FOX RANCHING IN CANADA

By J. A. ALLEN, B.V.Sc.
Animal Pathologist, Fox Research Station, Charlottetown, P.E.I.

AND

G. ENNIS SMITH, B.A.Sc.
Nutritionist, Geneticist, and Superintendent Experimental Fox Ranch, Summerside, P.E.I.

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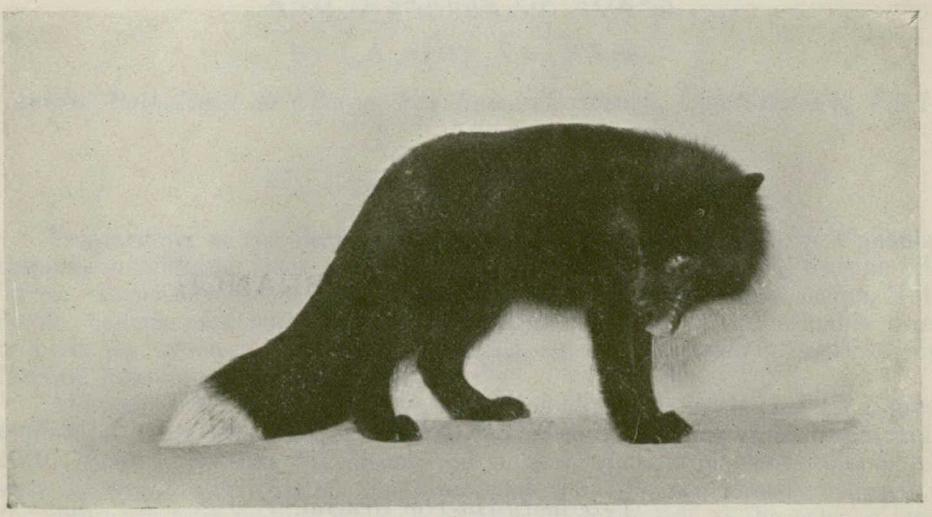

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SECTION I

CONSTRUCTION OF RANCHES, MANAGEMENT, SANITATION AND DISEASES OF FOXES

By J. A. Allen, V.S., B.V.Sc.,

Animal Pathologist in Charge, Fox Research Station, Charlottetown, P.E.I.

INTRODUCTION

Fox-farming is the direct outgrowth of the early attempts of Canadian trappers to hold over foxes, captured out of season, until the animal became full-furred. Experiments conducted in the provinces of Prince Edward Island, Nova Scotia, Quebec and Ontario resulted in fixing the type of the valuable black or silver fox, which is a sport of the common red fox. The new industry of fox-farming followed as a natural sequence.

Although a few foxes have been kept in confinement in Canada for a great number of years the expansion of the fox industry did not really begin until 1910. Before this time fox raising was a secret pursuit in which only a few were allowed to participate. The knowledge that the men already engaged in the enterprise were making handsome profits from the sale of the pelts of foxes which they were raising gradually leaked out, and a scramble to get possession of foundation stock became a veritable craze.

So great was the demand for foundation stock that the practice of pelting ceased about 1911, and all available foxes were sold alive. The cost of a pair of foxes steadily rose from $3,000 a pair in 1910 to $20,000 a pair in 1913. During the hey-day of the boom as high as $35,000 was paid for exceptional specimens. When the supply of foxes for foundation stock became exhausted, foxes were captured and brought from other parts of the country to help to supply the demand; and optimistic investors began speculating in futures, and options were taken on unborn pups.

The European war brought an end to speculative fox-trading, and a highly speculative venture was changed into a legitimate industry. So far as the fox industry on this continent is concerned, the day of speculation is apparently over, and live foxes are sold for what their pelts would bring or a little more, because breeders recognize that every pair of foxes sold means a competitor.

Fox farming has weathered these early, trying experiences, and to-day is on a substantial commercial foundation. As evidence that the industry has made great strides within the last few years it is estimated that in 1912 there were not more than ten ranches operating in Canada. According to the official report on the Fur Farms of Canada for 1924, there were 1,466 ranches in Canada having in captivity at the end of December, 34,593 foxes. This does not include the animals pelted and sold for breeding stock during that year. The value of foxes in the ranches at the end of 1924 is placed at $8,283,695, and the value of the property amounted to $10,813,833.

The growth of the industry in the United States is also astonishing. The Bureau of Biological Survey estimates that there are 800 fox ranches, having in all from 12,000 to 15,000 foxes in captivity. The figures quoted above for Canada probably include the farmer who has one or two pairs, for the raising of a few pairs of foxes on the farm is becoming a common enterprise; the farm housewife devoting her attention to this rather than to the more prosaic work of feeding chickens.

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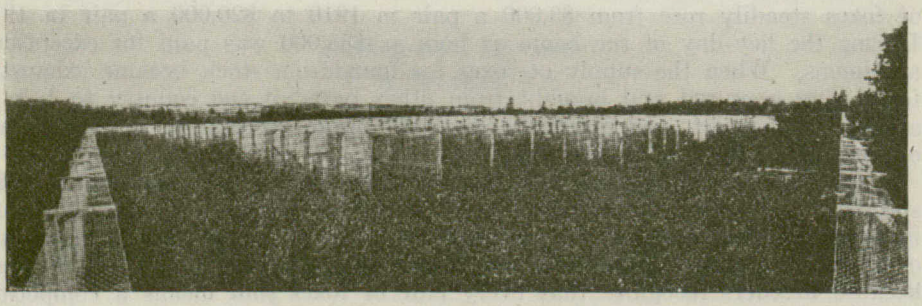
Because of the newness of the industry one would expect that fox-farmers would experience some dietary and pathological difficulties in attempting to keep in confinement a wild animal that was accustomed, in its natural environment, to roam over a wide territory; and this bulletin is partly designed for the purpose of furnishing a guide to the accepted principles of fox-ranching, and pointing out how some of the pitfalls may be avoided. Throughout this bulletin, it is assumed that the reader has no knowledge of fox ranching. Because of the many inquiries concerning the method of ranch construction we have deemed it advisable to include a chapter on ranch equipment.

Ranch Equipment

The question as to whether a fox ranch should be located on a woodland site or on clear ground is a very contentious one. Some maintain that foxes raised in dense forest sites are superior in quality of fur, while the advocates of the open ranch are just as positive that better results can be obtained when the ranch is located on clear ground. We are of the opinion that there ought to be a compromise between these opposing views, and that a site not too dense and not too open should be selected. While prime pelts have and are being produced on sites where there is not a single tree, the consensus of opinion is that there should be sufficient foliage to serve as a protection for the animals in winter. For sanitary reasons there should be enough sunlight admitted to keep the ground dry, and in order that advantage may be taken of its germicidal action. It is not generally accepted that sunlight influences either the texture or colour of fox fur, but there should be sufficient foliage to give the animals a feeling of security and to give protection during the heat of summer.



Bird's Eye View of Fox Ranch.

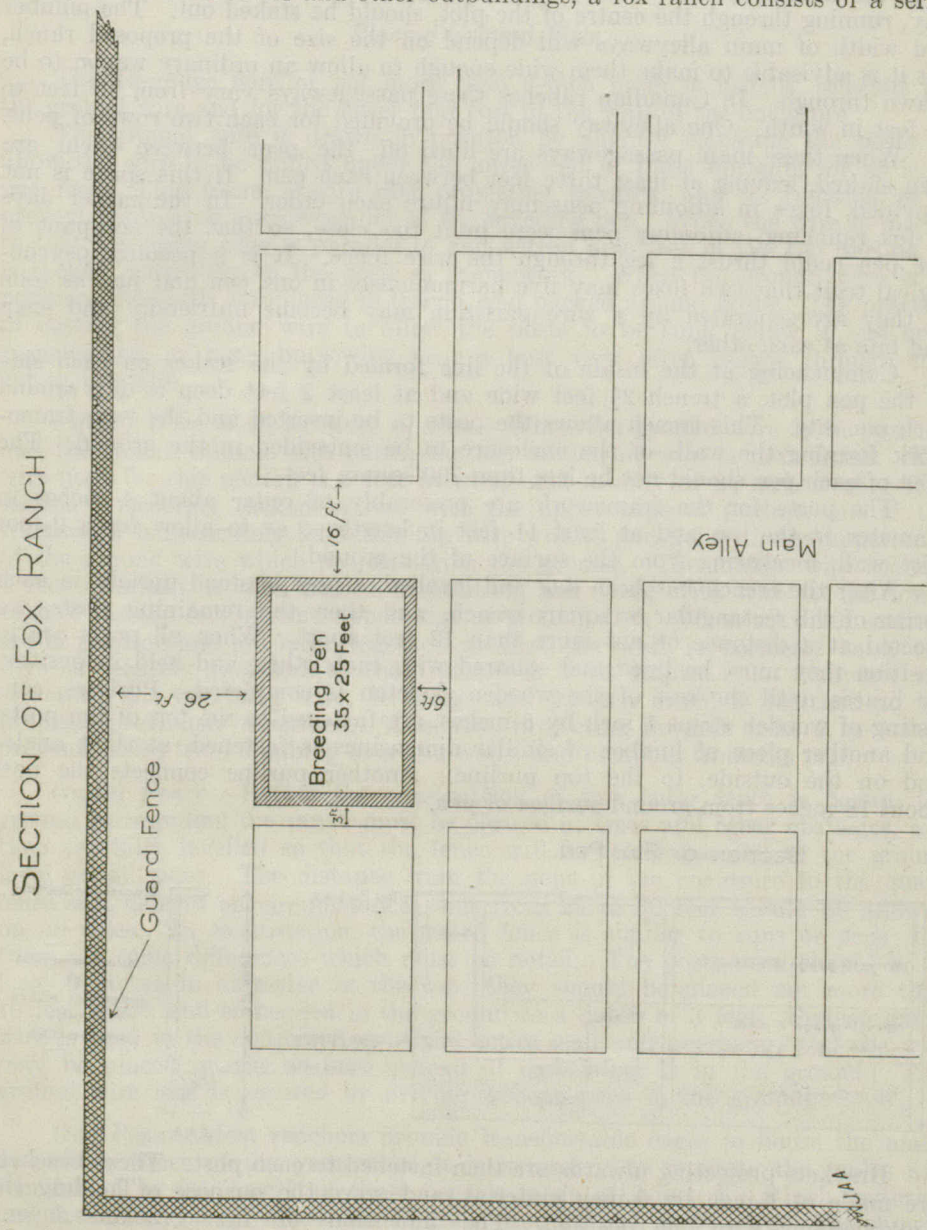
The site chosen should have sufficient elevation to provide adequate drainage. A ranch built on a slope with a southern exposure has evident advantages as the snow in early spring will sooner disappear and leave the ground dry before the pups come out of the dens.

The site should be as far away as practicable from a settlement. In some localities it has been customary to concentrate a number of ranches on the one plot. Many of these ranches are separated by only a few yards. In our experience this is a dangerous practice since if contagious disease breaks out in one of the ranches it is likely to spread to adjoining enclosures. It may be said without any qualification that fox ranches should be built as far apart as possible.

The average ranch contains about 30 pens. There is, however, a tendency to build large ranches of from 60 to 80 pens. It seems unwise to ranch more than thirty pairs of foxes in any one ranch. If expansion be necessary it is a better plan to build a distinct structure as far as possible away from the original

ranch, rather than extend the original structure. By this means the risk of loss from contagious diseases is at least cut in two. True, the plan means the duplication of some equipment, but the advantages to be derived justify the extra expense.

Leaving out of consideration, for the present, caretaker's dwelling, meat house, observation tower and other outbuildings, a fox ranch consists of a series



of wire pens of varying dimensions, surrounded by one large enclosure. Each pen is provided with a kennel. The outer enclosure, which is popularly known as the "guard fence," is designed for the dual purpose of preventing trespass from without and the escape of foxes which may have accidentally gained their freedom from the breeding pens within.

Construction of Fox Enclosures

In order to give a rough idea of the construction of a fox enclosure, a brief description of the usual method of mapping out the plot and erecting the pens will be given. When the site has been selected, and decision has been reached as to the number of area and the breeding pens required, the first main alleyway, running through the centre of the plot, should be staked out. The number and width of main alleyways will depend on the size of the proposed ranch, but it is advisable to make them wide enough to allow an ordinary wagon to be drawn through. In Canadian ranches these passageways vary from 10 feet to 25 feet in width. One alleyway should be provided for each two rows of pens.

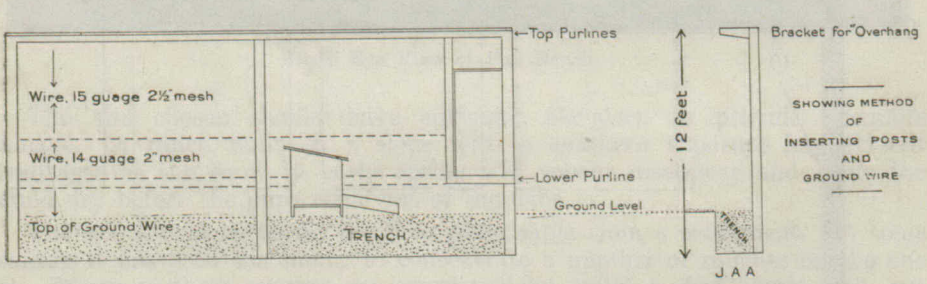
When these main passageways are lined off, the pens between them are then staked, leaving at least three feet between each pen. If this space is not provided, foxes in adjoining pens may injure each other. In the earlier days of fox ranching, adjoining pens were built too close, so that the occupant of one pen could thrust a leg through the wire fence. It is a peculiar psychological trait that two foxes may live harmoniously in one pen and just as soon as they are separated by a wire partition may become unfriendly and snap and bite at each other.

Commencing at the inside of the line formed by the stakes on each side of the pen plot, a trench 2½ feet wide and at least 2 feet deep is dug around each pen site. This trench allows the posts to be inserted and the wire framework forming the walls of the enclosure to be embedded in the ground. The area of each pen should not be less than 700 square feet.

The posts for the framework are preferably of cedar about 4 inches in diameter at the top and at least 11 feet in length so as to allow for a 9-foot wire wall, measuring from the surface of the ground.

