DOMINION OF CANADA

DEPARTMENT OF AGRICULTURE

DOMINION EXPERIMENTAL FARMS

DOMINION EXPERIMENTAL FOX RANCH

SUMMERSIDE, P.E.I.

PROGRESS REPORT

RESULTS OF EXPERIMENTS

1936-1946

C. K. GUNN, Ph.D.
Superintendent

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TEN-YEAR REPORT OF WORK

at

THE DOMINION EXPERIMENTAL FOX RANCH, SUMMERSIDE, P.E.I.

DR. C. K. GUNN, *Superintendent*

Canada's natural geographic and climative conditions have made it an ideal country for the production of fine dense furs. However, colonization and indiscriminate trapping soon gave rise to a scarcity of wild fur-bearing animals in the more accessible regions. This condition, coupled with the high prices paid for fur pelts, led more enterprising men at the beginning of this century to attempt raising fur-bearing animals in captivity. Their early endeavours in the field of fur farming were attended, however, with many difficulties, which arose in breeding, nutrition and control of diseases.

As a result of these difficulties, coupled with the rapid growth of fur farming and expansion of the industry to all provinces of the Dominion, recognition of the importance of fur farming was given by the establishment in 1925 of the Dominion Experimental Fox Ranch at Summerside, Prince Edward Island. At this Station the fur ranchers' problems of breeding, feeding, housing and general care of silver black foxes were and are being studied. To supplement the work of this Station, the Maritime Fox Illustration Stations were established in 1938 to demonstrate the scientific management of foxes under local conditions peculiar to the surrounding country in which the Stations are located.

The work carried out at the Dominion Experimental Fox Ranch during the past decade and based upon the problems affecting fox ranchers is described in the following pages.

BREEDING OF FOXES

In relation to the breeding of foxes it is important to know when they come in season so that they can be mated. Since the practice of polygamous mating has come into use among fox ranchers, it has become especially important to be able to detect when vixens are in "heat".

Vaginal-Smear Test

In many species of animals, the cells lining the female reproductive tract undergo specific changes during the different phases of the mating cycle. This makes it possible to determine whether or not a particular animal is in "heat" by microscopic examination of a few cells scraped from the vaginal walls. In view of these facts, an investigation was carried out to determine whether or not the vaginal-smear test could be used in the fox ranching industry.

During the breeding seasons of 1938-40, more than 2,000 vaginal smears were studied in conjunction with the mating of 225 vixens at the Dominion Experimental Fox Ranch. It was found that 87 per cent of these vixens were in heat coincident with the cornified phase of the oestrus cycle.

The test was found to be of particular aid in the accurate detection of oestrus in pup vixens in which swellings of the vulva is often quite indefinite or absent. Further, a definite knowledge of which vixens are in heat saves the rancher much time that would otherwise have to be spent watching the vixens, where ranching methods are employed which necessitate the presence of a male with a vixen to determine her willingness to accept service. An

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accurate guide such as the vaginal-smear test, to determine which females are ready to mate at a particular time in the breeding season also allows the fox rancher to maintain a smaller number of male foxes. This facilitates a wider use of outstanding sires in the practice of polygamous mating by reducing unnecessary sexual activity of trial-test methods.

By means of the variation in appearance of the vaginal smears, the oestrus cycle of the vixen can be sub-divided into four periods: proestrus, oestrus, metoestrus and anoestrus.

Photomicrographs of the cells indicative of the different phases during the breeding season of the vixen are shown in Fig. 1. The details of this test were published under the title "Vaginal-Smear Test for the Detection of Heat in Vixens", in *Canadian Silver Fox and Fur*, 7:3, 4, 1941.

Mating Time and Production

In fox ranching procedure it is also essential to have good production from the breeding stock. In other species of animals, the particular time at which mating takes place during the period of oestrus has been found to affect the number of young born. Consequently, experimental studies were carried out with foxes to determine whether or not the size of litters, or the number of vixens becoming pregnant, was affected by early or late mating during oestrum.

The experimental work of the investigation reported was carried out during the mating seasons of 1939-44, and comprises data from a study of the mating of 274 vixens. Two different methods were used for the detection of oestrum in the vixen, namely, the vaginal-smear test and trial tests with male foxes. Table 1, giving analysis of the data of both methods, shows quite definitely that early-mated vixens (1st and 2nd days of heat) give a higher average litter size than late-mated vixens (3rd and 4th days of heat). A significant drop in litter size takes place between second- and third-day matings.

TABLE I

LITTER-SIZE IN RELATION TO MATING TIME AS DETECTED BY THE VAGINAL-SMEAR TEST

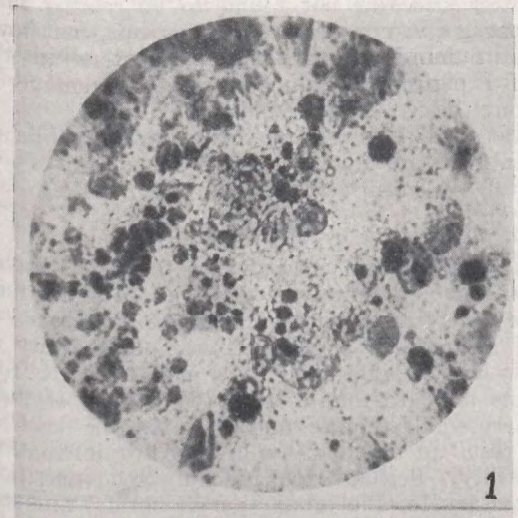
Time of Mating	No. of matings	0	1	2	3	4	5	6	7	8	Average litter size of mated vixens	Per cent misses	Average litter size of pregnant vixens
Early heat	116	18	5	13	15	19	25	16	3	2	3·53	15·5	4·2
Middle heat	50	9	1	5	8	8	12	6	0	1	3·42	18·0	4·2
Late heat	108	48	6	7	7	17	10	10	2	1	2·23	44·0	4·0

Early heat = proestrum and early cornification. Middle heat = middle cornification. Late heat = late cornification and metoestrus.

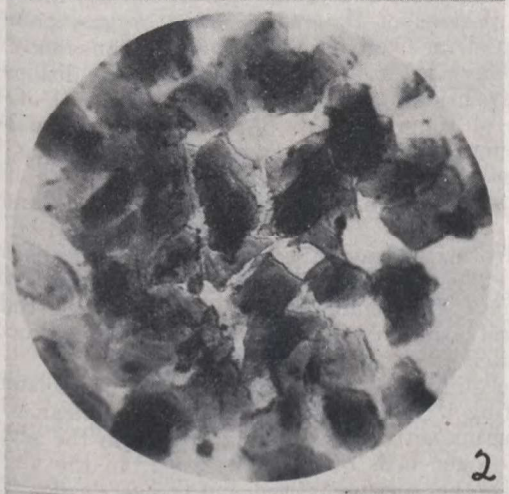
LITTER-SIZE IN RELATION TO MATING TIME AS DETECTED BY TRIAL TESTS

Mating Time	No. of matings	0	1	2	3	4	5	6	7	8	Average litter size of mated vixens	Per cent misses	Average litter size of pregnant vixens
1st day of lifting tail	132	34	6	10	13	22	26	16	4	1	3·14	25·7	4·23
2nd day of lifting tail	80	15	5	10	7	13	14	13	1	2	3·36	18·7	4·13
3rd day of lifting tail	47	17	0	4	10	7	7	1	0	1	2·44	36·2	3·83
4th day of lifting tail	13	7	1	1	0	2	1	1	0	0	1·69	53·8	3·66
5th day of lifting tail	1	1	0	0	0	0	0	0	0	0	.....	.....	.....
6th day of lifting tail	1	0	0	0	0	0	0	0	0	0	.....	.....	.....

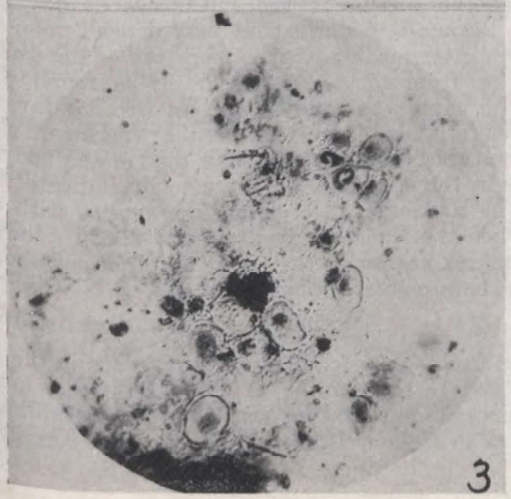
Misses = mated, but not pregnant.



1. PHOTOMICROGRAPH X 375. Vaginal Smear showing "Proestrus phase" of oestrus cycle. Vixen may come in "heat" toward end of this phase.



2. PHOTOMICROGRAPH X 375. Vaginal Smear showing "Cornified cell phase" of oestrus cycle, indicating period of "heat".



3. PHOTOMICROGRAPH X 375. Vaginal Smear in metoestrus phase of oestrus cycle, showing "round cells", indicating end of "heat" period.

The cause of variation in litter size was not found to be related to a decrease in average litter size among the vixens which had pups, but was shown to result from the difference in numbers of non-pregnant vixens in the early- and late-mated groups of experimental animals. The percentage of misses is significantly greater among the late-mated vixens.

The complete paper with statistical analysis of this work is published under the title "The Effect of Mating Time upon Reproduction in Foxes", in the Empire Journal of Experimental Agriculture, 13 : 52, 193-199. 1945.

Sperm Smear and Litter Size

In the foregoing experimental work it was noticed that the litter size in fox pups was larger when there was a copious supply of sperm in the semen fluid of the male animals. It was also determined that the presence or absence of sperm in the female tract after mating was a good criterion of sterility or fertility in male animals. Sterility in foxes has not been found to result from any special cause, but smear tests indicate that a small percentage of male animals produce no sperm, or a very small number, and these may be dead.

Poor condition, either as the result of malnutrition or parasitic infestation, contributes to sterility or low fertility. Perhaps, too, not only good nutrition, but a well balanced ration is necessary for the production of normal amounts and quality of semen. Specific diseases of the reproductive organs, namely, the testicles and the prostate gland, as well as the urinary organs, may be contributory to the sterility of many males. In vixens too, poor conditions as the result of malnutrition, or parasitic infestation, and abnormalities of the reproductive tract are the cause of some sterility. Mating late in the heat period may result in non-pregnancy; this may be caused by not mating the female earlier with an active male. Some strains of foxes appear to have little sex instinct. Selection for sex vigour and litter size are the best known assurances of good reproduction.

Testing the semen of males by taking vaginal smears after mating is now a routine test on many ranches. The technique is to introduce a small glass rod 2 to 3 inches inside the vagina. The seminal fluid adhering to the rod is then smeared on a glass slide and examined for sperms under a microscope with about 100 to 300 magnifications.

If a drop of semen cannot be obtained, the glass rod should be moistened with a salt solution before inserting it into the vagina. A good smear when freshly drawn shows numerous sperms actively swimming around in the semen. In addition, numerous cells and broken cells of various sizes from the vagina are usually present. Occasionally the sperms in the smear are dead. This does not necessarily indicate that the male is sterile, but may depend upon the length of time the smear was taken after mating, the temperature of the smear, or to contamination with urine or from dirty glassware. It is found that sperms do not live very long in the vagina as conditions there are not favourable for their existence. Temperature is also important because sperms quickly lose their activity when the temperature becomes lower than that of the body.

Abnormal and broken sperms in the smear do not necessarily indicate that the male is at fault. They may be the result of crushing the sperms with the glass rod, or with another slide when the smear is dry, or particularly allowing the smear to get frozen. When smears are made the proper precautions should be taken to get live, active sperms before condemning the male.

