospitals which would be equipped with microscopes, staining utensils and glassware in which ordinary bacteriological examinations could be carried on. Dissecting instruments are to be kept on hand and dissecting rooms arranged where, as occasion arises, the post-mortem examination of horses suffering with infectious diseases (glanders) ought to be performed in order to insure an orderly examination and disposition of the cadaver.

Immobile Horse Hospitals

We then finally come to immobile horse hospitals back home, which receive those horses that require prolonged treatment or that need to be especially cared for, and which transfer with the usual caution the unfit horses to the civil authorities. The horses that have been cured and shown to be free from infectious diseases and their usefulness determined, can be given over to the permanent horse depots at home.

Immobile Horse Depots

The duty of the immobile horse depots is to determine whether the horses that are well and serviceable for war purposes, from the immobile horse hospitals, as well as the newly purchased horses from home, are free from glanders; this is done by means of the ophthalmic mallein test and blood examination. These horses are to be trained so that in the event of their being needed at the front, they may be sent as horses accustomed both to the saddle and wagon.

Mobile Horse Depots

In case no direct transportation of horses to the troops is desired, they are then sent from the immobile horse depots to the mobile horse depots of the army or army corps, from where the required horses are given over to the individual bodies of troops.

GENERAL MEASURES FOR THE PREVENTION OF INFECTIOUS DISEASES

Inspections of the horses are to be carried out at least every 14 days. The horse depots, horse hospitals and military formations often come in contact with strange horses and when infectious diseases are actually present in the military formation or in their neighborhood, inspections should be repeated every seven days. Notice should be taken that at these times *all* horses should be examined.

Horses recently assigned to troops are held separate until the veterinary examination shows them to be free from infectious disease, after which they are allowed to enter the military formations. Captured horses are not to be placed with the regular army horses until, by the use of the ophthalmic test or serological tests, they have been shown to be free from infectious diseases, especially from glanders.

To prevent the nasal discharges and saliva of sick horses from soiling drinking and feeding utensils, such articles should not be allowed to be used in common. In that way the chief sources of spreading infectious diseases like glanders and strangles are overcome. Before occupying stables the mangers should be carefully cleaned whenever circumstances permit. The bedding is removed whenever possible; and where a permanent bedding is used the upper layer, at least, should be changed.

Periodic disinfections of the hospitals and depots should be carried out by using formalin and milk of lime, for which special apparatus must be provided (see chapter on disinfection on page 21).

The changing and mixing up of horses during the movement of troops or while they are in their quarters are to be limited as far as possible.

The placing together of army horses or bringing them in contact with horses of the civil population is to be especially avoided. Cattle and sheep barns, and sheds and granaries are to be used whenever possible.

Stables in which infected horses are stalled or have been stalled are to be marked with distinct and substantial inscriptions, stating the name of the disease in question. Furthermore these inscriptions should designate the branch of the service and the time of departure of such troops. Infected places should not be allowed to be occupied by strange horses.

By regular and repeated instructions, the troops are to be taught how to recognize infectious diseases of horses and how to combat them. All horses that are to be given over to a horse hospital or depot or sent back home, must be branded with the insignia of the branch of the service from which they have come, or marked in some other manner, so that in case of inquiry regarding a glanderous case it can be determined from what body of troops the horse originates.

BLOOD EXAMINATION STATIONS

IMMOBILE BLOOD EXAMINATION STATIONS

Near the front at suitable and conveniently centralized points, blood examination stations are located. It is the function of those in charge of these stations to examine, for glanders-antibodies, with the agglutination and complement-fixation methods, the blood of all horses within

their province. The blood examination stations are supplied with trained veterinarians and the necessary helping personnel in order to handle the large amount of work required of them. They provide laboratories which make it possible to examine 1,000 or more horses per day.

The equipment of the laboratory consists of water-baths with racks that, at the same time, will receive 100 or more test tubes, which can be regulated; centrifuges, pipettes, test tubes, centrifuge tubes, bottles, small animal cages, etc., as well as the necessary washing apparatus for cleaning the glassware. From these laboratories suitable boxes are also forwarded containing centrifuge tubes necessary for the examinations and bleeding needles; also the examination lists are to be placed in these boxes (see chapter on glanders on page 29).

MOBILE BLOOD EXAMINATION STATIONS

It was found necessary, especially when difficulties in transportation were to be taken into consideration, to have, besides the immobile ones, mobile blood examination stations, which could move forward with the quickly advancing troops, in order not to delay the results of the examinations through the long transportation of the blood samples. These blood examination stations are equipped with wagons, automobiles, etc., with which means the blood can be collected direct from those bodies of troops that must be examined. The equipment of the mobile examination stations is similar to that of the immobile ones except that they are provided with smaller apparatus on account of their smaller range of activity. The arrangement has the advantage that the apparatus necessary for the blood examination can easily be packed and in emergency can be shipped to a more favorably located point, where a new mobile blood examination station is to be fitted out.

DISINFECTION

By disinfection we mean the freeing of objects from infectious materials, everything living or dead which can cause infectious diseases in man or animals being looked upon as infectious matter. The disinfection consists of (1) the mechanical removal of the infectious materials; (2) the killing or preventing the growth of living disease-producing agents. It is necessary that objects to be disinfected undergo a mechanical cleaning process first; without following such a procedure it is questionable whether effect of the disinfection reaches such objects and no proof can be given that all infectious matter is destroyed.

Disinfection is effected in several different ways. In some cases it may result in the infectious material disintegrating entirely as by the use of antiformin; in other cases it depends on the osmotic disturbances which may lead to the death of delicate bacteria. Likewise, oxidizing processes may assist in the rapid extinction of bacteria. However, the destruction is mostly done by coagulating the living protoplasm. The lesser effect of dry heat in contrast to that of moist heat can be easily accounted for by this method; also the greater resistance of spores, as a general rule, compared to the vegetative forms of life. The vegetative forms contain decidedly more water (80%) than the spores. As a result of this greater water content, they are more easily coagulated and are, therefore, destroyed at lower temperatures than the spores, which contain little water. Moist heat has a stronger effect than dry heat because in this way moisture is brought in contact with the spores so that the albumin is caused to coagulate more quickly.

Most of the disinfecting agents, including those which form gas, work best in watery solutions; therefore, as an

example, concentrated formaldehyd gas or absolute alcohol is not good for disinfecting purposes, but, the moment these substances are diluted with water, their disinfecting powers are very materially increased.

Oils are not suitable as vehicles for disinfectants for they prevent water from penetrating the bacteria. Albumins hinder the disinfecting power in the same way, since they form insoluble compounds with metals. To demonstrate: bichlorid of mercury will kill anthrax bacteria in a 1 to 500,000 watery solution, but in an albuminous solution, not in a weaker solution than 1 to 1,500. The following demands are to be made of disinfectants: They must—

1—act quickly,
2—be readily soluble in water,
3—be cheap and easily kept,
4—not too poisonous,
5—have recognizable odor,
6—be as little injurious as possible to the objects which are to be disinfected.

DISINFECTION OF EQUIPMENT

Disinfection of metal objects, chains, etc., is best done with fire. Parts of harness should, as far as practicable, be left in a disinfectant for some time (bacillol, creolin, lysol). If this is not possible they should be carefully cleaned and then washed with a disinfectant.

DISINFECTION OF STABLES AND RAILROAD CARS

Disinfection of these places must necessarily be preceded by a mechanical cleansing. Litter that may be present, is to be removed and stowed away in some outlying spot, or eventually burned. We may proceed as follows: A layer of noninfected manure, straw or peat is placed on the floor of the stables or cars about 25 cm.

deep, 1.5 to 2 m. wide and of desirable length, and on this the manure to be disinfected is piled with slanting sides about 1.25 m. high. On top of this pile is placed a layer of noninfected manure, straw, leaves, peat or other loose material about 10 cm. thick; if this is done in the open the pile is then covered with a layer of earth about the same thickness. Further disposition of this material may then be made as suggested above. This is to be followed by a thorough mechanical cleaning of the floor, walls and ceilings of the respective quarters. Steam is best for this purpose, although brushing with stiff brushes and hot soda water must suffice in most instances.

After the cleaning the disinfection follows. Any of the various disinfectants may be used for this purpose. The simplest and safest is to disinfect with formaldehyd, milk of lime or milk of chlorinated lime. Attention is called to the fact that in the field one has to deal chiefly with the killing of the nonspore-bearing bacteria. When sporulating bacteria (anthrax) are in question, it is important that the disinfection be more thorough.

(a) FORMALDEHYD

Formaldehyd (CH_2O) is derived by oxidizing methyl alcohol (Ch_3OH).

$$\underset{\text{Methyl alcohol}}{CH_3OH} + O = \underset{\text{Formaldehyd}}{CH_2O} + H_2O$$

This is done by passing the methyl alcohol vapors mixed with air over glowing spirals of platinum or copper, and while these vapors are cooling a solution of formaldehyd is yielded. By passing this into water a solution of formaldehyd of about 40 per cent strength —formalin—is obtained; this is better known in the Pharmacopœia as formaldehydrin solution.

Use of Formaldehyd

The best disinfecting action from formaldehyd can be gotten when formaldehyd and water are heated, and a sufficient quantity of the mixed vapors developed to saturate a given area (Flügge). Five per cent solutions of formaldehyd (12.5 per cent formalin) have proved themselves to be most effective. Therefore the dry formaldehyd preparations which can be obtained on the market are not suited for disinfecting purposes; the formaldehyd must be diluted with water and applied in the form of vapor. In order to vaporize diluted watery formaldehyd solutions, an apparatus which has been recommended by Flügge's has proved to be very good. It consists of a kettle for the formaldehyd solution and above is a little spout (Düse) which leads the steam away. Below the kettle an alcohol lamp is placed. Both the kettle and alcohol lamp are encased in a metal covering in order to prevent any loss of heat. For an area of 10 cb. m. which has been tightly closed and where several hours' disinfection is desired, one liter of formaldehyd solution, *i.e.*, 50 grams formaldehyd or 125 grams formalin, is necessary. When applying the formaldehyd process, it is always necessary to tightly close the building so as to prevent the entrance of air or exit of formaldehyd vapors.

Formaldehyd remains in the building for quite a while and irritates the mucous membranes. One can overcome this disadvantage in human medicine by the introduction of ammonia into the disinfected room by which means the formaldehyd is changed to neutral hexamethylentetramin. For this purpose about 150 c.cm. commercial, 25 per cent ammonia should be vaporized for every 100 c.cm. formol or 40 gm. formaldehyd. The ammonia vaporizers are given to the formaldehyd disinfectors (in human medicine) but can be dispensed

with in veterinary medicine. For the vaporization and distribution of the formalin one can use an apparatus as seen in the accompanying illustration; the segmented sheet lead cans serve as containers for the formalin, alcohol and ammonia. The catalogue of Leitz-Bergmann,

FIGURE 1

Formalin disinfection apparatus according to Flügge, model 1914, of the main sanitary depot of Berlin.

Berlin, lists this apparatus with all the parts at 127.50 Mk.; without the ammonia developer, 110 Mk.

Besides the formaldehyd vapors one can use one to one and one-half per cent formaldehyd solution, which is best applied by using a fire water-pump or a disinfecting apparatus as is used for the spraying of milk of lime. Schnürer recommends that disinfection with formaldehyd solution be repeated after an interval of one to one and one-half hours, since by this method a stronger and more lasting action is obtained. For the disinfec-

tion of a railroad car he uses each time 30 liters of a one per cent formaldehyd solution, 15 liters being sprayed through one door and 15 through the other. When repeating he uses a like amount, which makes a total of 60 liters of a one per cent formaldehyd or 2.25 per cent formaldehyd solution for such an area. In disinfecting a stable a similar procedure is to be followed. In order that the disinfector may not be too much annoyed himself by this preparation, he must station himself in the stable door or some other place which opens on the outside and from there spray all corners and angles of the stable.

(b) MILK OF LIME

If formaldehyd can not be had, milk of lime or milk of chlorinated lime will give good results.

Milk of lime is best applied by the use of a pressure apparatus. Such disinfection apparatuses are provided with a hand pump, pressure hose and long nozzle. They can be carried on the back and hold 25 liters, or are transportable and contain 60 liters. If such apparatuses are lacking one can use a brush or scouring rag fastened to a long stick.

The preparation of milk of lime is done as follows:

One slakes the lime (CaO) by sprinkling it evenly with one-half its quantity of water until it is entirely pulverized.

$$\underset{\text{quick lime}}{CaO} \text{ and } H_2O = \underset{\text{slaked lime.}}{Ca(OH)_2}$$

By mixing the slaked lime (pulverized hydrate of lime) with different quantities of water, milk of lime can be made to any desired strength.

Thick milk of lime is made by adding three liters of water while gently stirring to one liter of freshly slaked lime.

Thin milk of lime (5 per cent milk of lime) is prepared by adding 20 liters of water to one liter of freshly slaked lime. In case freshly slaked lime is not to be had, one can also prepare the milk of lime by mixing to every liter of slaked lime 3 to 20 liters of water.

The unslaked lime in the lime quarry remains unchanged approximately four years, since on the surface a thin layer of carbonate of lime is formed which prevents the penetration of air into the depths of the lime. This upper layer in lime quarries is not suitable for disinfecting purposes and must first be removed. The milk of lime should be thoroughly stirred before using and in case one wishes to apply it with a spraying apparatus, it should also be passed through a sieve in order to prevent any clogging of the apparatus.

(c) MILK OF CHLORINATED LIME

Milk of chlorinated lime is produced from chlorid of lime. Thick milk of chlorinated lime is made by slowly adding one liter of chlorid of lime to three liters of water, stirring it all the while. Thin milk of chlorinated lime is made in the same manner except that 20 liters of water are used instead of but three. It is to be noted that the chlorid of lime must be kept in a closed vessel where it is protected from light and must have a strong chlorin odor. Milk of chlorinated lime should always be freshly prepared before using.

(d) CRESOLS

Cresol is obtained by first adding lye to coal tar from which a shake extract is then made. This is acidified and distilled at 200° C. (392° F.). The various cresols are soluble in water only to the extent of five per cent; the addition of soap increases the solubility. Such mix-

tures can be used as disinfectants with very little fear of poisoning and are on the market under the following names: liquor cresoli saponatus (carboxal I); carboxal II (substitute for creolin); bacillol; diluted cresol-water, *e.g.,* liq. cres. sap. 50, aq. 100.

(e) PHENOLS

Coal tar, distilled at 200° C. (392° F.) which contains 40 per cent phenol, is shaken with lye and then mixed with hydrochloric acid; the phenols floating on the surface are removed and distilled. Pure carbolic acid becomes red when exposed to air and readily decomposes. When wishing to keep it for some length of time it is better to use carbolic acid liquefied with ten per cent water.

Three per cent phenol solution is made:

Acid carbol. liquef.....	3
Aq. font.	100

(f) BICHLORID OF MERCURY

Hydrargyri Chloridum Corrosioum ($HgCl_2$).

Tablets of bichlorid of mercury contain equal parts of bichlorid and sodium chlorid (NaCl). Bichlorid of mercury is obtained by dissolving mercury in nitro-hydrochloric acid and then evaporating this to the point of crystallization. Its solubility is increased by the addition of sodium chlorid. A 1 to 1,000 solution destroys vegetative forms and a 1 to 100 solution destroys spores in a short time.

PART TWO

GLANDERS, MALLEUS

ETIOLOGY OF GLANDERS

Bacillus mallei, which was discovered by Lœffler and Schütz in 1882, is recognized as the cause of glanders. The rods are 2 to 5 micra long, 0.2 to 0.5 micron wide, nonmotile, Gram negative and lie individually and sometimes in pairs—one behind the other.

It stains best with carbol-fuchsin (about ½ minute) with which quite a number of granules can be demonstrated.

The honey-like growth obtained on potatoes is typical for the glanders bacillus; this turns a brownish color after a variable length of time. Glycerin-agar cultures appear slimy, transparent, grey to yellowish-white.

The resistance of the glanders bacillus is comparatively weak. Dried nasal discharge which contains the glanders bacillus is not infective after three days. Sunlight or drying kills the bacillus in a few hours, whereas it remains virulent for several months under damp and dark weather conditions. Ten minutes exposure to a temperature of 55° C. (131° F.) destroys pure cultures. Material from the internal organs of a glanderous horse is not infective after a few days.

Bichlorid of mercury 1 to 1,000; milk of chlorinated lime 1 to 800; milk of lime 4 to 100; lysol, creolin, carbolic acid in one to three per cent solutions, destroy the glanders bacillus in a few minutes.

THE SPREAD OF GLANDERS

Glanders is spread:

1—Indirectly by one horse sniffing at another or by snorting or violently sneezing;

2—Directly:

(a) By using common drinking troughs or mangers which are soiled with nasal discharge, saliva or particles of food from glanderous horses;

(b) Through equipment, *e.g.,* blankets, harness, saddles, currycombs, etc., which have been used on glanderous horses.

SYMPTOMATOLOGY OF GLANDERS

The portals of entrance for the glanders bacillus are the skin and mucous membranes. The lesions of glanders are dependent upon the manner in which the bacillus gains entrance to the body.

Skin Lesions

(*Dermatitis Malleosa*)

In the beginning boils and tubercles appear which vary in size from that of cherries to walnuts. They later rupture to form ulcers with irregular edges about the size of a lentil to that of a twenty-five cent coin. (Dermatitis malleosa ulcerosa.) A pus-like, yellow discharge exudes from the surface of the ulcer which often dries and leaves a scab-like covering on the ulcer. The lesions may heal and become covered with hair again so that later the affected area is more difficult to find. Besides the affections of the skin, we find an inflammation of the regional lymph glands and lymph vessels. These become swollen in a cord-like manner and in their course nodular enlargements are formed. The pearl-like enlargements which develop in the course of the cord may rupture and appear as an ulcer. When the lymph system of the limbs is involved, we often find combined with it an inflammation of the subcutaneous tissue and phlegmonous processes of the extremities (Dermatitis malleosa diffusa phlegmonosa).

Glanders lesions are found especially on the head, also in the places where the harness rests, particularly on the withers and in the region where the saddle rests as well as on the limbs. Swellings that occur on the fetlock are apt to be mistaken for ordinary bruises, except that the phlegmonous inflammation of the subcutaneous

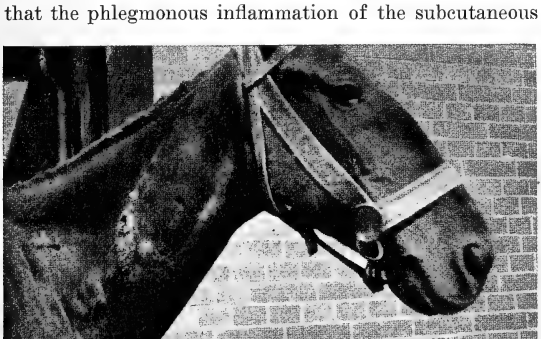


FIGURE 2

Nodules and ulcers on the skin of a glanderous horse arranged like a string of pearls.

tissue, which usually occurs here, is absent. Furthermore, the glanderous processes have the tendency to follow the lymph vessels, which results in new nodules or swellings. By means of the blood circulation we get in addition to the skin lesions, metastatic glanderous processes in the internal organs, especially in the lungs.

Lesions of the Mucous Membrane

(a) *Digestive Tract:* It is rare to find visible lesions in the digestive tract, although one must admit that the

glanders bacilli are often taken up with food and especially water. When the stomach is only partly filled, acidity is high, and as a consequence those bacilli that pass into the stomach become very much attenuated or even destroyed. This explains why glanders lesions are seldom found in the intestinal mucous membrane.

(b) *Respiratory Tract:* Infection of the mucous membrane of the respiratory tract occurs either through the inspired air or by soiling it with glanderous nasal discharges and particles of food, and finally by food or water containing glanders bacilli coming from the fauces or pharynx. Consequently, we find on the visible nasal mucous membrane, lentil-sized grey-red nodules at first and later ulcers with irregular edges and a lardaceous base. In case they heal they form scars which are flat and ranged in a star-like manner. Associated with this is a nasal discharge of a purulent character. Since the lesions of the mucous membrane often occur only on one side of the nasal cavity, the nasal discharge is consequently mostly unilateral. Accompanying these changes is a steady enlargement of the regional submaxillary lymph nodes. The nodules, which originally were the size of a lentil to that of a pea and from which the lymph nodes of that region are composed, become the size of a hazelnut; they become confluent and grow one into the other, which results in hard, compact, painless knots without increased warmth, and which are the size of a hen's egg. Finally, although not always, these lymph nodes become attached to the neighboring subcutaneous tissue. Fluctuation and abscess formations are never observed. The lungs become involved secondarily from the mucous membrane of the oral respiratory tract through the bronchioles or blood.

(c) *Sexual Organs:* Occasionally glanders infection can occur through testicular glanders of a stallion. The

first ulcerations localize on the mucous membrane of the vagina, and secondarily the infection occurs on the skin of the inner surface of the hind leg by means of the vaginal secretions which contain glanders bacilli and which flow over these regions.

Summary

All nodular-forming, ulcerated or cicatrized glanders lesions of the skin or mucous membrane are always associated with pathological conditions of the regional lymph system; consequently, when making a diagnosis it is necessary to take into consideration the condition of the lymph vessels and lymph nodes that become firm, painless and enlarged as well as often being grown into one another when glanders is present. When glanders lesions are in the lungs, one will observe in such infected animals a cough and occasionally shortness of breath. Although horses become emaciated in generalized acute glanders of the internal organs and show a continual rising of the temperature above 38.5° C. (101.3° F.), we miss these symptoms when the lesions are very small or partly or entirely healed. Usually the animals are in good condition, the coat shines and they do not show any rise in temperature.

PATHOLOGICAL ANATOMY OF GLANDERS

The typical product of reaction following invasion of the glanders bacilli into tissue is the glanderous nodule. It is produced as a result of proliferative and exudative processes of the tissue, which one can assume occur through irritation by the glanders bacillus and its toxins. First, the fixed cells of the tissue (connective tissue cells, endothelial cells of blood and lymph vessels, epithelial cells of the alveoli and glands) become swollen and then proliferate by means of mitosis (indirect cell division).

The resulting exudating process which follows somewhat later causes a gradual degeneration of the nodule produced by the cellular proliferation. In this degenerative

FIGURE 3

Ulcers and scars on the nasal mucosa of a horse.

process some nuclear granules remain which can be stained (chromatotexis). The central part of the nodule assumes a purulent appearance.

The nodules in the mucous membrane rupture to the outside and ulcers result which may become confluent with neighboring nodules that have undergone degen-

FIGURE 4

Glanderous ulcers of the mucosa on the ventral wall of the trachea.

eration, producing larger ulceration. These ulcers result in flat, star-like scars. Occasionally the proliferation gains the upper hand and the entire mucous mem-

brane becomes covered with a streaked, slightly elevated scar tissue as is sometimes seen in the trachea. Glander-

FIGURE 5

Glanders scars on the tracheal mucosa arranged in a streaked or striped manner.

ous changes of the mucous membranes occur most frequently on the nasal septum, on the floor of the inferior meatus, the mucous membrane of the pharyngeal cav-

ity, the covering valve of the eustachian tube, the laryngeal surface of the epiglottis, the arytenoid cartilage, the edges of the arytenoid-epiglottal folds and vocal cords,

FIGURE 6

Section through the lung of a horse showing new and old glanders nodules: (a) new focus with grey proliferation center and red periphery; (b) somewhat older focus showing yellow degeneration center; (c) still older focus showing central area degenerated and a translucent periphery.

the ventral walls of the trachea and the bifurcation of the trachea.

According to Schütz the glanders nodules in the lungs

are first composed of new formed tissue cells and appear grey. As a consequence of the resulting exudation, the peripheral portions of the nodule soon show pneumonic changes and are reddened—red hepatization. In the central part polymorphonuclear neutrophilic leukocytes occur coming from the exudate; the degeneration of the centrally lying cells now begins, leaving behind nuclear fragments of the cells. The focal area of degeneration which seems to be irregularly outlined gradually becomes larger, and the acute inflammation in the surrounding pulmonary tissue passes over into a chronic one so that the original red peripheral zone becomes grey, due to the fibrous tissue proliferation which becomes hyaline as it gets older. Calcification of the central area is never observed. The glanderous lesions in the lungs are always of various ages. Adjoining new homogeneous grey nodules, there occur some with a red periphery in which the central region shows a small, yellow, purulent area; also older nodules having a glassy, hyaline peripheral grey zone and a larger, straw-yellow, somewhat dry, degenerative area of a mortar-like quality.

As a result of the confluence of several glanders foci in the lungs, larger nodule formations may arise, in which as a rule, upon cross-section, the original confluence of the individual foci can be detected. Furthermore, as a result of the toxic irritation of the glanders bacillus, pneumonia and accumulation of exudate in the interstitial pulmonary tissue may occur and cause such a portion of the lung to be in a gelatinous condition (gelatinous pneumonia). A gelatinous pneumonia, which is occasionally observed in other diseases, can only be recognized as glanderous when it occurs in conjunction with the nodular changes. In connection with the lung lesions, we always find in the bronchial or mediastinal lymph glands glanderous changes which are

often of such small size that they can be found only after a careful examination of the lymph system and by making many sections. Then, however, one observes in the even and usually swollen marrow-like lymphatic tissue, straw-yellow degeneration-areas about the size of a pinhead or pea, which are filled with purulent or dry mortar-like material—never with calcified degeneration masses.

Glanderous nodules which occur under the pleura and even in some cases deeper in the lung tissue, are usually found only by careful scrutiny and palpation. Furthermore, considerable skill is necessary in sectioning such nodules, which should only be done with a thin sharp knife, for one can recognize the structure of a glanderous nodule only by sectioning squarely through the center, never by passing through the peripheral portion.

The mandibular and retropharyngeal lymph glands are considerably enlarged as soon as glanderous lesions occur on the skin or mucous membranes of the head. Individual nodules attain the size of a hazelnut to that of a walnut. The inflammatory process extends from the interstitial lymph gland tissue to the capsule (periadenitis) eventually to the contiguous tissue or the skin (paradenitis) which is followed by adhesions in these parts. In the swollen nodules one can find small yellow foci which later become enlarged and develop into a purulent fluid; usually they contain, besides the glanders bacilli, cocci.

In the spleen and the liver, glanderous nodules frequently occur of the size of a pea to that of a hazelnut. As a rule they contain a central, purulent degenerative area and a tough, grey-yellow periphery. Lymph nodes which occur at the porta of the liver have undergone changes similar to those in the bronchial lymph nodes.

The kidneys are seldom the seat of glanderous proc-

esses. However, glanders occurs here in the form of various sized nodules containing central degenerative areas. The cortex is the part principally affected.

Only a few instances have been cited where glanderous changes have occurred in the intestinal mucosa and the regional lymph glands. Ulcers of the intestinal mucosa sometimes described as glanderous, are usually parasitic in nature (Strongylus bidentatus).

The sexual apparatus is seldom affected. Occasionally one finds stallions with diseased testicles, in which case the testicle and the surrounding tissue have become a caseous mass. In mares the vaginal and uterine mucous membrane is swollen and infiltrated with nodules, ulcers and scars which resemble those found on the nasal mucosa.

Glanderous lesions of muscles and bones do not occur very frequently. In the muscle one finds foci of the size of lentils to that of walnuts which have degenerated in the center. The bones are enlarged (especially to be observed in the ribs) and infiltrated with pea-sized foci which occasionally communicate through openings with the surrounding tissue.

DIFFERENTIAL DIAGNOSIS

In the Living Horse

(a) *Chronic Nasal Catarrh:* In this condition a mucous, watery discharge occurs from both nostrils. The typical glanderous involvement of the mandibular lymph nodes does not occur.

(b) *Chronic Catarrh of the Accessory Nasal Cavities:* Such changes are usually unilateral. A fairly copious discharge that has a foul odor due to carious processes occurs, particularly when the head is lowered. Percussion and trephining give results that are worthy of consideration in making a diagnosis.

(c) *Tumors of the Nasal Cavities:* Fibroma, chondroma, carcinoma, sarcoma, rhinoscleroma, amyloid. Usually these changes are associated with a snorting respiratory sound, and the lymph nodes are normal.

(d) *Tuberculosis:* During recent times nodules, swellings and scars have been found on the nasal mucosa in tuberculosis. Corresponding with the preponderant proliferative character of tuberculosis, we find the ulcer surrounded by an elevated rim. In a similar manner the scars become elevated on the surface of the mucous membrane and usually in a star-shaped manner. The regional lymph nodes are infiltrated with tough, very small, caseous and calcareous foci. In the ulcers, tubercles and lymph nodes, one can readily find tubercle bacilli.

(e) *Strangles:* Strangles is usually found only among young horses; in them it usually occurs as an acute infectious disease, which is associated with painful and fluctuating inflammatory processes of the submaxillary lymph nodes. Suppurating lymph nodes, which are always present, have the tendency to rupture toward the outside.

(f) *Morbus maculosis:* In morbus maculosis one occasionally finds ulcers or nodular hemorrhagic points on the nasal mucosa, and sometimes resultant scars, which are apt to be misleading. The submaxillary lymph nodes are usually unchanged. The preliminary descriptions are to be taken into consideration.