After the trench has been dug and levelled, a post is stood upright in each corner of the rectangular or square trench, and then the remaining posts are erected at a distance of not more than 12 feet apart. When all posts are in position they must be lined and squared with each other, and held in position by braces until the rest of the wooden skeleton is completed. Purlines, consisting of wooden strips 1 inch by 5 inches, are fastened to the top of the posts, and another piece of lumber of similar dimensions is fastened, at right angles and on the outside, to the top purline. Another purline connects the post about 18 inches from ground surface of pen.

SECTION OF FOX PEN



Brackets projecting inwards are then fastened to each post. These brackets are made of 1-inch by 5-inch material, and serve the purpose of holding the "overhanging wire" in position. The dimensions of these brackets depend on the width of the "overhang," usually about 2 feet.

The entrance to each pen should face the alleyway. The door frame is made of 2-inch by 6-inch material, and the door itself should measure at least 2½ feet by 5 feet. The bottom of the door should be raised about 18 inches from the ground.

Fox Wire.—The wire used in building fox enclosures is similar in structure to ordinary chicken netting wire, but of heavier gauge. Netting wire manufacturers now provide a special wire for this purpose. The weight usually recommended varies from 14 to 16 gauge, and the mesh varies from 1 to 2½ inches. This wire is marketed in various widths—from 2 to 6 feet—and in rolls of 150 feet in length.

Placing Ground Wire

The 14-gauge wire of not more than 2-inch mesh is usually selected for the ground wire and for the lower four feet of the wall of the enclosure.

The ground wire is drawn in position by slightly elevating the posts to allow the wire to be pulled under the lower end of these uprights for at least two feet. This forms a wire mat projecting inwards, and its function is to prevent foxes from burrowing out of the breeding pen. When the wire is placed so that the upper edge is parallel to and within nine feet of the top purline, it is tacked accurately to the posts or framework. When the ground wire is in position, the earth is replaced in trench, and packed around posts. The practice of cutting the ground wire to allow the posts to be sunk below it has been discontinued, as foxes burrowing near a post very often escape through this cut in the wire.

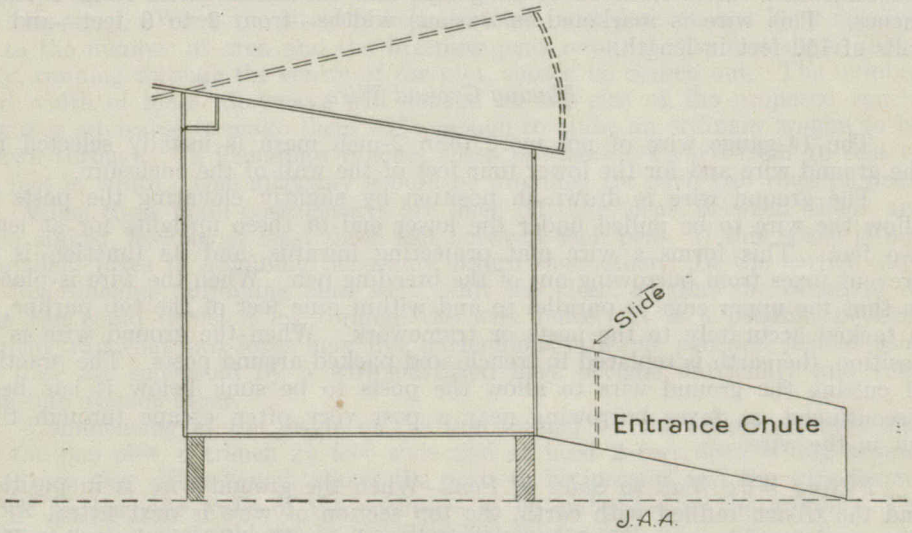
Fitting Wire Wall to Sides of Pen.—When the ground wire is in position and the trench refilled with earth, the top section of wire is next fitted. The wire used for this section is 5 feet in width and usually of 2½-inch mesh. This section is securely tacked in line with the upper edge of purline, and if the framework is accurately built this top wire will be parallel with the upper edge of the ground wire which projects from the ground. The middle wire section, 4 feet in width, is then placed in position, and laced with wire to the lower edge of the top section, and upper edge of ground wire. When all three sections are in position and are laced together so that the wall is perfectly taut, the wire is securely fastened to the framework with staples. To complete the structure, the overhang wire, 16 gauge and 2½-inch mesh, is fastened to the brackets previously described. This wire, projecting inwards from 2 to 3 feet, prevents foxes from climbing over the walls, and escaping from the pen.

Guard Fence.—Before the construction of this outer fence is begun, the ground surrounding the ranch must be cleared of trees and other obstacles, and then carefully levelled so that the fence will be fairly parallel to the ground level on all sides. The distance from the pens in the enclosure to the guard fence will depend on circumstances, but from 25 to 30 feet should be allowed on all sides. In construction, the guard fence is similar to runs or pens; but there are some differences which must be noted. The posts used should be at least 6 inches in diameter at the top; they should be placed not more than 10 feet apart, and embedded in the ground to a depth of 3 feet. Sixteen gauge wire is used in the construction of the entire wall and overhang; and the wire may be placed on the surface instead of embedding it in the ground. This ground wire mat is secured by driving wooden pegs in the ground.

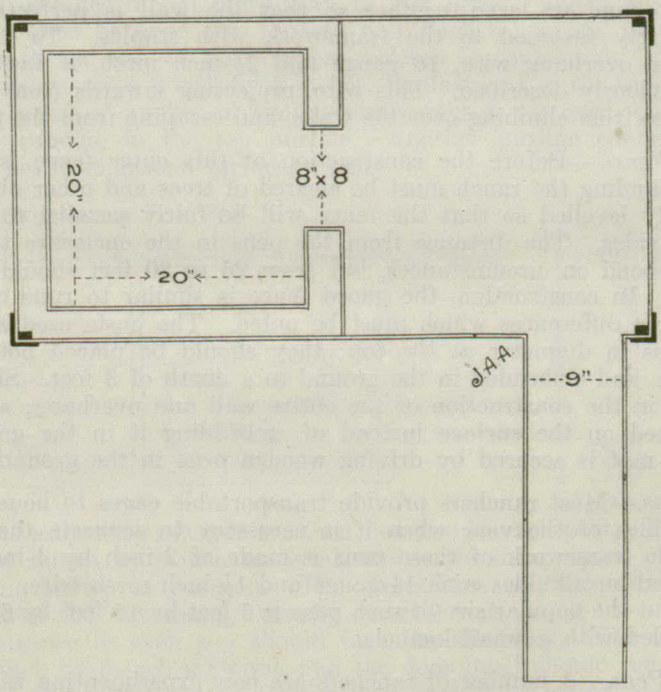
Dog Pens.—Most ranchers provide transportable cages to house the males at certain times of the year when it is necessary to separate the males and females. The framework of these pens is made of 2-inch by 4-inch material, and are netted on all sides with 14-gauge and 1½-inch mesh wire. The dimensions vary, but the popular size of such pens is 6 feet by 15 feet by 6 feet. Each pen is provided with a small kennel.

Special Pens.—A number of ranchers are now experimenting with a system of double-mating; that is, the same male is used to serve more than one female.

SHOWING ENTRANCE TO KENNEL



FLOOR PLAN OF KENNEL



Some selected polygamous males will serve as many as four females, and have been known to sire as many as twenty pups in one season. If this system can be put in general operation, its advantages are obvious, for it is not only more economical but means that only the best sires may be kept. In providing for double-mating, it is necessary to have the dog pen connected by a chute with two or more breeding yards.

Pelting Runs.—A few ranchers are experimenting with large pens, with area of about two acres. The foxes that are being prepared for their pelts are allowed to run free. Up to the present no serious accidents have happened.

The Octagonal Breeding Pen.—Instead of building the ordinary square or rectangular pen, some ranchers are constructing an eight-sided enclosure. The advantages claimed for this type of pen are as follows: (*a*) Twenty per cent more area can be enclosed with the same amount of wire. (*b*) The corner angles being less acute, foxes are not so likely to climb the walls of the pen, and therefore accidents are avoided. (*c*) A ranch constructed on this plan gives a better general appearance.

A pen built on this plan with eight 12½ feet sides gives an enclosed area of 750 square feet. An overhang wire similar to that previously described may be provided or the entire top of pen may be covered with wire netting.

Fox Kennels.—In the early days of fox-farming some of the failures were attributed to insufficiently protected quarters for the young. Improvised log burrows were buried in the ground and were found inadequate since they did not provide sufficient warmth for the young, and were inaccessible for the purpose of cleansing and observation. At present there are many designs for kennels depending upon the whim of the builder, but generally speaking a fox kennel may be described as a compartment within a compartment.

The inner chamber is called a den, and is made so that it can be readily removed for cleansing and disinfection. A space is left between all sides of the den and the outer compartment so that it may be packed with sawdust, chaff or other insulating material. The inner and outer chamber are connected by a chute.

The inside dimension of the floor of the outer kennel is 2½ feet by 5 feet. The rear of the house measures 2 feet 7 inches in height, while the front is only 2 feet 3 inches in height. This difference in height allows for a sloping roof for drainage. The inner nest is made 1 foot 8 inches square. The inside of both chambers should be smoothed and sandpapered so as not to injure the fur; and the lower corners of the nest filled in with a triangular piece of lumber.

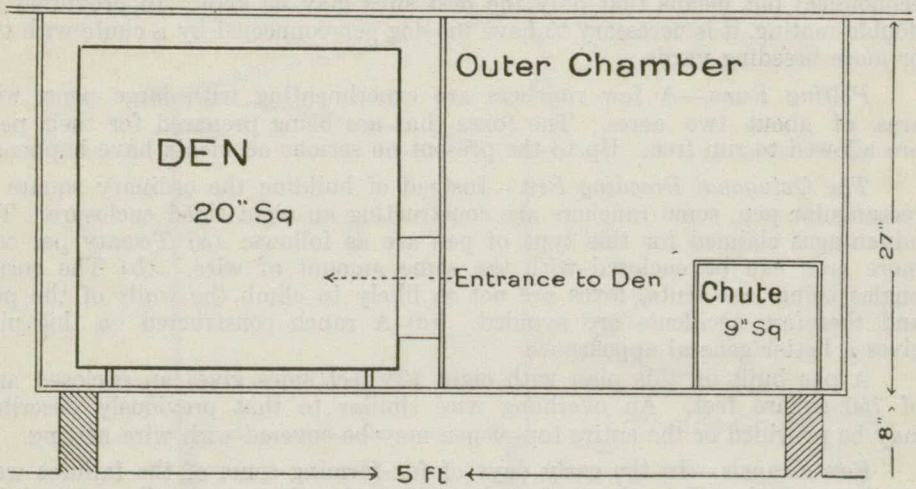
Ventilation is provided by cutting a hole 4 inches square at the top of each end of the kennel. A wooden shaft, perforated by 1-inch round holes, connects these openings.

Chute Runs.—Some ranchers recommend placing a wire cage, about 3 feet square, at the end of the kennel chute. The cage is raised a foot or so from the ground, and is very valuable for preventing the vixen from carrying out her pups to the cold, wet ground in early spring.

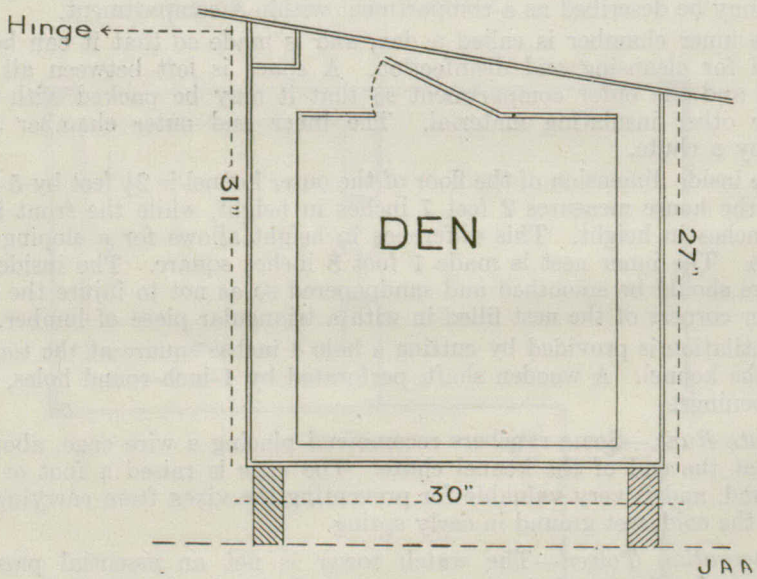
Observation Tower.—The watch tower is not an essential part of the equipment of a fox ranch, but some ranchers find it invaluable in keeping their animals under surveillance during the breeding season, so that accurate mating charts may be kept and the expected date of whelping recorded. Other ranchers obtain this information by allowing the males into the breeding pens only in the day time. The observation tower in use is merely a narrow building located in the centre and sufficiently elevated to give a clear view of all parts of the ranch. The top room has windows in all sides. A room may be built underneath to serve either as a pelting room or sleeping quarters for a watchman.

FOX KENNEL

FRONT ELEVATION



END ELEVATION



Meat House.—The storage house is preferably located outside the guard fence. Its construction will depend solely upon the size of the ranch it has to serve. In localities where fox meat can be bought on the hoof, it is necessary to provide an abattoir in proximity to the meat house.

Specifications for a meat house will not be given here; it is only necessary to state that concrete floors, and benches with impervious tops are essential features of the ideal structure. A few of the ranches recently built contain brine freezers in which the meat supply may be kept without deterioration.

Suggestions for Improvement of Ranch Equipment

The Double Unit Ranch.—A ranch on the double unit plan could be provided so that one half of the ranch would be in use while the fouled soil of the vacant unit was being thoroughly disinfected and left to be acted upon by sunlight and air. Such a plan would doubtless lessen the danger from parasitic infestation and other diseases. The chief objection against this scheme is one of cost since it means the duplication of equipment; but this should not be an obstacle when the returns from the industry are taken into consideration.

Isolation Hospital.—Very few ranches are equipped to take care of diseased foxes. The common experience is that ranches are so congested that there is not even a single vacant pen. If the rancher has not a sufficient number of foxes of his own to fill his ranch, he will take in foxes belonging to other individuals.