Fertilization in the Fox

Studies were carried out to determine how fertilization took place in the fox in order to understand the essential factors in the mating of these animals. Specific information on the processes of fertilization was obtained by killing a few vixens at intervals of 7 minutes to 1½ hours after unlocking. The reproduc-

tive organs were removed as quickly as possible after killing. By nicking the uterus and taking smears, numerous sperms were found at the ovarian end of the horns of the uterus as soon as 10 minutes after the pair unlocked. This indicates that a rapid propulsion of the sperms takes place through the reproductive tract of the vixens during or immediately after mating.

In addition, the ovaries of a number of vixens were examined and a check made on the shedding of eggs. By sacrificing some mated and some unmated females, it was ascertained that the shedding of eggs in vixens is not dependent upon mating, as is the case in some animals such as the rabbit and ferret.

There is evidence from other animals that eggs do not survive very long after they have been shed unless fertilized. It would appear, therefore, that for maximum litter size, early matings should be practised in order to have sperms in the uterus by the time, or soon after the first eggs are shed.

Spermatozoa do not live more than one or two days in the reproductive tract of the female as shown by experimental work on other species of animals. Examination of vixens' ovaries indicates that not all the late eggs are shed, but that some degenerate. The interest in recent years in sex hormones has a bearing on this point. There is some evidence that the injection of appropriate sex hormones helps to ripen and shed all, or most of the eggs, quickly, and thus increases litter size. Experiments are in progress to determine the effect and economy of injecting various sex hormones. It should be understood, however, that litter size is largely governed by hereditary factors, and if it were possible to induce (artificially) large litters this might result in perpetuating a strain of foxes that would need the injection of hormones in their progeny to maintain large litter size.

Breeding Methods

Observations and studies upon the breeding of foxes show that linebreeding, when practised with rigorous selection and careful outcrossing has proved to be the safest and most effective system of breeding. It tends to fix the various characteristics and thus establishes uniform and prepotent strains. The method is to continue mating related animals with careful selection for litter size, quality of fur and body size, until weak traits begin to appear in the progeny. When this occurs, outcrossing should be practised, either as a complete outcross or outcrossing to other lines in the ranch that will tend to correct the weaknesses.

Sometimes a single outcross may correct the weaknesses and then linebreeding can be continued until such time as other weaknesses occur. It is often difficult, however, to find animals that will nick. Sometimes two lines will cross well together, producing well furred animals of good size and quality as a result of hybrid vigour, but when further bred together the progeny tends to split up into individual lines again. When introducing new blood into the ranch, it is advisable to get distantly related animals and to make a few crosses with them and their progeny before using them too much in the ranch. During the past three years linebreeding work with two outstanding strains of Canadian foxes has been carried out at the Dominion Experimental Fox Ranch with excellent results.

Much depends upon the rigid culling methods employed in the selection of breeding stock which entail a close study of such hereditary traits as fur characters, fecundity, size, mating vigour, good conformation, milking and eating properties and a quiet temperament.

Breeding New Type Foxes

In the breeding of mutant-type foxes it has been found that the transmission of mutant characters follows the Mendelian laws of heredity. In these the hereditary traits are thought to be transmitted from parents to progeny through the sex cells, via the spermatozoa and ova, within bodies located in these cells,

called chromosomes. The latter carry all the individual hereditary traits of the animal. The fox has 32 of these hereditary carriers or chromosomes, in its body cells, or two complete sets of 16 chromosomes in each body cell. Each chromosome is like a string of beads, in which each bead (or gene) is representative of a single hereditary trait, such as, coat colour, eye colour, size, shape and all the other hereditary characters.

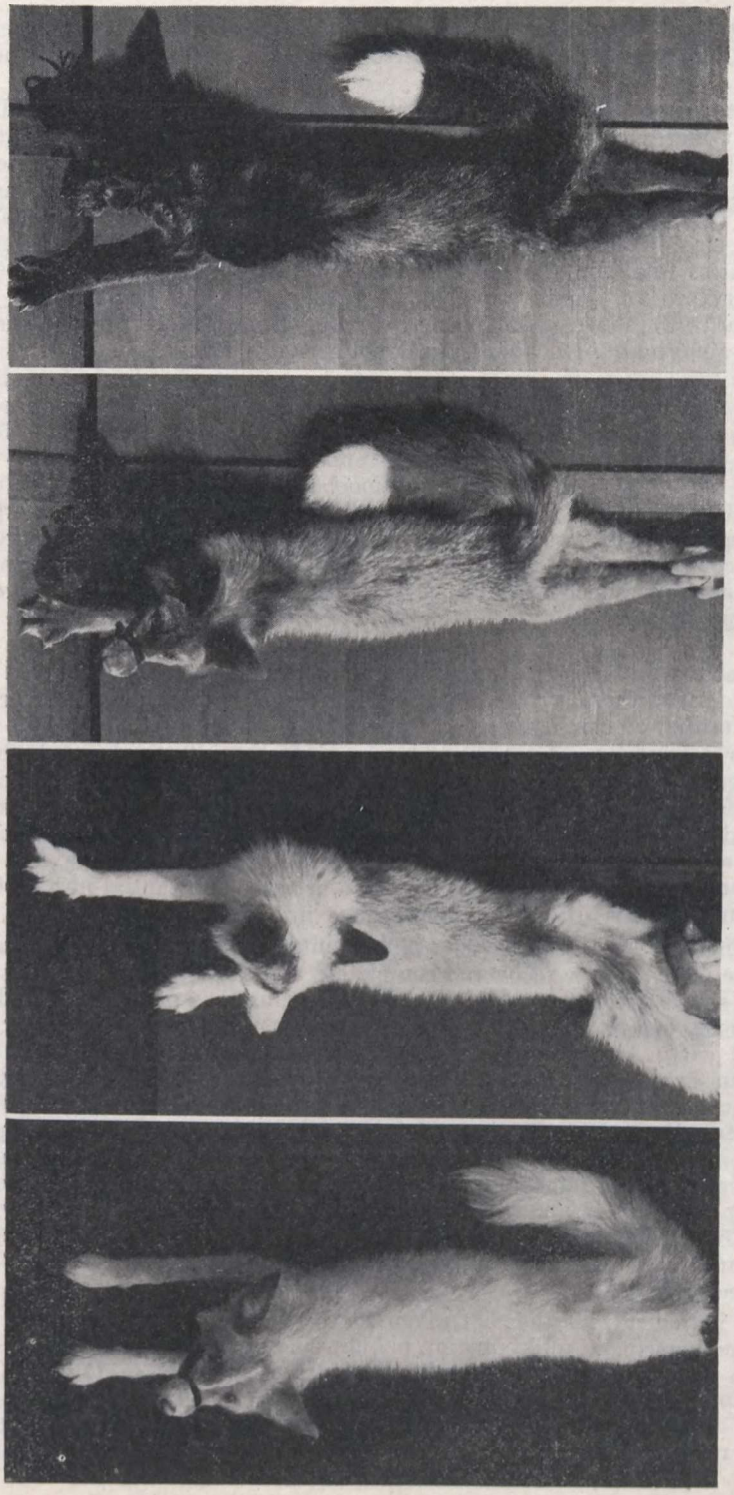
When the germ cells, the sperm and ovum are formed only one complete set of 16 chromosomes goes into each sperm or ovum. Thus when a single sperm and ovum unite at fertilization to give rise to a fox embryo, the original number of 32 chromosomes is restored again. Half the number (16) or one complete single set of hereditary carriers comes from the sire through the sperm, and the other half or complete single set (16) is derived from the dam, through the ovum. In this way every fox pup gets two complete sets of hereditary factors, one set from each parent.

In order to study the manner of heredity of mutant-type foxes a group of these was added to the breeding stock of the Experimental Fox Ranch in 1944, and in conjunction with studies at the Station, breeding data were collected in collaboration with the Canadian Silver Fox Breeders' Association. The genetical formulae were worked out for the various crosses of these new type foxes, such as for standard platinum, standard pearl platinum (Ontario and New Brunswick strains) and white-marked foxes. These formulae show the genetical background of the different crosses and the most economic manner in which mutant foxes can be produced.

More recently the observation has been made that the white-marked fox of either the Colpitt or McNeil strain can occasionally be produced from a cross of standard platinum with standard silver fox (27 cases on record). Here the platinum parent has previously been derived from a cross of standard platinum with the particular strain of white-marked animal produced in the progeny of the second generation. This evidence of segregation shows that the white-marked mutant and standard platinum strains are distinct mutant types. Details of the genetics of mutant type foxes are graphically outlined in the bulletin, "Genetics of Some New Type Foxes", Dominion Department of Agriculture, publication No. 768.

Anaemia in Mutant Fox Pups

Apparently reduction of pigmentation in the formation of new mutant strains of foxes is accompanied by other constitutional changes in these animals. It is well known in genetical studies with mutations in other species of animals, that often the resultant genetic balance assumed in a new mutation may give rise to a constitution that is lethal to the new animal type. In 1942 attention was drawn to such a condition among standard platinum fox pups of the Quebec and Norwegian mutant strains. From post-mortem examinations and blood work this was found to be an anaemic condition that was 100 per cent fatal to affected animals. Further investigation showed there was a mortality of over 20 per cent among standard platinum fox pups, and the total value of foxes annually lost in Canada from this disease is great. This condition is found to occur chiefly in standard platinum fox pups and to a lesser extent among white-marked and pearl platinum mutants in ages ranging from 2 weeks to 4 months. Studies were carried out on 33 anaemic platinum fox pups. Among the last group of anaemic foxes which were cured of this condition, four of the affected animals were from crosses of standard silver with platinum foxes. One platinum was of Norwegian type and four were of the Quebec



Progeny of back-cross of Standard Platinum, (carrier of Pearl Platinum) with a Pearl Platinum fox. (1) Standard Silver (carrier); (2) Pearl Platinum; (3) Standard Platinum (carrier); (4) Glacier blue.

mutant strain. The anaemia is thought to probably result from hereditary lethal factors closely associated (linked) with the mutant genes in new type foxes.

Affected pups show loss of appetite and emaciation; they are smaller than their litter mates, have sunken eyes and dry fur. As the anaemia progresses, the pups become weak and stagger about their pen. The feces are often black and the fox pups may show a terminal jaundiced condition. The carcass has a blanched (desanguinated) appearance. The spleen and liver are usually subnormal in size. Hemorrhage into the intestinal tract is a frequent finding. The abnormalities found in the blood of anaemic foxes were as follows: (1) subnormal erythrocyte count (red blood cells); (2) low haemoglobin content (achromia); (3) slower than normal clotting time. Blood smears showed no apparent abnormalities in the erythrocyte except achromia.