(g) *Shortness of breath:* The pulmonary changes in glanders which are so often associated with shortness of breath and cough can easily be confused with harmless conditions, and only specific biological methods of examination will give satisfactory results here.

(h) *Lymphangitis with phlegmon:* In connection with infected skin wounds, one sometimes observes phlegmonous inflammation of the surrounding tissue; these can

be differentiated from the glanderous condition by their marked tendency to heal; however, such changes should always be examined with great circumspection.

(i) *Scars:* Scars, resulting from traumata, occasionally occur after injuring the mucous membrane of the nasal septum, with the thumb-nail during the examination of the oral opening of the nostril. Failure to find other changes verifies such a diagnosis.

In the Autopsied Horse

(a) *Entozoic nodules:* They are caused by the larva of the Strongylus dentatus, which have escaped from the circulation into the lungs, while migrating from the intestinal region. The parasitic nodules can be differentiated from the glanderous nodules in that the central degenerative area is surrounded by a smooth, glassy, grey-white, fibrous capsule. As a rule the central mass quickly undergoes calcification. Furthermore, we find upon microscopical examination collections of eosinophilic leukocytes which occur in the glanders nodules only in quickly disappearing small numbers. The regional lymph glands are, as a rule, not affected; occasionally there occur small calcified foci in the intact tissue of the lymph nodes. It is necessary to distinguish between the grey transversely-sectioned nodules (Schütz) which occur in the parenchyma of the lung and which later become calcified centrally only, and the embolic fibrous nodules (Olt). They are spherical, the size of a peppercorn to that of a pea, and the round, thin capsule is in close contact with a small obliterated blood vessel. Later they become almost entirely calcified, during which process the lamellar condition of the capsule is distinguishable. Corresponding to the embolic nature of these nodules, one occasionally finds the lungs filled with countless numbers of such calcified nodules, which causes one

to imagine that it is infiltrated with grains of sand—gritty lung.

The ulcers caused by the Strongylus bidentatus, found especially in the large intestine, are often confused with the glanderous lesions which are rarely found in this

FIGURE 7

Calcareous fibrous nodules of embolic nature in the lung. Sandy lung or gravelly lung.

location. A further examination of the mesenteric lymph nodes, which are always involved in glanderous conditions of the intestinal mucosa, but not in verminous conditions, should always be made in such cases. A marked eosinophilia of the ulcers on the mucous membrane is always noted in strongylus invasions.

(b) *Chronic bronchial catarrh:* Bronchitis develops in the form of nodules, which extend from the inflamma-

tory process of the smaller bronchioles to the surrounding pulmonary parenchyma. When examined with a good light the center of the sectioned bronchus shows such nodular points, from which, as a rule, sausage-like, calcareous masses can be pressed out.

(c) *Blood aspiration:* This occurs most often in horses after strong aspiration following death. The nodules are of the size of a pea to a hazelnut and are colored an even red; the communicating bronchi likewise contain blood.

(d) *Hemorrhagic Infarcts:* The hemorrhagic infarcts are wedge shaped and show a homogeneous condition of the cut surface, which, according to their age, may be partly red and partly grey.

DIAGNOSIS OF GLANDERS

The diagnosis of glanders is especially difficult during the life of the animal when the external parts which are to be examined are either intact or healed, and as a result show changes that are difficult to recognize. All of the former usual methods such as determining the presence of the bacillus, inoculation of guinea pigs, trephining, etc., have been more or less withheld. In animal inoculations one must always use at least four to six guinea pigs, because occasionally not all guinea pigs become sick. This should especially be taken into account when one is dealing with chronic glanders. The inoculation follows by using material which has been triturated in a mortar with sterile water and then filtered free from the coarser particles, the injection being made subcutaneously in the abdominal region between the hind legs. After four to eight days the precrural lymph glands become swollen as does also the scrotum; at the site of injection an abscess develops; the animals die usually in two to six weeks. It cannot be emphasized too strongly

that all methods for diagnosing glanders should seriously be taken into consideration.

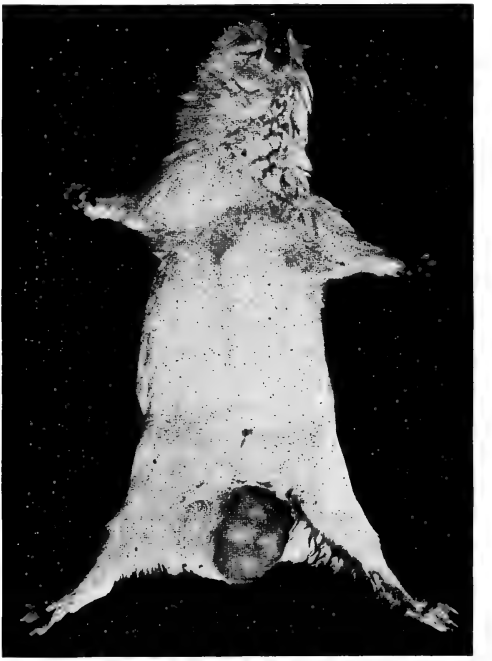


FIGURE 8

Male guinea pig infected with glanderous material. Abscess at the site of infection on the abdominal skin; marked swelling of the scrotum. (Strauss' reaction.)

The clinical symptoms are equally as important as the biological reactions. We do not have to deal with the

solving of mathematical problems but with conditions in the living body. Here the changes are not as constant, so it behooves one to observe all symptoms. It is necessary that one have broad training and experience in order to arrive at the correct conclusion in doubtful cases. A decision at times is made not only from objective findings in a single case, but also from all circumstances bearing upon it, such as age, the spread of glanders in one group of horses, the equipment of the stables, drinking troughs, the manner of feeding, etc.; in other words, the ease or difficulty of the spread of the glanders bacillus.

In a clinical examination one must, above all things, examine the skin for the presence of nodules and ulcers, in which case the points where the harness rests are first to be taken into consideration. Enlargements of the lymph glands and cord-like swellings of the lymph vessels, are also to be observed. Following this, a careful examination is to be made of the Schneiderian membrane for nodules, ulcers and scars as well as the presence of a nasal discharge. Coincidentally, we always find painless, firm enlargements of the regional submaxillary lymph glands without elevation of temperature of these glands. Furthermore, one must be on the alert for cough, shortness of breath and note the general condition of nutrition, and finally the temperature must be considered, since in acute glanders the temperature always rises above 38.5° C. (101.3° F.).

Aside from the clinical examination, thorough use is to be made of the biological reactions. In this respect what was said above holds good, for they are not infallible, and it is well to use at times this method and at others some other method. For that reason, one should, wherever possible, carry out different tests at the same time. Consequently, the following are to be considered:

The agglutination test.
The complement-fixation test.
The conglutination test.
The ophthalmic test.

THE AGGLUTINATION TEST

By agglutination we understand the clumping together of microörganisms, which at the same time lose their mobility.

Agglutination is always observed when one brings together the serum of an artificially infected animal or one that has suffered a natural infection, with the corresponding causal bacterium. Those substances which occur in the serum as the result of such infection are spoken of as the agglutinins. As an example, they are found in greater quantities in the serum of a glanderous horse. Such a serum will agglutinate glanders bacilli.

Agglutination of the glanders bacillus is best accomplished by adding known dilutions of the horse serum to 2 c.c. of a killed B. mallei culture and reading the results after twenty-four to thirty-six hours. When a positive agglutination reaction is finished, the agglutinated glanders bacilli have gravitated to the bottom of the tube and formed a broad, irregularly edged, white precipitate, and the supernatant fluid is perfectly clear. In the event of a negative reaction (no glanders) there are quite a number of bacteria which gravitate to the bottom, but in the deepest portion of the test tube will be found a non-transparent, circular percipitate and the supernatant fluid will be clouded. The agglutinins are specific, *i.e.*, they will act only upon the causal bacterium with the help of which they were produced in the animal body. In other words, the serum of a glanderous patient will agglutinate only glanders bacilli, and the serum of a typhoid patient will agglutinate only typhoid bacilli,

etc. The agglutinins are not immediately formed in the serum of glanders-affected horses, but it requires about *four* to *five* days before we can demonstrate their presence. The quantity of the agglutinins then steadily increases, and the development reaches its maximum on the tenth or eleventh day after the infection. This potency remains with but slight variation for two or three weeks and then gradually decreases until after a lapse of about six to nine months, after which the quantity of agglutinins will be approximately as great as at the time of infection. It is worthy of note that agglutinating substances are found in the serum of horses free from glanders (normal agglutinins), although they may be present in much smaller quantities. The presence of normal agglutinins forces us, when carrying out the agglutination test, in testing the agglutinability of a suspected serum, not to overlook this fact.

It is not only necessary to demonstrate the mere presence of agglutinins, for some are found in every horse, but it is necessary to determine the amount of agglutinins which will act as a criterion whether the serum originated from a glanderous or healthy horse. For that reason only a highly diluted serum should be brought together with glanders bacilli because experience in this respect has taught that sera of glanderous horses will still agglutinate in high dilutions but not so with sera from glanders-free horses. The smallest amount of serum that will agglutinate we refer to as agglutination titre and as a rule express this as 1 to 400 or 1 to 2,000, abbreviating this, 400 or 2,000, *i.e.*, the serum has a maximum dilution of 400 or 2,000. The higher the agglutination titre, just so much greater are the probabilities that the serum originated from a glanderous horse.

Healthy horses on the average have an agglutination titre of about 400, *i.e.*, their serum will agglutinate in

dilutions of 1 to 400. However, it is not unusual that non-glanderous horses have an agglutination titre of 600, 800 and even 1,000, although this is very uncommon.

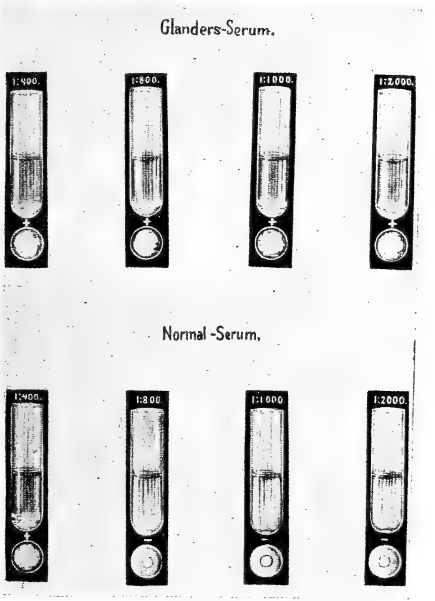


FIGURE 9

Agglutination. Upper row: agglutination of a glanders serum having an agglutination titre of 1:400 to 1:2000; in all four tubes is a clear supernatant fluid and a broad veil-like, irregularly outlined precipitate.

Lower row: agglutination of a normal serum having an agglutination titre of 1:400. In a dilution of 1:800 and above no agglutination; fluid cloudy; sharply outlined precipitate. (According to a drawing by Dr. Lütje.)

Sera showing an agglutination titre above 1,000 always originated from glanderous horses.

Corresponding with the aforementioned increase and decrease of agglutinins during the course of glanders infection, the agglutination titre will naturally become changed, and when the serum of a normal horse shows an agglutination titre of approximately 300, he will, in four to five days after infection, show a rise to 500 and at the tenth to eleventh day a rise of 2,000 to 4,000. In the course of time the agglutination titre gradually decreases and at the end of three or four months will show a maximum of 800; after six to nine months it will have reached the terminal maximum of 300 (Schütz and Miessner).

We can conclude from this increase and decrease in the agglutination titre of the serum of a glanderous horse the following:

(a) By means of the agglutination reaction it is possible to recognize an infection with glanders in horses on the sixth to ninth day.

(b) High agglutination titre bespeaks a recent glanders infection.

(c) Horses chronically infected with glanders (those having been sick more than six months) cannot definitely be determined as glanderous by means of the agglutination reaction.

THE COMPLEMENT-FIXATION TEST

The disadvantage of the agglutination reaction lies in the fact that by its use a case of chronic glanders in a horse cannot, as a rule, be diagnosed. This gave impetus to inaugurate a second serological test, the so-called complement-fixation reaction.

By antigens we mean such proteins (bacterial, cytological, milk, hemotological, etc.) which have the power

to cause the production of antibodies in the living animal. Antibodies have distinctly different characteristics; those which take part in the complement fixation are, according to Erlich's side-chain theory, two armed—amboceptors, *i.e.*, they have two distinct affinities. With these they seek to bind on the one hand the antigen and on the other the ever-present complement. Antibodies develop as a result of treating an animal with antigens; they are specific and will unite only with their antigens from which they originated. The antibodies resist heat (thermostabile); the complement is destroyed at 56° C. (thermolabile).

This phenomenon can be demonstrated *in vitro*, which can be made especially lucid by using as antigens blood corpuscles. By injecting sheep blood corpuscles (antigen) into a rabbit there are produced the two-armed antibodies (sheep blood anti-serum) which possess affinities to join with the blood corpuscles (antigen) on the one hand and the complement on the other. When mixing sheep blood corpuscles with sheep blood anti-serum (antibodies) of a rabbit in a test tube, a binding of the antibodies with the blood corpuscles results and this binds with the complement in the serum. This action is indicated by the appearance of a red color which is caused by the red corpuscles going into solution—hemolysis (+).

If the sheep blood anti-serum (sensitized rabbit serum) is previously heated to 56° C. (132° F.), *i.e.*, inactivated, there will be no hemolysis because at this temperature the complement is destroyed—the complement being the lytic factor. The combination of antigen and heated anti-serum in which the thermostabile antibody (amboceptor) is contained, but the thermolabile complement missing, we designate the inactive hemolytic system. If one adds to this system normal guinea pig

serum (complement) hemolysis will be produced due to the complement in this serum. It is to be deduced from this that in order to produce hemolysis, the complement is always used and bound (a similar action takes place in bacteriolysis as well as in the union of any antigen and antibody). The complement fixation reaction and its use as a diagnostic test rest upon these facts.

As an example, if we bring the serum of a glanderous horse, which serum has been previously heated to 56° C. in order to destroy the thermolabile complement, together with glanders bacilli, then the one arm of the amboceptors in the serum will show an affinity for the glanders bacilli and the other for the complement. Since the glanderous horse serum was previously heated, the complement was destroyed and consequently one arm will remain free. But if we add some complement artificially; that is, by the addition of normal guinea pig serum, the one free affinity of the amboceptor will immediately unite with the complement in the guinea pig serum.

The complement binding process can be recognized either macroscopically or microscopically; consequently, in order to make this visible, we use an indicator, which has been mentioned previously in the inactivated hemolytic system (Schütz and Schubert).

Experiment No. 1. In a test tube mix inactivated serum from a glanderous horse, guinea pig serum (complement) and B. mallei extract. In one hour sheep blood corpuscles and the inactivated sheep blood anti-serum (inactivated sensitized rabbit serum) are added. Solution of the red blood corpuscles can result only if the complement (guinea pig serum) which is free in the test tube unites with the sheep blood anti-serum. However, this is not what takes place since the complement was previously bound to the glanders antibodies. Con-

sequently, hemolysis of the blood corpucles does not occur owing to the absence of complement in the sheep blood anti-serum. As a result the blood corpuscles after a time precipitate to the bottom and the supernatant fluid becomes water-clear—inhibited hemolysis (– hemolysis).

Experiment No. 2. The experiment will result entirely different if we should add in the first part inactivated serum of a non-glanderous horse together with guinea pig serum (complement) and B. mallei extract. The glanders-free serum does not contain a two-armed antibody for glanders bacilli and complement and as a result there will be no union with the glanders bacilli nor with the complement, the complement remaining free, not fixed. If, after the lapse of an hour, we add the inactivated hemolytic system, the blood corpuscle amboceptor (inactivated sensitized rabbit serum), which has become fixed with its one arm to the blood corpuscles (hemolytic antigen), will act with greater energy on the complement contained in the guinea pig serum and a solution of the blood corpuscles (+ hemolysis) will ensue. The hemolysis can be easily recognized by the appearance of a cherry red color in the test tube.

Both experiments are expressed in the following formal manner:

1. B. mallei extr. + inact. glanders serum + complement; after one hour + bld. corp. anti-serum + bld. corp. = negative hemolysis –

2. B. mallei extr. + inact. normal serum + complement; after one hour + bld. corp. anti-serum + bld. corp. = hemolysis +

The lack of hemolysis is a sign that the suspected serum originated from a glanderous horse; the presence of hemolysis indicating that the serum originated from a glanders-free horse.

The complement binding substances will first appear

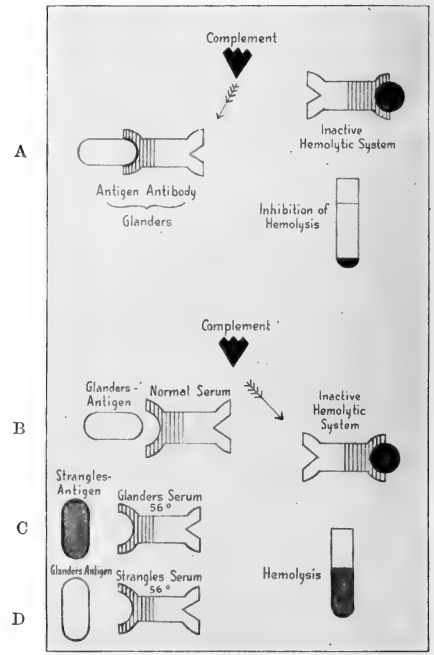


FIGURE 10

Schematic representation of complement-fixation reaction.

A. — hemolysis when using glanders bacilli (antigen) and glanders serum (antibodies) as in Experiment 1.

B. + hemolysis when using glanders bacilli and normal serum as in Experiment 2.

C. + hemolysis when using strangles cocci (antigen) and glanders serum.

D. + hemolysis when using glanders bacilli and strangles serum.

after some time following a glanders infection in the horse similarly as with the agglutinins; also a considerable interim elapses as in the agglutination process. As a rule they can first be demonstrated in a serum of glanders infected horses on the twelfth to the fourteenth

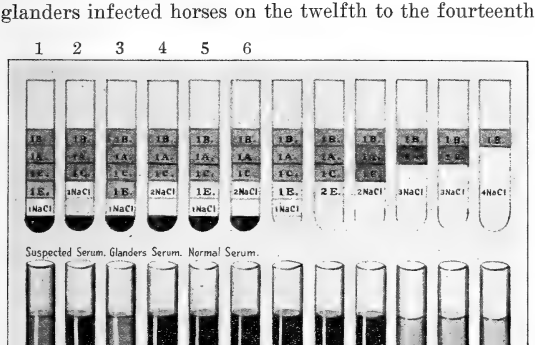


FIGURE 11

Complement-fixation experiment. Tubes 1 and 2 contain the suspected serum; 3 and 4, the known glanders serum as control; 5 and 6, the known normal serum as control. The last six tubes serve as controls in order to determine whether the substance employed in the experiment react as they should; extract (E), complement (C), sheep blood anti-serum (A), blood corpuscles (B), and salt solution (NaCl).

day. Deducing from this one can conclude that the complement fixation method for diagnosing of a recent case of glanders is not so well suited as the agglutination reaction, but on the other hand the complement binding substances (glanders antibodies) remain in the serum of a glanderous horse much longer than the agglutinins; consequently, the complement fixation method can still

be applied for some time in chronic cases of glanders, in which instance the agglutination reaction would not be applicable. In such cases (chronic glanders) the complement fixation method is of inestimable value.

In the case of the agglutination reaction, it is necessary to reckon with very high dilutions of the suspected horse serum, whereas in the complement fixation method this is not the case, and we can express ourselves in a more lucid manner by using actual figures to show the quantity of serum used in every experiment. Experience has shown that all sera originating from glanderous horses, used in the quantity of .2 c.c., are able to bind the glanders bacilli and complement. We designate the smallest amount of serum that will still bind the complement as fixing titre (potency) or binding titre. We can deduce from this that the smaller the binding titre just so much more certainly has the horse glanders. The agglutination and complement-fixation methods supplement one another in a very desirable manner since the agglutination method gives us an idea how recently the horse was infected, and frequently the approximate duration of the glanders infection. This is also the reason why Schütz uses both methods for diagnosing glanders.

THE CONGLUTINATION TEST

Cattle serum which has been inactivated by heating to 56° C. (132.8° F.) has the ability to agglutinate red blood corpuscles (sheep) if active horse serum (not heated) is added. Neither horse serum nor inactivated cattle serum can produce this agglutination separately. In this action the blood corpuscles become clumped together in a fibrous-like mass, which equals positive conglutination (+) and the fluid which originally was a cloudy red is now clear and colorless. This reaction is caused by the thermostabile conglutinin which is present

in the cattle serum and is also known as colloid. The conglutinin will act only if the red blood corpuscles are bound to the complement (alexin) of normal horse serum by means of the two-armed normal amboceptors (sensibilisin) that occur in cattle serum. If the complement is missing, there will be no conglutination. The unaffected (not sensitized and alexinized) red blood corpuscles gravitate to the bottom of the test tube and the supernatant fluid becomes water clear (negative conglutination) as in negative hemolysis.

The conglutination test accordingly can be used in a similar manner as the complement fixation test for diagnosing glanders, except that in place of the complement-containing guinea pig serum, one uses the complement-containing serum of a normal horse, and in place of using sheep blood antiserum (sensitized rabbit serum), one uses inactivated cattle serum (conglutinin).

The absence or presence of conglutination of the red blood corpuscles serves as an indicator, *i.e.*, whether the complement was bound or not bound, and accordingly whether the suspected horse serum originated from a glanderous or nonglanderous horse (Pfeiler and Weber).

Experiment No. 1. In a test tube add to a mixture of inactivated glanders serum and B. mallei extract, normal horse serum (complement). After the lapse of one hour, sheep blood corpuscles and inactivated cattle serum (conglutinin) are added to this. Conglutination of the red blood corpuscles could occur only if the complement (normal horse serum) were free (not bound) in the test tube and, with the help of normal amboceptors in the cattle serum, unite with the red blood corpuscles. This does not occur because the complement was previously united with the glanders antibodies. Consequently conglutination of the blood corpuscles does not occur, owing to the absence of complement, which indi-

cates that the suspected serum originated from a glanderous horse.

Experiment No. 2. The experiment will result differently as soon as we bring together the inactivated serum of a glanders-free horse and normal horse serum (complement) and B. mallei extract. The glanders-free serum does not contain a two-armed antibody for binding the glanders bacilli and complement; consequently there will be no union with the glanders bacilli or with the complement—the complement is not bound. If after the lapse of one hour we add red blood corpuscles and inactivated cattle serum (conglutinin), the red blood corpuscles can be so influenced by the use of the available normal amboceptors and the complement of the normal horse serum, that the cattle serum will bring about conglutination of the red blood corpuscles.

Both experiments are expressed in the following formal manner:

1. B. mallei extr. + inact. glanders serum + normal horse serum; after one hour + inact. cattle serum + bld. corps. = – conglutination.

2. B. mallei extr. + inact. normal serum + normal horse serum; after one hour + inact. cattle serum + bld. corps. = + conglutination.

The absence of conglutination indicates that the suspected serum originated from a glanderous horse; the presence of conglutination indicates the serum originated from a glanders-free horse.

The conglutination test is carried out analogously to the complement fixation test with which it primarily has great similarity. Consequently what was said in regard to the complement fixation test also applies here. It is frequently used as a control on other serological tests and is at times used to diagnose chronic cases of glanders instead of using complement fixation tests. The

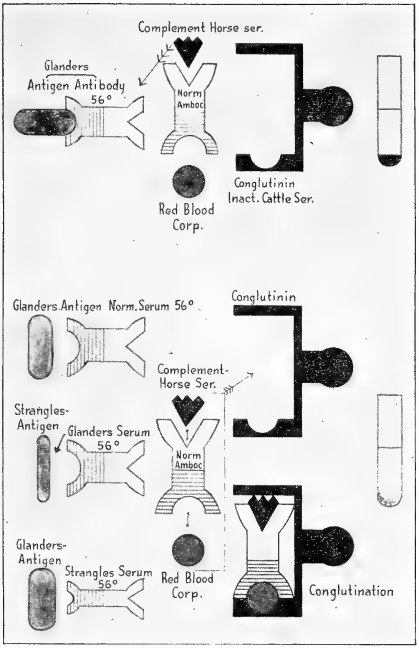


FIGURE 12

Schematic representation of conglutination reaction.

A. — conglutination when using glanders bacilli (antigen) and glanders serum (antibodies) as in Experiment 1.

B. + conglutination when using glanders bacilli and normal serum as in Experiment 2.

C. + conglutination when using strangles cocci (antigen) and glanders serum.

D. + conglutination when using glanders bacilli and strangles serum.

conglutination test, due to its more simple character, is often preferred to the complement fixation test; also, the latter requires the tediously produced sheep blood antiserum (sensitized rabbit serum) and expensive guinea pig serum, whereas with the conglutination test one can use the easily obtained normal sera of cattle and horses.

Examining the Sera of Suspected Cases of the Ass and Mule

The normal sera of the ass and mule contain substances that bind guinea pig complement of their own accord (without first binding with B. mallei extract). We can quite naturally see that upon adding the inactivated hemolytic system, solution of the red blood corpuscles does not occur due to the lack of complement. Consequently the complement fixation test for these sera is not applicable when endeavoring to make a diagnosis. This also applies for some normal horse sera, although this is very rare. The exact nature of these complement binding substances is not well understood, but in all probability they are normal amboceptors which on account of their peculiar behavior toward guinea pig complement are spoken of as anti-complementary normal amboceptors.

The above-mentioned sera possess no anti-complementary characteristics toward the complement in horse serum. Therefore, in the diagnosis of glanders in the ass and mule as well as in a few horses whose sera bind normal guinea pig complement, it is highly desirable, if not necessary, to use the conglutination method in which the complement of horse serum determines the reaction instead of the guinea pig complement.

Schütz and Waldmann introduced the modified complement fixation method for these sera. It resembles a conglutination method, but instead of sheep corpuscles being used guinea pig blood corpuscles are used. This method is referred to as the K. H. method.

THE OPHTHALMIC TEST

Theory of Action

It is well known that in the ophthalmic test a preparation containing glanders substance (mallein) is brought in contact with the conjunctiva. In glanderous horses there develops after ten to twenty hours an inflammatory swelling of the conjunctiva accompanied by a purulent discharge. The development of this reaction can be explained according to Ehrlich's side chain theory; the glanders substances in the mallein (antigens) endeavor

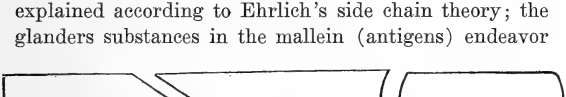


FIGURE 13

(a) Mallein; (b) antimallein; (c) complement (serum + leukocytes).

to unite with the antibodies which develop in the body of the glanderous animal. It is well known that the antibodies are composed of two uniting arms (haptophore groups), one of which attempts to unite with the antigen (mallein), and the other with the complement. The complement, a fermentative substance, occurs in serum and has as its origin, at least in part, in leukocytes. Consequently, one can readily see that at the site where the mallein was applied, following the union of glanders antibodies and glanders antigens, a serous fluid and white blood corpuscles will be drawn to that locality; and as a consequence inflammation and exudation result, leukocytes being mixed with the exudate.

According to this theoretical discussion, one can readily understand the development of the reaction, the swelling of the eyelids and the purulent discharge. As

the result of the incomplete destructive action of the complement on the mallein, peptones are developed in the body which are poisonous, and they cause a rising temperature. According to this it is self-evident that the mallein must be brought in the closest contact with the mucous membrane in order to produce a satisfactory reaction, *i.e.*, it should draw serum and leukocytes to the part.

Performing the Test

According to my personal experience, I have gotten very good results with that form of mallein known as *Malleinum siccum*—Foth (dry mallein). I have no experience with other preparations. My observations have proved to me that it is necessary to become well acquainted with the strength of the preparation which one uses and always to use mallein coming from the same source (same firm), because there is no doubt whatever that the method of preparation, density and virulence of the bacteria used have a decided influence on the character of the reaction.

In some localities a fluid mallein is being used and it is remarkable that quite a few positive reactions are obtained in glanders-free horses. This can only be explained by the presence of preservatives in the mallein, which have an irritating action on the mucosa and cause the animals to rub themselves on halter chains and cribs, which readily leads to a resulting inflammatory process. It is also possible that fluid mallein after some time may spoil and the resulting products act as irritants to the mucous membrane. Considering these facts I cannot recommend too strongly the exclusive use of dry mallein which will not cause any of the aforementioned false reactions.

Malleinum siccum—Foth (dry mallein) is prepared from a 4.5 per cent glycerin bouillon culture of B. mallei.

In order to maintain the virulence of the glanders bacilli, only such strains are to be used that have been passed through field mice, guinea pigs or cats. Cultures are grown on a large scale in flasks of 100 to 250 cc. for three weeks at 37.7° C. (99.8° F.), and then after testing for purity, it is concentrated to one-tenth of its original volume by heating at a constant temperature of 76° C. (168.8° F.). Following this it is filtered through Swedish filter paper. This fluid mallein is then slowly poured into twenty-five to thirty times its volume of absolute alcohol. Almost immediately a dense, fine white precipitate results. This precipitate is then, after twenty-four hours, collected on absorbent filter paper, freed from alcohol and finally dried in a vacuum in the presence of freshly dehydrated calcium chlorid, without heating. The final product is a very light voluminous, yellowish white, not entirely hygroscopic powder which should form an absolutely clear solution in water. This can be had on the market in tubes containing .03 of a gram.