It is essential that all ranches be equipped with a suitable building to serve as a hospital and isolation area. The type and size of building will depend, of course, on the number of animals kept on the ranch. The floors should be made of concrete, and the cages so constructed that they may readily be taken apart for cleansing and disinfection. The building should be surrounded by a small guard fence to prevent dogs, cats and other small animals from gaining access to the building. The hospital should be built outside the main guard fence, and as far away as convenient from the ranch.

Impervious Flooring for Runs.—One of the chief problems of ranch equipment lies in the difficulty of keeping the floors of pens and runs in a sanitary condition. The disinfection of pens with earth bottoms has its limitations since the common disinfectant substances used are quickly absorbed and soon become inert; and it is impossible to keep burrows in anything approaching a sanitary condition. In allowing their foxes to honeycomb the ground of the pens with burrows, ranchers have tried to copy nature, but where facilities are lacking, as is the case in raising foxes in captivity, it is advisable to deviate from natural habits. In raising foxes in captivity there must in future be a gradual adoption of artificial conditions if some of the essential requirements of sanitation are to be approached. It seems advisable that some experiments should be conducted with impervious flooring such as concrete or asphalt so that the runs could be flushed with water and thoroughly disinfected. One rancher reports that he is having excellent results with concrete floors covered with shore-sand. The sand is scraped off and replaced with a fresh layer at frequent intervals.

The Incinerator.—A small incinerator should be built on every ranch in order that refuse and accumulating dirt might be destroyed. This is particularly useful if infectious disease gain entrance to a ranch as the diseased carcasses and infective material may be expeditiously and safely destroyed by fire.

The Double Kennel System.—The sanitary condition of fox kennels could be greatly improved by furnishing two houses for each pen instead of only one. Foxes could be trained to occupy one kennel while the other was being cleansed and disinfected. These kennels could be located outside and on opposite sides of the pen; the foxes reaching the kennel through a chute leading from the enclosure. It would be a further improvement to have fox houses made detachable so that they might be more readily and effectively cleansed and disinfected.

Sanitation

In nature the fox is accustomed to roam over a wide territory, and there is not the same chance of his coming in contact with the secretions or excretions of his fellows as when penned up from year to year in a small

enclosure with several other foxes. Under these conditions the ground becomes fouled and is a nidus for parasitic and other infections. When animals are kept on small areas, and the greater the congestion the more the danger, disease is certain to appear among them unless strict attention is given to the cleanliness of the premises and general equipment. When a few animals are kept on an unlimited range there may be no outward result even when indifferent sanitary conditions prevail; while serious result may be experienced in areas more congested.

Aside from the danger of intimate contact between animals living in limited areas, we have the problem of the effective disposal of the excretions. Bad smells from decaying manure and other organic material do not directly affect the health of the animals, yet they are an offence and may be regarded as a danger signal. Accumulated dirt is dangerous since it may be the vehicle for infection. This is clearly illustrated in the case of worm infestation. It must be remembered that worms or other forms of parasitic life do not arise spontaneously; that is, they result from reproduction by their kind. When an animal is infested with round worms, thousands of worm eggs are passing out with the manure, and an animal to become infested must ordinarily take these eggs in with its food.

If fox enclosures are allowed to become littered up with manure, the chance of getting those eggs in the food is very great because foxes will drag their meat over the runs before finally consuming it. In addition to this, foxes in captivity are guilty of filthy habits, and will soil their feed pans, which is a very direct method of disseminating disease.

External parasites, like fleas, also spend part of their life in filth, and if dirt is allowed to accumulate then this problem is also accentuated.

It is a matter of common observation that flies and other insects breed in dirt and decaying material. While we do not know if flies have any important relationship to the spread of disease among foxes, it is sure that they are a source of annoyance.

There is a great advantage in knowing the cause and the means of spreading disease as it gives us vantage ground from which we may hope to find means of controlling its ravages. Foxes are fortunately not subject to many diseases due to specific germs, the principal one being distemper or influenza. When it is realized that an animal suffering from infectious disease is continually eliminating from its body the germs causing the sickness, it is readily understood that an animal suffering from such disease is the chief source of infection, and that all other animals coming in direct or indirect contact with him are very apt to contract the same disease. This is the means by which so-called infectious and contagious diseases are spread. It seems reasonable, then, that one of the methods of avoiding the ravages of communicable disease is to isolate or effectively destroy the affected animal, particularly if the outbreak is just beginning. This, of course, brings forward the matter of early diagnosis, and fox breeders should in every case take advantage of competent veterinary advice; for the condition that the uninitiated may regard as unimportant may subsequently prove to be of serious consequence.

As pointed out under the head of improved equipment, all ranches of any size should have an isolation hospital in which suspects might be housed. It should be made a general routine in ranch practice to isolate all animals showing any manifestations of sickness. Even in simple disorders this is advisable, because a fox can be more readily treated and given greater protection from inclement weather in a house specially constructed for the purpose of caring for the sick than in an open pen.

The conditions that now obtain in many ranches for the handling of diseased stock is entirely inadequate. In investigational work, it is a common experience to find that a contagious disease is not reported until a large number

of animals have died; and very often the carcasses are left exposed so that birds and rats may feed on the infected material and these doubtlessly spread the contagion. All infected material should be burned.

Fox ranchers do not realize the importance of indirect contact in spreading disease. It is an ordinary experience in handling outbreaks to find ranch assistants passing from infective to clean areas without taking any of the common-sense precautionary measures such as the disinfection of their boots. Very often, ranchers will pelt diseased carcasses and without disinfecting their hands, they will begin cutting the meat supply for the following meal. In this case the germs are indirectly planted in other animals, and the disease may be spread over the entire ranch.

Feed pans, too, may be an indirect source of infection. The practice of gathering the pans from all the enclosures and rinsing them in the same water should be discontinued, unless it is possible to thoroughly boil these utensils before they are replaced in the runs. It is essential that the feed pans be removed from the pens after each meal and not allowed to remain there to become contaminated with the excretions from the animals. This applies not only when disease is present in the ranch, but also in everyday ranch practice.

It seems more than a coincidence that fox ranches, generally speaking, are freer of disease during the winter when the ground is covered with snow. The increase of disease at other times of the year cannot be entirely attributed to seasonal conditions. It is more likely that the falling off in mortality is due in part at least to the fact that the contaminated soil is covered up and that the animals do not come in such intimate contact with it. In this there is an indication of the importance of keeping a ranch scrupulously clean during the months when the ground is bare. It is particularly essential to enforce strict sanitary measures during the spring and summer, because the young are much more susceptible to the influence of an insanitary environment.

The sanitary work in large ranches should be systematized so that each pen and den is thoroughly cleaned out at least once a week. It should not be a difficult arrangement to have ranches mapped out so that assistants would know the day on which each pen should be cleansed and disinfected.

The conception of what constitutes careful and thorough cleansing of ranch equipment held by some ranches is indeed inadequate. Some think that the mere sweeping out of manure and food waste is all that is required. It cannot be too strongly emphasized here that the most dangerous filth, germs and parasite eggs, is microscopic, and cannot be seen by the naked eye.

Unless this work is thoroughly done, it gives a false feeling of security. After all the visible dirt is removed by sweeping and scraping, the kennels and dens should be scrubbed out with soap and water. When all the organic material has been thus removed, a good disinfectant solution should be sprayed on all parts of the structure. If trouble is being experienced with fleas or other external parasites, the seams and crevices of the houses should be torched with a torch similar to that employed by painters in removing old paint. It is a good practice to do this occasionally even when fleas are not present.

If two kennels were provided for each pen, the work of cleansing dens would be greatly simplified, as one kennel would be idle and undergoing cleaning and disinfection while the other one was in use. If this system were carried out weekly throughout the year the animals would become accustomed to being moved from one den to the other and little inconvenience would be caused even during the breeding season, except, of course, during the period immediately before and after whelping.

Keeping the earth floors of pens in a sanitary condition is a more complex problem; and it is for this reason that we suggest that impervious flooring should be tried in fox runs. The disinfection of pens with earth bottoms has its

limitations since the disinfectant substance is quickly absorbed and soon becomes inert. A more efficient method of disinfecting the ground would be to employ the actual flame, and thoroughly scorch the ground.

Such an apparatus as described by Stiles, United States Department of Agriculture, Bureau of Animal Industry, could, after a little experimentation, be applied to fox ranches. The following description of this apparatus is quoted from an article by Riley and Fitch:—

"Experiments were made with the cyclone nozzle. An oil spray from this nozzle when ignited was found to give a very hot and effective flame. Crude oil was first used as a burning fluid, but as it is very objectionable on account of its rank odour, paraffin gas oil was substituted later. This oil has less odour and burns to better advantage, but is somewhat more expensive. A fifteen-gallon tank, which could be readily carried about by two men, was provided. On such a tank a Johnson pump, with a fine strainer placed over the suction pipe, was mounted and a short hose of the kind made for the delivery of oil was attached. Ordinary rubber hose is worthless for such a purpose, as it is soon destroyed by the corrosive action of the oil, and in the meantime the disintegrated particles frequently clog the nozzle. A pole, consisting of an iron pipe 12 feet long, braced by being surrounded by wood for three-fourths of its length, was coupled to the hose. No solder could be used in the fittings of the pipe or nozzle, as the fierce heat of the flame would fuse it. The wooden cylinder into which the pipe was thrust was 1¼ inches in diameter. The wood being a non-conductor of heat, was of great convenience in handling the pole. The end of the pipe was fitted with a cyclone nozzle. The aperture of this nozzle is very small, hence the value of the strainer before mentioned, which prevents the entrance of foreign substances with the oil, and a consequent clogging of the nozzle. The two men handling this apparatus filled the tank with oil and then carried it to the spot where the burning was to be done. One man then operated the pump while the other handled the pole and nozzle. As soon as the pump was started a fine spray of oil was thrown into the air and ignited by a match. By means of the pole the resulting fierce flame was carried among the undergrowth and over the ground, destroying every living thing in its path. When this work was carefully done no eggs escaped, except such as were hidden in ledges or holes in the ground. An attempt was also made with this apparatus to destroy eggs which had been deposited in stone walls. Though this was partially successful, in so far as the fire reached and destroyed most of the eggs, those which were deposited under the lower stones were cracked and broken by the heat. As it sometimes became necessary to use this apparatus in burning out walls near growing crops, a sheet-iron screen was set up between the flame and the growing vegetables to protect them from the heat, being moved along the wall as the work progressed. Burning was thus done without any resultant injury to the gardens. This machine, which has been named the "Cyclone burner," would be most useful in checking invasions of crawling pests, like the army worm.

"It is understood, of course, that burning with a flame of this kind will disinfect only the surface of the ground, unless the flame is held in one place for some seconds or minutes.

"Complaint has been made that there is a high mortality from uncinariasis among high-bred pups. The use of this flame in kennels ought to reduce this mortality practically to nothing, and I see no reason why the same general method of disinfection, modified to suit the particular conditions at hand, should not be used on the seal rookeries and fox farms of the Alaskan Islands."

Whichever method of disinfection is followed, it is important that the gross dirt be removed from the pen and burned before attempting disinfection.

The average rancher prepares the disinfection solution in a haphazard manner, he depends more on the colour of the solution than on accurate

measurement. In order that the rancher may have some guide in making up disinfectant solutions the Health of Animals Standard Method of mixing solutions is here given:—

"A disinfectant should be made using therefor forty pounds of freshly burned stone lime to the barrel of water as a base, and to this add sufficient disinfectant having a phenol co-efficient of not less than 2.0 to make a three per cent solution of the disinfectant in the limewash preparation. Where the phenol co-efficient is shown to be in excess of 2.0, the amount of disinfectant having a phenol co-efficient of 10.0 is used, a limewash solution containing 0.6 per cent of the disinfectant will be the equivalent.

"Assuming that a barrel of water holds 50 gallons imperial measure, then the following table will prove useful in determining the amount of disinfectant to be added to the limewash solution.

Biological Laboratory	Amount of Disinfectant to be Added		
Phenol Co-efficient	Per cent	Quantity	Imperial measures
2·0	3·0	11 pints plus	8 ounces
3·0	2·0	7 "	14 "
4·0	1·5	5 "	14 "
5·0	1·2	4 "	6 "
6·0	1·0	3 "	16 "
7·0	0·85	3 "	5 "
8·0	0·75	2 "	16 "
9·0	0·66	2 "	10 "
10·0	0·6	2 "	6 "
11·0	0·54	2 "	1 "
12·0	0·5	1 " plus	18 "
13·0	0·46	1 "	15 "
14·0	0·42	1 "	13 "
15·0	0·4	1 "	12 "

"N.B.—The disinfectants should be diluted with four times their bulk of water before mixing with the lime solution.

Food Hygiene.—During our investigational work a number of reports of sudden deaths have been received, and the history and post-mortem findings have clearly pointed to meat poisoning. Several of these outbreaks have come under our personal observation. In one case sixteen animals died within ten hours after the ingestion of the suspected meat and all the deaths were traced to one box of horse meat.

Too much care cannot be given to the selection and storage of meat for fox consumption. Cases are on record where fox ranchers have bought carcasses of cattle and other animals that died from disease. Cattle that have died from the poisonous effects of retained afterbirth have been bought and fed to foxes. It must be remembered that when animals have suffered from certain diseases that the flesh is unfit for food. The germs of such diseases as hemorrhagic septicemia, blackleg, malignant odema and general blood poisoning produce changes in the living flesh in which they are growing that render the meat dangerous when eaten by other animals.

It is also important that the meat supply be properly stored as the flesh from healthy animals may become contaminated during the course of its storage and preparation with germs that are capable of bringing about alteration in the meat which renders it toxic.

DISEASES OF FOXES

This bulletin is not intended to be a comprehensive treatise on all fox diseases. Foxes are subject to most of the ordinary disorders of canines, and disease of nearly every organ is observed from time to time. Only those diseases that are of the most common occurrence, and those that occasion the greatest economic waste in fox life, are considered here.

Mange.—Sarcoptic mange or scabies is of rare occurrence in Canadian foxes in captivity though it is said to be prevalent elsewhere. It is fortunate that foxes are not often affected since the parasites attack the body of the animal and produce typical skin eruptions with scales; and since the fox owes its intrinsic value to its fur, it follows that mange, if introduced, would be a disastrous disease.