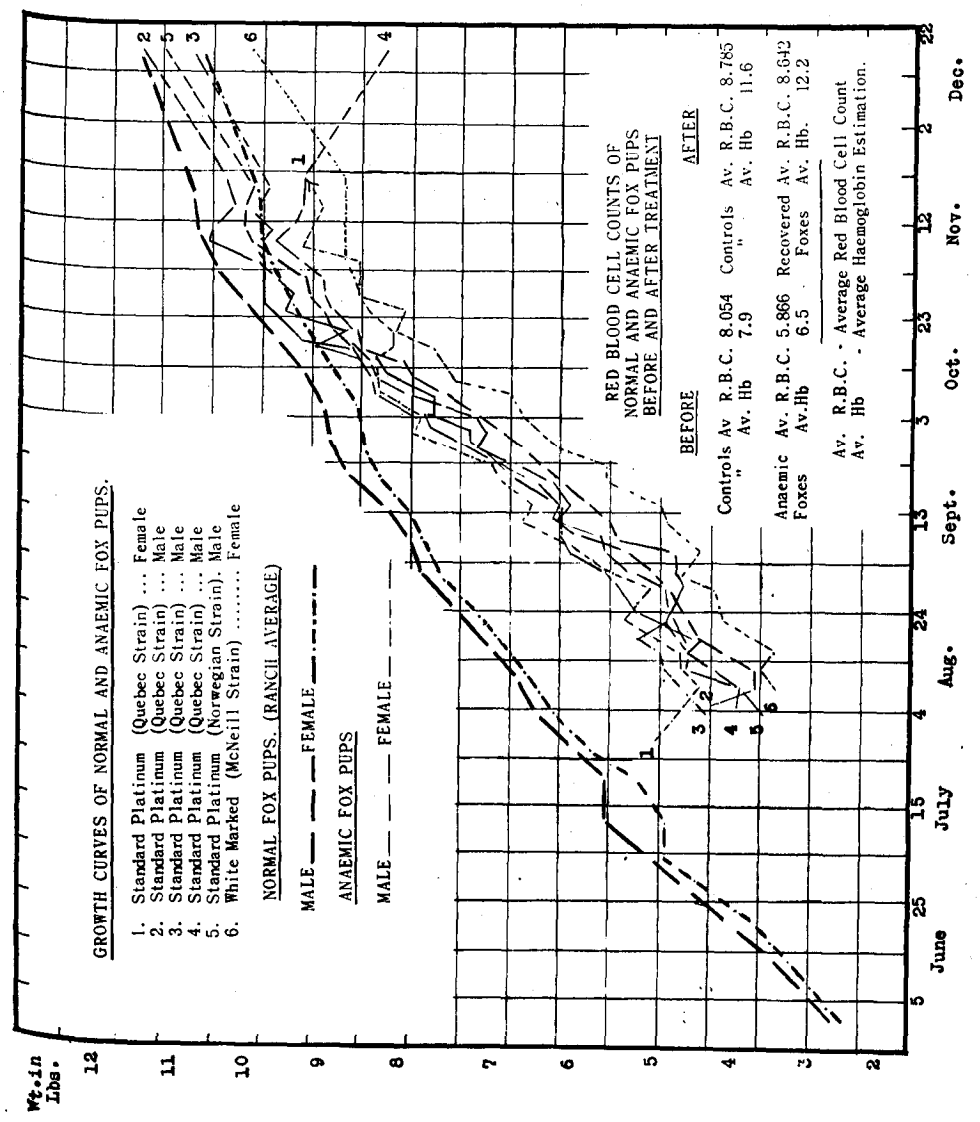
Because anaemia is a concurrent symptom of many infective conditions, a survey of the possible underlying causes of anaemia in fox pups was carried out on 15 anaemic platinum pups during the summer of 1943 with the following results:—(1) Negative findings for fleas and earmites as causal agents. (2) No intestinal parasites in the form of entamoeba, hookworms, ascarids or coccidia. (3) Negative findings for potentially pathogenic intestinal bacterial organisms. (4) No specific blood parasites present. (5) The non-infective nature of the anaemic condition was determined by blood transfer and fecal contamination. (Droppings from affected fox pups were fed to normal pups. The latter did not become sick or visibly affected as a result of fecal contamination of their feed).

Initial attempts at treatment for this condition involved iron (in reduced form) and liver therapy, the latter in the form of injections of liver extract and the feeding of raw liver.

Later a condition of internal bleeding into the intestinal canal was found to be a common symptom, and as a result of this observation, and also that anaemic foxes had a slower blood clotting time than normal animals, injections of normal horse serum, vitamin K and vitamin B, were administered. The latter was given to increase the appetite of the anaemic fox pups, and in some cases appetite was increased, but after two or three substantial meals of regular fox ration the pups died from hemorrhage into the intestine.

During the 1944 season successful results were obtained with a group of 6 anaemic pups. These recovered completely and grew to normal adult animals. Figure 3 shows the body weight and blood estimations of anaemic and normal control foxes before and after receiving treatment. During the latter part of July and early August these anaemic fox pups were brought from different ranches in Prince Edward Island to the Dominion Experimental Fox Ranch, where they were retained for observation purposes and to test experimental treatments. It can be seen that the average weight of the 5 anaemic platinum fox pups and 1 anaemic white-marked pup was less than two-thirds the normal body weight of fox pups of comparable ages. The correlation of low body weight and degree of anaemia was apparent because the average erythrocyte count (5,855) and average haemoglobin estimation (6·5) were correspondingly lower than those of normal fox pups of comparable ages, which were 8,054 and 7·9 respectively.

The ingredients of the diet given to the anaemic foxes consisted of liver, tripe, eggs, horsemeat, milk, nutrim, pablum and strained vegetables, in conjunction with a therapy of high vitamin concentrates of A, B, C, D and K and an iron compound. Each fox pup was also given 15 oz. of fresh whole cows' milk daily in a separate pan. Weighed amounts (2-4 ounces finely ground) of unmixed raw glandular meats, cereal and raw eggs were fed to them twice daily


GROWTH CURVES OF NORMAL AND ANAEMIC FOX PUPS.
1. Standard Platinum (Quebec Strain) ... Female
2. Standard Platinum (Quebec Strain) ... Male
3. Standard Platinum (Quebec Strain) ... Male
4. Standard Platinum (Quebec Strain) ... Male
5. Standard Platinum (Norwegian Strain). Male
6. White Marked (McNeill Strain) ..... Female
NORMAL FOX PUPS. (RANCH AVERAGE)
MALE — — — FEMALE — · — · —
ANAEMIC FOX PUPS
MALE — — — FEMALE — — —
RED BLOOD CELL COUNTS OF
NORMAL AND ANAEMIC FOX PUPS
BEFORE AND AFTER TREATMENT
BEFORE
AFTER
Controls Av R.B.C. 8.054 Controls Av. R.B.C. 8.785
" Av. Hb 7.9 " Av. Hb 11.6
Anaemic Av. R.B.C. 5.866 Recovered Av. R.B.C. 8.642
Foxes Av.Hb 6.5 Foxes Av. Hb. 12.2
Av. R.B.C. - Average Red Blood Cell Count
Av. Hb - Average Haemoglobin Estimation.
Wt. in Lbs.
12
11
10
9
8
7
6
5
4
3
2
5 June
25
15 July
4 Aug.
24
13 Sept.
3 Oct.
23
12 Nov.
2 Dec.
22

for 6 weeks, then once a day. Whenever a fox pup was noticed to appear sick, with a loss of normal appetite, it was given strained liver, beef, and vegetables for one or two days. This diet of finer texture given in small meals twice daily enabled healing of the hemorrhaging intestinal mucosa, and prevented the internal bleeding from becoming fatal. The ingredients of the diet were changed each week so that the foxes maintained a good appetite for their rations.

This group of foxes regained a normal average body weight of 10·7 lb. by December 16. They also gave a normal average blood (red blood cell) count of 8,642 and an average haemoglobin estimation of 12·2. Control normal foxes had a comparable body weight of 10·11 lb. and blood estimations (red cell count) of 8,785 with haemoglobin content of 11·6

Further modification of the treatment was found necessary to prevent the occurrence of anaemia in pups during the lactation period.

Although the feeding of iron during the gestation period causes a disposition of this element in the organs of the dam, after birth and during the lactation period the young fox gets practically no supply of iron from the milk. Therefore, it was found necessary to supplement the ration of suckling puppies with iron. Details of the measures to prevent anaemia in platinum foxes are outlined in two pamphlets: the original investigation "Preliminary Note on the Treatment of Anaemia in Mutant Fox Pups" and a later work, "Modification of Treatment of Anaemia in Fox Pups Based on Trial Field Tests".

Fur Characters

A study of the individual fur characters and their manner of inheritance has been carried out to gain further knowledge of the best methods to breed different types of foxes in order to get good combinations of hereditary factors in the progeny.

The silver bar which is a very important fur character, was studied in detail. It varies considerably in different foxes. The most desirable bar is reasonably long and bright, the black portion of the hair being sharply demarcated from the silver bar. Poor types have a short bar and the black pigment fades into the bar giving a dull appearance to the silver. The growth of the silver bar portion of the guard hair occurs some time in midsummer. The time varies with different foxes. A series of microscopic sections of skin taken in August showed that the silver bars on some foxes had already been formed, while others were in a state of growth.

A statistical study was made of the length of the bar in mature hairs to determine the number that should be measured in order to give reasonably accurate results. It was finally decided to use the measurements of bars of 16 guard hairs from the region of the thigh in each fox. An arbitrary standard of classification was set up in which the length of the bar was divided into short (10 mm. and under), medium (10 to 14 mm.), long (14 to 18 mm.) and extra long (18 mm. and over). It is the opinion of some ranchers that the silver bar can change in length after it has grown out of the skin. To check this a number of measurements were made on the bar length of hairs of the same group of foxes, taken from the same body area at different intervals from October 15 to January 16. The results show that no differences in length occurred between those dates. The average length of silver bar of hairs in the pup year, second year and third year was measured. There was a slight, but significant decrease in the bar length of 1·54 millimetres between the pup year and second year, as determined on the hairs from 97 foxes.

No real difference in bar length was found between the second and third year fur growth of these animals.

Miscellaneous measurements were made on a number of other fur characters, as given below. No correlation was found between total hair length and that of the silver bar length on the group of foxes studied. In other words, guard hairs of the same length may have long, medium or short bars. Neither was there any relationship between bar length and hair diameter. Some relationship was found between the length of bar and the extent of cloudy area, that is, in guard hairs with longer bars there was a greater tendency of the black pigment to shade into the edges of the silver bar. A difference was found in guard hair length on different surfaces of the body. The greatest difference, amounting to over 1 inch, was found between the hairs on the hips and those on the sides, the latter being the longest, with the hair on the back being intermediate in length between that of the above regions. Small variation was found in the diameter of hairs taken from different body surfaces of foxes. The guard hairs in the hip region are of greater average diameter than those occurring on the back or sides of foxes.

Twenty years ago the black or almost black pelt with dark blue underfur was in demand. It is about two decades since the fashion began to change in favour of the lighter phases, until in recent years paler silvers have largely come into vogue. The change from the darker to the lighter phases has been comparatively rapid, owing to rigorous selection by breeders of paler animals. This was accomplished through the development of the system of polygamous matings.

The lighter phase of silver pelts results from several characteristics. In addition to the silver guard hair extending over most of the body, the proportion of silvered hairs to solid black hairs or king hairs is very large. Hence, the veiling effect, that is, the black hairs and tips showing above the silver bars, is not so pronounced. In addition, many of the hairs are o nly black tipped, the bar extending down to the roots, while some hairs are completely white. Animals with a wide bar have been keenly selected as breeding stock. When, however, the bar is very wide and sufficient veiling is not present the paleness of the pelt is increased even to the extent of being chalky, giving the fur an undesirable appearance.

A light blue underfur is desirable in order to get a better blend of colours. More recently the still lighter platinum types, which are mutants of the silver blacks, are coming to the fore. These include the pearl platinums (Ontario and New Brunswick strains) which are recessive mutants, as well as the dominant mutants: platinum, platinum silver and white-marked silver.

Changes in style trends are a handicap to investigations on the inheritance of pelt qualities, because the latter is a slow task. Moreover, many of the pelt qualities, such as the finer coloration, density, strength of fur, lustre, etc., are difficult and almost impossible to measure with any degree of accuracy. Consequently, reliance has to be made on the pelt grade. The finer grading of pelts is most effectively accomplished by contrasting one with another. Naturally, the grades vary somewhat according to the quality of the pelts being judged, and hence the standard is not quite the same from one year to another.

The method of measuring the silvered area of foxes was accomplished by a series of graduated rules, differing in length corresponding to the varying lengths of foxes. This system permits of reading the percentage of silvered area on each fox directly. Owing to the scattering or irregular demarcation of the silvered area the measurements cannot be made with a close degree of accuracy. A routine examination was made of the silvered area of parents and progeny, the results of which show that the silvered area of parents is arranged in 18 groups ranging from 40·0 to 42·5 per cent up to the higher group of 83·0 to 85·0 per cent silver. In all groups the average silvered area

of the progeny is lower than that of the parents, ranging from 6 to 50 per cent. The progeny of course showed a wide difference in the percentage of silvered area, ranging from the dark to the pale phases.