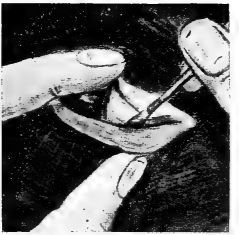
The powder is placed into any small available dish and in order to prepare a one per cent solution 3 c.c. of physiological salt solution or sterile water are added to it. Complete solution takes place very quickly. With an ordinary small camel's hair brush, a little of this mallein solution is painted on the inner surface of the eyelid. It is not difficult to execute this simple process even upon the most nervous horses. It is much to be preferred to other methods such as the introduction of the mallein with a pipette or a glass rod; also when applying the mallein to a large number of horses at one time, as it often happens in practice, one does not always have satisfactory control so that the drop of mallein may not go into the conjunctival sack. This would also prove to be the case under poor stabling conditions or where there was

poor light. Considerable material is also wasted by this method. Furthermore, it is necessary to remember that as soon as the drop of mallein is placed in the eye, the horse immediately closes the eye and most of the fluid is forced out by this sudden movement, which prevents the most important feature in malleinization, *i.e.*, the intimate union between the mallein and the conjunctiva, which alone can produce a reaction.

Judging the Reaction

After about twelve hours following the malleinization, the horses are to be examined in order to see what reaction has occurred. In the healthy horse the eyes will be unchanged. Occasionally one may observe a slight mucous discharge, which, however, cannot be looked upon as a true reaction, but nevertheless it should be noted on the examination list with a plus sign (+).

Glanders-sick horses show variations in their reaction. The weak reaction (++) is indicated in that the eyelashes are moist and that eventually a small drop of pus is formed. In such cases as well as in those where a serous discharge occurs in a healthy horse, one is forced to closely examine the conjunctival sack itself; this is done by forcing the eyeball back with the index finger of the left hand, which readily exposes the conjunctival sack for examination. In the glanders-sick animal we will find small drops of pus on the surface of the conjunctiva even though the reaction is very slight; in the healthy animal we will find only a mucous exudate. In the medium reaction (+++) the conjunctiva is reddened and at the same time a purulent discharge is noted; also the lower eyelid is swollen and light is painful to the eye. The strong reaction (++++) is indicated in that besides the purulent conjunctivitis, a swelling of both eyelids and photophobia are present. The very strong



Introducing the mallein.

Negative reaction —.

Sero-mucous discharge +.

Pus drops in conjunctival sac + +.

Purulent discharge + + +.

Discharge with pasting together of eyelids + + + +.

FIGURE 14

Ophthalmic reaction. (After a drawing by Dr. Lütje.)

reaction (+++++) is recognized in that the eyelashes are pasted together by the purulent material and the eye is kept closed; also the animal shows a weakened condition and refuses to eat. Still stronger reactions are shown by a unilateral nasal discharge and swelling of the submaxillary lymph nodes.

Reactions such as are indicated by three plus signs (+++), four plus signs (++++) and five plus signs (+++++) can never cause a doubt in one's mind as to their positiveness. The beginner may have trouble in recognizing the weaker reaction, as indicated by one plus and two plus signs and where we find a mucous discharge in the non-glanderous horse. However, if one is always on the alert for a purulent exudate and inflamed condition of the conjunctiva, one should with a little practice always make a correct diagnosis. In order to draw comparisons one should examine the untreated eye, for in that way the inexperienced individual will be able in a short time to make a correct diagnosis on large numbers of horses even though he is doing so by just casually glancing at them in walking by. He must, of course, be very careful in the doubtful cases in which the skin at the inner canthus of the eye is covered with a serous exudate, to examine the conjunctival sack for the possible presence of purulent fluid. In the event that a doubt still exists, one can apply mallein to the other eye and after twenty-four hours one will usually find that such doubtful cases will give a strong reaction after the second malleinization. As a last resort one can still use in individual cases the serological tests.

Measuring Temperatures

Schnürer first demonstrated that every reaction is accompanied by a rising temperature above 38.5° C (101.3° F.). Through personal experience I could barely con-

firm such findings, for I found under certain conditions that the temperature rise was very small at times, sometimes not more than 0.2 to 0.3 degrees [Centigrade] and furthermore this only remained for a short length of

FIGURE 15

Ophthalmic reaction; degree of reaction ++++.

time. Consequently, if one desires to make use of the temperature readings these should be taken every two hours by a responsible person from the tenth to the twentieth hour after malleinization. This is the only way in which one may diagnose doubtful cases and such cases where there is a slight rise of temperature that lasts but a short time. This is not at all practicable in

examining large numbers of horses as is done in the army and should be excluded.

Considering the small temperature rises that often occur and can only be determined by the most careful readings, they can be omitted if it is desirable to simplify the method of measuring the temperature.

Misleading Results

Previously Existing Conjunctivitis

Misleading results can be avoided in horses that are already suffering from a conjunctivitis by not submitting them to the test. Therefore, it is necessary before carrying out the ophthalmic test to determine the existing character of the mucous membrane, especially where there already exists a conjunctivitis. In cases where there is a very slight watery discharge which occasionally occurs from both eyes in horses, one can nevertheless carry out the test, since one can come to a correct decision by first drawing a comparison between the treated and untreated eye.

In case there is a unilateral conjunctivitis one should apply the mallein to the mucosa of the healthy eye. In cases where both eyes are affected with a purulent conjunctivitis, one must perforce omit the ophthalmic test entirely.

Foreign Bodies

Schnürer called attention to the fact that occasionally the small hairs of the brush or small pieces of glass which chip off in opening the mallein tube might give rise to a misleading reaction. In a like manner small particles of hay or straw or lime from the wall may produce a purulent discharge. In all such cases one should carefully examine the conjunctival sack for the presence of possible foreign bodies.

Previous Removal of the Discharge

It is possible, especially in the army, that the secretion might be wiped away, because here the attending soldier always endeavors to present his animal in as clean a condition as possible. Consequently, the stable attendants should be previously instructed not to attempt to do anything to the eyes of the animals and, during the time under which the horses are under observation, not to clean them.

Periodic Ophthalmia

Occasionally periodic ophthalmia may lead to an incorrect diagnosis. According to my views, this can only occur where the ophthalmic test is made coincidentally with an acute attack of moon blindness, associated with conjunctivitis. Personally I have had no experience in this respect. However, a critical examination of the eyes should prevent such mistakes in most cases.

Strangles and Diseases Simulating Influenza

In determining the character of a reaction in a case of strangles, which frequently has associated with it a purulent conjunctivitis, it is necessary to use considerable careful judgment. No doubt a better plan would be to postpone the time of carrying out the ophthalmic test until after convalescence. In a like manner it is necessary to take into consideration the conjunctivitis which always occurs in equine influenza.

Fly Troubles in the Open

In midsummer, when large numbers of flies are always present, the possibility exists that these flies will take up the secretion (especially if slight) resulting from the test and cause one to make a false report on the examination. It is, therefore, necessary to exercise great care when carrying out the ophthalmic test in the open

on very warm days when large swarms of flies are present (personal communication from Foth).

Previous Malleinization

According to Schnürer, about .01 per cent of healthy horses that have been repeatedly subjected to subcutaneous and local mallein injections show a positive reaction to the ophthalmic test. I have had no opportunity to observe such instances; surely the number must be very small, for it is only occasionally that one has to do with horses that have been repeatedly treated with mallein.

Applying the Ophthalmic Test

Since the good results obtained in the combating of glanders in Germany are doubtless due to the proved sero-diagnostic tests, one would not deviate under normal conditions from these methods, the more so, as constant and uniform results are guaranteed when the blood samples are submitted to a central office which will insure coöperative work with outlying points, an advantage which cannot be underestimated. However, in such cases where large numbers of horses are under consideration, and which, furthermore, are widely separated and not in close proximity to laboratories and when there are insufficient working forces or transport difficulties, etc., etc., and when one is forced to make a quick diagnosis, then it becomes necessary to use the ophthalmic test in order to combat glanders. The amount of antibodies in the serum is not changed by locally applying mallein in glanders-free horses, so that later when one applies blood examination methods one is not influenced because of such malleinization. In antithesis to this, upon the subcutaneous application of mallein, the agglutination and complement fixation titres are increased, so that healthy horses will appear glanderous.

The ophthalmic test should be given preference to the serological methods in diagnosing suspected cases of glanders because of the simplicity of its application and the rapidity with which it enables one to establish a diagnosis. The confusion of blood samples which occurs at times is also excluded when applying the ophthalmic test. As in all other tests, in order to judge the reactions correctly, a certain amount of experience is necessary, especially when dealing with doubtful cases. Consequently, the beginner will do well to apply the ophthalmic test a second time in doubtful cases and to separate such horses from others and await the results from a serological test.

Directions for Applying the Ophthalmic Test

1. Enough *malleinum siccum* (dry mallein) and camel's hair brushes for the treatment of twenty horses.

2. A dose of mallein is prepared by mixing it with 3 c.c. of sterile water or physiological salt solution and then well shaken to bring about its solution.

3. The camel's hair brush is dipped into the mallein solution and the lower conjunctival sack of one eye painted with it.

4. About 12 to 20 hours later the degree of reaction in the eye is observed and a note made accordingly with the following marks:

− = Conjunctiva unchanged, no discharge.
+ = Limited sero-mucous discharge.
++ = Discharge mixed with drops of pus.
+++ = Purulent discharge, lower lid swollen, photophobia.
++++ = Purulent discharge, lower and upper lids swollen, photophobia.
+++++ = Strong purulent discharge, both eyelids swollen and pasted together; photophobia; weakness.

5. After noting the degree of reaction, the same eye in all weakly reacting horses is again treated with the mallein solution (see No. 2).

6. About 12 to 20 hours later the degree of reaction is noted in this second examination.

7. All typically reacting horses are to be isolated immediately.

8. Horses that are to be looked upon as reacting typically have in the conjunctival sack or in the inner angle of the eye, a distinctly fresh drop of pus or a purulent discharge has formed. This is to be noted in the record with, at least, a two-plus mark (++).

COMBATING GLANDERS

Biological Methods of Examination

(a) Blood Examination

First Blood Examination: The examination of the sera of all suspected animals, by means of the agglutination and complement-fixation tests, has proved eminently satisfactory in Prussia, and extensive use of them is made in time of war. More recently the conglutination test is also being used.

For these purposes, blood examination stations have been arranged near the front, to which are brought the blood of the suspected army horses for examination. All horses of the army are to be examined by means of serological tests.

The withdrawal of the blood is done wherever possible by the veterinarians of the hospitals, horse depots and divisions of the reserve troops. The necessary blood tubes and needles are obtained from the blood examination stations or institutions from that district and forwarded by special messenger in order to avoid any possible delay. The results of the blood examinations are

to be communicated to the horse hospitals, divisions of reserve troops, etc.

In withdrawing the blood, one should first observe that the needle is free from any particles of blood, which might, as the result of a previous withdrawal of blood, still be clogging it. This is accomplished by thoroughly rinsing it in clear water; secondly, the tube should be so marked as to define its source in order to avoid any possible confusion with other blood samples.

After recording this special mark, the horses are to be numbered consecutively, which is best done by cutting the hair, branding or braiding a numbered tag in the mane or tail. In this way only is it possible to avoid losing the identification of an animal. The filled and marked test tubes are sent to the blood examination station and there examined according to the usual methods. The blood examination may require about three days and, considering the time required to arrange laboratory apparatus, the sending of the blood specimen and sending of the report to the troop, it will require under the most favorable transport conditions at least a lapse of eight days.

Horses that are reported as suspected of being glanderous, according to the findings of the blood examination, should be destroyed.

Repeating the Blood Examination

If there are clinical cases of glanders among a group of horses at the time of the first withdrawal of blood or which were proved glanderous by means of serodiagnostic tests, a further blood examination is to be carried out after two to three weeks. This is done for the purpose of detecting any horses that might have been in the incubative stage at the time of the first examination and separation of glanderous horses. From

foregoing remarks, it is seen that definite results are obtained with the agglutination test on the sixth to the ninth day after infection and with the complement fixation test on the fourteenth day. Consequently, horses which were in the incubative stage at the time of the first withdrawal of blood, were not proved to be infected

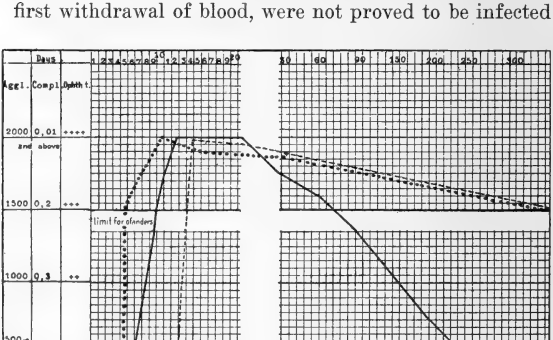


FIGURE 16

Graphic representation of the agglutination and fixation titre as well as the ophthalmic reaction during the course of a glanders case.

by such sero-diagnostic tests and are only recognized upon performing the second test. As a result of this it is often necessary to perform a third and even a fourth blood examination, when the possibility exists that glanders has again made its appearance in a locality.

The changes in the agglutination and complement fixation titre, as well as those occurring in the conjunctival reaction, should be shown in the record in the form of a curve (see illustration 16).

Ophthalmic Test

In such cases, where difficulties are met in the transportation of blood tubes or other necessary apparatus, as in the case where troops are miles away from a railroad station, or in cases where troop advancements are executed during the examination, serological tests cannot be carried out. In such instances free use should be made of the ophthalmic test.

All horses that show a positive ophthalmic reaction are to be killed.

For the purpose of bringing about the necessary control in detecting the presence of glanders, I consider it expedient, at least in the case of the eastern army, to apply the ophthalmic test to all troop horses that are either on the firing line or on the march. Its application is always possible and assures an immediate finding of the largest number of existing cases of glanders. Serological tests should be postponed until some later time, when the troops have the assurance of being given a fairly long rest by being placed in the reserve or permanent quarters, where such tests are more applicable. A quickly completed examination of all horses is made possible, also the work in combating glanders is considerably lessened, by systematically applying the ophthalmic test and the blood examinations. Individual blood examinations, without considering the duties and location of troop horses at a given time, are not to be recommended; they burden the blood examination stations entirely too much without giving the desired advantage.

The following is the type of record cards forwarded to the blood examination stations to be filled out by the veterinarians who withdraw the blood samples and apply the ophthalmic test.

Station:.....

BLOOD EXAMINATIONS AND OPHTHALMIC TESTS OF HORSES

of:.....

(Remount Station, Regiment, Squadron, etc.)

Results of Examination. (Laboratories should record all data in following columns)

Date of Arrival	Number of Examinations	Number of this Examination?	Number Glanderous		Number Suspected of Being Glanderous		Which horses Need Be Examined Again and When?	Record of Results	Remarks
			Total Number	Serial Number	Total Number	Serial Number			

In filling out the cards and before withdrawing the blood observe the following notice: In cases of horses owned by military persons the local laws are to be observed

Consecutive Number of Blood Test	Division of Troop or Owner (Detailed Information of Stables)	Name or Number of Horses	Remarks: Disease Symptoms; Autopsy; Results of Autopsy and Ophthalmic Test
1.	2.	3.	4.

I. Blood Sample Date..... Method		II. Blood Sample Date..... Method		III. Blood Sample Date..... Method		
Agglutination 5a	Complem.-Fixat. 5b	Agglutination 6a	Complem.-Fixat. 6b	Agglutination 7a	Complem.-Fixat. 7b	8

Instructions for Withdrawing Blood and Filling Out Record Cards

For withdrawing blood a needle is introduced into the jugular vein, and the blood allowed to flow into a sterile glass tube which is filled about three-quarters. Every tube should be immediately stoppered and given the correct serial number. The label should be placed as near the opening of the glass as possible (top of tube) in order to avoid defacing the label or losing it entirely when placing it in and out of the rack, etc.

The blood specimens are well packed and sent to the nearby blood examination stations; one should also make certain that they will be kept as cool as possible.

The blood specimens should be numbered consecutively under all conditions and be recorded in column one in this manner, as well as when being placed in the test tube racks. In recording the results of the blood examinations only such numbers are to be used. Blood samples which do not conform to these demands cannot be examined.

In column three, the names or numbers of the horses are to be recorded.

The remaining columns are to be filled out properly, the fourth column being especially important. It is very important to mention the suspected cases as well as the probable time of their infection or the exact time when infection could no longer have occurred. In a like manner it is very important to record the day when the blood was withdrawn.

In order to prevent the blood of one horse becoming mixed with that of another, the hands should be *washed* thoroughly after each bleeding; a *new needle* is to be used for every horse or in case that they are not available, those having been used may again be used after removing all signs of remaining blood.

A short notation should be made in column eight as to the dates of applying the ophthalmic test and the results of the same (positive + +, doubtful +, negative –).

Under remarks, in column four, one should note whether dealing with glanders-suspects, glanders-carriers, or glanders-free horses.

Care of the Needle

The needles are obtained from the laboratory in a clean sterile condition. They should never be sterilized in the flame or with dry heat.

After blood has been withdrawn, the needle is to be washed in cold water by using the wire stylet; however, they should not remain in the water any longer than necessary. Following this they should be rinsed in alcohol, dried with moderate heat, and vaselin applied inside and outside. The needles are always to be returned with the blood specimens and record cards.

Immunization

Passive Immunization

Passive immunization of horses has as yet not proved satisfactory, chiefly because no serum has been obtained that was high enough in potency.

Active Immunization with Virulent Glanders Bacilli

Active immunization has not given practical results, because on the one hand it is dangerous to produce a glanders vaccine, and on the other no satisfactory immunization can be obtained. Furthermore, there is too much danger connected with the handling of virulent glanders bacilli.

Active Immunization with Attenuated or Killed Glanders Bacteria or Glanders Extract

The attenuation of the bacteria was performed by animal passage, prolonged cultivation of the bacteria on

artificial media, preservation of cultures at low temperature, previously handling with cattle bile or serum, without showing that such vaccine materials had any practical value. Recently Levi, Blumenthal and Marxer believe they have gotten better results by using bacteria attenuated in a solution of urea. There are no corroborative tests up to date that have proved the value of such immunization. Recently, however, Marxer and Pfeiler produced an immunity with large quantities of bacterial substances and their extracts, but since no experiments have been carried out up to date, no opinion can be expressed on the efficiency of this method.

Notation: The simultaneous method, *i.e.*, the simultaneous application of a serum and bacteria or bacterial extracts precludes itself because we have no efficacious serum at our disposal.

ATTEMPTS AT CURING

The author has carried out numerous experiments for the purpose of curing by using salvarsan on animals that were artificially infected with glanders, but always had negative results. Recently similar experiments were carried out on naturally glanderous horses with neosalvarsan. According to the publications of a number of Russian authors no healing influence whatever was obtained from the use of this preparation on glanderous lesions nor did it check the spread of glanders. Even after using five grams of neosalvarsan several times, the new formation of glanderous nodules in the lungs of horses was not prevented.

VETERINARY POLICE REGULATIONS

In the first place, glanders is introduced by means of glanderous horses; it was proved in this war that the

spread of glanders in our army was due to captured and requisitioned horses from occupied territories. Therefore, these horses should not be brought in contact with service horses until they have been proved free from glanders by means of the ophthalmic test.

Horses looked upon as glanderous *in lieu* of clinical lesions or from the results obtained by means of biological tests, are to be killed immediately and the non-mutilated cadavers removed. In every outbreak of glanders it is necessary to determine how it was introduced. Immediate notification is to be sent to military divisions that receive these glanderous horses and also to those to whom horses were forwarded within six months previous to the outbreak of the disease. Stock that is considered to be capable of infecting other animals with glanders are all to be given the ophthalmic test and examined with other serological tests with the object of actually determining whether they are glanderous or not. All such horses are to be kept isolated until the conclusion of the examinations. As is self-evident, the researches and examinations must be extended to the horses of the civil population.

The sanitary officers of the respective divisions of troops are to be informed of an outbreak of glanders; the troops are to be thoroughly instructed regarding the disease so that the veterinarians' attentions are brought to the first case at the earliest possible time.

All mangers are to be carefully cleaned before being used. Placing horses with those of the civil population is to be avoided.

Persons who come in contact with animals that are sick with glanders or suspected of having glanders or cadavers or parts of cadavers should immediately clean and disinfect their hands and other parts of the body that might become soiled. For this purpose water, soap and suitable

disinfectants (diluted cresol, carbolic acid solution or solution of bichlorid) are to be kept conveniently at hand on the glanders-infected farm.

As soon as a glanders-sick animal or glanders-suspect is removed from a station, that place must immediately be cleaned and disinfected, as well as the horse's harness, other equipment, etc., inasmuch as such equipment cannot be used for the nursing of other glanders-sick horses.

Before lifting a quarantine the veterinarian, according to his judgment, is to clean and disinfect certain parts of stables or the entire stable, equipment and other necessary parts (mangers, racks, posts, pillars, partitions, buckets, and other stable utensils, halters and chains, parts of bridles, harness, saddles, grooming articles, blankets, saddle blankets, clothes and shoes of the attendants, wagon poles, chains, well buckets, blacksmith shop, etc.) which could have come in contact with glanders-infected horses and glanders suspects, their excreta, cadavers or parts of cadavers, and, if necessary, soiled pastures or portions of pastures as well.

Before the actual disinfection a general cleaning should be carried out with hot soda water. Harness, parts of equipment, etc., are then to be washed with carbolic acid, bacillol, etc., of a one to three per cent solution. Stables can easily be disinfected by painting or spraying with diluted milk of lime or milk of chlorinated lime. Parts of the stable which have been soiled with nasal discharges or the secretions from skin ulcers as well as with feces and urine of sick or suspected cases deserve special attention. Excreta, straw, parts of food, etc., can be used after baling; liquid manure which has become contaminated with the excreta of sick or suspected animals can, after disinfection, be utilized.

In the event that a disinfection of the stables is not possible, one should make this fact known by painting a

notice with a concentrated solution (2 per cent) of pyoktanin.

Lifting the Quarantine

Glanders can be considered eradicated and enforced precautions dispensed with when:

(a) The glanders-sick horses have died or been killed.

(b) The glanders-suspects have either been killed or declared healthy.

(c) The exposed animals, during their isolation or while under observation at the time the biological examinations were being carried out, showed no suspicious symptoms of glanders.

(d) The required disinfection has been completed.

Compensation for glanderous animals is given up to three-fourths their value. [In Germany.]

ANTHRAX

ETIOLOGY OF ANTHRAX

Anthrax is caused by *Bacillus anthracis,* which was observed in the year 1849 by the German veterinarian, Pollender, but which was first described by him in the

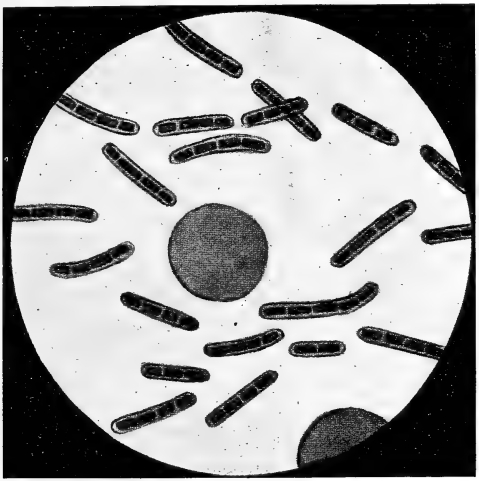


FIGURE 17
Bacillus anthracis. Showing the capsule stained.
(After a drawing by Dr. Lütje.)

year 1855. In the year 1850, the French physician, Rayer, reported a case of anthrax in a sheep. We are indebted to Koch, whose classical researches in the year 1876 disclosed the etiological significance as well as the biology of the anthrax bacillus.

The *Bacillus anthracis* is 1 to 1.5 micra broad and 1.5 to 2 micra long. As a rule it grows in long chains the

individual elements of which lie one behind the other, the points of separation often being difficult to recognize; consequently long individual elements are sometimes incorrectly reported. In some preparations due to fixing with heat the ends of the individual elements frequently become thickened, resembling in some cases the epiphyses of bones, and the sides appear concave. The chain formation of such forms suggested the term bamboo-form. The bacillus forms a capsule which, however, occurs only in bacteria originating in the animal body, not those that have been grown on artificial media. Gruber and Preisz look upon this mucin-composed capsule as a protective structure against the bactericidal substances in the animal body, while Fischoder and Baumgarten antithetically look upon it as a degeneration form.

Occasionally one finds within the body of the bacillus noticeable degeneration changes; the capsule is entirely complete, whereas the inner structure is only represented by destroyed portions of parts of the bacterium. Some capsules are entirely empty. The farther advanced the degeneration process goes, the less staining ability will the capsule have and finally one will see only indistinct schematic forms—shadows. These degeneration forms are especially to be found in anthrax of swine. The anthrax bacillus forms spores outside the animal body. Sporulation does not occur in the living organism owing to the lack of acid.

Cultivating the Anthrax Bacillus

The anthrax bacillus grows well on ordinary culture media. On agar, greyish white colonies are formed having irregularly serrated edges, which, upon microscopic examination, appear like bundles of parallel anthrax threads. They follow the periphery of the colony, extend outwardly in wavy lines and then almost always

return to the inner portion of the colony. As the result of this the colonies appear like curly locks of hair. In gelatin stick cultures one will observe a growth which simulates a test tube brush. Liquefaction occurs gradually from above downwards (in contrast to that of the hay bacillus the line of inoculation of which is entirely surrounded with an even zone of liquefaction).

Staining the Anthrax Bacillus

In order to determine by staining whether one is dealing with the anthrax bacillus one must first demonstrate the presence of the capsule.

1. Staining with gentian violet. A preparation that has been air dried and fixed in the flame is stained for one-half to one minute with gentian violet, rinsed in and examined while it is under water.

2. Staining according to W. Raebiger with formol-gentian violet. (100 c.c. of forty per cent formaldehyd is poured on 15 grams of gentian violet while thoroughly stirring it; after twenty-four hours the solution is filtered.) Fixation in the flame is satisfactory. After allowing the stain to act for one-fourth of a minute the preparation is rinsed and dried and examined (not under water). The body of the bacillus is violet, the capsule blue and distinctly contoured.

3. Staining according to Olt with three per cent safranin solution. (Three grams of safranin are poured in boiling distilled water). The stain is applied for two or three minutes, frequently bringing it to the boiling point. Rinse in and examine under water. The capsule of the anthrax bacillus becomes a quince yellow and is surrounded by a reddish brown border. The body of the bacillus is colored red-brown.

4. Staining according to Klett. A watery solution of methylene blue is applied for two or three minutes, fre-

quently warming. Rinse in water and counter-stain with a watery solution of fuchsin for five to ten seconds. Examine while it is under water. The capsule is reddish and surrounded with a blue border. This method of Klett is especially applicable in examining old decayed material.

Resistance of Bacillus Anthracis

The great resistance of the anthrax bacillus is due to its sporulation. The vegetative forms of the bacilli are easily killed with heat, sunlight, drying, or disinfectants, whereas the spores withstand these for a long time; they will withstand drying for eighteen years. Bichlorid 1 to 1,000 destroys the spores in fifteen minutes; formaldehyd vapors and five per cent carbolic acid solution, in two days. The spores resist dry heat of 120° C. to 140° C. (248° F. to 284° F.) longer than two hours, whereas streaming steam destroys them in five to six minutes. The bacilli as they occur in layers of manure die at 70° C. to 76° C. (158° F. to 168.8° F.) in a few minutes, whereas the spores do not die until after three or four days. Caustic lime and chlorid of lime can kill the spores in 12 to 17 days. Gastric juice kills the vegetative forms but not the spores. Putrefaction destroys the bacilli in a few days.

SPREAD OF ANTHRAX.

Anthrax material, originating from living or dead animals, will remain infective for years, this being due to the great resistance of the anthrax spores. Consequently one sees, as a rule, in pastures in which animals previously became sick with anthrax, died or were buried, new outbreaks of anthrax as soon as other animals have access to these places or are given feed that was obtained from these places. It is also possible to spread anthrax by using water coming from streams which flow past tanneries; the same thing can occur by grazing animals on

pastures previously inundated with streams of this kind which have become contaminated with anthrax spores. The danger of spreading anthrax is equally as great where anthrax-sick animals have stood in stables that had not been subjected to a thorough disinfection and where feed that was possibly infected was not destroyed.

Anthrax is also introduced in many cases by means of feed which originated in localities where the disease exists. Animal fertilizers must likewise be looked upon with suspicion, for in recent times the origin of anthrax among swine can be traced to this. The cause lies chiefly in the fact that in the production as well as in the packing and sending of the animal fertilizer proper precautions were not taken. Also the feeding of fish fertilizer adulterated with animal fertilizer containing anthrax spores, has resulted in many cases of anthrax.

In some cases anthrax can be spread by flies that have been on anthrax material.

SYMPTOMATOLOGY OF ANTHRAX

The period of incubation in anthrax is one to four days.