The external anatomy of the mange mite can be seen only by the aid of the microscope. To the casual observer it then looks very much like a crab. Although the structure of the mite cannot be seen, its presence may be observed by the naked eye by placing some of the scales from the diseased area on a piece of black paper and exposing them to the sun's rays. The warmth gives the mites activity and they may be seen as small moving points.

The mite penetrates the skin by digging with the mouth, which is equipped for this purpose. These parasites feed on the cells of the layers of the skin.

Animals become affected either by direct or indirect contact. A fox, suffering from scab, brought from outside is the chief means of starting the disease on a ranch.

The chief symptom of skin mange is the intense itchiness, caused by the activity of the mites in the skin. In order to get some relief the animal will rub the affected parts against any suitable object such as the top of the chute, which results in the part becoming denuded of fur. Fluid matter will ooze from the sores, and when this dries, scabs are formed. In severe cases the skin becomes much thickened. When the crusts are removed, bright red, sensitive and bleeding sores are revealed. The breast, neck and rump are the parts of the fox most often involved.

Mange mites produce an inflammation of the skin that sometimes simulates less important skin conditions, and an accurate diagnosis of mange can be made only with the aid of the microscope.

If only one or two animals are affected, no treatment should be attempted; the animals should be slaughtered and both carcass and pelt burned. The pens and houses occupied by the affected animals should be thoroughly cleansed and disinfected, and the enclosure should not be used for other animals for at least four months. If treatment is attempted it should be done as far as possible away from the ranch, and the persons having charge of the ranch should not come in contact with the diseased area. The treatment should be undertaken only by a skilled veterinary surgeon.

Mange is a notifiable disease coming under the operation of the Animal Contagious Diseases Act, and all suspected cases must be reported to the nearest Inspector of the Health of Animals Branch.

Ear Mange.—The mite responsible for this condition does not bore into the skin, and this is the reason that it seeks a secluded part of the body like the outer ear in which to live. There are certain anatomical differences between this mite and the one producing body mange, but these differences will not be described here.

This parasite may be present in the external ear of a large number of foxes without their showing any external manifestation of disease. In some large ranches, the parasite has been found by us to be present in over 80 per cent of the animals. Ordinarily an infested fox will not show any signs of irritation, but foxes do not usually betray such feelings in the presence of observers.

Even when the ear contains a heavy infestation, the skin of the ear may not be damaged, but sometimes raw spots are seen on the skin when the scales are removed from the ear.

Occasionally the mite penetrates to the inner structure of the ear, and causes an inflammation that is difficult to heal. When this takes place the fox shows real concern, and will carry the head obliquely; sometimes the neck is twisted to such a degree that the head is carried upside down. As the parasites further invade the ear, the germs carried in with the mites accentuate the inflammation, which may eventually reach the brain. When this occurs the animal becomes frantic, climbs the wire, and will travel unceasingly in circles until exhausted.

The preventive treatment consists in examining the ears at frequent intervals to determine the presence of the mite. Attention should be given to the houses and pens, because, if the houses are infested, there is not much use in treating the animals, as they become very readily reinfested.

In beginning treatment it is essential that all dirt and scales be removed from the external ear; this should be done by washing with castile soap and hot water. The ear is then swabbed out with a 2 per cent solution of creolin in glycerine. The treatment must be repeated in a week so that the mites hatching from the eggs, not removed by the first treatment, may be destroyed. One part of carbon tetrachlorid and three parts of castor oil is a treatment recommended by Hall (1922) for ear mange in cats. This treatment should also be repeated at intervals.

Very good results have been obtained from the following liniment:—

	Metric.
Liquor cresolis compositus	20 cc.
Glycerine	100 cc.
Ether	100 cc.
Distilled water added to make	1,000 cc.

When the ears are discharging they should be syringed out with a saturated solution of boric acid. In such cases excellent results have been obtained from the use of a vaccine prepared from the germs in the discharge.

Fleas.—The fleas most often found on foxes are of the same species that infest cats and dogs. They are also capable of infesting man, and a number of wild animals.

Fleas are more abundant in the warmer and moist seasons of the year. During the spring and summer, they are so rampant that nearly all foxes in confinement become infested.

In completing their life-history, fleas pass through four distinct stages. The eggs are deposited on the host animal, and subsequently fall off on the bedding or floors of the kennel, where they hatch in from two to twelve days. The number of eggs laid by an individual depends on several circumstances. Bacot of the Lister Institute has counted as many as 448 eggs deposited by a female flea (Bishopp). Each flea egg represents a potential adult; so an idea is obtained of the rapidity of flea infestation.

Under favourable conditions, the eggs hatch into immature or larval forms, which look like small maggots.

These are to be found in the dust and dirt of kennels, etc. Fleas remain in this larval stage for from one to three weeks or longer, depending upon conditions. The larva then spin cocoons in which the pupa is formed. These cocoons are difficult to see in dust and dirt, because the silken material from which they are formed collects the dust and dirt. In our climate the winter is usually passed in this dormant stage. During favourable weather, however, the complete cycle from egg to adult flea may be gone through in less than a month.

Because of the irritation and annoyance which fleas occasion, a heavily infested fox cannot be expected to thrive or produce fur of good texture. It

must be remembered that fleas are blood suckers and consequently, when present in sufficient numbers, sap the life out of the host.

Since fleas pass the inmature stages of their life-history in dirt, infestation cannot be successfully controlled unless their breeding places are eliminated. All filth should be constantly removed, and the kennels thoroughly disinfected so as to prevent the larvel forms from maturing and getting on the host. If this is not done it is useless to attempt any form of treatment for the removal of adult fleas, because the parasites will develop and get on the host almost as quickly as they are removed by insecticides.

In some cases, especially where the fleas are found in abundance, dipping is the only means of getting rid of the parasite. It should be employed, however, as a last resort, and avoided in cold weather. The writer has stated in earlier publications that coal tar products like creolin apparently had no detrimental effect on the fur. Further experience calls for a qualification of this statement. While the animal is wearing its old coat, there is little danger, but when the new coat is growing or has reached full growth, discoloration is apt to follow dipping.

A 2 per cent solution of creolin or lysol is recommended, but in all cases it must be washed out of the fur by dipping in clean water before releasing the fox.

Avoid sheep dips containing arsenic. We have knowledge of one rancher who killed twenty foxes in one day by using such solutions.

The sores which are sometimes produced by excessive rubbing and scratching are best treated with calamine lotion or zinc oxide ointment.

The following formula is very useful in removing fleas from other small animals, but it must be used with caution and washed out of the fur when applied to foxes:—

One pound of soap, two gallons of kerosene, one gallon of water. The strength of the mixture is reduced by adding nine parts of water to one part of the mixture.

When it is impossible to dip the animals, much benefit may be derived by spraying the fur with spirits of camphor, and rubbing it in well, especially in the vicinity of the long fur around the neck.

Several kinds of insect powders are also used, but some of these only stun the fleas and do not kill them. In some cases pyrethrum or dalmatian insect powder may be used to advantage, it must however be employed only on healthy animals, and should be dusted off within ten or fifteen minutes after its use.

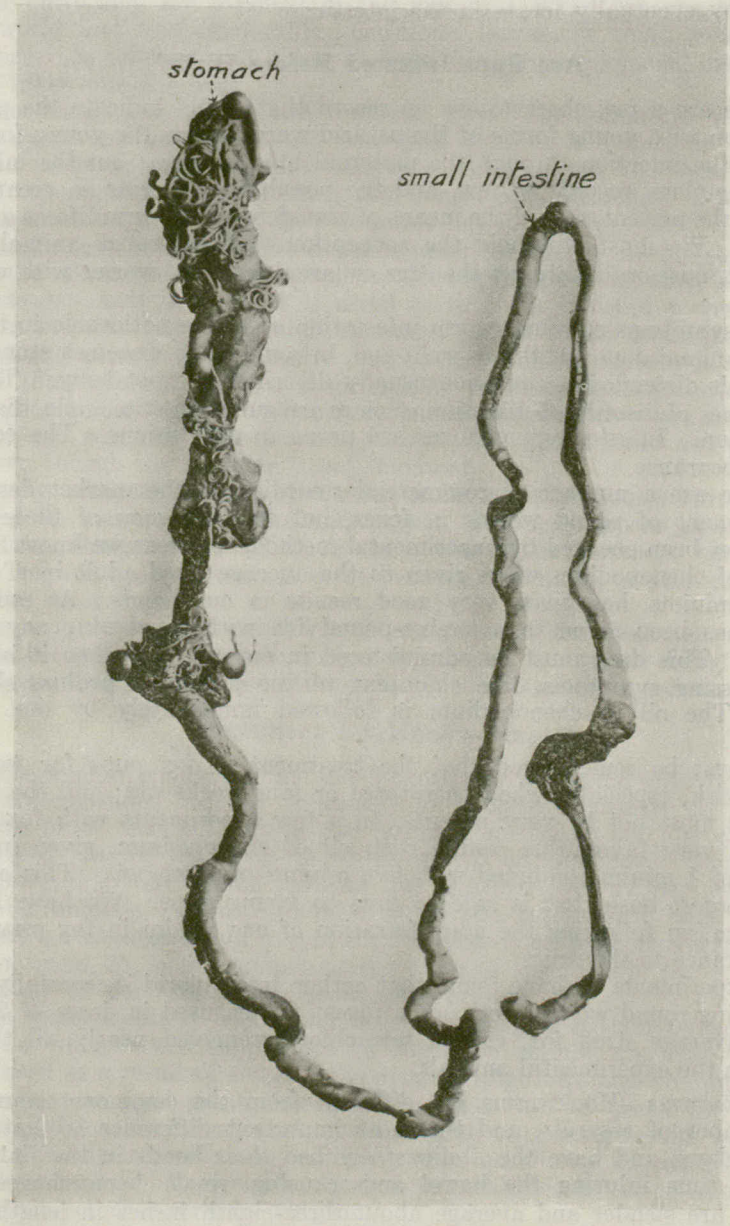
Internal Parasites

Round Worms or Ascarids.—These are the most common intestinal parasites found in young foxes. They are less commonly found, and when present the infestation is seldom heavy, in adult foxes. This comparative freedom is doubtless due in part to the persistent efforts of ranchers to rid the animals of worms during early life, but there is also an indication that animals are less susceptive in later life. Hall (1922) observes that it might be that these ascarids, normally parasitic in dogs and cats, are accidentally parasites of foxes and not adapted to this host, infesting young animals as the turkey gapeworm infests chicks, but very rarely occurring in mature animals.

In Canadian foxes we have found three distinct species of ascarids: *Belascaris marginata, Toxascaris limbata,* and *Belascaris cati.* All these species are commonly found in both the dog and cat. There is a difference in size and colour between these different species, and their eggs show some distinctive characteristics; but they are all remarkable for having projections or narrow wings on either side of the head. The female is larger than the male.

The usual habitat of the adult worm is the small intestines, but in foxes they have been observed growing in the gall bladder and in the substance of the liver. In this case the immature forms migrate through the small duct leading from the gall bladder to the upper portion of the intestines. When

the infestation is heavy in young foxes it is not uncommon to find them in the stomach; indeed the whole intestinal canal may be completely packed with ascarids from stomach to rectum.



Round Worm Infestation in Four Weeks' Old Fox Pup.
276 Worms taken from this Specimen.

The life-history of ascarid worms in foxes has not been fully worked out. Formerly it was believed that the worm eggs were taken in with the food and developed, directly in the intestine, into young worms. Swine are infested with

similar worms, and it has been shown by Ransom (1921) that the small immature larval forms after hatching, pass through the walls of the intestine, gain the blood stream, and are eventually lodged in the lungs from whence they gain the windpipe, are swallowed, and finally settle in the intestine. Experimental evidence would indicate that round worms in foxes go through a similar cycle before they eventually locate in the intestines.

Are Pups Infested Before Birth?

There are a few observations on record that would indicate the possibility of infection with young forms of the ascarid worm before the young fox is born, receiving the infection through the maternal blood stream; but the information is so incomplete, records so few, and the possibility of error so great that we must, for the present, regard the means of transference of worm life as a scientific curiosity. We must still hold the conception that before an animal becomes infested it must ordinarily get the eggs or larval forms of worms with water and food.

The symptoms of round worm infestation are more noticeable in the young fox; the animal does not thrive well, and, in some cases, becomes stunted. The abdomen is distended, a condition usually describel as " pot belly." There may be evidences of disordered digestion, such as irregular appetite, colic, diarrhœa or constipation. Infested young foxes are prone to convulsions. The coat has a rough appearance.

There are a number of commercial remedies on the market designed for the treatment of round worms in foxes, but the efficiency of these products has not yet been checked by experimental method, so far as we know.

Oil of chenopodium when given to the average sized adult in a dosage of 5 to 10 minims, has given very good results in our hands. As much as 30 minims has been given to a twelve-pound fox without causing any apparent ill effect. This drug must be administered in capsule, for when it is given in oil distressing symptoms, like champing of the jaws and profuse slobbering, result.. The oil of chenopodium is followed immediately by one ounce of castor oil.

It must be remembered that the treatment of fox pups for worms is a delicate task, especially when only three or four weeks old; and the substance employed must not be very potent. In a few experiments with fox pups, we have had very favourable results with oil of chenopodium, given in capsules in doses of ¼ minim combined with five minims of castor oil. This appears to be the largest dose that is safe to give to young pups. We have had cases of intoxication following the administration of one minim in fox pups showing an intolerance to the drug.

In experiments we have found that carbon tetrachlorid is especially valuable in removing round worms from adult foxes. When used in doses of 20 minims for the average sized fox, carbon tetrachlorid removed nearly all the worms present in the experimental animals.

Hookworms—Hookworms are different from the commoner round worms in a number of respects, and the most important difference is that they are blood suckers, and have the ability to embed their heads in the lining of the intestine, thus injuring the bowel and causing small hemorrhages. These parasites are slender and average about three-eighth inches in length, so they are difficult to see in the presence of partly digested food in the intestines.

The head is equipped with a cup-shaped mouth having cutting plates. It is this fastening apparatus that causes the injury and makes it possible for the parasite to live on the blood of the infested fox. The tail of the male shows an umbrella-shaped expansion which serves to clasp the female during copulation.

The life-history of the fox hookworm has not been fully worked out. It is very probable that this worm passes through similar developmental stages as the other species which are related to it. In the case of the worm that infests human beings, the adult hookworm lives in the small intestine, where the male and female mate. The female deposits numerous eggs which do not develop into larva until they are expelled in the manure. When the eggs reach the external world and find favourable conditions, larvae, or small young forms of the worm are hatched and these undergo further development before they are again taken into the body.