Comparison of the silvered area of the foxes in their pup, second, third, fourth and fifth year, shows that the silvered area changes somewhat with age. It can be noted that the largest difference occurred between the pup and second year, the average silver area of 299 pups being 61·53 per cent which increased in the following year to an average of 68·61 per cent or an average increase of 11·83 per cent. The figures for other years showed a slight decrease from 1·37 per cent to 5·16 per cent in the silvered area from one year to the next.

FEEDING OF FOXES

The feeding of foxes is a subject which has been developed by trial and error methods. Even today there is great difference of opinion among leading fox ranchers as to the best methods and choice of ingredients for fox rations. In the early days, the plan was followed of examining the stomachs of wild caught foxes to determine the natural feed of these animals. The observation that cereal was often present in their stomachs, eaten from the stomach of prey, gave rise to its use in the feeding of ranch foxes. At that time considerable trouble arose with parasites, disease and storage problems which led to cooking the feed. Later, considerable controversy arose among fox men as to whether the cereal portion of the diet should be cooked or fed in the raw state.

Further refinement in the feeding of foxes took place when it was realized that better furring results, greater production from the breeding stock and more virile living pups could be produced when different rations were used during the furring and breeding seasons as well as in the gestation period.

This led to nutritional studies in fox feed on the effects of processing and to studying digestibility of different ingredients of the diet, in conjunction with studies of radical diets to determine the effects of individual or small groups of feed factors upon the growth and fur production of foxes. The feeding of fish of different kinds from fresh and salt water sources has been a problem demanding considerable experimental study.

During the war years it became necessary, because of the shortage of protein and meats for feeding purposes, to devote attention to the suitability of substitute products in the rations of foxes.

Raw vs. Cooked Cereal in a Fox Ration

To determine whether the cereal portion of fox feed should be fed raw or in a cooked state, an experiment was planned to settle this difference of opinion among fox ranchers. In this experiment the foxes were divided into comparable groups according to age, size and body weight, etc., with the comparative groups maintained under similar housing conditions and the same cereal was fed to foxes in the raw or cooked state.

The cereal mixture comprised finely ground whole wheat, barley, oats, rice and cornmeal mixed together. Half of each mix was cooked and the remainder used in the raw state. Both the raw and cooked cereal were then incorporated into an otherwise identical fox ration and fed to fox pups and adults animals throughout the 1941-42 season. In this way the effects of raw and cooked cereals were studied during the following different phases of fox ranching procedure: (1) Growth of young fox pups up to 9-10 weeks of age; (2) Growth of fox pups from 10 weeks of age to maturity; (3) Maintenance of body weight of adult males and vixens; (4) Condition of foxes, quality of fur produced and

pelt prices; (5) Time of onset of oestrus in vixens; (6) Mating activity of male foxes; (7) Average litter production; (8) Comparative digestibility of raw and cooked cereal rations by fox pups and adult animals.

The weights of comparable groups of 65 fox pups between 9 and 10 weeks of age, which received raw and cooked cereals in their rations, were studied. The average weights at this age showed a significant difference between the groups fed raw and cooked cereals with body weights of 42·9 and 39·6 ounces respectively. The better growth produced by the raw cereal ration possibly results from its greater vitamin content and the more efficient absorption of its fats. The latter was shown by digestibility studies.

Growth curves of male and female groups of 35 fox pups based on weekly body weights taken until the fox pups reached maturity, showed no real difference, however, between the animals fed raw and cooked cereals. Similar findings were also recorded with groups of 40 male and 40 female adult foxes receiving the same maintenance ration in which raw or cooked cereal was incorporated.

To determine the effect of raw and cooked cereal upon fur quality and condition of foxes, comparable groups of pups and adult foxes were allowed to fur out on rations identical other than the raw and cooked state of the cereal content. To eliminate the personal factor in evaluating the fur quality of the comparative groups of foxes, the services of an outside expert fur grader were obtained to score the foxes. During the examination of the above foxes, the fur grader had no knowledge as to which foxes had received raw or cooked cereal in their rations. The average of the scoring for condition and fur quality was 7·3 points and 7·2 respectively for the raw and cooked cereal groups of 70 foxes each, showing no significant difference between their condition and fur quality.

As a further check upon the scoring of the quality of fur of comparable groups of foxes which received raw and cooked cereals in their rations, the average prices received for 74 pelts (of foxes culled from the ranch stock) were as follows: 34 pelts from raw cereal rations brought $20.43 as compared with an average return of $19.77 for the remainder of the pelts from foxes which had received cooked cereal in their diet.

Studies to determine the relative effects that raw or cooked cereal rations might have upon bringing the foxes into heat early or late in the breeding season gave the following results. Here again, the raw or cooked cereal was incorporated into an otherwise identical breeding ration to the extent of 15 per cent of dry weight of the total ration. The 26 vixens receiving cooked cereal in their ration came in heat on an average of 20·68 days dated from the first mating of the 1941 breeding season, whereas 31 vixens receiving raw cereal came in heat on an average of 21·26 days from the same date of reckoning, thus showing no real difference in the time these controlled groups of vixens were in heat.

Mating activity of the male foxes showed that some of the most active dogs were in the raw cereal ration group. Although the evidence here did not eliminate the many other factors which might contribute to the production of sexually active males, nevertheless it demonstrated that raw cereals in a fox ration were not inimical to good mating activity on the part of the male foxes.

From groups of 18 and 19 vixens fed raw and cooked cereals in their rations throughout the summer, breeding and gestation seasons, an average vixen litter production of 4·83 and 4·84 pups respectively was obtained, showing no difference from the effects of the raw or cooked state of this cereal mixture used in quantities as specified in the seasonal rations given below.

Digestibility studies carried out upon the growing ration for fox pups and the summer adult maintenance ration, containing raw or cooked cereals in their composition, showed no very important differences. Here the ether extract

fraction or crude fat from the rations containing the raw cereal mixture was significantly better digested. A difference in the digestibility of dry matter and organic matter was found in which the rations containing cooked cereals were utilized to slightly better advantage, but this difference did not quite reach statistical significance.

In order to get a more definite idea of the effects of individual and small groups of dietary ingredients (radical diets) upon the growth of foxes (pups and adults) and the development of their fur, twenty-one relatively simple diets comprising one or a few basic ingredients of fox rations were fed to controlled groups of fox pups of both sexes. Weekly records of the weight (growth) curves showed considerable variation. Relatively good growth was obtained with four of the exploratory rations as compared with that of control animals receiving standard fresh meat rations. These were: fresh beef and vegetables; fresh and frozen fish and milk; fishmeal, cooked potatoes and milk; and fishmeal, cooked potatoes and vegetables.

The growth on other experimental rations was significantly less than that of control animals. The poorest growth resulted from a ration comprising raw cereal, bonemeal and cod liver oil.

The quality of the fur on the fox pups receiving the exploratory rations was grossly inferior to that of control animals receiving the balanced ranch ration, except in the case of two groups of foxes receiving fresh beef and vegetables, and fish with milk. Some interesting correlations were also noted between certain specific defects in fur colour and some of the simple experimental rations.

Exploratory rations and others using fresh meat substitutes were fed to comparable groups of pup and adult foxes. Fishmeal and commercial cube rations were found to be significantly inferior to the control ration containing fresh meats. The fur colour of the foxes which received commercial cubes was good, while fishmeal caused a marked greying of the guard hair and gave rise to very light coloured underfur.

Seasonal Fox Rations

Considerable work has been carried out to determine the best seasonal rations for foxes. As the breeding season approaches, it is found advisable for fox ranchers to make changes in the kind and proportion of the feed given to their foxes during that period of the year.

Although the basic constituents of the ration in the form of carbohydrates, fat, protein, mineral salts, vitamins and water are still present in the diet, changes are made in the kinds and quantities of the meats, cereals and vitamin-rich supplements. These changes in the quantity and proportions of the fox ration bring about definite reactions in the functioning of the animals' body systems, such that mating behaviour and breeding are affected.

The more fundamental breeding qualities and behaviour are dependent upon the specific heredity of the fox, but these can be modified to a large extent by environmental factors. Among the latter the various constituents of the diet play an important role, especially the vitamins. Other factors, however, such as the amount of sunlight, temperature, the amount of exercise and general condition of the foxes are very important.

The actual body mechanism inherited by the animal, which reacts to environmental influences, is known as "the endocrine gland system". Normal breeding behaviour, ovulation, and other phenomena of reproduction are directly dependent upon secretions poured into the blood stream by these glands. It may, therefore, be said that with a given hereditary constitution in a (normal) healthy fox receiving an adequate diet, general body condition is probably the most important factor in bringing about good breeding results.

It is important to have the breeding stock in a state of rising condition as the mating season approaches. That is, the foxes are fed sparingly just prior to

the breeding season and the feed is then gradually increased as the mating time approaches. This tends to act as a stimulus to the animals' body reactions causing the foxes to take more exercise and making them keener for their feed and mating activity.

A system of feeding which resulted in an average production of over five pups to the litter, indicates that the quantity of feed be increased during December so that the breeding stock puts on weight at that season of the year. Then the ration is reduced by one-third or to about 7-8 ounces of feed. This is done to make the foxes lean and trim so that they will take more exercise. It puts the breeders in good muscular condition and sharpens their appetite so that the foxes respond readily to an increase in their rations at the beginning of the breeding season. Toward the end of January the quantity of feed is increased gradually so that the breeders are in a rising condition at the time of mating.

Breeding Season.—The following ration has been found to produce consistently good breeding results at the Dominion Experimental Fox Ranch:—

Late Fall and Breeding Season

35 lb. Horsemeat or beef, or horsemeat, pork (boar) and rabbits.
25 lb. Tripe, meat offal, canned chicken and fish.
8 lb. Liver or brains.
15 lb. Cereal mixture
8 lb. Wheat germ } mercial cereal is used.
2 lb. Dried brewers' yeast } Reduce these ingredients 50 per cent if com-
4 lb. Minerals (green bonemeal 9, salt 1) 2% commercial steamed bonemeal 0·5% salt.
3 lb. Finely ground vegetables, greens and sprouted grains.

100 lb.

The amount of feed found satisfactory is from 10-12 ounces (dry weight) daily in one meal. These amounts, however, vary with male and female foxes as well as with the amount of exercise the foxes take. Some animals which tend to put on weight readily should be given less than the above quantities, while others will require more feed to maintain good condition. It is advisable to handle (weigh the foxes whenever convenient) foxes from time to time to determine their condition, then the quantity of feed required by the different vixens can be more accurately assessed.

Considerable latitude is given in the kinds of meat in the above ration, and a wide variety of cereals and vegetables can also be used. A study of the rations used by a number of prominent breeders shows that the winter rations may vary from 60 to 80 per cent in meat content, 20 to 35 per cent in cereal mixture and 5 to 20 per cent in supplements. Here the mixture is given for convenience in 100 lb. of dry weight but can be mixed to the proper consistency with either water or milk, where the latter is cheaply available.

A good practice is to feed males which are being used extensively in polygamous mating, a small morning meal (3-4 ounces) of raw eggs and fish, in the proportion of 2 raw eggs to 1 lb. of fish.

It is also important that changes in kind or quantity of fox rations should be made gradually so that the foxes do not go off their feed at this season of the year.

Gestation Period.—During the gestation period the requirements of the pregnant vixen can be further supplemented to good advantage. Changes in the diet at this period are chiefly directed toward supplying a ration which contains a variety of essential ingredients adequate for the formation of all the new tissues of the growing embryo fox pups. Certain constituents in the ration, such as a plentiful supply of vitamins and mineral salts, are of particular

importance. It is also essential that the foxes do not become too fat and lazy during the gestation period. Such a condition leads to poor muscle tone and a constipated state, both of which react detrimentally upon the vixen at birth of the pups. Lack of proper muscular development at whelping time makes it necessary for the vixen to aid the natural muscular contractions and pull upon the pups with her teeth. The taste of blood in this operation may cause an excitable vixen to kill her pups and once this habit has become established it is difficult to rear further litters from such vixens.