Peracute anthrax. Apoplectic form

No disease symptoms are observed in this form of anthrax during the life of the animal; death occurs as if the animal had suffered an apoplectic stroke. Animals that had previously appeared well suddenly die while on the pasture or at work or they are found dead in the stable.

Acute Anthrax

The first symptom to be observed in acute anthrax is a sudden rise in temperature to 41° C. (105.8° F.) and higher; associated with this we have increased rate of the pulse and respirations. These animals manifest symptoms of dizziness. The visible mucous membranes are cyanotic (colored dark bluish red); at times edema-

tous swellings occur in the subcutaneous tissue; bloody discharge flows from the natural openings of the body. Horses show marked symptoms of colic (anthrax colic) and slight tympany in the flank. Death occurs as a rule in 12 to 48 hours.

Subacute Anthrax

The most noticeable symptom in the beginning is an abnormally high temperature which has no comparison to other changes that are taking place in the animal. In addition there appear colic symptoms, diarrhea with red colored manure. The respirations become increased and edematous swellings occur in the subcutaneous tissues. The animals almost always die in from two to six days.

Cutaneous-anthrax (pustula maligna), the most common form of anthrax in man, occurs mostly from infection of the skin through punctures or incision wounds, etc. At the site of infection carbuncle-like swellings are formed which later rupture and may develop into large carbuncle-like ulcers.

Rag sorter's disease in man is confined to the respiratory tract and occurs mostly in such persons as are employed in establishments where animal hairs are worked over.

PATHOLOGICAL ANATOMY OF ANTHRAX

The cause of death in anthrax has not as yet been established, but in all probability it can be traced to the toxin production of the anthrax bacillus. Anthrax represents a distinct septicemic disease. Consequently we always find, besides some local changes at the portal of entrance, marked clouding and swelling of the parenchymatous organs. The blood is black-red, not fluid; the fatty tissue is, for the most part, infiltrated with bloody fluid; the body lymph glands enlarged, juicy and upon cross section they appear reddened. The changes

in the intestinal tract do not occur evenly throughout the intestinal mucosa, but occur principally in short portions of the bowel and alternate with normal areas. The mucous membranes of the affected parts are very much swollen. As a result of the death of the superficial epithelium large carbuncle-like ulcers develop, which, corresponding to the course of the blood and lymph channels, become larger in the transverse direction of the intestine. The liver and kidneys are markedly enlarged, soft, clouded and of a grey-brown color. The spleen is enlarged about five to six times its normal size; through its stretched capsule can be seen the very dark red pulp. Upon incision a mushy, almost fluid, tarry, black-red mass exudes. The actual stromal tissue can no longer be recognized. Many hemorrhages are found under the serous membrane; they are especially to be found under the endocardium and epicardium, where they frequently attain considerable size. The mucosa at the entrance of the larynx and pharynx is black-red and of a gelatinous character. The tonsils are frequently enlarged and infiltrated with dry, dead masses. The submaxillary and retropharyngeal lymph glands have undergone hemorrhagic inflammation, which is followed by necrosis.

In gloss-anthrax of swine the subcutaneous tissue in the region of the throat is hemorrhagic, infiltrated and changed into a gelatinous mass.

Cutaneous anthrax predominates in the stratum papillare from whence the inflammatory material spreads partly to the dermis and partly to the superficial epidermis.

In localized intestinal anthrax of swine there occur, as a rule, only mild inflammatory changes in the mucosa, while on the other hand, individual intestinal lymph nodes are decidedly enlarged. The cut surface is reddened, quite dry, finely granular and usually contains grey-red, dead and encapsulated foci. In such cases the

spleen, as a rule, is not swollen *in toto,* but is simply infiltrated with individual grey-red nodules of the size of a pea to that of a hazelnut—spleen infarct. Frequently spleen changes are entirely lacking.

DIAGNOSIS OF ANTHRAX

According to Prussian regulations it is required that a confirmatory test be carried out in an institution for the diagnosis of anthrax in every case of equine anthrax. In the event other animals are sick the confirmatory tests are confined to those cases where an autopsy and microscopical examination did not give satisfactory results, according to the views of the district veterinarian; the same is to be done in case a difference of opinion exists between the district veterinarian and the veterinarian employed by an owner.

Three cover-glass smears and three pieces of filter paper, upon which is placed some of the suspected material, are to be sent to the examination station for confirmation. The specimens for examination are taken from the jugular vein in the living animal and from the spleen in the dead animal. The cover-glasses are smeared over with blood or spleen pulp, as the case might be, and the small pieces of filter paper are to be saturated in the blood or spleen pulp. This manner of sending the material should prevent further putrefaction during transport and assist in the greatest possible production of spores of the anthrax bacillus with the object of preservation.

The preparation sent in should be stained according to the methods given in the introduction. Later three agar plates are to be inoculated with the material that has been sent in and two white mice inoculated subcutaneously. As a rule, the mice die after 24 to 48 hours. In the event that no anthrax bacilli are found in the spleen or blood the site of infection should always be

examined for the presence of bacteria. Finally, it is necessary in such cases where bacteriological diagnosis is unsatisfactory, to employ the precipitation test.

The Precipitation Test

Immune sera not only have the power to influence their corresponding bacteria, but also those extracts derived from them, so that when a mixture is made of clear bacterial extract with the respective sera, precipitates result (Kraus, 1879). The substances contained in the immune sera that have the ability to precipitate their corresponding proteins are called precipitins, and the antigens of the bacterial extract are called precipitinogens. The precipitate is always specific, *i.e.*, it only results from the combined action of an immune serum and its corresponding bacterial extract. In more recent times it is not customary to mix extracts and sera, but the extract is carefully superimposed upon the serum by means of a pipette while holding the test tube in a slanting position. This layer-upon-layer method (*schichtungsmethode*) has the advantage over the mixing method in that the entire fluid is not clouded when precipitation sets in, but instead a distinct, white, non-transparent ring is formed at the point of contact of the two fluids. Judging the precipitation during the reaction can be done much more certainly with the layer-upon-layer method. The precipitation reaction is applicable to the diagnosis of many different diseases since Ascoli and Valenti have determined that a precipitate can be formed by using extracts of organs from infected animals and the corresponding antisera. Consequently very good results are obtained in employing the precipitation test for diagnosing anthrax. For this purpose an anthrax precipitating antiserum is produced in asses by repeatedly injecting them with anthrax bacilli. In cases where

the presence of anthrax is suspected, extracts are made from the organs of the suspected animal, and layers of these extracts are placed upon separate small quantities of this immune serum. In case anthrax is present a distinct white ring will appear within a very few minutes at the point of contact—otherwise this does not occur. The aforementioned authorities all ascertain the degree of heat resistance that the extracts would show and can even obtain a precipitation with boiled extracts of an-

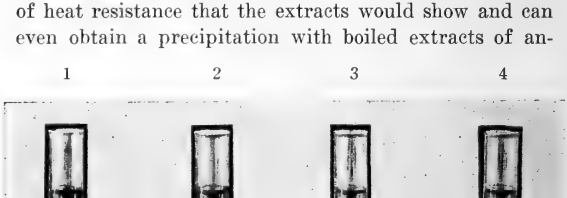


FIGURE 18
Precipitation experiment in anthrax.

thrax organs (thermo-precipitation method). Boiling of those portions of the organs which are to be used in the diagnosis, has the advantage that, as the result of the rapid coagulation of the albumin, clear extracts are more easily obtained.

Performing the Thermo-Precipitation Test

A portion of organ taken from the cadaver to be examined, about the size of a pea, is mixed with 10 c.c. of physiological salt solution and allowed to remain in boiling water for several minutes. After the boiled material has cooled it is filtered and the clear filtrate (extract) is used for the examination. This extract is carefully superimposed with a pipette on some anthrax anti-serum

in a test tube. If anthrax is present, precipitation results at the point of contact of the serum and extract, which is discernible by a distinct white ring which forms within a few minutes. It is desirable to carry out the necessary controls which will show whether the fluids employed are working satisfactorily. The necessary controls are:

Suspected organ extract and normal serum in order to show that precipitation does not occur (Fig. 2); anthrax bacillus extract and precipitating serum in order to show that the serum and its corresponding antigen will give a distinct reaction (Fig. 3); extract of normal organs plus precipitating serum as a control to show the specific action of the serum—no reaction (Fig. 4).

Schütz and Pfeiler demonstrated the reliability of this method by means of exhaustive research. However, they prefer an extract obtained by using chloroform (chloroform extract) instead of the so-called boiled extract. A portion of spleen about the size of a hazelnut is triturated with about 10 grams of dry sand in a mortar, covered with chloroform and securely closed. After a few hours the supernatant chloroform is decanted and the hard pulpy mash broken up with a glass rod. The chloroform is replaced with carbol-salt solution and the mash stirred a number of times with a glass rod, and after several hours filtered until it is perfectly clear.

The precipitation test has always proved reliable in all cases of anthrax in cattle, horses and sheep; and furthermore, it is applicable when practically all other bacteriological methods have proved unsatisfactory. This is a great advantage, as would be the case where anthrax bacilli have undergone putrefaction, which may occur quite rapidly. In local anthrax among swine both the precipitation test and bacteriological tests have proved equally satisfactory.

COMBATING ANTHRAX

Immunization

Active Immunization: Pasteur first introduced active immunization. He employed two vaccines—No. 1 and No. 2—which are prepared by allowing anthrax bouillion-cultures to remain in a temperature of 42.5° C. (108.5° F.) for twenty-four days and twelve days respectively. By this means attenuation of the anthrax bacillus is obtained, so that after it has been applied, those animals vaccinated, as a rule, are not subject to vaccination anthrax, but instead show an active immunity. The two vaccines are applied subcutaneously in quantities of 0.5 c.c., allowing an interval between them of twelve days.

Passive Immunization

Sclavo and Marchoux in 1895 first worked with a highly potent anthrax serum. The serum is to be used only where sporadic cases of anthrax occur in order to prevent the remaining animals from becoming sick, and consequently it can be used at times as a curative medium.

Simultaneous Method

Disadvantages, which are attributable to active immunization because it is produced so slowly (10 days), and to passive immunization because it lasts such a short time (2 to 3 weeks), were overcome by Sobernheim by applying both the active and passive immunization at the same time (simultaneous method). He injected animals subcutaneously with 4.5 c.c. highly potent serum and followed this with 0.25 to 0.5 c.c. of attenuated bouillon culture, the virulence of which was approximately that of vaccine No. 2.

Use of Vaccination

Sobernheim's method is to be given preference to both the other methods because by its use a much more rapid immunity is produced. Since actively immunized

animals discharge anthrax bacilli for some time, this method of vaccination can only be used where it has been proved that anthrax occurs periodically. In such herds where animals show a rise in temperature, only serum is to be used. The passive immunizing method is in all cases appropriate where anthrax appears only occasionally, partly as a curative method for the sick animal and partly as a preventive for the remainder of the animals in the herd. As a curative about 50 to 100 c.c. of the serum is given subcutaneously for adult horses and cattle, and for young animals and sheep, about 30 c.c.; as a preventive, 15 c.c. of serum for the adults and 10 c.c. for smaller animals.

VETERINARY POLICE REGULATIONS

As soon as the presence of anthrax is determined or suspected, the sick animals or the suspected ones, as the case might be, are immediately to be isolated, together with halter chains, water snaffles, saddle blanket and girth. Those parts of the equipment used by the animals as well as the grooming articles are to be burned so that no infection of healthy animals may follow. The bedding of the respective animals is to be removed, the stalls disinfected, and, if possible, the animals should be quarantined. The slaughter of these animals for food purposes is not to be permitted. Endeavors to cure should only be attempted by veterinarians. The milk, hair and wool of anthrax-sick or suspected animals should be removed and made noninfective.

The cadavers or portions of cadavers of anthrax-dead or anthrax-suspected animals must immediately be rendered noninfective. Skinning of cadavers is not to be permitted. In order to remove cadavers or portions of cadavers, only such vehicles should be used, wherever possible, which will not allow blood or body discharges to pass through. The grave should be made sufficiently

deep so that after the cadaver is placed therein a layer of earth at least one yard deep can be placed over it. After the cadaver has been placed in the grave, the portions of sod that have become contaminated with blood are to be dug up and buried with the cadaver. Excrements, blood and other discharges of anthrax-sick animals, manure contaminated with discharged material, also bedding and portions of feed of suspected animals, must be gathered and burned or buried. Special attention should be given to careful disinfection of the stables. All parts of stables that are made of wood should be burned; in case they cannot be removed, they are to be planed and freshly painted. When the floor is composed of blocks of stone fitted together, these should be torn up, the underlying ground dug up and disinfected and covered with new flooring. Before placing horses in cattle or sheep stables, one should always ascertain that no cases of anthrax have occurred during the previous few months in the respective stables.

Lifting the Quarantine

Anthrax can be considered eradicated and enforced precautions dispensed with when:

(a) All anthrax-sick and suspected animals are removed or killed, or

(b) If within two weeks after the outbreak of anthrax no suspected or new cases of anthrax have occurred in the herd, and

(c) When the disinfection has been carried out as directed by the official veterinarian.

Compensation for cattle, horses, mules and asses which died of anthrax or which were proved to have had anthrax after dying, is made up to four-fifths their value [in Germany]. Animals which have been introduced into the country within the last 14 days are not to be compensated for.

RABIES

(*Hydrophobia, Lyssa*)

ETIOLOGY OF RABIES

Through the researches of Pasteur it was determined that the seat of the cause of rabies is in the central nervous system; the Italian research worker, Negri, succeeded in the year 1903 in demonstrating typical forms

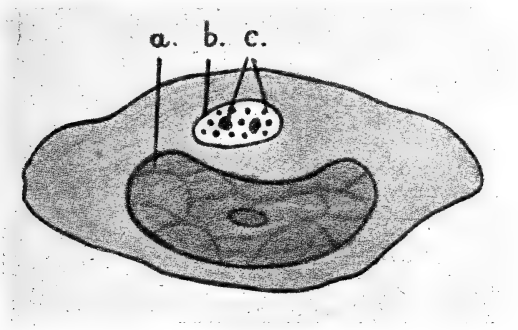


FIGURE 19

Negri bodies in a ganglion cell: (a) nucleus of ganglion cell; (b) covering of Negri body; (c) large and small internal bodies.

in the ganglion cells and Ammon's horn which were found in the greater majority of cases of rabies (Negri bodies).

Negri bodies are elliptical in shape, about 1 to 25 micra long and occur most frequently alongside of the nucleus of the ganglion cells, but occasionally also outside of them. Within these bodies one will observe refractive forms, one to three large ones lying in the center, and

smaller ones which occasionally tend to form concentric rings surround these larger ones—smaller and larger internal bodies. When using the eosin-methylene blue method of staining, Negri bodies are colored a crimson red and show a slightly granular condition. Since the cause of rabies is filtrable and therefore can pass through the finest of porcelain filters, the pores of which are smaller than one micron in diameter, Negri bodies cannot be looked upon as the cause of rabies (they cannot pass through the filter on account of their size). On the strength of more recent investigations, one is to recognize that only the internal bodies can be considered as etiological agents and their surrounding capsules as products of the ganglion cells' reaction to these foreign bodies. It is for this reason that Volpino and von Prowazek look upon the cause of rabies as being the Chlamydozoa (encapsulated protozoa—Hülltierchen). Josef Koch likewise looks upon these internal bodies, which he calls cocci-like forms, as the cause of rabies. According to him, the surrounding cell envelope is composed of a hyaline degeneration product of the cell protoplasm. He also found these cocci-like forms without the capsule outside of the ganglion cells.

Demonstration of Negri Bodies

Sections of Ammon's horn about one-half to three-fourths millimeter thick are fixed in about 15 c.c. of acetone for one-half hour at 37° C. (98.6° F.). They are embedded in paraffin.

Staining results can be best obtained according to Lentz's modification of Mann's method:

1. Staining in eosin solution one minute.
   Eosin (extra B Höchst).....0.5 grams
   Sixty per cent ethyl alcohol.....100 c.c.
2. Rinse in water.

3. Staining in methylene blue solution one minute.
   Saturated alcoholic solution of methylene blue (B patent Höchst)..... 30 c.c.
   0.01% caustic potash.....100 c.c.
4. Wash in water and dry with filter paper.
5. Differentiate in alkaline alcohol until the preparation shows a weak eosin staining.
   Absolute alcohol .....30 c.c.
   1% solution caustic soda in absolute alcohol .....5 drops
6. Differentiate in acid alcohol just to that point where the ganglion cells appear as weak blue lines.
   Absolute alcohol .....30 c.c.
   50% acetic acid.....1 drop
7. Quickly rinse in absolute alcohol.
8. Xylol and mount in Canada balsam.

This method of staining shows the nuclei of the ganglion cells, leukocytes and capillary endothelium a dark blue, the erythrocytes vermilion. The Negri bodies are crimson red, the internal bodies blue (Josef Koch).

SPREAD OF RABIES

The dog, respectively, the animals belonging to the canine family, are to be looked upon almost exclusively as the carriers of the rabies virus. Since the dog is used most generally as a house animal, he acts as the spreading medium for most of the rabies. In localities where wolves occur much importance is to be attached to them as a spreading medium for rabies.

The virus occurs in the saliva of rabies-sick animals and is spread to other individuals by means of their bite. Since rabid dogs are inclined to run great distances from home, there is, of course, the danger, by means of the desire to bite, of the further spreading of the disease to

larger stock. It can be attributed to this circumstance that rabies occurs comparatively frequently in regions where insufficient veterinary police regulations against rabies exist or the existing regulations are carried out in a lax manner. On the strength of this, we have to reckon without a doubt on the appearance of rabies on a large scale in the occupied territory of Russia.

SYMPTOMATOLOGY OF RABIES

Rabies appears either in the form of a furious, or dumb (paralytic) disease. The incubation period ranges from two weeks to one year.

Rabies in the Dog

The incubation period in the dog is, as a rule, three to eight weeks.

Prodromal Period

The dogs show a different attitude. They may become shy or become trustful (to the owner), frequently uneasy and obstinate; the animals crawl away and hide themselves, ingest objects which they ordinarily would not eat, such as wood, straw, rags, etc.

Irritable Period

About one or two days following the prodromal symptoms, the animals attempt to escape, run around aimlessly and travel great distances from their homes. At the same time they show increased inclination to bite. They bite objects held before them, such as pieces of wood, etc.; attack people and animals as well as attacking their own masters. It is in this stage that the first paralytic symptoms of the muscles of the larynx and pharynx (throat) appear. The animals bark with hoarse voices; they cannot take up food and water as they ordinarily do, nor swallow their saliva, and drooling results.

Paralytic Period

The dogs become more quiet, lie down considerably, pay no attention to their surroundings, and as a result of the gradual progressive paralysis of the limbs they can no longer move about. The paralysis of the muscles of the jaw can progress to such extent that the animal is no longer capable of moving it. As the result of the exhaustion and debilitation, which occurs after the paralytic period has continued for three or four days, death supervenes.

In dumb rabies the first two described periods are lacking or they are so short that one will not observe them. Paralytic symptoms manifest themselves and death follows, as a rule, within two or three days after the appearance of the first symptoms of disease.

Rabies in the Cat

The period of incubation is, as a rule, from two to four weeks; otherwise the same symptoms are manifested as in the dog. Of course, the entire disease picture must be modified on account of the different habits of cats.

Rabies in Cattle

On the average the incubation period here, is about four to eight weeks. The affected animals are fearful and the eyeballs protrude somewhat. They show colicky symptoms and often look back toward their abdomens. As a result of difficulties in swallowing, salivation results; also food hangs from their mouths. The animals attempt to take up water and food in a greedy manner, but cannot swallow, so that as a result the water again runs out of their mouths, but the rough food remains hanging to the mouth. Upon the approach of a dog, rabid cattle become much excited and bellow. Gradually, paralysis of the hind quarters develops, the animals can move along only with great difficulty until eventu-

ally they cannot rise, and they finally die because of sheer exhaustion.

Rabies in the Horse

After an incubation period of four to eight weeks, the irritable stage frequently makes its appearance in a well-pronounced desire to bite. Horses bite into objects held before them, exhibit symptoms of marked itching, and at times even tear away pieces of their skins. They strike and kick at persons and animals. All animals suffering from rabies show increased sexual excitement and frequent desire to urinate and defecate. In connection with the paralysis of the pharynx, salivation and continuous chewing are associated. Usually grinding of the teeth is observed. Symptoms of uneasiness and an aggressive attitude are lacking in some animals; they stand with drooping head in front of the crib, go through swaying motions and lie down a great deal of the time.

The period of irritability is followed by the paralytic period, which has associated with it paralysis of the limbs. Finally, the animals cannot raise themselves and die during attacks of marked dyspnea. A rise of temperature is present and the disease lasts for four or five days.

Rabies in Sheep and Goats

In sheep and goats the symptoms of irritability seldom appear. The animals frequently gnaw at the bite-wound, show symptoms of paralysis and die.

Rabies in Man

The incubation period, on the average, is fifteen to sixty days. Frequently the disease begins by the appearance of psychical derangement; the patients are irritable and surly or sullen. In the irritable period, difficulty usually occurs in swallowing, which is caused by reflexive swallowing spasms, which cause much pain to the patient.

Foods and fluids can no longer be taken up; besides, there is present an increased thirst. Even upon the mere sight of water, or when hearing the noise of flowing water, painful swallowing spasms develop which may give rise to an attack of generalized spasms. It is due to these features that rabies is spoken of as hydrophobia. The respiration becomes irregular, the sick individuals become uneasy and saliva flows from their mouths. These attacks become more intense and may lead to disturbances of the mind. During the period of paralysis, weakness and inability to stand also develop; the body temperature gradually rises and shortly before death reaches 41° C. to 42° C. (105.8 to 106.6° F.).

PATHOLOGICAL ANATOMY OF RABIES

The postmortem findings in animals which have died of rabies is frequently so atypical that they are unsatisfactory to assure diagnosis of rabies. As a rule, limited swellings and reddened areas occur on the mucous membrane of the pharynx and later in the entrance and exit to the stomach. The stomach itself is contracted and usually does not contain particles of food; on the other hand, it contains, however, undigested foreign bodies of the most various kinds such as hair, straw, leather, rags, grass, stone, pieces of wood or metal. The mucosa of the digestive tract usually manifests evidence of having been in a catarrhal condition. The brain and meninges show hyperemia and edema.

DIAGNOSIS OF RABIES

Negri bodies may be demonstrated in Ammon's horn in 85 to 90 per cent of rabid dogs. The diagnosis is confirmed by animal inoculation, for the rabbits inoculated with the respective material always succumb to rabies. Consequently, demonstrating the Negri bodies serves as a valuable help in determining an early diag-

nosis. Instructions therefore are that the brain of all rabies-suspected animals, in all cases where a person has been bitten, is to be sent to a laboratory in order to insure diagnosis. For this purpose it is best to send the dog's head. Since rabies virus remains viable for a considerable length of time in glycerin, one can, if desired, place portions of the brain in glycerin and send them in this condition to the examination stations.

In the event that Negri bodies are not found, animal inoculations are to be made on rabbits or rats and the results made dependent upon these experiments. Since rabbits, as a rule, do not sicken until after two or three weeks, the disease sometimes even holding back until the eighth week, therefore at times information cannot be received from the rabies stations until after the lapse of the above-mentioned spaces of time.

The rabies vaccine for man, which is mentioned in the next section, will only be crowned with success if it is applied early, before the virus has an opportunity to get a firm hold on the organs of the central nervous system. Therefore, any delay in the treatment of people may result in an unfavorable termination of rabies. As a result of this it seems expedient that all persons bitten by animals, even though the veterinarian is ever so slightly suspicious of rabies, should be immediately subjected to treatment with rabies vaccine.

COMBATING RABIES

Immunization

Active Immunization: We must thank Pasteur for the first preventive vaccine for rabies, which he produced in the year 1883. After the subdural injection of brain emulsion of a naturally rabid dog (street rabies) into rabbits, death of these will, as a rule, occur within eighteen to twenty-one days. By means of many contin-

uous re-inoculations of healthy rabbits with brains of rabid rabbits (*animal passage*) one will obtain at about the fiftieth rabbit passage a virus which will probably kill rabbits in seven to nine days after subdural infection. Pasteur called this virus, which had a constant pathogenicity, *virus fixe* (fixed virus) in order to distinguish it from the street virus (*virus dés rues*) that can be immediately obtained from animals naturally infected with rabies. The spinal cord of sick rabbits which have been inoculated with fixed virus is attenuated by drying (desiccation). Pasteur used this method of attenuation in the production of his rabies vaccine for man. The spinal cord of rabbits which had died of rabies (fixed virus) was suspended under sterile conditions in a bottle in the presence of caustic potash for various lengths of time and exposed to the drying-out process of the preparation. Portions of these spinal cords, which had been rubbed into an emulsion, served as a vaccine for man.

In more recent times active immunization has also been carried out in animals (Miessner). Up to date no practical experiences are obtainable.

Passive Immunization

In the serum of horses, which have gradually been immunized against rabies, there occur antibodies against the rabies virus. Consequently, one can use the serum of such animals for passive immunization. Pfeiler claims to have obtained especially good action from such sera when applying them intraspinally. Experiences in general practice are lacking at this time.

Simultaneous Method

The simultaneous use of serum and virus has been recommended; no opinion can be given regarding its action, due to the lack of a relatively great number of experiments.

VETERINARY POLICE REGULATIONS

(a) For Rabies in Dogs

Rabid dogs and those suspected of having rabies must be immediately killed or confined securely in a cage. If the internment can be carried out without danger, it must then always be done in such cases where a person was bitten by a dog that was suspected of having rabies. This modification of the rule is the more appropriate because an expert can more easily diagnose a case of rabies in a living animal than in a dead one. In the event that persons are bitten by rabid dogs or by dogs suspected of having rabies, then, following the autopsy, the brain, including the spinal cord which has been freed from all muscles and portions of bone, should immediately be sent to a rabies prevention station. The individual sending in material can always obtain information from these institutions regarding the results of the examination.

In case the official veterinary examination leaves the exact condition of the confined dog in doubt, then the period of confinement must usually be extended to one week, and, if necessary, to two weeks. If the official veterinary examination has shown that the suspicion was substantiated, the animal must then be immediately killed. The first suspicion of rabies in dogs is only justified when typical symptoms are present and not merely by the fact that the dog was bitten by a rabid dog. If it is actually determined that rabies is present, then all dogs that had come in contact with rabid dogs or cats, or dogs or cats suspected of being rabid, should be killed. In the older laws only bitten dogs were subject to such regulations. Due to the difficulty of finding a bite-wound, we have desisted from this provision and made the later regulations entirely independent of the

coming in contact with the dogs. If, however, the animal can be confined in such a manner that it will not be a source of danger to man and animals, then, in place of immediately killing it, exception can be made and permission given to confine it for three months. In such cases an official veterinary examination must take place every four weeks at the expense of the owner, and this must be certified to by the official veterinarian, that the dog is free from symptoms of rabies and that his further confinement can be continued without danger to man or animal [in Germany].

In the event that a rabid or rabies-suspected dog has been running around loose, then all existing dogs in the endangered district must be tied up for three months. If it is desired to lead dogs around they must not only be kept leashed but also muzzled.

The endangered district comprises all villages in which the rabid or rabies-suspected dog had been and also, as a rule, all places within ten kilometers (6.21 miles) of these villages. It is of course readily understood that consideration should be shown to the village conditions and natural boundaries, river beds, seas, woods, etc. The exportation of dogs from the endangered district is only permitted if it is acceptable to the village police after a veterinary examination has previously been carried out. The police authorities of the village to which the dog is to be sent are to be notified and the dog, there, subjected to the same confinement and rules which were prescribed for him, at the time of his export from his original village. Of such dogs as draft dogs, hunting dogs, sheep dogs, and police dogs, exception can be made at the time they are being used, but at other times they are to be subjected to the same conditions as are other dogs.

(b) For Rabies in Cats

The instructions for dogs are conformable for cats except that it is not practicable to make exception of the death clause in rabies-suspected cases among cats. Dogs are to be tied up in endangered districts.

(c) For Rabies in Other House Animals

Rabid animals in this class are to be killed immediately and those suspected of having rabies may be confined in a secure cage or enclosure until the police take charge.

House animals which have come in contact with rabid or rabies-suspected animals must be placed under police observation for the time that there is danger of their transmitting the disease to others (horses and cattle, six months; sheep, hogs and goats, three months). In the case of army horses the time of observation is limited to three months. During this time the station can be changed only when permission is obtained from the police. Suspected animals are allowed to graze on pasture; likewise their slaughter is allowed under police supervision.

Horses that have been placed under observation are allowed to be used in service as long as they remain healthy, but must be examined daily.

For horses that have been isolated, according to a certain German military regulation, the following provisions are made: special, well marked and easily recognized stable equipment and cleaning utensils are to be used. The troops are to be instructed in the danger of transmitting rabies to man and in case they have wounds on the exposed portions of the body they are not to be allowed to care for such isolated animals. The men detailed to this work are examined daily and are to be separated from the rest of the troops as well as possible.

Special attention should be given to the careful cleaning and disinfection of hands and other soiled portions of the body after one has left the isolation stable. The attending personnel is not allowed to remain in the isolation stable unnecessarily, and persons unattached are to be refused admittance.