Infestation may occur in two different ways; the immature worm may find its way to the intestine, being conveyed there in the food or water; or these small undeveloped forms may penetrate the skin, and find their way into the blood stream, reaching the heart and lungs, and ultimately finding their way to the intestine where they grow to adult size.

The harm that hookworms do depends upon the age of the infested animal and upon the number of parasites present. Young fox pups are more susceptible to their ravages, and in them it is usual to find the infestation very heavy. Older foxes seem to have a greater tolerance, and it is not unusual to find a few hookworms present in apparently healthy and well-furred adults. It is our experience that where there is a large number of hookworms present there is always a poor quality of fur. When pups become infested they are likely to be malformed and stunted. The animals become thin and anemic and gradually decline even though the appetite is not impaired.

The only accurate method of making a diagnosis of hookworm disease is to examine the manure under the microscope. The eggs appear as small oval bodies with a dense centre, which in the course of development become segmented. There is nearly always a space between this inner, or yolk part of the egg, and the outer shell.

When a large body of hookworms are present, the flesh and tissue of the organs become flabby, which is due to part of the watery blood escaping into the tissue spaces. This condition is technically known as oedema.

Treatment for Hookworms

In experiments conducted at the Fox Research Station with the various remedies recommended for the treatment of hookworm disease in man and dogs, it was found that chloroform was not only inefficient but also dangerous, since it killed half of the foxes to which it was administered. Thymol was more effective in removing the parasite but it killed over 17 per cent of the experimental animals. It was found that carbon tetrachlorid was the most efficient and least dangerous of any of the remedies tried for hookworms. Given in doses of from 20 to 25 minims to the average sized adult fox it removed approximately 93 per cent of the hookworms present.

In our experiments it was found necessary to give carbon tetrachlorid in capsules, for when it was simply poured down the animal, alarming symptons were produced as a result of some of the drug getting down the windpipe. Even when capsules are used great care must be taken not to break the capsules while forcing them down the throat, else the same distressing results will follow. In order to facilitate swallowing a little castor oil should be poured in after the capsule is pushed out of sight. Carbon tetrachlorid should be administered only by a competent veterinary surgeon.

If, in using carbon tetrachlorid, the animal shows sign of sickening, which it at first indicated by a peculiar quiver, it should be immediately released. If the animal is unable to stand and is struggling and breathing heavily, the hand should be placed on the chest wall, and the chest pushed in and out. A number of animals that would otherwise die may be saved by this simple manipulation.

Tetrachlorethylene—A New and Promising Worm Remedy

Chemically this drug is closely related to carbon tetrachlorid. Hall and Shillinger, who were the first to introduce tetrachlorethylene, state that it is apparently as good as, and perhaps slightly better than carbon tetrachlorid, for the removal of hookworms from dogs. They state also that the contra-indications from tetrachlorethylene will probably be identical with those of carbon tetrachlorid, and include distemper or other febrile diseases, mange, or other debilitating diseases, liver lesions, extreme youth or old age, and gastroenteritis, especially hemorrhagic forms.

Judging by a subsequent contribution to this problem by Schlingman, it appears that this new drug is much safer than the related drug, carbontetrachlorid.

Tetrachlorethylene has been used at the Canadian Fox Research Station with good results, and we believe further experimentation will prove that the drug will be just as efficacious and less dangerous than carbon tetrachlorid.

When the manner in which foxes live is taken into consideration, one readily sees the magnitude of the problem of hookworm eradication. From two to seven animals are housed together over long periods, and if one infested fox, continually voiding eggs, finds it way into the herd, the remaining animals very soon become involved. It is clear, then, that new animals being introduced into an unaffected ranch should be isolated until it is determined that they are free from hookworms.

The problem of hookworm diseases is largely one of sanitation, and it can best be controlled by the religious application of sanitary measures. Ordinary disinfectant solutions have their limitation, and some of them are unsuitable in preventing the spread of hookworms. The spreading of lime at intervals and digging it under after some days is very advisable. We have done this in a number of instances without noting an untoward effect on the fur. After the woodwork of pens and kennels has been thoroughly scrubbed with soap and water, the application of strong, hot coal tar creosote solution is recommended; but, where possible, the application of the actual flame should follow chemical disinfection.

In ranches where infestation has appeared, the adults should be treated and there should be a rigorous clean up of ranch equipment in the autumn before mating time. In keeping down the spread of hookworms it is necessary to have constant vigilance over the sanitation of the ranch. The double kennel system previously recommended will, we believe, go a long way towards solving the hookworm and round worm problem.

Lung Worms.—This parasite is found in the larynx, windpipe and large bronchial tubes. These worms are often found in the windpipe when there is no indication of inflammation of the lung tissue.

The parasite is very slender and about the same colour as the lining of the windpipe and is therefor difficult to see. When present the parasite is found lying in symmetrical flat coils. These worms are an inch or so long, and the female is a little larger than the male worm. The eggs, which are lemon shaped, are found constantly in the windpipe, gullet and manure.

Frequently one does not know of the presence of these worms until their eggs are demonstrated in the manure, and there is no external evidence to betray the activity of the parasite in the tissue. However, in the presence of a large number of worms, a chronic bronchitis, that simulates distemper, has been observed. An acute inflammation of the windpipe is also sometimes seen.

Because of the location of the parasite, ordinary medicinal treatment is ineffective. No successful treatment has been found for lung worm found in other species of animals.

The enforcement of strict sanitary measures is the best safeguard against the disease. All affected animals should be isolated. In ranches in which only a few foxes are infested, the animals should be carefully nursed until autumn and then pelted.

Coccidia.—These are small, one-celled parasites. They are microscopic in size, and go through a very complex life history. In a number of species of animals Coccidia produce a disease known as coccidiosis, which is due to the invasion of the cells of the intestine and other organs, liver and lungs, by the organism when it has reached certain stages of its life history.

The free types usually found on the lining of the bowel or in the manure are roundish cells with one or more denser bodies in the centre.

With our present knowledge it is impossible to state the relationship of coccidia to fox disease. They have been found in apparently normal animals, and they also have been associated with distemper-like diseases; but not constantly, even in the same outbreak. We have found them together with hookworms and other parasites and it was impossible to say which of the parasites was responsible for the death of the animals. It is quite possible that foxes become immune to the parasite, but at certain times they may overcome the animals' resistance and produce grave inflammation of the gut.

So far no satisfactory treatment has been devised for the removal of coccidia from either dogs or foxes. At the time they are causing most trouble they are lodged in the lining of the bowel, and no medicine of which we have knowledge will reach them.

Frequent cleansing and disinfection of ranch equipment is the best safeguard against the spread of the parasite. The droppings contain the parasite and this is the usual vehicle of infection.

Distemper or Influenza

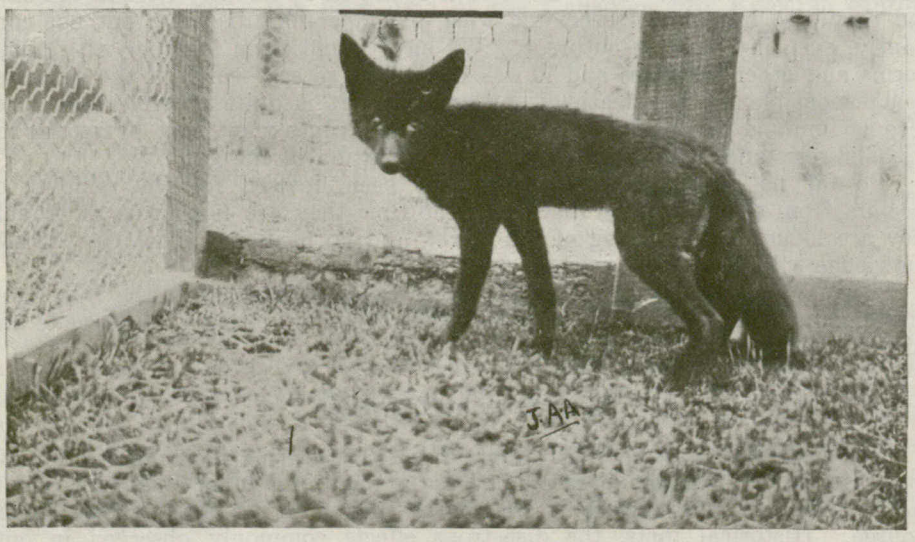
Fox distemper is a very infectious disease, appearing in a number of different forms. A similar disease appears in dogs and other members of the canine family. This disease is frequently spoken of as the greatest canine scourge. Historical facts, the disastrous effects commonly observed in outbreaks in kennels of pure-bred dogs, and our personal observations during our investigations, lead us to conclude that fox influenza is a grave potential danger to the fox-farming industry.

In Greenland and Iceland, where many dogs are kept for transportation purposes, the disease has been so disastrous since 1859, as nearly to exterminate the canine species. Nearly all European countries, too, have experienced great losses from distemper.

Cause of Distemper.—Influenza of man and the distemper of animals have given investigators and clinicians more concern than any other group of diseases. That these are transmissible germ diseases, there is no doubt but the numerous attempts to discover the specific germ has resulted in much confusion. Germs of all shapes and forms have been discovered and described and said to be the true cause of distemper. Indeed, there has been nearly as many germs found as there has been investigators.

It is not the purpose of this bulletin to go into a minute critique of the attempts to find the virus of canine distemper. Suffice it is to say that present day authorities are divided into two camps: first, those that hold that the disease is due to a germ or organism that is so small that it cannot be seen through a microscope, and can freely pass through the pores of a fine filter; second, those that attribute the disease to the presence of a germ known as the *Bacillus bronisepticus*, described independently by Ferry in America and by McGowan in England. Carre was the chief exponent of the filtrable or invisible

germ form and its relationship to distemper, and his conclusion was based upon the result of some experiments in which he passed the pus or discharges from affected animals through a fine filter, and found that the liquid that passed through the filter still harboured the virus and was still capable of producing the disease when put into healthy animals. Ferry claims that he has never been able to confirm Carre's observations and states that the germ described by him and others is indisputably the true cause of canine distemper, although numerous other germs may be found in the diseased animal. These he considers as secondary invaders after the bulwark of the animal body has been broken down by the germ *Bacillus bronisepticus*. Dr. R. G. Green has recently reported the finding of a paratyphoid-like germ in fox distemper. Until more evidence is available, judgment as to the relationship of this germ to distemper must be reserved.



Fox Distemper.

During an extensive investigation of fox distemper we have been able to discover a germ that agrees with the characteristics of the *Bacillus bronisepticus*. When germs were found and isolated by the ordinary methods of bacteriological examination, we never found the same germ constantly in all diseased foxes. The disease, however, has been reproduced by filtered material, which leads us to believe that the germ responsible for fox distemper belongs to the ultra-microscopic variety and cannot be seen or cultivated by ordinary methods.

Mortality in Fox Distemper.—When distemper invades a ranch it may be expected that the death rate will be anywhere from 20 per cent to 70 per cent. The percentage of deaths among young animals is greater than that among older animals, though adult foxes have in no sense an immunity against the disease. The mortality depends on several factors, such as the season of the year at which the animals are attacked, and whether the disease is recognized early, so that measures may be enforced to prevent the disease from spreading. The highest death rate is usually experienced during early spring and late autumn.

The Spread of Distemper.—Distemper has never become epidemic in fox ranches in Canada. The nearest thing approximating an epidemic was experienced last year when the animals in three adjoining ranches became

involved. Each ranch is in itself an isolated unit, and for that reason fox distemper never spreads over a wide area as it does in dog distemper; that is, there is not the same chance of direct contact between diseased animals. But when distemper gains entrance to a ranch it usually creates great havoc, and quickly spreads to nearly all the animals in the enclosure.

The excretions coming from infected animals contain the germs of the disease, and foxes coming in contact, either directly or indirectly with the excretions, such as manure when the bowels are involved, are apt to contract the disease. In all probability dogs, cats, rats, and birds may carry the virus of the disease from infected quarters. Very often the disease is spread more directly by caretakers carrying the infective material on their boots from pen to pen, or in handling diseased animals, and then handling other foxes or their food.

Symptoms of Distemper.—The premonitory symptoms of distemper in dogs are loss of appetite, loss of lustre of the coat, dullness, langour, and preference for warmth. These preliminary symptoms are not always noted in fox distemper. This is probably due to the high nervous temperament of the fox, and, although the animal may feel sick during the onset of the disease, it does not betray any external manifestation in the presence of observers. Indeed, this is true of other fox ailments, for, in many cases, the illness is not observed until the animal has become so exhausted that it cannot stand. According to our experience, the preliminary symptoms in distemper are not characteristic and the only indication of disorder that may be noted is disinclination to feed.

In hardly two outbreaks does one find the same train of symptoms; even in the same outbreak the symptoms may change as the outbreak advances. The first symptoms that may be evident are running from the eyes and nose, looseness of the bowels and perhaps a slight cough.

The animal will drink much water but will refuse its ordinary food, sometimes, however, meat will be eaten when all else is rejected.

As the disease advances, the matter from the nose and eyes becomes thicker, and the eye lids become matted and closed with the sticky discharge. In some cases the ears begin to run. The bowel discharge becomes more offensive, is thin or watery, and of a brownish colour. In some of the cases, the anus or vent becomes swollen. Inflammation of the mouth and tongue has been noted but it is not a constant sympton. As the disease further advances, foxes become inactive, hump their backs, and when forced to walk will do so with a staggering gait. Later the limbs become paralyzed.

During the course of the disease, foxes may have several attacks of fits; and in such cases the catarrhal symptoms are not always evidenced. When the sick animals survive for a week or so, the fur becomes loose and falls out. This is particularly noted when attempting to pelt distempered foxes, and very often in pelting, the tail is easily torn from the skin.

The course of the disease varies from a few days to several weeks. When the nervous symptoms are prominent, the sick animal usually dies in less than a week.

Post-Mortem Findings.—The changes seen in the organs after death depend on the location of the disease. If the lung tissue is chiefly involved, one or more divisions of this organ will be highly inflamed and consolidated, giving an appearance of a piece of liver; or the lobes may be still solid but of a greyish colour. When the lung tissue is cut with a knife, pus will ooze out of the incision, but this depends on the stage the disease has reached at the time of death. Frequently the inflammation extends up the windpipe to the "voice box," and more rarely the mouth and tongue show intense redness. The kidneys are sometimes inflamed, but may appear of a lighter colour than normal.