During the gestation period it is also advisable not only to feed a diet containing adequate roughage, in order to maintain normal intestinal action, but also to limit the amount of feed given to vixens so that they are kept active and hungry for their meals. The increased exercise along with the bulk in the diet tends to reduce the possibility of constipation, while the lessened amount of feed prevents the vixens becoming overfat, with the result that a good muscular condition is maintained which facilitates birth of the pups. A wide variety of minerals, particularly calcium, phosphorous and iodine, are essential to normal development of the embryo fox pups. Calcium and phosphorous give rise to normal tooth and bone structure, preventing rickets in the pups and also milk fever in vixens later during the lactation period. Iodine may be conveniently given in the organic form (in kelp or dulse) or an inorganic potassium iodine in iodised salt. The demand for iodine is greater during the gestation period and this element should be included in the diet as it plays a very important role in bringing about normal development and differentiation of the tissues of growing embryo fox pups.

Vitamins also deserve special consideration during the gestation period, as they are important in many phases of development of young animals. Since large reserves of vitamins B, C and D are not carried by animals, it is essential that the vixen receive a supply from the diet. Although vitamin A can be stored in the body, the demand for this vitamin is very great in growing animals and the diet should be accordingly supplemented by some vitamin-rich ingredient, such as cod liver oil. Experimental evidence with other animals has shown that the offspring are stronger and the mothers better able to nurse the young with less detrimental effect to themselves when vitamins A, D and C are liberally supplied during the gestation period. Vitamins C and D are particularly important in tooth development, while D also plays an important role in bringing about the necessary absorption of calcium and phosphorous from the diet.

The following is a ration for foxes during the gestation period which has been proved to produce strong, healthy pups at the Dominion Experimental Fox Ranch:—

20 lb.	Horsemeat, or beef and rabbits.	
15 lb.	Tripe, meat offal, canned chicken.	
15 lb.	Fish (not caplin or mackerel). If fish is not available replace with offal meats.	
8 lb.	Liver or brains (on alternate days).	
5 lb.	Ground green bone.	
15 lb.	Cereal mixture.	
5 lb.	Wheat germ	Where a commercial cereal is used, reduce these quantities by 50%
4 lb.	Wheat bran	
1 lb.	Linseed meal	
5 lb.	Brewers' yeast	
1 lb.	Iodised salt	
1 lb.	Cod liver oil	
5 lb.	Finely ground vegetables, greens, sprouted grains and canned tomatoes.	
100 lb.		

The foxes are fed 8-12 ounces, dry weight, daily in one meal or divided into morning and evening meals. The amount should be varied so that the vixens according to age and condition do not become too fat and are always keen for their feed. Pup vixens usually require more feed than other females. The above quantities of feed may be reduced to half the amount one or two days before whelping or replaced by 4-5 ounces of liver on the day before whelping. It has been found convenient to change vixens to the gestation rations in groups of ten after they are mated.

In the above ration a wide variety of proteins has been incorporated to supply adequately all the essential amino acids for tissue building. Vitamin-rich substances and mineral salts have also received special consideration with the inclusion of such ingredients as bonemeal, iodized salt, wheat germ, yeast, cod liver oil and vegetables.

The summer growing ration for pup foxes differs widely from that of a maintenance ration for adult animals.

The ration for fox pups must supply a greater variety of substances and accessory factors to bring about growth at this season. Adult foxes, on the other hand, require only a maintenance ration to supply the necessary feed to effect the normal functional requirements of the full grown animal. Therefore the summer feed requirements for growing foxes are considered separately from those of the adults.

Growing Rations for Pups.—Fox pups are usually weaned at 8-12 weeks of age and are then started on their summer growing ration. This should contain all the essential ingredients for development of the different tissues in the young fox. To supply these ingredients for the growth of a fox pup, it is necessary to see that good sources of animal protein in the form of meats are present in the ration. This part of the ration is further augmented by a cereal mixture containing a number of seed grains to supply a variety of plant proteins, fats, carbohydrates, minerals and vitamins. However, in carnivorous animals, these are only of secondary importance in comparison with the essential animal proteins found in the meat portion of the ration. The former should represent the greater proportion of the ration for growing fox pups.

To enable fox pups to produce bone and teeth, it is essential that their diet also contain an adequate supply of vitamins and mineral salts. Calcium and phosphorous should be supplied in proper proportions, and to bring about absorption of these substances it is necessary that the fox pups have a naturally stimulated source of vitamin D (sunlight) or be supplied with concentrated vitamin D in the ration. Cheaply available sources of these essential ingredients of the ration for growing fox pups are bonemeal or ground green bone and cod liver oil.

Adequate roughage, in the form of finely ground green grass (lawn clippings, not coarse field grasses) is an excellent and economical addition to the diet of young foxes. This portion of the ration supplies bulk to the feed which aids in maintaining good intestinal muscle tone.

It cannot be too strongly emphasized that no sudden changes should be made in the rations of fox pups at weaning time, as these cause gastric disturbances in young fox pups, often resulting in diarrhoea and a set-back in growth. Any changes made in the pup rations should be gradual and carried out very carefully to avoid the above harmful effects.

Particular care should also be taken not to handle growing fox pups in hot weather. Pilling, ear marking, or moving them to new pens should not be done after they have been fed, otherwise some pups may take fits. Whenever such operations are carried out, feeding should be delayed until afterwards, and it is advisable that the feed be cut down on that particular day.

The following is a list of the ingredients and their proportions in growing ration for fox pups. Here the fish is gradually added to the ration when the pups have reached the age of 16 weeks.

	Without Fish per cent	With Fish per cent
Tripe	20	10
Horsemeat	40	35
Liver or brains	5	5
Fish (ocean white fish)	..	15
Milk (whole cows')	10	10
Cereal (commercial)	12	12
Bran	2	2
Wheat germ	3	3
Bonemeal (commercial steamed)	2	2
Cod liver oil	½	½
Grass (lawn clippings or canned tomatoes)	2½	2½
Yeast (dried brewers')	1½	1½
Linseed meal	1	1
Iodized salt	½	½
	100 lb.	100 lb.

The pups should be fed all they can consume of the above ration once daily, late in the afternoon or evening. When these animals are watered the following morning, any remaining feed should be removed to prevent it becoming sour or fly-blown during the heat of the day.

Substitutes in Fox Rations

As a result of wartime shortage of fresh meats for animal feeds, during that period experimental work on silver foxes was chiefly confined to problems dealing with meat substitutes in the rations.

Fresh-water fish and ocean fish were used as substitutes for fresh meat in fox rations. Work with non-fatty white, ocean fish (fishblox) and cold storage ocean herring has been carried out. These fish were fed to groups of foxes under controlled conditions, at different levels, as partial and complete substitutes for the meat portion of an otherwise balanced fox ration.

Because certain species of fish are capable of destroying vitamin B_1 when they are allowed to remain mixed with the other ingredients of a fox ration over a period of time, causing a condition known as chastek paralysis, the experimental feeding was arranged so that each substitution level of both kinds of fish was duplicated, using a previously mixed feed, and one that was mixed immediately before it was fed to the foxes.

Fox pups 10 weeks old, of comparable weights, size and heredity were placed in individual pens and daily records were made of the feed consumed by each. Growth rates of the fox pups were recorded from weekly weight determinations. Condition of the stool, general health and appetite were noted, as well as the degree of external and internal parasitic infestation. The latter was checked by flotation methods at monthly intervals.

Fox pups maintained on experimental rations of fresh meat, cereal and fish (herring and fishblox replacing 50 per cent by weight of meat) showed better growth than control fox pups on rations in which no fish was substituted for fresh meat.

Among fox pups receiving cold storage ocean herring (75 and 100 per cent meat replacements in their rations) 85 per cent of the animals died during an experimental feeding period of 5-12 weeks time. Post mortem examination showed multiple gastric ulcers with hemorrhage into the intestinal tract as the commonest finding. No symptoms of the typical syndrome of chastek paralysis were noted.

Where a ration of 100 per cent herring was supplemented with 10 per cent of whole cows' milk the fox pups grew more rapidly and remained alive significantly longer than control animals receiving the same diet without milk. No

foxes died and all experimental animals grew well on the fishblox-supplemented rations (frozen ocean cod and haddock, 50 per cent replacement) as compared with growth of control foxes on fresh meat rations.

Another experiment was carried out in which "no grade" egg powder was used as a protein substitute for part of the meat of the standard ranch ration.

PHOTOGRAPHS OF FOXES SHOWING BIOTIN DEFICIENCY

The control group of fox pups (1-3) were fed exactly the same ration (fresh meat, cereal, supplemented with bonemeal, cod liver oil and milk) as the foxes below (4-6) except that in the case of the 3 experimental foxes in the lower panel, 25 per cent of their meat (by weight) was substituted by egg powder.

Groups of adult and pup foxes (6 in each group) were fed a ration in which 25, 50 and 100 per cent by weight of meat was replaced by egg powder. Comparable housing conditions, heredity and ages were established for control and experimental foxes. The daily consumption of feed was recorded and the growth rate determined from weekly weights of experimental and control foxes.

The groups of foxes receiving egg powder in their rations made good gains in body weight, exceeding the control foxes in some cases. However, after receiving the experimental egg powder ration for 12-15 weeks, pup foxes began to show characteristic symptoms of biotin deficiency, with greying and loss of fur over the body and tail, the occurrence of eye infections, grey nozzles and weakness of the limbs. Adult foxes receiving the egg powder, however, proved to be almost resistant to this deficiency. Attempts to overcome this deficiency were made by: (1) cooking the egg powder, and (2) by addition of 5 per cent brewers' yeast to the ration.

Examination of the fur of fox pups receiving the supplemented rations containing egg powder showed that the 5 per cent yeast or cooking (by autoclave, 15 lb. pressure for 15 minutes) greatly lessened the symptoms of biotin deficiency, but in some fox pups the fur still showed signs of the deficiency. Therefore egg powder is not a safe product for fox ranchers to use as a substitute for the protein of fresh meats. (Figure 4 shows control normal foxes (1-3) and (4-6) biotin-deficient foxes).

Other confirmatory evidence along this line was found in an experiment conducted to note the effect on fur colour of egg powder, autoclaved egg powder, commercial fishmeal, defatted fishmeal, iodinated milk and phenylthiourea. The results indicate that egg powder lightens the underfur even to a definite white in some cases. The autoclaved egg did not produce as light underfur. Both the commercial fishmeal and the defatted fishmeal shortened the silver bar of the guard hair. Iodinated milk and phenylthiourea stimulated the production of silver bars along the nape of the neck and on some foxes the bars were longer.

Substitute Rations

During the summers of 1944-46 an attempt to grow fox pups on a diet consisting entirely of commercial cereal containing dehydrated meats was made. In previous attempts to grow fox pups on a similar diet, significantly inferior growth and furring results were obtained in groups of experimental fox pups receiving the commercial cereal diet as compared with groups of control pups given a fresh meat ration. However, since some individual foxes made good weight gains on the ordinary commercial cereal ration, it was suspected that palatability and appetite for the dry commercial cereal might be important factors in determining the amounts of the diet eaten. Consequently, the vitamin and protein contents of the commercial cereal were increased in an attempt to raise the average growth rate of fox pups receiving this feed to approximately that of a fresh meat ration. The vitamin content (A, B and D) was increased 33 per cent and 1 per cent molasses was added to the commercial cereal to improve palatability. The animal protein content was also increased 50 per cent in an attempt to augment growth in foxes which did not like the feed and ate small amounts of it.