No attempts may be made to cure rabid animals or animals suspected of having rabies; likewise, slaughter of these animals, the sale and use of individual parts, milk and other products, are prohibited.

The cadavers of dead or killed rabid or rabies-suspected animals are to be removed so that no harm can come from them; skinning is forbidden. The station and such equipment as has been contaminated are to be disinfected.

Lifting the Quarantine

According to German military regulations the disease is to be considered eradicated and the arranged precautionary regulations to be lifted when:

(a) The rabid horses have been killed or died,

(b) The rabies-suspected horses have been declared healthy, and

(c) The prescribed disinfection has been carried out, or

(d) The time of observation has come to an end.

Compensation is made for cattle, horses, mules and asses which have died of rabies or which were proved after they were dead to have had rabies, up to four-fifths of their value [in Germany]. According to a German military regulation it is self-evident that compensation is to be made for all animals which had been killed for rabies according to police directions, with the exception of dogs and cats. For animals that were introduced ninety days before the outbreak of rabies, no compensation is to be made.

MANGE

(*Scabies*)

ETIOLOGY OF MANGE

Mange is caused by mites of which we recognize three different kinds.

1. Sarcoptes (burrowing mite).
2. Psoroptes or Dermatocoptes (sucking mite).
3. Symbiotes or Dermatophagus (scale-eating mite).

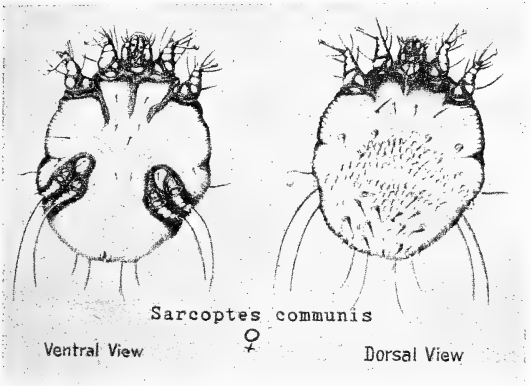


FIGURE 20
Female Sarcoptes communis. (After Fürstenberg.)

Sarcoptes

(*Burrowing Mite*)

Their bodies resemble that of a turtle, grooved transversely, and have a short head with two strong mandibulae (upper jaws). The female is .2 to .5 m. m.

long and has an oval form. On the short thick legs, attached to long unjointed stems, are placed cup-shaped holding-disks. The hind legs are placed so far under the abdomen that they do not extend beyond the outer edge of the animal and consequently can not be seen from the dorsal surface. On the first, second and fourth pairs of legs, the male carries holding-discs, whereas the female possesses these on the first and second pairs of legs. Those pairs of legs which are not supplied with such discs possess long bristles. On the inferior thoracic part are found six thorn-like points and on the back fourteen, which are arranged in four rows. Besides these the body is covered with a large number of scales. The mites do not embed themselves in the deeper, moister layers of the epidermis, as was once thought, but in the ducts of the horn layer (stratum superficialis), in which they lay their eggs (Olt-Ströse).

Psoroptes

(*Sucking Mite*)

These are approximately twice the length of the sarcoptes and have an elongated body. The pointed head is distinctly accentuated. In place of the strong chewing apparatus we find on the head sucking organs (sucking mouth-parts). Distributed on the long limbs, which are composed of five segments, there are placed, in the male, on jointed stems, suction discs. In the female these occur only on the first, second and fourth pairs of legs, the third pair being supplied with long bristles. The body of the mite is grooved, the back is not supplied with sharp points, and on the edge occur long bristles. The Psoroptes pierce with their sucking apparatus down into the papillary portion of the skin and obtain nourishment there.

Symbiotes, Chorioptes

(*Scale-Eating Mite*)

These mites are small, occurring only on the skin and are said to obtain their nourishment when the skin

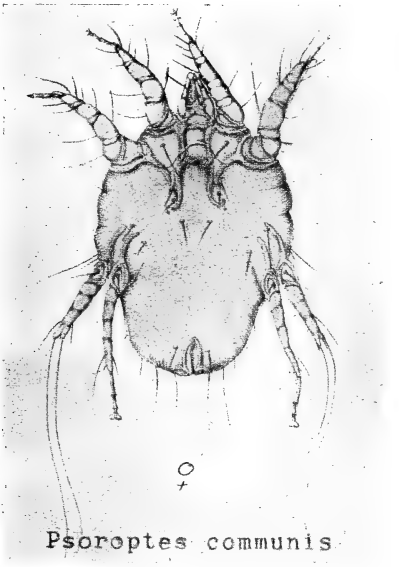


FIGURE 21

Female Psoroptes communis.
(After Fürstenberg.)

scales. Their flat, cup-shaped, prehensile organs are placed on unjointed stems and in the male they occur on all the limbs, whereas in the female, as in the psoroptes, they are lacking on the third pair of legs.

The mites chiefly occur on the lower portions of the extremities in mangy animals.

Development of the Mite

The males die after copulation, whereas the females lay about fifteen to twenty-five eggs, from which, after three to seven days, six-legged larvae hatch. During the first cystic period, the larvae develop into eight-legged, sexless nymphs. After a second cystic period they develop into sex animals. The entire period of development requires about two to three weeks. According to Gerlach, one generation, about one and one-half million progeny, should develop in the course of three months.

DEMONSTRATING THE PRESENCE OF THE MITES

Sarcoptes

It is not always easy to demonstrate the presence of mites, for which reason the veterinary police regulations, based on the imperial animal plague laws, do not require the demonstration of the causative agent independently for the diagnosis of mange. Antithetically, however, regulation number thirty-nine of the German military veterinary regulations requires the demonstration of these mites in order to determine the presence of mange.

The material to be examined is scraped with a knife from the suspected area, in which case the deeper layers are also to be scraped. The material, which consists of cuticle, portions of skin and hair, is allowed to lie for from five to six hours in a glass containing ten per cent caustic potash solution. As a result of the action of the lye, the scabs and scales become swollen and in some cases they become entirely dissolved, whereas the mites remain unchanged. The sediment is spread on a glass

and covered with a cover-glass and then examined microscopically. By using a weak magnification (Leitz's objective No. 3), the mites, and in many cases the mite eggs, are easily found.

Psoroptes

According to Brandl and Gmeiner, cuticle-containing material is scraped from the skin, without injuring it, however, the hair cut away and the mass of cuticle cut and broken up and placed on a glass for microscopical examination. It is also shown to be desirable to place the material to be examined in a watch-glass for one hour at a temperature of 25° C. to 30° C. (77 to 86° F.). As a result of this increased warmth, the mites leave the cuticle and crawl around over the watch-glass. If it is desired to dissolve the cuticle, one may place it in ten per cent caustic potash solution for one to two hours and then examine microscopically.

RESISTANCE OF THE MANGE MITE

According to Hertwig, the mites die in a few days, as soon as they are placed exposed in a room, probably on account of the lack of moisture. When protected in a moist atmosphere, on the skin, they remain viable up to three weeks; whereas in a dry atmosphere, they die in fourteen days. Gerlach and later Brandl and Gmeiner tested the influence of parasiticides with the following results: chloroform, bisulphid of carbon and glacial acetic acid will immediately kill the mites. Liquor cresoli saponitus and carbolic acid in two per cent watery solutions, kill them in two to three minutes, while it takes half an hour for a one per cent bichlorid solution to kill them. According to this, mercury preparations are not very suitable. A decoction of tobacco leaves (20 per cent) did not destroy the mites in three hours; arsenous acid also had a very unreliable action,

for it did not kill a number of mites that had been exposed to its action for twenty hours when using a one-half to a one-and-one-half per cent solution.

Based on their experiments, Brandl and Gmeiner came to the following conclusions: the optimum temperature ranges from 15° C. to 30° C. (59° to 86° F.). At 35° C. (97° F.) they shrink, become dry (shrivel). Mites that have fallen from the skin remain alive for three weeks at 16° C. to 20° C. (60.8 to 68° F.); for one week at 1° C. to 10° C. (33.8° to 51° F.); and for about three days at 1° C. to 5° C. (33.8 to 41° F.). In warm water the parasites remain alive for twelve to fourteen days; in cold water, nine to twelve days.

SARCOPTIC MANGE OF HORSES

(*Burrowing Mites*)

Etiology: Sarcoptic mange is the most frequently occurring form of mange of horses. *Sarcoptes scabiei var. equi* were first seen in 1784 by Kersting, first director of the Hannoverian veterinary school, although he may not have exactly understood their etiological relation to mange. Later Gohier, Hertwig, Hering and especially Gerlach demonstrated the etiological significance of the mite, partly by reproduction of the disease.

The female mites are 0.4 to 0.5 m.m. and the male mites 0.2 to 0.3 m.m. long.

Symptomatology: Sarcoptic mange begins as a rule on the head and on the side of the neck or shoulders, but may, as a result of neglecting the animals, spread over the entire body. A marked itching is associated with mange. If the affection continues for a long time, the skin becomes thickened and the state of nutrition of the animal is decidedly lowered. The hair falls out at the most affected areas either in patches or large areas and the skin is covered with scales and dried cuticle. In the

eastern battle area, during the present war, mange made its appearance, especially in the Polish and Galician horses, which caused many cases to be transmitted to the German troop horses. The infestations presumably occurred in that the German army horses, partly due to a

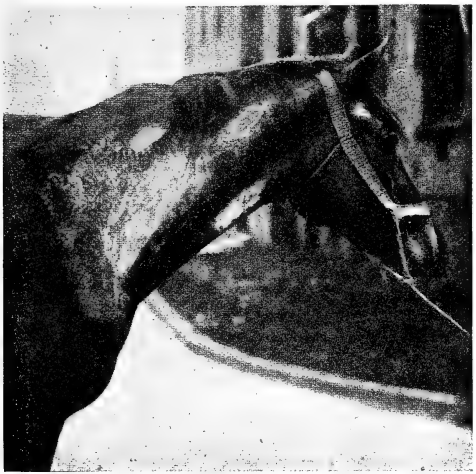


FIGURE 22
Sarcoptic mange.

lack of prearranged sites and partly unknowingly, were placed in stables in which mangy horses had previously stood. By means of blankets, parts of harness and grooming utensils, mange was spread quite rapidly among all horses which belonged to the same body of troops. Under such conditions mange can in a short time spread to many horse stations if not opportunely prevented.

Pathological Anatomy: According to the more recent profitably resulting examinations of Olt-Ströse, the sarcoptic mites force themselves only into the upper layers of the epidermis (stratum superficialis) and not into the deeper layers of the epidermis. Here they burrow canals which retain the form of the mite and gradually raise themselves with the epidermis. Every mite burrows its own canal, at the termination of which it becomes encysted or remains to lay eggs. In these canals are found eggs and small round clumps of fecal matter. According to Fürstenberg, the female mites burrow canals 12 to 15 millimeters long. The males burrow short canals and often leave their original sites after becoming sexed for copulating purposes. As a result of mechanical irritation and the excretion of a poisonous salivary secretion, an inflammation of the epidermis is produced which is accompanied by cell degeneration and the death of many cells. The dead epidermal cells become cemented together by means of the excreted inflammation-producing fluid and form bark-like layers. The fluid of the mites produces at the same time, pruritus and as a result of rubbing, superficial and deeper layers of the epidermis become worn off. The inflammation extends to the papillae, which results in a flakiness of the shaft of the hair in the hair follicle and a loss of the hair.

PSOROPTIC MANGE OF HORSES

(*Sucking Mites*)

Mange in horses is caused in one-third of the cases by the psoroptes and in two-thirds of the cases by sarcoptes (Gerlach). It is caused by *Psoroptes communis var. equi* which was first observed by Gohier in 1812. Males are 0.5 millimeters and females 0.6 to 0.7 millimeters long. The mites prefer the protected parts of the body

which are covered with long hair; consequently, this form of mange is especially observed in the mane, tail and also upon the throat and on the inner surface of the thighs and on the udder. In sucking, the mites bore their long trunks down into the cutis, in which act they raise the hind parts high and stand almost perpendicularly on their heads. After becoming satiated they slowly crawl along and fasten themselves to the base of the hairs. As a result of the boring and the excretion of a strong juice, a decided pruritus is produced (Gerlach). Coincidentally an inflammation results, proliferation and an increased degeneration of epithelium occurs and this collects as scabs and scales on the surface of the skin. Mange makes itself manifest by the loss of hair, formation of scales, thickening of the skin and pruritus—similar to sarcoptic mange.

SYMBIOTIC MANGE OF HORSES

(*Scale-Eating Mites*)

This is produced by *Chorioptes symbiotes var. equi* and causes foot mange which, however, is not combated by the veterinary police. The male is 0.25 to 0.3 millimeters long and the female 0.35 to 0.4 millimeters long. The mites live on the skin in colonies, especially in the fetlock, where they lie in large masses composed of fine mealy scales.

DIFFERENTIAL DIAGNOSIS

Lice. Haematopinus macrocephalus

They belong to the Hexapods; are about 2.5 to 3.5 millimeters long and suck blood. The pear-shaped eggs (nits), which have a cover, are about the size of a pinhead and are glued to the hair. The lice go through three cystic stages (Fiebiger). The horses rub them-

selves much on account of the marked pruritus caused by the lice; they lose their hair and the state of their nutrition becomes poor. Owing to the ease of recognizing the eggs (resembling some seeds of plants), which are attached to the hair, mistakes in diagnosis are not apt to occur.

Bird Mites. Dermanyssus gallinae

At times these parasites are observed among horses in the event that fowls are housed in horse stables. They affect the animals only at night, being found more particularly on the necks and backs of their hosts, and very difficultly during the day time (Dieckerhoff).

Acne, Heat-Eruptions. Summer Mange

Summer mange occurs chiefly in the spring, during great heat, at the time of shedding the hair. It is probable that it originates through the occlusion of the excretory ducts of the sebaceous glands and the openings of the hair follicles (Hutyra-Marek). The disease is either spread evenly over the entire body or at the points where the harness rests, especially under the saddle.

Alopecia Areata. Herpes Tonsurans

Alopecia areata is caused by the Trichophyton tonsurans, a fungus, which belongs to the blastomycetes. It multiplies by sprouting and forms a dense matted mass from which hyphae protrude. Spores are placed on the ends of the hyphae in a rosary-like chain. They surround the hair shaft in thick masses and become inclosed by the dense mat. The disease appears as rounded, sharply contoured, hairless areas. Such lesions may become confluent and be complicated with increased desquamation, causing possible confusion with mange,

which it resembles in certain respects. As a rule, pruritus is not present or is insignificant. Alopecia areata occurs most frequently in cattle, and can be transmitted to horses which are housed in cattle stables.

COMBATING HORSE MANGE

Therapeutic Treatment

Preparatory Treatment: On account of the rapid spread of sarcoptic and psoroptic mange, every skin eruption, which is associated with a sense of itching, is for the sake of precaution to be treated with anti-mange remedies. Before treatment is begun, the bark-like layers are to be softened so that the chemical preparations which are used to destroy the mites, may come in direct contact with the parasites. For this purpose green soap or 10 per cent carbol-glycerin are best used. The preparations are allowed to act for about 24 hours on the areas most affected. After the lapse of this period they are washed off and the mange liniment is thoroughly rubbed in by using a brush. Marek recommends that the actual treatment should be preceded always by clipping the hair and rubbing potash soap over the entire body, which is afterwards washed off.

Actual Treatment

Many preparations have been recommended for destroying mites. I shall only allude to such preparations that have proved successful, according to the authoritative judgment of those colleagues who had much to do with the combating of mange, in the world war. When compounded preparations were not available, petroleum or 2 to 3 per cent creolin, lysol or bacillol solutions, when rubbed in, gave good results. According to Marek, a mixture of one part petroleum and two parts sesame oil

gave much better results than the classical mange remedies. On account of the irritating action of petroleum, the treatment must be carried out somewhat carefully. Peru balsam in 4 to 5 per cent alcoholic solution or in a 4 to 5 per cent salve were also used with good results, but its high cost may prohibit its use in large quantity.

In the majority of cases Fröhner's creolin liniment was used. After the soap has been washed off twenty-four hours, the following liniment should be rubbed in daily over one-third of the body:

℞

Creolini anglici		
Spiritus	aa	100.0
Sapon. virid.		800.0

Misce

Signa, Mange liniment.

Creolin, which at times is very expensive, can be replaced with carboxol II.

In place of using Fröhner's liniment, the following mixture may be used: Liquor cresoli saponatus, one part; spiritus dilutus, nine parts, which can be kept on hand.

After an interval of two to three days, the preparation is washed off with soap and warm water and the diseased areas of the skin as well as new lesions are again treated with the liniment. One day later, the treatment is repeated on the different third portions of the body in the same order as first applied. [Application to one-third of the body at a time is done for the purpose of avoiding poisoning the animal that is being treated.] Careful application of this kind repeated once, leads to complete recovery in most cases. Four to five weeks later the areas of the skin that had been diseased were

covered with hair. According to Marek, the Vienna tar liniment and creosote oil (1 to 20 to 25) as used in his clinic, have proved successful for a long time, while cresol liniment failed to effect a cure.

℞

Picis liq.
Sulphuris resub. aa 100
Sapon. virid.
Spiritus aa 200
Misce (Vienna tar liniment)

After applying both of these preparations four to six times successively on the different third portions of the body, a cure was effected in the most obstinate cases. However, the creosote oil was somewhat more irritating and was better borne in the winter season, the irritation of the oil being increased by warmth. Relapses occurred only when the tar liniment alone was used. These mange remedies were washed off with soap and warm water four or five days after completion of the treatment, two washings being necessary to cleanse the animal. The application of the remedy as well as its removal is done in the stable in winter and in the open in summer. Good results are obtained only when the attendants who carry out the treatment are carefully instructed in their duties and continuously watched; otherwise, the parts of the body that are difficult to reach are liable to escape the treatment. In such cases, the length of treatment is extended.

Dipping vats were constructed in many horse hospitals in which the horses could be submerged to their backs in a creolin solution. Their bodies were thoroughly rubbed while in the solution. According to Marek, such treatment gave good results.

VETERINARY POLICE REGULATIONS

Aside from isolating and treating sick and suspected animals, the army veterinary regulations prescribe the isolation of horses exposed to mange. The time of isolation is placed at six weeks, figuring from the last day of contact with mangy horses.

Special stress should be laid on the disinfection of stables and equipment, particularly the saddle blankets and grooming utensils. Since isolation of sick and suspected animals is not possible in the field, they should be segregated; saddle blankets and grooming utensils should be disinfected.

Lifting the Quarantine

Mange is to be considered eradicated and the prescribed precautionary measures discontinued when (a) horses that had been mangy show no symptoms of the affection within six weeks after the termination of treatment; (b) when the mangy and exposed horses have been declared healthy; and (c) when the prescribed disinfection has been carried out.

INFLUENZA OF HORSES

CONTAGIOUS PLEUROPNEUMONIA OF HORSES

(*Influenza Pectoralis*)

ETIOLOGY OF INFLUENZA

Schütz recognizes as the cause of this disease a diplococcus which occurs in the lungs of horses affected with influenza, while Lignieres and other research workers look upon the bipolar bacteria as the cause (pasteurella). According to recent investigations, especially those of Robert Koch and his co-workers, we are to understand that those microörganisms described up to the present time have no causal relationship with this form of influenza, but that they may much more frequently occur as secondary invaders. Gaffky and Lührs discovered in the alveolar epithelium distinctly set-off (definitely outlined) vacuoles that were filled with six little grains and which they recognized as the etiological factor. Confirmation of these results is as yet lacking.

SPREAD OF INFLUENZA

The extended investigations of Gaffky and Lührs have shown that the transmission through indirect contact from animal to animal can occur, or there exist intermediary hosts that are as yet unrecognized, in which the infective substance must pass through a ripening process (developing process) and influenza made transmissible in this way. All artificial attempts to transmit the disease by such means as stable utensils, food, water, manure which had come in contact with sick horses, dust from sick animals, mice, rats, flies, lice, have given negative results up to the present time. The possibility that the disease does not always continue from animal to animal, but frequently skips several animals in the same stable, be-

speaks the possibility that, aside from the direct contact, another unknown intermedium must exist. Possibly we have to deal in influenza, as in all other infectious diseases, with a virus carrier, which gives off or excretes the virus for a variable length of time after recovery from the disease and by this means produces the disease anew in neighboring animals.

Mature horses (five to ten-year-olds) become sick most frequently. One attack of the disease, as a rule, produces a lasting immunity.

SYMPTOMATOLOGY OF INFLUENZA

The incubation period in influenza on the average is ten days, usually two to three weeks, but it may extend as much as forty days. The sick horses show, in the beginning, peculiar action; they frequently interchangably relieve both hind legs, and the hind parts sway. The appetite is diminished. The temperature suddenly rises to 40° C. (104° F.) and above and remains at this point, with few remissions, until the crisis is reached on the sixth or eighth day, and then it rapidly drops to normal. Coincidentally with the appearance of the fever, the conjunctiva becomes yellowish red and the sclera shows a yellowish discoloration.

Soon symptoms appear which indicate that the respiratory tract is affected. This is signalized by a short, exhaustive, hacking cough and a rusty yellow discharge issues from the nose; respirations gradually increase from twenty to forty per minute. In painful pleurisy, during breathing, the ribs of the diseased side are moved as little as possible. The breathing then is superficial, accompanied with dilatation of the nostrils. In the beginning of the disease, there exists increased vesicular breathing; later a rattling and rubbing noise develops. When percussing the lungs solid areas can be demon-

strated in the region of the chest wall. However, this is always observed when there are pneumonic changes or when a considerable quantity of fluid has already collected in the pleural sacs. In these cases the solid areas show horizontal limitations. The number of pulse beats slowly increases from fifty to sixty or eighty and may in serious cases go up to one hundred per minute. When myocarditis exists the heart tones become dull and weak.

The inflammation of the lung as a rule first manifests itself on the second or third day after the existence of the fever, increases until the seventh or the ninth day of the disease (crisis) and then diminishes coincidentally with the body temperature. At about this same time a simultaneous drop occurs in the frequency of the pulse and respiration. The convalescent period lasts eight to fourteen days.

During the typical course of the disease many deviations occur which are independent of the seat or scope of the disease, of the virulence of the causal agent, of the susceptibility of the diseased animal and of external influences. As a result of this, influenza at times runs an abortive course and may lead to recovery within eight days. Now and then many pneumonic foci develop closely under the pleura, or the heart muscle may become severely affected. Along with affection of the gastro-intestinal canal, swelling of the limbs occurs, which unfavorably influences the normal course of the disease.

Sequellae that are to be feared are necrosis that may result from the pneumonia, and gangrene by means of the development of putrid matter. In the latter case a marked nasal discharge exists and the expired air has a nauseating, fetid odor.

As a result of influenza we may finally observe: in-

flammation of tendons, tendon sheathes and joints; also roaring, following paralysis of the recurrent laryngeal nerves; broken wind (dyspnea), following chronic bronchitis; pneumonia and, as well, occasional inflammation of the inner parts of the eye.

PATHOLOGICAL ANATOMY OF INFLUENZA

The mucous membranes are reddened. In the pleural sacs an albuminous, partly coagulated fluid is found. Adhesions occur between the parietal and visceral layers of the pleura, which is transformed into a non-transparent, thickened, and at some places gelatinous, mass. The pneumonic changes occur chiefly in the middle of the lower portion of the lungs; the lesions are never of the same age and are usually observed at different points and separated from the healthy lung tissue. Therefore, the process must be described as variable with reference to locality and time of development.

In influenza the typical course of the sero-fibrinous pneumonia consists of four stages.

Catarrhal Stage (Infarct): The infective agent irritates the capillary walls and a serous fluid exudes into the alveoli. The alveolar epithelia simultaneously become swollen and mix with this fluid. In this stage the lung is congested and heavy. In an autopsy, upon exerting pressure, a cloudy, thick, grey-red fluid flows from the alveoli in which there is very little air.

Hemorrhagic Stage: As a result of the extended injury of the capillaries, red blood corpuscles occur in the exudate which causes the fluid exuding from the alveoli to appear red.

Hepatization Stage: As a result of the formation of fibrin, the fluid in the alveoli coagulates and develops into a comparatively firm mass, which gives the lung the consistency of liver. Such parts of the lung feel

tough, the cut surface is somewhat granular and the alveolar contents, following the sectioning, exude in a granular condition as a result of the retraction of the elastic alveolar walls.

Resolution Stage: After a while the contents of the alveoli again become fluid, very likely as a result of peptonization (grey hepatization), and resolution gradually results.

There are many deviations from the typical or normal course and the following changes may develop:

(a) Pulmonary Necrosis. As a result of an insufficient amount of blood being carried to hepatized portions of the lung, and through the assistance of microorganisms, such portions of the lungs die. This at the same time results in a demarcation from the neighboring tissue. Such areas of the lung appear grey-yellow and are dry.

(b) Pulmonary Abscess. In the event that pyogenic bacteria enter such an area, the degenerated tissue becomes softened and cavities develop, which are partly filled with pus and partly with necrotic material (not exactly an abscess).

(c) Pulmonary Gangrene. If, in addition to pyogenic bacteria, putrefactive bacteria have gained entrance, pulmonary gangrene results. The areas are filled with very fetid-smelling masses, which are discolored and at first pasty or pap-like and later more fluid.

COMBATING INFLUENZA

General Treatment

The horses are to be placed in a well ventilated stable and frequently offered fresh drinking water, good hay, carrots, etc. Cardiac stimulants that can be recommended are caffein hydrochlorid, six to eight grams in 10 c.c. distilled water; or 20 to 50 c.c. oil of camphor

every two to three hours, never giving more than 100 to 150 c.c. *per diem*. The diseased conditions of the pleura are favorably influenced by poulticing according to Priessnitz or by rubbing in a mixture of oil of mustard five to eight c.c. and alcohol 100 c.c. In intestinal affections Karlsbad salts in doses of 100 to 150 grams are to be used.

Immunization

Active Immunization: The immunization experiments with Schütz's diplococcus carried on by a number of different individuals have as yet not given practical results, nor have those experiments of Gaffky and Lührs, who employed extracts made from the triturated areas of the diseased lungs of horses infected with influenza.

Passive Immunization

Immunization experiments with serum from animals that had recovered from influenza gave variable results. In general, the protective powers of such a serum are but slight, consequently, according to Jensen, large doses must be employed (150 to 200 c.c.).

Simultaneous Method

In recent times simultaneous inoculation with 100 c.c. of serum and 50 c.c. of vaccine has been recommended. Further results regarding this method and experiments in practice, with reference to its action, are lacking.

Chemo-Therapy

According to Ehrlich we must consider the body cells as being supplied with nutri-receptors (food receptors) which serve for the taking up of nutrient matter and others for parasites. The latter, which are also referred to as receptors or side chains, regenerate themselves as soon as they have become injured through parasites and are thrown off in large amounts into the blood stream.

Like the nutri-receptors, the cells, according to Ehrlich's theory, should also be supplied with receiving stations for chemical substances which are to be called chemo-receptors. They have the ability to take up drugs and carry them to the cells where they may act harmfully or usefully. As an example, such receptors (oxygen receptors) exist in the blood for the taking up of acid substances. Parasites are supplied with chemo-receptors which serve to bind chemical elements in a way similar to that of organic cells. According to whether the chemical substances possess greater affinity for organic cells or parasites, one speaks of organo-tropism or parasito-tropism. The skill of the chemo-therapeutist consists in the choice of preparations for the combating of infectious diseases which are more parasito-tropic than organo-tropic, and it is upon these facts that Ehrlich's extended and prolonged therapeutic researches have been based. Chemo-receptors are specific to the extent that they will take up only definite molecular combinations of one chemical group and not those that consist of a number of different molecular combinations. Therefore, we find that there are chemo-receptors for all triphenyl-methan dyes which can unite with fuchsin, ethyl green and malachit green; other receptors for the taking up of the trypan red group, and others again which are intended for the taking up of arsenicals (Ehrlich and Gonder).

As a result of the experiments of Ehrlich and his co-workers it was further determined that only trivalent arsenic possesses a marked parasito-tropic property as is observed in the reduction products of aromatic arsenous acid. According to this the trivalent arsenic compounds to which the arseno-benzols belong, prove themselves exceptionally good as parasiticides. There were produced from these a large number of chemical compounds

which were tested for their ability to sterilize the body instantaneously (*Therapia sterilisans magna*). In this manner arsacetin was originated, also the combination 118—arsenophenylglycin—which showed a decided destructive action without being especially poisonous. At a later time Ehrlich and Bertheim produced the arsenic preparation 606, which was named salvarsan, the efficiency of which was tested with animal experiments by Doctor Hata.

Salvarsan

According to its chemical composition salvarsan is a dioxydiamidoarsenobenzoldichlorhydrate, which is a yellow powder soluble in a strongly acid water. Air easily affects it, and it is changed when acid substances come in contact with it, which change, when the composition is examined either as to color or solubility, can not be detected and can only be determined by means of animal experiments. Therefore, salvarsan is packed in glass ampules which are filled with gas that does not influence it chemically and in this way protected against oxidation. In the event that ampules are damaged during transportation, they should not be used, nor should left over portions of previously employed preparations be used. For this reason it is not safe to prepare a solution for a considerable length of time before it is to be used. It can only be used intravenously because the salvarsan causes considerable necrosis in the skin and muscles.