If the stomach and intestines are attacked, the whole intestinal tube may be inflamed throughout its entire length, or only strips of bowel may show

intense redness. At these inflammatory areas, the bowel is usually contracted so that the intestinal tube is narrowed. The stomach is usually free of partly digested food and its walls are lined with stringy mucous. The bowel contents are usually stained with blood. The lymph glands of the intestine, in such cases, are swollen and hemorrhagic; and the spleen may be greatly enlarged.

In outbreaks some of the animals may die suddenly without showing any of the characteristic symptoms, and in these cases it is sometimes difficult to observe any naked eye changes in the organs.

Treatment of Distemper.—There is no specific treatment for fox distemper; the symptoms can only be treated as they appear, and this is essentially the work of a competent veterinary surgeon. There is no fox disease in which amateur treatment may lead to so disastrous results as in distemper. It is for this reason that we hesitate in giving any more than a general outline of treatment. Medicines that may be indicated in the treatment of one patient is not necessarily applicable to other cases.

It is necessary to pay strict attention to the hygienic conditions of the sick quarters. It is futile to try and treat affected animals and keep them in open pens. Animals affected with pneumonia cannot be expected to recover when kept in cold, damp pens any more than a person with pneumonia can be expected to recover when left lying on the roadway. The sick animals should be removed to a warm, well ventilated building. Strict attention should be given to the diet; only concentrated foods like milk and eggs, meat broth, and gruel should be fed. Meat should be fed sparingly, and, if given at all, should be finely chopped.

The medicinal treatment consists in part in stimulating the animal. A little whiskey, brandy or sweet spirits of nitre (10 to 15 drops every two hours) may sometimes be given to advantage. To combat general weakness, 15 or 20 minims of a mixture, consisting of one part of camphor and four parts of olive oil may be injected under the skin with beneficial results. In repeating the dose a different point of the skin should be selected for each injection.

When diarrhœa is present, the lower bowel should be frequently washed out with injections of warm water and castile soap, and either bismuth subcarbonate or bismuth subnitrate should be given by the mouth, in doses of not more than 10 grains.

The eyes are best treated by washing them with boric acid solution, followed by the installation of a few drops of solution consisting of one grain of sulphate of zinc and one ounce of rose water; or a few drops of a 10 per cent solution of argyrol may be used.

Serums and Vaccines in Distemper

A number of different serums, bacterins and vaccines have been tried in the treatment of fox distemper without obtaining results that would justify their recommendation. So far this mode of treatment for fox distemper is in the experimental stage, and it is impossible to say what the outcome of further experimentation will be.

Control of Distemper.—At best the treatment of fox distemper is a difficult task, and in spite of all treatment discouraging results are often experienced. For the present, the greatest hope lies in strict attention being given to hygienic practice, and to the adoption of methods that will tend to prevent the dissemination of the disease. The early recognition of the disease is the greatest factor in controlling an outbreak. If the first one or two animals that contract the disease are destroyed or quickly segregated, the pens and equipment thoroughly disinfected, and other principles of sanitation enforced, the disease is kept at a minimum. It has been our experience that fox-keepers do not

recognize the seriousness of the disease until nearly every animal in the ranch becomes infected. Then it is too late to attempt preventive measures, and the disease must run its course. Naturally, it is in such cases that the highest mortality is experienced.

During an outbreak a special attendant must be furnished for the sick and exposed animals. He should be furnished with rubber boots and a rubber gown, which can be disinfected in a strong solution. There should be no contact between the staff of the ranch and the men on the infected area. The pens on the ranch should be thoroughly disinfected, locked, and kept closed for as long a period as possible. All cats and dogs and other small animals on the ranch should be destroyed in order that they may not carry the infection.

The precautionary measures to be observed in keeping a ranch free from the disease lie in preventing as far as possible the introduction of diseased animals, and preventing indirect contact with infected material. All new stock should be isolated for at least thirty days before it is allowed to mingle with foxes already in the ranch. Animals sent to shows should also be isolated before they are put back in the herd. This is advisable because it sometimes takes an animal three weeks or longer after exposure to develop distemper.

Big Head

Big Head is the name given by practical fox ranchers to a disease which is characterized by the marked swelling of the head and sometimes the neck. It is, generally speaking, a disease of young animals, resulting from tooth infection, during the teething period. According to our observation it occurs most frequently in pups between the age of three and three and one-half months, the time at which they are shedding their milk teeth. The same disease, however, has been produced in older animals as the result of cutting off the crowns of the canine teeth or tusks as they are commonly called to prevent vicious foxes from killing each other. Big Head is not contagious, but a number of cases may occur simultaneously on the same ranch. Some years the disease is more prevalent than in others.

Big Head is primarily a tooth infection. The germs gain entrance through the tooth cavity. The infection frequently spreads to the flesh of the head and neck, and often terminates in general blood poisoning. When this occurs, the germs become so virulent that a few drops of the heart's blood taken immediately after death from an infected fox will cause death inside of twenty-four hours when injected into rabbits.

In nearly every case we found that the primary point of infection was in the vicinity of either the upper or lower third premolar tooth. There was usually a track between that tooth and the outside of the bone forming the tooth cavity, but the tooth cavity itself was not always involved. If a probe were introduced into this track or fistula, when the upper side of the jaw was affected, it could be pushed up almost to the eye cavity.

The chief symptom noted is the enlargement of the head, which in some cases becomes twice the normal size. The lips and tissue of the inside of the mouth are much swollen, and if the swollen parts are pressed with the finger nail the impression remains for a long time. These swellings may become so large in severe cases that the animal cannot close its mouth. When the disease has advanced, a rusty-coloured fluid runs continuously from the eyes and nose. The eyelids become so swollen that the animal cannot keep its eyes open. The lining membrane which covers the lids, the conjunctiva, becomes filled with fluid and causes a bladder-like protrusion. If this swollen membrane is pricked with a needle, the fluid matter contained therein will ooze out. Usually there is very little pus to be found in any part of the affected tissue.

In the early stages of the disease, the treatment consists in extracting the teeth in the vicinity of the infected cavity, and syringing out the track to remove the accumulated infective material. Good results have been obtained in some early cases by swabbing the cavity with tincture of iodine and applying stimulating liniments to the swollen parts. After the disease has advanced and the germs have reached the blood stream, treatment is very discouraging, and a large percentage of the affected animals die.

A case of "Big Head."

We have tried a few experiments in some ranches in which the disease appeared more or less frequently, and these experiments indicate that vaccines prepared from the germs found in infected animals have some value in protecting pups against infection.

The disease has been controlled in Prince Edward Island by feeding cooked food to pups at teething time. When such practice is followed a case of big head is rarely seen.

SECTION II

NUTRITION AND FEEDING OF FOXES IN CAPTIVITY

By G. Ennis Smith

Nutritionist; Geneticist and Superintendent, Experimental Fox Ranch, Summerside, P.E.I.

DIGESTION AND METABOLISM

The food is introduced into the animal system through the alimentary canal. The digestive ferments, which are secreted into the mouth, stomach and intestines, convert the food into such a condition that it can be absorbed into the circulatory system of the body. The undigested residues of the fool material are eliminated in the solid excrement or feces. The ratio of the amount of food which passes into the circulatory system to the amount of total food material intake gives the proportion of food digested or the digestibility co-efficient.

The food is transported by the circulatory system to the individual cells, in which it is broken down and reformed into new compounds to repair the old cells or to form new cells or to produce heat and other form of energy. The residues of these processes are expelled into the circulatory system and eventually excreted from the body by the lungs and the kidneys. The minute individual active cells must be considered as the only actual consumers of the food and the sum of the chemical changes of the food material under the influence of the living cells is known as metabolism.

Food Supply

The animal cells are entirely dependent on the vegetable cells for their supply of food, if not always directly at least through animals which have accumulated a supply of food material, that has been elaborated in the first place by vegetable cells. Vegetable cells have the power to build all the materials, which they require for their construction and maintenance, from the elementary substances of the atmosphere and soil, with the aid of the heat from the sun which they are capable of utilizing. On the other hand animal cells can only liberate energy and the building units, which they require, from highly complex compounds. Animal cells have the power to form compounds similar to those of which they are composed, but to a limited extent, as they can only function when highly complex food materials and accessories are supplied.

Functions of the Food

The main functions of the food are:—

(1) To supply fuel to be the source of the body heat and of the energy which is exerted during the various activities of the animal.
(2) To furnish the building materials to make good the wear and tear of the body tissues and for the formation of new tissues.
(3) To supply the body-regulating substances which enable the body to grow and prevent disorders arising in the mechanism of the system.

These requirements should be met by a palatable mixture of food materials arranged together in such proportions as to burden the animal system with the minimum amount of labour.

An ideal food fuel is one which can be completely burnt by animal cells leaving no solid residues, the final products of the combustion being water and gaseous compounds which can be eliminated without any strain on the system. The continued combustion of excessive quantities of digested food materials which leave a large percentage of solid residues will eventually give rise to serious disorders.

As the animal cells cannot produce the building units, which they require, the food supply should furnish the various building units in a fairly well balanced proportion.

The mechanism of the animal body is a system of a multitude of compensating actions, and a disorder arising in any one of them would be liable to cause a disturbance in the whole system. A mechanical engine will neither run smoothly nor keep in order without a continued supply of lubricants. Though little is known of the mechanism of metabolism, it has been well established that grave disorders will arise without a continued supply of body-regulating substances as food accessories.

Constituents of the Food

For convenience, food materials are generally divided into the following groups:—

(1) Carbohydrates.
(2) Fats.
(3) Proteins.
(4) Mineral compounds.
(5) Vitamins or food accessories.

Carbohydrates.—The principal carbohydrates are starches, sugars, and cellulose. Starches and sugars under favourable conditions are completely digested. On the other hand cellulose of which the walls of vegetable cells are mainly constructed, has a low digestibility co-efficient, practically only the cellulose of young vegetable cells being digestible. As the vegetable cells mature the walls become lignified and otherwise modified which renders the cellulose impervious to the digestive juices. The digestible carbohydrates taken with the food are acted upon, first by ptyalin of the saliva and afterwards by amylase and other ferments of the intestines, and are finally converted into simple sugars, in which state they are absorbed into the blood. In the system they are either converted into fat or glycogen—the latter to only a very small extent—as a reserve supply of fuel or are broken down and burnt in the cells for the production of heat and other forms of energy. The final products of the combustion are carbon dioxide and water. The carbon dioxide is eliminated by the lungs and the water by evaporation at exposed surfaces or during urination.

While sugars are very digestible, it would not be advisable to feed them in large quantities as concentrated solutions of sugars attack the mucous lining of the alimentary canal. Continued ingestion of quantities of sugar promote diarrhœa and other intestinal disturbances. Although starch, during digestion, is all eventually converted into sugar, the sugar is absorbed into the blood immediately after it is formed. Under that condition only dilute solutions occur in the intestines and relatively large quantities of starch can be fed without promoting intestinal disturbances.

From an economic standpoint both as regards the cost of the food and the conserving of the energy of the animal system, the food materials should have a relatively high digestibility co-efficient. On the other hand indigestible constituents of the food often have a beneficial scouring effect and promote a healthy condition in the intestines. Large quantities of bran and roughage having a low

digestibility coefficient, can be fed to domestic animals with favourable results. But it is advisable that the scouring effect should be induced with suitable indigestible constituents rather than with undigested digestible food material.

Sugars are present in the cell sap of different parts of various plants and it is probably in the form of sugar that most of the food supply is transported to different parts of the plant.

The seeds of cereals and the tubers of some plants, principally the potato, are the important sources of starch, 60 to 70 per cent being present in most cereals and about 17 per cent in raw potatoes. The starch granules are enclosed in cells, the walls being constructed of cellulose. When the cereals are cooked or heated, the starch granules expand and burst the cell walls. If the cereals were eaten before being well cooked the cells walls would have to be partly digested before the starch could be attacked and a large percentage might escape digestion. It is advisable that cereals should be finely ground and well cooked, in order to have favourable conditions for their digestion.

Fats.—The digestibility of fats varies from less than one-third to the full amount according to the particular fat and the manner in which it is fed. Natural fats are converted by the combined action of the bile and pancreatic juice into glycerine and fatty acids, in which state they pass into the circulatory system and then are immediately re-united to form natural fats. They are then conveyed either to the active cells and broken down and burnt or to the cells of the adipose tissue where they are held as a reserve store of energy. The most conspicuous use of the fat of the body is to act as a reserve fund of fuel. Fats can store over ten times more available energy than any other constituent of the body in the same volume. The final products of the combustion of fats are carbon dioxide and water which can easily be eliminated.

Fats are generally grouped as vegetable, animal and milk fats. In general, seeds and their by-products, contain more fats than any other parts of the plant. Animal and milk fats are the most edible. Natural fats are important constituents of the food as they invariably carry the growth-promoting vitamin.

Proteins.—Proteins are the most important constituents of all living cells, and are the flesh forming compounds. They are often designated as the nitrogenous compounds. Natural proteins are highly complex compounds and are composed of amino acids, the principal building units required by animal cells. Up to the present time eighteen different animo acids have been found to occur in natural proteins. Each protein molecule contains a large number of many different amino acids. Some proteins contain nearly all the amino acids required by the different cells of the body, and are designated as proteins of a high biological value. While in other proteins many of the amino acids are absent. These are designated as proteins of a low biological value. The proteins of meat, fish, milk and rice have a high biological value; those of peas, beans, corn and wheat flour a low biological value. When several different proteins having a low biological value are fed simultaneously, they may then have a high biological value. In general a great variety of the different proteins fed simultaneously will enhance the biological value of the whole protein content of the food.