Experimental feeding trials were carried out with comparable groups of pup foxes receiving (1) ordinary pup grower, commercial cereal and water; (2) specially supplemented pup grower, commercial cereal and water; and (3) a standard fresh meat ration and water.

Careful records of parasitic infestation among these foxes were maintained and other factors such as housing and heredity were controlled in the experimental set-up. Daily records of the feed consumed by each group were made and from weekly body weights growth curves were established.

The findings of this experiment show: (1) that significantly better average growth occurs in fox pups fed the vitamin-protein supplemented feed, but that growth is not so rapid as that produced by a fresh meat ration; (2) that the colour of the pelts on the cereal rations is on the average better than that of the fresh meat ration; (3) that added flavouring substance acted as a temporary stimulus to appetite, but there was no significant difference in the amount of feed consumed over the summer growing season.

Digestibility of Fox Feeds

In order to make up a balanced ration for any animals it is necessary to know the amount of each nutrient in a feed that is digested and the only accurate way to measure this value is to conduct actual digestibility trials with the species of animal in question. Such data are of economic importance to ranchers interested in the scientific feeding of foxes.

The procedure with foxes is as follows:—the feed is first analysed chemically to find the percentage of each food nutrient that it contains. The animal is then fed a weighed quantity of feed, daily, for 7 days. The first 3 days are known as the preliminary period wherein the fox defecates all residues of former food and also becomes accustomed to the new feed. The following 4 days constitute the collection period. The feces from this period are collected and preserved for chemical analysis, similar to that performed on the original feed. The difference between the amount of nutrient fed and the amount found in the feces is considered as the digestible portion. The "coefficient of digestibility" is computed by dividing the quantity of a nutrient that was digested by the quantity of the same nutrient that was fed. This figure is multiplied by 100 and the result is expressed as a percentage. The coefficients of digestibility of a few feeds such as fresh beef or fresh horsemeat, which can be fed as a complete ration, are easily calculated. However, most feeds have to be fed with horsemeat to maintain palatability and the coefficients of digestibility are calculated by differences, having first determined the coefficients for horsemeat.

The application of the coefficient of digestibility has its limitations. With cereal grains it should be noted whether they are fed whole or ground, also whether raw or cooked. The variation between foxes and the variation of the same fox from one trial to another can be greatly minimized by a large number of trials.

All matter in feces does not represent undigested food. Feces always contain some waste from the body itself, such as unabsorbed residues from the bile and other digestive juices, wornout cells, mucous from the lining of the digestive tract, waste mineral matter and a high percentage of bacteria. In carnivorous animals these form a considerable portion of the feces and although they are not derived from undigested food they are an extraneous factor in the digestion of feed and are therefore legitimately considered as waste products.

The coefficient of digestibility of the dry matter of a feed is an accurate calculation and is of considerable value in making up a balanced ration, but this cannot be said for the other food nutrients. The nitrogen of the feces of foxes is mostly of body origin and not of food origin. Crude fat, (ether extract) contains waxes, resins and bile pigments besides the fat and because of the small quantity of fat in the average ration, it is difficult to accurately determine the coefficient of digestibility for this food nutrient. Practically all waste minerals are excreted in the feces and so it is impossible to obtain digestibility coefficients for the minerals of a food. Because of this fact the coefficient of digestibility of the nitrogen-free-extract is of little value as it is obtained by difference, from the coefficients of protein, crude fat, crude fibre and minerals.

The following Table No. 2 lists some of the more common feeds and rations used in the fox industry with their coefficients of digestibility:—

TABLE No. 2

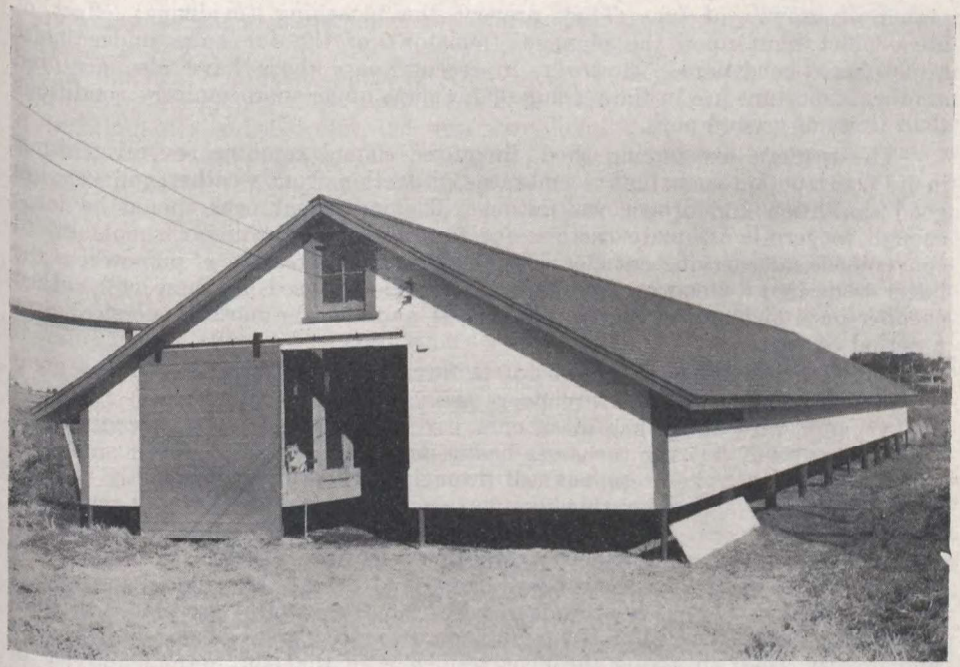
COEFFICIENTS OF DIGESTIBILITY OF VARIOUS FOX FEEDS IN PER CENT

—	Dry Matter	Protein	Crude Fat (Ether Extract)	Crude Fibre	Nitrogen-Free-Extract	No. of Analyses
Barley, ground, uncooked	63·7	41·7	50·4	4·2	72·4	4
Beef, fresh	97·4	97·8	98·7	.....	.....	16
Beef, frozen	96·1	96·9	98·1	.....	.....	16
Beef tripe, frozen	91·9	94·9	96·2	.....	.....	9
Beef lip meat, frozen	96·4	96·1	98·8	.....	.....	5
Beef hearts, frozen	95·3	95·4	97·9	.....	.....	5
Beef udders, frozen	93·8	91·9	98·3	.....	.....	5
Beef manifolds, frozen	91·0	93·3	96·0	.....	.....	4
Blood meal	54·7	61·7	71·9	.....	.....	4
Bone, ground, green	41·3	66·0	98·9	.....	.....	4
Bonemeal, steamed	15·1	40·1	88·2	.....	.....	4
Cabbage, fresh, ground	73·6	100·0	50·4	42·8	.....	4
Carrots, fresh, ground	83·3	103·9	65·6	32·4	.....	4
Fish, frozen, ground (Novascot fishblox)	75·8	95·4	70·8	.....	.....	4
Fishmeal (non-oily)	74·7	90·9	62·8	.....	.....	4
Fishmeal (oily)	61·1	69·4	93·5	.....	.....	4
Fox carcasses	84·5	91·5	98·8	.....	.....	4
Hake, fresh	89·2	96·7	90·9	.....	.....	5
Hake, frozen	87·5	96·0	95·8	.....	.....	4
Herring, frozen	91·5	96·1	98·0	.....	.....	4
Horsemeat, frozen	93·9	94·2	96·0	.....	.....	20
Lobster bodies, boiled	50·7	78·7	92·5	.....	.....	4
Meatmeal	61·1	80·2	92·5	.....	.....	4
Oats, ground, uncooked	64·3	70·7	83·2	17·0	72·7	4
Smelts, frozen	88·0	95·2	95·0	.....	.....	4
Tomatoes, canned	80·6	91·9	44·7	53·7	.....	4
Turnips, fresh, ground	30·7	65·5	69·0	33·1	.....	4
Wheat bran	33·3	58·8	43·3	14·5	26·4	4
Wheat, ground, uncooked	65·7	65·0	78·9	2·1	69·2	4
A.B.C. Marine Fox and Mink Feed	85·7	85·1	98·9	19·8	86·8	4
Hexite Fox Ration with Meat	72·8	70·3	86·4	18·3	83·8	4
Marmill Fox Feed Ration No. 2	69·7	73·7	75·9	23·1	82·0	4
Master Adult Summer Ration	73·8	76·9	83·2	19·1	85·2	4
Purina Chow	72·8	70·6	90·3	22·7	84·1	4
Ross-Miller Standard Cubes B	70·7	73·6	84·7	18·3	80·6	4
Royal Fox Meal	64·0	67·1	78·6	6·9	78·4	4
Silver Tip Standard Fox Cubes	63·0	63·5	84·4	13·0	70·8	4
Spratt's Weetmeat	87·4	75·8	38·4	11·2	92·7	4
Sunglo Growing Ration (Cubes)	62·7	71·0	82·8	14·6	.....	4
Sunglo Ration No. 2	71·2	72·4	86·4	20·1	85·5	4
Adult Ration with Raw Cereal	75·5	87·0	90·0	33·4	.....	4
Adult Ration with cooked cereal	79·5	83·3	85·2	19·7	.....	4
Pup Ration with raw cereal	65·6	82·4	91·9	31·0	.....	4
Pup Ration with cooked cereal	69·6	78·6	92·6	27·6	.....	4
Pup Ration with fishmeal and unpeeled boiled potatoes	69·5	86·5	69·9	11·1	.....	4
Adult Ration containing fishmeal and meatmeal	68·0	83·9	85·5	18·9	.....	4
Standard Growing Ration	79·6	88·0	92·7	21·3	.....	4
Standard Adult Ration	79·5	85·7	84·4	20·9	.....	4

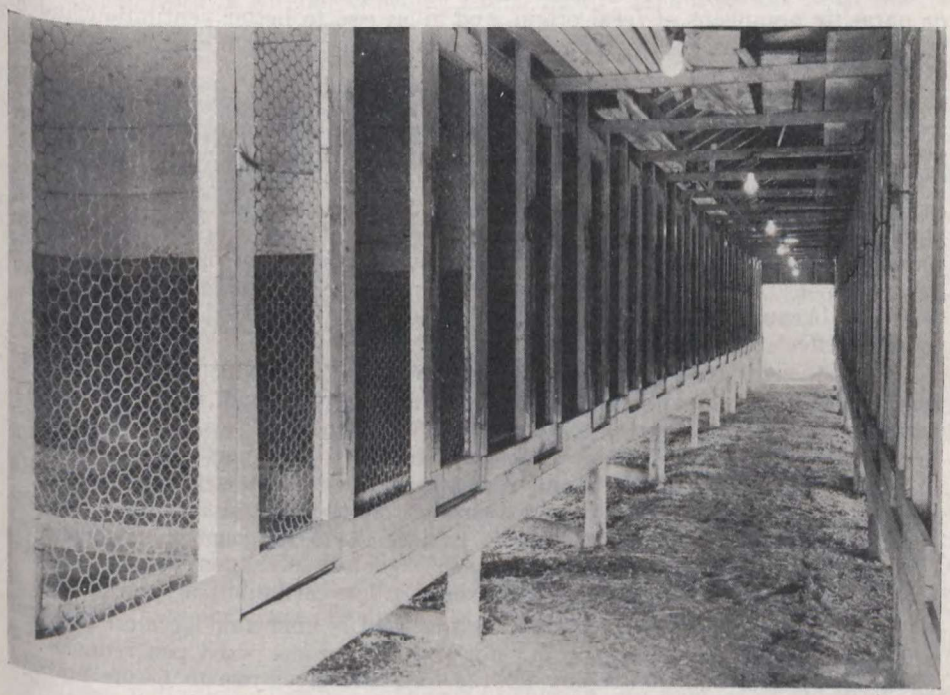
HOUSING

Considerable study has been given to the housing of foxes in captivity. The trend in modern fox pens is to reduce their size and maintain smaller numbers of animals in each pen.