Use of Salvarsan

Rips was the first to use salvarsan according to Ehrlich's directions. In order to make a solution of one gram, three drops of normal sodium hydroxid and 500 c.c. sterilized physiological salt solution are used. Therefore, 1,500 c.c. of this fluid had to be used when using three grams of salvarsan—the quantity for one treat-

ment. For the injection Rips used a specially designed infusion apparatus, which consisted of a 500 c.c. glass cylinder, to the lower end of which a rubber tube with a cannula was attached. The solution is injected intravenously. No serious results were observed in the patients at any time, with the exception of transitory symptoms of restlessness.

The difficulties connected with the injection of such large quantities of fluid, caused Miessner to inject the salvarsan in concentrated form. In these experiments it was proved that concentrated solutions (one gram in 30 c.c. fluid) were also well withstood when the solution was made sufficiently alkaline. If this instruction is not observed, fatal complications may result, since, according to Miessner, acid solutions of salvarsan cause coagulation of the blood and may produce thrombosis in the lungs, which would cause early death of the animal. The use of concentrated alkaline solutions did not result in prolonged restless symptoms.

Preparation and Application of Salvarsan Solution

One gram of salvarsan is placed in a sterile 100 c.c. medicine bottle and thoroughly shaken with 20 to 30 c.c. sterile physiological (0.9%) salt solution until the salvarsan has entirely gone into solution and forms a golden yellow, perfectly clear fluid. To this solution 10 c.c. of normal sodium hydroxid are added; one should observe that, by careful addition of the hydroxid, there is at first formed a precipitate which is later followed by the precipitated substances going back into solution. If it is desired to inject two to three grams instead of one, the process is similar to that just described. In such cases it was found advisable to make solutions in a special medicine bottle of but one gram at a time. The dose to be applied in cases of influenza is *three grams.*

The injection is carried out by using a 10 to 20 c.c. syringe, making an intravenous injection.

Later Reinecke and Bauer also preferred the use of the concentrated solutions. Bauer expresses himself regarding this in the following manner: "The concentrated solution of salvarsan is equally as efficient as the very dilute solution and its use is entirely without danger. The simplified method of injection made possible a more convenient incorporation of the remedy within the body than did the infusion method and the solution was more easily transported."

Reinecke also recommended an infusion apparatus for the application of the concentrated salvarsan.

Action of Salvarsan

The highly satisfactory results that were shown by the use of salvarsan in the treatment of syphilis induced Rips to use the preparation for influenza in 1911. The first experiments carried out on only four horses caused a diminution in the frequency of the pulse and increased the appetite. Thereupon the army administration ordered the treatment of influenza with salvarsan in a number of army corps. Equally as good results were obtained, which can be summarized as follows:

1. The course of the disease is favorably influenced by the use of salvarsan;
2. The body temperature of the patient drops to normal within 24 hours after applying the treatment;
3. The frequency of the pulse and respirations fall to normal;
4. The appetite is increased;
5. When used early, pneumonia does not develop; an existing pneumonia is favorably influenced;
6. The period of convalescence is shortened;
7. Sequelae as a rule do not occur.

Experiments ordered by the ministry of agriculture (*Landwirtschaftsministeriums*) and carried out by Nevermann, Puschke and Fischer, led to similar results. A great many army veterinarians have used salvarsan in influenza with the same good results, so that any doubt as to its efficacy is entirely out of the question. Salvarsan therapy must, therefore, be considered as a great advance in the combating of influenza. Also those experiences that have been had with salvarsan during the present war, confirm everything that has been said heretofore.

Neosalvarsan

The inconvenience in regularly preparing salvarsan solution and the serious accidents which occurred in people by not carefully observing the technic, caused Ehrlich to prepare a convenient and available preparation having about the same action. This he accomplished by manufacturing preparation No. 914, a salvarsan derivative, which is placed on the market in the form of a yellow powder under the name of neosalvarsan. Neosalvarsan (dioxydiamidoarsenobenzol-monomethanacid sodium sulfine) contains as its most active ingredient 20 per cent arsenic. It goes into solution very readily in water with an alkaline reaction and is immediately ready for use.

It resembles salvarsan with reference to its susceptibility to air, in which, when in the presence of an acid, it oxidizes to a poisonous preparation, which outwardly does not change in color, but which in animal experiments leads to serious symptoms of poisoning. It is for this reason that neosalvarsan is also placed in glass ampules which are filled with a gas which chemically is not active. Ampules damaged during transport should not be used. The solutions are always to be prepared immediately before they are to be employed. The effi-

ciency of neosalvarsan is almost half that of salvarsan. Therefore, double the quantity must be used.

Preparation and Application of Neosalvarsan Solution

One gram of neosalvarsan is dissolved in 15 to 20 c.c. of sterile water and, therefore, for five grams, which are necessary for one injection, in about 100 c.c. of water. Complete solution of the preparation is attained in about one minute. Instead of the recommended distilled water, well water and tap water are satisfactory. According to my own experiences, these quantities can be injected very conveniently with a 10 to 20 c.c. syringe. It is best to use ordinary glass syringes with an asbestos piston since the preparation easily affects metal. Rips uses a 100 c.c. syringe.

Others recommend infusion apparatuses. To me it seems that the use of simple glass syringes is the most satisfactory because, due to their small size, one can easily carry them around. It is frequently necessary in neosalvarsan therapy to apply the treatment early, which is only possible if the syringe and several doses of neosalvarsan are immediately at hand. The infusion apparatuses are not suitable for transport and are not durable. They may, however, give good service in horse hospitals and depots and also for horses placed in resting stations.

Action of Neosalvarsan

Rips and Neven first carried out experiments with neosalvarsan which gave the same good results as were obtained with the use of salvarsan. Stödter, Toepper, Baumgarten and Lütje also conducted such experiments later. Rips and Neven are of the opinion that neosalvarsan is to be most certainly preferred to salvarsan, because the solution can be prepared so much more

easily. The efficacy of neosalvarsan can be summarized as follows:

1. Application of neosalvarsan induces a rapid drop in the temperature;
2. Sick animals, following an injection, show increased appetite;
3. The pneumonic changes are checked;
4. Rapid cure; absence of sequelae;
5. The number of virus carriers are decidedly diminished.

Time of Application of Neosalvarsan

The question often brought up, at which time should the injection be made, is answered in scientific circles in various ways. Rips does not desire to do homage to Ehrlich's basic sentence, "*Frapper fort et frapper vite*" (Strike hard and strike quickly), which he as a rule pleads for in acute infectious diseases. He fears, when applying neosalvarsan so very early, a too rapid extinction of the germ of influenza (*Therapia sterilisans magna*), thereby disturbing the formation of antibodies. The same stand is taken by Lütje, who observed an outbreak of influenza in a horse fourteen days after an apparently too early treatment with neosalvarsan. However, Ehrlich and his school have experimentally succeeded in showing that when antibody formation is once induced, it is not hindered at all by the use of neosalvarsan. Therefore, there is nothing that could stand in the way of the early application of neosalvarsan, and, based on personal experiences, I wish to especially recommend it now during the war. It is not always possible for a veterinarian to look up his patients daily when the horse stations of a division are widely separated. Also the observations of the attendants are not always to be looked upon as reliable when we consider

the poor sheltering conditions that often exist for horses and troops. The beginning of the feverish condition is frequently not immediately recognized and it is not easy to decide the question whether horses have but recently become sick or whether they have been feverish for several days. I have, therefore, decided to give an injection immediately in such cases where the temperature was above 40° C. (104° F.) or where there was the slightest suspicion that pneumonia could be expected, and always got very satisfactory results. In this there was also the advantage that the horse was ready for traveling on the following day, a factor one is not apt to underestimate when unexpected marching orders come, with which one has almost always to deal in war.

I also want to ascribe the early arrest of influenza in a battery of my regiment as being due to early therapeutic interference. If one heeds Ehrlich's view of the significance of *therapia sterilisans magna,* then the influenza germs are destroyed with neosalvarsan and their further spread prevented. In this way—by early treatment—the rapid eradication of the disease is explained. Lütje also calls attention to the diminution of virus carriers or virus excreting animals.

Neosalvarsan can not at all be considered as an immunizing agent and, therefore, its prophylactic application is useless, especially since the active arsenic after eight days is already mostly excreted from the body.

According to this, neosalvarsan can be looked upon as a substitute for salvarsan in the fullest sense of the word and its timely application in pectoral influenza cannot be recommended too strongly because we must accept that the high therapeutic value of the preparation has been definitely proved. Thus we have the splendid results which were developed from neosalvarsan therapy.

Arsinosolvin

Arsinosolvin (Bengen & Co.) is the sodium salt of aminophenyl-arsenous acid. According to the statements of several authorities, it acts similarly to salvarsan or neosalvarsan, causing a drop in the temperature and bringing about an early convalescence. An advantage over the other two preparations is that it is much cheaper.

More recently arsalyt has been praised as having good action.

VETERINARY POLICE REGULATIONS

At the very first appearance of a case of pectoral influenza or a suspected case of it, carry out the following:

(a) Strict segregation of the sick horses and their attendants;

(b) Close every means of communication leading to or from the segregated horses;

(c) Vacate and close those stalls in which sick horses stood;

(d) Saturate litter with disinfectant.

When the disease is spreading, the sick horses should also be isolated, because this will more certainly prevent the appearance of a generalized epizootic, which can nullify the usefulness of an entire troop, than if all the horses in a station are allowed to become infected gradually. Early and timely recognition of further cases is made possible only by immediately beginning to take daily temperatures and continuing to do this in all the horses of the stable or station under consideration. If one should wait until the horses refuse to eat, then they have already spread the infection during that time, for it is during the first few days of the disease that the infective ability of pectoral influenza is greatest (see veterinary police regulations in catarrhal influenza).

CATARRHAL INFLUENZA

(*Influenza Catarrhalis*)

ETIOLOGY OF CATARRHAL INFLUENZA

In the past the cause of catarrhal influenza was not known, but, according to more recent investigations, it appears that a filtrable virus comes under consideration. The disease can be transmitted to other horses by means of blood, serum, nasal and conjunctival secretion of sick horses. The period of incubation is four to seven days.

SPREAD OF CATARRHAL INFLUENZA

Catarrhal influenza is very contagious, just the opposite of pectoral influenza, and spreads through a station in a very short time. It does not attack only younger animals, but older horses become sick quite as easily. Transmission results usually from direct contact from animal to animal, but it can occur indirectly by means of inanimate objects, *e.g.*, food, water, stable implements, manure, stable equipment, etc. Up to the present time insects have not been observed to act as intermediary carriers. It is claimed that stallions have transmitted the disease during the act of serving one year after having had catarrhal influenza.

SYMPTOMATOLOGY OF CATARRHAL INFLUENZA

The disease makes its appearance with a rise in temperature of 40° C. to 41° C. (104° F. to 105.8° F.), which continues for about two to six days. At the same time the animal manifests a noticeably early generalized fatigue. Their gait is clumsy or awkward, and at times they sway with the hind quarters. They stand in front of the crib in an uninterested manner with head lowered and ears drooping. The eyes are usually kept closed;

photophobia and lacrimation exist. The conjunctivae show edematous, glassy swelling. As the disease progresses a cloudiness of the cornea appears and an exudate occurs in the anterior chamber of the eye. Complete anorexia exists. Respiratory movements are as a rule not labored, but at times the frequency of breathing is somewhat increased. A mucous, nasal discharge exists. The cough, which is not spontaneous, is mildly strong. In the beginning the pulse is affected very little, in spite of the high temperature; in serious, progressive heart disease the pulse is small and frequent. The oral mucous membrane is reddened and the tongue covered with a dry coat. Constipation is present at first, but this is mostly followed by a foul, offensive diarrhea. In the deeper lying portions of the subcutis under the chest and abdomen, especially on the sheath, there occur swellings; as a rule the subcutis of the limbs is edematously swollen. In other cases patchy swellings occur; also rounded or elongated swellings about the size of a cent to that of a half-dollar are found distributed unevenly over the body (urticaria).

The course of catarrhal influenza is generally to be looked upon as mild. Sometimes complete recovery takes place in two to three days. After an illness of seven days the animals usually recover after a convalescence of eight to fourteen days. It is to be observed that complications or sequelae are always to be feared when horses are drawn into active service, especially when the weather is bad, in the beginning or during the period of convalescence. Sequellae, that deserve chief consideration, are: Broncho-pneumonia which frequently terminates in gangrene; dyspnea as a result of edema of the glottis; hemorrhagic inflammation of the gastro-intestinal tract; nephritis; icterus; laminitis; spinal paralysis resulting in paralysis of the hind quarters or all four

limbs; marked painful swellings of the subcutis on the limbs.

PATHOLOGICAL ANATOMY OF CATARRHAL INFLUENZA

The pathologic anatomical changes are mostly those of a general blood infection (septicemia). As a consequence we find cloudy swelling of all parenchymatous organs. Since the mucous membranes are primarily concerned, we observe loosening, catarrh and gelatinous swellings, which can likewise spread to the diseased portions of the subcutis. When complications are present, corresponding changes are observed in the organs concerned.

COMBATING CATARRHAL INFLUENZA

Treatment: Nothing has been produced up to the present time with which to immunize animals against the disease. Neither is there any special specific for the affection, such as we find, for example, in salvarsan for pectoral influenza. Consequently, one must depend entirely on removing the animals early from service and giving them a long rest, even after the acute symptoms have disappeared. As for the other measures to be pursued, symptomatic treatment should take place. Good ventilation of the stables is the first requirement.

Give a little green feed and warm bran gruel. Antipyretic treatment is useless. In cases of heart weakness, which should be given special attention, 10 to 30 c.c. oil of camphor is to be given subcutaneously. If an inflammation of the lungs exists, oil of mustard should be rubbed into the chest walls. When the intestinal tract is affected, give saline remedies, sodium salicylate or calomel (4 to 8 grams). The shoes should be taken off the horses and the limbs washed with cold water till cool and then massaged and bandaged.

VETERINARY POLICE REGULATIONS FOR INFLUENZA OF HORSES

(*Both Catarrhal and Pectoral Forms*)

According to the decree of July 29, 1908 (in the German Empire) influenza (pectoral and catarrhal forms) is a reportable disease (compulsory). According to this ruling it is compulsory to keep influenza-sick and suspected animals under quarantine in the stables, and those thought to have been exposed are not allowed to come in contact with others.

Influenza can be considered as eradicated if no suspicious disease symptoms have appeared five or six weeks after the day when the last sick case occurred among the horses; and when the prescribed disinfection has been carried out.

STRANGLES

(*Coryza Contagiosa Equorum*)

ETIOLOGY OF STRANGLES

Strangles is a disease of Equidae which affects the mucosa of the upper respiratory tract and is associated with purulent inflammation of the regional lymph nodes. It is caused by the *Streptococcus equi,* discovered by Schütz in 1888 and independently of him by Sand and Jensen as well as Poels. Based on its pathogenic, immunizing and cultural characteristics as well as its action toward certain carbohydrates, the strangles streptococcus is to be looked upon as a distinct species which has no relation to the streptococci that occur in human beings.

The streptococcus occurs in great numbers in the abscesses of horses affected with strangles. It occurs in long chains which are often tortuous and which are composed of cocci. The individual elements occur as round or at times oval forms. In artificial culture media they also form long chains. The culture media must be weakly alkaline; addition of glycerin, glucose or serum favors the growth of the bacterium. The colonies are the size of a lentil and sharply contoured. In stick cultures one observes a peculiar wing-formation (Jensen) (outgrowth from line of inoculation). The streptococcus hemolyzes blood corpuscles (taken from a dog, Andersen). It ferments many carbohydrates, with the production of acid, and in this it shows a specificity, in contrast to that of the other cocci. White or grey mice inoculated with strangles pus die, as a rule, after nine to twelve days. Pure cultures of the streptococcus can easily be obtained from such mice.

Staining the streptococcus: Staining can be accomplished with the ordinary anilin dyes. This can be

especially well done according to Gram's method (anilin-water gentian violet, two minutes; pour off stain; iodin solution one minute; decolorize in absolute alcohol, one-half minute; rinse; eosin one-fourth minute).

SPREAD OF STRANGLES

O. Müller and R. Pfeiffer have experimentally proved that the alimentary tract is the chief portal of entrance. This is contrary to the usual conception that the streptococcus of strangles primarily gains entrance to the nasal mucosa and disseminates from that point, which idea has existed up to the present time. They were always able to produce typical strangles in about four to five days by feeding pure cultures. In this way it was conclusively shown that the cause of bacteria localized between the base of the tongue and larynx and in the tonsils; this explained the pharyngeal as well as the other lymph nodes of the head becoming diseased. The disease spreads through infections from animal to animal or by means of intermediary carriers which carry the strangles pus. Common drinking and feeding places are especially dangerous.

SYMPTOMATOLOGY OF STRANGLES

Typical Form

Strangles is chiefly a disease of young horses for which reason it is so frequent in studs and foaling-depots. After an incubation period of three to six days a rise in temperature occurs which is associated with profuse reddening and loosening of the nasal mucosa. At the same time, rarely later, a bilateral nasal discharge develops. At first the exudate is watery, then mucous, and later purulent. This discharge continues about eight to fourteen days. Very soon the submaxillary lymphatic glands begin to swell; they increase in warmth; they are very

painful and show, after four to eight days, distinct fluctuation as the result of pus formation. They always have the tendency to rupture toward the outside in such cases where one has not already evacuated the pus by means of an incision. Coincidentally with the swelling of the lymph nodes, an inflammatory edema of the subcutis may develop, especially in the submaxillary region. In such cases where the pharyngeal and laryngeal mucosa is affected, as well as the pharyngeal and subparotid lymph nodes, the entrance of air and swallowing can be interfered with and in this way give rise to inspiratory rattling noises and difficulties in swallowing. In cases where lymph node abscesses do not rupture from the outside, the pus often burrows its way to the larynx, the pharynx or to the jugular vein.

In general, healing soon results after opening abscessed lymph nodes. However, frequently metastases also develop in the internal organs by means of the lymph and blood streams, generally resulting in serious febrile conditions and usually the death of the animal.

Atypical Form

During the present war the occurrence of a very infectious form of laryngo-pharyngitis was reported from many districts, which apparently first led to severe casualities in Belgium among the advancing troops. Later the disease also made its frequent appearance and the author had the opportunity to observe it during the war in epizoötic form in his regiment (artillery). It affected both younger and older animals in the same degree and spread comparatively quickly to many of the animals of the station. As a rule the disease began with a swelling of the respiratory mucosa which was at the same time associated with cough, slight dyspnea and difficulties in swallowing. In many cases this developed into a

swelling of the submaxillary, subparotid and retropharyngeal lymph nodes and infiltration of the surrounding tissue. A tenseness of the skin resulting from this was especially to be observed in the parotid region and often brought about greater difficulties in the treatment. The tendency for lymph nodes to develop abscesses was not always very great; on the other hand, necrosis of the lymphatic tissue occurred frequently, to which Bambauer has referred (Deut. t. Woch. 1915, p. 65). The process of necrosis occurred quite frequently. The prepectoral lymph nodes may also be affected and become swollen the size of the fist. Barthel (Zschr. f. Vet.-Kunde, 1915) describes an infectious catarrh of the upper respiratory tract which presumably is to be identified with the atypical form of strangles. Upon examination of a similar case in the institute assigned to me, streptococci beside other cocci were demonstrated in the purulent foci of the lymph nodes; one is, therefore, safe without a doubt in ascribing this form of the disease to strangles as is also done by Hutyra and Marek in their text.

Dieckerhoff named this infectious laryngeal and tracheal catarrh "skalma."

COMPLICATIONS AND SEQUELAE OF STRANGLES

Multiple Abscess Formation in Lymph Vessels and in the Skin of the Head

At times there are to be observed cord-like swellings of the lymph vessels in the head and formations of nodules in the course of the vessels, which are often distributed like a string of pearls. These changes are conditioned upon the presence of the streptococcus which localizes itself in the vessels and produces the inflammation. Frequently the surrounding subcutis is markedly swollen and infiltrated with small pus foci. Timely

incision leads to early recovery. In other cases the skin lying above these parts becomes necrosed.

Gangrenous Broncho-Pneumonia

In such cases where the retropharyngeal or subparotid lymph node abscesses rupture into the pharynx or trachea, a serious gangrenous bronco-pneumonia develops, which almost always leads to death.

Metastases

Streptococci, by means of the blood and lymph streams reach the lungs, liver, spleen, kidney, or intestine or the regional lymph glands and lead to numerous abscess formations. These changes after prolonged illness frequently result in the death of the animals.

Morbus Maculosus

Frequently morbus maculosus follows strangles.

COMBATING STRANGLES

Therapeutic Treatment

The sick horses should be taken out of active service at the proper time. The strangles horses should be isolated whenever possible; common drinking troughs and mangers should be avoided. Keep them in well-ventilated stables and feed them easily digested and appetizing food. The catarrh of the mucous membrane can be eased somewhat by means of expectorants.

℞

Stib. sulfurat. aurant.	30.0
Ammon. chlorat.	100.0
Sodium sulphate	150.0
Pulv. rad. Liquirit.	100.0

Misce, Disp., Signa. Three tablespoonfuls daily with the feed.

When difficulties in breathing exist, tracheotomy should be performed. As for the rest, a symptomatic treatment, especially for the removal of the swellings on the head and lymph nodes should be carried out. Whenever possible attempts should be made to distribute the products of inflammation by means of poulticing according to Priessnitz, rubbing in green soap or employing light applications of liniment, which is to be followed with warm packs. As soon as fluctuation appears the lymph nodes should be opened and given the proper after-treatment. The best possible drainage should be provided for the products of degeneration; as a result of the frequently appearing necrosis, which develops within a few days, the dead material in the interstices should be removed with a curette, or, if necessary, with a dressing forceps. The treatment of necrotic lymph nodes is often very difficult, especially when they lie, as they frequently do, in unfavorable locations, as under the parotid gland, particularly when the necrotic process has the tendency to progress. Tampons with tincture of iodin have given very good results in such cases. Salvarsan and neosalvarsan have also come to be used in the treatment of strangles, however, without substantially bettering the condition. Possibly further experiments will be tried. Barthel claims to have obtained good results with neosalvarsan in infectious catarrh of the upper respiratory tract.

Immunization

Active immunization

Jensen and Sand first proved that an immunity could be produced by injecting living strangles streptococci. O. Müller and R. Pfeiffer again took up these experiments and claim that they prevented foals becoming

sick by vaccinating them early at the base of the ear on each side of the head.

Passive immunization

Passive immunization with antistreptococcic serum was first carried out on man and later attempted on horses by Jess and Piorkowski. At the present time a number of manufacturers recommend strangles sera. Views differ regarding its efficiency.

Simultaneous Method

It has been suggested to use the antistreptococcic serum and the strangles vaccine simultaneously in stables where strangles was present.

Positive results and noticeable advances in combating strangles have not been obtained with the immunization methods in vogue today.

Presumably the cause of the poor results is that the streptococci, which were selected for vaccination or for hyperimmunizing the horses were not selected in a sufficiently scientific manner, particularly since the general view is that streptococci found to be pathogenic for horses and man are identical.

VETERINARY POLICE REGULATIONS

Strangles of horses is a reportable disease in the province of East Prussia and in the governmental district Stade. Sick and suspected horses are subjected to farm and pasture quarantine. Infected farms and pastures are quarantined against strange horses.

DOURINE

ETIOLOGY OF DOURINE

Dourine is caused by the *Trypanosoma equiperdum.* Trypanosomae belong to the unicellular forms of animal

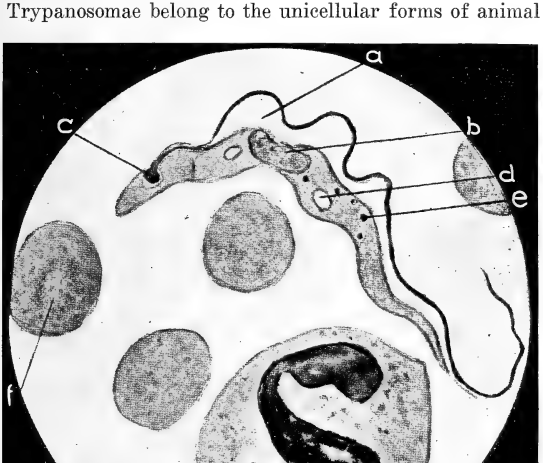


FIGURE 23

Trypanosoma equiperdum: (a) flagellum with undulating membrane; (b) principal nucleus; (c) blepharoplast; (d) vacuoles; (e) chromatin bodies; (f) erythrocyte; (g) polymorphonuclear leukocyte. (After a drawing by Dr. Lütje.)

life (protozoa) and live in the serum, in which they move between the red corpuscles in a lively wave-like, tortuous manner. Their bodies are about 10 to 15 micra

long and tapered at each end. The blunter end is provided with a long flagellum. In the inner parts of the parasite, a principal nucleus is found in the approximate center and a secondary nucleus or blepharoplast in the posterior end. The flagellum originates from the blepharoplast and follows next to the body as an undulating membrane and then projects as a long thread from the anterior end of the protozoön. It is frequently very difficult to demonstrate parasites; at times one succeeds in doing this in smears of the prepucial secretion (smegma) or of the urethral secretion, and in the fluid which escapes upon incising a raised area (plaque). It can be more certainly demonstrated by experimentally inoculating mice, rabbits or dogs. In the consideration of the small number of trypanosomes, it was found desirable to use at least 20 to 30 mice or other experimental animals and to infect these with prepucial secretion, fluid from the plaques or with defibrinated blood. This experiment does not always result in a positive manner, but nevertheless a few animals become sick, and in the course of a week one then comparatively easily finds the trypanosomes in the blood.

Preparation and Staining of Blood Specimens

A fresh drop of blood from a puncture wound is caught on the narrower edge of a clean glass slide. The narrow edge of a piece of filter paper having the same form as the glass slide is dipped into this drop and drawn with the free end to the opposite narrow edge of the glass slide. In this manner the drop of blood between the filter paper and the glass slide is spread out over the slide into a very thin film.

(a) Simple staining. After fixation (with flame or alcohol) of the preparation, stain with carbol-fuchsin one-fourth minute and rinse in water.

(b) Rapid staining according to Giemsa. The preparations are first fixed by placing them in a mixture of alcohol and ether for one-half hour. After completely

FIGURE 24
Dourine. Unpigmented spots on the vulvar lips.

drying, they are placed in a freshly prepared solution of ten drops of Giemsa's stain (Dr. Grübler, Leipzig) with 10 c.c. of distilled water for twenty to thirty minutes. Rinse in distilled water and dry.

SPREAD OF DOURINE

Dourine is the only protozoan disease known at the present time which is not transmitted by means of intermediary carriers but is transmitted by direct contact from animal to animal. Infection always occurs during coition, and the disease is transmitted entirely by means of coition through mares and stallions infected with dourine.

Dourine can be termed only conditionally a war plague, since among army horses themselves it will play but a subordinate part, because being spread only through the sexual act, it is not given an opportunity to become generalized. The reason why dourine has, in spite of this, been mentioned in this book, lies in the fact that the captured horses, especially those originating from Russia and which are used in the interior for breeding, have spread the disease to our home-bred stallions and in that way also to our mares. Therefore, when delivering horses captured from Russia, particular attention must be directed toward this disease and only horses whose non-suspicious character is ensured after being kept under observation for a prolonged period should be used for breeding purposes. Due to the fact that dourine runs a chronic course and is very difficult to diagnose, which is often the case, it is most expedient not to use for breeding purposes horses captured from Russia. This regulation appears all the more justified since, according to the experiences so far with dourine among horses that originate in localities where the disease is indigenous, the disease runs such a mild course that its diagnosis is clinically impossible. Not until our native stallions have covered Russian mares and after that again have served a large number of native mares, does dourine become evident among our animals. Our

horse husbandry seems just at this time to be in great danger through the introduction of horses captured from Russia, which are afflicted with latent dourine; therefore, we must attempt by all possible means to preserve the good health of our expensive breeding mares. This circumstance should lead to a general prohibition of the use for breeding purposes of horses captured from Russia.

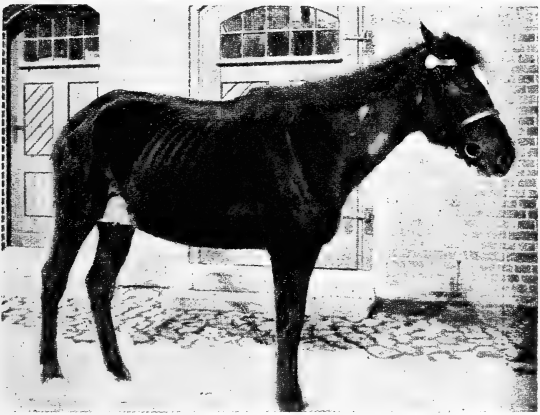


FIGURE 25
Dourine. Swelling of the udder.

SYMPTOMATOLOGY OF DOURINE

The period of incubation varies from one week to several months.