Proteins are very digestible and it can be assumed, under normal conditions, that the digestion will be complete. The proteins are first attacked by the pepsin of the stomach which partly breaks them down. After the food passes into the intestines, the proteins are completely broken down by trypsin to amino acids and are then absorbed into the circulatory system. The amino acids are the building units which are used for the construction of the cells. They are sorted out by the cells and bound together in a specific order to produce the particular protein that is required by the cell. The animal cells are able to convert parts of some of the amino acids into sugar, and finally into fat. The residues and the excess of the amino acids are burnt by the cells for the produc-

tion of heat and other forms of energy. The final products of the combustion are carbon dioxide, water, urea, and small quantities of other compounds which vary under different conditions. Urea is a solid residue and the amount in the final products of combustion of protein by the animal cell is more than 30 per cent of the protein digested. This large residue is eliminated entirely by the kidneys and excessive quantities over a continued period will eventually produce grave disorders in their functions. An entire meat diet or excess of proteins in the food of human beings eventually produces an inflammatory condition of the kidneys, sometimes called Brights Disease. Postmortem examinations of foxes show that a large percentage of them have inflammatory conditions of the kidneys probably brought on by excessive quantities of meat in the diet.

Meat is the most concentrated protein food. Fish and eggs are mostly composed of proteins with varying amounts of fat. Milk contains favourable quantities of desirable proteins. The protein content of cereals varies from 8 to 16 per cent according to the variety.

Mineral Compounds.—Mineral compounds are essential constituents of the food as they are necessary building materials required for the construction of the animal cell. Lime is required for the bone cells; iron for the blood cells; potassium and magnesium for the flesh cells; salt for the blood plasma; phosphorous for bone and flesh cells; iodine for the thyroid, and small quantities of many other mineral compounds for the different cells. All these minerals are being eliminated continually from the body with the waste products resulting from the wear and tear of the body cells, and the supply must be continually replenished.

Only small quantities of soluble mineral compounds may be placed in the food as excessive quantities would produce diarrhœa. Insoluble mineral compounds are converted by different secretions into soluble compounds in which state they are absorbed into the blood. They are carried to different parts of the body where they are utilized, or perhaps to some extent, stored as a reserve supply. It is claimed that the skin acts as a storehouse for salt. The mineral compounds resulting from destroyed flesh and bone tissues are apparently eliminated partly by the kidneys, but probably under normal conditions the greater part of the excess and waste mineral constituents is secreted into the intestines.

The water supply is an important source of the mineral requirements of the majority of animals. If snow, which is devoid of mineral matter, constitutes the water supply of the animal during winter, a mineral deficiency would result if not counteracted. Milk would help to make good any mineral deficiency if fed in sufficient quantities. Bonemeal would always insure a supply of lime and phosphorous. Of the cereals rolled oats and legumes have favourable mineral contents.

Body Regulating Substances.—The food mixture should be palatable as this influences the secretion of the digestive juices. The food should also have fairly laxative effects in order to keep the intestines in a healthy condition. But the most important body-regulating substances are the food accessories, the so-called vitamins. The influences of three of them have been identified and studied.

Vitamin A, the fat-soluble, growth-promoting food accessory.

Vitamin B, the water-soluble, anti-neuritic food accessory.

Vitamin C, the anti-scorbutic element.

While the different vitamins sometimes occur together in the same food material, their functions are separate and distinct. The food mixture may have desirable qualities regarding fuel value, protein and mineral content and presence of Vitamin B and Vitamin C, but despite these conditions if Vitamin A were absent from the food of young animals, growth would not take place. In the absence of Vitamin B. the general nourishment of body and nervous system

breaks down and the animals lose control of some limbs. The absence of Vitamin C in the diet of human beings causes scurvy. The vitamins must be continually supplied in the food. The lack of vitamins in the food forces the animal to get these substances from its own tissues. The result is an enormous loss of weight. After this available stock begins to be scarce there is consequent breaking down of body and nerve tissues with the result that symptoms, such as observed in deficiency diseases, manifest themselves.

Vitamins are found very generally in animal and vegetable tissues, but they are probably all of vegetable origin. The vitamin content of fleshy foods is influenced by the diet of the animal previous to slaughtering by the type or species of animal, by the type of tissue used as food and by the method of the food treatment. Milk obtained from cows fed on dried hay and straw has very small quantities of vitamins in comparison with that obtained from cows on fresh pastures. Offals are richer in vitamins than the meat. While vitamins are fairly resistant to heat and drying, yet prolonged heating and improper methods of drying the food will destroy the greater part of the vitamin content.

VITAMIN CONTENTS OF COMMON FOODSTUFFS

—	Vitamin A Fat-soluble	Vitamin B Water-soluble	Vitamin C Anti-scorbutic
Oats		++	
Oatmeal	0	+	
Barley		++	
Barley flour		0	
Wheat, bran		++	
Wheat, germinated	0	+++	
Wheat, bread		0	
Rice		++	
Rice, polished	0	0	
Corn, yellow		+++	
Corn meal		+	
Clover, dried	+++	++	
Alfalfa, dried	+++	++	
Peas		+++	
Cabbage, raw	+	++	+++
Cabbage, cooked			
Potato, cooked	++	++	++
Turnips, Swede		++	+++
Beet root		++	0
Tomato, raw	++	++	+++
Onions, raw		++	++
Spinach, dried	+++	++	
Oranges		++	++++
Lemons		++	++++
Apples		+	
Malt		++	++
Yeast, bakers'		++	
Yeast, brewers'		++++	0
Milk, raw	+	+	+
Butter	+++		
Eggs	++	++	
Meat, lean, raw		+	
Liver, beef		+++	+
Heart, beef		+++	
Heart, pork	++	++	
Kidney, pork	++	++	
Liver, pork	++	++	
Brains, pork		+++	
Fat, pork	+	0	
Fat, beef	+		
Fish		+	
Cod liver oil	++++		

In the table a single plus sign denotes that the respective vitamin is present only in traces: four plus signs, in relatively large quantities. Zero denotes that experimental evidence indicates that the respective vitamin is absent. Where blank spaces occur there is no available experimental evidence regarding the respective vitamin content of the foodstuff.

Deficiency Diseases

Beriberi.—This disease is very prevalent in Asiatic countries where the food of some of the inhabitants consists almost entirely of rice. Symptoms: Loss of weight, prostration, palpitation of the heart and unsteadiness after exertion, paralysis of the limbs with contraction of the muscles.

The diseases has been produced experimentally in a wide range of animals by feeding a diet consisting solely of polished rice or similarly deficient diets, and the evidence indicates that the majority of animals would be susceptible. The disease results from the absence of Vitamin B, the water-soluble food accessory, from the food. Complete recovery follows the addition of the vitamin to the diet, except after long duration of the disease. Paralysis in cases of short duration is relieved in a few hours after the vitamin is administered.

Scurvy.—The disease is prevalent on board ships during long voyages, in European prisons, and during war in prison camps and besieged cities, Symptons: Peculiar paleness of the skin which becomes dry and scaly, apathy, melancholy, muscle weakness, large livid spots due to subcutaneous hemorrhages and eruptions especially on the lower extremities.

The disease results from the absence in the diet of Vitamin C, which is present in fresh vegetables and fruits (see table, page 32). The addition of this vitamin to the diet completely counteracts the condition, for which reason it has been designated as the anti-scorbutic element.

Rickets.—Rickets is primarily a disease of the bones, although it must be regarded as a general disturbance of metabolism.

Rickets has been very prevalent recently in Central Europe, due, supposedly, to the scarcity of milk, butter, and eggs. It is stated that over 90 per cent of the children born in Vienna after 1917 suffered from rickets. A large percentage of these cases appear to have been congenital; undoubtedly a pregnant animal fed a diet devoid of vitamins would be extremely liable to produce rachitic offspring. Some authorities claim that rickets results from the absence in the diet of Vitamin A, the growth-producing food accessory, and they have designated this substance as the anti-rachitic vitamin, because cod liver oil always appears to correct the condition. On the other hand, many authorities claim that the disease may arise from different causes.

The following preventive methods should be adopted with young animals susceptible to rickets:—

(1) Avoid keeping them on damp low ground.
(2) Place them where they may get plenty of direct sunlight.
(3) Avoid a diet composed chiefly of starchy materials.
(4) Feed a diet containing sufficient proteins and fats.
(5) Insure an abundant supply in the food of lime, phosphates, and vitamins, more especially Vitamin A, the fat-soluble, growth-promoting food accessory.

Previously it has been considered that only young animals contracted this disease, but evidence obtained in European countries since 1914 indicates that individuals of all ages are susceptible to rickets.

Pellagra.—This is a non-contagious disease of corn-eating populations, and is prevalent in northern Italy, Roumania, and North America. Symptoms: Characteristic eruptions of the skin, diarrhœa and other intestinal disturbances, degeneration of the nervous system.

The following are now claimed by some to be contributing factors to the disease:—

(1) Partial lack of vitamins.
(2) Lack of proteins of a high biological value.
(3 Lack of a still-unknown vitamin.
(4) The combined influence of all the above factors.

Kallak.—This disease occurs among the Eskimos of Newfoundland and consists of marked eruptions on the hands, elbows, and other parts of the body, with persistent itching. The disease is usually curable and makes its appearance when only a small quantity of seal meat is available.

Fetal Athyrosis, or Hairlessnees and Goitre in New-Born Animals.—This disease is very prevalent among new-born domestic animals, especially pigs and sheep, which are born hairless and very often dead.

The marked characteristics of the disease are the hairless condition of the skin of the new-born animals, and the enlargement of the thyroid. The disease has a pronounced congenital influence, especially when the gestation period is during the winter months.

The disease results from a deficiency of iodine in food and water of pregnant animals, and can be completely counteracted by adding a small quantity of potassium iodine to the diet throughout the gestation period.

Calorific Value of Foods

Rations are defined in terms of their fuel value because it is the most accurate means of showing the relative value of the different varieties of food for maintenance purposes and because practically all the food with an adult animal is used eventually for producing heat and other forms of energy. It has been pointed out that some food materials are capable of functioning both as building units and as heat producers. In general, the amount of heat evolved by the combustion of any such food material would be identical with the total heat evolved during the successive chemical changes of the materials in the cell construction and degeneration. So whether the food material be used for cell formation or otherwise, it will have practically the same fuel value. Fuel values are expressed in terms of calories. A calorie is the amount of heat which is required to raise the temperature of one thousand grams of water one degree centigrade.

APPROXIMATE FOOD FUEL VALUE OF SOME CONSTITUENTS OF THE DIET OF A RANCH FOX

		Calories
1 pint	Milk	390
1 lb.	Beef tripe	450
1 lb.	Fat tripe	600
1 lb.	Beef heart	450
1 lb.	Fat beef heart	550
1 lb.	Shank beef	450
1 lb.	Fat beef	650
1 lb.	Beef liver	650
1 lb.	Lamb heart	850
1 lb.	Lamb lights	450
1 lb.	Lamb liver	750
1 lb.	Lamb liver, slightly cooked	850
1 lb.	Haddock	165
1 lb.	Smelts	230
1 lb.	Herring	375
4 oz.	Rice	400
4 oz.	Whole wheat flour	400
4 oz.	Corn meal	400
4 oz.	Rolled oats	400
4 oz.	Fox biscuits	400
2 oz.	Cod liver oil	500
2 oz.	Beef suet	450
1	Egg	65 to 85

Maintenance Ration

The maintenance ration is the minimum amount of food required to maintain the body weight. This, of course, would vary according to the activity of the animal. With animals of the same variety the maintenance requirements would vary with the size of the animal, also with the proportion of the weight of the animal to the exposed areas. A long and rangy animal will have a greater requirement than a short plump animal of the same weight.

The Daily Food Requirements of a Ranch Fox

It has been found, in our investigations with adult foxes, that the most desirable results were obtained when the foxes were fed daily rations which were only 5 to 10 per cent in excess of a maintenance ration. The foxes were then more active and alert, their health and condition were more satisfactory, the gain of weight in the fall was quite as great as when the foxes were fed larger amounts, and they maintained their body weight throughout the winter quite as well. All our results tend to indicate that continued over-feeding should be avoided, and that, as far as mere quantity goes, the most suitable daily ration for a ranch fox is just a little in excess of a maintenance ration. There is, as far as our investigations go, only one period when it would be advisable to feed large quantities, that is during the lactation period, when the female is giving suck to her young.

The daily ration of a ranch fox should provide the following number of calories according to the respective size of the fox:—

Weight of Fox	Body length of Fox	Fuel value of daily ration
9 lbs.	24 inches	410
10 "	25 "	450
11 "	26 "	490
12 "	27 "	530

The above standards are based on the minimum weight of the foxes.

An outline of daily rations for adult foxes based on the fuel value of the food and the food requirements of a fox is given below. For practical purposes the foxes have been grouped according to their size, whether they are small, medium sized, large or very large foxes. While it is very improbable that there is any one factor that would determine the comparative size of the fox, yet in grouping the foxes the chief factor that has been relied upon for determining the size of the fox in the experimental work has been the body length of the fox; that is the measurement from the end of the snout to the base of the tail. For feeding purposes foxes with body length of 24, 25, 26 and 27 inches may be considered as small, medium sized, large and very large foxes respectively.

AN OULTINE OF DAILY RATIONS FOR TWENTY ADULT FOXES

FROM JAN. 15TH TO FOUR WEEKS AFTER MATING

—	Small Foxes	Medium Foxes	Large Foxes or Pups	Very Large Foxes or Large Pups
Biscuits or *Cereals, cooked	15 ozs.	17 oz.	20 ozs.	22 ozs.
Meat	5½ lbs.	5½ lbs.	6½ lbs.	7 lbs.
Cod Liver Oil	9 ozs.	10 ozs.	11 ozs.	12 ozs.
FOUR WEEKS AFTER MATING UNTIL FEMALES WHELP				
Biscuits or *Cereals, cooked	36 ozs.	40 oz.	44 ozs.	48 ozs.
Meat	4½ lbs.	5 lbs.	5½ lbs.	6 lbs.
Milk	4½ pts.	5 pts.	5½ pts.	6 pts.
JUNE 1ST TO SEPTEMBER 1ST				
*Cereals, cooked	40 ozs.	44 ozs.	48 ozs.	52 ozs.
Meat	3½ lbs.	4 lbs.	4½ lbs.	4½ lbs.
Milk	4½ pts.	5 pts.	5½ pts.	6 pts.
SEPTEMBER 1ST TO JANUARY 1ST				
*Cereals, cooked	20 ozs.	22 ozs.	24 ozs.	26 ozs.
Meat	5¼ lbs.	5½ lbs.	6½ lbs.	7 lbs.
Milk	4½ pts.	5 pts.	5½ pts.	6 pts.
Beef suet	6 ozs.	6½ ozs.	7 ozs.	8 ozs.