However, the essential part of the housing of foxes is now carried out in furring sheds. These, as their name implies, were primarily introduced into the fox ranching industry to protect foxes from the sun and rain during the



A modern fox furring shed.



Interior of same furring shed, showing construction of individual pens.

period of growth of fur. They prevent the bleaching (oxidizing) effect of ultra-violet light upon the pigment (melanin) of the fur hairs under moist atmospheric conditions. However, in recent years sheds have also acquired another important use in the rearing of fox pups under more sanitary conditions than those of ground pens.

The modern fox furring shed, therefore, should combine several features in its construction such that it embraces protection from weather and supplies good sanitation and proper ventilation. The individual pens should be large enough to permit adequate exercise for fox pups and the design should afford convenience for carrying out cleaning, feeding and the rearing of pups where the latter is desired. Good quality materials should be used, as these will outlast cheaper ones and reduce future repair costs and thus be more economical over a period of years.

Sanitation is an important factor in furring sheds. Wire floors are a great aid in this respect. Where wire floors are used they should be constructed of heavy gauge wire of 1½-inch mesh or 1 x 2 inch welded wire. In conjunction with this type of flooring the cross beams and side boards of the pens should be bevelled so that the droppings fall through the flooring quite readily without any obstruction. Some fox ranchers make a board run (2 ft. wide) across the middle of their pens. They feel that this board runway causes the foxes to exercise more and maintain better condition. However, there is a danger here that the foxes will lie on these board floors and defeat the original purpose of the wire flooring. If heavy strands of wire (No. 9 soft wire) are placed beneath the wire flooring they hold it up an inch from the cross beams of the floor and greatly assist in giving the floor resiliency so that the normal activity of the foxes causes all fecal material to fall through. Wire flooring constructed in this way practically eliminates the possibility of infection from bacterial or parasitic organisms of fecal origin, and gives rise to better ventilation and a cooler shed in hot weather. Smooth wire should be selected to eliminate chafing of the fur in foxes.

It is also a good plan to line the insides of the shed pens with galvanized iron to a height of 2½ feet from the floor. This eliminates the chewing of wooden structures and further reduces chafing and injury through the wire partitions. The remainder of the partition between fox pens is usually constructed of 3 feet of fine mesh wire and board above that. The wire portion of this partition should be of chain link of ½-¾ inch mesh wire so that the foxes cannot get their paws or tongues through it, otherwise these will be bitten off by animals in adjacent pens. Wire partitions between the pens are preferable to a solid board partition because they offer better ventilation and the added visibility has a quieting effect upon the foxes.

Proper ventilation in a shed is essential to the production of good fur texture. If the furring shed is placed on a high dry ground, especially in dry windy climates, and exposed to the wind the fur on the foxes will become too dry. Therefore, it is advisable to build a fox shed in a north-south direction unless the prevailing winds would indicate otherwise. However, good results can be obtained in a shed three or four feet off the ground if hinged wooden shutters or factory cotton are used to protect the foxes from rain, snow and excessive under draught. The latter type of structure offers considerably greater ease in cleaning beneath the pens than those in low set buildings.

Size of the individual pens in a furring shed is important because this can affect the general well-being of the fox pups. A proper sized pen reduces fur chewing, fighting and quarrelling for the feed and gives rise to better fur and body condition.

Many designs of feeders and watering devices are used by different ranchers to good advantage. Two kinds are worthy of description, namely: (1) a pail (well tapered to prevent bursting with ice in cold weather) suspended by a wire from the ceiling approximately 1 foot from the front of the pen. This type eliminates spilled water and torn wire, but it also has the defect of being unsuitable for small pups and the water becomes stagnant unless the pail is cleaned regularly. (2) The second type of watering device is one in which a pan with a lip or projection from it projects through a board into the fox pen. From this smaller projection of 2 x 3 inches the fox drinks. The reservoir pan rests on a shelf outside the pen and is 6 x 9 inches and 3 inches in depth. This pan can be placed low in the pen for the convenience of small pup foxes and is readily filled without going into the fox pen. It should have bevelled sides to counteract the effect of ice formation in it.

Several good feeding devices are also in operation in furring sheds. One of the best practical types, which can be readily cleaned, is constructed from a 4-inch board covered with galvanized iron so that a trough is formed with the pen wire between the two 4-inch metal-covered boards. The board outside the pen is hinged so that it can be let down and thoroughly cleaned. This type of feeder is relatively expensive to instal, but it will give longer and better service than the majority of other types.

Where shelves are used in wire-bottomed pens they should also be made with wire or slats and be so constructed as to be removable.

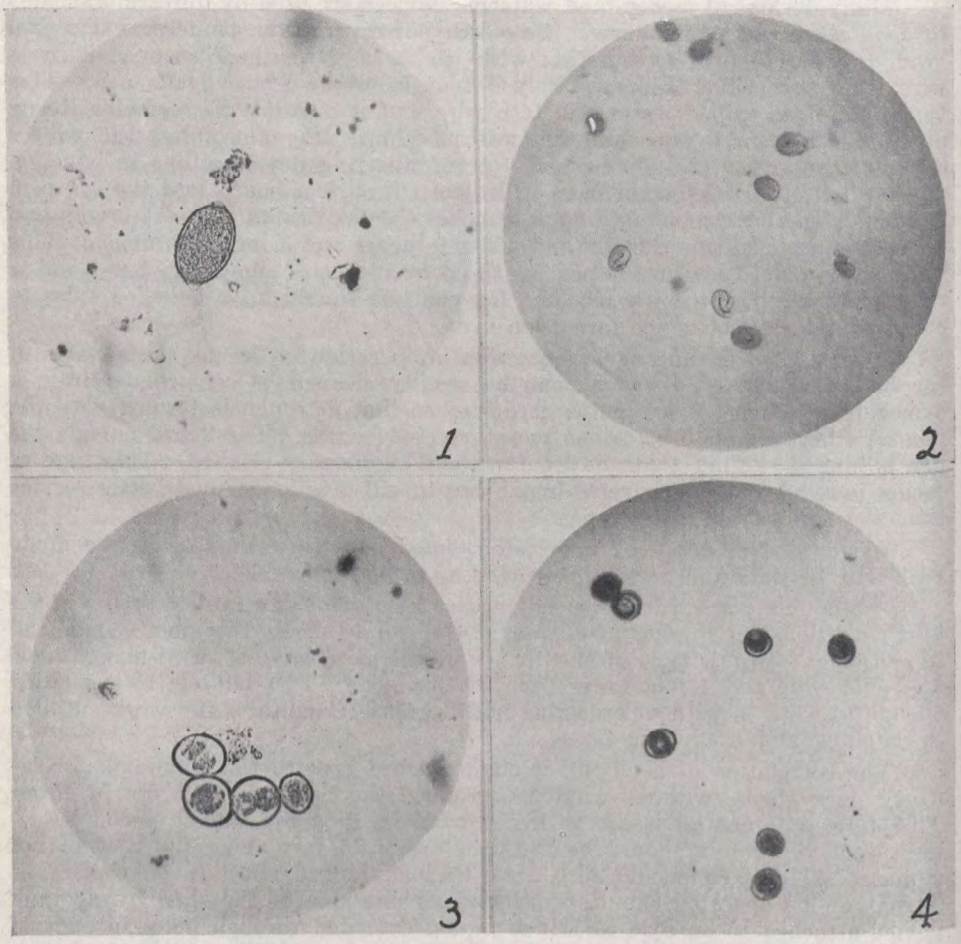
The double-row shed with pens on each side of a central aisle produces the best conditions for furring foxes and at the same time is the most economical to construct. In this type of shed it is convenient to have a board-floored aisle 4½-5 feet wide and 1 foot lower than the fox pens. This built-in aisle is wide enough to work in without crowding and it greatly facilitates the work entailed in catching and examining foxes.

The correlation of good fur colour and shed construction shows that relatively dark sheds, without windows, produce the best coloured fur in foxes. Therefore, it is not advisable to instal windows in a fox furring shed. However, roof ventilators should be installed every 25 feet along the roof in hot climates. The shed should also have 24-inch hinged shutters on each side. These can be operated simultaneously along one side of the shed by a crank device attached to an axle to 1 inch piping extended through holes in ends of protruding rafters continuing out from the roof to about 2½ feet. Each shutter is connected by a light chain to the pipe and when the pipe is operated by the crank at the end of the shed all the shutters on one side of the shed can be opened to any extent or closed by a single operation.

FOX PARASITES

Parasitic infestation in foxes is a major factor in causing heavy financial losses in fox ranches through the detrimental effects upon fox fur, general lowering of the vitality of the stoek and as a result of deaths from this cause.

Fox parasites are usually recognized as forms of animal life which live within (endoparasites) or upon the outer body surface (ectoparasites) of the fox (the host) at the expense of these fur bearers. Some parasitic forms are relatively harmless to foxes, whereas others may cause physical injury or a weakened, anaemic condition by blood sucking and the production of injurious toxins. In young foxes, parasites do great damage by retarding growth and even causing death. The effects in adults are more chronic in nature, giving rise to a lowered state of resistance to other diseases in conjunction with poor fertility and a dry, lustreless condition of the fur. In pregnant vixens the cause of abortion has, in some cases, been traced to heavy parasitic infestation.



COCCIDIA AND OVA OF FOX ENDOPARASITIC WORMS

1. Fox Lungworm Egg (*Crenosoma decoratum*).
2. Fox Hookworm Eggs (*Uncinaria stenocephala*).
3. Fox Coccidia (*Isospora bigemina*).
4. Fox Ascarid Eggs (*Toxocara canis*).

The external or ectoparasites found on foxes are:—fleas (*Ctenocephalus canis*) and earmites (*Otodectes cynotis*) and less frequently skin mange (*Sarcoptes scabiei*) and lice (*Dinogenathus setosus*), the latter parasitic form has chiefly been found on Greenland and Alaskan blue foxes. Among the internal or endoparasites which infest foxes, roundworm (*Toxocara canis and Toxascaris limbata*), hookworm (*Uncinaria stenocephala*) and lungworm (*Capillaria aerophilla* and *Crenosoma decoratum*) are the most common forms, while less frequently bladderworm (*Capillaria plica*) tapeworms (*Diphyllobothrium latum*), *Taenia serialis, T. pisiformis and Dipylidium caninum*), flukes (*Alaria spp. Cryptocotyle spp.* and *Metochis spp.*) and coccidia (*Isospora bigemina*) have been found to occur in ranch-bred foxes.

A careful check for such external parasites as fleas and earmties should be carried out as routine practice on fox ranches with the onset of hot weather (June) and again in late autumn (December) well in advance of the breeding season.

Fleas and DDT

Of the external parasites of foxes, fleas are very detrimental to their general health and well being through irritation and they make the animals thin and anaemic as a result of their blood sucking habits. Fleas can be readily detected on foxes by examination of the fur at the back of the head and neck where the insects tend to congregate. Here the fur becomes granular and matted with their excrement. They can often be seen on infested foxes by parting the fur and examining this region under a good light.

The life cycle of the dog flea (*Ctenocephalus canis*) commonly found on the fox, is such that reproduction takes place from flea eggs in the litter of the fox pen where the ova hatch into larval forms. The latter go through a resting phase and emerge as adult fleas, which reinfest the foxes. It is, therefore, just as important, when treating flea-infested foxes with powdered pyrethrum, derris root or DDT, to also clean out the pens and spray them with kerosene or fuel oil. This destroys the larvae and acts as a repellent to adult fleas. Care should be taken, however, not to allow the oil to come in contact with the foxes, their feed or drinking water. The pens should not be used for a few days until the oil has dried into the wood. Light dry soil and sandy ground in fox pens permit fleas to thrive and under such conditions greater care and more frequent treatment of the soil will be required to control infestation of foxes. Light spraying of the ground with fuel oil, strong salt (table salt) solution or borax have been used to good advantage in counteracting the effects of sandy soil.