First Stage

Stallions: In the male animal one will observe swelling of the testicle, sheath and penis. The urethral mucous membrane is loosened and slightly reddened.

Very often a mild, slightly clouded discharge exists. Frequently there is difficulty in micturation.

Mares: In the female animal we find there always exists first of all a loosening of the vaginal mucous membrane associated with the formation of a slightly mucous and clouded exudate. The lips of the vulva become swollen, but above all one observes on the otherwise pigmented skin of the vulva and the region of the anus, non-pigmented spots (toad spots) which surround the edge of the vagina and the opening of the anus. With this is associated a swelling of the udder and the neighboring subcutaneous tissue, in which manner the subcutis from the udder to the external angle of the hip may become changed into an edematous mass. The swelling may incidentally disappear only to suddenly reappear.

Second Stage

During the course of weeks or months, rounded or elongated swellings of the skin occur on different parts of the body in mares and stallions. The hair at these locations is staring and the swelling feels soft and slightly edematous. The form and size of these patches (plaques) vary considerably. Frequently they attain the size of the hand but are not always regularly outlined. As a rule these patches remain only for a few days, then disappear entirely or reappear on other parts of the body. They do not leave a residuum.

Third Stage

Symptoms of paralysis appear coincidentally with atrophy of the musculature. The hind feet are moved forward in a scraping, dragging manner. The symptoms of paralysis may become so severe that the animal falls, "goes down," and is no longer in a condition to rise.

At times the paralysis extends to the facial muscles and causes the upper and lower lips to be drawn in a slanting manner. Likewise, paralysis of the penis may

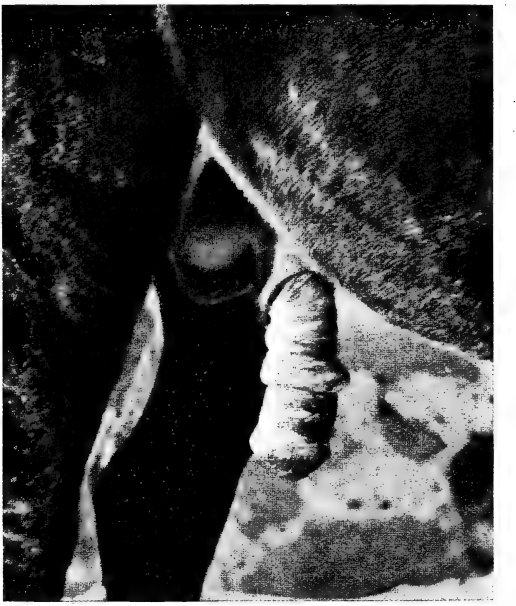


FIGURE 26

Dourine. Swelling of the testicle and penis. Paralysis of the penis and beginning gangrene. (After Lorenz and Miessner.)

ensue. It hangs in a limp manner and as a result injuries occur that develop into gangrenous processes, which may cause the death of the animal.

Fourth Stage

During this last stage cachexia rapidly develops so that when death ensues the animal is reduced to a mere skeleton.

PATHOLOGICAL ANATOMY OF DOURINE

The mucosa of the vagina and vulva is thickened and has undergone cellular infiltration. The tissue surrounding the udder has undergone a gelatinous metamorphosis. The scrotum and tissue of the penis have undergone a similar edematous swelling. The lymph nodes near the genital organs are enlarged and upon section appear moist. The musculature is fairly dry. Just the opposite to this, however, we find that the intermuscular fibrous tissue, especially where the nerves pass through (hind limbs), has undergone a pappy, gelatinous metamorphosis. The lumbar portion of the spinal cord has at times become entirely softened and the bone marrow has a red color.

DIFFERENTIAL DIAGNOSIS OF DOURINE

Glanders

Dourine can be confused with glanders in cases in which glanders affects the genital organs, as occurs sometimes when stallions with affected testicles are used for service. The appearance of ulcers on the vaginal mucous membrane and on the inner surface of the thigh, which never occur in dourine, as well as the absence of unpigmented spots and plaques, guards against error.

Coital Exanthema

Coital exanthema consists of an exudative inflammation of the vulva and vagina of the mare, or the prepuce and penis of the stallion. The exanthema is characterized by vesicles, which soon rupture after their forma-

tion, leaving superficial erosions. This may lead to swelling of the mucous membrane of the vagina, on the prepuce and on the lower end of the penis. The course is

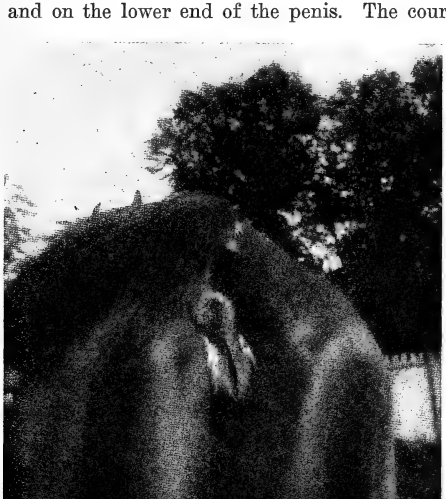


FIGURE 27

Pustular skin eruption. Unpigmented spots on the skin fold between the vulvar lips and muscles of the thigh. (After Miessner and Evers.)

mild and complete recovery occurs in two to three weeks. The typical lesions, which occur on the udder and skin in dourine as well as the paralytic symptoms, are absent.

Contagious Pustular Cutaneous Eruptions of the Genitals

Not until recently did I have opportunity to see, in company with Veterinarian Evers, in a number of mares

that had been covered by an imported Belgian stallion, unpigmented spots (toad spots) on the skin which were very suspicious of dourine. These spots occurred in the fold of the skin between the muscles of the thigh and vulvar lips. These unpigmented spots represented the remains of previous pustular nodules and ulcers the site of which had been in the previously mentioned fold of the skin. Furthermore, the Belgian stallion, as well as the home-bred stallion of the farm that had again covered some of the mares after they had been covered by the former, showed on the skin of the penis in each case two or three sharply defined unpigmented spots about the size of a lentil. The course of the disease in all animals was mild. Swelling of the testicles or udder, plaques and paralytic symptoms were absent. Furthermore, the unpigmented spots of dourine always occur on the skin of the vulvar lips (see Fig. 27).

COMBATING DOURINE

Serotherapy and Chemotherapy

Up to the present time no success has been attained in producing either an active immunity by using attenuated trypanosomes, or a passive immunity with the serum of animals which had withstood an attack of dourine. Consequently, one must confine the treatment to chemotherapy. According to the experiments of the author, arsenophenylglycin, which was used intravenously in doses of 20 grams, has proved itself very successful. Since more efficient arsenical preparations are being used at the present time, it would doubtless be well to recommend a trial with neosalvarsan in cases where it is indicated; it should be applied similarly as in pectoral influenza, in doses of four and one-half grams dissolved in about 100 c.c. of sterile water and injected intravenously. Also, in the second place, trypan-blue

could be injected intravenously in quantities of 50 c.c. of a one to five per cent solution.

VETERINARY POLICE REGULATIONS

Since the disease is always transmitted by means of copulation, it is therefore necessary to prevent all sick stallions and mares from copulating for a period of three years. It is, furthermore, necessary to carefully examine at intervals of fourteen days all other stallions in the endangered district that are still healthy and capable of being used for service.

Suspected horses should not be allowed to have sexual intercourse until they have been freed from suspicion and should be examined every two weeks by an official veterinarian. Stallions and mares that have had coitus with diseased horses should not be allowed to copulate for one year from the date of the last copulation and may not be changed to another station without the consent of the veterinary police. They should be examined every four weeks by an official veterinarian.

Lifting the Quarantine

The quarantine regulations may be discontinued:

(a) In the case of diseased horses, three years after the official veterinarian announces the disappearance of visible disease symptoms;

(b) In the case of suspected animals, just as soon as they can be looked upon as nonsuspicious, according to the official veterinarian's judgment;

(c) In the case of exposed animals, just as soon as they do not show any suspicious symptoms after being held under observation one year, or as soon as it is proved that the animals with which they came in coital contact need no longer be suspected;

(d) After all sick and suspected stallions have been castrated.

CONTAGIOUS PLEUROPNEUMONIA OF CATTLE

Pleuropneumonia contagiosa bovum
(*Lungenseuche*)

ETIOLOGY OF CONTAGIOUS PLEUROPNEUMONIA

The etiological agent of contagious pleuropneumonia (Asterococcus mycoides) was first cultivated by Nocard and Roux in collodion sacks in the abdominal cavity of rabbits. The virus is so small that it passes through porcelain filters and consequently cannot be demonstrated microscopically. Therefore, one must always rely, in making a diagnosis, on the symtoms in the living animal and the pathological lesions in the dead animal. Only cattle are susceptible to this disease; not even small experimental animals.

SYMPTOMATOLOGY OF CONTAGIOUS PLEUROPNEUMONIA

The symptoms of the disease are easily recognized in the living animal by the aid of the following described anatomical lesions. Usually one will observe after an incubation period of three to six weeks, but which may prolong or shorten itself, cough, slight fever and reduced appetite. Somewhat later during the course of the disease larger portions of the lungs may become affected which manifest themselves clinically in increased respiratory rate. These symptoms may continue more or less for a long time, according to when the process extends to the pleura, which will occur sooner or later. Coincidentally with the appearance of the pleuritis, fluid collects in the pleural sacks, recognized upon percussion by dullness which is limited by a horizontal line. At the same time further rising in the temperature and increased respirations will be observed. The appetite as well as the secretion of milk stops almost entirely.

If contagious pleuropneumonia is found to be present in a large cattle station which manifests itself in the herd by a great deal of coughing, then one can, as a rule, assume that a number of cattle were sick at the time of the arrival of the veterinarian. Animals that are acutely sick stand back from the manger, do not eat, show increased body temperature, and auscultation and percussion, furthermore, conclusively show that the thoracic organs are involved. Due to the fact that these manifestations appear not only in this disease, but in others also, a positive diagnosis during the life of the animal is frequently difficult. Therefore, one must always take the post-mortem lesions into consideration and in case a dead animal is not available for autopsy, a sick animal should be killed. These precautions are especially to be observed since contagious pleuropneumonia has not appeared in Germany for many years, and therefore much depends upon a correct diagnosis.

PATHOLOGICAL ANATOMY OF CONTAGIOUS PLEUROPNEUMONIA

Contagious pleuropneumonia manifests itself as a fine interstitial process which occurs in the interlobular pulmonary tissue; therefore, one justly designates contagious pleuropneumonia as pneumonia interstitialis or as peripneumonia. The virus, which is probably taken up with the inspired air, finds lodgment in the interstitial tissue where, as a result of irritating the blood and lymph vessels, it produces a marked exudation into the surrounding tissue. As a result of this the interstitium expands and acquires a gelatinous nature. Coincidentally proliferation of the connective tissue takes place; the tissue in between becomes firm and of a whitish-grey color. Gradually the process creeps farther into the interstitial tissue so that soon larger portions of the

interlobular lung tissue become involved and take on a firmer consistence. At the same time the walls of the larger blood and lymph vessels in the interlobular tissue become affected, which then often form thrombi. The vessels upon cross section of these parts of the lung

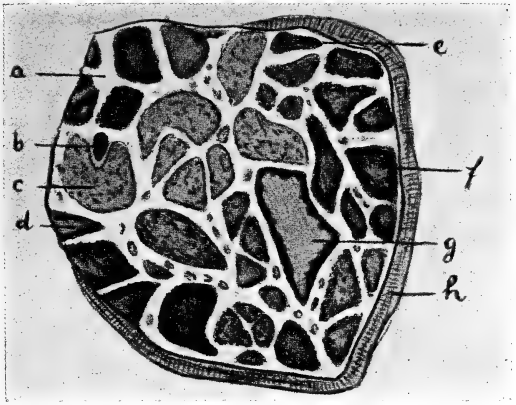


FIGURE 28

Scheme of contagious pleuropneumonia sectioned lung: (a) distended interlobular tissue showing lymph spaces; (b) thrombus; (c) normal lung tissue; (d) beginning pneumonia in the periphery of the lobule; (e) totally changed lobule—grey hepatization; (f) totally changed lobule—red hepatization; (g) sphacelus; (h) pleuritis. (After a drawing by Dr. Lütje.)

appear as more or less thick plugs or cords, according to whether they are cut tranversely or longitudinally.

The changes that have just been described greatly resemble erysipelas in their manner of development as well as in their anatomical appearance. In the interlobular tissue, which is composed of many lymph spaces and lymph vessels analogous to the skin, the process

advances rapidly as in erysipelas and can spread over large areas in a short time. Schütz, whose descriptions are used as a base in the following deductions, therefore refers to contagious pleuropneumonia as *erysipelas pulmonum.*

When the disease continues for some time, the changes do not confine themselves to the interstitial tissue, but extend to the alveolar pulmonary parenchyma. With this, exudation and engorgement of the alveoli with fibrin occur. What is to be looked upon as especially characteristic is that as a result of the gradual advancing of the hepatization from the periphery toward the center, one will find upon cross section lobules in which the inflammation has always confined itself to the peripheral zone, whereas those alveoli lying centrally still contain air and are pink. The cut surface of the hepatized areas is granular. This is caused by fibrin plugs, which protrude from the alveoli upon making the section, whereas the closing elastic, alveolar walls retract. As a result of the process gradually continuing to creep on and extending from the interstitium to the parenchyma, not all portions of the lung are attacked simultaneously. Consequently, one encounters hepatized areas of various ages. Alternating with air-containing, pink lobules we find such as are of a firm consistence and partly dark or yellow-red and partly grey. As a result of the varied colored lobules of the lung which are separated by the distended, grey-white interlobular tissue bands, the cut surface assumes a veined, somewhat coarsely reticulated, mottled appearance resembling marble (marbled cut surface).

The filling up of the interlobular tissue with fluid and cellular matter is conditional upon a pressure on the pulmonary veins. This results in a compression of the vessels in question and an arterial passive hyperemia

in the lobules which they supply. Associated with this we usually have an obstruction-edema and as a result of the vessel walls continually becoming more seriously affected the blood passes through. The hemorrhagic infarct which finds its origin in this manner, finally undergoes necrosis. By means of peripheral suppuration the dead area becomes separated and we find within the lung tissue more or less large necrosed foci (sphacelus or sequester). As has been proved, the virus of contagious pleuropneumonia can remain viable in these sphaceli longer than one year. Consequently, such animals are able to infect healthy cattle for a long time. For this reason they represent a greater danger for the further spread of the disease. Conditions are different when a thick capsule has been formed around the sphacelus as a result of reactive inflammation. Such foci are to be looked upon as not dangerous.

The process finally extends from the capsular tissue to the mucosa of the bronchioles; this leads to a catarrh and thickening of the mucosa (catarrhal bronchitis).

As long as the catarrhal process remains within the lung, the pleura does not become involved. But the moment that part of the perilobular tissue, which lies closely under the pleura, becomes affected, there is danger of extension of pathological changes to the pleura. The delicate endothelium of the pleura cannot resist the pressure of the fluid in the perilobular tissue and consequently ruptures. The virus now escapes into the pleural sacks and in that way inflammatory changes, with collection of the fluid in the pleural sacks as well as fibrinous adhesions between the visceral and thoracic pleura, follow. Later, after the continuation of this development, thick, skin-like layers form on the two layers of the pleura, in which case the pericardium is usually involved.

The bronchial and mediastinal lymph nodes also be-

come involved in this process; they become swollen three to five times their normal size and are very moist upon their cut surface. At times one meets within the enlarged lymph nodes more or less large dead foci.

The moment the exudative inflammation attacks the pleura, the originally chronic disease assumes an acute character; the temperature rises and the appetite becomes lessened. Dullness, limited by a horizontal line, is found to be present upon percussion. The period at which the chronic form of the disease passes over to the acute varies according to whether the primary foci were distant or near the pleura and whether the process from such a focus toward the pleura extends slowly or rapidly.

DIFFERENTIAL DIAGNOSIS

Hemorrhagic Septicemia

Occasionally the interstitial tissue may also be affected and distended in hemorrhagic septicemia, which causes one to suspect contagious pleuropneumonia. Distinction can be made, however, in that hemorrhagic septicemia hepatization has a hemorrhagic character and the process proceeds from the center to the periphery. Furthermore, the alveolar tissue is always affected first and the perilobular tissue secondarily. Also when such changes are of the same age and of recent development, it furthermore indicates that hemorrhagic septicemia is present. As a rule, we also fail to find in this condition thrombotic changes, never observe sphacelus-formation and also the rind-like layers on the pleural membranes are absent. As a final test one could inoculate a rabbit which would always give a negative result in case the disease is contagious pleuropneumonia. If, however, hemorrhagic septicemia is present, then the rabbits, which may be infected with bits of lung, usually die in

one to two days and many bipolar bacteria can be demonstrated in their blood.

Catarrhal Bronchopneumonia

Such a disease particularly occurs in young cattle during transport. Such animals cough a good deal. Upon autopsy one finds the interlobular tissue distended and the lobules at different points in the stage of grey hepatization. As a rule sphacelus formations and pleuritic lesions are absent.

Verminous Bronchopneumonia

It is possible that the marked coughing of cattle afflicted with verminous bronchopneumonia can, from a clinical standpoint, arouse one's suspicions of contagious pleuropneumonia. The fact that only young cattle, after running on pasture are affected, ought to exclude the possibility of contagious pleuropneumonia. The lung worms are demonstrated comparatively easily in the finer branches of the bronchioles.

Traumatic Pericarditis

In this disease adhesions are found to occur between the pericardium, visceral and thoracic pleura; furthermore, in case the process which produced the rind-like layers should further involve the lungs and be accompanied by a distension of the interlobular tissue, one's suspicions of contagious pleuropneumonia may be aroused. Usually the foreign body which produced the traumatic pericarditis can easily be found.

Gangrenous Bronchopneumonia

As a result of medicines intended for the alimentary tract being inspired by cattle, or due to other causes,

serious pneumonic changes associated with mortification of the tissue may result which may also lead to a distension of the interstitial tissue. The formation of necrotic foci can arouse one's suspicion of sphacelus formations as we are accustomed to see in contagious pleuropneumonia. But in such cases, we always notice the serious affection of the bronchial mucous membrane, filling of the bronchioles with a smeary, fetid fluid and the strong, putrid odor of the necrotic areas, which guards us in making a mistake. The affected areas in contagious pleuropneumonia never give off a putrid odor.

COMBATING CONTAGIOUS PLEUROPNEUMONIA

Vaccination

In combating contagious pleuropneumonia the healthy animals are vaccinated at the base of the tail with the lymph obtained from diseased portions of lung. They then pass through a light form of the disease and develop an active immunity. In this way, however, virus carriers are produced which may help in the further spread of contagious pleuropneumonia. Consequently, this method of immunization has been entirely given up in Germany. (H. Raebiger.)

VETERINARY POLICE REGULATIONS

As in rinderpest, the veterinary police regulations have given the best results when all sick animals as well as those suspected of having contagious pleuropneumonia and those which had been exposed were immediately killed. The lungs from the sick animals must be entirely destroyed; the meat can be distributed only after being cooled; the hides are to be exported only after they have been dried in case they are not immediately taken to a tannery.

Lifting the Quarantine

The disease can be considered eradicated and the prescribed quarantine regulations dispensed with when the entire herd has died, been killed or been removed. The same may be done when the sick and suspected animals have been killed and if no new cases of the disease have appeared among the exposed animals for a period of at least six months after the killing of the last case of the disease. In both instances the disinfection is to be carried out by the official veterinarian according to instructions.

Compensation

Whenever the owner has reported the disease at the proper time he will receive as compensation four-fifths of the actual value of the dead animals [in Germany]. No compensation is given in such cases where the animals became sick 180 days after their importation [in Germany].

RINDERPEST

PESTIS BOVINA

(*Cattle plague*)

ETIOLOGY OF RINDERPEST

We must look upon the cause of rinderpest as a very small, non-filtrable microörganism, but which up to the present time has not been demonstrated. It has

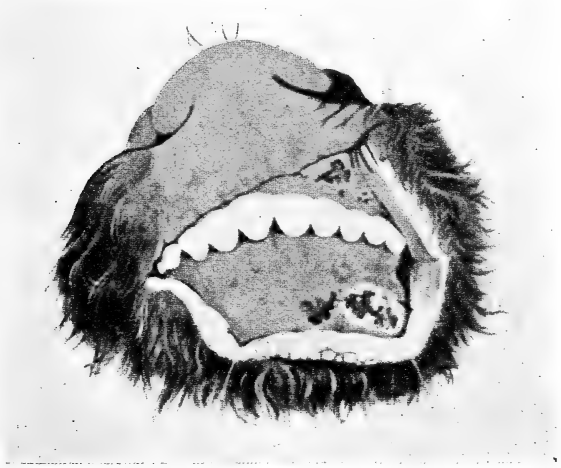


FIGURE 29

Rinderpest. Diphtheroid lesions on the mucosæ of the upper and lower jaws. (English commission of 1866.)

very little resistance; it is easily destroyed by sunlight, drying and highly diluted solutions of disinfectants. The virus can be found in the blood and the secretions and

excretions of sick animals. Even virus-containing blood, which has been protected at low temperature and from the light, remains viable only for a few days. Consequently, the contagium soon dies in the outside world.

The spread of rinderpest results principally by means of direct contact with sick or apparently healthy cattle which are already infected or which have withstood an attack of the disease (virus carriers, *i.e.,* virus spreaders); it may also result from hides, scraps of meat from animals infected with rinderpest, or from urine or feces or the manure on which diseased animals have stood. Finally, goats and sheep, which are susceptible to the disease, may cause a further spread, as well as men and animals that have come either in direct or indirect contact with such animals. The contagium is not spread with unusual ease, and in this respect, rinderpest differs in a favorable manner from foot-and-mouth disease.

SYMPTOMATOLOGY OF RINDERPEST

The period of incubation is three to seven days, and at the most, nine days. The disease begins with a continuous but high temperature, which is usually 41° C. to 42° C. (105.8° F. to 107.6° F.); vacillations in temperature up to one degree daily are observed. The fever continues two to three days before other disease symptoms appear; this is to be considered especially typical. After this the temperature falls again, but remains above normal except, of course, in rapidly fatal cases, where an unexpected sudden drop in the temperature occurs. Two or three days after the appearance of the fever, the appetite and milk secretion become less; the animals become noticeably weaker and weaker. At first the feces are dry, but on the third day they become thin and fluid, slimy and mixed with traces of blood. Bloody diarrhea is seldom observed (Gerlach). Toward the end, invol-

untary defecation sets in; the anus is held open and allows the dark red, hemorrhagic and infiltrated rectal mucosa to protrude.

Nervous cases which are at times observed, manifest themselves in a shaking of the head, swaying gait, shiv-

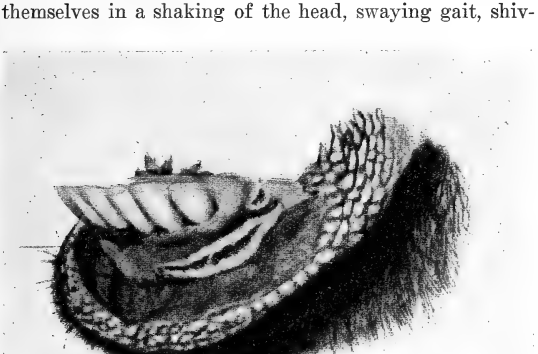


FIGURE 30

Rinderpest. Reddening of the gums around the neck of the incisors, associated with loss of substance and fibrinous layers; in front of and below these an elongated diphtheroid layer showing a deep central area; on a number of papillæ the superficial layer of epidermis is detached in a circular manner and the underlying tissue becomes visible. (After Hutyra and Marek.)

ering and twitching, symptoms that resemble malignant catarrhal fever, although one fails to find corneal opacity, which is so typical of the latter disease.

An exanthema develops on the finer unpigmented areas of the skin on the udder and scrotum as well as on the inner surfaces of the thighs; desquamation and scurf-like formations occur, and at times emphysema is ob-

served in the subcutis. Frequently, however, these changes are lacking.

The oral mucosa is loosened and reddened in patches; grey points develop about the size of a pinhead to that of a hempseed, due to the drying of the superficial epithelial layer. The cheesy dead material may either remain at these sites or it is cast off, leaving behind more or less large erosions having a red base and an irregular border. The mucosa is chiefly affected in the neighborhood of the incisor teeth, inner surface of the lips, commissures of the mouth, edges of the tongue and inner surface of the cheeks.

Hutyra and Marek, as well as Zwick, describe as particularly striking, the inflammatory process resulting in necrosis on the papillae of the mucosa of the lips and cheeks, to which C. Müller also alluded in 1877. The papillae are often partially or totally denuded, leaving them reddened at these points; at times the apex of the papillae is entirely missing. Excoriations on the hard palate are constantly observed (Goring).

Robert Koch did not find the exanthematous and diphtheroid changes of the mucosa of the mouth and hard palate very marked, whereas most authors allude to them as having differential significance and seldom, if ever, failed to find them present (Theiler). In the grey race of cattle, the disease process frequently confines itself to the gums around the incisors (Hutyra and Marek).

The internal portions of the conjunctivae are reddened and lacrimation exists. The lacrimal secretion, which is at first cloudy and mucous in character, later becomes purulent.

The nasal mucosa is at first reddened in patches and later diffusely reddened. Near the openings of the nostrils one will observe larger and smaller grey spots and eventually loose layers of the dead epithelium. In such

cases, the expired air has a noticeably fetid odor (Hutyra and Marek).

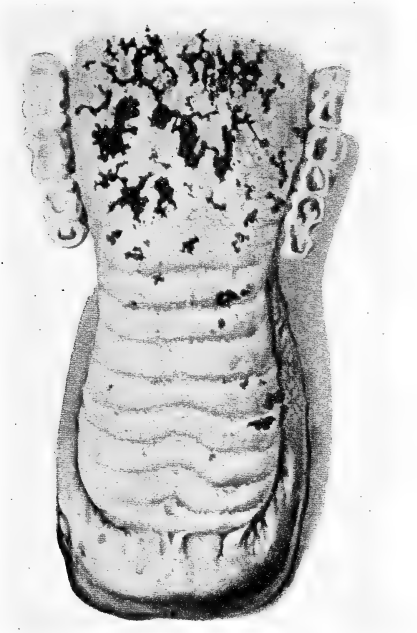


FIGURE 31

Rinderpest. Large losses of substance with occasional diphtheroid layers on the hard palate of cattle. (English commission of 1866.)

Usually a cough exists, and the respirations at times are increased to thirty to forty per minute, especially when death is about to occur. A mucopurulent nasal

discharge of variable quantity, which later becomes a dirty grey and has an offensive odor, is usually associated with these changes. Abnormal sounds are not, as a rule, detected upon percussion and auscultation. When rinderpest made its appearance in Germany in 1877, C. Müller records that the respiratory organs appeared especially affected in the first stage of the disease. Coughing and dyspnea were always present, so that it was not impossible to confuse the symptoms with those of contagious pleuropneumonia or ordinary pneumonia. But at the same time the changes in the epithelium of the oral mucosa, especially the buccal papillae, were seldom lacking. These experiences coincide to a marked degree with the observations of the Austro-Hungarian commission in 1914.

The vaginal mucosa is reddened in patches or streaks; in the later stage of the disease small areas of the superficial surface of the mucosa die and leave ulcers behind.

Eggebrecht always observed polyuria.

COURSE OF RINDERPEST

Due to the peculiar course of rinderpest, only the simultaneous appearance of several typical symptoms in different animals of the same herd can be taken into consideration in establishing a diagnosis. Never are all of the described symptoms observed in one and the same animal, but only in a few of them. The difficulty in making a diagnosis is also increased in that the disease occurs much more mildly in animals coming from rinderpest-infected districts than in our native-bred cattle. This is doubtless due to the fact that cattle in such localities where rinderpest prevails possess a certain immunity; also partly that they have withstood an attack of the disease. Consequently, in such animals rinderpest will usually run an abortive course, and some cattle

will not sicken at all. In contrast to this, the disease may run a much more serious course in our native-bred animals, and in that way exhibit deviations from the normal.

FIGURE 32

Heifer sick with rinderpest. The animal is very weak and somnolent; lachrimation is increased and a mucopurulent nasal discharge exists. (After Zwick.)

Animals in which the disease runs an abortive course are weak only a few days, as a rule; eat little; go lame and show a little fever. Now and then a mild catarrh of the mucous membranes develops which may be accom-

panied by diarrhea. Often such animals entirely recover within eight days. In spite of this, however, they harbor the virus and excrete it during their illness and also most likely for a longer or shorter period after recovery. Virus excreting animals therefore are a source of infection to all neighboring animals, and in case the disease is not recognized early enough, they can very quickly spread the infection further.

In the milder course, fever first develops, followed by streaked and patchy reddening of the mucosae, which may result in defects of the superficial layers. Diarrhea appears on the third to fourth day. On the fourth to fifth day the symptoms usually subside, and in eight to fourteen days the animals usually recover in case the disease does not become more serious and lead to death. The mortality is ordinarily about fifty per cent.