* Dry weight of Cereals before any water has been added.

Foxes raised in the Experimental Ranch that have been fed rigidly according to the outline given above have developed and retained good fur and breeding qualities. While the results have been satisfactory, yet the evidence would indicate that it may be necessary to make modifications. The whole question is at present being investigated and the evidence obtained in the experimental work will be given out from time to time.

Food Requirements of the Breeding Season

During the gestation period there is a great increase in the activity of the protein metabolism which is mobilizing the amino acids, or building units, for the development of the fetus which is carried out at the expense of the maternal protein tissue, at least, for the first part of the gestation period. On this

account it might be thought that there should be a great increase in the protein content of the food. But it must be remembered that the task of mobilizing all the resources of the maternal system to ensure the development of the fetus has already greatly increased the protein metabolism, and to still further burden it with the task of producing heat and other forms of energy would probably give rise to grave disorders in the system which might, in turn, affect the development of the fetus. It is far more advisable to reduce the protein content of the food to the lowest possible level, compatible with the proper development of the fetus by a judicious selection of a wide variety of favourable proteins.

It has already been pointed out that a pregnant animal fed a diet devoid of vitamins would be extremely liable to produce rachitic offspring. Every precaution should be taken to ensure a sufficient supply of vitamins during this period.

It has been found that the total metabolism does not increase except for a short period just before parturition. Therefore, one should avoid feeding large quantities. The most favourable results in our experimental work have been obtained with rations only 5 to 10 per cent in excess of a maintenance ration. The foxes maintained a bright and healthy appearance. The increase in size of the females due to pregnancy was very great, and there was favourable development of milk glands.

Food Requirements During the Period of Growth

The average pup at birth weighs about 3 ounces. At the end of four weeks it should weigh about 1½ pounds. With a litter containing four pups there should be a total gain of approximately 5 pounds, all of which must be sustained by the maternal organism; and there will be a still greater requirement to meet the maintenance requirements of the litter. To cope with this heavy drain upon the mother's resources it is imperative that there should be a great increase in the daily rations.

During the lactation period the total food requirements will vary according to the size of the litter. An outline of daily rations for vixens with three, four and five pups respectively is given herewith.

DAILY RATIONS DURING LACTATION PERIOD

VIXEN AND THREE PUPS

——	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week
Morning Meal—							
Milk	¼ pint	¼ pint	¼ pint	¼ pint	¼ pint	½ pint	½ pint
Meat, ground	.....	.....	4 ozs.	4 ozs.	.....	.....	.....
*Cereals, cooked	1 oz.	1 oz.	1 oz.	1 oz.	1 oz.	2 ozs.	2 ozs.
Cod Liver Oil	.....	.....	.....	.....	.....	.....	½ oz.
Noon Meal—							
Milk	¼ pint	¼ pint	¼ pint	¼ pint	¼ pint	¼ pint	¼ pint
Bread	2 ozs.	2 ozs.	2 ozs.	2 ozs.	2 ozs.	2 ozs.	2 ozs.
Eggs	1	1	1	1	1	1	1
Evening Meal—							
Milk	.....	.....	¼ pint	¼ pint	¼ pint	¼ pint	½ pint
Meat, ground	4 ozs.	8 ozs.	4 ozs.	4 ozs.	4 ozs.	4 ozs.	4 ozs.
*Cereals, cooked	.....	.....	1 oz.	1 oz.	1 oz.	1 oz.	2 ozs.

VIXEN AND FOUR PUPS

—	1st Week	2nd Week	3rd Week	4th Week	5th Week	6th Week	7th Week
Morning Meal—							
Milk	¼ pint	¼ pint	¼ pint	½ pint	½ pint	½ pint	½ pint
Meat, ground	.....	.....	4 ozs.	4 ozs.	.....	.....	4 ozs.
*Cereals, cooked	1 oz.	1 oz.	1 oz.	2 ozs.	2 ozs.	2 ozs.	2 ozs.
Cod Liver Oil	.....	.....	.....	.....	½ oz.	½ oz.	½ oz.
Noon Meal—							
Milk	¼ pint	¼ pint	¼ pint	¼ pint	¼ pint	½ pint	½ pint
Bread	2 ozs.	2 ozs.	2 ozs.	2 ozs.	2 ozs.	4 ozs.	4 ozs.
Eggs	1	1	1	1	1	2	2
Evening Meal—							
Milk	.....	.....	¼ pint	¼ pint	¼ pint	¼ pint	½ pint
Meat, ground	6 ozs.	8 ozs.	4 ozs.	4 ozs.	4 ozs.	4 ozs.	4 ozs.
*Cereals, cooked	.....	.....	1 oz.	1 oz.	1 oz.	1 oz.	2 ozs.

VIXEN AND FIVE PUPS

Morning Meal—							
Milk	¼ pint	¼ pint	¼ pint	¼ pint	½ pint	½ pint	½ pint
Meat, ground	4 ozs.	4 ozs.	4 ozs.	4 ozs.	.....	4 ozs.	4 ozs.
*Cereals, cooked	1 oz.	1 oz.	1 oz.	1 oz.	2 ozs.	2 oz.	2 ozs.
Cod Liver Oil	.....	.....	.....	.....	½ oz.	½ oz.	½ oz.
Noon Meal—							
Milk	¼ pint	¼ pint	½ pint	½ pint	½ pint	½ pint	½ pint
Bread	2 ozs.	2 ozs.	4 ozs.	4 ozs.	4 ozs.	4 ozs.	4 ozs.
Eggs	1	1	2	2	2	2	2
Evening Meal—							
Milk	.....	¼ pint	¼ pint	¼ pint	¼ pint	½ pint	½ pint
Meat, ground	4 ozs.	4 ozs.	4 ozs.	4 ozs.	4 ozs.	4 ozs.	4 ozs.
*Cereals, cooked	.....	1 oz.	1 oz.	1 oz.	1 oz.	2 ozs.	2 ozs.

* Dry weight of Cereals before any water has been added.

When the pups are four weeks old it is the custom to eliminate meat from the diet as the female begins about that time to carry the meat to the pups. The rations then generally consists entirely of cereals and milk. Such a ration causes the feces to become very bulky. Cod liver oil and eggs could, with advantage, be introduced into the diets.

When the pups are about eight weeks old, if possible, they should be separated from their mother. To obtain a normal growth of the pups and to avoid an onset of rickets precautions should be taken to prevent the following irregularities in the rations; a too-restricted diet, a farinaceous diet, protein or fat deficiency, a lime deficiency, a lack of food accessories. To counteract a restricted diet, the rations should be varied as much as possible and had better not be restricted to one cereal. Rice, whole wheat, flour, rolled oats and corn meal may all be fed either collectively or separately. A farinaceous diet and protein or fat deficiency will be avoided if sufficient milk, a little meat, cod liver oil and eggs be included in the rations. To insure a supply of lime, bone meal or edible tankage should be added to the porridge. Lime water is of no value for offsetting a lime deficiency. The inclusion of milk and eggs would ensure a supply of the fat soluble food accessory, but there is still a possibility that there may be a deficiency of the water soluble food accessory. The addition of yeast would counteract that deficiency.

Below, an outline is given of the rations with which we have successfully raised in the experimental ranch fox pups that have shown no signs of rickets and have maintained uniform growth and a good development of fur with very desirable qualities regarding colour.

DAILY RATIONS FOR TWENTY PUPS

——	2 months old	2½ months old	3 months old	4 months old	5 months old	From October 1st to January 1st
Morning Meal—						
Milk	1½ pints	1½ pints	3 pints	3 pints	3 pints	6 pints
*Cereals, cooked	10 ozs.	10 ozs.	20 ozs.	20 ozs.	20 ozs.	2 lbs.
Meat, ground	10 ozs.	20 ozs.	40 ozs.	60 ozs.	60 ozs.	.....
Beef suet	.....	.....	.....	.....	.....	8 oz.
Noon Meal—						
Milk	2½ pints	2¼ pints	2½ pints	2½ pints	2½ pints	.....
Bread	1¼ lbs.	1¼ lbs.	1¼ lbs.	1¼ lbs.	1¼ lbs.	.....
Eggs	10	10	10	10	10	.....
Erening Meal—						
Milk	1½ pints	1½ pints	1½ pints	3 pints	3 pints	.....
*Cereals, cooked	10 ozs.	10 ozs.	10 ozs.	20 ozs.	20 ozs.	.....
Meat, ground	10 ozs.	20 ozs.	40 ozs.	60 ozs.	60 ozs.	7 lbs.

* Dry weight of Cereals before any water has been added.

Dietary Deficiencies during Winter

During winter there appears to be a pronounced mineral deficiency in the diet of the average ranch fox. There are several factors that contribute to this deficiency. The water supply is an important source of the mineral requirements of the majority of animals. Snow, which is devoid of mineral matter, constitutes the water supply of the ranch fox during the winter. The mineral content of meat, which very often composes the whole diet, is extremely low, and the majority of the fox biscuits on the market are notably deficient in mineral matter. The winter diet also appears to be deficient in cereals, fat and food accessories.

The vixen's milk is extremely rich in fat. If this biological fact is any evidence of the requirements of the animal, then the diet of the fox should contain relatively large amounts of fats and oils, if not with the adult fox at least with the young pup.

The use of milk and a suitable fox biscuit during winter would tend to counteract some of the dietary deficiencies. Such a biscuit might advantageously contain several cereals, such as whole wheat flour, rolled oats, rice flour, corn meal, etc., but it is advisable that they should be ground to a fine powder before being introduced into the biscuit. It should contain also 8 to 10 per cent of fat, cod liver oil being preferable, and at least 8 to 10 per cent of edible tankage or bone meal.

What is said with regard to fox biscuits will apply also to the porridge used during the summer for feeding adult foxes and pups. It should be made from two or more finely ground cereals either collectively or separately, while for every pound of cereals two ounces of bone meal or edible tankage could with advantage be added. For fox pups it would be beneficial to add also half an ounce of yeast cake after the porridge is cooked.

Milk appears to be almost entirely excluded from the winter diet of the ranch fox, most fox-breeders claiming that the foxes will not take it during the winter and also asserting that frozen milk will promote diarrhœa with the pregnant fox. Its exclusion from the winter diet may have been influenced by the fact that a continued supply is very often not available during the winter.

Whole cow's milk is in itself a fairly well-balanced food for the fox, as it contains protein, mineral matter and food accessories in favourable amounts and can make good any dietary deficiency whatsoever if fed in sufficient quantities. It is a relatively cheap food, for 1¼ pints of whole cow's milk has about the same food value as one pound of the average meat that is fed to a ranch fox.

An attempt was made to feed milk throughout the winter to foxes in the experimental ranch. The foxes, especially the females, were very partial to it and ate it all except for a short period around the mating season, from the middle of January to about the middle of February, when the foxes appeared to be indifferent to food of any kind. Sometimes the foxes ate the milk before it had time to freeze, but very often it was eaten after it was frozen. There was no sign of diarrhœa that could be attributed to the frozen milk. It must be remembered that large quantities of snow are ingested by the fox during the winter. If that does not cause any disturbances it is very questionable if frozen milk would unless an excessive amount were eaten. Moreover, in some ranches a large quantity of frozen meat is fed, and even where it is the practice to thaw out all the meat, a large percentage becomes frozen before it is eventually eaten by the fox.

Food Materials of the Ranch Fox

Beef, mutton and horse meat.—These meats probably have equal food values and they may be fed occasionally as part of the meat diet.

Beef heart.—An excellent food material containing vitamins; the meat diet should contain large proportions.

Beef tripe.—A favourable food material, can be fed once or twice a week, generally has a low calorific value.

Beef Liver.—A very desirable food material, contains vitamins and has laxative properties. Small quantities should be fed once a week.

Pork.—A rich food, has a high calorific value, may be fed occasionally.

Pork heart and kidney.—Very rich foods with high calorific values, contain favourable quantities of vitamins, may be fed occasionally with favourable results.

Brains.—Contain vitamins, promote a healthy stool, have low digestibility co-efficient.

Lamb plucks.—A favourable food material with a relatively high calorific value, contain desirable vitamins.

Fish.—An excellent food material, when fresh.

Salt fish.—Not a very palatable food material, may be fed occasionally, should be soaked in fresh water for twenty-four hours before being fed.

Rice.—A very good cereal with protein of a high biological value, has a high digestibility co-efficient when well cooked.

Rolled oats.—A good cereal, has a favourable mineral content and fairly digestible.

Coarse oatmeal.—Very indigestible. Rolled oats are preferable.

Whole wheat flour.—A fairly good cereal, contains vitamins; proteins have a low biological value.

Corn meal.—A fair cereal containing vitamins, proteins have a low biological value, should be very finely ground.

Fox biscuits.—Rice flour, rolled oats, corn meal, and whole wheat flour, four parts of each; bone meal, two parts; cod liver oil, one part; salt, q.s.

Commercial Fox biscuits.—Generally made entirely of wheat flour which by itself has a low biological value, also generally deficient in fat and mineral matter.

Porridge.—Rice, rolled oats, corn meal, whole wheat flour, four parts of each; bone meal, two parts; salt, q.s. For every twenty pounds of dry cereals one pint of liquid yeast should be added.

Milk.—Should be included in the daily ration of a ranch fox throughout the entire year.

Eggs.—Should be fed regularly to the pregnant fox and to the pups.

Cod liver oil.—Contains more of the fat-soluble growth promoting vitamin than any other known substance.

Swede turnips.—Contain favourable quantities of the anti-scorbutic vitamin, should be fed cooked with cereals and ground meat.

Bran.—Very indigestible but promotes a healthy stool.

Bone meal.—A very valuable source of lime and phosphorus, should be finely ground.

Edible tankage.—A valuable source of lime and phosphorus.

Sugar and molasses.—In quantity will attack the mucous lining and cause intestinal disturbances.

Yeast.—Contains large quantities of the water soluble vitamin. Preparation: add one yeast cake to two pounds of well cooked potatoes in one gallon of water, allow to stand for twenty-four hours at a temperature between 75° and 90° F. Pour away the clear liquid. For the next batch use a quarter of a pint of this liquid yeast instead of the yeast cake. Start with a new yeast cake once a week to avoid wild strains.

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