Further exploratory work in the control of flea infestation in foxes using the insecticide DDT has been carried out to determine the extent and safety with which this new insecticide can be used on fur ranches. The DDT used was in powder form (Geigy's A10 Neocid) containing 10 per cent DDT. This was also employed as a flea powder in experimental groups of 20 adult and 20 pup foxes. Splendid results were obtained in the eradication of fleas and no deleterious effects were detected in the fur and skin or upon the health of treated foxes. Other studies were also carried out in which a watery solution was painted on the surfaces of fox pen doors and outer surfaces of feed boards to determine its controlling effect upon the number of flies in a large fox shed. A very noticeable decrease in the number of flies for over a period of 6 weeks duration followed a single application of DDT.

The ground of fox pens infested with hookworm larvae was also treated with DDT to determine whether or not the substance could be used to control hookworm infestation in such clay bottom fox pens. Measured estimates of hookworm infestation in groups of foxes housed in treated and untreated fox pens showed no significant difference.

A study of the minimum lethal dosage of Geigy's 10 per cent DDT for foxes showed that it was relatively non-toxic for foxes. Graded doses of 0·5 to 10·0 grams of the above powder were mixed in the feed and fed to groups of adult and pup foxes. The latter were 6 months of age. In the case of the largest dose employed, 10 grams (containing 1 gram of pure DDT) 6 foxes were each given this dosage without any of them showing symptoms of poisoning. These findings are in close agreement with those of other investigators who have studied the toxic effects of DDT in sheep, pigs and horses.

Phenothiazine

In the study of anthelmintics for the control of fox parasites, the efficiency of phenothiazine was tested for the expulsion of fox endoparasitic worms.

In this experimental work (1) tests were made to determine the qualitative and quantitative infestation in samples of feces collected on three consecutive days in 20 foxes. (2) No change was made in the rations of the foxes receiving the phenothiazine. (3) The dose of 10 grams of phenothiazine was added to the diet. (4) Examination of all feces passed for 5 days was carried out with identification of all parasites excreted. (5) At termination of the period (the critical test) post mortem examination of the 20 foxes was performed and any parasitic worms present were identified and counted. These numbers were included as estimation of the efficiency of the drug.

The percentage of efficiency of phenothiazine as a fox intestinal, parasitic worm anthelmintic was based upon the total number of worms recovered from the feces and from the carcass.

The above procedure was kindly outlined by Dr. W. E. Swales, Institute of Parasitology, Macdonald College, Que.

The experimental findings showed that phenothiazine did not seriously affect the health of the foxes nor interfere with the foxes taking their rations. It was readily eaten and no adverse symptoms were noticed in the group of experimental animals receiving the drug. Only one fox showed enteritis at post mortem examination. However, the drug was only 24·4 per cent efficient in the expulsion of ascarid worms from adult foxes out of a total of 45 worms recorded. In one carcass at post mortem, hookworms were recovered quite alive after treatment with the phenothiazine.

The above findings agree with those of previous work carried out upon the effects of phenothiazine in the treatment of endoparasites of carnivorous animals.

Prenatal Ascarid Larval Infestation

Among the internal parasites which inhabit the intestinal canal of foxes, some forms are particularly prevalent and dangerous to young foxes. On the other hand, the adult fox may develop a strong degree of resistance to many of these parasitic forms and their larvae.

One of the most common fox parasites is the roundworm or ascarid worm (*Toxocara canis*). The mature worms are four to five inches in length and appear creamy white in colour. They lay very large numbers of eggs which are passed out with the feces. These are enclosed in a tough shell which makes them very difficult to kill by drying, freezing, disinfectants, or heat. Foxes become infested by eating contaminated feed or licking eggs which have adhered to their fur. The egg, when swallowed, develops into a larval form which bores through the intestinal wall and traverses the liver and lungs before it is coughed up and swallowed into the intestinal tract again, where the mature worm develops. Ascarid worms do not attach themselves to the intestinal wall of the fox, but lie in the cavity of the intestine and derive their nourishment by absorption of the digesting food, causing intestinal obstruction and possibly giving off toxins which are detrimental to the foxes.

This is a particularly dangerous parasite to young foxes. When vixens harbour these parasites (which more frequently is the case with pup females) and they are not treated for roundworms when the danger of reinfestation is past in the autumn after the snow and cold weather come, with a 16 minim Tetrachlorethylene pill, the young foxes in the uterus of a pregnant vixen may become infested with larvae before they are born. This gives the worms a head start on the young pups, causing their growth to be stunted and also lowers their resistance to pneumonia, while the larvae traverse their lung tissues. Such

pups appear to have dry, lustreless fur and may have a somewhat bloated, hard abdomen. From experimental work and observations it was found that if adequate treatment is not administered at an early age (2-4 minims of oil of chenopodium in pill form at 2-3 weeks of age) in sufficient strength to remove most of the worms, when the second treatment is given 10 days later the worms may have increased in number and size to such an extent that the anthelmintic merely paralyzes some of the parasites in the front end of the gut. As many as 120 worms were found plugging the lumen of the gut in one fox pup. These become pushed back by the rhythmic movements of the intestine and plug the cavity of the gut, often killing the fox. Late and inadequate initial treatment of young pups infested with ascarid worms is an important cause of deaths on fox ranches each year.

When foxes are heavily infested with these worms they usually appear unthrifty. Their appetite is spasmodic and the fur is usually dry and lacks the gloss or sheen of a healthy animal. This condition is caused by the interference with the normal movement of the food through the intestines and possibly by the absorption of poisonous substances produced by the worms.

Detection of Parasitic Ova

The detection of the presence of intestinal parasites is carried out by examination of the droppings for worms or parasitic eggs. To find and identify the eggs, a microscope is necessary with a minimum magnification of approximately 100 diameters. The procedure is as follows:—(1) clinically significant cases may be detected by a simple fecal smear on a microscope slide, while a more detailed examination may be carried out by (2) the flotation method: half an ounce of the stool from the fox to be examined is placed in a half-pint bottle with 3-4 tablespoonsful of salt solution (dissolve 1 lb. table salt in a quart of water) and broken up as thoroughly as possible. The bottle is then filled with salt solution and allowed to stand 10-16 hours. Worm eggs float to the surface of the salt solution in the bottle and can conveniently be transferred to a slide by means of a glass rod or pencil. The latter is brought into contact with the surface of the salt solution and the small drops that adhere to it are transferred to a microscopic slide. A cover slide is placed over the droplets before they are examined under the microscope.

The ability to identify ova of the different species of parasitic worms can be readily acquired with the aid of photomicrographs, or directly from samples where the assistance of the fox fieldman is available. Periodic examinations of fox feces for the presence of parasites should be made at definite intervals of time, the length of the periods depending upon the amount of infestation in the particular ranch. Examinations should be made in December or just after the final freeze-up and again in the spring during the month of May and early in July. These checks should be routine on every ranch and others should be carried out at intervals between these where the foxes are heavily infested with parasitic worms.

MARITIME FOX ILLUSTRATION STATIONS

The Maritime Fox Illustration Stations were established in 1938 in the three Maritime Provinces. Three Stations were located in each of the provinces of Nova Scotia and New Brunswick and two in Prince Edward Island. From 1941, these Stations have been under the supervision of the Dominion Experimental Fox Ranch, Summerside, P.E.I. Later the Stations at Truro and Antigonish, Nova Scotia, and at Fredericton, New Brunswick, were discontinued, but the one at Fredericton has since been replaced and a new Station has been established at Meteghan, Nova Scotia.

The specific requirements of fox ranchers vary somewhat with respect to the availability of different feedstuffs, transportation, refrigeration facilities and other problems peculiar to the district in which the Illustration Stations are located.

The size of these Stations and the numbers of foxes maintained in them approximate those kept in the average small ranches throughout these provinces.

As the name implies, the Illustration Stations are chiefly testing grounds to demonstrate improved methods of housing, feeding, breeding and parasite control, with the attending improvements of the breeding stock, production, sanitary conditions and particularly to show the increased pelt values accruing from such methods in operation. Through the visits of individual ranchers to the Stations, advertising methods and periodic field days, the findings of the Stations are disseminated.

Annual inspections of the Maritime Fox Illustration Stations are carried out for the purpose of a detailed check-up on housing conditions, grounds of the ranch, conditions of the stock, pups and adults, to note any new stock introduced, sickness and deaths during the year, breeding systems in operation, rations, kinds of cereal, meats and the relative proportions, availability and cost of ingredients and average pelt prices received during the preceding year; to record the number of visitors to the Station during the year and to determine the attitude of the operator toward his work, as well as to note any new help at the Station.

During the past 9 years these Stations have been in existence, great improvements in housing conditions and selection of breeding stock have been made. The latter has brought about a greatly improved standard of breeding stock and has resulted in a much better class of pelts being produced on the Illustration Stations.

Better housing methods, with wire-bottomed pens and covered shed arrangement of the umbrella design, used on the Illustration Stations, have given rise to such obvious improvement in sanitation and colour of the fur in foxes maintained in these pens, that they have been widely adopted in the districts in which the Illustration Stations have been placed.

Parasite control on such wire-floored pens has become a minor difficulty in the raising of foxes in contrast to the former extensive losses incurred from this source when the animals were reared on ground or board floors formerly common throughout the Maritime Provinces prior to the establishment of the Fox Illustration Stations. The wide adoption of wire-floored type of fox pen construction throughout the districts surrounding the Illustration Stations has done much to decrease the annual losses from parasitic infestation and to greatly increase the general sanitation in the Maritime fox ranches.

However, one of the greatest achievements of the Fox Illustration Stations since their inception is the marked improvement in the fur quality of Station foxes as a result of the introduction of outstanding sires into these ranches, combined with better selection and breeding methods.

Higher pelt prices have been obtained at nearly all Stations, and the many winnings at live fox shows are indicative of this marked improvement in breeding stock. The good example of the advances to be made through breed improvement has not been confined to the operators of these Stations and to the improvement of the stock of these Stations alone, for at nearly all Stations the operators have reported sales of large numbers of animals to neighbouring ranchers for breeding purposes.

Although housing and nutrition are important in production and general well-being of the foxes, definite breed advancement has made a much greater contribution to the improvements that are evident at the different Stations.

The variation is dietary ingredients used at the different Illustration Stations shows that considerable difference can exist in the types of feed used and the quantities of wholesome feedstuffs that can be given to foxes with desirable results, with the exception possibly of during the furring season, when the dietary requirements of these animals become relatively more exacting. This wide variation in fox feeds, which cannot readily be eliminated from the procedure adopted at the Illustration Stations because of the differences in availability of feedstuffs in the districts surrounding the different Stations, serves also as a control to demonstrate that good fox pelts can be produced from a variety of meats and cereal products.

The advantages of the improved housing method on parasite control, production of clear coloured pelts, and the improvement in breeding stock, for the most part, have been incorporated into the remainder of the fox ranch, where the Illustration Station forms only a part of the whole ranching program.

LIST OF NUMBERS AND TITLES OF ACTIVE EXPERIMENTAL PROJECTS AT DOMINION EXPERIMENTAL FOX RANCH.

NUTRITION:

A. *PROJECT No. N S 2 (901)*

The Effect of Processing upon the Digestibility of Fox Feeds.

BREEDING:

B. *PROJECT No. R G 1 (903)*

The Efficiency of Breeding Systems and Combinations of Such Methods (Linebreeding) with Foxes.

PARASITES:

C. *PROJECT No. P G 1 (908)*

The Control of Parasitic Infestation in Foxes under Standard Ranching Methods.

HOUSING:

D. *PROJECT No. H G 1 (910)*

Methods of Housing Foxes.

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