The serious course is immediately ushered in with a high fever. After the third day this is followed by serious disturbances, especially of the digestive apparatus. Diarrhea develops, characterized by fluid, ill-smelling feces, which are mixed with traces of blood. Coëxisting with this is involuntary defecation, due to paralysis of the sphincter muscle of the anus. The animals do not eat; give no milk; are strikingly weak; lie down a good deal, and die in ninety per cent of the cases on the fourth to fifth day. At times nervous symptoms can also be present, such as muscular tremors, spasms or disturbances of the respiratory apparatus, which manifest themselves by dyspnea, loud groaning or purulent nasal discharge.

PATHOLOGICAL ANATOMY OF RINDERPEST

The most marked anatomical changes occur in the mucosa of the digestive tract, and secondarily in the mucosa of the respiratory tract. Occasionally one finds

the previously described scab formations and nodules in the skin.

Besides the loosened necrotic layers and ulcers on the lips, gums, hard palate and tongue, which have already

FIGURE 33

Serious diphtheroid lesions on the mucosæ of the tongue and pharynx. (English commission of 1866.)

been alluded to, further pathognomonic changes are to be met in the abomasum and small intestines. The mucosa of the fore-stomachs can be stripped off very easily and the underlying surface is hyperemic. The omasum is always filled with dry contents. The mucosa of the abomasum and pylorus is loosened, reddened in

patches and streaks and covered with a slimy mass. In the majority of cases variously sized necrotic layers are found on the summits of the folds of mucosa, which, after they are removed, leave ulcers of the size of lentils to that of a penny, with irregular edges and a red base. Hutyra and Marek found in some of the cases scabs of the size of hemp to lentil seeds, which were grey, flat and somewhat centrally raised, and upon removing them, smooth-edged depressions were left. They also observed in some apparently healthy animals, round, cicatrized ulcers on the edges and sides of the folds of the mucosa, which probably answer for the "residues of rinderpest" described by Mrowka.

The intestinal mucosa exhibits all the gradations of the metamorphosis, beginning with an ordinary catarrh and passing over to more or less marked loosening and black-red discoloring of the mucosa, and finally to superficial death, which results in diphtheroid layers being formed. However, extensive croupous layers and crust formations are seldom met. Koch found in three cases out of ten autopsies, fibrinous bloody exudates in the intestinal walls. These formed themselves into casts on the intestinal wall, sometimes three feet long, and consisted of cast-off intestinal epithelium, firm fibrinous masses and blood. The single and grouped lymph nodules (Peyer's patches) are almost always affected. At first they are swollen and manifest themselves as protuberances. They then undergo purulent degeneration. Remains of the follicle are still to be seen on the basic structure. Finally, all the lymph nodules transform to purulent granular masses, which supplant the sites of the Peyer's patches in the form of bed-like elevations.

The mucosa of the glottis, trachea and bronchi is swollen and reddened; at times small ulcers are found in it. Associated with the more marked changes in the

bronchial mucosa there is always an interlobular pulmonary emphysema.

The liver, heart and kidneys show parenchymatous degeneration. The gall bladder is stretched and filled with greenish bile. Its mucosa is reddened, at first with

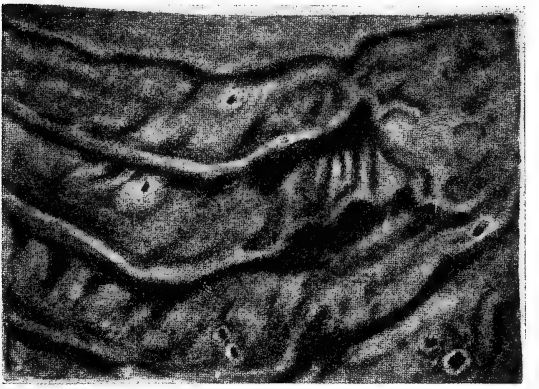


FIGURE 34

Rinderpest. Hyperemia of the abomasum; round ulcers, which are partly covered with scabs. (After Hutyra and Marek.)

petechiae and later with small wart-shaped nodules. The latter may undergo degeneration and leave ulcers which later become confluent. The spleen is usually normal.

DIFFERENTIAL DIAGNOSIS OF RINDERPEST

According to the judgment of experienced practitioners, the diagnosis is often more easily made during the life of the animal than by basing conclusions on the pathologic anatomical lesions. In cases of doubt, it was found best to stand sick animals with healthy ones or to

artificially infect healthy cattle, goats or sheep with material taken from sick animals (slime, blood, etc.), in which case one should, of course, absolutely separate all animals.

Foot-and-Mouth Disease

In this disease not only are the oral mucosae involved, but also the feet. The spread of the disease occurs faster among all animals of a stable than does rinderpest. The saliva on the mouth forms long, sticky threads.

Contagious Pleuro-Pneumonia

Here exclusive affection of the respiratory organs prevails, which manifests itself by cough, dyspnea and dullness which is limited horizontally. The lack of changes in the mucosae of the head may be used for differential diagnosis. Finally, when making a post mortem examination in cases of contagious pleuro-pneumonia, we find distension of the interlobular tissue, which is filled with a lymphatic fluid; various aged pneumonic areas, which always begin at the perilobular tissue; and thrombi.

Malignant Catarrhal Fever

The changes of the mucous membrane limit themselves chiefly to those of the respiratory tract; they are diphtheroid in nature. Deeper losses in substance are lacking. Marked difficulty in breathing exists. The cornea of the eyes is always dim.

Rabies

Only the nervous forms of rinderpest, which have associated with them paralysis of the limbs, can be confused with rabies. In rabies no changes occur on the mucous membranes in either the living or dead animal.

Serious Diarrhea (Gastro-Enteritis)

Gastro-enteritis can be caused by spoiled or improper food or water containing Hyphomycetes (mold-fungi),

irritating substances (saltpetre, etc.), as well as various bacteria, especially the paratyphoid group. The rapid course of rinderpest has without a doubt much similarity to gastro-enteritis, particularly when the course is associated with a discharge of bloody feces as in gastro-

FIGURE 35

Rinderpest. Striated hyperemia, especially on the summits of the folds of the mucosa. (After Hutyra and Marek.)

enteritis. The diagnosis of gastro-enteritis is made certain by the fact that excoriations on the oral mucosa are lacking in this disease; also careful observation of the accompanying circumstances and especially the eating of harmful feed.

Coccidiosis

This is a noncontagious intestinal disease due to *Coccidium Zürni,* in which during the advanced stage bloody

diarrhea may develop. The disease is almost exclusively confined to young animals or such that have grazed on pastures.

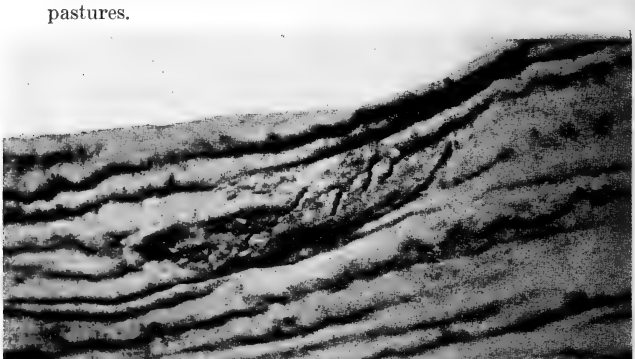


FIGURE 36

Rinderpest. Portion of small intestine showing striated and patchy hemorrhages in the mucosa, especially on the summits of the longitudinal folds; at one point is seen a grey-yellow, dry scab-like layer on a Peyer's patch. (After Zwick.)

Paratuberculosis

This disease (Johne's disease) is caused by an acid-fast rod (B. paratuberculosis) which resembles the tubercle bacillus. It leads to a thickening of the intestinal mucosa and profuse diarrhea. The diagnosis is made certain by considering the chronic character of this disease and the failure to find diphtheroid lesions of the mucous membranes.

Poisoning

Lead poisoning is at times apt to produce similar lesions, for here we also see excoriations on the oral mucosa

and nervous symptoms, muscular tremors and attacks of mania. The animals are always constipated in lead poisoning, and the history of the case will prevent error

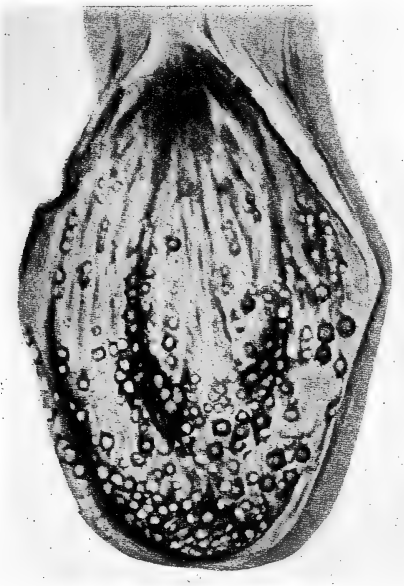


FIGURE 37

Rinderpest. Acute inflammation of the gall bladder; swelling and necrosis of the mucous follicles. (After Hutyra and Marek.)

in diagnosis. The animal may obtain the lead from feed in the neighborhood of mines or from water that has been conducted through lead pipes. Finally, we must also consider that cattle may lick freshly painted

structures to which lead paint (red lead) has been applied, and in that way become affected with lead poisoning.

COMBATING RINDERPEST

Immunization

Active Immunization (Bile and Blood Vaccination): Active immunization was carried out by using bile in some cases and blood in others, which were obtained from animals sick with rinderpest. Animals vaccinated with these materials remained immune for one year. The vaccinations have as a general rule proved successful, but should be used only in rinderpest regions, *i.e.*, where the disease occurs more frequently, for we produce in this way virus carriers or virus disseminators, through which the disease becomes more widely spread. In regions where the disease occurs only sporadically, the vaccinations will give disadvantageous results.

Passive Immunization: In regions free from rinderpest, good results can be obtained through passive immunization, especially in such instances where it is desirable to produce a broad belt of immune farms around a disease-infected locality and in that way prevent the further spread of the disease.

The sera of animals that have withstood an attack of rinderpest are used for immunizing purposes. Due to the low protective power of such a serum, the process of Kolle and Turner has been used more recently, in which cattle are highly immunized by systematically treating with virulent rinderpest blood, which produces an efficient serum and produces satisfactory immunity in doses of 50 to 100 c.c.

Simultaneous Method (Serum-blood Vaccination): In order to increase the passive immunity produced with

serum, which affords protection only for one to two weeks, 10 to 30 c.c. of the specific serum are injected on one side and simultaneously 0.5 to 1 c.c. of virulent rinderpest blood is injected on the opposite side of the animal.

VETERINARY POLICE REGULATIONS FOR RINDERPEST

As a result of the German rinderpest law of April 7, 1869, rinderpest has not made its appearance in Germany within the last twenty-five years. The most important means of combating the disease is by killing not only the sick but also such cattle as have come in direct or indirect contact with sick cattle, as well as carrying out isolation and compensation. If necessary, the isolation of an infected farm or village may be accomplished by a military cordon. The use of hides and meat of animals found to be healthy on the ante- and post-mortem examinations, is allowed after the meat has been cooled and the hides dried or placed in milk of lime (1 to 60) for three days. Animals which have died or been killed should be buried or otherwise destroyed so as to render them innocuous. Skinning of cadavers is prohibited.

In order to prevent the further spread of the disease, it was found desirable to appoint inspectors whose duty it was to closely observe all stock on the farms adjacent to the disease-infected area. Furthermore, all larger slaughter houses are to be quarantined, because it is easiest to spread the disease from animals that are suffering from a latent form of the disease.

All rinderpest-sick or suspected animals are to be reported within eight days from the time the disease made its appearance. When suspicion is based on very good ground, temporary quarantine is to be declared.

Lifting the Quarantine

The disease can be considered as eradicated when all stock has either died or been killed, or when three weeks have elapsed since the last sick animal or death occurred, and when the prescribed disinfection has been carried out.

Compensation

Compensation is given up to the actual value of animals, equipment, etc., destroyed by government order, the amount of compensation being determined by tax commissioners. No compensation is allowed for stock that die ten days after their importation. [In Germany.]

APPENDIX

HINTS ON HANDLING WAR HORSES IN AMERICA

By A. A. Leibold, D. V. M.*

Before horses and mules reach their respective destinations for service during war time, veterinarians must necessarily give them much thought and attention. From the time that animals pass inspection for purchase until they are safely landed in a fit condition for the service they are to perform, they are subjected to many and various conditions that tend to diminish greatly their numbers. A moment's reflection on the altered conditions that mobilization and transportation occasion, will convince anyone who is familiar with the handling and transportation of large numbers of "green" horses, that, at best, it is bad for the horse and far from ideal for those whose duty it is to give him needful care.

Dismissing without discussion the recommendations that could be made in connection with physical examination of horses for soundness, and considering the problems relative to their care after they have been purchased, one may consider the handling of horses for use in war under two general classifications, viz.: *in concentration camps or at remount depots* and *during transportation to the scenes of action.*

Handling Horses in Concentration Camps

It should be stated at the outset that every horse that is purchased for military purposes by the various countries that have well organized logistic branches of their armies, is identified by branding. This makes possible the most careful investigations in connection with each individual animal, including its purchase price, from whom purchased, its origin, the officers who make the

* Abstracted from The American Journal of Veterinary Medicine.

inspection at the time of purchase, and any data in connection with its treatment at hospitals in case of sickness; and if lost, a report of the cause of death is returned to those to whom such is due.

In a discussion of certain phases of the subject of caring for horses at concentration camps, Dr. T. C. Teidebold* of Chicago states:

They (the horses or mules) are shipped from the original point of purchase to some concentration camp, such as I have run for two different contractors since the war has started. They are shipped usually to the limit on time; that is to say, they are allowed to be in the cars right up to thirty-six hours, as it is an offense to leave them longer, and I want to state that they receive very little food or nourishment while they are in transit.

Immediately a trainload of horses comes into the Union Stock Yards or a concentration camp, the horses are put in pens which are thirty feet square and are bedded deeply with straw, the mangers being full of hay. They are allowed to eat as much as they desire for some two or three hours before being watered, and this is an all important point from a veterinary viewpoint, for if there is anything discouraging to the veterinarian, it is to have a trainload of horses come in and through some misunderstanding allowed to be watered immediately upon arrival. In such an event the veterinarian's services are in great demand, for he has then to treat colic, chills, and what not. One can readily understand the amount of water a horse will drink after having had none for thirty-six hours. I have even had horses come in during the summer time so fatigued and thirsty that to allow them to take a quart or two of water would mean death. Great care has to be exercised at this time, as I have stated, after their arrival. After the horses have stood for some two or three hours, the water is given to them gradually until their thirst is satisfied. They have hay at liberty.

After the horses are kept on this diet for twenty-four hours, they are placed the first day for fifteen minutes on a ration of grain, consisting of two-thirds oats and one-third corn, with a little bran in it. We allow them, after the first day, twenty minutes to this grain ration, and we figure that in this time a horse will consume six to eight pounds.

* American Journal of Veterinary Medicine, Vol. XII, page 391.

The horses are sorted under a veterinarian's direction every day. We employ a system of feeding here which is different from any place that I have seen in the United States. The grain ration which these horses are fed is given in a separate pen. We do this, feeling that we have accomplished three very important parts which go to make up the proper handling of army horses, namely: we feed the grain, we exercise the horses, and every horse comes before the caretaker's eye each day. One of the important points for a veterinarian who is handling many army horses is the segregation of all sick animals immediately when they are found ailing, and this is a large task when one has from a few hundred to five or six thousand horses on hand at a time.

Each concentration camp is equipped with a hospital and good facilities for caring for horses. We practice here in the yards the following methods in our hospital, and I wish to state that we have found them to work out quite well under most conditions:

A horse is brought from the concentration camp to the hospital. The veterinarian in charge immediately gives the horse an examination, prescribes for him and numbers him, and he is recorded on a chart. This chart states the date this horse came to the hospital, the medicine that was given, his temperatures night and morning, and the medicine he is given as an adjunct to the initial dosing. In this way, it matters not how many are treated or in the hospital, as each horse is treated, one might say, as an individual case. We have carried in our concentration camp here in the hospital department up to 1,388 head of horses. The hospital attendants are allotted a certain number of horses to care for. The doctors in charge are likewise allotted a number. All horses reaching our concentration camp are vaccinated with the United States Standard Serum Company's vaccine twelve hours after landing, if it is possible to give them this length of time.

The question will arise as to loss, and the percentage which are sick from the totals. With the experiences I have had it is hard to state just what percentage of the horses get sick, as there are a great many things that cause the differences in the percentage I might enumerate. I will simply state that for one man I have handled and kept in the concentration camp some 75,000 head of horses, with a total loss of 1.52 per cent. These horses average on feed about fifteen days at this concentration

camp, from which they are shipped directly to the boats. The losses as a whole, talking with the different contractors, amount to between 8 per cent and 10 per cent. One bunch of horses may pass and land with a percentage of 2 or 3 per cent, while another one may run as high as 20 per cent, but on an average about 8 per cent would about meet the conditions.

Following a careful inspection of a British concentration camp, Dr. J. V. Lacroix* has written as follows:

To handle such large numbers of animals, necessarily there is required large fields that adjoin stables and corrals and hospitals. "Pasture riders" keep watch of the horses and bring to the hospital any animal that manifests evidence of being sick. Those who ride about inspecting horses must, of course, be able to recognize unwell animals on sight, and as they are handled in such large numbers that individual attention is impossible, often the first evidence of an animal's being in an abnormal condition is its gauntness.

Where about thirty thousand horses and mules are kept under the general supervision of one veterinarian, and this without the existence of elaborate facilities for handling the multitudinous ailing subjects, they are perforce handled in groups and classified according to the general character of ailment or acuteness of affection. As soon as convalescence has progressed sufficiently to justify such measures, subjects are turned out in lots where they may exercise at will and feed from common troughs. In such lots it is noticed that immediately an animal regains sufficient vigor and desire to become playful, it is then an annoyance to others and must be placed with stronger animals where none will suffer because of its gamboling tendencies. On the other hand, when subjects suffer a relapse or fail to progress satisfactorily when placed with a given group of convalescent animals, they are returned to quarters where exertion is unnecessary and where individual attention is possible.

Infectious pneumonia and pleuritic affections are of common occurrence in the particular camp visited by the writer. There pneumonia is generally treated by providing for the patient's comfort in every way possible. Fresh air is allowed in abundance and subjects are not frequently molested for any reason. Medica-

* American Journal of Veterinary Medicine, Vol. XII, page 440.

tion is infrequent. Needless to say, probably every form of pneumonia occurs at this place, and consequently complications of all sorts are numerous.

Among the more common complications that attend the various respiratory diseases are pleurisy, cardial and pericardial affections, laryngeal hemiplegia, purpura hemorrhagica, cerebral, spinal and meningeal inflammations. Influenza also is to be observed, and intestinal manifestations of this affection are usually signalized by serious diarrheic disturbances. Amaurosis is to be noted in some animals and is probably, in most instances, a sequel to influenza contracted in camp rather than of long standing. Acute digestive disorders are said to be of rare occurrence. This, according to the popular conception regarding the feeding of horses, is remarkable. These animals are necessarily fed grain in common from large troughs where many horses eat together. Such methods of handling horses should, it would seem, result in considerable trouble from colic.

Animals that are not hopelessly affected but unfit for army service are sold at "cash sale" as soon as they may be put in marketable condition. The percentage of losses, all things taken into consideration, is not great.

Surgical cases are not so numerous as are non-surgical affections, excepting for fistula of the withers and poll. Approximately 12 to 15 per cent of these cases are of poll evil; the balance are fistulæ of the withers, and in about 3 per cent of cases the two conditions coëxist. Brand abscesses—crural infections that result from branding—are of rather frequent occurrence and somewhat troublesome to treat. This is due chiefly to the fact that the true condition is not recognized, as a rule, until considerable suppuration has taken place, and then it becomes necessary to drain the parts surgically. And as these cases require more or less after-attention, restraint of subjects so affected in a suitable manner to give them proper attention, is time-consuming.

Contused wounds and lacerations of considerable extent occur during stampedes. Horses occasionally run into fences or other obstacles when stampeded at night, and various wounds of the forearms or prepectoral region are inflicted. Such cases are treated along usual surgical lines and results therefrom are quite satisfactory.

Lameness is to be observed as the result of various causes, chief among which are foot affections such as thrush, "nail

quick'' injuries, subcoronary abscesses and quitters. Tendinitis and sprains occur and occasionally a chronic affection is to be observed.

The one thing that was most interesting to the writer was the one hundred and eighty-nine cases of fistula and poll evil that were under the care of one of the veterinarians. To this particular veterinarian is entrusted the care of all of these cases, and results in so far as final outcome is concerned are unusually good. The method of treatment is decidedly not in keeping with surgical teachings, and at first thought is seemingly not really humane. However, upon careful consideration of the situation as it presents itself, one is compelled to acknowledge that no evidence of suffering greater than would be occasioned by average surgical intervention is to be observed. Moreover, in view of the fact that the numbers of such cases treated preclude their being handled in the manner that is recommended and practiced by those who are most successful in this work in private practice, it is quite necessary that other means be employed.

The method[1] of treatment consists in confining the subjects and, after making an incision into the abscess cavity at a point near the median line, pus is evacuated and Lewis' lye (a preparation whose active principle consists of sodium hydrate) is introduced into the cavity. The amount employed varies somewhat with the size of the cavity and the condition of the affected parts. As soon as the caustic comes in contact with the tissues, chemical changes that occur from the combination of moisture abstracted from the wound and the caustic, result in immediate evacuation of the contents of the cavity. This prevents further introduction of caustic even if it should be desirable or necessary. Five or six dessert spoonsful[2] are probably the greatest quantity employed at a time, and it is very seldom that this amount can be introduced. Subsequent to the introduction of this agent, reactionary inflammation occurs, but not more than attends the use of the milder caustic agents and not so much as results from those commonly employed. This is probably due to the fact that the caustic is not confined in the depths of the wound in any way, and because of a free opening

[1] Credit is due Dr. J. H. Snider for this method of handling fistulæ. Dr. Snider began using this treatment in private practice and later employed it in hundreds of cases in his work at a remount station.

[2] One or two dessert spoonsful are all that is required in the average instance.

at the top, spontaneous evacuation resultant from chemical activity prevents extensive destruction of tissue.

It is of utmost importance to thoroughly anoint the skin of both shoulders and fore legs to prevent injury that would result from discharge issuing from the wound. This is accomplished by carefully rubbing into the skin a heavy petrolatum and subsequently applying an additional amount upon the surface of the skin. This precaution is taken before the caustic is introduced or immediately following its use.

After-care consists in cleansing the wound area and removing any eschars or necrotic tissue that may be contained within the wound. This is done in from one to two weeks after the animals are first handled. A second application of petrolatum to the skin surrounding the wound is now made and no further treatment is ordinarily necessary. The animals that are undergoing treatment are kept in a large corral, where they may exercise at will. No rubbing or molesting of wounds is observed, and recoveries succeed this form of treatment in from one and one-half to three months' time. Comparatively little disfigurement follows, and the percentage of recoveries is much higher than would be believed by anyone who has had extensive experience in handling such cases, unless he were to make critical observations of these animals.

In a discussion of the treatment of pneumonia as it occurs at the British Remount Depot at Newport News, Va., Capt. James Gregg, M. R. C. V. S., and his assistants* call attention to extraordinary results that they have gotten with the use of soluble iodin injected intravenously.

Dr. G. S. Glover, one of the aforementioned writers of the articles on pneumonia, describes their method of intravenous medication with a preparation of iodin that is dissolved in a normal saline solution. He describes his technic thus:

The jugular vein is raised by compression with cord and a small area is clipped and painted with iodin. The animal is bled, about one gallon of blood being removed by the use of a

* American Journal of Veterinary Medicine, Vol. XII, page 505.

large caliber slip hypodermic needle, one and one-half inches long. Immediately after bleeding and through the same needle, normal salt, one quart, with soluble iodin, one dram, is injected by use of Fowler's salt solution apparatus. The adapter fitting the slip of the needle makes only one puncture necessary for the bleeding and administration of medicine. (I have yet to see my first jugular infection from this method.)

Daily or every two or three days the injection is repeated according to results. Bleeding is also repeated in a few days if a full pulse is noticed. This treatment has been found beneficial even in cases where the pulse contraindicated bleeding. The results in many cases were nothing short of wonderful.

In our work, animals have to be hastened to the convalescent stage in order to make room for new arrivals, but full time is given in the convalescent pen for a complete recovery before they are moved to the shipping pen.

Strychnin (one grain t. i. d.) is given as a tonic to all animals off feed. Tapping is resorted to when indicated.

Biological preparations have their place in the treatment of various ailments affecting "green" animals that are being handled for purposes of war. The method of employing bacterins, serums and antitoxins is so well known that more than mere mention of their use is unnecessary.

Handling Horses During Their Transportation

When the transportation of horses to the scenes of action necessitates a long journey, and particularly when the journey is to another country and by boat, greater hazard attends such transportation. A good description of the veterinarian's duties is here quoted from an article, "The Veterinarian's Duties as Conducting Officer in Trans-Oceanic Shipment of Horses," by Charles Banks, D. V. M.* Dr. Banks describes his experiences as a veterinarian on transport duty between America and Great Britain, while in the service of the latter country.

* American Journal of Veterinary Medicine, Vol. XII, page 370.

The first duties generally will be to inspect all grain, hay and feed in general. This is no small job on the New Orleans docks on a hot day. Quantity as well as quality of feed has to be considered with reference to the length of trip, weather conditions, etc., etc. All stalls, troughs, pharmacy outfit, list of medicines and instruments are also inspected.

At the time of loading, mules are to pass inspection in single file from a chute one-quarter of a mile long. Horses are brought before the veterinarian four at a time, and a physical examination is necessary. Membranes are examined, pulse noted, respiration counted, mouth examined, etc. The ship is waiting and the examination must be fast but thorough, because once an animal gets past and on the ship, it is in the veterinarian's charge and counts against him if not delivered in good condition on the shores of the United Kingdom.

Various forms of influenza, stomatitis, pneumonia, fever, lameness, wounds, stocked legs and general physical mal-condition must be dealt with. These horses and mules have already passed by the British remount veterinary officer at the pens, but I have rejected as many as twenty-one in a shipment of 900 head and as many as eighteen in a shipment of 500. As soon as the last animal is on board, carpenters tear down the loading chutes, board up the entrances, which are used as stalls; goodbyes are said with best wishes, and with a handshake the pilot gives the order to "cast off" and the steamer slowly moves away on her perilous trip across the Atlantic.

Besides the animals, the cargo generally is mixed, always one-third food products or munitions, always weight sufficient to put her deep enough in the water to retard her speed and make it very dangerous in rough weather on account of the open hatches. One is provided with a head foreman, four or more assistant foremen, one horseman to every twenty head, and sometimes a dispenser and two night watchmen. They are generally easy to handle, good natured and jolly but rough, and on shore in the United Kingdom are generally closely watched.

The first two or three days out hay only is fed, about 15 pounds with salt and plenty of water. The third day, one part oats is fed with two parts bran morning and night, 7 a. m. and 4:30 p. m.; hay three times daily and salt every other day.

Mucking out must begin at once and continue throughout the voyage. One cannot enter any port without inspection, and if filth has accumulated the ship may be refused entrance into

the dock. Disinfection continues throughout the voyage and is very important. Crude creolin and chlorid of lime are used mostly.

The conducting officer must be energetic. There must be unremitting attention to and supervision of watering, feeding, mucking out, etc. In other words, one must look after every man and every animal personally day and night.

Sick animals are removed to the upper decks as far as possible, which is not very easy when the runway is removed to allow the hatches to be put on in case of rough weather. The treatment of hopeless cases is not attempted. It is contrary to hygienic principles and leads to the infection of neighboring animals. Unnecessary drugging is avoided. Preventive hygiene and active individual attention are far more important than drugs on board ship.

The thermometer is very valuable on shipboard, but many times in using it one needs to be an athlete on account of the forward-backward motion of the animals, the limited space and crowding neighbors, etc.

The successful conducting officer must be a hygienist and disciplinarian rather than a therapeutist, a good horse master rather than a skilled prescriber.

The trip from New Orleans, La., to Avonmouth, England, a port of Bristol on the Avon river, takes twenty-two days from the start to the unloading time. It takes eight days going through the Gulf of Mexico and the straits of Florida. The temperature of the water there was never less than 80° and in parts of the steamer the thermometer registered 107°. The nights were as hot as the days down below. There was no breeze, or else the breeze would follow us, which is worse than none. The steamer being all steel, the sun and the water (86°) keep it from cooling until it passes Bermuda and starts across the Atlantic.

On one trip I had 100 mules with high fever, not eating anything except a little hay. They had pus in the inferior, anterior chambers of their eyes so they couldn't see the feed trough. There were cases of regular sea sickness, heat exhaustion, fever, collapse, influenza and complications. Every case of septic pneumonia must be destroyed as soon as a definite diagnosis can be made. Any animal landed with the symptoms counts against one's bonus. About this time there may be a strike among the horsemen or a shirking of work, failure to carry

out orders, etc., which leads to heroic measures, especially with a negro crew. Ship life and food do not agree with the average American hobo, and he rebels about the second week. When due to the carelessness of some horseman, the veterinarian in charge sees a mule going over the side, costing him from $50 to $100, according to the per cent it makes, it causes him to sit up and take notice.

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